Appendix F-1

Mojave River Watershed Water Quality Management Plan for
Amrapur Stoddard Wells, Victorville, CA

Ware Malcomb

April 22, 2022

MOJAVE RIVER WATERSHED

Water Quality Management Plan

For:

Amrapur Stoddard Wells, Victorville, CA

16716 STODDARD WELLS ROAD, VICTORVILLE, CA 92394

GRADING PERMIT NO. (TBD), BUILDING PERMIT NO. (TBD), TRACT NUMBER, LAND DEVELOPMENT FILE NO. (TBD), APN 0472-181-11-0-000, 0472-181-12-0-000, 0472-181-13-0-000, 0472-181-43-0-000, 0472-181-44-0-000, 0472-181-47-0-000, & 0472-181-72-0-000

Prepared for:

Suraj Victorville, LLC

1560 E. 6th Street, Suite 101

Corona, CA 92879

(714) 893-8808

Prepared by:

Ware Malcomb

10 Edelman

Irvine, CA 92618

(949)-660-9128

Submittal Date: **04/22/2022**

Revision No. and Date: _____

Revision No. and Date: _____

Revision No. and Date: _____

Revision No. and Date: _____

Revision No. and Date: _____

Final Approval Date:______________________

Project Owner's Certification

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

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

Project Data			
Permit/Application Number(s):	TBD	Grading Permit Number(s):	TBD
Tract/Parcel Map Number(s):	Parcels 1 through 7	Building Permit Number(s):	TBD
CUP, SUP, and/or APN (Specify Lot Numbers if Portions of Tract):			0472-181-11-0-000, 0472-181-12-0-000, 0472-181-13-0-000, 0472-181-43-0-000, 0472-181-44-0-000, 0472-181-47-0-000, & 0472-181-72-0-000

Owner's Signature			
Owner Name: Kevin Wadhwani			
Title	Chief Executive Officer		
Company	Suraj Victorville, LLC		
Address	1560 E. 6th Street, Suite 101, Corona, CA 92879		
Email	kevin@amrapur.com		
Telephone #	714-893-8808 x212		
Signature		Date	

Preparer's Certification

Project Data			
Permit/Application Number(s):	TBD	Grading Permit Number(s):	TBD
Tract/Parcel Map Number(s):	Parcels 1 through 7	Building Permit Number(s):	TBD
CUP, SUP, and/or APN (Specify Lot Numbers if Portions of Tract):			0472-181-11-0-000, 0472-181-12-0-000, 0472-181-13-0-000, 0472-181-43-0-000, 0472-181-44-0-000, 0472-181-47-0-000, & 0472-181-72-0-000

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

Engineer: Lucas Corsbie, PE		PE Stamp Below
Title	Regional Director	REGISTERED PROFESSIONAL ENGINEER LUCAS A. CORSBIE No. 72588 CIVIL STATE OF CALIFORNIA
Company	Ware Malcomb	
Address	10 Edelman, irvine, CA 92618	
Email	lcorsbie@waremalcomb.com	
Telephone #	949.660.9128 x1159	
Signature	Lucas Corsbie	
Date	03/03/22	

Table of Contents

Forms

Section I – Introduction

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

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

Section 1 Discretionary Permit(s)

<table>
<tr><th colspan="6">Form 1-1 Project Information</th></tr>
<tr><td colspan="2">Project Name</td><td colspan="4">Amrapur Stoddard Wells, Victorville, CA</td></tr>
<tr><td colspan="2">Project Owner Contact Name:</td><td colspan="4">Suraj Victorville, LLC</td></tr>
<tr><td>Mailing Address:</td><td>1560 E. 6th Street, Suite 101, Corona, CA 92879</td><td>E-mail Address:</td><td>kevin@amrapur.com</td><td>Telephone:</td><td>714-893-8808 x212</td></tr>
<tr><td colspan="2">Permit/Application Number(s):</td><td>TBD</td><td>Tract/Parcel Map Number(s):</td><td colspan="2">Parcels 1 through 7</td></tr>
<tr><td colspan="2">Additional Information/ Comments:</td><td colspan="4">N/A</td></tr>
<tr><td colspan="2">Description of Project:</td><td colspan="4">This project proposes the construction of a new industrial warehouse building, parking areas, covered truck docks, loading stalls, landscaping, and utilities on approximately 39.8 acres of undeveloped land.
The proposed project site area will be considered as a single drainage area.
Runoff will be conveyed via proposed curb and gutters and captured by proposed inlets throughout the site. Trench drains will capture runoff from the proposed truck docks. Runoff will then be conveyed via proposed private storm drain to a proposed underground infiltration BMP for pollutant control and hydromodification control. Runoff from larger storm events will overflow and discharge at the project site's outall along the western property line.
In the existing condition, there is a culvert that conveys offsite flows from Stoddard Wells Road into an existing onsite earthen channel. In the proposed condition, the culvert will be piped into a storm drain to convey the offsite flows to the outfall along the southern property line as in the existing condition. This is to prevent the comingling of onsite and offsite flows.</td></tr>
</table>

Provide summary of Conceptual WQMP conditions (if previously submitted and approved). Attach complete copy.	Not applicable, this is a Conceptual WQMP.

Section 2 Project Description

2.1 Project Information

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

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

2.1.1 Project Sizing Categorization

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

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

<table>
<tr><th colspan="6">Form 2.1-1 Description of Proposed Project</th></tr>
<tr><td colspan="6">1 Regulated Development Project Category (Select all that apply):</td></tr>
<tr><td colspan="2">☒ #1 New development involving the creation of 5,000 ft² or more of impervious surface collectively over entire site</td><td>☐ #2 Significant re-development involving the addition or replacement of 5,000 ft² or more of impervious surface on an already developed site</td><td colspan="2">☐ #3 Road Project – any road, sidewalk, or bicycle lane project that creates greater than 5,000 square feet of contiguous impervious surface</td><td>☐ #4 LUPs – linear underground/overhead projects that has a discrete location with 5,000 sq. ft. or more new constructed impervious surface</td></tr>
<tr><td colspan="6">☐ Site Design Only (Project Total Square Feet > 2,500 but < 5,000 sq.ft.) Will require source control Site Design Measures. Use the “PCMP” Template. Do not use this WQMP Template.</td></tr>
<tr><td>2 Project Area (ft2):</td><td>1,734,234</td><td>3 Number of Dwelling Units:</td><td>N/A</td><td>4 SIC Code:</td><td>TBD</td></tr>
<tr><td colspan="6">5 Is Project going to be phased? Yes ☐ No ☒ If yes, ensure that the WQMP evaluates each phase as a distinct DA, requiring LID BMPs to address runoff at time of completion.</td></tr>
</table>

2.2 Property Ownership/Management

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

Form 2.2-1 Property Ownership/Management
Describe property ownership/management responsible for long-term maintenance of WQMP stormwater facilities:
The property owner will contract with a third-party maintenance group or be directly responsible for the long-term maintenance of WQMP stormwater facilities for the privately-owned property. Property Owner: Suraj Victorville, LLC Name: Kevin Wadhwani Address: 1560 E. 6th Street, Suite 101, Corona, CA 92879 Contact Information: (714) 893-8808 "Property owner shall be responsible for BMP operation and maintenance until the property is transferred or sold."

2.3 Potential Stormwater Pollutants

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

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

Form 2.3-1 Pollutants of Concern

Pollutant	Please check: E=Expected, N=Not Expected		Additional Information and Comments
Pathogens (Bacterial / Virus)	E ☒	N ☐	Petroleum hydrocarbons (Commercial/Industrial Development). Bacterial indicators (Parking Lots).
Nutrients - Phosphorous	E ☒	N ☐	Landscaping (Commercial/Industrial Development & Parking Lots).
Nutrients - Nitrogen	E ☒	N ☐	Landscaping (Commercial/Industrial Development & Parking Lots).
Noxious Aquatic Plants	E ☒	N ☐	Landscaping (Commercial/Industrial Development & Parking Lots).
Sediment	E ☒	N ☐	Landscaping (Commercial/Industrial Development & Parking Lots).
Metals	E ☒	N ☐	
Oil and Grease	E ☒	N ☐	
Trash/Debris	E ☒	N ☐	
Pesticides / Herbicides	E ☒	N ☐	
Organic Compounds	E ☒	N ☐	Landscaping (Commercialy/Industrial Development). Solvents (Commercial/Industrial Development). Petroleum hydrocarbons (Parking Lots).
Other: Oxygen Demanding Compounds	E ☒	N ☐	Landscaping (Commercial/Industrial Development & Parking Lots).
Other:	E ☐	N ☐	
Other:	E ☐	N ☐	

Section 3 Site and Watershed Description

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

Form 3-1 Site Location and Hydrologic Features

Site coordinates *take GPS measurement at approximate center of site*	Latitude 34° 33' 35.4348" N	Longitude 117° 17' 29.8176" W	Thomas Bros Map page N/A

[1] San Bernardino County climatic region: ☒ Desert

[2] Does the site have more than one drainage area (DA): Yes☐ No☒ *If no, proceed to Form 3-2. If yes, then use this form to show a conceptual schematic describing DMAs and hydrologic feature connecting DMAs to the site outlet(s). An example is provided below that can be modified for proposed project or a drawing clearly showing DMA and flow routing may be attached*

Conveyance	Briefly describe on-site drainage features to convey runoff that is not retained within a DMA
DA1 DMA C flows to DA1 DMA A	*Ex. Bioretention overflow to vegetated bioswale with 4' bottom width, 5:1 side slopes and bed slope of 0.01. Conveys runoff for 1000' through DMA 1 to existing catch basin on SE corner of property*
DA1 DMA A to Outlet 1	
DA1 DMA B to Outlet 1	
DA2 to Outlet 2	

Form 3-2 Existing Hydrologic Characteristics for Drainage Area 1

For Drainage Area 1's sub-watershed DMA, provide the following characteristics	DMA A	DMA B	DMA C	DMA D
1 DMA drainage area (ft^2)	429,136	445,093	860,005	
2 Existing site impervious area (ft^2)	0	0	0	
3 Antecedent moisture condition *For desert areas, use http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_map.pdf*	I	I	I	
4 Hydrologic soil group *Refer to County Hydrology Manual Addendum for Arid Regions – http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_addendum.pdf*	A	A	A	
5 Longest flowpath length (ft)	1722.9	1576	1860.3	
6 Longest flowpath slope (ft/ft)	0.0300	0.0329	0.0216	
7 Current land cover type(s) *Select from Fig C-3 of Hydrology Manual*	Barren	Barren	Barren	
8 Pre-developed pervious area condition: *Based on the extent of wet season vegetated cover good >75%; Fair 50-75%; Poor <50%* ***Attach photos of site to support rating***	Poor (10%)	Poor (25%)	Poor (30%)	

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

Form 3-3 Watershed Description for Drainage Area	
Receiving waters Refer to SWRCB site: http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml	Mojave River (Upper Narrows to Lower Narrows) Mojave River (Mojave Forks Reservoir Outlet to Upper Narrows) West Fork Mojave River below Silverwood Lake Silverwood Lake
Applicable TMDLs *http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml*	Mojave River (Upper Narrows to Lower Narrows): No Applicable TMDLs Mojave River (Mojave Forks Reservoir Outlet to Upper Narrows): No Applicable TMDLs West Fork Mojave River below Silverwood Lake: No Applicable TMDLs Silverwood Lake: No Applicable TMDLs
303(d) listed impairments *http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml*	Mojave River (Upper Narrows to Lower Narrows): Oxygen (Dissolved), Fluoride, Sulfates, Total Dissolved Solids, Manganese, & Sodium Mojave River (Mojave Forks Reservoir Outlet to Upper Narrows): Sulfates, Fluoride, & Sodium West Fork Mojave River below Silverwood Lake: Chloride, Sodium, Sulfates, & Total Dissolved Solids Silverwood Lake: Mercury & PCBs
Environmentally Sensitive Areas (ESA) *Refer to Watershed Mapping Tool – http://sbcounty.permitrack.com/WAP*	Burrowing Owl Mojave Ground Squirrel (ST) (FE) Desert Tortoise - Medium Population
Hydromodification Assessment	☒ Yes *Complete Hydromodification Assessment. Include Forms 4.2-2 through Form 4.2-5 and Hydromodification BMP Form 4.3-9 in submittal* ☐ No

Section 4 Best Management Practices (BMP)

4.1 Source Control BMPs and Site Design BMP Measures

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

4.1.1 Source Control BMPs

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

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

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

Form 4.1-1 Non-Structural Source Control BMPs

Identifier	Name	Check One: Included	Check One: Not Applicable	Describe BMP Implementation OR, if not applicable, state reason
N1	Education of Property Owners, Tenants and Occupants on Stormwater BMPs	☒	☐	Information materials will be provided to the property owner/responsible party on general housekeeping practices to contribute to the protection of stormwater BMPs.
N2	Activity Restrictions	☒	☐	Vehicle and equipment washing, vehicle and equipment maintenance and repair, fuel dispensing, outdoor processing, and food preparation activities are prohibited on-site.
N3	Landscape Management BMPs	☐	☐	Comply with local ordinances as they relate to the usage of fertilizer and/or pesticide usage.
N4	BMP Maintenance	☒	☐	The property owner will take responsibility of the O&M as outlined in this report or assign responsibility to a property management company.
N5	Title 22 CCR Compliance (How development will comply)	☒	☐	Comply with hazardous waste management requirements as applicable to the tenant's operations on-site.
N6	Local Water Quality Ordinances	☐	☒	Comply with local water quality ordinances.
N7	Spill Contingency Plan	☒	☐	Building operator shall develop for specific occupancies and will include stockpiling of cleanup materials, notification of responsible agencies, disposal of cleanup materials, documentation, etc.
N8	Underground Storage Tank Compliance	☐	☒	No underground storage tanks are proposed.
N9	Hazardous Materials Disclosure Compliance	☒	☐	Comply with local ordinances of all enforcing agencies for management of hazardous materials.

Form 4.1-1 Non-Structural Source Control BMPs

Identifier	Name	Check One		Describe BMP Implementation OR, if not applicable, state reason
		Included	Not Applicable	
N10	Uniform Fire Code Implementation	☒	☐	Comply with Article 80 of the Uniform Fire Code.
N11	Litter/Debris Control Program	☒	☐	Implement trash management and litter control procedures in the common areas to reduce pollution of drainage water.
N12	Employee Training	☒	☐	Provide an education program by preparing manual(s) for site maintenance.
N13	Housekeeping of Loading Docks	☒	☐	Loading docks to be kept clear of trash and debris to ensure safe and swift ingress and egress of docking vehicles.
N14	Catch Basin Inspection Program	☒	☐	Inspect, clean, and maintain drainage facilities on weekly basis.
N15	Vacuum Sweeping of Private Streets and Parking Lots	☒	☐	Vacuum sweep all paved areas on a weekly basis.
N16	Other Non-structural Measures for Public Agency Projects	☐	☒	Not a public agency project.
N17	Comply with all other applicable NPDES permits	☒	☐	Comply with SWPPP and other applicable NPDES permits.

Form 4.1-2 Structural Source Control BMPs

Identifier	Name	Check One: Included	Check One: Not Applicable	Describe BMP Implementation OR, If not applicable, state reason
S1	Provide storm drain system stencilling and signage (CASQA New Development BMP Handbook SD-13)	☒	☐	Provide stencilling at all catch basins and inlets. Reapply as needed.
S2	Design and construct outdoor material storage areas to reduce pollution introduction (CASQA New Development BMP Handbook SD-34)	☐	☒	Outdoor material storage areas are not proposed.
S3	Design and construct trash and waste storage areas to reduce pollution introduction (CASQA New Development BMP Handbook SD-32)	☒	☐	Provide trash and waste storage areas for adequate collection and removal of waste from the site.
S4	Use efficient irrigation systems & landscape design, water conservation, smart controllers, and source control (Statewide Model Landscape Ordinance; CASQA New Development BMP Handbook SD-12)	☒	☐	Employ rain shutoff devices to prevent irrigation after precipitation. Design irrigation systems to each landscape area's specific water requirements. Design timing and application methods to minimize the runoff of excess irrigation. Group plants with similar water requirements. Use mulches in planter areas without ground cover. Install planter materials appropriate for the location and in accordance with the amount of sunlight and climate. Use native planter material where possible, and choose plants that minimize or eliminate the use of fertilizer or pesticides.
S5	Finish grade of landscaped areas at a minimum of 1-2 inches below top of curb, sidewalk, or pavement	☒	☐	Finished grade of all landscaped areas shall be 1-2 inches below top of curb or sidewalk.
S6	Protect slopes and channels and provide energy dissipation (CASQA New Development BMP Handbook SD-10)	☐	☒	No slopes or channels are proposed.
S7	Covered dock areas (CASQA New Development BMP Handbook SD-31)	☒	☐	Loading dock areas will not be covered. Instead, trench drains are proposed at the low points of truck docks to capture stormwater.

S8	Covered maintenance bays with spill containment plans (CASQA New Development BMP Handbook SD-31)	☐	☒	No maintenance bays are proposed.
S9	Vehicle wash areas with spill containment plans (CASQA New Development BMP Handbook SD-33)	☐	☒	No vehicle wash areas are proposed.
S10	Covered outdoor processing areas (CASQA New Development BMP Handbook SD-36)	☐	☒	No outdoor processing areas are proposed.

Form 4.1-2 Structural Source Control BMPs

Identifier	Name	Check One		Describe BMP Implementation OR, If not applicable, state reason
		Included	Not Applicable	
S11	Equipment wash areas with spill containment plans (CASQA New Development BMP Handbook SD-33)	☐	☒	No equipment wash areas are proposed.
S12	Fueling areas (CASQA New Development BMP Handbook SD-30)	☐	☒	No fueling areas are proposed.
S13	Hillside landscaping (CASQA New Development BMP Handbook SD-10)	☐	☒	No hillside landscaping is proposed.
S14	Wash water control for food preparation areas	☐	☒	Food preparation areas are not proposed.
S15	Community car wash racks (CASQA New Development BMP Handbook SD-33)	☐	☒	Community car wash racks are not proposed.

4.1.2 Site Design BMPs

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

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

Describe site design and drainage plan including:

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

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

Form 4.1-3 Site Design Practices Checklist
Site Design Practices *If yes, explain how preventative site design practice is addressed in project site plan. If no, other LID BMPs must be selected to meet targets*
Minimize impervious areas: Yes ☐ No ☒ Explanation:
Maximize natural infiltration capacity; Including improvement and maintenance of soil: Yes ☐ No ☒ Explanation:
Preserve existing drainage patterns and time of concentration: Yes ☒ No ☐ Explanation: The proposed drainage pattern will mimic the existing drainage pattern of the site.
Disconnect impervious areas. Including rerouting of rooftop drainage pipes to drain stormwater to storage or infiltration BMPs instead of to storm drain : Yes ☐ No ☒ Explanation:
Use of Porous Pavement.: Yes ☐ No ☒ Explanation:
Protect existing vegetation and sensitive areas: Yes ☐ No ☒ Explanation:
Re-vegetate disturbed areas. Including planting and preservation of drought tolerant vegetation. : Yes ☒ No ☐ Explanation: A landscaping plan will be provided to indicate proposed areas for re-vegetation.
Minimize unnecessary compaction in stormwater retention/infiltration basin/trench areas: Yes ☒ No ☐ Explanation: BMPs will be located in areas not subject to frequent soil compaction.

Utilize naturalized/rock-lined drainage swales in place of underground piping or imperviously lined swales: Yes ☐ No ☒ Explanation:
Stake off areas that will be used for landscaping to minimize compaction during construction : Yes ☒ No ☐ Explanation: Proposed areas for landscaping will be staked off and preserved during the construction process.
Use of Rain Barrels and Cisterns, Including the use of on-site water collection systems.: Yes ☐ No ☒ Explanation:
Stream Setbacks. Includes a specified distance from an adjacent steam: : Yes ☐ No ☒ Explanation:

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

San Bernardino County Special Districts:

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

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

Mojave Water Agency:

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

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

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

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

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

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

4.2 Treatment BMPs

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

4.2.1 Project Specific Hydrology Characterization

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

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

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

Methods applied in the following forms include:

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

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

Form 4.2-1 LID BMP Performance Criteria for Design Capture Volume (DA 1)		
1 Project area DA 1 (ft^2): 1,734,234	2 Imperviousness after applying preventative site design practices (Imp%): 86.4%	3 Runoff Coefficient (Rc): _0.680 *R_c = 0.858(Imp%)^3-0.78(Imp%)^2+0.774(Imp%)+0.04*
4 Determine 1-hour rainfall depth for a 2-year return period $P_{2yr-1hr}$ (in): 0.373 http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html		
5 Compute P_6, Mean 6-hr Precipitation (inches): 0.461 *P_6 = Item 4 *C_1, where C_1 is a function of site climatic region specified in Form 3-1 Item 1 (Desert = 1.2371)*		
6 Drawdown Rate *Use 48 hours as the default condition. Selection and use of the 24 hour drawdown time condition is subject to approval by the local jurisdiction. The necessary BMP footprint is a function of drawdown time. While shorter drawdown times reduce the performance criteria for LID BMP design capture volume, the depth of water that can be stored is also reduced.*		24-hrs ☐ 48-hrs ☒
7 Compute design capture volume, DCV (ft^3): 88,932 *DCV = 1/12 * [Item 1* Item 3 *Item 5 * C_2], where C_2 is a function of drawdown rate (24-hr = 1.582; 48-hr = 1.963)* *Compute separate DCV for each outlet from the project site per schematic drawn in Form 3-1 Item 2*		

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

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

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

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

Condition	Runoff Volume (ft^3)	Time of Concentration (min)	Peak Runoff (cfs)
Pre-developed	1 119,616 *Form 4.2-3 Item 12*	2 14.965 *Form 4.2-4 Item 13*	3 54.38 *Form 4.2-5 Item 10*
Post-developed	4 248,123 *Form 4.2-3 Item 13*	5 8.101 *Form 4.2-4 Item 14*	6 87.98 *Form 4.2-5 Item 14*
Difference	7 *128,507* *Item 4 – Item 1*	8 *6.864* *Item 2 – Item 5*	9 *33.60* *Item 6 – Item 3*
Difference (as % of pre-developed)	10 *107.4%* *Item 7 / Item 1*	11 *45.9%* *Item 8 / Item 2*	12 *61.8%* *Item 9 / Item 3*

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

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

5 Pre-Developed area-weighted CN:	**7** Pre-developed soil storage capacity, S (in): 2.821 *S = (1000 / Item 5) - 10*	**9** Initial abstraction, I_a (in): 0.564 *I_a = 0.2 * Item 7*
6 Post-Developed area-weighted CN:	**8** Post-developed soil storage capacity, S (in): 1.236 *S = (1000 / Item 6) - 10*	**10** Initial abstraction, I_a (in): 0.247 *I_a = 0.2 * Item 8*

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

12 Pre-developed Volume (ft^3): 119,616
*V_{pre} =(1 / 12) * (Item sum of Item 3) * [(Item 11 – Item 9)^2 / ((Item 11 – Item 9 + Item 7)*

13 Post-developed Volume (ft^3): 248,123
*V_{pre} =(1 / 12) * (Item sum of Item 3) * [(Item 11 – Item 10)^2 / ((Item 11 – Item 10 + Item 8)*

14 Volume Reduction needed to meet hydromodification requirement, (ft^3): 128,507
*Vhydro = (Item 13 * 0.95) – Item 12*

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

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

Variables	Pre-developed DA1 *Use additional forms if there are more than 4 DMA*				Post-developed DA1 *Use additional forms if there are more than 4 DMA*			
	DMA A	DMA B	DMA C	DMA D	DMA A	DMA B	DMA C	DMA D
1 Length of flowpath (ft) *Use Form 3-2 Item 5 for pre-developed condition*								
2 Change in elevation (ft)								
3 Slope (ft/ft), S_o *= Item 2 / Item 1*								
4 Land cover								
5 Initial DMA Time of Concentration (min) *Appendix C-1 of the TGD for WQMP*								
6 Length of conveyance from DMA outlet to project site outlet (ft) *May be zero if DMA outlet is at project site outlet*								
7 Cross-sectional area of channel (ft^2)								
8 Wetted perimeter of channel (ft)								
9 Manning's roughness of channel (n)								
10 Channel flow velocity (ft/sec) $V_{fps} = (1.49 / \text{Item } 9) * (\text{Item } 7/\text{Item } 8)^{0.67} * (\text{Item } 3)^{0.5}$								
11 Travel time to outlet (min) $T_t = \text{Item } 6 / (\text{Item } 10 * 60)$								
12 Total time of concentration (min) $T_c = \text{Item } 5 + \text{Item } 11$								
13 Pre-developed time of concentration (min): 14.965 *Minimum of Item 12 pre-developed DMA*								
14 Post-developed time of concentration (min): 8.101 *Minimum of Item 12 post-developed DMA*								
15 Additional time of concentration needed to meet hydromodification requirement (min): 6.116 $T_{C\text{-}Hydro} = (\text{Item } 13 * 0.95) – \text{Item } 14$								

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

Compute peak runoff for pre- and post-developed conditions

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

8 Pre-developed Q_p at T_c for DMA A: *Q_p = Item 6_{DMAA} + [Item 6_{DMAB} * (Item 1_{DMAA} - Item 5_{DMAB})/(Item 1_{DMAB} - Item 5_{DMAB})* Item $7_{DMAA/2}$] + [Item 6_{DMAC} * (Item 1_{DMAA} - Item 5_{DMAC})/(Item 1_{DMAC} - Item 5_{DMAC})* Item $7_{DMAA/3}$]*	9 Pre-developed Q_p at T_c for DMA B: *Q_p = Item 6_{DMAB} + [Item 6_{DMAA} * (Item 1_{DMAB} - Item 5_{DMAA})/(Item 1_{DMAA} - Item 5_{DMAA})* Item $7_{DMAB/1}$] + [Item 6_{DMAC} * (Item 1_{DMAB} - Item 5_{DMAC})/(Item 1_{DMAC} - Item 5_{DMAC})* Item $7_{DMAB/3}$]*	10 Pre-developed Q_p at T_c for DMA C: *Q_p = Item 6_{DMAC} + [Item 6_{DMAA} * (Item 1_{DMAC} - Item 5_{DMAA})/(Item 1_{DMAA} - Item 5_{DMAA})* Item $7_{DMAC/1}$] + [Item 6_{DMAB} * (Item 1_{DMAC} - Item 5_{DMAB})/(Item 1_{DMAB} - Item 5_{DMAB})* Item $7_{DMAC/2}$]*
10 Peak runoff from pre-developed condition confluence analysis (cfs): 54.38 *Maximum of Item 8, 9, and 10 (including additional forms as needed)*		
11 Post-developed Q_p at T_c for DMA A: *Same as Item 8 for post-developed values*	12 Post-developed Q_p at T_c for DMA B: *Same as Item 9 for post-developed values*	13 Post-developed Q_p at T_c for DMA C: *Same as Item 10 for post-developed values*
14 Peak runoff from post-developed condition confluence analysis (cfs): 87.98 *Maximum of Item 11, 12, and 13 (including additional forms as needed)*		
15 Peak runoff reduction needed to meet Hydromodification Requirement (cfs): 33.60 *$Q_{p-hydro}$ = (Item 14 * 0.95) – Item 10*		

4.3 BMP Selection and Sizing

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

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

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

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

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

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

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

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

4.3.1 Exceptions to Requirements for Bioretention Facilities

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

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

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

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

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

4.3.2 Site Design BMP

Section E.12.e. of the Small Phase II MS4 Permit emphasizes the use of LID preventative measures; and the use of Site Design Measures reduces the portion of the DCV that must be addressed in downstream BMPs. Therefore, all applicable Site Design Measures shall be provided except where they are mutually exclusive with each other, or with other BMPs. Mutual exclusivity may result from overlapping BMP footprints such that either would be potentially feasible by itself, but both could not be implemented. Please note that while there are no numeric standards regarding the use of Site Design BMPs. If a project cannot feasibly meet BMP sizing requirements or cannot fully address hydromodification, feasibility of all applicable Site Design BMPs must be part of demonstrating that the BMP system has been designed to retain the maximum feasible portion of the DCV. Complete Form 4.3-2 to identify and calculate estimated retention volume from implementing site design BMP. Refer to Section 5.4 in the TGD for more detailed guidance.

Form 4.3-2 Site Design BMPs (DA 1)

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

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

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

4.3.3 Infiltration BMPs

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

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

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

4.3.3.1 Allowed Variations for Special Site Conditions

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

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

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

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

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

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

1 Remaining LID DCV not met by site design BMP (ft^3): 88,932 *V_{unmet} = Form 4.2-1 Item 7 - Form 4.3-2 Item19*

BMP Type *Use columns to the right to compute runoff volume retention from proposed infiltration BMP (select BMP from Table 5-4 in TGD for WQMP) - Use additional forms for more BMPs*	DA 1 DMA ABC BMP Type Underground Infiltration	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
2 Infiltration rate of underlying soils (in/hr) *See Section 5.4.2 and Appendix C of the TGD for WQMP for minimum requirements for assessment methods*	22.18		
3 Infiltration safety factor *See TGD Section 5.4.2 and Appendix D*	4.125		
4 Design percolation rate (in/hr) *P_{design} = Item 2 / Item 3*	5.38		
5 Ponded water drawdown time (hr) *Copy Item 6 in Form 4.2-1*	48		
6 Maximum ponding depth (ft) *BMP specific, see Table 5-4 of the TGD for WQMP for BMP design details*	21.52		
7 Ponding Depth (ft) *d_{BMP} = Minimum of (1/12*Item 4*Item 5) or Item 6*	21.52		
8 Infiltrating surface area, SA_{BMP} (ft^2) *the lesser of the area needed for infiltration of full DCV or minimum space requirements from Table 5.7 of the TGD for WQMP*	4,133		
9 Amended soil depth, d_{media} (ft) *Only included in certain BMP types, see Table 5-4 in the TGD for WQMP for reference to BMP design details*	N/A		
10 Amended soil porosity	N/A		
11 Gravel depth, d_{media} (ft) *Only included in certain BMP types, see Table 5-4 of the TGD for WQMP for BMP design details*	N/A		
12 Gravel porosity	1		
13 Duration of storm as basin is filling (hrs) *Typical ~ 3hrs*	3		
14 Above Ground Retention Volume (ft^3) *$V_{retention}$ = Item 8 * [Item7 + (Item 9 * Item 10) + (Item 11 * Item 12) + (Item 13 * (Item 4 / 12))]*	0		
15 Underground Retention Volume (ft^3) *Volume determined using manufacturer's specifications and calculations*	129,381		

16 Total Retention Volume from LID Infiltration BMPs: 129,381 *(Sum of Items 14 and 15 for all infiltration BMP included in plan)*

17 Fraction of DCV achieved with infiltration BMP: 145.5% *Retention% = Item 16 / Form 4.2-1 Item 7*

18 Is full LID DCV retained onsite with combination of hydrologic source control and LID retention/infiltration BMPs? Yes ☒ No ☐
If yes, demonstrate conformance using Form 4.3-10; If no, then reduce Item 3, Factor of Safety to 2.0 and increase Item 8, Infiltrating Surface Area, such that the portion of the site area used for retention and infiltration BMPs equals or exceeds the minimum effective area thresholds (Table 5-7 of the TGD for WQMP) for the applicable category of development and repeat all above calculations.

4.3.4 Biotreatment BMP

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

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

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

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

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

Form 4.3-5 Volume Based Biotreatment (DA 1) – Bioretention and Planter Boxes with Underdrains			
Biotreatment BMP Type *(Bioretention w/underdrain, planter box w/underdrain, other comparable BMP)*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
1 Pollutants addressed with BMP *List all pollutant of concern that will be effectively reduced through specific Unit Operations and Processes described in Table 5-5 of the TGD for WQMP*			
2 Amended soil infiltration rate *Typical ~ 5.0*			
3 Amended soil infiltration safety factor *Typical ~ 2.0*			
4 Amended soil design percolation rate (in/hr) *P_{design} = Item 2 / Item 3*			
5 Ponded water drawdown time (hr) *Copy Item 6 from Form 4.2-1*			
6 Maximum ponding depth (ft) *see Table 5-6 of the TGD for WQMP for reference to BMP design details*			
7 Ponding Depth (ft) *d_{BMP} = Minimum of (1/12 * Item 4 * Item 5) or Item 6*			
8 Amended soil surface area (ft^2)			
9 Amended soil depth (ft) *see Table 5-6 of the TGD for WQMP for reference to BMP design details*			
10 Amended soil porosity, *n*			
11 Gravel depth (ft) *see Table 5-6 of the TGD for WQMP for reference to BMP design details*			
12 Gravel porosity, *n*			
13 Duration of storm as basin is filling (hrs) *Typical ~ 3hrs*			
14 Biotreated Volume (ft^3) *$V_{biotreated}$ = Item 8 * [(Item 7/2) + (Item 9 * Item 10) +(Item 11 * Item 12) + (Item 13 * (Item 4 / 12))]*			
15 Total biotreated volume from bioretention and/or planter box with underdrains BMP: *Sum of Item 14 for all volume-based BMPs included in this form*			

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

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

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

4.3.5 Conformance Summary

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

Form 4.3-8 Conformance Summary and Alternative Compliance Volume Estimate (DA 1)
1 Total LID DCV for the Project DA-1 (ft^3): 88,932 *Copy Item 7 in Form 4.2-1*
2 On-site retention with site design BMP (ft^3): 0 *Copy Item18 in Form 4.3-2*
3 On-site retention with LID infiltration BMP (ft^3): 129,381 *Copy Item 16 in Form 4.3-3*
4 On-site biotreatment with volume based biotreatment BMP (ft^3): N/A *Copy Item 3 in Form 4.3-4*
5 Flow capacity provided by flow based biotreatment BMP (cfs): N/A *Copy Item 6 in Form 4.3-4*
6 LID BMP performance criteria are achieved if answer to any of the following is “Yes”: • Full retention of LID DCV with site design or infiltration BMP: Yes ☒ No ☐ *If yes, sum of Items 2, 3, and 4 is greater than Item 1* • Combination of on-site retention BMPs for a portion of the LID DCV and volume-based biotreatment BMP that address all pollutants of concern for the remaining LID DCV: Yes ☐ No ☒ *If yes, a) sum of Items 2, 3, 4, and 5 is greater than Item 1, and Items 2, 3 and 4 are maximized; or b) Item 6 is greater than Form 4.3--5 Item 6 and Items 2, 3 and 4 are maximized* ▪ On-site retention and infiltration is determined to be infeasible; therefore biotreatment BMP provides biotreatment for all pollutants of concern for full LID DCV: Yes ☐ No ☒ *If yes, Form 4.3-1 Items 7 and 8 were both checked yes*
7 If the LID DCV is not achieved by any of these means, then the project may be allowed to develop an alternative compliance plan. Check box that describes the scenario which caused the need for alternative compliance: • Combination of Site Design, retention and infiltration, , and biotreatment BMPs provide less than full LID DCV capture: ☐ *Checked yes if Form 4.3-4 Item 7is checked yes, Form 4.3-4 Item 6 is zero, and sum of Items 2, 3, 4, and 5 is less than Item 1. If so, apply water quality credits and calculate volume for alternative compliance, V_{alt} = (Item 1 – Item 2 – Item 3 – Item 4 – Item 5) * (100 - Form 2.4-1 Item 2)%* • Facilities, or a combination of facilities, of a different design than in Section E.12.e.(ii)(f) may be permitted if all of the following Phase II Small MS4 General Permit 2013-0001-DWQ 55 February 5, 2013 measures of equivalent effectiveness are demonstrated: 1) Equal or greater amount of runoff infiltrated or evapotranspired; ☐ 2) Equal or lower pollutant concentrations in runoff that is discharged after biotreatment; ☐ 3) Equal or greater protection against shock loadings and spills; ☐ 4) Equal or greater accessibility and ease of inspection and maintenance. ☐

4.3.6 Hydromodification Control BMP

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

<table>
<tr><th colspan="2">Form 4.3-9 Hydromodification Control BMPs (DA 1)</th></tr>
<tr><td>1 Volume reduction needed for hydromodification performance criteria (ft³): 128,507
(Form 4.2-2 Item 4 * 0.95) – Form 4.2-2 Item 1</td><td>2 On-site retention with site design and infiltration, BMP (ft³): 129,381 Sum of Form 4.3-8 Items 2, 3, and 4. Evaluate option to increase implementation of on-site retention in Forms 4.3-2, 4.3-3, and 4.3-4 in excess of LID DCV toward achieving hydromodification volume reduction</td></tr>
<tr><td>3 Remaining volume for hydromodification volume capture (ft³): 0 Item 1 – Item 2</td><td>4 Volume capture provided by incorporating additional on-site BMPs (ft³): 0</td></tr>
<tr><td colspan="2">5 Is Form 4.2-2 Item 11 less than or equal to 5%: Yes ☐ No ☒
If yes, hydromodification performance criteria is achieved. If no, select one or more mitigation options below:
• Demonstrate increase in time of concentration achieved by proposed LID site design, LID BMP, and additional on-site BMP ☒
• Increase time of concentration by preserving pre-developed flow path and/or increase travel time by reducing slope and increasing cross-sectional area and roughness for proposed on-site conveyance facilities ☐</td></tr>
<tr><td colspan="2">6 Form 4.2-2 Item 12 less than or equal to 5%: Yes ☐ No ☒
If yes, hydromodification performance criteria is achieved. If no, select one or more mitigation options below:
• Demonstrate reduction in peak runoff achieved by proposed LID site design, LID BMPs, and additional on-site retention BMPs ☒</td></tr>
</table>

4.4 Alternative Compliance Plan (if applicable)

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

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

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

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

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

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

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

Section 5 Inspection and Maintenance Responsibility for Post Construction BMP

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

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

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

BMP	Reponsible Party(s)	Inspection/ Maintenance Activities Required	Minimum Frequency of Activities
Treatment BMP	Owner	Inspection Activities 1) Inspect isolator row for sediment. If upon visual inspection sediment has accumulated, insert a stadia rod to determine the average depth of sediment. If average depth of sediment exceeds 3 inches, clean-out should be performed. Maintenance Activities 1) Apply multiple passes of JetVac until backflush water is clean. Vacuum manhole sump as required. 2) Replace all caps, lid covers, record observations, and actions. 3) Clean catch basins and manholes upstream of system. Refer to the manufacterer's operation and maintenance manual.	Inspect prior to and at least four times per year during the rainy season (October 1^{st} to April 30^{th}) and within 24 hours after at least two storm events greater than or equal to 0.5 inches. Maintain as needed.
N1	Owner	Owner, tenants, and contracted personnel are distributed approprirate materials via contract language, mailings, website, or meetings. Refer	Information provided to owners upon sale

		to Appendix C for Educational Materials specific for this site.	or lease. Reminders are set or posted annually.
N2	Owner	Vehicle and equipment washing, vehicle and equipment maintenance and repair, fuel dispensing outdoor processing, and food preparation activities are prohibited on-site.	Ongoing
N3	Owner	Comply with local ordinances as it relates to the usage of fertilizer and/or pesticide usage. Verify that the irrigation system is working properly. Check for broken sprinkler heads and verify proper coverage. Adjust valve run times to avoid over-watering and/or ponding in landscape areas.	Inspect and maintain weekly.
N4	Owner	Owner to provide maintenance of BMPs per requirements of the WQMP and O&M Plan.	Ongoing
N5	Owner	Comply with Hazardous Waste Management requirements as applicable to the operations at the facility.	Ongoing
N6	Owner	Comply with Local Water Quality Ordinances	Ongoing
N7	Owner	Building operator to develop for specific occupancies and will include stockpiling of cleanup materials, notification of responsible agencies, disposal of cleanup materials, documentation, etc.	Ongoing

Form 5-1 BMP Inspection and Maintenance (use additional forms as necessary)			
BMP	Reponsible Party(s)	Inspection/ Maintenance Activities Required	Minimum Frequency of Activities
N9	Owner	Comply with County/City ordinances on Hazardous Materials Disclosure	Ongoing
N10	Owner	Comply with Article 80 of the Uniform Fire Code	Ongoing
N11	Owner	Litter/Debris control may be included with landscaping maintenance or with waste disposal services. Check for and clean up litter and debris on-site.	Inspect and maintain weekly.
N12	Owner	Conduct training sessions on stormwater quality. Should include but not limited to: 1) Good housekeeping practices 2) Maintenance requirements 3) Material Management Practices 4) Visual observations for evidence of stormwater impacts (illicit discharges) and BMP function 5) Spill Prevention and Response 6) Location of the facility's BMPs, catch basins, spill kits, and drains	Annually and/or within 30 days of employee start date
N13	Owner	Provide regular cleaning of loading dock areas with a program of sweeping and litter control. Spills and broken containers should be cleaned immediately. Wash water should not be used.	Regular cleaning weekly. Clean up spills immediately.

N14	Owner	Owner to provide for inspection of common area catch basins. Clear inlets of trash, debris, and silt.	Inspect weekly and after rain events. Regular maintenance as needed but once a year at minimum.
N15	Owner	Vacuum sweep all paved areas.	Weekly.
N17	Owner	Comply with SWPPP requirements during construction and any other NPDES permits.	Ongoing

Form 5-1 BMP Inspection and Maintenance (use additional forms as necessary)			
BMP	Reponsible Party(s)	Inspection/ Maintenance Activities Required	Minimum Frequency of Activities
S1	Owner	Verifiy legibility of prohibitive language markers and signs at storm drain inlets and catch basins. Replace and/or refresh as needed.	Inspect monthly and replace as needed but no less than every five years.
S3	Owner	Owner to provide for regular maintenance and cleaning of trash and waste storage areas. Check that outdoor waste storage structure is consistently covered, structural stability is sound, and that no run-on or contact of the trash with runoff is occurring. Repair leaks or damages and mitigate if trash is coming into contact with stormwater, as needed. Check that trash is removed by the local waste management contractor.	Regular cleaning weekly and maintain as needed.
S4	Owner	Owner to provide for inspection of irrigation systems and connections for deficiencies. Correct deficiencies as needed.	Inspect weekly and maintain as needed.
S5	Owner	Check that finish grade of all landscaped areas are 1-2 inches below top of curb, sidewalk, or pavement. Regrade and replant as necessary.	Inspect weekly and maintain as needed.
S7	Owner	Ensure that loading docks are clean from litter and debris. Prevent the use of wash water in loading dock areas. Clean up spills immediately.	Regular cleaning weekly. Clean up spills immediately.

Section 6 WQMP Attachments

6.1. Site Plan and Drainage Plan

Include a site plan and drainage plan sheet set containing the following minimum information:

- Project location
- Site boundary
- Land uses and land covers, as applicable
- Suitability/feasibility constraints
- Structural Source Control BMP locations
- Site Design Hydrologic Source Control BMP locations
- LID BMP details
- Drainage delineations and flow information
- Drainage connections

6.2 Electronic Data Submittal

Minimum requirements include submittal of PDF exhibits in addition to hard copies. Format must not require specialized software to open. If the local jurisdiction requires specialized electronic document formats (as described in their Local Implementation Plan), this section will describe the contents (e.g., layering, nomenclature, geo-referencing, etc.) of these documents so that they may be interpreted efficiently and accurately.

6.3 Post Construction

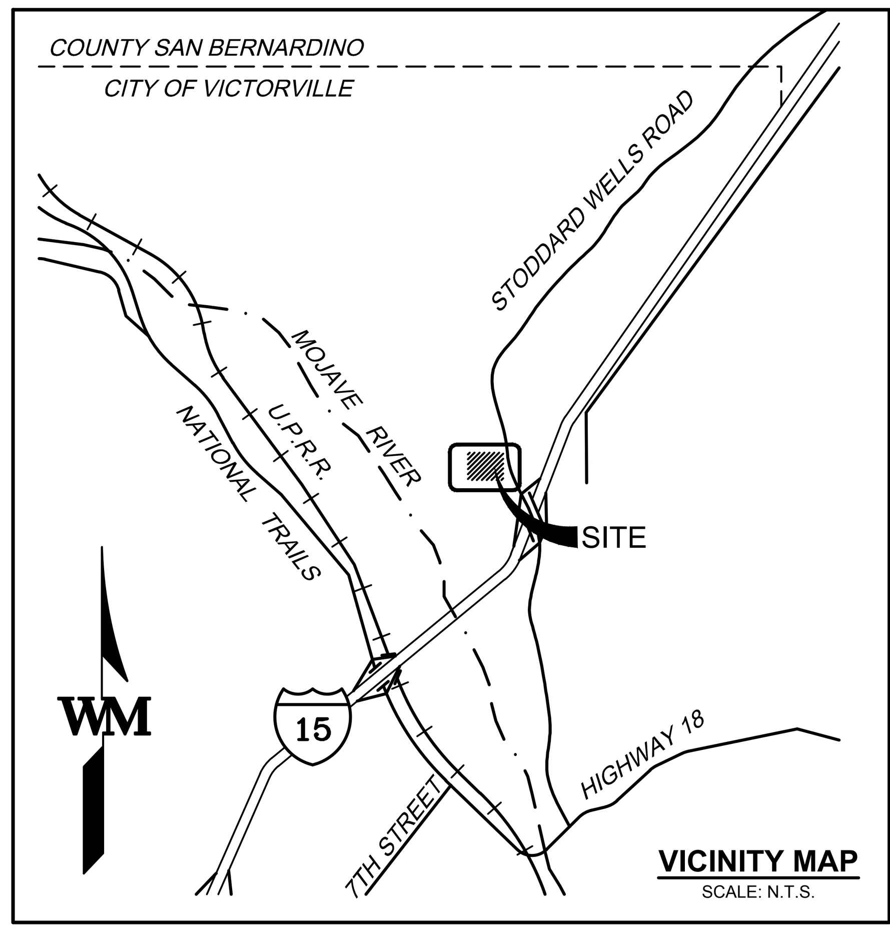
Attach all O&M Plans and Maintenance Agreements for BMP to the WQMP.

6.4 Other Supporting Documentation

- BMP Educational Materials
- Activity Restriction – C,C&R's & Lease Agreements

Appendix A - WQMP Exhibit

CAUTION: IF THIS SHEET IS NOT 24"x36" IT IS A REDUCED PRINT



VICINITY MAP
SCALE: N.T.S.

NON-STRUCTURAL SOURCE CONTROL BMPS:

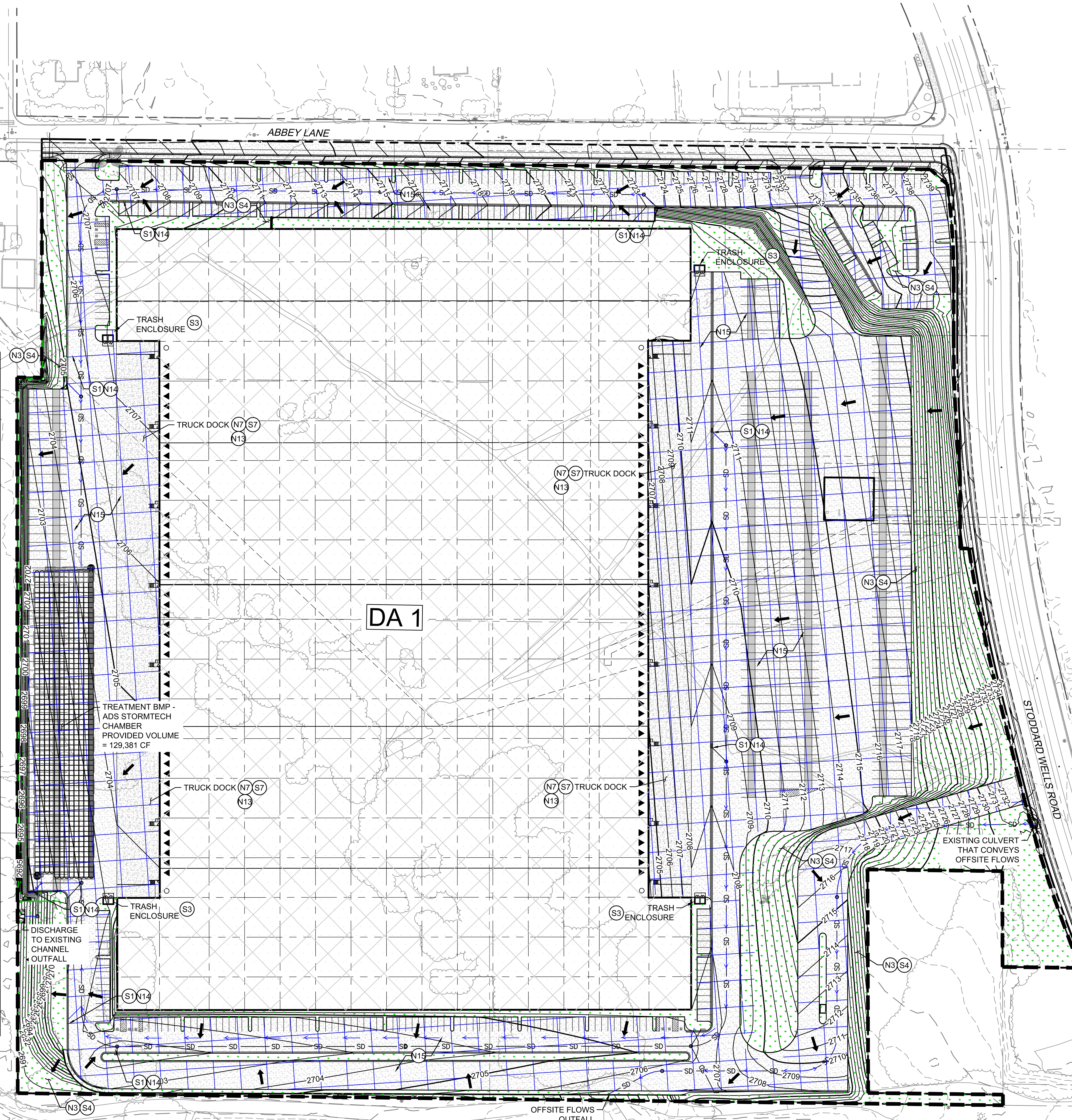
- N1 EDUCATION OF PROPERTY OWNERS, TENANTS, AND OCCUPANTS ON STORMWATER BMPS (NOT SHOWN)
- N2 ACTIVITY RESTRICTIONS - NOT SHOWN, APPLIES TO WHOLE SITE
- N3 LANDSCAPE MANAGEMENT BMP'S.
- N4 BMP MAINTENANCE - NOT SHOWN, APPLIES TO ALL BMP'S.
- N5 TITLE 22 CCR COMPLIANCE - NOT SHOWN, APPLIES TO WHOLE SITE
- N6 LOCAL WATER QUALITY ORDINANCES - NOT SHOWN, APPLIES TO WHOLE SITE
- N7 SPILL CONTINGENCY PLAN
- N9 HAZARDOUS MATERIALS DISCLOSURE COMPLIANCE - NOT SHOWN, APPLIES TO WHOLE SITE
- N10 UNIFORM FIRE CODE IMPLEMENTATION - NOT SHOWN, APPLIES TO WHOLE SITE
- N11 LITTER/DEBRIS CONTROL PROGRAM - NOT SHOWN, APPLIES TO WHOLE SITE
- N12 EMPLOYEE TRAINING - NOT SHOWN, APPLIES TO WHOLE SITE
- N13 HOUSEKEEPING OF LOADING DOCKS
- N14 CATCH BASIN INSPECTION PROGRAM
- N15 VACUUM SWEEPING OF PRIVATE STREETS AND PARKING LOTS
- N17 COMPLY WITH ALL OTHER APPLICABLE NPDES PERMITS - NOT SHOWN, APPLIES TO WHOLE SITE

STRUCTURAL SOURCE CONTROL BMPS:

- S1 STORM DRAIN STENCILING AND SIGNAGE
- S3 TRASH AND WASTE STORAGE
- S4 EFFICIENT IRRIGATION
- S5 FINISH GRADE AT LANDSCAPE AREAS MIN 1-2" BELOW FACE OF CURB, SIDEWALK, OR PAVEMENT - NOT SHOWN, APPLIES TO WHOLE SITE
- S7 DOCK AREAS

TREATMENT BMP:

UNDERGROUND INFILTRATION



LEGEND

- ROOF AREA
- PAVED AREA
- PERMEABLE AREA
- DMA BOUNDARY
- DRAINAGE FLOW PATH
- PIPE FLOW PATH

DCV CALCULATIONS

PROJECT AREA (DA1) = 1,734,234 SF
IMP = 86.4%
$R_C = [(0.858)(0.864)^3] - [(0.78)(0.864)^2] + [(0.774)(0.864)] + 0.04$
$R_C = 0.680$
2-YR, 1-HR RAINFALL DEPTH (NOAA) = 0.373 IN
C_1 DESERT = 1.2371
$P_6 = (0.373)(1.2371) = 0.461$ IN
C_2 48-HR DRAWDOWN = 1.963
$DCV = (\frac{1}{12})*[(1,734,234)(0.680)(0.461)(1.963)] = 88,932$ CF

WM

0 40 80 160
SCALE: 1" = 80'
ORIGINAL GRAPHIC SCALE

811
Know what's **below.**
Call 811 before you dig.

AREA SUMMARY / COMPARISON

DESCRIPTION	EXISTING	PROPOSED	DIFFERENCE
HARDSCAPE/IMPERMEABLE	0 SF	1,498,393 SF	+1,498,393 SF
LANDSCAPE/PERMEABLE	1,734,234 SF	235,841 SF	-1,498,393 SF
TOTALS	1,734,234 SF	1,734,234 SF	

AREA CLASSIFICATION	TOTAL
TOTAL IMPERVIOUS AREA	1,498,393 SF

WARE MALCOMB
LEADING DESIGN FOR COMMERCIAL REAL ESTATE

10 edelman
irvine, ca 92618
p 949.660.9128
waremalcomb.com

REGISTERED PROFESSIONAL ENGINEER
LUCAS A. CORSBIE
No. 72588
CIVIL
STATE OF CALIFORNIA
Apr 22, 2022

FOR AND ON BEHALF OF WARE MALCOMB

WQMP EXHIBIT

NO.	DATE	REMARKS

JOB NO.:	IRV21-0068
PA / PM:	LC
DRAWN BY:	BS
DATE:	11/30/21
PLOT DATE:	

SHEET
1
Sheet 1 of 1

CAUTION: IF THIS SHEET IS NOT 24"x36" IT IS A REDUCED PRINT

PROJECT INFORMATION	
ENGINEERED PRODUCT MANAGER	
ADS SALES REP	
PROJECT NO.	

ADS Advanced Drainage Systems, Inc.

ADS SiteAssist FOR STORMTECH INSTALLATION INSTRUCTIONS VISIT OUR APP

AMRAPUR STODDARD WELLS

VICTORVILLE, CA

MC-3500 STORMTECH CHAMBER SPECIFICATIONS

1. CHAMBERS SHALL BE STORMTECH MC-3500.
2. CHAMBERS SHALL BE ARCH-SHAPED AND SHALL BE MANUFACTURED FROM VIRGIN, IMPACT-MODIFIED POLYPROPYLENE COPOLYMERS.
3. CHAMBERS SHALL MEET THE REQUIREMENTS OF ASTM F2418, "STANDARD SPECIFICATION FOR POLYPROPYLENE (PP) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS" CHAMBER CLASSIFICATION 45x76 DESIGNATION SS.
4. CHAMBER ROWS SHALL PROVIDE CONTINUOUS, UNOBSTRUCTED INTERNAL SPACE WITH NO INTERNAL SUPPORTS THAT WOULD IMPEDE FLOW OR LIMIT ACCESS FOR INSPECTION.
5. THE STRUCTURAL DESIGN OF THE CHAMBERS, THE STRUCTURAL BACKFILL, AND THE INSTALLATION REQUIREMENTS SHALL ENSURE THAT THE LOAD FACTORS SPECIFIED IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS, SECTION 12.12, ARE MET FOR: 1) LONG-DURATION DEAD LOADS AND 2) SHORT-DURATION LIVE LOADS, BASED ON THE AASHTO DESIGN TRUCK WITH CONSIDERATION FOR IMPACT AND MULTIPLE VEHICLE PRESENCES.
6. CHAMBERS SHALL BE DESIGNED, TESTED AND ALLOWABLE LOAD CONFIGURATIONS DETERMINED IN ACCORDANCE WITH ASTM F2787, "STANDARD PRACTICE FOR STRUCTURAL DESIGN OF THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS". LOAD CONFIGURATIONS SHALL INCLUDE: 1) INSTANTANEOUS (<1 MIN) AASHTO DESIGN TRUCK LIVE LOAD ON MINIMUM COVER 2) MAXIMUM PERMANENT (75-YR) COVER LOAD AND 3) ALLOWABLE COVER WITH PARKED (1-WEEK) AASHTO DESIGN TRUCK.
7. REQUIREMENTS FOR HANDLING AND INSTALLATION:
   - TO MAINTAIN THE WIDTH OF CHAMBERS DURING SHIPPING AND HANDLING, CHAMBERS SHALL HAVE INTEGRAL, INTERLOCKING STACKING LUGS.
   - TO ENSURE A SECURE JOINT DURING INSTALLATION AND BACKFILL, THE HEIGHT OF THE CHAMBER JOINT SHALL NOT BE LESS THAN 3".
   - TO ENSURE THE INTEGRITY OF THE ARCH SHAPE DURING INSTALLATION, a) THE ARCH STIFFNESS CONSTANT AS DEFINED IN SECTION 6.2.8 OF ASTM F2418 SHALL BE GREATER THAN OR EQUAL TO 450 LBS/IN/IN. AND b) TO RESIST CHAMBER DEFORMATION DURING INSTALLATION AT ELEVATED TEMPERATURES (ABOVE 73° F / 23° C), CHAMBERS SHALL BE PRODUCED FROM REFLECTIVE GOLD OR YELLOW COLORS.
8. ONLY CHAMBERS THAT ARE APPROVED BY THE SITE DESIGN ENGINEER WILL BE ALLOWED. UPON REQUEST BY THE SITE DESIGN ENGINEER OR OWNER, THE CHAMBER MANUFACTURER SHALL SUBMIT A STRUCTURAL EVALUATION FOR APPROVAL BEFORE DELIVERING CHAMBERS TO THE PROJECT SITE AS FOLLOWS:
   - THE STRUCTURAL EVALUATION SHALL BE SEALED BY A REGISTERED PROFESSIONAL ENGINEER.
   - THE STRUCTURAL EVALUATION SHALL DEMONSTRATE THAT THE SAFETY FACTORS ARE GREATER THAN OR EQUAL TO 1.95 FOR DEAD LOAD AND 1.75 FOR LIVE LOAD, THE MINIMUM REQUIRED BY ASTM F2787 AND BY SECTIONS 3 AND 12.12 OF THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS FOR THERMOPLASTIC PIPE.
   - THE TEST DERIVED CREEP MODULUS AS SPECIFIED IN ASTM F2418 SHALL BE USED FOR PERMANENT DEAD LOAD DESIGN EXCEPT THAT IT SHALL BE THE 75-YEAR MODULUS USED FOR DESIGN.
9. CHAMBERS AND END CAPS SHALL BE PRODUCED AT AN ISO 9001 CERTIFIED MANUFACTURING FACILITY.

IMPORTANT - NOTES FOR THE BIDDING AND INSTALLATION OF MC-3500 CHAMBER SYSTEM

1. STORMTECH MC-3500 CHAMBERS SHALL NOT BE INSTALLED UNTIL THE MANUFACTURER'S REPRESENTATIVE HAS COMPLETED A PRE-CONSTRUCTION MEETING WITH THE INSTALLERS.
2. STORMTECH MC-3500 CHAMBERS SHALL BE INSTALLED IN ACCORDANCE WITH THE "STORMTECH MC-3500/MC-4500 CONSTRUCTION GUIDE".
3. CHAMBERS ARE NOT TO BE BACKFILLED WITH A DOZER OR AN EXCAVATOR SITUATED OVER THE CHAMBERS. STORMTECH RECOMMENDS 3 BACKFILL METHODS:
   - STONESHOOTER LOCATED OFF THE CHAMBER BED.
   - BACKFILL AS ROWS ARE BUILT USING AN EXCAVATOR ON THE FOUNDATION STONE OR SUBGRADE.
   - BACKFILL FROM OUTSIDE THE EXCAVATION USING A LONG BOOM HOE OR EXCAVATOR.
4. THE FOUNDATION STONE SHALL BE LEVELED AND COMPACTED PRIOR TO PLACING CHAMBERS.
5. JOINTS BETWEEN CHAMBERS SHALL BE PROPERLY SEATED PRIOR TO PLACING STONE.
6. MAINTAIN MINIMUM - 6" (150 mm) SPACING BETWEEN THE CHAMBER ROWS.
7. INLET AND OUTLET MANIFOLDS MUST BE INSERTED A MINIMUM OF 12" (300 mm) INTO CHAMBER END CAPS.
8. EMBEDMENT STONE SURROUNDING CHAMBERS MUST BE A CLEAN, CRUSHED, ANGULAR STONE MEETING THE AASHTO M43 DESIGNATION OF #3 OR #4.
9. STONE MUST BE PLACED ON THE TOP CENTER OF THE CHAMBER TO ANCHOR THE CHAMBERS IN PLACE AND PRESERVE ROW SPACING.
10. THE CONTRACTOR MUST REPORT ANY DISCREPANCIES WITH CHAMBER FOUNDATION MATERIALS BEARING CAPACITIES TO THE SITE DESIGN ENGINEER.
11. ADS RECOMMENDS THE USE OF "FLEXSTORM CATCH IT" INSERTS DURING CONSTRUCTION FOR ALL INLETS TO PROTECT THE SUBSURFACE STORMWATER MANAGEMENT SYSTEM FROM CONSTRUCTION SITE RUNOFF.

NOTES FOR CONSTRUCTION EQUIPMENT

1. STORMTECH MC-3500 CHAMBERS SHALL BE INSTALLED IN ACCORDANCE WITH THE "STORMTECH MC-3500/MC-4500 CONSTRUCTION GUIDE".
2. THE USE OF EQUIPMENT OVER MC-3500 CHAMBERS IS LIMITED:
   - NO EQUIPMENT IS ALLOWED ON BARE CHAMBERS.
   - NO RUBBER TIRED LOADER, DUMP TRUCK, OR EXCAVATORS ARE ALLOWED UNTIL PROPER FILL DEPTHS ARE REACHED IN ACCORDANCE WITH THE "STORMTECH MC-3500/MC-4500 CONSTRUCTION GUIDE".
   - WEIGHT LIMITS FOR CONSTRUCTION EQUIPMENT CAN BE FOUND IN THE "STORMTECH MC-3500/MC-4500 CONSTRUCTION GUIDE".
3. FULL 36" (900 mm) OF STABILIZED COVER MATERIALS OVER THE CHAMBERS IS REQUIRED FOR DUMP TRUCK TRAVEL OR DUMPING.

USE OF A DOZER TO PUSH EMBEDMENT STONE BETWEEN THE ROWS OF CHAMBERS MAY CAUSE DAMAGE TO CHAMBERS AND IS NOT AN ACCEPTABLE BACKFILL METHOD. ANY CHAMBERS DAMAGED BY USING THE "DUMP AND PUSH" METHOD ARE NOT COVERED UNDER THE STORMTECH STANDARD WARRANTY.

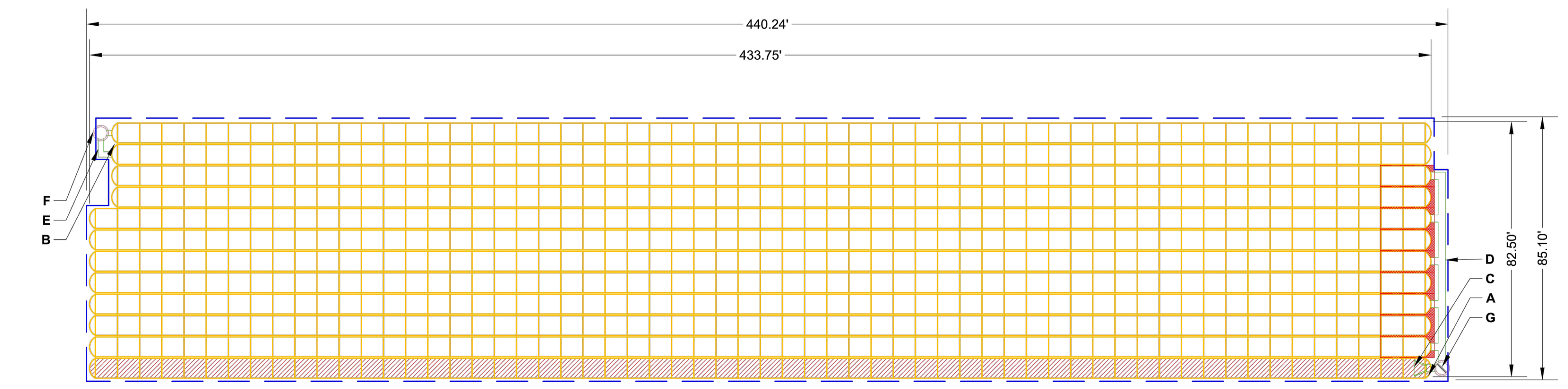
CONTACT STORMTECH AT 1-888-892-2694 WITH ANY QUESTIONS ON INSTALLATION REQUIREMENTS OR WEIGHT LIMITS FOR CONSTRUCTION EQUIPMENT.

PROPOSED LAYOUT	
716	STORMTECH MC-3500 CHAMBERS
24	STORMTECH MC-3500 END CAPS
12	STONE ABOVE (in)
9	STONE BELOW (in)
40	STONE VOID
129381	INSTALLED SYSTEM VOLUME (CF) (PERIMETER STONE INCLUDED) (COVER STONE INCLUDED) (BASE STONE INCLUDED)
37242	SYSTEM AREA (SF)
1058.9	SYSTEM PERIMETER (ft)

PROPOSED ELEVATIONS	
MAXIMUM ALLOWABLE GRADE (TOP OF PAVEMENT/UNPAVED):	2699.50
MINIMUM ALLOWABLE GRADE (UNPAVED WITH TRAFFIC):	2693.50
MINIMUM ALLOWABLE GRADE (UNPAVED NO TRAFFIC):	2693.00
MINIMUM ALLOWABLE GRADE (TOP OF RIGID CONCRETE PAVEMENT):	2693.00
MINIMUM ALLOWABLE GRADE (BASE OF FLEXIBLE PAVEMENT):	2693.00
TOP OF STONE:	2692.50
TOP OF MC-3500 CHAMBER:	2691.50
24" x 24" BOTTOM MANIFOLD INVERT:	2687.92
24" ISOLATOR ROW PLUS INVERT:	2687.92
18" x 18" BOTTOM MANIFOLD INVERT:	2687.90
18" BOTTOM CONNECTION INVERT:	2687.90
BOTTOM OF MC-3500 CHAMBER:	2687.75
BOTTOM OF STONE:	2687.00

*INVERT ABOVE BASE OF CHAMBER

PART TYPE	ITEM ON LAYOUT	DESCRIPTION	INVERT*	MAX FLOW
PREFABRICATED END CAP	A	24" BOTTOM CORED END CAP, PART#: MC3500IEPP24BC / TYP OF ALL 24" BOTTOM CONNECTIONS AND ISOLATOR PLUS ROWS	2.06"	
PREFABRICATED END CAP	B	18" BOTTOM CORED END CAP, PART#: MC3500IEPP18BC / TYP OF ALL 18" BOTTOM CONNECTIONS	1.77"	
FLAMP	C	INSTALL FLAMP ON 24" ACCESS PIPE / PART#: MC350024RAMP		
MANIFOLD	D	24" x 24" BOTTOM MANIFOLD, ADS N-12	2.06"	
MANIFOLD	E	18" x 18" BOTTOM MANIFOLD, ADS N-12	1.77"	
CONCRETE STRUCTURE	F	OCS (DESIGN BY ENGINEER / PROVIDED BY OTHERS)		8.0 CFS OUT
CONCRETE STRUCTURE W/WEIR	G	(DESIGN BY ENGINEER / PROVIDED BY OTHERS)		35.8 CFS IN



ISOLATOR ROW PLUS (SEE DETAIL)

PLACE MINIMUM 17.50' OF ADSPLUS175 WOVEN GEOTEXTILE OVER BEDDING STONE AND UNDERNEATH CHAMBER FEET FOR SCOUR PROTECTION AT ALL CHAMBER INLET ROWS

BED LIMITS

NOTES

- MANIFOLD SIZE TO BE DETERMINED BY SITE DESIGN ENGINEER. SEE TECH NOTE #6.32 FOR MANIFOLD SIZING GUIDANCE.
- DUE TO THE ADAPTATION OF THIS CHAMBER SYSTEM TO SPECIFIC SITE AND DESIGN CONSTRAINTS, IT MAY BE NECESSARY TO CUT AND COUPLE ADDITIONAL PIPE TO STANDARD MANIFOLD COMPONENTS IN THE FIELD.
- THE SITE DESIGN ENGINEER MUST REVIEW ELEVATIONS AND IF NECESSARY ADJUST GRADING TO ENSURE THE CHAMBER COVER REQUIREMENTS ARE MET.
- THIS CHAMBER SYSTEM WAS DESIGNED WITHOUT SITE-SPECIFIC INFORMATION ON SOIL CONDITIONS OR BEARING CAPACITY. THE SITE DESIGN ENGINEER IS RESPONSIBLE FOR DETERMINING THE SUITABILITY OF THE SOIL AND PROVIDING THE BEARING CAPACITY OF THE INSITU SOILS. THE BASE STONE DEPTH MAY BE INCREASED OR DECREASED ONCE THIS INFORMATION IS PROVIDED.
- **NOT FOR CONSTRUCTION:** THIS LAYOUT IS FOR DIMENSIONAL PURPOSES ONLY TO PROVE CONCEPT & THE REQUIRED STORAGE VOLUME CAN BE ACHIEVED ON SITE.

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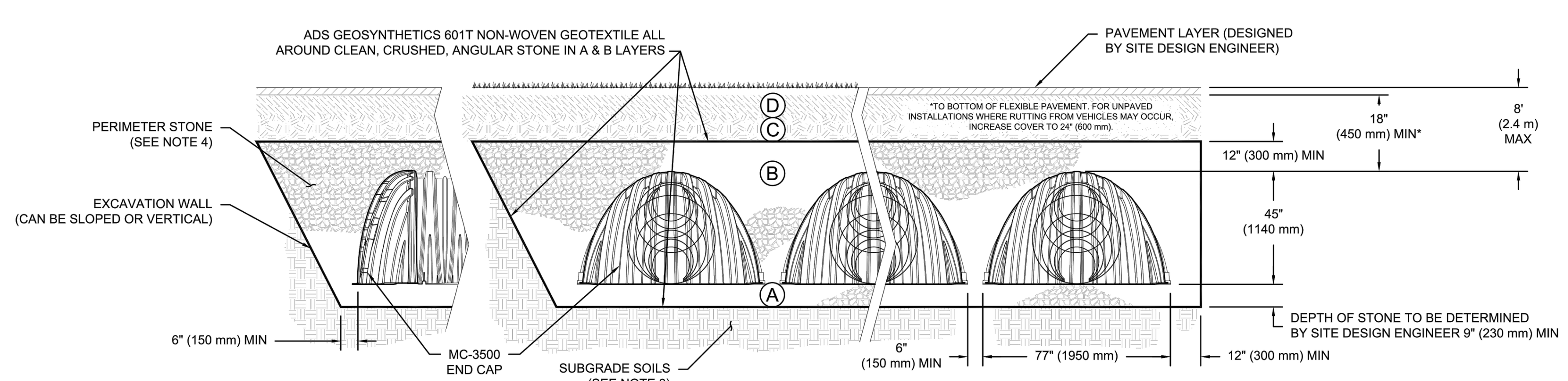
SHEET 2 OF 5

ACCEPTABLE FILL MATERIALS: STORMTECH MC-3500 CHAMBER SYSTEMS

	MATERIAL LOCATION	DESCRIPTION	AASHTO MATERIAL CLASSIFICATIONS	COMPACTION / DENSITY REQUIREMENT
D	**FINAL FILL:** FILL MATERIAL FOR LAYER 'D' STARTS FROM THE TOP OF THE 'C' LAYER TO THE BOTTOM OF FLEXIBLE PAVEMENT OR UNPAVED FINISHED GRADE ABOVE. NOTE THAT PAVEMENT SUBBASE MAY BE PART OF THE 'D' LAYER	ANY SOIL/ROCK MATERIALS, NATIVE SOILS, OR PER ENGINEER'S PLANS. CHECK PLANS FOR PAVEMENT SUBGRADE REQUIREMENTS.	N/A	PREPARE PER SITE DESIGN ENGINEER'S PLANS. PAVED INSTALLATIONS MAY HAVE STRINGENT MATERIAL AND PREPARATION REQUIREMENTS.
C	**INITIAL FILL:** FILL MATERIAL FOR LAYER 'C' STARTS FROM THE TOP OF THE EMBEDMENT STONE ('B' LAYER) TO 24" (600 mm) ABOVE THE TOP OF THE CHAMBER. NOTE THAT PAVEMENT SUBBASE MAY BE A PART OF THE 'C' LAYER.	GRANULAR WELL-GRADED SOIL/AGGREGATE MIXTURES, <35% FINES OR PROCESSED AGGREGATE. MOST PAVEMENT SUBBASE MATERIALS CAN BE USED IN LIEU OF THIS LAYER.	AASHTO M145[1] A-1, A-2-4, A-3 OR AASHTO M43[1] 3, 357, 4, 467, 5, 56, 57, 6, 67, 68, 7, 78, 8, 89, 9, 10	BEGIN COMPACTIONS AFTER 24" (600 mm) OF MATERIAL OVER THE CHAMBERS IS REACHED. COMPACT ADDITIONAL LAYERS IN 12" (300 mm) MAX LIFTS TO A MIN. 95% PROCTOR DENSITY FOR WELL GRADED MATERIAL AND 95% RELATIVE DENSITY FOR PROCESSED AGGREGATE MATERIALS.
B	**EMBEDMENT STONE:** FILL SURROUNDING THE CHAMBERS FROM THE FOUNDATION STONE ('A' LAYER) TO THE 'C' LAYER ABOVE.	CLEAN, CRUSHED, ANGULAR STONE	AASHTO M43[1] 3, 4	NO COMPACTION REQUIRED.
A	**FOUNDATION STONE:** FILL BELOW CHAMBERS FROM THE SUBGRADE UP TO THE FOOT (BOTTOM) OF THE CHAMBER.	CLEAN, CRUSHED, ANGULAR STONE	AASHTO M43[1] 3, 4	PLATE COMPACT OR ROLL TO ACHIEVE A FLAT SURFACE.[2,3]

PLEASE NOTE:
1. THE LISTED AASHTO DESIGNATIONS ARE FOR GRADATIONS ONLY. THE STONE MUST ALSO BE CLEAN, CRUSHED, ANGULAR. FOR EXAMPLE, A SPECIFICATION FOR #4 STONE WOULD STATE: "CLEAN, CRUSHED, ANGULAR NO. 4 (AASHTO M43) STONE".
2. STORMTECH COMPACTION REQUIREMENTS ARE MET FOR 'A' LOCATION MATERIALS WHEN PLACED AND COMPACTED IN 9" (230 mm) (MAX) LIFTS USING TWO FULL COVERAGES WITH A VIBRATORY COMPACTOR.
3. WHERE INFILTRATION SURFACES MAY BE COMPROMISED BY COMPACTION, FOR STANDARD DESIGN LOAD CONDITIONS, A FLAT SURFACE MAY BE ACHIEVED BY RAKING OR DRAGGING WITHOUT COMPACTION EQUIPMENT. FOR SPECIAL LOAD DESIGNS, CONTACT STORMTECH FOR COMPACTION REQUIREMENTS.
4. ONCE LAYER 'C' IS PLACED, ANY SOIL/MATERIAL CAN BE PLACED IN LAYER 'D' UP TO THE FINISHED GRADE. MOST PAVEMENT SUBBASE SOILS CAN BE USED TO REPLACE THE MATERIAL REQUIREMENTS OF LAYER 'C' OR 'D' AT THE SITE DESIGN ENGINEER'S DISCRETION.



NOTES:

1. CHAMBERS SHALL MEET THE REQUIREMENTS OF ASTM F2418, "STANDARD SPECIFICATION FOR POLYPROPYLENE (PP) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS" CHAMBER CLASSIFICATION 45x76 DESIGNATION SS.
2. MC-3500 CHAMBERS SHALL BE DESIGNED IN ACCORDANCE WITH ASTM F2787 "STANDARD PRACTICE FOR STRUCTURAL DESIGN OF THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
3. THE SITE DESIGN ENGINEER IS RESPONSIBLE FOR ASSESSING THE BEARING RESISTANCE (ALLOWABLE BEARING CAPACITY) OF THE SUBGRADE SOILS AND THE DEPTH OF FOUNDATION STONE WITH CONSIDERATION FOR THE RANGE OF EXPECTED SOIL MOISTURE CONDITIONS.
4. PERIMETER STONE MUST BE EXTENDED HORIZONTALLY TO THE EXCAVATION WALL FOR BOTH VERTICAL AND SLOPED EXCAVATION WALLS.
5. REQUIREMENTS FOR HANDLING AND INSTALLATION:
   - TO MAINTAIN THE WIDTH OF CHAMBERS DURING SHIPPING AND HANDLING, CHAMBERS SHALL HAVE INTEGRAL, INTERLOCKING STACKING LUGS.
   - TO ENSURE A SECURE JOINT DURING INSTALLATION AND BACKFILL, THE HEIGHT OF THE CHAMBER JOINT SHALL NOT BE LESS THAN 3".
   - TO ENSURE THE INTEGRITY OF THE ARCH SHAPE DURING INSTALLATION, a) THE ARCH STIFFNESS CONSTANT AS DEFINED IN SECTION 6.2.8 OF ASTM F2418 SHALL BE GREATER THAN OR EQUAL TO 450 LBS/IN/IN. AND b) TO RESIST CHAMBER DEFORMATION DURING INSTALLATION AT ELEVATED TEMPERATURES (ABOVE 73° F / 23° C), CHAMBERS SHALL BE PRODUCED FROM REFLECTIVE GOLD OR YELLOW COLORS.

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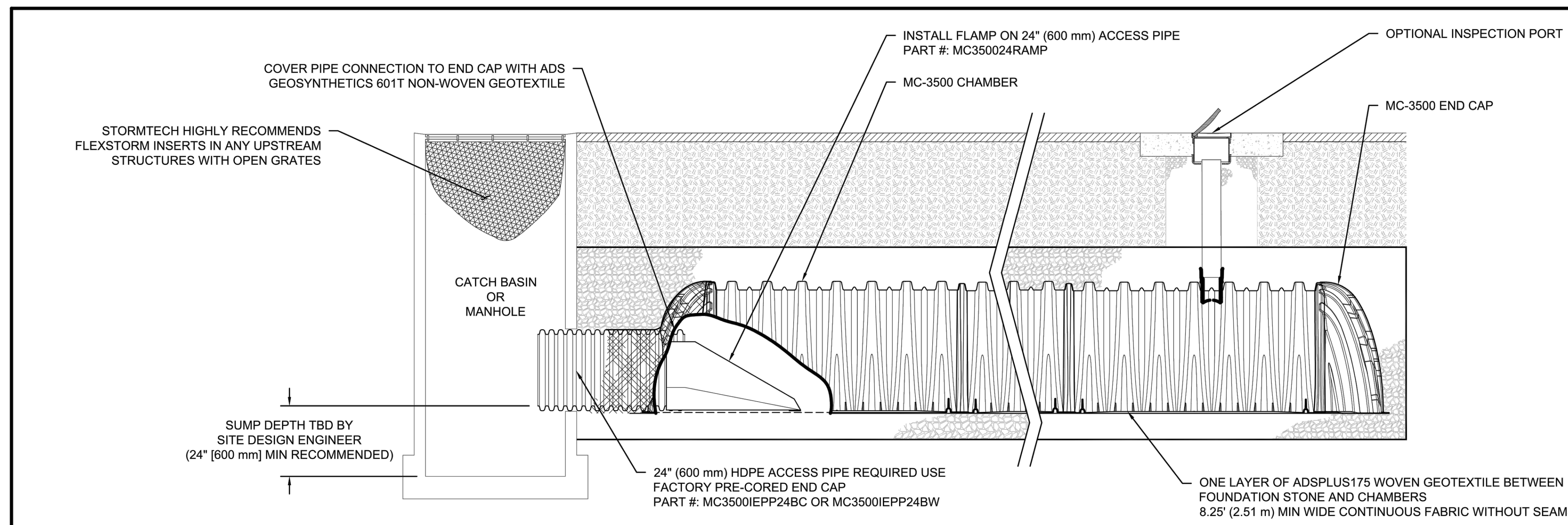
SHEET 3 OF 5



MC-3500 ISOLATOR ROW PLUS DETAIL

NTS

INSPECTION & MAINTENANCE

STEP 1) INSPECT ISOLATOR ROW PLUS FOR SEDIMENT
- A. INSPECTION PORTS (IF PRESENT)
  - A.1. REMOVE/OPEN LID ON NYLOPLAST INLINE DRAIN
  - A.2. REMOVE AND CLEAN FLEXSTORM FILTER IF INSTALLED
  - A.3. USING A FLASHLIGHT AND STADIA ROD, MEASURE DEPTH OF SEDIMENT AND RECORD ON MAINTENANCE LOG
  - A.4. LOWER A CAMERA INTO ISOLATOR ROW PLUS FOR VISUAL INSPECTION OF SEDIMENT LEVELS (OPTIONAL)
  - A.5. IF SEDIMENT IS AT, OR ABOVE, 3" (80 mm) PROCEED TO STEP 2. IF NOT, PROCEED TO STEP 3.
- B. ALL ISOLATOR PLUS ROWS
  - B.1. REMOVE COVER FROM STRUCTURE AT UPSTREAM END OF ISOLATOR ROW PLUS
  - B.2. USING A FLASHLIGHT, INSPECT DOWN THE ISOLATOR ROW PLUS THROUGH OUTLET PIPE
    - i) MIRRORS ON POLES OR CAMERAS MAY BE USED TO AVOID A CONFINED SPACE ENTRY
    - ii) FOLLOW OSHA REGULATIONS FOR CONFINED SPACE ENTRY IF ENTERING MANHOLE
  - B.3. IF SEDIMENT IS AT, OR ABOVE, 3" (80 mm) PROCEED TO STEP 2. IF NOT, PROCEED TO STEP 3.

STEP 2) CLEAN OUT ISOLATOR ROW PLUS USING THE JETVAC PROCESS
- A. A FIXED CULVERT CLEANING NOZZLE WITH REAR FACING SPREAD OF 45" (1.1 m) OR MORE IS PREFERRED
- B. APPLY MULTIPLE PASSES OF JETVAC UNTIL BACKFLUSH WATER IS CLEAN
- C. VACUUM STRUCTURE SUMP AS REQUIRED

STEP 3) REPLACE ALL COVERS, GRATES, FILTERS, AND LIDS; RECORD OBSERVATIONS AND ACTIONS.

STEP 4) INSPECT AND CLEAN BASINS AND MANHOLES UPSTREAM OF THE STORMTECH SYSTEM.

NOTES

1. INSPECT EVERY 6 MONTHS DURING THE FIRST YEAR OF OPERATION. ADJUST THE INSPECTION INTERVAL BASED ON PREVIOUS OBSERVATIONS OF SEDIMENT ACCUMULATION AND HIGH WATER ELEVATIONS.
2. CONDUCT JETTING AND VACTORING ANNUALLY OR WHEN INSPECTION SHOWS THAT MAINTENANCE IS NECESSARY.

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SHEET 4 OF 5

TREATMENT BMP DETAIL - ADS STORMTECH CHAMBER (SHEETS 1-4 OF 5)

N.T.S.

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REGISTERED PROFESSIONAL ENGINEER
LUCAS A. CORSBIE
No. 72588
CIVIL
STATE OF CALIFORNIA
Mar 03, 2022

FOR AND ON BEHALF OF WARE MALCOMB

WQMP DETAILS

NO.	DATE	REMARKS

JOB NO.:	IRV21-0068
PA / PM:	LC
DRAWN BY:	BS
DATE:	11/30/21
PLOT DATE:	

SHEET
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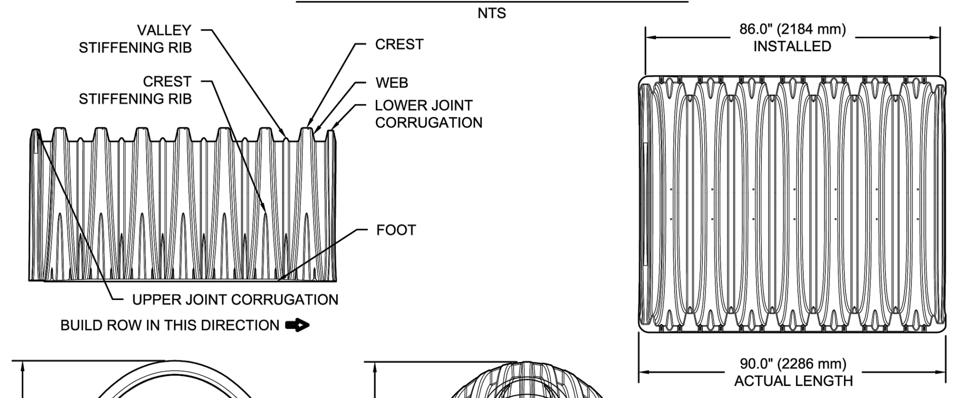
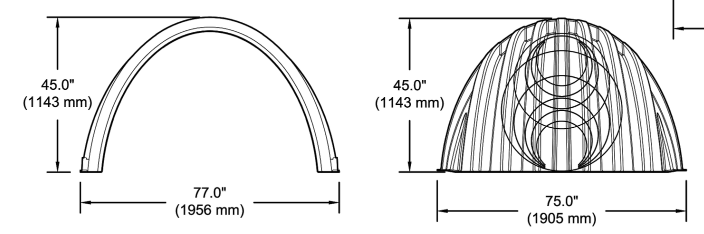
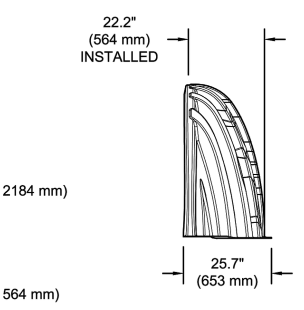
Sheet 2 of 3

MC-3500 TECHNICAL SPECIFICATION
NTS







NOMINAL CHAMBER SPECIFICATIONS

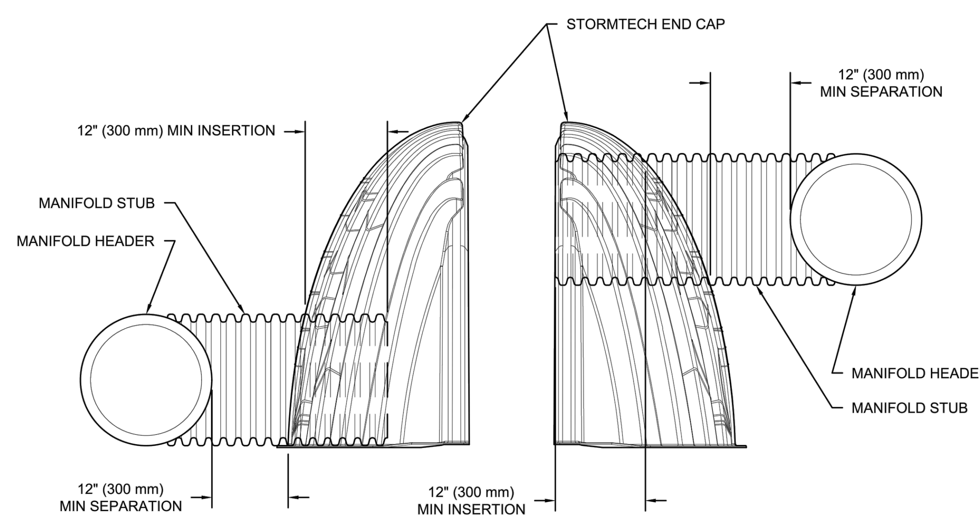
SIZE (W X H X INSTALLED LENGTH)	77.0" X 45.0" X 86.0"	(1956 mm X 1143 mm X 2184 mm)
CHAMBER STORAGE	109.9 CUBIC FEET	(3.11 m³)
MINIMUM INSTALLED STORAGE*	175.0 CUBIC FEET	(4.96 m³)
WEIGHT	134 lbs.	(60.8 kg)

NOMINAL END CAP SPECIFICATIONS

SIZE (W X H X INSTALLED LENGTH)	75.0" X 45.0" X 22.2"	(1905 mm X 1143 mm X 564 mm)
END CAP STORAGE	14.9 CUBIC FEET	(0.42 m³)
MINIMUM INSTALLED STORAGE*	45.1 CUBIC FEET	(1.28 m³)
WEIGHT	49 lbs.	(22.2 kg)

*ASSUMES 12" (305 mm) STONE ABOVE, 9" (229 mm) STONE FOUNDATION, 6" SPACING BETWEEN CHAMBERS, 6" (152 mm) STONE PERIMETER IN FRONT OF END CAPS AND 40% STONE POROSITY

MC-SERIES END CAP INSERTION DETAIL
NTS

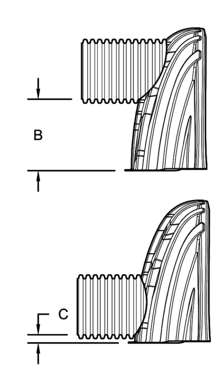


NOTE: MANIFOLD STUB MUST BE LAID HORIZONTAL FOR A PROPER FIT IN END CAP OPENING.

STUBS AT BOTTOM OF END CAP FOR PART NUMBERS ENDING WITH "B"
STUBS AT TOP OF END CAP FOR PART NUMBERS ENDING WITH "T"
END CAPS WITH A WELDED CROWN PLATE END WITH "C"
END CAPS WITH A PREFABRICATED WELDED STUB END WITH "W"

PART #	STUB	B	C
MC3500IEPP06T	6" (150 mm)	33.21" (844 mm)	---
MC3500IEPP06B		---	0.66" (17 mm)
MC3500IEPP08T	8" (200 mm)	31.16" (791 mm)	---
MC3500IEPP08B		---	0.81" (21 mm)
MC3500IEPP10T	10" (250 mm)	29.04" (738 mm)	---
MC3500IEPP10B		---	0.93" (24 mm)
MC3500IEPP12T	12" (300 mm)	26.36" (670 mm)	---
MC3500IEPP12B		---	1.35" (34 mm)
MC3500IEPP15T	15" (375 mm)	23.39" (594 mm)	---
MC3500IEPP15B		---	1.50" (38 mm)
MC3500IEPP18TC	18" (450 mm)	20.03" (509 mm)	---
MC3500IEPP18TW			
MC3500IEPP18BC		---	1.77" (45 mm)
MC3500IEPP18BW			
MC3500IEPP24TC	24" (600 mm)	14.48" (368 mm)	---
MC3500IEPP24TW			
MC3500IEPP24BC		---	2.06" (52 mm)
MC3500IEPP24BW			
MC3500IEPP30BC	30" (750 mm)	---	2.75" (70 mm)

NOTE: ALL DIMENSIONS ARE NOMINAL



CUSTOM PRECORED INVERTS ARE AVAILABLE UPON REQUEST. INVENTORIED MANIFOLDS INCLUDE 12-24" (300-600 mm) SIZE ON SIZE AND 15-48" (375-1200 mm) ECCENTRIC MANIFOLDS. CUSTOM INVERT LOCATIONS ON THE MC-3500 END CAP CUT IN THE FIELD ARE NOT RECOMMENDED FOR PIPE SIZES GREATER THAN 10" (250 mm). THE INVERT LOCATION IN COLUMN 'B' ARE THE HIGHEST POSSIBLE FOR THE PIPE SIZE.

AMRAPUR STODDARD WELLS
VICTORVILLE, CA

DATE:	DRAWN: AC
PROJECT #:	CHECKED: N/A

DATE	DRW	CHK	DESCRIPTION

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Chamber System
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HILLIARD, OH 43026
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SHEET
5 OF 5

TREATMENT BMP DETAIL - ADS STORMTECH CHAMBER (SHEET 5 OF 5)
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WQMP DETAILS

NO.	DATE	REMARKS

JOB NO.:	IRV21-0068
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PLOT DATE:	

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3
Sheet 3 of 3

Appendix B - Reference Materials

NOAA Atlas 14, Volume 6, Version 2 VICTORVILLE PUMP PT
Station ID: 04-9325
Location name: Victorville, California, USA*
Latitude: 34.535°, Longitude: -117.3058°
Elevation:
Elevation (station metadata): 2858 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

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

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

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

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.107 (0.088-0.131)	0.145 (0.119-0.177)	0.198 (0.163-0.243)	0.244 (0.199-0.303)	0.313 (0.247-0.401)	0.370 (0.286-0.483)	0.431 (0.325-0.578)	0.499 (0.366-0.687)	0.599 (0.421-0.859)	0.682 (0.464-1.01)
10-min	0.153 (0.127-0.188)	0.207 (0.171-0.254)	0.284 (0.233-0.348)	0.350 (0.286-0.434)	0.448 (0.354-0.574)	0.530 (0.410-0.693)	0.618 (0.467-0.828)	0.716 (0.525-0.985)	0.858 (0.604-1.23)	0.977 (0.665-1.45)
15-min	0.185 (0.153-0.227)	0.251 (0.207-0.307)	0.343 (0.282-0.421)	0.424 (0.346-0.525)	0.542 (0.428-0.694)	0.641 (0.495-0.838)	0.748 (0.564-1.00)	0.866 (0.635-1.19)	1.04 (0.731-1.49)	1.18 (0.804-1.76)
30-min	0.243 (0.201-0.298)	0.329 (0.271-0.403)	0.450 (0.370-0.553)	0.556 (0.453-0.688)	0.711 (0.561-0.910)	0.840 (0.650-1.10)	0.981 (0.740-1.31)	1.14 (0.833-1.56)	1.36 (0.958-1.95)	1.55 (1.06-2.30)
60-min	0.276 (0.228-0.338)	0.373 (0.308-0.457)	0.511 (0.420-0.627)	0.631 (0.515-0.782)	0.808 (0.637-1.03)	0.954 (0.738-1.25)	1.11 (0.840-1.49)	1.29 (0.946-1.77)	1.55 (1.09-2.22)	1.76 (1.20-2.61)
2-hr	0.383 (0.316-0.469)	0.510 (0.421-0.626)	0.688 (0.566-0.845)	0.840 (0.685-1.04)	1.06 (0.837-1.36)	1.24 (0.958-1.62)	1.43 (1.08-1.92)	1.64 (1.20-2.26)	1.94 (1.36-2.78)	2.18 (1.48-3.24)
3-hr	0.451 (0.372-0.551)	0.599 (0.493-0.733)	0.802 (0.659-0.985)	0.975 (0.795-1.21)	1.22 (0.965-1.57)	1.42 (1.10-1.86)	1.63 (1.23-2.19)	1.86 (1.36-2.56)	2.18 (1.54-3.13)	2.44 (1.66-3.62)
6-hr	0.604 (0.498-0.739)	0.802 (0.661-0.983)	1.07 (0.880-1.32)	1.30 (1.06-1.60)	1.61 (1.27-2.06)	1.86 (1.44-2.43)	2.12 (1.60-2.84)	2.39 (1.75-3.29)	2.77 (1.95-3.98)	3.08 (2.09-4.57)
12-hr	0.769 (0.635-0.942)	1.03 (0.851-1.26)	1.38 (1.13-1.70)	1.66 (1.36-2.06)	2.06 (1.62-2.63)	2.36 (1.82-3.08)	2.67 (2.01-3.57)	2.99 (2.19-4.11)	3.42 (2.41-4.91)	3.77 (2.56-5.59)
24-hr	0.981 (0.870-1.13)	1.33 (1.18-1.54)	1.79 (1.58-2.07)	2.16 (1.90-2.52)	2.67 (2.26-3.21)	3.05 (2.53-3.75)	3.43 (2.78-4.33)	3.83 (3.02-4.96)	4.36 (3.30-5.89)	4.77 (3.49-6.67)
2-day	1.12 (0.990-1.29)	1.54 (1.37-1.78)	2.10 (1.86-2.43)	2.56 (2.24-2.98)	3.18 (2.69-3.82)	3.65 (3.03-4.49)	4.14 (3.35-5.21)	4.64 (3.66-6.01)	5.32 (4.02-7.18)	5.85 (4.27-8.17)
3-day	1.22 (1.08-1.40)	1.70 (1.50-1.95)	2.32 (2.05-2.68)	2.84 (2.49-3.31)	3.54 (3.00-4.27)	4.09 (3.40-5.03)	4.65 (3.77-5.86)	5.23 (4.12-6.77)	6.01 (4.55-8.12)	6.63 (4.84-9.26)
4-day	1.30 (1.15-1.49)	1.81 (1.60-2.08)	2.48 (2.19-2.86)	3.03 (2.65-3.52)	3.77 (3.20-4.54)	4.35 (3.61-5.35)	4.94 (4.00-6.22)	5.54 (4.37-7.18)	6.37 (4.81-8.60)	7.01 (5.12-9.79)
7-day	1.40 (1.25-1.62)	1.93 (1.71-2.23)	2.62 (2.31-3.02)	3.17 (2.78-3.69)	3.92 (3.32-4.72)	4.49 (3.72-5.51)	5.06 (4.10-6.37)	5.64 (4.45-7.31)	6.43 (4.86-8.68)	7.03 (5.14-9.83)
10-day	1.48 (1.32-1.71)	2.03 (1.80-2.34)	2.73 (2.41-3.16)	3.30 (2.89-3.84)	4.05 (3.43-4.88)	4.62 (3.83-5.68)	5.19 (4.20-6.53)	5.77 (4.54-7.47)	6.53 (4.94-8.82)	7.12 (5.20-9.95)
20-day	1.70 (1.51-1.95)	2.34 (2.08-2.70)	3.18 (2.81-3.67)	3.85 (3.37-4.48)	4.75 (4.03-5.72)	5.44 (4.51-6.68)	6.13 (4.96-7.72)	6.83 (5.38-8.84)	7.76 (5.87-10.5)	8.48 (6.19-11.8)
30-day	1.91 (1.69-2.20)	2.67 (2.36-3.07)	3.67 (3.24-4.24)	4.49 (3.94-5.23)	5.62 (4.76-6.77)	6.50 (5.39-7.99)	7.39 (5.99-9.31)	8.32 (6.55-10.8)	9.58 (7.24-12.9)	10.6 (7.72-14.8)
45-day	2.19 (1.95-2.52)	3.11 (2.76-3.58)	4.36 (3.85-5.04)	5.42 (4.75-6.32)	6.92 (5.87-8.34)	8.13 (6.75-9.99)	9.39 (7.61-11.8)	10.7 (8.46-13.9)	12.6 (9.55-17.1)	14.2 (10.4-19.8)
60-day	2.37 (2.10-2.73)	3.39 (3.00-3.91)	4.83 (4.26-5.58)	6.08 (5.32-7.08)	7.90 (6.70-9.51)	9.41 (7.81-11.6)	11.0 (8.94-13.9)	12.8 (10.1-16.6)	15.4 (11.6-20.8)	17.5 (12.8-24.5)

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

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

Please refer to NOAA Atlas 14 document for more information.

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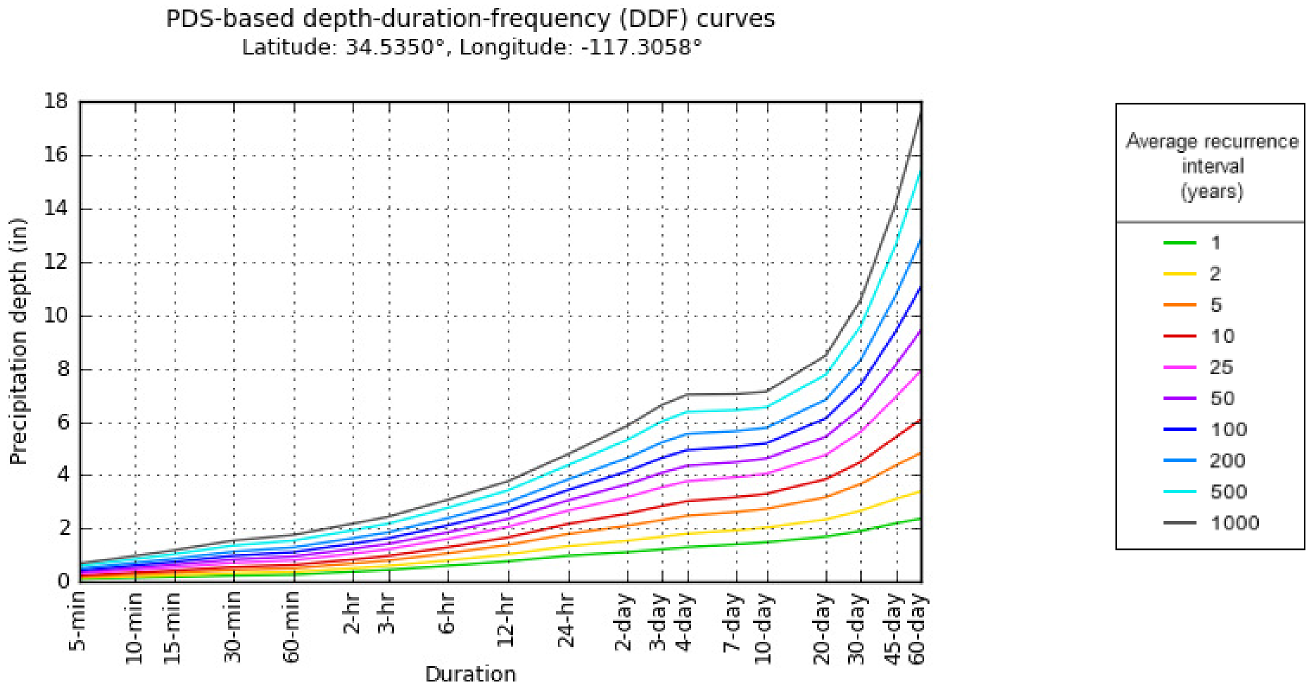
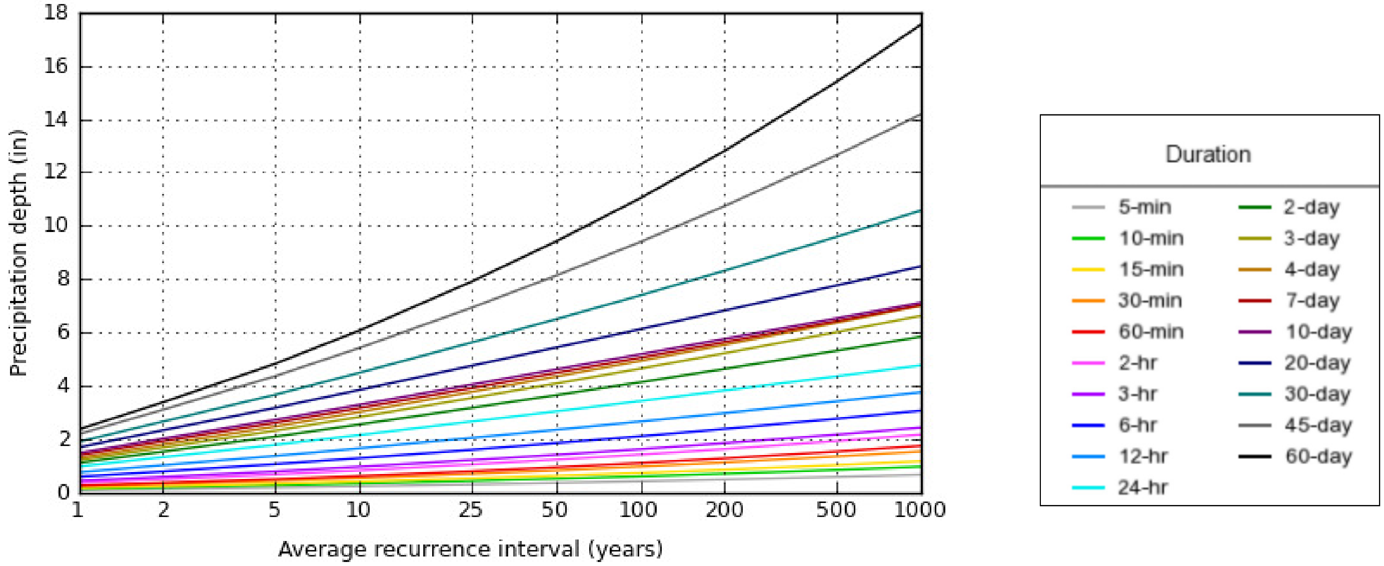
PF graphical





NOAA Atlas 14, Volume 6, Version 2 Created (GMT): Mon Nov 22 19:50:59 2021

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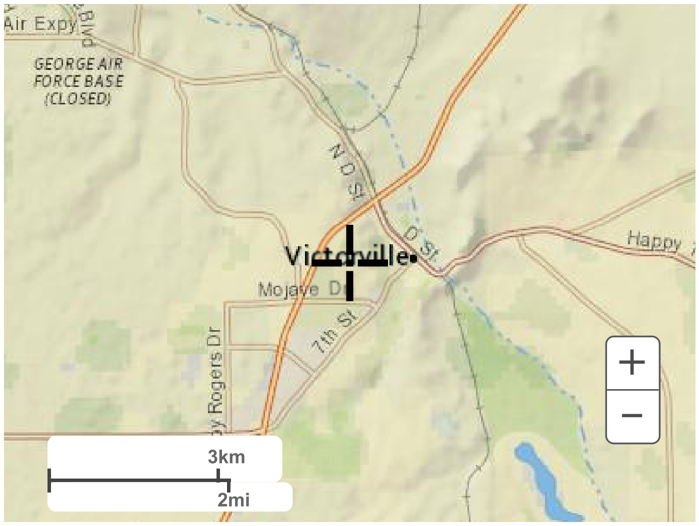
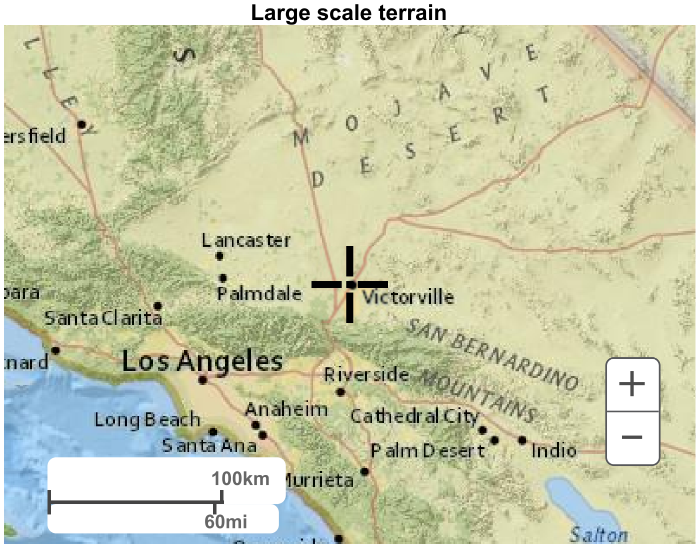
Maps & aerials

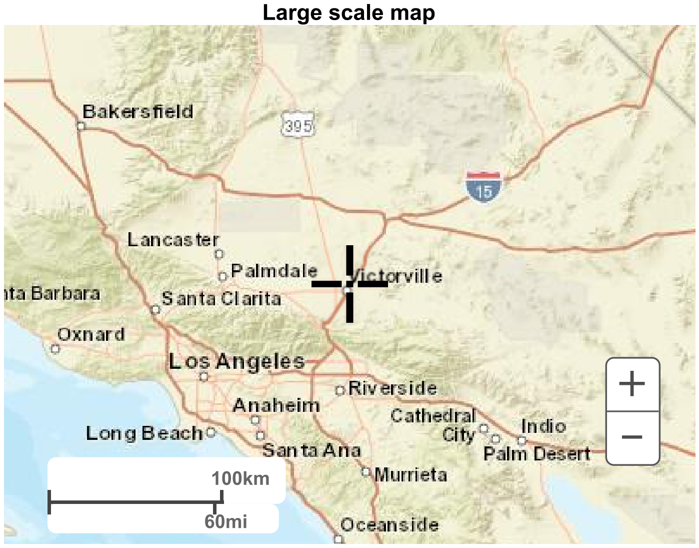
Small scale terrain



Large scale terrain



Large scale map



Large scale aerial

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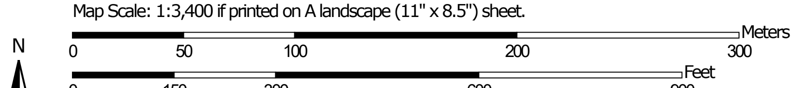
US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

Soil Map—San Bernardino County, California, Mojave River Area
(Amrapur Stoddard Wells - Victorville, CA)

Map Scale: 1:3,400 if printed on A landscape (11" x 8.5") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 11N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: San Bernardino County, California, Mojave River Area
Survey Area Data: Version 13, Sep 13, 2021

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 27, 2021—May 24, 2021

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
113	CAJON SAND, 2 TO 9 PERCENT SLOPES	2.2	5.5%
118	CAJON-ARIZO COMPLEX, 2 TO 15 PERCENT SLOPES*	22.2	55.8%
171	VILLA LOAMY SAND	15.4	38.7%
Totals for Area of Interest		**39.8**	**100.0%**

San Bernardino County, California, Mojave River Area

113—CAJON SAND, 2 TO 9 PERCENT SLOPES

Map Unit Setting

National map unit symbol: hkrk
Elevation: 1,800 to 3,500 feet
Mean annual precipitation: 3 to 6 inches
Mean annual air temperature: 59 to 68 degrees F
Frost-free period: 180 to 290 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Cajon and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Cajon

Setting

Landform: Alluvial fans
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from mixed sources

Typical profile

A - 0 to 6 inches: sand
C1 - 6 to 25 inches: sand
C2 - 25 to 60 inches: gravelly sand

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 1 percent
Available water supply, 0 to 60 inches: Very low (about 3.0 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: R030XF012CA - Sandy
Hydric soil rating: No

Minor Components

Cajon, gravelly surface

Percent of map unit: 5 percent
Landform: Alluvial fans

Helendale

Percent of map unit: 5 percent
Landform: Alluvial fans
Hydric soil rating: No

Kimberlina

Percent of map unit: 5 percent
Landform: Alluvial fans
Hydric soil rating: No

Data Source Information

Soil Survey Area: San Bernardino County, California, Mojave River Area
Survey Area Data: Version 13, Sep 13, 2021

San Bernardino County, California, Mojave River Area

118—CAJON-ARIZO COMPLEX, 2 TO 15 PERCENT SLOPES*

Map Unit Setting

National map unit symbol: hkrq
Elevation: 2,800 to 3,300 feet
Mean annual precipitation: 3 to 6 inches
Mean annual air temperature: 59 to 66 degrees F
Frost-free period: 180 to 290 days
Farmland classification: Not prime farmland

Map Unit Composition

Cajon, gravelly surface, and similar soils: 55 percent
Arizo and similar soils: 30 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Cajon, Gravelly Surface

Setting

Landform: Alluvial fans
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from granite sources

Typical profile

H1 - 0 to 6 inches: gravelly sand
H2 - 6 to 60 inches: gravelly sand

Properties and qualities

Slope: 2 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Rare
Frequency of ponding: None
Calcium carbonate, maximum content: 1 percent
Available water supply, 0 to 60 inches: Very low (about 3.0 inches)

Interpretive groups

Land capability classification (irrigated): 4s
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Ecological site: R030XF028CA - COBBLY SANDY
Hydric soil rating: No

Description of Arizo

Setting

Landform: Alluvial fans
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from granite sources

Typical profile

H1 - 0 to 6 inches: gravelly loamy sand
H2 - 6 to 60 inches: extremely gravelly loamy coarse sand

Properties and qualities

Slope: 2 to 9 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: NoneOccasional
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 3.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7w
Hydrologic Soil Group: A
Ecological site: R030XF025CA - GRAVELLY COARSE LOAMY
Hydric soil rating: No

Minor Components

Helendale

Percent of map unit: 4 percent
Hydric soil rating: No

Bryman

Percent of map unit: 4 percent
Hydric soil rating: No

Joshua

Percent of map unit: 4 percent
Hydric soil rating: No

Cajon, clayey substratum

Percent of map unit: 3 percent

Data Source Information

Soil Survey Area: San Bernardino County, California, Mojave River Area

Survey Area Data: Version 13, Sep 13, 2021

San Bernardino County, California, Mojave River Area

171—VILLA LOAMY SAND

Map Unit Setting

National map unit symbol: hktf
Elevation: 1,700 to 2,800 feet
Mean annual precipitation: 3 to 6 inches
Mean annual air temperature: 59 to 63 degrees F
Frost-free period: 180 to 280 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Villa and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Villa

Setting

Landform: Flood plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from granite

Typical profile

H1 - 0 to 7 inches: loamy sand
H2 - 7 to 60 inches: stratified sand to fine sandy loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: About 36 to 72 inches
Frequency of flooding: Rare
Frequency of ponding: None
Calcium carbonate, maximum content: 1 percent
Maximum salinity: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 4.9 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Ecological site: R030XF034CA - COARSE LOAMY BOTTOM
Hydric soil rating: No

Minor Components

Unnamed soils

Percent of map unit: 10 percent
Hydric soil rating: No

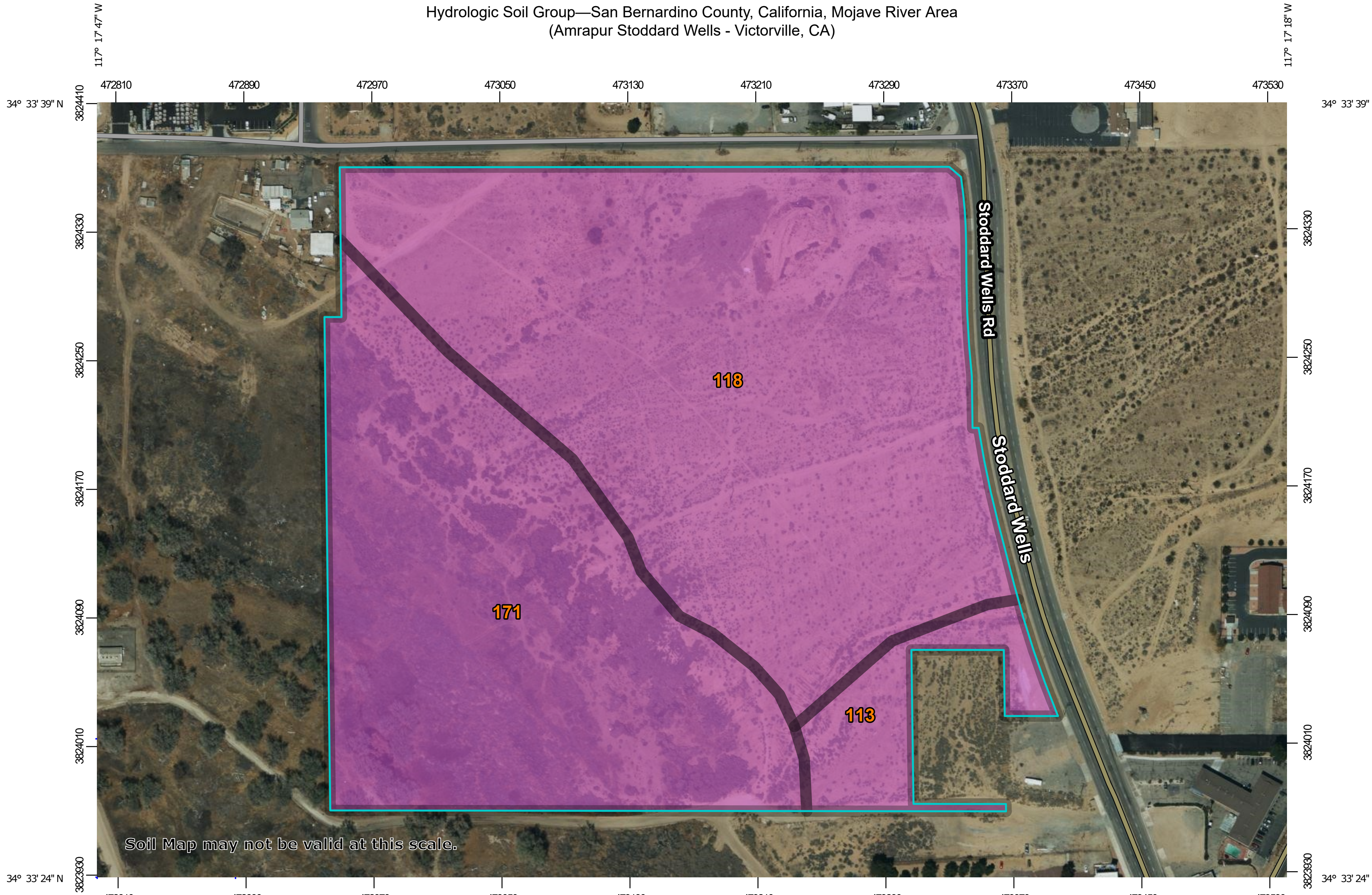
Unnamed

Percent of map unit: 5 percent
Landform: Fan remnants
Hydric soil rating: Yes

Data Source Information

Soil Survey Area: San Bernardino County, California, Mojave River Area
Survey Area Data: Version 13, Sep 13, 2021

Hydrologic Soil Group—San Bernardino County, California, Mojave River Area
(Amrapur Stoddard Wells - Victorville, CA)



Map Scale: 1:3,400 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 50, 100, 200, 300

Feet: 0, 150, 300, 600, 900

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 11N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

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Soil Survey Area: San Bernardino County, California, Mojave River Area
Survey Area Data: Version 13, Sep 13, 2021

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 27, 2021—May 24, 2021

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
113	CAJON SAND, 2 TO 9 PERCENT SLOPES	A	2.2	5.5%
118	CAJON-ARIZO COMPLEX, 2 TO 15 PERCENT SLOPES*	A	22.2	55.8%
171	VILLA LOAMY SAND	A	15.4	38.7%
Totals for Area of Interest			**39.8**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Depth to Water Table—San Bernardino County, California, Mojave River Area
(Amrapur Stoddard Wells - Victorville, CA)

Map Scale: 1:3,400 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 50, 100, 200, 300

Feet: 0, 150, 300, 600, 900

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 11N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

0 - 25

25 - 50

50 - 100

100 - 150

150 - 200

> 200

Not rated or not available

Soil Rating Lines

0 - 25

25 - 50

50 - 100

100 - 150

150 - 200

> 200

Not rated or not available

Soil Rating Points

0 - 25

25 - 50

50 - 100

100 - 150

150 - 200

> 200

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

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Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

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Depth to Water Table

Map unit symbol	Map unit name	Rating (centimeters)	Acres in AOI	Percent of AOI
113	CAJON SAND, 2 TO 9 PERCENT SLOPES	>200	2.2	5.5%
118	CAJON-ARIZO COMPLEX, 2 TO 15 PERCENT SLOPES*	>200	22.2	55.8%
171	VILLA LOAMY SAND	137	15.4	38.7%
Totals for Area of Interest			**39.8**	**100.0%**

Description

"Water table" refers to a saturated zone in the soil. It occurs during specified months. Estimates of the upper limit are based mainly on observations of the water table at selected sites and on evidence of a saturated zone, namely grayish colors (redoximorphic features) in the soil. A saturated zone that lasts for less than a month is not considered a water table.

This attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Rating Options

Units of Measure: centimeters

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Lower

Interpret Nulls as Zero: No

Beginning Month: January

Ending Month: December

Worksheet H: Factor of Safety and Design Infiltration Rate Worksheet

Factor Category		Factor Description	Assigned Weight (w)	Factor Value (v)	Product (p) $p = w \times v$
A	Suitability Assessment	Soil assessment methods	0.25	2	0.5
		Predominant soil texture	0.25	2	0.5
		Site soil variability	0.25	1	0.25
		Depth to groundwater / impervious layer	0.25	1	0.25
		Suitability Assessment Safety Factor, $S_A = \Sigma p$			1.5
B	Design	Tributary area size	0.25	3	0.75
		Level of pretreatment/ expected sediment loads	0.25	3	0.75
		Redundancy	0.25	3	0.75
		Compaction during construction	0.25	2	0.5
		Design Safety Factor, $S_B = \Sigma p$			2.75

Combined Safety Factor, $S_{TOT} = S_A \times S_B$	4.125
Measured Infiltration Rate, inch/hr, K_M (corrected for test-specific bias)	22.18
Design Infiltration Rate, in/hr, $K_{DESIGN} = S_{TOT} / K_M$	5.38

Supporting Data

Briefly describe infiltration test and provide reference to test forms:

Four (4) percolation test borings P-1 through P-4 were advanced to a depth of approximately five (5) feet below the existing ground surface. The proposed infiltration BMP will be located near P-1's boring location. The infiltration rate at P-1 was 22.18 inches per hour and this does not include a factor of safety. The infiltration testing was performed in general accordance with the County of San Bernardino Technical Guidance Document. Refer to the project's soils report provided in Appendix E.

Appendix C - BMP Educational Materials and BMP Details

StormTech®

MC-3500 & MC-4500 Design Manual

StormTech® Chamber Systems for Stormwater Management

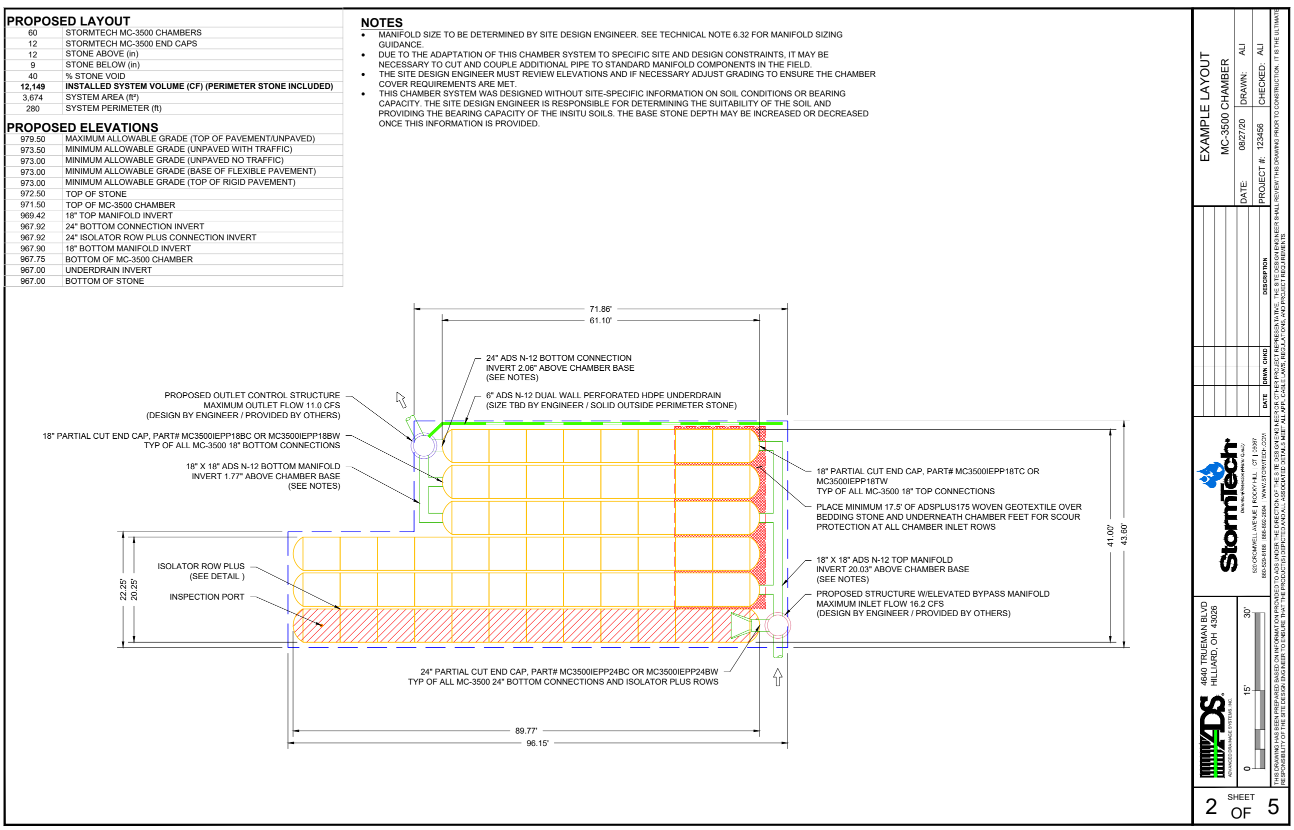
THE MOST ADVANCED NAME IN WATER MANAGEMENT SOLUTIONS®

ADS®

Table of Contents

*For SC-160LP, SC-310, SC-740 & DC-780 designs, please refer to the SC-160LP/SC-310/SC-740/DC-780 Design Manual.

StormTech Engineering Services assists design professionals in specifying StormTech stormwater systems. This assistance includes the layout of chambers to meet the engineer's volume requirements and the connections to and from the chambers. They can also assist converting and cost engineering projects currently specified with ponds, pipe, concrete vaults and other manufactured stormwater detention/retention products. Please note that it is the responsibility of the site design engineer to ensure that the chamber bed layout meets all design requirements and is in compliance with applicable laws and regulations governing a project.



This manual is exclusively intended to assist engineers in the design of subsurface stormwater systems using StormTech chambers.

StormTech MC-3500 Chamber

Designed to meet the most stringent industry performance standards for superior structural integrity while providing designers with a cost-effective method to save valuable land and protect water resources. The StormTech system is designed primarily to be used under parking lots, thus maximizing land usage for private (commercial) and public applications. StormTech chambers can also be used in conjunction with Green Infrastructure, thus enhancing the performance and extending the service life of these practices.

Stormtech MC-3500 Chamber
(not to scale)
Nominal Chamber Specifications

Size (L x W x H)
90” x 77” x 45”
2,286 mm x 1,956 mm x 1,143 mm

Chamber Storage
109.9 ft^3 (3.11 m^3)

Min. Installed Storage*
175.0 ft^3 (4.96 m^3)

Weight
134 lbs (60.8 kg)

Shipping
15 chambers/pallet
7 end caps/pallet
7 pallets/truck

*Assumes a minimum of 12” (300 mm) of stone above, 9” (230 mm) of stone below chambers, 6” (150 mm) of stone between chambers/end caps and 40% stone porosity.

Stormtech MC-3500 END CAP
(not to scale)
Nominal End Cap Specifications

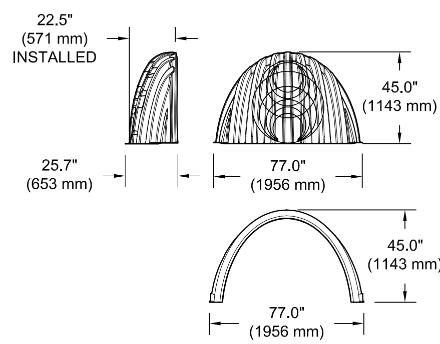
Size (L x W x H)
26.5” x 71” x 45.1”
673 mm x 1,803 mm x 1,145 mm

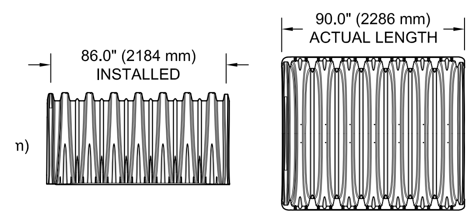
End Cap Storage
14.9 ft^3 (0.42 m^3)

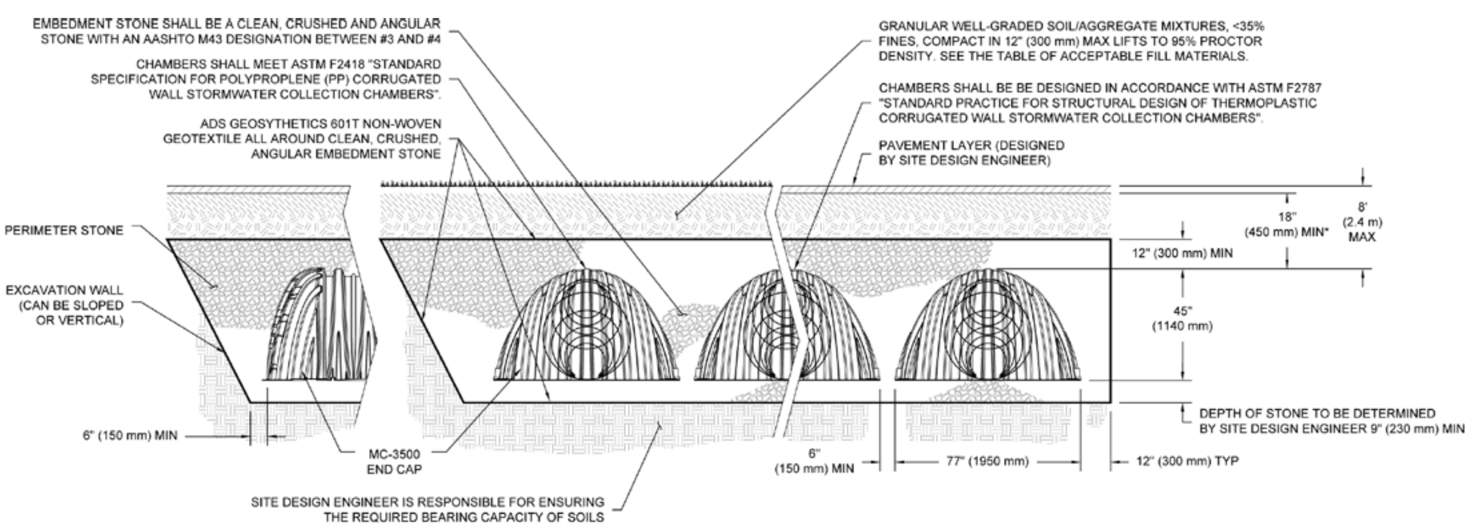
Min. Installed Storage*
45.1 ft^3 (1.28 m^3)

Weight
49 lbs (22.2 kg)

*Assumes a minimum of 12” (300 mm) of stone above, 9” (230 mm) of stone below, 6” (150 mm) of stone perimeter, 6” (150 mm) of stone between chambers/end caps and 40% stone porosity.







*MINIMUM COVER TO BOTTOM OF FLEXIBLE PAVEMENT. FOR UNPAVED INSTALLATIONS WHERE RUTTING FROM VEHICLES MAY OCCUR, INCREASE COVER TO 24" (600 mm).

StormTech MC-3500 Chamber

Storage Volume Per Chamber/End Cap ft³ (m³)

	Bare Unit Storage ft³ (m³)	Chamber/End Cap and Stone Volume — Stone Foundation Depth in. (mm)			
		9 (230)	12 (300)	15 (375)	18 (450)
MC-3500 Chamber	109.9 (3.11)	175.0 (4.96)	179.9 (5.09)	184.9 (5.24)	189.9 (5.38)
MC-3500 End Cap	14.9 (0.42)	45.1 (1.28)	46.6 (1.32)	48.3 (1.37)	49.9 (1.41)

Note: Assumes 6" (150 mm) row spacing, 40% stone porosity, 12" (300 mm) stone above and includes the bare chamber/end cap volume.

Amount of Stone Per Chamber

ENGLISH tons (yd³)	Stone Foundation Depth			
	9"	12"	15"	18"
Chamber	8.5 (6.0)	9.1 (6.5)	9.7 (6.9)	10.4 (7.4)
End Cap	3.9 (2.8)	4.1 (2.9)	4.3 (3.1)	4.5 (3.2)
METRIC kg (m³)	**230 mm**	**300 mm**	**375 mm**	**450 mm**
Chamber	7711 (4.6)	8255 (5.0)	8800 (5.3)	9435 (5.7)
End Cap	3538 (2.1)	3719 (2.2)	3901 (2.4)	4082 (2.5)

Note: Assumes 12" (300 mm) of stone above and 6" (150 mm) row spacing and 6" (150 mm) of perimeter stone in front of end caps.

Volume of Excavation Per Chamber/End Cap yd³ (m³)

	Stone Foundation Depth			
	9" (230 mm)	12" (300 mm)	15"(375 mm)	18"(450 mm)
Chamber	11.9 (9.1)	12.4 (9.5)	12.8 (9.8)	13.3 (10.2)
End Cap	4.0 (3.1)	4.1 (3.2)	4.3 (3.3)	4.4 (3.4)

Note: Assumes 6" (150 mm) of separation between chamber rows and 24" (600 mm) of cover. The volume of excavation will vary as depth of cover increases.

Special applications will be considered on a project by project basis. Please contact our application department should you have a unique application for our team to evaluate.

StormTech MC-4500 Chamber

Designed to meet the most stringent industry performance standards for superior structural integrity while providing designers with a cost-effective method to save valuable land and protect water resources. The StormTech system is designed primarily to be used under parking lots, thus maximizing land usage for private (commercial) and public applications. StormTech chambers can also be used in conjunction with Green Infrastructure, thus enhancing the performance and extending the service life of these practices.

Stormtech MC-4500 Chamber
(not to scale)
Nominal Chamber Specifications

Size (L x W x H)
52" x 100" x 60"
1321 mm x 2540 mm x 1524 mm

Chamber Storage
106.5 ft³ (3.01 m³)

Min. Installed Storage*
162.6 ft³ (4.60 m³)

Weight
Nominal 125 lbs (56.7 kg)

Shipping
7 chambers/pallet
5 end caps/pallet
11 pallets/truck

*Assumes a minimum of 12" (300 mm) of stone above, 9" (230 mm) of stone below chambers, 9" (230 mm) of stone between chambers/end caps and 40% stone porosity.

Stormtech MC-4500 end cap
(not to scale)
Nominal End Cap Specifications

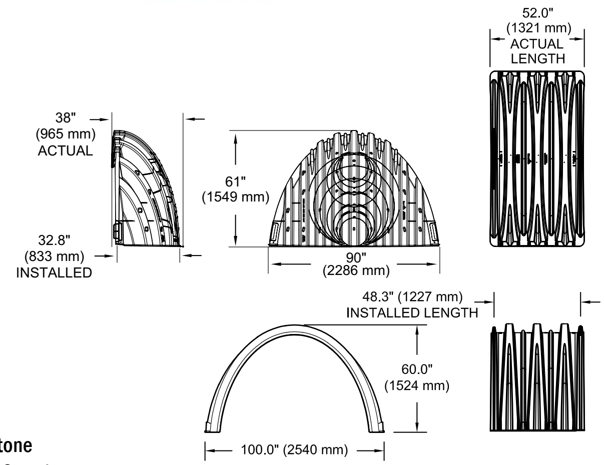
Size (L x W x H)
38" x 90" x 61"
965 mm x 2286 mm x 1549 mm

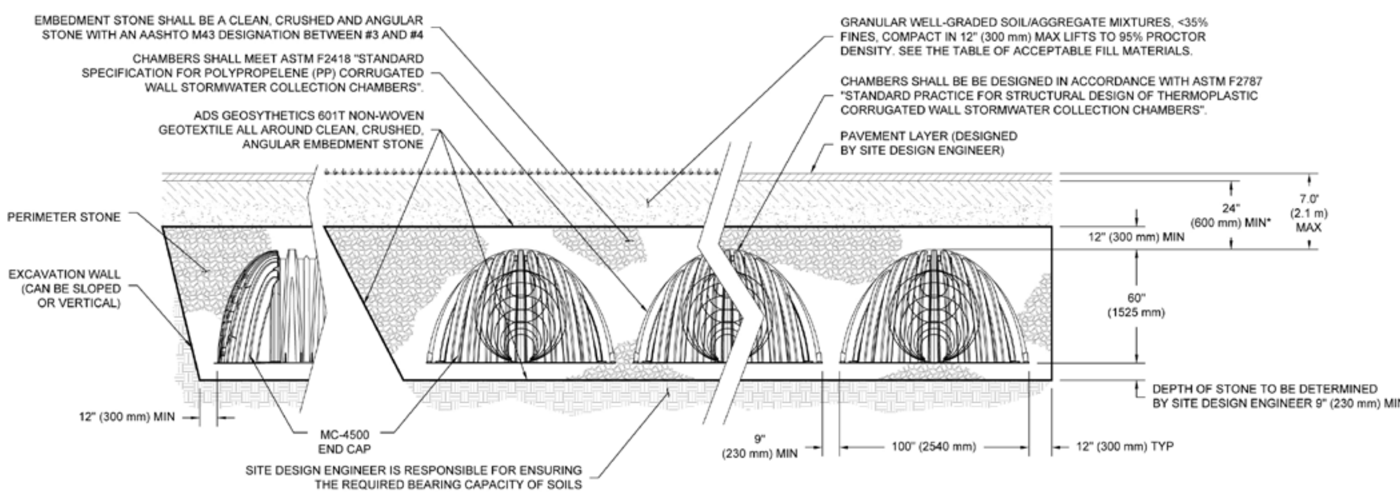
End Cap Storage
39.5 ft³ (1.12 m³)

Min. Installed Storage*
115.3 ft³ (3.26 m³)

Weight
Nominal 90.0 lbs (40.8 kg)

*Assumes a minimum of 12" (300 mm) of stone above, 9" (230 mm) of stone below, 12" (300 mm) of stone perimeter, 9" (230 mm) of stone between chambers/end caps and 40% stone porosity.





*MINIMUM COVER TO BOTTOM OF FLEXIBLE PAVEMENT. FOR UNPAVED INSTALLATIONS WHERE RUTTING FROM VEHICLES MAY OCCUR, INCREASE COVER TO 30" (750 mm).

StormTech MC-4500 Chamber

Storage Volume Per Chamber/End Cap ft^3 (m^3)

	Bare Unit Storage ft^3 (m^3)	Chamber/End Cap and Stone Volume — Stone Foundation Depth in. (mm)			
		9 (230)	12 (300)	15 (375)	18 (450)
MC-4500 Chamber	106.5 (3.02)	162.6 (4.60)	166.3 (4.71)	169.9 (4.71)	173.6 (4.91)
MC-4500 End Cap	39.5 (1.12)	115.3 (3.26)	111.9 (3.17)	121.9 (3.45)	125.2 (3.54)

Note: Assumes 9" (230 mm) row spacing, 40% stone porosity, 12" (300 mm) stone above and includes the bare chamber/end cap volume. End cap volume assumes 12" (300 mm) stone perimeter in front of end cap.

Amount of Stone Per Chamber

ENGLISH tons (yd^3)	Stone Foundation Depth			
	9"	**12"**	**15"**	**18"**
Chamber	7.4 (5.2)	7.8 (5.5)	8.3 (5.9)	8.8 (6.2)
End Cap	9.8 (7.0)	10.2 (7.3)	10.6 (7.6)	11.1 (7.9)
METRIC kg (m^3)	**230 mm**	**300 mm**	**375 mm**	**450 mm**
Chamber	6713 (4.0)	7076 (4.2)	7529 (4.5)	7983 (4.7)
End Cap	8890 (5.3)	9253 (5.5)	9616 (5.8)	10069 (6.0)

Note: Assumes 12" (300 mm) of stone above and 9" (230 mm) row spacing and 12" (300 mm) of perimeter stone in front of end caps.

Volume of Excavation Per Chamber/End Cap yd^3 (m^3)

	Stone Foundation Depth			
	9" (230 mm)	**12" (300 mm)**	**15"(375 mm)**	**18"(450 mm)**
Chamber	10.5 (8.0)	10.8 (8.3)	11.2 (8.5)	11.5 (8.8)
End Cap	9.7 (7.4)	10.0 (7.6)	10.3 (7.9)	10.6 (8.1)

Note: Assumes 9" (230 mm) of separation between chamber rows, 12" (300 mm) of perimeter in front of the end caps, and 24" (600 mm) of cover. The volume of excavation will vary as depth of cover increases.

Special applications will be considered on a project by project basis. Please contact our application department should you have a unique application for our team to evaluate.

1.0 Product Information

1.1 PRODUCT DESIGN

StormTech's commitment to thorough product testing programs, materials evaluation and adherence to national standards has resulted in two more superior products. Like other StormTech chambers, the MC-3500 and MC-4500 are designed to meet the full scope of design requirements of the American Society of Testing Materials (ASTM) International specification F2787 "Standard Practice for Structural Design of Thermoplastic Corrugated Wall Stormwater Collection Chambers" and produced to the requirements of the ASTM F 2418 "Standard Specification for Polypropylene (PP) Corrugated Stormwater Collection Chambers".

The StormTech MC-3500 and MC-4500 chambers provide the full AASHTO safety factors for live loads and permanent earth loads. The ASTM F 2787 standard provides specific guidance on how to design thermoplastic chambers in accordance with AASHTO Section 12.12. of the AASHTO LRFD Bridge Design Specifications. ASTM F 2787 requires that the safety factors included in the AASHTO guidance are achieved as a prerequisite to meeting ASTM F 2418. The three standards provide both the assurance of product quality and safe structural design.

The design of larger chambers in the same tradition of our other chambers required the collaboration of experts in soil-structure interaction, plastics and manufacturing. Years of extensive research, including laboratory testing and field verification, were required to produce chambers that are ready to meet both the rigors of installation and the longevity expected by engineers and owners.

This Design Manual provides the details and specifications necessary for consulting engineers to design stormwater management systems using the MC-3500 and MC-4500 chambers. It provides specifications for storage capacities, layout dimensions as well as requirements for design to ensure a long service life. The basic design concepts for foundation and backfill materials, subgrade bearing capacities and row spacing remain equally as pertinent for the MC-3500 and MC-4500 as the SC-740, SC-310 and DC-780 chamber systems. However, since many design values and dimensional requirements are different for these larger chambers than the SC-740, SC-310 and DC-780 chambers, design manuals and installation instructions are not interchangeable.

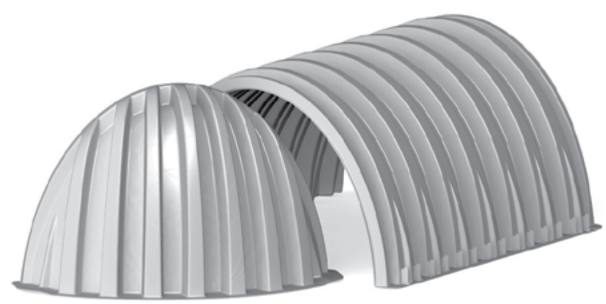
This manual includes only those details, dimensions, cover limits, etc for the MC-3500 and MC-4500 and is intended to be a stand-alone design guide for the MC-3500 and MC-4500 chambers. A Construction Guide specifically for these two chamber models has also been published.

1.2 TECHNICAL SUPPORT

The StormTech Technical Services Department is available to assist the engineer with the layout of MC-3500 and MC-4500 chamber systems and answer questions regarding all the StormTech chamber models. Call the Technical Services Department, email us at info@stormtech.com or contact your local StormTech representative.

1.3 MC-3500 AND MC-4500 CHAMBERS

All StormTech chambers are designed to the full scope of AASHTO requirements without repeating end walls or other structural reinforcing. StormTech's continuously curved, elliptical arch and the surrounding angular backfill are the key components of the structural system. With the addition of patent pending integral stiffening ribs **(Figure 5)**, the MC-3500 and MC-4500 are assured to provide a long, safe service life. Like other StormTech chambers, the MC-3500 and MC-4500 are produced from high quality, impact modified resins which are tested for short-term and long-term mechanical properties.



With all StormTech chambers, one chamber type is used for the start, middle and end of rows. Rows are formed by overlapping the upper joint corrugation of the next chamber over the lower joint corrugation of the previous chamber **(Figure 6)**.

1.4 CHAMBER JOINTS

All StormTech chambers are designed with an optimized joining system. The height and width of the end corrugations have been designed to provide the required structural safety factors while providing an unobstructed flow path down each row.

To assist the contractor, StormTech chambers are molded with simple assembly instructions and arrows that indicate the direction in which to build rows. The corrugation valley immediately adjacent to the lower joint corrugation is marked “Overlap Here - Lower Joint.” The corrugation valley immediately adjacent to the upper joint corrugation is marked “Build This Direction - Upper Joint.”

Two people can safely and efficiently carry and place chambers without cumbersome connectors, special tools or heavy equipment. Each row of chambers must begin and end with a joint corrugation. Since joint corrugations are of a different size than the corrugations along the body of the chamber, chambers cannot be field cut and installed. Only whole MC-3500 and MC-4500 chambers can be used. For system layout assistance contact StormTech.

1.5 MC-3500 AND MC-4500 END CAPS

The MC-3500 and MC-4500 end caps are easy to install. These end caps are designed with a corrugation joint that fits over the top of either end of the chamber. The end cap joint is simply set over the top of either of the upper or lower chamber joint corrugations **(Figure 7)**.

The MC-3500 end cap has pipe cutting guides for 12”–24” (300 mm–600 mm) top inverts **(Figure 9)**.

The MC-4500 end cap has pipe cutting guides for 12”–42” (300 mm–1050 mm) bottom inverts and 12”–24” (300 mm–600 mm) top inverts **(Figure 8)**.

Standard and custom pre-cored end caps are available. MC-3500 pre-cored end caps, 18” in diameter and larger include a welded crown plate.

FIGURE 5—Chamber and End Cap Components

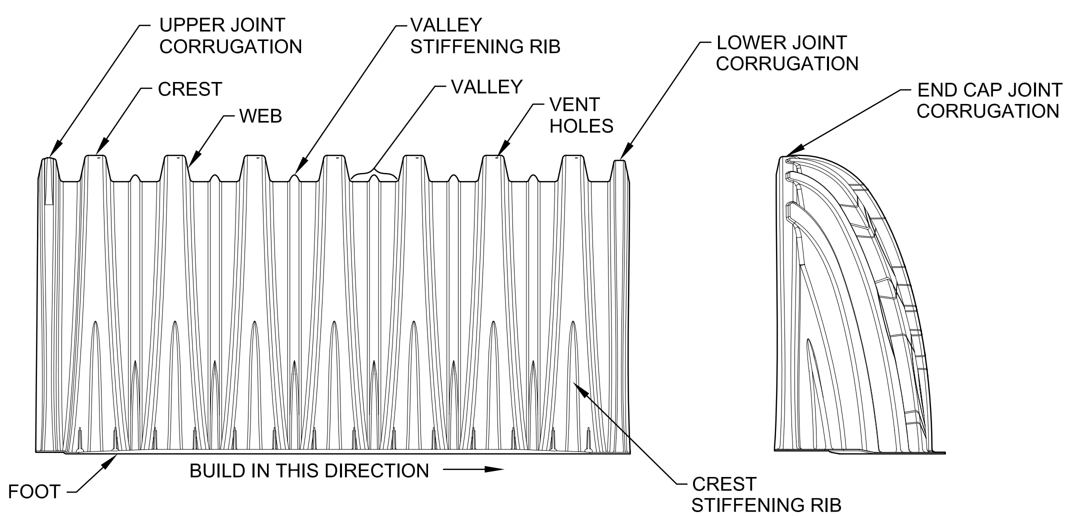


FIGURE 6—Chamber Joint Overlap

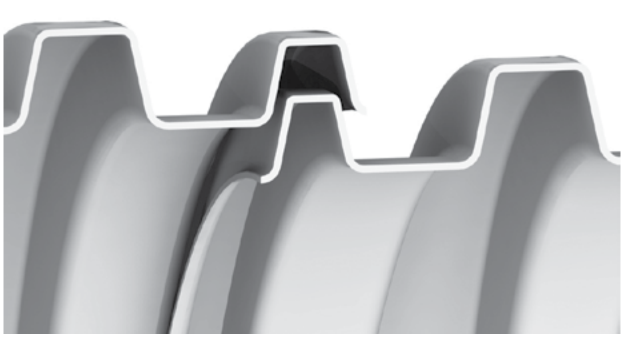
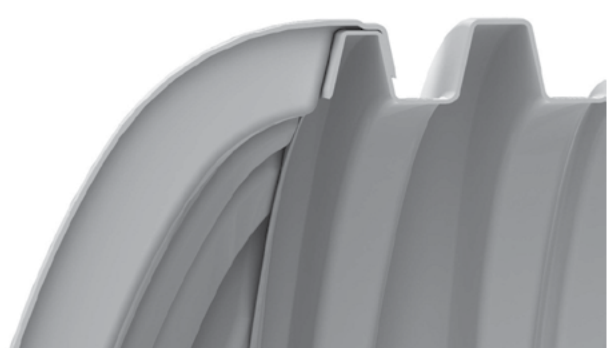


FIGURE 7—End Cap Joint Overlap



1.0 Product Information

FIGURE 8—MC-4500 End Cap Inverts

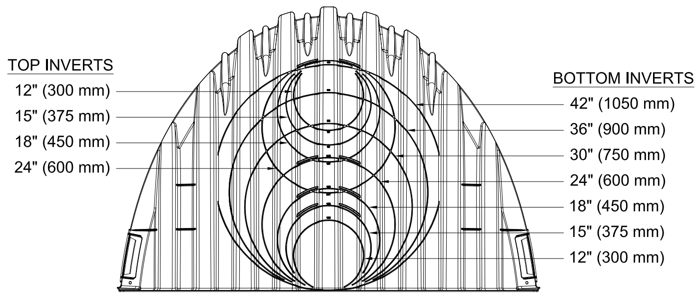
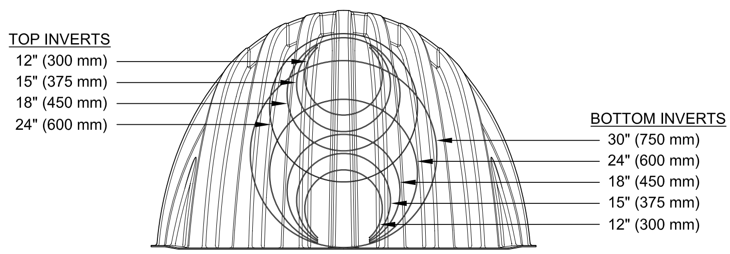


FIGURE 9—MC-3500 End Cap Inverts

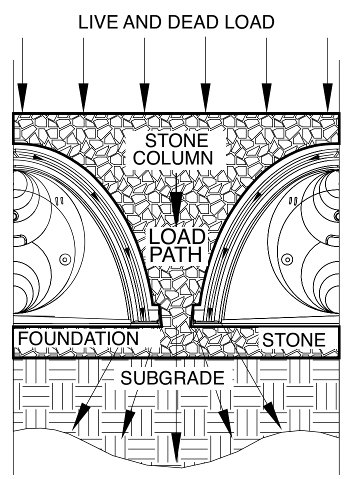


2.0 Foundations for Chambers

2.1 FOUNDATION REQUIREMENTS

StormTech chamber systems can be installed in various soil types. The subgrade bearing capacity and the cover height over the chambers determine the required depth of clean, crushed, angular foundation stone below the chambers. Foundation stone, also called bedding, is the stone between the subgrade soils and the feet of the chamber. Flexible structures are designed to transfer a signi f cant portion of both live and dead loads through the surrounding soils. Chamber systems accomplish this by creating load paths through the columns of embedment stone between and around the rows of chambers. This creates load concentrations at the base of the columns between the rows. The foundation stone spreads out the concentrated loads to distributed loads that can be supported by the subgrade soils.

Since increasing the cover height (top of chamber to f nished grade) causes increasing soil load, a greater depth of foundation stone is necessary to distribute the load to the subgrade soils. **Table 1** and **2** specify the minimum required foundation depths for varying cover heights and allowable subgrade bearing capacities. These tables are based on StormTech service loads. The minimum required foundation depth is 9” (230 mm) for both chambers. For additional guidance on foundation stone design please see our Technical Note 6.22 - StormTech Subgrade Performance



2.2 WEAKER SOILS

StormTech has not provided guidance for subgrade bearing capacities less than 2000 pounds per square foot [(2.0 ksf) (96 kPa)]. These soils are often highly variable, may contain organic materials and could be more sensitive to moisture. A geotechnical engineer must be consulted if soils with bearing capacities less than 2000 psf (96 kPa) are present.

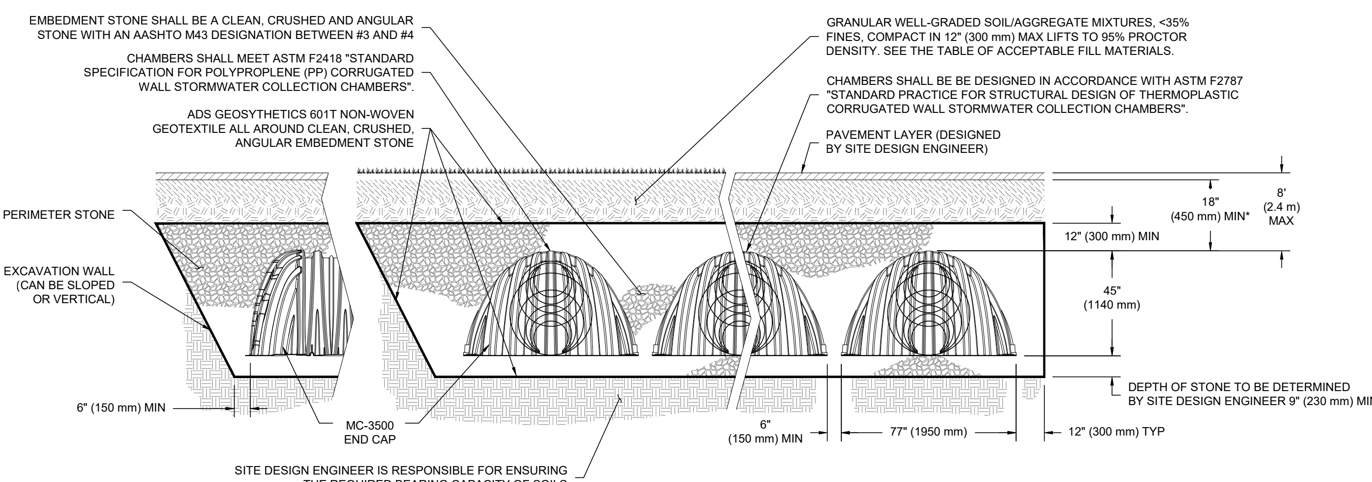
2.0 Foundations for Chambers

TABLE 1—MC-3500 Minimum Required Foundation Depth in inches (millimeters)
Assumes 6” (150 mm) row spacing.

Cover Hgt. ft. (m)	Minimum Bearing Resistance for Service Loads ksf (kPa)																						
	4.4 (211)	4.3 (206)	4.2 (201)	4.1 (196)	4.0 (192)	3.9 (187)	3.8 (182)	3.7 (177)	3.6 (172)	3.5 (168)	3.4 (163)	3.3 (158)	3.2 (153)	3.1 (148)	3.0 (144)	2.9 (139)	2.8 (134)	2.7 (129)	2.6 (124)	2.5 (120)	2.4 (115)	2.3 (110)	2.2 (105)	2.1 (101)	2.0 (96)
1.5 (0.46)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	18 (450)
2.0 (0.61)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)
2.5 (0.76)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	21 (525)
3.0 (0.91)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)
3.5 (1.07)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	24 (600)
4.0 (1.22)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	21 (525)	21 (525)	21 (525)	24 (600)	24 (600)
4.5 (1.37)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	21 (525)	24 (600)	24 (600)	27 (675)
5.0 (1.52)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	24 (600)	24 (600)	24 (600)	27 (675)	30 (750)
5.5 (1.68)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	24 (600)	24 (600)	24 (600)	27 (675)	27 (675)	30 (750)
6.0 (1.83)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	21 (525)	24 (600)	24 (600)	27 (675)	27 (675)	30 (750)	30 (750)
6.5 (1.98)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	21 (525)	24 (600)	24 (600)	27 (675)	27 (675)	30 (750)	30 (750)	30 (750)
7.0 (2.13)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	21 (525)	24 (600)	24 (600)	27 (675)	27 (675)	30 (750)	30 (750)	30 (750)	30 (750)
7.5 (2.30)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	21 (525)	24 (600)	24 (600)	27 (675)	27 (675)	27 (675)	30 (750)	30 (750)	30 (750)	30 (750)
8.0 (2.44)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	21 (525)	24 (600)	24 (600)	24 (600)	27 (675)	27 (675)	30 (750)	30 (750)	30 (750)	30 (750)	30 (750)

NOTE: The design engineer is solely responsible for assessing the bearing resistance (allowable bearing capacity) of the subgrade soils and determining the depth of foundation stone. Subgrade bearing resistance should be assessed with consideration for the range of soil moisture conditions expected under a stormwater system.

FIGURE 10A—MC-3500 Structural Cross Section Detail (Not to Scale)



*MINIMUM COVER TO BOTTOM OF FLEXIBLE PAVEMENT. FOR UNPAVED INSTALLATIONS WHERE RUTTING FROM VEHICLES MAY OCCUR, INCREASE COVER TO 24" (600 mm).

Special applications will be considered on a project by project basis. Please contact our applications department should you have a unique application for our team to evaluate.

2.0 Foundations for Chambers

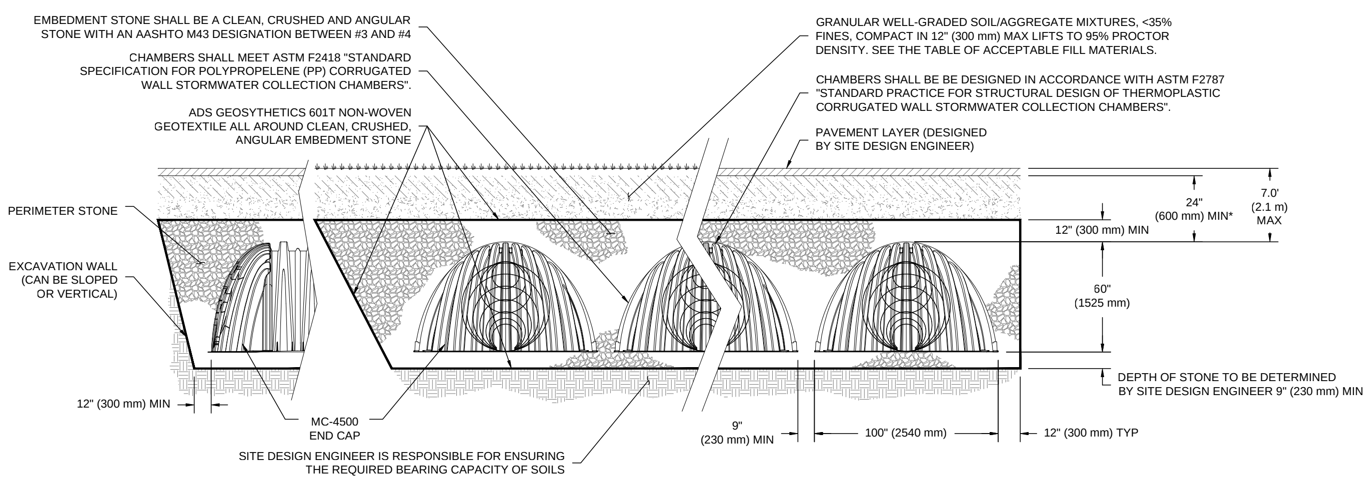
TABLE 2—MC-4500 Minimum Required Foundation Depth in inches (millimeters)

Assumes 9" (230 mm) row spacing.

Cover Hgt. ft. (m)	Minimum Bearing Resistance for Service Loads ksf (kPa)																								
	4.4 (211)	4.3 (206)	4.2 (201)	4.1 (196)	4.0 (192)	3.9 (187)	3.8 (182)	3.7 (177)	3.6 (172)	3.5 (168)	3.4 (163)	3.3 (158)	3.2 (153)	3.1 (148)	3.0 (144)	2.9 (139)	2.8 (134)	2.7 (129)	2.6 (124)	2.5 (120)	2.4 (115)	2.3 (110)	2.2 (105)	2.1 (101)	2.0 (96)
2.0 (0.61)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	21 (525)	21 (525)
2.5 (0.76)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	24 (600)
3.0 (0.91)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	21 (525)	21 (525)	24 (600)	24 (600)	27 (675)
3.5 (1.07)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	24 (600)	24 (600)	27 (675)	30 (750)
4.0 (1.22)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	21 (525)	24 (600)	27 (675)	27 (675)	30 (750)	30 (750)
4.5 (1.37)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	24 (600)	24 (600)	27 (675)	27 (675)	30 (750)	33 (825)	33 (825)
5.0 (1.52)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	21 (525)	24 (600)	24 (600)	27 (675)	27 (675)	30 (750)	33 (825)	33 (825)	36 (900)
5.5 (1.68)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	24 (600)	24 (600)	24 (600)	27 (675)	27 (675)	30 (750)	33 (825)	33 (825)	36 (900)	36 (900)
6.0 (1.83)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	21 (525)	24 (600)	24 (600)	27 (675)	27 (675)	30 (750)	30 (750)	33 (825)	33 (825)	36 (900)	36 (900)	36 (900)
6.5 (1.98)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	24 (600)	24 (600)	24 (600)	27 (675)	27 (675)	30 (750)	30 (750)	33 (825)	33 (825)	36 (900)	36 (900)	36 (900)	36 (900)
7.0 (2.13)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	21 (525)	24 (600)	24 (600)	24 (600)	27 (675)	27 (675)	30 (750)	30 (750)	33 (825)	36 (900)	36 (900)	36 (900)	36 (900)	36 (900)	36 (900)

NOTE: The design engineer is solely responsible for assessing the bearing resistance (allowable bearing capacity) of the subgrade soils and determining the depth of foundation stone. Subgrade bearing resistance should be assessed with consideration for the range of soil moisture conditions expected under a stormwater system.

FIGURE 10B—MC-4500 Structural Cross Section Detail (Not to Scale)



*MINIMUM COVER TO BOTTOM OF FLEXIBLE PAVEMENT. FOR UNPAVED INSTALLATIONS WHERE RUTTING FROM VEHICLES MAY OCCUR, INCREASE COVER TO 30" (750 mm).

Special applications will be considered on a project by project basis. Please contact our applications department should you have a unique application for our team to evaluate.

3.1 Foundation and Embedment Stone

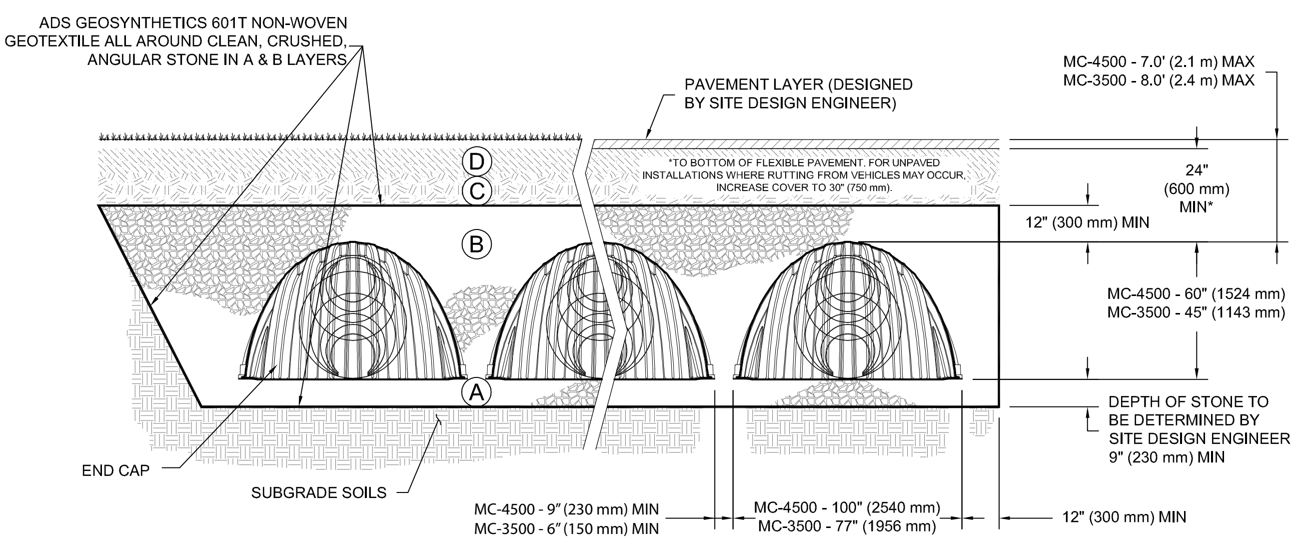
The stone surrounding the chambers consists of the foundation stone below the chambers and embedment stone surrounding the chambers. The foundation stone and embedment stone are important components of the structural system and also provide open void space for stormwater storage. **Table 3** provides the stone specifcations that achieve both structural requirements and a porosity of 40% for stormwater storage. **Figure 11** specifes the extents of each backfll stone location.

TABLE 3—Acceptable Fill Materials

MATERIAL LOCATION		DESCRIPTION	AASHTO DESIGNATION	COMPACTION/DENSITY REQUIREMENT
D	**FINAL FILL:** FILL MATERIAL FOR LAYER 'D' STARTS FROM THE TOP OF THE 'C' LAYER TO THE BOTTOM OF FLEXIBLE PAVEMENT OR UNPAVED FINISHED GRADE ABOVE. NOTE THAT PAVEMENT SUBBASE MAY BE PART OF THE 'D' LAYER	ANY SOIL/ROCK MATERIALS, NATIVE SOILS, OR PER ENGINEER'S PLANS. CHECK PLANS FOR PAVEMENT SUBGRADE REQUIREMENTS.	N/A	PREPARE PER SITE DESIGN ENGINEER'S PLANS. PAVED INSTALLATIONS MAY HAVE STRINGENT MATERIAL AND PREPARATION REQUIREMENTS.
C	**INITIAL FILL:** FILL MATERIAL FOR LAYER 'C' STARTS FROM THE TOP OF THE EMBEDMENT STONE ('B' LAYER) TO 24" (600 mm) ABOVE THE TOP OF THE CHAMBER. NOTE THAT PAVEMENT SUBBASE MAY BE A PART OF THE 'C' LAYER.	GRANULAR WELL-GRADED SOIL/AGGREGATE MIXTURES, <35% FINES OR PROCESSED AGGREGATE. MOST PAVEMENT SUBBASE MATERIALS CAN BE USED IN LIEU OF THIS LAYER.	AASHTO M145[1] A-1,A-2-4,A-3 OR AASHTO M43[1] 3, 357, 4, 467, 5, 56, 57, 6, 67, 68, 7, 78, 8, 89, 9, 10	BEGIN COMPACTOINS AFTER 24" (600 mm) OF MATERIAL OVER THE CHAMBERS IS REACHED. COMPACT ADDTIONAL LAYERS IN 12" (300 mm) MAX LIFTS TO A MIN. 95% PROCTOR DENSITY FOR WELL-GRADED MATERIAL AND 95% RELATIVE DENSITY FOR PROCESSED AGGREGATE MATERIALS.
B	**EMBEDMENT STONE:** FILL SURROUNDING THE CHAMBERS FORM THE FOUDATION STONE ('A' LAYER) TO THE 'C' LAYER ABOVE.	CLEAN, CRUSHED, ANGULAR STONE	AASHTO M43[1] 3, 4	NO COMPACTION REQUIRED
A	**FOUNDATION STONE:** FILL BELOW CHAMBERS FROM THE SUBGRADE UP TO THE FOOT (BOTTOM) OF THE CHAMBER.	CLEAN, CRUSHED, ANGULAR STONE	AASHTO M43[1] 3, 4	PLATE COMPACT OR ROLL TO ACHIEVE A FLAT SURFACE. [2 3]

PLEASE NOTE:
1. THE LISTED AASHTO DESIGNATIONS ARE FOR GRADATIONS ONLY. THE STONE MUST ALSO BE CLEAN, CRUSHED, ANGULAR. FOR EXAMPLE, A SPECIFICATION FOR #4 STONE WOULD STATE: "CLEAN, CRUSHED, ANGULAR NO. 4 (AASHTO M43) STONE".
2. STORMTECH COMPACTION REQUIREMENTS ARE MET FOR 'A' LOCATION MATERIALS WHEN PLACED AND COMPACTED IN 9" (230 mm) (MAX) LIFTS USING TWO FULL COVERAGES WITH A VIBRATORY COMPACTOR.
3. WHERE INFILTRATION SURFACES MAY BE COMPROMISED BY COMPACTION, FOR STANDARD DESIGN LOAD CONDITIONS, A FLAT SURFACE MAY BE ACHIEVED BY RAKING OR DRAGGING WITHOUT COMPACTION EQUIPMENT. FOR SPECIAL LOAD DESIGNS, CONTACT STORMTECH FOR COMPACTION REQUIREMENTS.

FIGURE 11—Fill Material Locations



Once layer 'C' is placed, any soil/material can be placed in layer 'D' up to the fnished grade. Most pavement subbase soils can be used to replace the materials of layer 'C' or 'D' at the design engineer's discretion.

3.0 Required Materials/Row Separation

3.2 FILL ABOVE CHAMBERS

Refer to **Table 3** and **Figure 11** for acceptable fill material above the clean, crushed, angular stone. StormTech requires a minimum of 24" (600 mm) from the top of the chamber to the bottom of flexible pavement. For non-paved installations where rutting from vehicles may occur StormTech requires a minimum of 30" (750 mm) from top of chamber to finished grade.

3.3 GEOTEXTILE SEPARATION

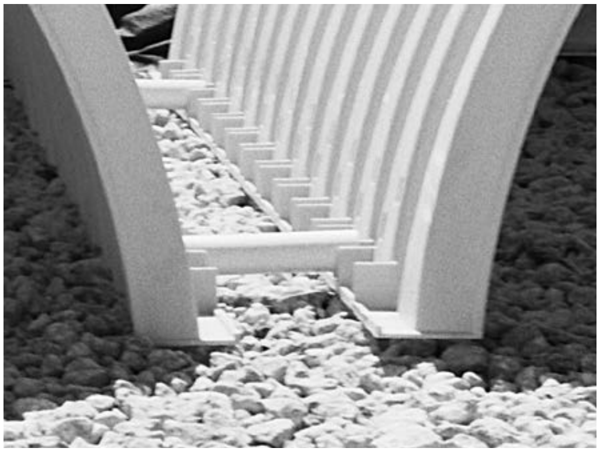
A non-woven geotextile meeting AASHTO M288 Class 2 separation requirements must be installed to completely envelope the system and prevent soil intrusion into the crushed, angular stone. Overlap adjacent geotextile rolls per AASHTO M288 separation guidelines. Contact StormTech for a list of acceptable geotextiles.

System Cross Section

3.4 PARALLEL ROW SEPARATION/ PERPENDICULAR BED SEPARATION

Parallel Row Separation

The minimum installed spacing between parallel rows after backfilling is 9" (230 mm) for the MC-4500 chambers and 6" (150mm) for the MC-3500 (measurement taken between the outside edges of the feet). Spacers may be used for layout convenience. Row spacing wider than the minimum spacing above may be specified.



Minimum Row Spacing

Perpendicular Bed Separation

When beds are laid perpendicular to each other, a minimum installed spacing of 36" (900 mm) between beds is required.

3.5 Special Structural Designs

StormTech engineers may provide special structural designs to enable deeper cover depths or increase the capacity to carry higher live loads. Special designs may utilize the additional strength that can be achieved by compaction of embedment stone or by increasing the spacing between rows.

Increasing the spacing between chamber rows may also facilitate the application of StormTech chambers with either less foundation stone or with weaker subgrade soils. This may be a good option where vertical restrictions on site prevent the use of a deeper foundation.

Contact ADS Engineering Services for more information on special structural designs.

4.0 Hydraulics

4.1 GENERAL

StormTech subsurface chamber systems offer the fexibility for a variety of inlet and outlet confgurations. Contact the StormTech Technical Services Department or your local StormTech representative for assistance confguring inlet and outlet connections.

The open graded stone around and under the chambers provides a signifcant conveyance capacity ranging from approximately 0.8 cfs (23 l/s) to 13 cfs (368 l/s) per MC-3500 chamber and 0.54 cfs (15 l/s) to 8.5 cfs (240 l/s) for the MC-4500 chamber. The actual conveyance capacity is dependent upon stone size, depth of foundation stone and head of water. Although the high conveyance capacity of the open graded stone is an important component of the fow network, StormTech recommends that a system of inlet and outlet manifolds be designed to distribute and convey the peak fow through the chamber system.

It is the responsibility of the design engineer to provide the design fow rates and storage volumes for the stormwater system and to ensure that the fnal design meets all conveyance and storage requirements. However, StormTech will work with the design engineer to assist with manifold and chamber layouts that meet the design objectives.

4.2 THE ISOLATOR® ROW PLUS

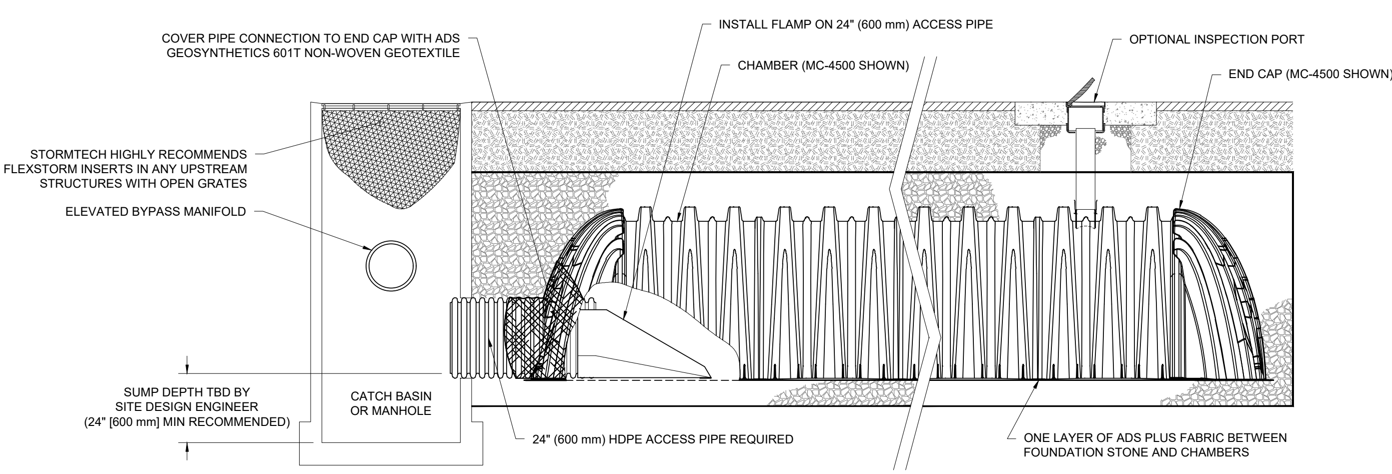
The Isolator Row PLUS is a patented system that inexpensively captures total suspended solids (TSS) and debris and provides easy access for inspection and maintenance. In a typical confguration, a single layer of ADS PLUS fabric is placed between the chambers and the stone foundations. This fabric traps and flters sediments as well as protects the stone base during cleaning and maintenance. Each installed MC-3500 chamber and MC-3500 end cap provides 42.9 ft2 (4.0 m2) and 7.5 ft2 (0.7 m2) of bottom flter area respectively. Each installed MC-4500 chamber and MC-4500 end cap provides 30.1 ft^2 (2.80 m^2) and 12.8 ft^2 (1.19 m^2) of bottom flter area respectively.

The Isolator Row PLUS can be confgured for maintenance objectives or, in some regulatory jurisdictions, for water quality objectives. For water quality applications, the Isolator Row PLUS can be sized based on water quality volume or fow rate.

All Isolator Plus Rows require: 1) a manhole for maintenance access, 2) a means of diversion of fows to the Isolator Row PLUS 3) a high fow bypass and 4) FLAMP (Flared End Ramp). When used on an Isolator Row PLUS, a 24" FLAMP (fared end ramp) is attached to the inside of the inlet pipe with a provided threaded rod and bolt. The FLAMP then lays on top of the ADS PLUS fabric.. Flow diversion can be accomplished by either a weir in the upstream access manhole or simply by feeding the Isolator Row PLUS at a lower elevation than the high fow bypass. Contact StormTech for assistance sizing Isolator Plus Rows.

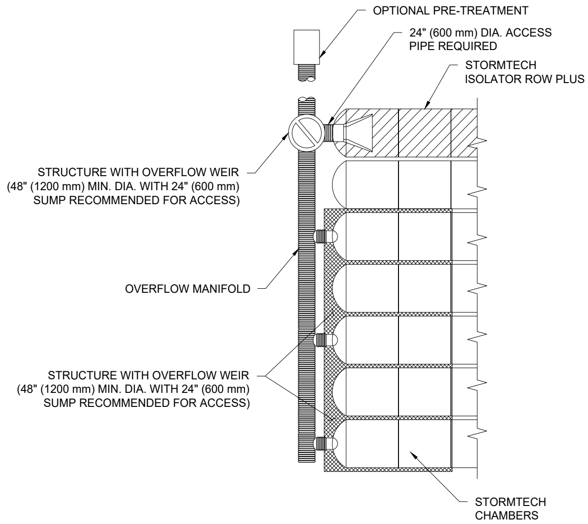
When additional stormwater treatment is required, StormTech systems can be confgured using a treatment train approach where other stormwater BMPs are located in series.

FIGURE 12—StormTech Isolator Row PLUS Detail



4.0 Hydraulics

FIGURE 13—Typical Inlet Configuration With Isolator Row PLUS and Scour Protection



4.3 INLET MANIFOLDS

The primary function of the inlet manifold is to convey and distribute f ows to a suff cient number of rows in the chamber bed such that there is ample conveyance capacity to pass the peak f ows without creating an unacceptable backwater condition in upstream piping or scour the foundation stone under the chambers.

Manifolds are connected to the end caps either at the top or bottom of the end cap. Standard distances from the base of chamber to the invert of inlet and outlet manifolds connecting to StormTech end caps can be found in table 6. High inlet f ow rates from either connection location produce a shear scour potential of the foundation stone. Inlet f ows from top inlets also produce impingement scour potential. Scour potential is reduced when standing water is present over the foundation stone. However, for safe design across the wide range of applications, StormTech assumes minimal standing water at the time the design f ow occurs.

To minimize scour potential, StormTech recommends the installation of woven scour protection fabric at each inlet row. This enables a protected transition zone from the concentrated f ow coming out of the inlet pipe to a uniform f ow across the entire width of the chamber for both top and bottom connections.

Allowable f ow rates for design are dependent upon: the elevation of inlet pipe, foundation stone size and scour protection. With an appropriate scour protection geotextile installed from the end cap to at least 14.5 ft (4.42 m) in front of the inlet pipe for the MC-3500 and for the MC-4500, for both top and bottom feeds, the f ow rates listed in **Table 4** can be used for all StormTech specif ed foundation stone gradations.

***See StormTech's Tech Note 6.32 for manifold sizing guidance.**

Table 4—Allowable Inlet Flows*

Inlet Pipe Diameter Inches (mm)	Allowable Maximum Flow Rate cfs (l/s)
12 (300)	2.48 (70)
15 (375)	3.5 (99)
18 (450)	5.5 (156)
24 (600)	8.5 (241) [MC-3500]
24 (600)	9.5 (269) [MC-4500]

*Assumes appropriate length of scour fabric per section 4.3

Table 5—Maximum Outlet Flow Rate Capacities From StormTech Oulet Manifolds

PIPE DIA.	FLOW (CFS)	FLOW (L/S)
6" (150 mm)	0.4	11.3
8" (200 mm)	0.7	19.8
10" (250 mm)	1.0	28.3
12" (300 mm)	2.0	56.6
15" (375 mm)	2.7	76.5
18" (450 mm)	4.0	113.3
24" (600 mm)	7.0	198.2
30" (750 mm)	11.0	311.5
36" (900 mm)	16.0	453.1
42" (1050 mm)	22.0	623.0
48" (1200 mm)	28.0	792.9

Table 6—Standard Distances From Base of Chamber to Invert of Inlet and Outlet Manifolds on StormTech End Caps

MC-3500 ENDCAPS			
	PIPE DIA.	INV. (IN)	INV. (MM)
TOP	6" (150 mm)	33.21	841
	8" (200 mm)	31.16	789
	10" (250 mm)	29.04	738
	12" (300 mm)	26.36	671
	15" (375 mm)	23.39	594
	18" (450 mm)	20.03	509
	24" (600 mm)	14.48	369
BOTTOM	12" (750 mm)	1.35	34
	15" (900 mm)	1.5	40
	18" (1050 mm)	1.77	46
	24" (1200 mm)	2.06	52

MC-4500 ENDCAPS			
	PIPE DIA.	INV. (IN)	INV. (MM)
TOP	12" (300 mm)	35.69	907
	15" (375 mm)	32.72	831
	18" (450 mm)	29.36	746
	24" (600 mm)	23.05	585
BOTTOM	12" (750 mm)	1.55	34
	15" (900 mm)	1.7	43
	18" (1050 mm)	1.97	50
	24" (1200 mm)	2.26	57

4.4 OUTLET MANIFOLDS

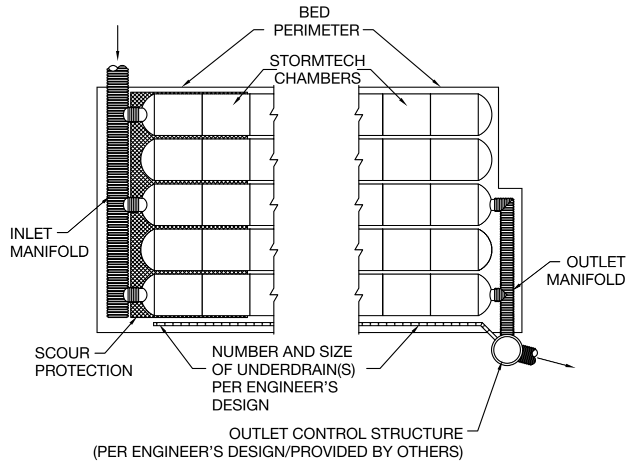
The primary function of the outlet manifold is to convey peak fows from the chamber system to the outlet control structure. Outlet manifolds are often sized for attenuated fows. They may be smaller in diameter and have fewer row connections than inlet manifolds. In some applications however, the intent of the outlet piping is to convey an unattenuated bypass fow rate and manifolds may be sized similar to inlet manifolds.

Since chambers are generally fowing at or near full at the time of the peak outlet fow rate, scour is generally not governing and outlet manifold sizing is based on pipe fow equations. In most cases, StormTech recommends that outlet manifolds connect the same rows that are connected to an inlet manifold. This provides a continuous fow path through open conduits to pass the peak fow without dependence on passing peak fows through stone.

The primary function of the underdrains is to draw down water stored in the stone below the invert of the manifold. Underdrains are generally not sized for conveyance of the peak fow.

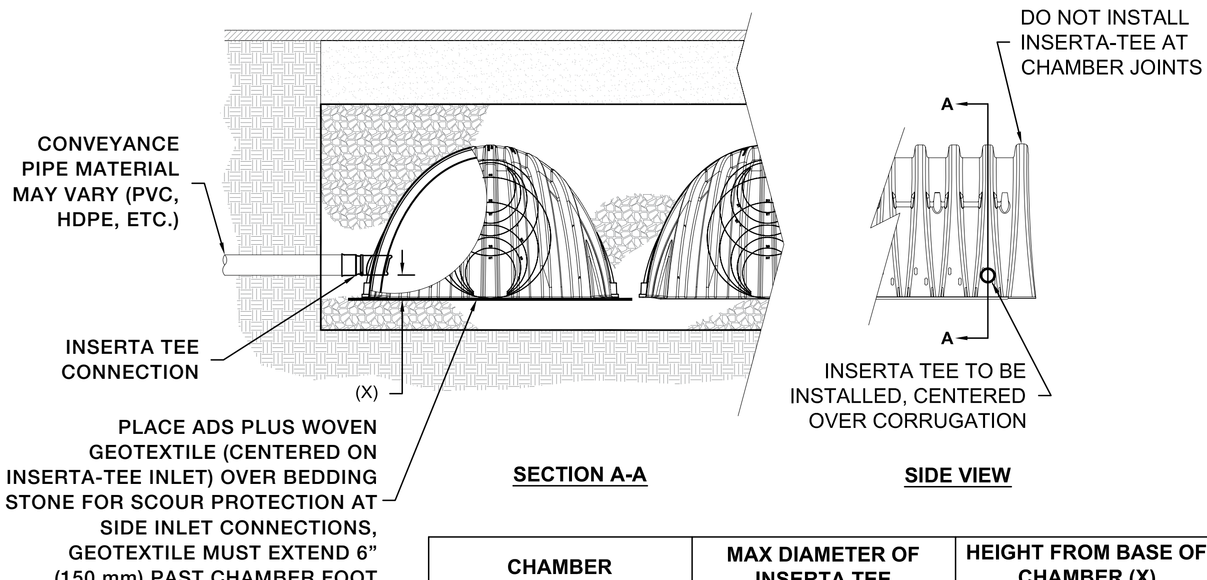
The maximum outlet fow rate capacities from StormTech outlet manifolds can be found in **Table 5.**

FIGURE 14—Typical Inlet, Outlet and Underdrain Configuration



4.5 INSERTA TEE INLET CONNECTIONS

FIGURE 15—Inserta Tee Detail



CHAMBER	MAX DIAMETER OF INSERTA TEE	HEIGHT FROM BASE OF CHAMBER (X)
MC-3500	12" (250 mm)	6" (150 mm)
MC-4500	12" (250 mm)	8" (200 mm)
INSERTA TEE FITTINGS AVAILABLE FOR SDR 26, SDR 35, SCH 40 IPS GASKETED & SOLVENT WELD, N-12, HP STORM, C-900 OR DUCTILE IRON		

NOTE:
PART NUMBERS WILL VARY BASED ON INLET PIPE MATERIALS. CONTACT STORMTECH FOR MORE INFORMATION.

5.0 Cumulative Storage Volumes

Tables 7 and **8** provide cumulative storage volumes for the MC-3500 chamber and end cap. These tables can be used to calculate the stage-storage relationship for the retention or detention system. Digital spreadsheets in which the number of chambers and end caps can be input for quick cumulative storage calculations are available at www.stormtech.com. For assistance with site-specific calculations or input into routing software, contact the StormTech Technical Services Department.

TABLE 7 – MC-3500 Incremental Storage Volume Per Chamber

Assumes 40% stone porosity. Calculations are based upon a 9" (230 mm) stone base under the chambers, 12" (300 mm) of stone above chambers, and 6" (150 mm) of spacing between chambers.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage ft^3 (m^3)	Total System Cumulative Storage ft^3 (m^3)
66 (1676)	0.00	175.02 (4.956)
65 (1651)	0.00	173.36 (4.909)
64 (1626)	0.00	171.71 (4.862)
63 (1600)	Stone 0.00	170.06 (4.816)
62 (1575)	Cover 0.00	168.41 (4.7.69)
61 (1549)	0.00	166.76 (4.722)
60 (1524)	0.00	165.10 (4.675)
59 (1499)	0.00	163.45 (4.628)
58 (1473)	0.00	161.80 (4.582)
57 (1448)	0.00	160.15 (4.535)
56 (1422)	0.00	158.49 (4.488)
55 (1397)	0.00	156.84 (4.441)
54 (1372)	109.95 (3.113)	155.19 (4.394)
53 (1346)	109.89 (3.112)	153.50 (4.347)
52 (1321)	109.69 (3.106)	151.73 (4.297)
51 (1295)	109.40 (3.098)	149.91 (4.245)
50 (1270)	109.00 (3.086)	148.01 (4.191)
49 (1245)	108.31 (3.067)	145.95 (4.133)
48 (1219)	107.28 (3.038)	143.68 (4.068)
47 (1194)	106.03 (3.003)	141.28 (4.000)
46 (1168)	104.61 (2.962)	138.77 (3.930)
45 (1143)	103.04 (2.918)	136.17 (3.856)
44 (1118)	101.33 (2.869)	133.50 (3.780)
43 (1092)	99.50 (2.818)	130.75 (3.702)
42 (1067)	97.56 (2.763)	127.93 (3.623)
41 (1041)	95.52 (2.705)	125.06 (3.541)
40 (1016)	93.39 (2.644)	122.12 (3.458)
39 (991)	91.16 (2.581)	119.14 (3.374)
38 (965)	88.86 (2.516)	116.10 (3.288)
37 (948)	86.47 (2.449)	113.02 (3.200)
36 (914)	84.01 (2.379)	109.89 (3.112)
35 (889)	81.49 (2.307)	106.72 (3.022)
34 (864)	78.89 (2.234)	103.51 (2.931)
33 (838)	76.24 (2.159)	100.27 (2.839)
32 (813)	73.52 (2.082)	96.98 (2.746)
31 (787)	70.75 (2.003)	93.67 (2.652)
30 (762)	67.92 (1.923)	90.32 (2.558)
29 (737)	65.05 (1.842)	86.94 (2.462)
28 (711)	62.12 (1.759)	83.54 (2.366)
27 (686)	59.15 (1.675)	80.10 (2.268)
26 (680)	56.14 (1.590)	76.64 (2.170)
25 (635)	53.09 (1.503)	73.16 (2.072)
24 (610)	49.99 (1.416)	69.65 (1.972)
23 (584)	46.86 (1.327)	66.12 (1.872)
22 (559)	43.70 (1.237)	62.57 (1.772)
21 (533)	40.50 (1.147)	59.00 (1.671)
20 (508)	37.27 (1.055)	55.41 (1.569)
19 (483)	34.01 (0.963)	51.80 (1.467)
18 (457)	30.72 (0.870)	48.17 (1.364)
17 (432)	27.40 (0.776)	44.53 (1.261)
16 (406)	24.05 (0.681)	40.87 (1.157)
15 (381)	20.69 (0.586)	37.20 (1.053)
14 (356)	17.29 (0.490)	33.51 (0.949)
13 (330)	13.88 (0.393)	29.81 (0.844)
12 (305)	10.44 (0.296)	26.09 (0.739)
11 (279)	6.98 (0.198)	22.37 (0.633)
10 (254)	3.51 (0.099)	18.63 (0.527)
9 (229)	0.00	14.87 (0.421)
8 (203)	0.00	13.22 (0.374)
7 (178)	0.00	11.57 (0.328)
6 (152)	Stone 0.00	9.91 (0.281)
5 (127)	Foundation 0.00	8.26 (0.234)
4 (102)	0.00	6.61 (0.187)
3 (76)	0.00	4.96 (0.140)
2 (51)	0.00	3.30 (0.094)
1 (25)	0.00	1.65 (0.047)

NOTE: Add 1.65 ft^3 (0.047 m^3) of storage for each additional inch (25 mm) of stone foundation.
Contact StormTech for cumulative volume spreadsheets in digital format.

5.0 Cumulative Storage Volume

TABLE 8 – MC-3500 Incremental Storage Volume Per End Cap

Assumes 40% stone porosity. Calculations are based upon a 9" (230 mm) stone base under the chambers, 12" (300 mm) of stone above end caps, and 6" (150 mm) of spacing between end caps and 6" (150 mm) of stone perimeter.

Depth of Water in System Inches (mm)	Cumulative End Cap Storage ft^3 (m^3)	Total System Cumulative Storage ft^3 (m^3)
66 (1676)	0.00	45.10 (1.277)
65 (1651)	0.00	44.55 (1.262)
64 (1626)	0.00	44.00 (1.246)
63 (1600)	Stone 0.00	43.46 (1.231)
62 (1575)	Cover 0.00	42.91 (1.2.15)
61 (1549)	0.00	42.36 (1.200)
60 (1524)	0.00	41.81 (1.184)
59 (1499)	0.00	41.27 (1.169)
58 (1473)	0.00	40.72 (1.153)
57 (1448)	0.00	40.17 (1.138)
56 (1422)	0.00	39.62 (1.122)
55 (1397)	0.00	39.08 (1.107)
54 (1372)	15.64 (0.443)	38.53 (1.091)
53 (1346)	15.64 (0.443)	37.98 (1.076)
52 (1321)	15.63 (0.443)	37.42 (1.060)
51 (1295)	15.62 (0.442)	36.85 (1.043)
50 (1270)	15.60 (0.442)	36.27 (1.027)
49 (1245)	15.56 (0.441)	35.68 (1.010)
48 (1219)	15.51 (0.439)	35.08 (0.993)
47 (1194)	15.44 (0.437)	34.47 (0.976)
46 (1168)	15.35 (0.435)	33.85 (0.959)
45 (1143)	15.25 (0.432)	33.22 (0.941)
44 (1118)	15.13 (0.428)	32.57 (0.922)
43 (1092)	14.99 (0.424)	31.91 (0.904)
42 (1067)	14.83 (0.420)	31.25 (0.885)
41 (1041)	14.65 (0.415)	30.57 (0.866)
40 (1016)	14.45 (0.409)	29.88 (0.846)
39 (991)	14.24 (0.403)	29.18 (0.826)
38 (965)	14.00 (0.396)	28.48 (0.806)
37 (948)	13.74 (0.389)	27.76 (0.786)
36 (914)	13.47 (0.381)	27.04 (0.766)
35 (889)	13.18 (0.373)	26.30 (0.745)
34 (864)	12.86 (0.364)	25.56 (0.724)

Depth of Water in System Inches (mm)	Cumulative Chamber Storage ft^3 (m^3)	Total System Cumulative Storage ft^3 (m^3)
33 (838)	12.53 (0.355)	24.82 (0.703)
32 (813)	12.18 (0.345)	24.06 (0.681)
31 (787)	11.81 (0.335)	23.30 (0.660)
30 (762)	11.42 (0.323)	22.53 (0.638)
29 (737)	11.01 (0.312)	21.75 (0.616)
28 (711)	10.58 (0.300)	20.96 (0.594)
27 (686)	10.13 (0.287)	20.17 (0.571)
26 (680)	9.67 (0.274)	19.37 (0.549)
25 (635)	9.19 (0.260)	18.57 (0.526)
24 (610)	8.70 (0.246)	17.76 (0.503)
23 (584)	8.19 (0.232)	16.94 (0.480)
22 (559)	7.67 (0.217)	16.12 (0.456)
21 (533)	7.13 (0.202)	15.29 (0.433)
20 (508)	6.59 (0.187)	14.45 (0.409)
19 (483)	6.03 (0.171)	13.61 (0.385)
18 (457)	5.46 (0.155)	12.76 (0.361)
17 (432)	4.88 (0.138)	11.91 (0.337)
16 (406)	4.30 (0.122)	11.06 (0.313)
15 (381)	3.70 (0.105)	10.20 (0.289)
14 (356)	3.10 (0.088)	9.33 (0.264)
13 (330)	2.49 (0.071)	8.46 (0.240)
12 (305)	1.88 (0.053)	7.59 (0.215)
11 (279)	1.26 (0.036)	6.71 (0.190)
10 (254)	0.63 (0.018)	5.83 (0.165)
9 (229)	0.00	4.93 (0.139)
8 (203)	0.00	4.38 (0.124)
7 (178)	0.00	3.83 (0.108)
6 (152)	Stone 0.00	3.28 (0.093)
5 (127)	Foundation 0.00	2.74 (0.077)
4 (102)	0.00	2.19 (0.062)
3 (76)	0.00	1.64 (0.046)
2 (51)	0.00	1.09 (0.031)
1 (25)	0.00	0.55 (0.015)

NOTE: Add 0.56 ft^3 (0.016 m^3) of storage for each additional inch (25 mm) of stone foundation.
Contact StormTech for cumulative volume spreadsheets in digital format.

5.0 Cumulative Storage Volumes

Tables 9 and **10** provide cumulative storage volumes for the MC-4500 chamber and end cap. These tables can be used to calculate the stage-storage relationship for the retention or detention system. Digital spreadsheets in which the number of chambers and end caps can be input for quick cumulative storage calculations are available at www.stormtech.com. For assistance with site-specific calculations or input into routing software, contact the StormTech Technical Services Department.

TABLE 9 – MC-4500 Incremental Storage Volume Per Chamber

Assumes 40% stone porosity. Calculations are based upon a 9” (230 mm) stone base under the chambers, 12” (300 mm) of stone above chambers, and 9” (230 mm) of spacing between chambers.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage ft³ (m³)	Total System Cumulative Storage ft³ (m³)
81 (2057)	0.00	162.62 (4.065)
80 (2032)	0.00	161.40 (4.570)
79 (2007)	0.00	160.18 (4.536)
78 (1981)	Stone 0.00	158.98 (4.501)
77 (1956)	Cover 0.00	157.74 (4.467)
76 (1930)	0.00	156.62 (4.432)
75 (1905)	0.00	155.30 (4.398)
74 (1880)	0.00	154.09 (4.363)
73 (1854)	0.00	152.87 (4.329)
72 (1829)	0.00	151.65 (4.294)
71 (1803)	0.00	150.43 (4.294)
70 (1778)	0.00	149.21 (4.225)
69 (1753)	106.51 (3.016)	147.99 (4.191)
68 (1727)	106.47 (3.015)	146.75 (4.156)
67 (1702)	106.35 (3.012)	145.46 (4.119)
66 (1676)	106.18 (3.007)	144.14 (4.082)
65 (1651)	105.98 (3.001)	142.80 (4.044)
64 (1626)	105.71 (2.993)	141.42 (4.005)
63 (1600)	105.25 (2.981)	139.93 (3.962)
62 (1575)	104.59 (2.962)	138.31 (3.917)
61 (1549)	103.79 (2.939)	136.61 (3.869)
60 (1524)	102.88 (2.913)	134.85 (3.819)
59 (1499)	101.88 (2.885)	133.03 (3.767)
58 (1473)	100.79 (2.854)	131.16 (3.714)
57 (1448)	99.63 (2.821)	129.24 (3.660)
56 (1422)	98.39 (2.786)	127.28 (3.604)
55 (1397)	97.10 (2.749)	125.28 (3.548)
54 (1372)	95.73 (2.711)	123.25 (3.490)
53 (1346)	94.32 (2.671)	121.18 (3.490)
52 (1321)	92.84 (2.629)	119.08 (3.372)
51 (1295)	91.32 (2.586)	116.94 (3.311)
50 (1270)	89.74 (2.541)	114.78 (3.250)
49 (1245)	88.12 (2.495)	112.59 (3.188)
48 (1219)	86.45 (2.448)	110.37 (3.125)
47 (1194)	84.75 (2.400)	108.13 (3.062)
46 (1168)	83.00 (2.350)	105.86 (2.998)
45 (1143)	81.21 (2.300)	103.56 (2.933)
44 (1118)	79.38 (2.248)	101.25 (2.867)
43 (1092)	77.52 (2.195)	98.91 (2.801)
42 (1067)	75.62 (2.141)	96.55 (2.734)
41 (1041)	73.69 (2.087)	94.18 (2.667)
40 (1016)	71.72 (2.031)	91.78 (2.599)
39 (991)	69.73 (1.974)	89.36 (2.531)
38 (965)	67.70 (1.917)	86.93 (2.462)
37 (948)	65.65 (1.859)	84.48 (2.392)
36 (914)	63.57 (1.800)	82.01 (2.322)
35 (889)	61.46 (1.740)	79.53 (2.252)
34 (864)	59.32 (1.680)	77.03 (2.181)
33 (838)	57.17 (1.619)	74.52 (2.110)
32 (813)	54.98 (1.557)	71.99 (2.038)
31 (787)	52.78 (1.495)	69.45 (1.966)
30 (762)	50.55 (1.431)	66.89 (1.894)
29 (737)	48.30 (1.368)	64.32 (1.821)
28 (711)	46.03 (1.303)	61.74 (1.748)
27 (686)	43.74 (1.239)	59.19 (1.675)
26 (680)	41.43 (1.173)	56.55 (1.601)
25 (610)	39.11 (1.107)	53.93 (1.527)
24 (609)	36.77 (1.041)	51.31 (1.453)
23 (584)	34.41 (0.974)	48.67 (1.378)
22 (559)	32.03 (0.907)	46.03 (1.303)
21 (533)	29.64 (0.839)	43.38 (1.228)
20 (508)	27.23 (0.771)	40.71 (1.153)
19 (483)	24.81 (0.703)	38.04 (1.077)
18 (457)	22.38 (0.634)	35.37 (1.001)
17 (432)	19.94 (0.565)	32.68 (0.925)
16 (406)	17.48 (0.495)	29.99 (0.849)
15 (381)	15.01 (0.425)	27.29 (0.773)
14 (356)	12.53 (0.355)	24.58 (0.696)
13 (330)	10.05 (0.284)	21.87 (0.619)
12 (305)	7.55 (0.214)	19.15 (0.542)
11 (279)	5.04 (0.143)	16.43 (0.465)
10 (254)	2.53 (0.072)	13.70 (0.388)
9 (229)	0.00	10.97 (0.311)
8 (203)	0.00	9.75 (0.276)
7 (178)	0.00	8.53 (0.242)
6 (152)	Stone 0.00	7.31 (0.207)
5 (127)	Foundation 0.00	6.09 (0.173)
4 (102)	0.00	4.87 (0.138)
3 (76)	0.00	3.66 (0.104)
2 (51)	0.00	2.44 (0.069)
1 (25)	0.00	1.22 (0.035)

NOTE: Add 1.22 ft³ (0.035 m³) of storage for each additional inch (25 mm) of stone foundation. Contact StormTech for cumulative volume spreadsheets in digital format.

5.0 Cumulative Storage Volumes

TABLE 10 – MC-4500 Incremental Storage Volume Per End Cap

Assumes 40% stone porosity. Calculations are based upon a 9" (230 mm) stone base under the chambers, 12" (300 mm) of stone above end caps, and 9" (230 mm) of spacing between end caps and 6" (150 mm) of stone perimeter.

Depth of Water in System Inches (mm)	Cumulative End Cap Storage ft^3 (m^3)	Total System Cumulative Storage ft^3 (m^3)
81 (2057)	0.00	115.28 (3.264)
80 (2032)	0.00	114.15 (3.232)
79 (2007)	0.00	113.02 (3.200)
78 (1981)	Stone 0.00	111.89 (3.168)
77 (1956)	Cover 0.00	110.76 (3.136)
76 (1930)	0.00	109.63 (3.104)
75 (1905)	0.00	108.50 (3.072)
74 (1880)	0.00	107.37 (3.040)
73 (1854)	0.00	106.24 (3.008)
72 (1829)	0.00	105.11 (2.976)
71 (1803)	0.00	103.98 (2.944)
70 (1778)	0.00	102.85 (2.912)
69 (1753)	39.54 (1.120)	101.72 (2.880)
68 (1727)	39.53 (1.119)	100.58 (2.848)
67 (1702)	39.50 (1.118)	99.43 (2.816)
66 (1676)	39.45 (1.117)	98.27 (2.783)
65 (1651)	39.38 (1.115)	97.10 (2.750)
64 (1626)	39.30 (1.113)	95.92 (2.716)
63 (1600)	39.19 (1.110)	94.73 (2.682)
62 (1575)	39.06 (1.106)	93.52 (2.648)
61 (1549)	38.90 (1.101)	92.29 (2.613)
60 (1524)	38.71 (1.096)	91.04 (2.578)
59 (1499)	38.49 (1.090)	89.78 (2.542)
58 (1473)	38.24 (1.083)	88.50 (2.506)
57 (1448)	37.97 (1.075)	87.21 (2.469)
56 (1422)	37.67 (1.067)	85.90 (2.432)
55 (1397)	37.34 (1.057)	84.57 (2.395)
54 (1372)	36.98 (1.047)	83.23 (2.357)
53 (1346)	36.60 (1.036)	81.87 (2.318)
52 (1321)	36.19 (1.025)	80.49 (2.279)
51 (1295)	35.75 (1.012)	79.10 (2.240)
50 (1270)	35.28 (0.999)	77.69 (2.200)
49 (1245)	34.79 (0.985)	76.26 (2.159)
48 (1219)	34.27 (0.970)	74.82 (2.119)
47 (1194)	33.72 (0.955)	73.36 (2.077)
46 (1168)	33.15 (0.939)	71.89 (2.036)
45 (1143)	32.57 (0.922)	70.40 (1.994)
44 (1118)	31.96 (0.905)	68.91 (1.951)
43 (1092)	31.32 (0.887)	67.40 (1.909)

NOTE: Add 1.08 ft^3 (0.031 m^3) of storage for each additional inch (25 mm) of stone foundation. Contact StormTech for cumulative volume spreadsheets in digital format.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage ft^3 (m^3)	Total System Cumulative Storage ft^3 (m^3)
42 (1067)	30.68 (0.869)	65.88 (1.866)
41 (1041)	30.00 (0.850)	64.35 (1.822)
40 (1016)	29.30 (0.830)	62.80 (1.778)
39 (991)	28.58 (0.809)	61.23 (1.734)
38 (965)	27.84 (0.788)	59.65 (1.689)
37 (948)	27.07 (0.767)	58.07 (1.644)
36 (914)	26.29 (0.744)	56.46 (1.599)
35 (889)	25.48 (0.722)	54.85 (1.553)
34 (864)	24.66 (0.698)	53.23 (1.507)
33 (838)	23.83 (0.675)	51.60 (1.461)
32 (813)	22.98 (0.651)	49.96 (1.415)
31 (787)	22.12 (0.626)	48.31 (1.368)
30 (762)	21.23 (0.601)	46.65 (1.321)
29 (737)	20.32 (0.575)	44.97 (1.273)
28 (711)	19.40 (0.549)	43.29 (1.226)
27 (686)	18.48 (0.523)	41.61 (1.178)
26 (680)	17.54 (0.497)	39.91 (1.130)
25 (610)	16.59 (0.470)	38.21 (1.082)
24 (609)	15.62 (0.442)	36.50 (1.033)
23 (584)	14.64 (0.414)	34.78 (0.985)
22 (559)	13.66 (0.387)	33.07 (0.936)
21 (533)	12.66 (0.359)	31.33 (0.887)
20 (508)	11.65 (0.330)	29.60 (0.838)
19 (483)	10.63 (0.301)	27.85 (0.3789)
18 (457)	9.60 (0.272)	26.11 (0.739)
17 (432)	8.56 (0.242)	24.35 (0.690)
16 (406)	7.51 (0.213)	22.59 (0.640)
15 (381)	6.46 (0.183)	20.83 (0.590)
14 (356)	5.41 (0.153)	19.07 (0.540)
13 (330)	4.35 (0.123)	17.31 (0.490)
12 (305)	3.28 (0.093)	15.53 (0.440)
11 (279)	2.19 (0.062)	13.75 (0.389)
10 (254)	1.11 (0.031)	11.97 (0.339)
9 (229)	0.00	10.17 (0.288)
8 (203)	0.00	9.04 (0.256)
7 (178)	0.00	7.91 (0.224)
6 (152)	Stone 0.00	6.78 (0.192)
5 (127)	Foundation 0.00	5.65 (0.160)
4 (102)	0.00	4.52 (0.128)
3 (76)	0.00	3.39 (0.096)
2 (51)	0.00	2.26 (0.064)
1 (25)	0.00	1.13 (0.032)

6.0 MC-3500 Chamber System Sizing

The following steps provide the calculations necessary for preliminary sizing of an MC-3500 chamber system. For custom bed conf gurations to f t specif c sites, contact the StormTech Technical Services Department or your local StormTech representative.

1) Determine the amount of storage volume (VS) required. It is the design engineer's sole responsibility to determine the storage volume required.

TABLE 11—Storage Volume Per Chamber/End Cap ft³ (m³)

	Bare Unit Storage ft³ (m³)	Chamber/End Cap and Stone Volume — Stone Foundation Depth in. (mm)			
		9 (230)	12 (300)	15 (375)	18 (450)
MC-3500 Chamber	109.9 (3.11)	175.0 (4.96)	179.9 (5.09)	184.9 (5.24)	189.9 (5.38)
MC-3500 End Cap	14.9 (0.42)	45.1 (1.28)	46.6 (1.32)	48.3 (1.37)	49.9 (1.41)

NOTE: Assumes 6" (150 mm) row spacing, 40% stone porosity, 12" (300 mm) stone above and includes the bare chamber/end cap volume. End cap volume assumes 6" (150 mm) stone perimeter.

2) Determine the number of chambers (C) required. To calculate the number of chambers required for adequate storage, divide the storage volume (Vs) by the storage volume of the chamber (from **Table 11**), as follows: **C = Vs / Storage Volume per Chamber**

3) Determine the number of end caps required. The number of end caps (EC) required depends on the number of rows required by the project. Once the number of chamber rows is determined, multiply the number of chamber rows by 2 to determine the number of end caps required. **EC = No. of Chamber Rows x 2**

NOTE: Additional end caps may be required for systems having inlet locations within the chamber bed.

4) Determine additional storage provided by end caps. End Caps will provide additional storage to the project. Multiply the number of end caps (EC) by the storage volume per end cap (ECS) to determine the additional storage (As) provided by the end caps. **As = EC x ECs**

5) Adjust number of chambers (C) to account for additional end cap storage (As). The original number of chambers (C) can now be reduced due to the additional storage in the end caps. Divide the additional storage (As) by the storage volume per chamber to determine the number of chambers that can be removed. **Number of chambers to remove = As/ volume per chamber**

NOTE: Additional storage exists in the stone perimeter as well as in the inlet and outlet manifold systems. Contact StormTech's Technical Services Department for assistance with determining the number of chambers and end caps required for your project.

6) Determine the required bed size (S). The size of the bed will depend on the number of chambers and end caps required:

MC-3500 area per chamber = 49.6 ft² (4.6 m²)
MC-3500 area per end cap = 16.4 ft² (1.5 m²)

S = (C x area per chamber) + (EC x area per end cap)

NOTE: It is necessary to add 12" (300 mm) of stone perimeter parallel to the chamber rows and 6" (150 mm) of stone perimeter from the base of all end caps. The additional area due to perimeter stone is not included in the area numbers above.

7) Determine the amount of stone (Vst) required. To calculate the total amount of clean, crushed, angular stone required, multiply the number of chambers (C) and the number of end caps (EC) by the selected weight of stone from **Table 12.**

NOTE: Clean, crushed, angular stone is also required around the perimeter of the system.

TABLE 12—Amount of Stone Per Chamber/End Cap

ENGLISH tons (yd³)	Stone Foundation Depth			
	9"	12"	15"	18"
MC-3500	8.5 (6.0)	9.1 (6.5)	9.7 (6.9)	10.4 (7.4)
End Cap	3.9 (2.8)	4.1 (2.9)	4.3 (3.1)	4.5 (3.2)
METRIC kg (m³)	**230 mm**	**300 mm**	**375 mm**	**450 mm**
MC-3500	7711 (4.6)	8255 (5.0)	8800 (5.3)	9435 (5.7)
End Cap	3538 (2.1)	3719 (2.2)	3901 (2.4)	4082 (2.5)

NOTE: Assumes 12" (300 mm) of stone above, and 6" (150 mm) row spacing, and 6" (150 mm) of perimeter stone in front of end caps.

8) Determine the volume of excavation (Ex) required. Each additional foot of cover will add a volume of excavation of 1.9 yd³ (1.5 m³) per MC-3500 chamber and 0.6 yd³ (0.5 m³) per MC-3500 end cap.

TABLE 13—Volume of Excavation Per Chamber/End Cap yd³ (m³)

	Stone Foundation Depth			
	9" (230 mm)	12" (300 mm)	15"(375 mm)	18"(450 mm)
MC-3500	11.9 (9.1)	12.4 (9.5)	12.8 (9.8)	13.3 (10.2)
End Cap	4.0 (3.1)	4.1 (3.2)	4.3 (3.3)	4.4 (3.4)

NOTE: Assumes 6" (150 mm) separation between chamber rows, 6" (150 mm) of perimeter in front of end caps, and 24" (600 mm) of cover. The volume of excavation will vary as the depth of cover increases.

9) Determine the area of geotextile (F) required. The bottom, top and sides of the bed must be covered with a non-woven geotextile (f lter fabric) that meets AASHTO M288 Class 2 requirements. The area of the sidewalls must be calculated and a 24" (600 mm) overlap must be included for all seams. Geotextiles typically come in 15 foot (4.57 m) wide rolls.

6.0 MC-4500 Chamber System Sizing

The following steps provide the calculations necessary for preliminary sizing of an MC-4500 chamber system. For custom bed confgurations to ft specifc sites, contact the StormTech Technical Services Department or your local StormTech representative.

1) Determine the amount of storage volume (VS) required. It is the design engineer's sole responsibility to determine the storage volume required.

TABLE 14—Storage Volume Per Chamber/End Cap ft³ (m³)

	Bare Unit Storage ft³ (m³)	Chamber/End Cap and Stone Volume — Stone Foundation Depth in. (mm)			
		9 (230)	12 (300)	15 (375)	18 (450)
MC-4500 Chamber	106.5 (3.01)	162.6 (4.60)	166.3 (4.71)	169.9 (4.81)	173.6 (4.91)
MC-4500 End Cap	39.5 (1.12)	115.3 (3.26)	118.6 (3.36)	121.9 (3.45)	125.2 (3.54)

NOTE: Assumes 9" (230 mm) row spacing, 40% stone porosity, 12" (300 mm) stone above and includes the bare chamber/end cap volume. End cap volume assumes 12" (300 mm) stone perimeter.

2) Determine the number of chambers (C) required. To calculate the number of chambers required for adequate storage, divide the storage volume (Vs) by the storage volume of the chamber (from **Table 14**), as follows: **C = Vs / Storage Volume per Chamber**

3) Determine the number of end caps required. The number of end caps (EC) required depends on the number of rows required by the project. Once the number of chamber rows is determined, multiply the number of chamber rows by 2 to determine the number of end caps required. **EC = No. of Chamber Rows x 2**

NOTE: Additional end caps may be required for systems having inlet locations within the chamber bed.

4) Determine additional storage provided by end caps.
End Caps will provide additional storage to the project. Multiply the number of end caps (EC) by the storage volume per end cap (ECS) to determine the additional storage (As) provided by the end caps. **As = EC x ECs**

5) Adjust number of chambers (C) to account for additional end cap storage (As). The original number of chambers (C) can now be reduced due to the additional storage in the end caps. Divide the additional storage (As) by the storage volume per chamber to determine the number of chambers that can be removed. **Number of chambers to remove = As/ volume per chamber**

NOTE: Additional storage exists in the stone perimeter as well as in the inlet and outlet manifold systems. Contact StormTech's Technical Services Department for assistance with determining the number of chambers and end caps required for your project.

6) Determine the required bed size (S).
The size of the bed will depend on the number of chambers and end caps required:

MC-4500 area per chamber = 36.6 ft² (3.4 m²)
MC-4500 area per end cap = 23.9 ft² (2.2 m²)

S = (C x area per chamber) + (EC x area per end cap)

NOTE: It is necessary to add 12" (300 mm) of stone perimeter parallel to the chamber rows and 6" (150 mm) of stone perimeter from the base of all end caps. The additional area due to perimeter stone is not included in the area numbers above.

7) Determine the amount of stone (Vst) required. To calculate the total amount of clean, crushed, angular stone required, multiply the number of chambers (C) and the number of end caps (EC) by the selected weight of stone from **Table 15.**

NOTE: Clean, crushed, angular stone is also required around the perimeter of the system.

TABLE 15—Amount of Stone Per Chamber

ENGLISH tons (yd³)	Stone Foundation Depth			
	9"	**12"**	**15"**	**18"**
MC-4500	7.4 (5.2)	7.8 (5.5)	8.3 (5.9)	8.8 (6.2)
End Cap	9.8 (7.0)	10.2 (7.3)	10.6 (7.6)	11.1 (7.9)
METRIC kg (m³)	**230 mm**	**300 mm**	**375 mm**	**450 mm**
MC-4500	6681 (4.0)	7117 (4.2)	7552 (4.5)	7987 (4.7)
End Cap	8890 (5.3)	9253 (5.5)	9616 (5.8)	10069 (6.0)

NOTE: Assumes 12" (300 mm) of stone above, and 9" (230 mm) row spacing, and 12" (300 mm) of perimeter stone in front of end caps.

8) Determine the volume of excavation (Ex) required. Each additional foot of cover will add a volume of excavation of 1.4 yd³ (1.0 m³) per MC-4500 chamber and 1.4 yd³ (0.8 m³) per MC-4500 end cap.

TABLE 16—Volume of Excavation Per Chamber/End Cap yd³ (m³)

	Stone Foundation Depth			
	9" (230 mm)	**12" (300 mm)**	**15"(375 mm)**	**18"(450 mm)**
MC-4500	10.5 (8.0)	10.8 (8.3)	11.2 (8.5)	11.5 (8.8)
End Cap	9.7 (7.4)	10.0 (7.6)	10.3 (7.9)	10.6 (8.1)

NOTE: Assumes 9" (230 mm) separation between chamber rows, 12" (300 mm) of perimeter in front of end caps, and 24" (600 mm) of cover. The volume of excavation will vary as the depth of cover increases.

9) Determine the area of geotextile (F) required. The bottom, top and sides of the bed must be covered with a non-woven geotextile (flter fabric) that meets AASHTO M288 Class 2 requirements. The area of the sidewalls must be calculated and a 24" (600 mm) overlap must be included for all seams. Geotextiles typically come in 15 foot (4.57 m) wide rolls.

Appendix D - Hydrology Calculations

Used in place of Forms 4.2-3, 4.2-4, and 4.2-5 for HCOC Assessment

```
999999999999999999999999999999999999999999999999999999999999999999999999
Pro*ess 'rom Point#Station       12.,,, to Point#Station       12.,,,
3333 C<&?";$&C$ <? MA & S:R$AMS 3333
======================================================================
:4e 'ollo(ing data inside Main Stream is listed/
 n Main Stream numOer/ 1
Stream 'lo( area 7     12.9-1(A*.)
Runo'' 'rom t4is stream 7     16.81,(C?S)
:ime o' *on*entration 7    9.82 min.
Rain'all intensity 7     +.628( n#Hr)
Area a5eraged loss rate (?m) 7    ,.,988( n#Hr)
Area a5eraged Per5ious ratio (A6) 7 ,.1,,,
Program is no( starting (it4 Main Stream &o. +


999999999999999999999999999999999999999999999999999999999999999999999999
Pro*ess 'rom Point#Station       +,.,,, to Point#Station       +1.,,,
3333  & : A" AR$A $!A";A: <& 3333
======================================================================
C<MM$RC A" suOarea ty6e
De*imal 'ra*tion soil grou6 A 7 1.,,,
De*imal 'ra*tion soil grou6 B 7 ,.,,,
De*imal 'ra*tion soil grou6 C 7 ,.,,,
De*imal 'ra*tion soil grou6 D 7 ,.,,,
SCS *ur5e numOer 'or soil(AMC +)  7 1+.,,
Per5ious ratio(A6) 7 ,.1,,,     Ma> loss rate(?m)7     ,.,98( n#Hr)
 nitial suOarea data/
 nitial area 'lo( distan*e 7    8-.6,,(?t.)
:o6 (o' initial area) ele5ation 7  +8-,.,,,(?t.)
Bottom (o' initial area) ele5ation 7  +81+.81,(?t.)
Di''eren*e in ele5ation 7     8.19,(?t.)
Slo6e 7    ,.,9618  s(@)7       9.6-
:C 7 A(,.1,-)3B(lengt4C1)#(ele5ation *4ange)DC,.+
 nitial area time o' *on*entration 7    +.8+- min.
Rain'all intensity 7      6.21-( n#Hr) 'or a    1,., year storm
$''e*ti5e runo'' *oe''i*ient used 'or area (E7FC A) is C 7 ,.888
SuOarea runo'' 7      ,.618(C?S)
:otal initial stream area 7        ,.11,(A*.)
Per5ious area 'ra*tion 7 ,.1,,
 nitial area ?m 5alue 7    ,.,98( n#Hr)


999999999999999999999999999999999999999999999999999999999999999999999999
Pro*ess 'rom Point#Station       +1.,,, to Point#Station       ++.,,,
3333  RR$%;"AR CHA&&$" ?"<G :RA!$" : M$ 3333
======================================================================
$stimated mean 'lo( rate at mid6oint o' *4annel 7      ,.,,,(C?S)
De6t4 o' 'lo( 7    ,.+,8(?t.)) A5erage 5elo*ity 7   2.689(?t#s)
        3333333  rregular C4annel Data 33333333333
-----------------------------------------------------------------
 n'ormation entered 'or suO*4annel numOer 1 /
Point numOer      HIH *oordinate     HJH *oordinate
        1              ,.,,              +.,,
        +            1,,.,,              ,.,,
        1            +,,.,,              +.,,
ManningHs H&H 'ri*tion 'a*tor 7   ,.,11
-----------------------------------------------------------------
SuO-C4annel 'lo(  7     1+.181(C?S)
  H     H        'lo( to6 (idt4 7     +,.811(?t.)
  H     H    5elo*ity7    2.689(?t#s)
  H     H        area 7      +.1-2(SK.?t)
  H     H        ?roude numOer 7     1.11,

;6stream 6oint ele5ation 7  +81+.81,(?t.)
Do(nstream 6oint ele5ation 7  +81,.62,(?t.)
?lo( lengt4 7   -16.2,,(?t.)
:ra5el time  7    1.+8 min.
:ime o' *on*entration 7    -.,, min.
De6t4 o' 'lo( 7   ,.+,8(?t.)
A5erage 5elo*ity 7   2.689(?t#s)
:otal irregular *4annel 'lo( 7    1+.181(C?S)
 rregular *4annel normal de6t4 aOo5e in5ert ele5. 7   ,.+,8(?t.)
```

```
A5erage 5elo*ity o' *4annel(s) 7   2.689(?t#s)
 Adding area 'lo( to *4annel
C<MM$RC A" suOarea ty6e
De*imal 'ra*tion soil grou6 A 7 1.,,,
De*imal 'ra*tion soil grou6 B 7 ,.,,,
De*imal 'ra*tion soil grou6 C 7 ,.,,,
De*imal 'ra*tion soil grou6 D 7 ,.,,,
SCS *ur5e numOer 'or soil(AMC +)  7 1+.,,
Per5ious ratio(A6) 7 ,.1,,,     Ma> loss rate(?m)7     ,.,98( n#Hr)
Rain'all intensity 7      -.988( n#Hr) 'or a    1,., year storm
$''e*ti5e runo'' *oe''i*ient used 'or area)(total area (it4 modi'ied
rational met4od)(E7FC A) is C 7 ,.88+
SuOarea runo'' 7     +1.,11(C?S) 'or    2.+61(A*.)
:otal runo'' 7     +1.62,(C?S)
$''e*ti5e area t4is stream 7        2.18(A*.)
:otal Study Area (Main Stream &o. +) 7       +1.1+(A*.)
Area a5eraged ?m 5alue 7    ,.,98( n#Hr)
De6t4 o' 'lo( 7   ,.+66(?t.)) A5erage 5elo*ity 7   6.8,-(?t#s)


999999999999999999999999999999999999999999999999999999999999999999999
Pro*ess 'rom Point#Station       ++.,,, to Point#Station       +1.,,,
3333 P P$?"<G :RA!$" : M$ (Program estimated siLe) 3333
=====================================================================
;6stream 6oint#station ele5ation 7  +8,8.62,(?t.)
Do(nstream 6oint#station ele5ation 7  +8,2.-,,(?t.)
Pi6e lengt4  7   -81.1,(?t.)   ManningHs & 7 ,.,11
&o. o' 6i6es 7 1  ReKuired 6i6e 'lo(  7    +1.62,(C?S)
&earest *om6uted 6i6e diameter  7     1,.,,( n.)
Cal*ulated indi5idual 6i6e 'lo(  7    +1.62,(C?S)
&ormal 'lo( de6t4 in 6i6e 7   +,.98( n.)
?lo( to6 (idt4 inside 6i6e 7   +8.2+( n.)
Criti*al De6t4 7   19.82( n.)
Pi6e 'lo( 5elo*ity 7      6.-2(?t#s)
:ra5el time t4roug4 6i6e 7    1.++ min.
:ime o' *on*entration (:C) 7     2.+1 min.


999999999999999999999999999999999999999999999999999999999999999999999
Pro*ess 'rom Point#Station       +1.,,, to Point#Station       +1.,,,
3333 S;BAR$A ?"<G ADD : <& 3333
=====================================================================
C<MM$RC A" suOarea ty6e
De*imal 'ra*tion soil grou6 A 7 1.,,,
De*imal 'ra*tion soil grou6 B 7 ,.,,,
De*imal 'ra*tion soil grou6 C 7 ,.,,,
De*imal 'ra*tion soil grou6 D 7 ,.,,,
SCS *ur5e numOer 'or soil(AMC +)  7 1+.,,
Per5ious ratio(A6) 7 ,.1,,,     Ma> loss rate(?m)7     ,.,98( n#Hr)
:ime o' *on*entration 7     2.+1 min.
Rain'all intensity 7      -.1-,( n#Hr) 'or a    1,., year storm
$''e*ti5e runo'' *oe''i*ient used 'or area)(total area (it4 modi'ied
rational met4od)(E7FC A) is C 7 ,.889
SuOarea runo'' 7     +2.912(C?S) 'or    8.+28(A*.)
:otal runo'' 7     -9.282(C?S)
$''e*ti5e area t4is stream 7       11.61(A*.)
:otal Study Area (Main Stream &o. +) 7       +9.28(A*.)
Area a5eraged ?m 5alue 7    ,.,98( n#Hr)


999999999999999999999999999999999999999999999999999999999999999999999
Pro*ess 'rom Point#Station       +1.,,, to Point#Station       +-.,,,
3333 P P$?"<G :RA!$" : M$ (Program estimated siLe) 3333
=====================================================================
;6stream 6oint#station ele5ation 7  +8,2.-,,(?t.)
Do(nstream 6oint#station ele5ation 7  +8,+.91,(?t.)
Pi6e lengt4  7   -18.6,(?t.)   ManningHs & 7 ,.,11
&o. o' 6i6es 7 1  ReKuired 6i6e 'lo(  7    -9.282(C?S)
&earest *om6uted 6i6e diameter  7     16.,,( n.)
Cal*ulated indi5idual 6i6e 'lo(  7    -9.282(C?S)
&ormal 'lo( de6t4 in 6i6e 7   +8.2,( n.)
?lo( to6 (idt4 inside 6i6e 7   +9.+-( n.)
Criti*al De6t4 7   +8.21( n.)
```

Pi6e 'lo(5elo*ity 7 8.+8(?t#s)
:ra5el time t4roug4 6i6e 7 ,.8- min.
:ime o' *on*entration (:C) 7 6.,8 min.

9999999999999999999999999999999999999999999999999999999999999999999999
Pro*ess 'rom Point#Station +-.,,, to Point#Station +-.,,,
3333 S;BAR$A ?"<G ADD : <& 3333
==
C<MM$RC A" suOarea ty6e
De*imal 'ra*tion soil grou6 A 7 1.,,,
De*imal 'ra*tion soil grou6 B 7 ,.,,,
De*imal 'ra*tion soil grou6 C 7 ,.,,,
De*imal 'ra*tion soil grou6 D 7 ,.,,,
SCS *ur5e numOer 'or soil(AMC +) 7 1+.,,
Per5ious ratio(A6) 7 ,.1,,, Ma> loss rate(?m)7 ,.,98(n#Hr)
:ime o' *on*entration 7 6.,8 min.
Rain'all intensity 7 1.8+9(n#Hr) 'or a 1,., year storm
$''e*ti5e runo'' *oe''i*ient used 'or area)(total area (it4 modi'ied
rational met4od)(E7FC A) is C 7 ,.886
SuOarea runo'' 7 1+.968(C?S) 'or 2.21,(A*.)
:otal runo'' 7 6+.221(C?S)
$''e*ti5e area t4is stream 7 19.1-(A*.)
:otal Study Area (Main Stream &o. +) 7 12.,8(A*.)
Area a5eraged ?m 5alue 7 ,.,98(n#Hr)

9999999999999999999999999999999999999999999999999999999999999999999999
Pro*ess 'rom Point#Station +-.,,, to Point#Station +2.,,,
3333 P P$?"<G :RA!$" : M$ (Program estimated siLe) 3333
==
;6stream 6oint#station ele5ation 7 +8,+.91,(?t.)
Do(nstream 6oint#station ele5ation 7 +698.81,(?t.)
Pi6e lengt4 7 819.-,(?t.) ManningHs & 7 ,.,11
&o. o' 6i6es 7 1 ReKuired 6i6e 'lo(7 6+.221(C?S)
&earest *om6uted 6i6e diameter 7 -+.,,(n.)
Cal*ulated indi5idual 6i6e 'lo(7 6+.221(C?S)
&ormal 'lo(de6t4 in 6i6e 7 1,.-8(n.)
?lo(to6 (idt4 inside 6i6e 7 18.-9(n.)
Criti*al De6t4 7 +9.86(n.)
Pi6e 'lo(5elo*ity 7 8.16(?t#s)
:ra5el time t4roug4 6i6e 7 1.61 min.
:ime o' *on*entration (:C) 7 8.8, min.

9999999999999999999999999999999999999999999999999999999999999999999999
Pro*ess 'rom Point#Station +2.,,, to Point#Station +2.,,,
3333 S;BAR$A ?"<G ADD : <& 3333
==
C<MM$RC A" suOarea ty6e
De*imal 'ra*tion soil grou6 A 7 1.,,,
De*imal 'ra*tion soil grou6 B 7 ,.,,,
De*imal 'ra*tion soil grou6 C 7 ,.,,,
De*imal 'ra*tion soil grou6 D 7 ,.,,,
SCS *ur5e numOer 'or soil(AMC +) 7 1+.,,
Per5ious ratio(A6) 7 ,.1,,, Ma> loss rate(?m)7 ,.,98(n#Hr)
:4e area added to t4e e>isting stream *auses a
a lo(er 'lo(rate o' E 7 26.6--(C?S)
t4ere'ore t4e u6stream 'lo(rate o' E 7 6+.221(C?S) is Oeing used
:ime o' *on*entration 7 8.8, min.
Rain'all intensity 7 1.126(n#Hr) 'or a 1,., year storm
$''e*ti5e runo'' *oe''i*ient used 'or area)(total area (it4 modi'ied
rational met4od)(E7FC A) is C 7 ,.88+
SuOarea runo'' 7 ,.,,,(C?S) 'or 1.--,(A*.)
:otal runo'' 7 6+.221(C?S)
$''e*ti5e area t4is stream 7 +,.28(A*.)
:otal Study Area (Main Stream &o. +) 7 16.2+(A*.)
Area a5eraged ?m 5alue 7 ,.,98(n#Hr)

9999999999999999999999999999999999999999999999999999999999999999999999
Pro*ess 'rom Point#Station +2.,,, to Point#Station +6.,,,
3333 P P$?"<G :RA!$" : M$ (Program estimated siLe) 3333

```
======================================================================
;6stream 6oint#station ele5ation 7  +698.81,(?t.)
Do(nstream 6oint#station ele5ation 7  +698.11,(?t.)
Pi6e lengt4  7    61.6,(?t.)   ManningHs & 7 ,.,11
&o. o' 6i6es 7 1  ReKuired 6i6e 'lo(  7    6+.221(C?S)
&earest *om6uted 6i6e diameter  7     19.,,( n.)
Cal*ulated indi5idual 6i6e 'lo(  7    6+.221(C?S)
&ormal 'lo( de6t4 in 6i6e 7   +8.82( n.)
?lo( to6 (idt4 inside 6i6e 7   12.1-( n.)
Criti*al De6t4 7   1,.+6( n.)
Pi6e 'lo( 5elo*ity 7      9.9+(?t#s)
:ra5el time t4roug4 6i6e 7    ,.11 min.
:ime o' *on*entration (:C) 7     8.81 min.


9999999999999999999999999999999999999999999999999999999999999999999999
Pro*ess 'rom Point#Station       +6.,,, to Point#Station       +6.,,,
3333 S;BAR$A ?"<G ADD : <& 3333
======================================================================
C<MM$RC A" suOarea ty6e
De*imal 'ra*tion soil grou6 A 7 1.,,,
De*imal 'ra*tion soil grou6 B 7 ,.,,,
De*imal 'ra*tion soil grou6 C 7 ,.,,,
De*imal 'ra*tion soil grou6 D 7 ,.,,,
SCS *ur5e numOer 'or soil(AMC +)  7 1+.,,
Per5ious ratio(A6) 7 ,.1,,,     Ma> loss rate(?m)7     ,.,98( n#Hr)
:ime o' *on*entration 7     8.81 min.
Rain'all intensity 7      1.1+6( n#Hr) 'or a    1,., year storm
$''e*ti5e runo'' *oe''i*ient used 'or area)(total area (it4 modi'ied
rational met4od)(E7FC A) is C 7 ,.88+
SuOarea runo'' 7      +.-98(C?S) 'or    1.+9,(A*.)
:otal runo'' 7     62.,-9(C?S)
$''e*ti5e area t4is stream 7       +1.88(A*.)
:otal Study Area (Main Stream &o. +) 7       19.81(A*.)
Area a5eraged ?m 5alue 7    ,.,98( n#Hr)


9999999999999999999999999999999999999999999999999999999999999999999999
Pro*ess 'rom Point#Station       +6.,,, to Point#Station       12.,,,
3333 P P$?"<G :RA!$" : M$ (Program estimated siLe) 3333
======================================================================
;6stream 6oint#station ele5ation 7  +698.11,(?t.)
Do(nstream 6oint#station ele5ation 7  +696.96,(?t.)
Pi6e lengt4  7   181.8,(?t.)   ManningHs & 7 ,.,11
&o. o' 6i6es 7 1  ReKuired 6i6e 'lo(  7    62.,-9(C?S)
&earest *om6uted 6i6e diameter  7     19.,,( n.)
Cal*ulated indi5idual 6i6e 'lo(  7    62.,-9(C?S)
&ormal 'lo( de6t4 in 6i6e 7   +8.88( n.)
?lo( to6 (idt4 inside 6i6e 7   1-.1,( n.)
Criti*al De6t4 7   1,.8,( n.)
Pi6e 'lo( 5elo*ity 7      9.9+(?t#s)
:ra5el time t4roug4 6i6e 7    ,.+9 min.
:ime o' *on*entration (:C) 7     8.1, min.


9999999999999999999999999999999999999999999999999999999999999999999999
Pro*ess 'rom Point#Station       12.,,, to Point#Station       12.,,,
3333 C<&?";$&C$ <? MA & S:R$AMS 3333
======================================================================
:4e 'ollo(ing data inside Main Stream is listed/
 n Main Stream numOer/ +
Stream 'lo( area 7     +1.88,(A*.)
Runo'' 'rom t4is stream 7     62.,-9(C?S)
:ime o' *on*entration 7    8.1, min.
Rain'all intensity 7     1.,-6( n#Hr)
Area a5eraged loss rate (?m) 7    ,.,988( n#Hr)
Area a5eraged Per5ious ratio (A6) 7 ,.1,,,
Summary o' stream data/

Stream ?lo( rate    Area    :C     ?m       Rain'all  ntensity
 &o.    (C?S)   (A*.)       (min) ( n#Hr)     ( n#Hr)
```

```
1     16.81    12.9-1      9.82    ,.,98      +.628
+     62.,2    +1.88,      8.1,    ,.,98      1.,-6
Ema>(1) 7
           1.,,, 3    1.,,, 3    16.81,) 9
           ,.868 3    1.,,, 3    62.,-9) 9 7      91.+,1
Ema>(+) 7
           1.12+ 3    ,.8+1 3    16.81,) 9
           1.,,, 3    1.,,, 3    62.,-9) 9 7      99.86,

:otal o' + main streams to *on'luen*e/
?lo( rates Oe'ore *on'luen*e 6oint/
      18.81,      66.,-9
Ma>imum 'lo( rates at *on'luen*e using aOo5e data/
       91.+,1       99.86,
Area o' streams Oe'ore *on'luen*e/
       12.9-1       +1.88,
$''e*ti5e area 5alues a'ter *on'luen*e/
       19.811       16.988


Results o' *on'luen*e/
:otal 'lo( rate 7     99.86,(C?S)
:ime o' *on*entration 7     8.1,1 min.
$''e*ti5e stream area a'ter *on'luen*e  7     16.988(A*.)
Study area a5erage Per5ious 'ra*tion(A6) 7  ,.1,,
Study area a5erage soil loss rate(?m) 7    ,.,98( n#Hr)
Study area total 7      19.81(A*.)
$nd o' *om6utations) :otal Study Area 7           19.81 (A*.)
:4e 'ollo(ing 'igures may
Oe used 'or a unit 4ydrogra64 study o' t4e same area.
&ote/ :4ese 'igures do not *onsider redu*ed e''e*ti5e area
e''e*ts *aused Oy *on'luen*es in t4e rational eKuation.

Area a5eraged 6er5ious area 'ra*tion(A6) 7 ,.1,,
Area a5eraged SCS *ur5e numOer 7  1+.,
```

U n i t   H y d r o g r a p h   A n a l y s i s

Study date 02/18/22

+++

San Bernardino County Synthetic Unit Hydrology Method
Manual date - August 1986

Program License Serial Number 6350

Storm Event Year = 10

Antecedent Moisture Condition = 2

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

English Units used in output format

Area averaged rainfall intensity isohyetal data:

	Sub-Area (Ac.)	Duration (hours)	Isohyetal (In)
Rainfall data for year 10			
	39.81	1	0.75
Rainfall data for year 2			
	39.81	6	0.80
Rainfall data for year 2			
	39.81	24	1.20
Rainfall data for year 100			
	39.81	1	1.20
Rainfall data for year 100			
	39.81	6	2.00
Rainfall data for year 100			
	39.81	24	3.50

++

******** Area-averaged max loss rate, Fm ********

SCS curve No.(AMCII)	SCS curve NO.(AMC 2)	Area (Ac.)	Area Fraction	Fp(Fig C6) (In/Hr)	Ap (dec.)	Fm (In/Hr)
98.0	98.0	33.98	0.854	0.040	0.010	0.000
32.0	32.0	5.83	0.146	0.978	0.990	0.968

Area-averaged adjusted loss rate Fm (In/Hr) = 0.142

********* Area-Averaged low loss rate fraction, Yb **********

Area (Ac.)	Area Fract	SCS CN (AMC2)	SCS CN (AMC2)	S	Pervious Yield Fr
0.34	0.009	98.0	98.0	0.20	0.894
33.64	0.845	98.0	98.0	0.20	0.894

```
     5.77   0.145         32.0      32.0      10.73     0.000
     0.06   0.001         98.0      98.0       0.20     0.894

Area-averaged catchment yield fraction, Y =  0.765
Area-averaged low loss fraction, Yb =  0.235
User entry of time of concentration  =   0.135 (hours)
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Watershed area =      39.81(Ac.)
Catchment Lag time =   0.108 hours
Unit interval =   5.000 minutes
Unit interval percentage of lag time = 77.1605
Hydrograph baseflow =     0.00(CFS)
Average maximum watershed loss rate(Fm) =  0.142(In/Hr)
Average low loss rate fraction (Yb) = 0.235 (decimal)
DESERT S-Graph Selected
Computed peak 5-minute rainfall =  0.356(In)
Computed peak 30-minute rainfall =  0.609(In)
Specified peak 1-hour rainfall =  0.750(In)
Computed peak 3-hour rainfall =  1.048(In)
Specified peak 6-hour rainfall =  1.294(In)
Specified peak 24-hour rainfall =  2.146(In)


Rainfall depth area reduction factors:
Using a total area of      39.81(Ac.) (Ref: fig. E-4)

5-minute factor = 0.998     Adjusted rainfall =  0.355(In)
30-minute factor = 0.998    Adjusted rainfall =  0.608(In)
1-hour factor = 0.998       Adjusted rainfall =  0.749(In)
3-hour factor = 1.000       Adjusted rainfall =  1.047(In)
6-hour factor = 1.000       Adjusted rainfall =  1.294(In)
24-hour factor = 1.000      Adjusted rainfall =  2.146(In)
---------------------------------------------------------------------

                        U n i t  H y d r o g r a p h
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Interval          'S' Graph          Unit Hydrograph
Number            Mean values            ((CFS))
---------------------------------------------------------------------
                (K =       481.49 (CFS))

  1                9.853                  47.440
  2               55.597                 220.251
  3               76.729                 101.749
  4               86.072                  44.988
  5               91.368                  25.499
  6               94.707                  16.078
  7               96.857                  10.349
  8               98.086                   5.918
  9               98.970                   4.259
 10               99.705                   3.538
 11              100.000                   1.419
---------------------------------------------------------------------
Peak Unit   Adjusted mass rainfall  Unit rainfall
Number              (In)              (In)
  1              0.3552             0.3552
  2              0.4373             0.0821
  3              0.4939             0.0566
  4              0.5384             0.0445
  5              0.5757             0.0373
  6              0.6081             0.0324
  7              0.6368             0.0288
  8              0.6629             0.0260
  9              0.6867             0.0238
 10              0.7088             0.0221
 11              0.7293             0.0206
 12              0.7486             0.0193
 13              0.7671             0.0185
 14              0.7847             0.0176
 15              0.8015             0.0167
 16              0.8174             0.0160
 17              0.8327             0.0153
 18              0.8474             0.0147
```

19	0.8615	0.0141
20	0.8751	0.0136
21	0.8883	0.0132
22	0.9010	0.0127
23	0.9134	0.0123
24	0.9253	0.0120
25	0.9369	0.0116
26	0.9482	0.0113
27	0.9593	0.0110
28	0.9700	0.0107
29	0.9804	0.0105
30	0.9907	0.0102
31	1.0006	0.0100
32	1.0104	0.0098
33	1.0199	0.0096
34	1.0293	0.0094
35	1.0385	0.0092
36	1.0474	0.0090
37	1.0562	0.0088
38	1.0648	0.0086
39	1.0733	0.0085
40	1.0816	0.0083
41	1.0898	0.0082
42	1.0978	0.0080
43	1.1057	0.0079
44	1.1134	0.0078
45	1.1211	0.0076
46	1.1286	0.0075
47	1.1360	0.0074
48	1.1433	0.0073
49	1.1505	0.0072
50	1.1576	0.0071
51	1.1646	0.0070
52	1.1715	0.0069
53	1.1783	0.0068
54	1.1851	0.0067
55	1.1917	0.0066
56	1.1983	0.0066
57	1.2047	0.0065
58	1.2111	0.0064
59	1.2174	0.0063
60	1.2237	0.0062
61	1.2299	0.0062
62	1.2360	0.0061
63	1.2420	0.0060
64	1.2480	0.0060
65	1.2539	0.0059
66	1.2597	0.0058
67	1.2655	0.0058
68	1.2712	0.0057
69	1.2769	0.0057
70	1.2825	0.0056
71	1.2880	0.0056
72	1.2935	0.0055
73	1.3001	0.0065
74	1.3065	0.0065
75	1.3130	0.0064
76	1.3193	0.0064
77	1.3256	0.0063
78	1.3319	0.0063
79	1.3381	0.0062
80	1.3443	0.0062
81	1.3504	0.0061
82	1.3565	0.0061
83	1.3625	0.0060
84	1.3684	0.0060
85	1.3744	0.0059
86	1.3803	0.0059
87	1.3861	0.0058
88	1.3919	0.0058
89	1.3976	0.0058
90	1.4034	0.0057
91	1.4090	0.0057

92	1.4147	0.0056
93	1.4203	0.0056
94	1.4258	0.0056
95	1.4313	0.0055
96	1.4368	0.0055
97	1.4423	0.0054
98	1.4477	0.0054
99	1.4531	0.0054
100	1.4584	0.0053
101	1.4637	0.0053
102	1.4690	0.0053
103	1.4742	0.0052
104	1.4795	0.0052
105	1.4846	0.0052
106	1.4898	0.0051
107	1.4949	0.0051
108	1.5000	0.0051
109	1.5050	0.0051
110	1.5101	0.0050
111	1.5151	0.0050
112	1.5200	0.0050
113	1.5250	0.0049
114	1.5299	0.0049
115	1.5348	0.0049
116	1.5396	0.0049
117	1.5445	0.0048
118	1.5493	0.0048
119	1.5541	0.0048
120	1.5588	0.0048
121	1.5636	0.0047
122	1.5683	0.0047
123	1.5729	0.0047
124	1.5776	0.0047
125	1.5822	0.0046
126	1.5869	0.0046
127	1.5914	0.0046
128	1.5960	0.0046
129	1.6005	0.0045
130	1.6051	0.0045
131	1.6096	0.0045
132	1.6140	0.0045
133	1.6185	0.0045
134	1.6229	0.0044
135	1.6273	0.0044
136	1.6317	0.0044
137	1.6361	0.0044
138	1.6405	0.0044
139	1.6448	0.0043
140	1.6491	0.0043
141	1.6534	0.0043
142	1.6577	0.0043
143	1.6619	0.0043
144	1.6662	0.0042
145	1.6704	0.0042
146	1.6746	0.0042
147	1.6788	0.0042
148	1.6829	0.0042
149	1.6871	0.0041
150	1.6912	0.0041
151	1.6953	0.0041
152	1.6994	0.0041
153	1.7035	0.0041
154	1.7075	0.0041
155	1.7116	0.0040
156	1.7156	0.0040
157	1.7196	0.0040
158	1.7236	0.0040
159	1.7276	0.0040
160	1.7315	0.0040
161	1.7355	0.0039
162	1.7394	0.0039
163	1.7433	0.0039
164	1.7472	0.0039

165	1.7511	0.0039
166	1.7550	0.0039
167	1.7588	0.0039
168	1.7627	0.0038
169	1.7665	0.0038
170	1.7703	0.0038
171	1.7741	0.0038
172	1.7779	0.0038
173	1.7816	0.0038
174	1.7854	0.0038
175	1.7891	0.0037
176	1.7929	0.0037
177	1.7966	0.0037
178	1.8003	0.0037
179	1.8040	0.0037
180	1.8076	0.0037
181	1.8113	0.0037
182	1.8149	0.0036
183	1.8186	0.0036
184	1.8222	0.0036
185	1.8258	0.0036
186	1.8294	0.0036
187	1.8330	0.0036
188	1.8366	0.0036
189	1.8401	0.0036
190	1.8437	0.0035
191	1.8472	0.0035
192	1.8507	0.0035
193	1.8543	0.0035
194	1.8578	0.0035
195	1.8612	0.0035
196	1.8647	0.0035
197	1.8682	0.0035
198	1.8717	0.0035
199	1.8751	0.0034
200	1.8785	0.0034
201	1.8820	0.0034
202	1.8854	0.0034
203	1.8888	0.0034
204	1.8922	0.0034
205	1.8956	0.0034
206	1.8989	0.0034
207	1.9023	0.0034
208	1.9056	0.0034
209	1.9090	0.0033
210	1.9123	0.0033
211	1.9156	0.0033
212	1.9189	0.0033
213	1.9222	0.0033
214	1.9255	0.0033
215	1.9288	0.0033
216	1.9321	0.0033
217	1.9354	0.0033
218	1.9386	0.0033
219	1.9418	0.0032
220	1.9451	0.0032
221	1.9483	0.0032
222	1.9515	0.0032
223	1.9547	0.0032
224	1.9579	0.0032
225	1.9611	0.0032
226	1.9643	0.0032
227	1.9675	0.0032
228	1.9706	0.0032
229	1.9738	0.0032
230	1.9769	0.0031
231	1.9800	0.0031
232	1.9832	0.0031
233	1.9863	0.0031
234	1.9894	0.0031
235	1.9925	0.0031
236	1.9956	0.0031
237	1.9987	0.0031

238	2.0018	0.0031
239	2.0048	0.0031
240	2.0079	0.0031
241	2.0109	0.0031
242	2.0140	0.0030
243	2.0170	0.0030
244	2.0200	0.0030
245	2.0231	0.0030
246	2.0261	0.0030
247	2.0291	0.0030
248	2.0321	0.0030
249	2.0351	0.0030
250	2.0380	0.0030
251	2.0410	0.0030
252	2.0440	0.0030
253	2.0469	0.0030
254	2.0499	0.0030
255	2.0528	0.0029
256	2.0558	0.0029
257	2.0587	0.0029
258	2.0616	0.0029
259	2.0645	0.0029
260	2.0674	0.0029
261	2.0703	0.0029
262	2.0732	0.0029
263	2.0761	0.0029
264	2.0790	0.0029
265	2.0819	0.0029
266	2.0847	0.0029
267	2.0876	0.0029
268	2.0905	0.0029
269	2.0933	0.0028
270	2.0961	0.0028
271	2.0990	0.0028
272	2.1018	0.0028
273	2.1046	0.0028
274	2.1074	0.0028
275	2.1102	0.0028
276	2.1130	0.0028
277	2.1158	0.0028
278	2.1186	0.0028
279	2.1214	0.0028
280	2.1242	0.0028
281	2.1269	0.0028
282	2.1297	0.0028
283	2.1324	0.0028
284	2.1352	0.0027
285	2.1379	0.0027
286	2.1407	0.0027
287	2.1434	0.0027
288	2.1461	0.0027

Unit Period (number)	Unit Rainfall (In)	Unit Soil-Loss (In)	Effective Rainfall (In)
1	0.0027	0.0006	0.0021
2	0.0027	0.0006	0.0021
3	0.0027	0.0006	0.0021
4	0.0027	0.0006	0.0021
5	0.0028	0.0006	0.0021
6	0.0028	0.0007	0.0021
7	0.0028	0.0007	0.0021
8	0.0028	0.0007	0.0021
9	0.0028	0.0007	0.0021
10	0.0028	0.0007	0.0021
11	0.0028	0.0007	0.0022
12	0.0028	0.0007	0.0022
13	0.0028	0.0007	0.0022
14	0.0028	0.0007	0.0022
15	0.0029	0.0007	0.0022
16	0.0029	0.0007	0.0022
17	0.0029	0.0007	0.0022

18	0.0029	0.0007	0.0022
19	0.0029	0.0007	0.0022
20	0.0029	0.0007	0.0022
21	0.0029	0.0007	0.0022
22	0.0029	0.0007	0.0022
23	0.0029	0.0007	0.0023
24	0.0030	0.0007	0.0023
25	0.0030	0.0007	0.0023
26	0.0030	0.0007	0.0023
27	0.0030	0.0007	0.0023
28	0.0030	0.0007	0.0023
29	0.0030	0.0007	0.0023
30	0.0030	0.0007	0.0023
31	0.0030	0.0007	0.0023
32	0.0030	0.0007	0.0023
33	0.0031	0.0007	0.0023
34	0.0031	0.0007	0.0023
35	0.0031	0.0007	0.0024
36	0.0031	0.0007	0.0024
37	0.0031	0.0007	0.0024
38	0.0031	0.0007	0.0024
39	0.0031	0.0007	0.0024
40	0.0031	0.0007	0.0024
41	0.0032	0.0007	0.0024
42	0.0032	0.0007	0.0024
43	0.0032	0.0008	0.0024
44	0.0032	0.0008	0.0024
45	0.0032	0.0008	0.0025
46	0.0032	0.0008	0.0025
47	0.0032	0.0008	0.0025
48	0.0033	0.0008	0.0025
49	0.0033	0.0008	0.0025
50	0.0033	0.0008	0.0025
51	0.0033	0.0008	0.0025
52	0.0033	0.0008	0.0025
53	0.0033	0.0008	0.0025
54	0.0033	0.0008	0.0026
55	0.0034	0.0008	0.0026
56	0.0034	0.0008	0.0026
57	0.0034	0.0008	0.0026
58	0.0034	0.0008	0.0026
59	0.0034	0.0008	0.0026
60	0.0034	0.0008	0.0026
61	0.0035	0.0008	0.0026
62	0.0035	0.0008	0.0027
63	0.0035	0.0008	0.0027
64	0.0035	0.0008	0.0027
65	0.0035	0.0008	0.0027
66	0.0035	0.0008	0.0027
67	0.0036	0.0008	0.0027
68	0.0036	0.0008	0.0027
69	0.0036	0.0008	0.0028
70	0.0036	0.0008	0.0028
71	0.0036	0.0009	0.0028
72	0.0036	0.0009	0.0028
73	0.0037	0.0009	0.0028
74	0.0037	0.0009	0.0028
75	0.0037	0.0009	0.0028
76	0.0037	0.0009	0.0028
77	0.0038	0.0009	0.0029
78	0.0038	0.0009	0.0029
79	0.0038	0.0009	0.0029
80	0.0038	0.0009	0.0029
81	0.0038	0.0009	0.0029
82	0.0039	0.0009	0.0029
83	0.0039	0.0009	0.0030
84	0.0039	0.0009	0.0030
85	0.0039	0.0009	0.0030
86	0.0039	0.0009	0.0030
87	0.0040	0.0009	0.0030
88	0.0040	0.0009	0.0031
89	0.0040	0.0009	0.0031
90	0.0040	0.0010	0.0031

91	0.0041	0.0010	0.0031
92	0.0041	0.0010	0.0031
93	0.0041	0.0010	0.0032
94	0.0041	0.0010	0.0032
95	0.0042	0.0010	0.0032
96	0.0042	0.0010	0.0032
97	0.0042	0.0010	0.0032
98	0.0043	0.0010	0.0033
99	0.0043	0.0010	0.0033
100	0.0043	0.0010	0.0033
101	0.0044	0.0010	0.0033
102	0.0044	0.0010	0.0033
103	0.0044	0.0010	0.0034
104	0.0044	0.0010	0.0034
105	0.0045	0.0011	0.0034
106	0.0045	0.0011	0.0034
107	0.0045	0.0011	0.0035
108	0.0046	0.0011	0.0035
109	0.0046	0.0011	0.0035
110	0.0046	0.0011	0.0035
111	0.0047	0.0011	0.0036
112	0.0047	0.0011	0.0036
113	0.0048	0.0011	0.0036
114	0.0048	0.0011	0.0037
115	0.0048	0.0011	0.0037
116	0.0049	0.0011	0.0037
117	0.0049	0.0012	0.0038
118	0.0049	0.0012	0.0038
119	0.0050	0.0012	0.0038
120	0.0050	0.0012	0.0038
121	0.0051	0.0012	0.0039
122	0.0051	0.0012	0.0039
123	0.0052	0.0012	0.0040
124	0.0052	0.0012	0.0040
125	0.0053	0.0012	0.0040
126	0.0053	0.0012	0.0041
127	0.0054	0.0013	0.0041
128	0.0054	0.0013	0.0041
129	0.0055	0.0013	0.0042
130	0.0055	0.0013	0.0042
131	0.0056	0.0013	0.0043
132	0.0056	0.0013	0.0043
133	0.0057	0.0013	0.0044
134	0.0058	0.0014	0.0044
135	0.0058	0.0014	0.0045
136	0.0059	0.0014	0.0045
137	0.0060	0.0014	0.0046
138	0.0060	0.0014	0.0046
139	0.0061	0.0014	0.0047
140	0.0062	0.0014	0.0047
141	0.0063	0.0015	0.0048
142	0.0063	0.0015	0.0048
143	0.0064	0.0015	0.0049
144	0.0065	0.0015	0.0050
145	0.0055	0.0013	0.0042
146	0.0056	0.0013	0.0042
147	0.0057	0.0013	0.0043
148	0.0057	0.0013	0.0044
149	0.0058	0.0014	0.0045
150	0.0059	0.0014	0.0045
151	0.0060	0.0014	0.0046
152	0.0061	0.0014	0.0047
153	0.0062	0.0015	0.0048
154	0.0063	0.0015	0.0048
155	0.0065	0.0015	0.0050
156	0.0066	0.0015	0.0050
157	0.0067	0.0016	0.0051
158	0.0068	0.0016	0.0052
159	0.0070	0.0016	0.0054
160	0.0071	0.0017	0.0054
161	0.0073	0.0017	0.0056
162	0.0074	0.0017	0.0057
163	0.0076	0.0018	0.0058

164	0.0078	0.0018	0.0059
165	0.0080	0.0019	0.0061
166	0.0082	0.0019	0.0062
167	0.0085	0.0020	0.0065
168	0.0086	0.0020	0.0066
169	0.0090	0.0021	0.0069
170	0.0092	0.0022	0.0070
171	0.0096	0.0022	0.0073
172	0.0098	0.0023	0.0075
173	0.0102	0.0024	0.0078
174	0.0105	0.0025	0.0080
175	0.0110	0.0026	0.0084
176	0.0113	0.0027	0.0086
177	0.0120	0.0028	0.0091
178	0.0123	0.0029	0.0094
179	0.0132	0.0031	0.0101
180	0.0136	0.0032	0.0104
181	0.0147	0.0035	0.0112
182	0.0153	0.0036	0.0117
183	0.0167	0.0039	0.0128
184	0.0176	0.0041	0.0134
185	0.0193	0.0045	0.0147
186	0.0206	0.0048	0.0157
187	0.0238	0.0056	0.0182
188	0.0260	0.0061	0.0199
189	0.0324	0.0076	0.0247
190	0.0373	0.0088	0.0285
191	0.0566	0.0118	0.0447
192	0.0821	0.0118	0.0703
193	0.3552	0.0118	0.3434
194	0.0445	0.0105	0.0340
195	0.0288	0.0068	0.0220
196	0.0221	0.0052	0.0169
197	0.0185	0.0044	0.0142
198	0.0160	0.0038	0.0122
199	0.0141	0.0033	0.0108
200	0.0127	0.0030	0.0097
201	0.0116	0.0027	0.0089
202	0.0107	0.0025	0.0082
203	0.0100	0.0023	0.0076
204	0.0094	0.0022	0.0072
205	0.0088	0.0021	0.0067
206	0.0083	0.0020	0.0064
207	0.0079	0.0019	0.0060
208	0.0075	0.0018	0.0058
209	0.0072	0.0017	0.0055
210	0.0069	0.0016	0.0053
211	0.0066	0.0016	0.0051
212	0.0064	0.0015	0.0049
213	0.0062	0.0015	0.0047
214	0.0060	0.0014	0.0046
215	0.0058	0.0014	0.0044
216	0.0056	0.0013	0.0043
217	0.0065	0.0015	0.0050
218	0.0064	0.0015	0.0049
219	0.0062	0.0015	0.0047
220	0.0061	0.0014	0.0046
221	0.0059	0.0014	0.0045
222	0.0058	0.0014	0.0044
223	0.0057	0.0013	0.0043
224	0.0056	0.0013	0.0043
225	0.0054	0.0013	0.0042
226	0.0053	0.0013	0.0041
227	0.0052	0.0012	0.0040
228	0.0051	0.0012	0.0039
229	0.0051	0.0012	0.0039
230	0.0050	0.0012	0.0038
231	0.0049	0.0012	0.0037
232	0.0048	0.0011	0.0037
233	0.0047	0.0011	0.0036
234	0.0047	0.0011	0.0036
235	0.0046	0.0011	0.0035
236	0.0045	0.0011	0.0035

237	0.0045	0.0010	0.0034
238	0.0044	0.0010	0.0034
239	0.0043	0.0010	0.0033
240	0.0043	0.0010	0.0033
241	0.0042	0.0010	0.0032
242	0.0042	0.0010	0.0032
243	0.0041	0.0010	0.0031
244	0.0041	0.0010	0.0031
245	0.0040	0.0009	0.0031
246	0.0040	0.0009	0.0030
247	0.0039	0.0009	0.0030
248	0.0039	0.0009	0.0030
249	0.0038	0.0009	0.0029
250	0.0038	0.0009	0.0029
251	0.0037	0.0009	0.0029
252	0.0037	0.0009	0.0028
253	0.0037	0.0009	0.0028
254	0.0036	0.0009	0.0028
255	0.0036	0.0008	0.0027
256	0.0035	0.0008	0.0027
257	0.0035	0.0008	0.0027
258	0.0035	0.0008	0.0027
259	0.0034	0.0008	0.0026
260	0.0034	0.0008	0.0026
261	0.0034	0.0008	0.0026
262	0.0034	0.0008	0.0026
263	0.0033	0.0008	0.0025
264	0.0033	0.0008	0.0025
265	0.0033	0.0008	0.0025
266	0.0032	0.0008	0.0025
267	0.0032	0.0008	0.0025
268	0.0032	0.0007	0.0024
269	0.0032	0.0007	0.0024
270	0.0031	0.0007	0.0024
271	0.0031	0.0007	0.0024
272	0.0031	0.0007	0.0024
273	0.0031	0.0007	0.0023
274	0.0030	0.0007	0.0023
275	0.0030	0.0007	0.0023
276	0.0030	0.0007	0.0023
277	0.0030	0.0007	0.0023
278	0.0029	0.0007	0.0022
279	0.0029	0.0007	0.0022
280	0.0029	0.0007	0.0022
281	0.0029	0.0007	0.0022
282	0.0029	0.0007	0.0022
283	0.0028	0.0007	0.0022
284	0.0028	0.0007	0.0022
285	0.0028	0.0007	0.0021
286	0.0028	0.0007	0.0021
287	0.0028	0.0006	0.0021
288	0.0027	0.0006	0.0021

```
      --------------------------------------------------------------------
      --------------------------------------------------------------------
      Total soil rain loss =      0.42(In)
      Total effective rainfall =      1.72(In)
      Peak flow rate in flood hydrograph =     87.98(CFS)
      ---------------------------------------------------------------------
      +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
                          24 - H O U R    S T O R M
                     R u n o f f      H y d r o g r a p h
      --------------------------------------------------------------------
                 Hydrograph in   5   Minute intervals ((CFS))

      --------------------------------------------------------------------
Time(h+m) Volume Ac.Ft   Q(CFS)  0       22.5      45.0      67.5      90.0
-----------------------------------------------------------------------
  0+ 5       0.0007      0.10  Q         |         |         |         |
  0+10       0.0045      0.56  Q         |         |         |         |
  0+15       0.0098      0.77  Q         |         |         |         |
  0+20       0.0158      0.87  Q         |         |         |         |
  0+25       0.0222      0.92  Q         |         |         |         |
  0+30       0.0288      0.96  Q         |         |         |         |
```

```
  0+35        0.0356      0.98  Q          |          |          |          |
  0+40        0.0425      1.00  Q          |          |          |          |
  0+45        0.0494      1.01  Q          |          |          |          |
  0+50        0.0565      1.02  Q          |          |          |          |
  0+55        0.0636      1.03  Q          |          |          |          |
  1+ 0        0.0707      1.03  Q          |          |          |          |
  1+ 5        0.0779      1.04  Q          |          |          |          |
  1+10        0.0850      1.04  Q          |          |          |          |
  1+15        0.0922      1.04  Q          |          |          |          |
  1+20        0.0994      1.05  Q          |          |          |          |
  1+25        0.1067      1.05  Q          |          |          |          |
  1+30        0.1140      1.06  Q          |          |          |          |
  1+35        0.1213      1.06  Q          |          |          |          |
  1+40        0.1286      1.06  Q          |          |          |          |
  1+45        0.1359      1.07  Q          |          |          |          |
  1+50        0.1433      1.07  QV         |          |          |          |
  1+55        0.1507      1.08  QV         |          |          |          |
  2+ 0        0.1582      1.08  QV         |          |          |          |
  2+ 5        0.1656      1.08  QV         |          |          |          |
  2+10        0.1731      1.09  QV         |          |          |          |
  2+15        0.1806      1.09  QV         |          |          |          |
  2+20        0.1882      1.10  QV         |          |          |          |
  2+25        0.1958      1.10  QV         |          |          |          |
  2+30        0.2034      1.10  QV         |          |          |          |
  2+35        0.2110      1.11  QV         |          |          |          |
  2+40        0.2187      1.11  QV         |          |          |          |
  2+45        0.2264      1.12  QV         |          |          |          |
  2+50        0.2341      1.12  QV         |          |          |          |
  2+55        0.2418      1.13  QV         |          |          |          |
  3+ 0        0.2496      1.13  QV         |          |          |          |
  3+ 5        0.2574      1.14  QV         |          |          |          |
  3+10        0.2653      1.14  QV         |          |          |          |
  3+15        0.2732      1.14  QV         |          |          |          |
  3+20        0.2811      1.15  QV         |          |          |          |
  3+25        0.2890      1.15  Q V        |          |          |          |
  3+30        0.2970      1.16  Q V        |          |          |          |
  3+35        0.3050      1.16  Q V        |          |          |          |
  3+40        0.3131      1.17  Q V        |          |          |          |
  3+45        0.3212      1.17  Q V        |          |          |          |
  3+50        0.3293      1.18  Q V        |          |          |          |
  3+55        0.3374      1.18  Q V        |          |          |          |
  4+ 0        0.3456      1.19  Q V        |          |          |          |
  4+ 5        0.3538      1.19  Q V        |          |          |          |
  4+10        0.3621      1.20  Q V        |          |          |          |
  4+15        0.3704      1.20  Q V        |          |          |          |
  4+20        0.3787      1.21  Q V        |          |          |          |
  4+25        0.3871      1.21  Q V        |          |          |          |
  4+30        0.3955      1.22  Q V        |          |          |          |
  4+35        0.4039      1.23  Q V        |          |          |          |
  4+40        0.4124      1.23  Q V        |          |          |          |
  4+45        0.4209      1.24  Q V        |          |          |          |
  4+50        0.4295      1.24  Q  V       |          |          |          |
  4+55        0.4381      1.25  Q  V       |          |          |          |
  5+ 0        0.4467      1.25  Q  V       |          |          |          |
  5+ 5        0.4554      1.26  Q  V       |          |          |          |
  5+10        0.4641      1.27  Q  V       |          |          |          |
  5+15        0.4729      1.27  Q  V       |          |          |          |
  5+20        0.4817      1.28  Q  V       |          |          |          |
  5+25        0.4906      1.28  Q  V       |          |          |          |
  5+30        0.4994      1.29  Q  V       |          |          |          |
  5+35        0.5084      1.30  Q  V       |          |          |          |
  5+40        0.5174      1.30  Q  V       |          |          |          |
  5+45        0.5264      1.31  Q  V       |          |          |          |
  5+50        0.5355      1.32  Q  V       |          |          |          |
  5+55        0.5446      1.32  Q  V       |          |          |          |
  6+ 0        0.5538      1.33  Q  V       |          |          |          |
  6+ 5        0.5630      1.34  Q  V       |          |          |          |
  6+10        0.5722      1.35  Q   V      |          |          |          |
  6+15        0.5816      1.35  Q   V      |          |          |          |
  6+20        0.5909      1.36  Q   V      |          |          |          |
  6+25        0.6003      1.37  Q   V      |          |          |          |
  6+30        0.6098      1.37  Q   V      |          |          |          |
  6+35        0.6193      1.38  Q   V      |          |          |          |
```

```
 6+40       0.6289      1.39  Q   V     |         |         |         |
 6+45       0.6385      1.40  Q   V     |         |         |         |
 6+50       0.6482      1.41  Q   V     |         |         |         |
 6+55       0.6579      1.41  Q   V     |         |         |         |
 7+ 0       0.6677      1.42  Q   V     |         |         |         |
 7+ 5       0.6775      1.43  Q   V     |         |         |         |
 7+10       0.6874      1.44  Q   V     |         |         |         |
 7+15       0.6974      1.45  Q   V     |         |         |         |
 7+20       0.7074      1.45  Q   V     |         |         |         |
 7+25       0.7175      1.46  Q    V    |         |         |         |
 7+30       0.7276      1.47  Q    V    |         |         |         |
 7+35       0.7378      1.48  Q    V    |         |         |         |
 7+40       0.7481      1.49  Q    V    |         |         |         |
 7+45       0.7584      1.50  Q    V    |         |         |         |
 7+50       0.7688      1.51  Q    V    |         |         |         |
 7+55       0.7793      1.52  Q    V    |         |         |         |
 8+ 0       0.7898      1.53  Q    V    |         |         |         |
 8+ 5       0.8004      1.54  Q    V    |         |         |         |
 8+10       0.8111      1.55  Q    V    |         |         |         |
 8+15       0.8218      1.56  Q    V    |         |         |         |
 8+20       0.8326      1.57  Q    V    |         |         |         |
 8+25       0.8435      1.58  Q    V    |         |         |         |
 8+30       0.8544      1.59  Q    V    |         |         |         |
 8+35       0.8655      1.60  Q     V   |         |         |         |
 8+40       0.8766      1.61  Q     V   |         |         |         |
 8+45       0.8878      1.62  Q     V   |         |         |         |
 8+50       0.8990      1.64  Q     V   |         |         |         |
 8+55       0.9104      1.65  Q     V   |         |         |         |
 9+ 0       0.9218      1.66  Q     V   |         |         |         |
 9+ 5       0.9333      1.67  Q     V   |         |         |         |
 9+10       0.9449      1.68  Q     V   |         |         |         |
 9+15       0.9566      1.70  Q     V   |         |         |         |
 9+20       0.9684      1.71  Q     V   |         |         |         |
 9+25       0.9802      1.72  Q     V   |         |         |         |
 9+30       0.9922      1.74  Q     V   |         |         |         |
 9+35       1.0043      1.75  Q      V  |         |         |         |
 9+40       1.0164      1.77  Q      V  |         |         |         |
 9+45       1.0287      1.78  Q      V  |         |         |         |
 9+50       1.0410      1.79  Q      V  |         |         |         |
 9+55       1.0535      1.81  Q      V  |         |         |         |
10+ 0       1.0660      1.82  Q      V  |         |         |         |
10+ 5       1.0787      1.84  Q      V  |         |         |         |
10+10       1.0915      1.86  Q      V  |         |         |         |
10+15       1.1044      1.87  Q      V  |         |         |         |
10+20       1.1174      1.89  Q      V  |         |         |         |
10+25       1.1305      1.91  Q      V  |         |         |         |
10+30       1.1438      1.92  Q       V |         |         |         |
10+35       1.1571      1.94  Q       V |         |         |         |
10+40       1.1706      1.96  Q       V |         |         |         |
10+45       1.1843      1.98  Q       V |         |         |         |
10+50       1.1980      2.00  Q       V |         |         |         |
10+55       1.2119      2.02  Q       V |         |         |         |
11+ 0       1.2260      2.04  Q       V |         |         |         |
11+ 5       1.2401      2.06  Q       V |         |         |         |
11+10       1.2545      2.08  Q       V |         |         |         |
11+15       1.2690      2.10  Q       V |         |         |         |
11+20       1.2836      2.13  Q       V |         |         |         |
11+25       1.2984      2.15  Q        V|         |         |         |
11+30       1.3134      2.17  Q        V|         |         |         |
11+35       1.3285      2.20  Q        V|         |         |         |
11+40       1.3438      2.22  Q        V|         |         |         |
11+45       1.3593      2.25  Q        V|         |         |         |
11+50       1.3750      2.28  |Q       V|         |         |         |
11+55       1.3909      2.30  |Q       V|         |         |         |
12+ 0       1.4069      2.33  |Q       V|         |         |         |
12+ 5       1.4229      2.32  |Q       V|         |         |         |
12+10       1.4379      2.17  Q         V         |         |         |
12+15       1.4524      2.11  Q         V         |         |         |
12+20       1.4669      2.11  Q         V         |         |         |
12+25       1.4815      2.12  Q         V         |         |         |
12+30       1.4962      2.14  Q         V         |         |         |
12+35       1.5111      2.16  Q         V         |         |         |
12+40       1.5262      2.19  Q         V         |         |         |
```

```
12+45       1.5416      2.22  Q         V         |         |         |
12+50       1.5571      2.26  |Q        V         |         |         |
12+55       1.5729      2.30  |Q        |V        |         |         |
13+ 0       1.5891      2.34  |Q        |V        |         |         |
13+ 5       1.6055      2.38  |Q        |V        |         |         |
13+10       1.6222      2.43  |Q        |V        |         |         |
13+15       1.6392      2.47  |Q        |V        |         |         |
13+20       1.6566      2.53  |Q        |V        |         |         |
13+25       1.6744      2.57  |Q        |V        |         |         |
13+30       1.6925      2.63  |Q        |V        |         |         |
13+35       1.7110      2.69  |Q        |V        |         |         |
13+40       1.7299      2.75  |Q        | V       |         |         |
13+45       1.7493      2.81  |Q        | V       |         |         |
13+50       1.7692      2.88  |Q        | V       |         |         |
13+55       1.7895      2.95  |Q        | V       |         |         |
14+ 0       1.8104      3.03  |Q        | V       |         |         |
14+ 5       1.8318      3.11  |Q        | V       |         |         |
14+10       1.8539      3.21  |Q        | V       |         |         |
14+15       1.8767      3.30  |Q        |  V      |         |         |
14+20       1.9002      3.41  |Q        |  V      |         |         |
14+25       1.9244      3.51  |Q        |  V      |         |         |
14+30       1.9494      3.64  |Q        |  V      |         |         |
14+35       1.9753      3.76  |Q        |  V      |         |         |
14+40       2.0022      3.91  |Q        |   V     |         |         |
14+45       2.0302      4.05  |Q        |   V     |         |         |
14+50       2.0593      4.23  |Q        |   V     |         |         |
14+55       2.0897      4.41  |Q        |   V     |         |         |
15+ 0       2.1216      4.63  | Q       |   V     |         |         |
15+ 5       2.1550      4.85  | Q       |    V    |         |         |
15+10       2.1904      5.14  | Q       |    V    |         |         |
15+15       2.2277      5.42  | Q       |    V    |         |         |
15+20       2.2677      5.81  | Q       |    V    |         |         |
15+25       2.3103      6.18  | Q       |     V   |         |         |
15+30       2.3562      6.67  | Q       |     V   |         |         |
15+35       2.4059      7.21  |  Q      |     V   |         |         |
15+40       2.4613      8.05  |  Q      |      V  |         |         |
15+45       2.5234      9.01  |   Q     |      V  |         |         |
15+50       2.5965     10.61  |   Q     |       V |         |         |
15+55       2.6851     12.88  |    Q    |       V |         |         |
16+ 0       2.8116     18.37  |       Q |        V|         |         |
16+ 5       3.0800     38.96  |         |      Q  |V        |         |
16+10       3.6859     87.98  |         |         |    V    |        Q|
16+15       4.0218     48.77  |         |         |Q      V |         |
16+20       4.2124     27.68  |         | Q       |        V|         |
16+25       4.3424     18.88  |       Q |         |         V         |
16+30       4.4390     14.03  |     Q   |         |         |V        |
16+35       4.5135     10.81  |   Q     |         |         |V        |
16+40       4.5712      8.39  |  Q      |         |         | V       |
16+45       4.6198      7.05  |  Q      |         |         | V       |
16+50       4.6620      6.13  | Q       |         |         | V       |
16+55       4.6959      4.93  | Q       |         |         | V       |
17+ 0       4.7241      4.08  |Q        |         |         |  V      |
17+ 5       4.7500      3.76  |Q        |         |         |  V      |
17+10       4.7740      3.49  |Q        |         |         |  V      |
17+15       4.7966      3.27  |Q        |         |         |  V      |
17+20       4.8178      3.09  |Q        |         |         |  V      |
17+25       4.8380      2.93  |Q        |         |         |  V      |
17+30       4.8572      2.79  |Q        |         |         |   V     |
17+35       4.8756      2.66  |Q        |         |         |   V     |
17+40       4.8932      2.55  |Q        |         |         |   V     |
17+45       4.9101      2.45  |Q        |         |         |   V     |
17+50       4.9263      2.36  |Q        |         |         |   V     |
17+55       4.9420      2.28  |Q        |         |         |   V     |
18+ 0       4.9572      2.20  Q         |         |         |   V     |
18+ 5       4.9721      2.17  Q         |         |         |   V     |
18+10       4.9879      2.29  |Q        |         |         |   V     |
18+15       5.0038      2.31  |Q        |         |         |    V    |
18+20       5.0196      2.29  |Q        |         |         |    V    |
18+25       5.0351      2.25  |Q        |         |         |    V    |
18+30       5.0503      2.21  Q         |         |         |    V    |
18+35       5.0653      2.17  Q         |         |         |    V    |
18+40       5.0799      2.13  Q         |         |         |    V    |
18+45       5.0943      2.09  Q         |         |         |    V    |
```

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  18+50       5.1084      2.05  Q         |         |         |    V    |
  18+55       5.1222      2.01  Q         |         |         |    V    |
  19+ 0       5.1357      1.97  Q         |         |         |    V    |
  19+ 5       5.1490      1.93  Q         |         |         |     V   |
  19+10       5.1621      1.90  Q         |         |         |     V   |
  19+15       5.1749      1.86  Q         |         |         |     V   |
  19+20       5.1875      1.83  Q         |         |         |     V   |
  19+25       5.1999      1.80  Q         |         |         |     V   |
  19+30       5.2121      1.77  Q         |         |         |     V   |
  19+35       5.2241      1.74  Q         |         |         |     V   |
  19+40       5.2359      1.71  Q         |         |         |     V   |
  19+45       5.2475      1.69  Q         |         |         |     V   |
  19+50       5.2590      1.66  Q         |         |         |     V   |
  19+55       5.2703      1.64  Q         |         |         |     V   |
  20+ 0       5.2814      1.62  Q         |         |         |      V  |
  20+ 5       5.2924      1.59  Q         |         |         |      V  |
  20+10       5.3032      1.57  Q         |         |         |      V  |
  20+15       5.3139      1.55  Q         |         |         |      V  |
  20+20       5.3245      1.53  Q         |         |         |      V  |
  20+25       5.3349      1.51  Q         |         |         |      V  |
  20+30       5.3452      1.49  Q         |         |         |      V  |
  20+35       5.3553      1.48  Q         |         |         |      V  |
  20+40       5.3654      1.46  Q         |         |         |      V  |
  20+45       5.3753      1.44  Q         |         |         |      V  |
  20+50       5.3851      1.42  Q         |         |         |      V  |
  20+55       5.3948      1.41  Q         |         |         |      V  |
  21+ 0       5.4044      1.39  Q         |         |         |      V  |
  21+ 5       5.4138      1.38  Q         |         |         |      V  |
  21+10       5.4232      1.36  Q         |         |         |      V  |
  21+15       5.4325      1.35  Q         |         |         |       V |
  21+20       5.4417      1.33  Q         |         |         |       V |
  21+25       5.4508      1.32  Q         |         |         |       V |
  21+30       5.4598      1.31  Q         |         |         |       V |
  21+35       5.4687      1.29  Q         |         |         |       V |
  21+40       5.4775      1.28  Q         |         |         |       V |
  21+45       5.4862      1.27  Q         |         |         |       V |
  21+50       5.4949      1.26  Q         |         |         |       V |
  21+55       5.5035      1.24  Q         |         |         |       V |
  22+ 0       5.5120      1.23  Q         |         |         |       V |
  22+ 5       5.5204      1.22  Q         |         |         |       V |
  22+10       5.5287      1.21  Q         |         |         |       V |
  22+15       5.5370      1.20  Q         |         |         |       V |
  22+20       5.5452      1.19  Q         |         |         |       V |
  22+25       5.5533      1.18  Q         |         |         |       V |
  22+30       5.5614      1.17  Q         |         |         |       V |
  22+35       5.5694      1.16  Q         |         |         |        V|
  22+40       5.5773      1.15  Q         |         |         |        V|
  22+45       5.5851      1.14  Q         |         |         |        V|
  22+50       5.5929      1.13  Q         |         |         |        V|
  22+55       5.6007      1.12  Q         |         |         |        V|
  23+ 0       5.6083      1.11  Q         |         |         |        V|
  23+ 5       5.6160      1.11  Q         |         |         |        V|
  23+10       5.6235      1.10  Q         |         |         |        V|
  23+15       5.6310      1.09  Q         |         |         |        V|
  23+20       5.6385      1.08  Q         |         |         |        V|
  23+25       5.6458      1.07  Q         |         |         |        V|
  23+30       5.6532      1.06  Q         |         |         |        V|
  23+35       5.6605      1.06  Q         |         |         |        V|
  23+40       5.6677      1.05  Q         |         |         |        V|
  23+45       5.6749      1.04  Q         |         |         |        V|
  23+50       5.6820      1.04  Q         |         |         |        V|
  23+55       5.6891      1.03  Q         |         |         |        V|
  24+ 0       5.6961      1.02  Q         |         |         |        V|
-----------------------------------------------------------------------
```

Appendix E - Soils Report

November 29, 2021 Project No. 21-7253

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14467 Park Avenue,
Victorville, CA 92392

Subject: Percolation Testing Report for Storm Water Infiltration, Proposed Industrial Building, 17198-17000 Abbey Lane, Victorville, California 92394

Robert,

In accordance with your request and authorization, TGR Geotechnical, Inc. (TGR) has completed percolation testing at the subject site for the design of the proposed storm water infiltration. Presented below are the details of our investigation.

Scope of Work

The scope of work for this percolation testing was limited to the following:

- Site reconnaissance, mark boring locations and call Dig-Alert.
- Drilling, sampling and logging four (4) hollow stem auger borings to an approximate depth of 5 feet below existing grade to perform percolation testing.
- Drilling, sampling and logging six (6) hollow stem auger boring to approximate depths ranging from 16.5 to 51.5 feet below existing grade to evaluate the presence or absence of groundwater. All borings were backfilled with soil cuttings and excess soil was disposed on-site.
- Preparation of this report summarizing the field and lab work and presenting infiltration rates along with a discussion of historic and seasonal high groundwater levels.

Field Investigation

Field exploration was performed on November 16 and 17, 2021 by members from our firm who logged the borings and obtained representative samples, which were subsequently transported to the laboratory for further review and testing. The approximate locations of the borings are indicated on the enclosed Boring Location Map (Figure 1).

The subsurface conditions were explored by drilling, sampling, and logging four (4) borings with a truck mounted hollow stem drill rig to approximate depths of 5 feet to perform percolation testing and six (6) hollow stem auger borings to depths ranging from 16.5 to 51.5 feet below existing grade to verify the presence or absence of groundwater. Subsequent to drilling, all borings were backfilled with cuttings. The boring logs are presented on Plates 1 through 12.

The drill rig was equipped with a sampling apparatus to allow for recovery of driven modified California Ring Sampler (CRS), 3-inch outside diameter, and 2.42-inch inside diameter and SPT samples. Driven samples and bulk samples of the earth materials encountered at selected intervals were recovered from the borings.

The samples were driven using an automatic 140-pound hammer falling freely from a height of 30-inches. The blow counts for CRS were converted to equivalent SPT blow counts. Soil descriptions were entered on the logs in general accordance with the Unified Soil Classification System (USCS). The locations and depths of the soil samples recovered are indicated on the logs in Plates 1 through 12.

Earth Units

The site soils generally consist of sand and silty sand with varying amounts of gravel interbedded to the maximum depth explored, 51.5 feet below existing grade. A more detailed description of the soils encountered is presented in the boring logs on Plates 1 through 12.

Groundwater

Groundwater was encountered during our subsurface exploration to a depth of 40 feet below existing grade in Boring B-3. Groundwater was no encountered in any other exploratory boring. Based on our review of available historical groundwater information (CDMG) regional historic high groundwater has not been mapped at the subject site.

Per USGS groundwater well data for the nation, the historic high groundwater for the northern portion of the subject site is approximately 11.9 feet below existing grade and 2688.1 feet above NGVD 1929, and for the historic high groundwater for the southern portion (area of the proposed infiltration basins) of the subject site groundwater is approximately 48.25 feet below existing grade and 2671.75 feet above NGVD 1929, dating back to 1957.

Seasonal and long-term fluctuations in the groundwater may occur as a result of variations in subsurface conditions, rainfall, run-off conditions and other factors. Therefore, variations from our observations may occur.

Static groundwater is not anticipated to impact the proposed stormwater infiltration for the southern half of the subject site based upon review of USGS groundwater well data and absence of groundwater in the six exploratory borings in the southern portion of the subject site.

Laboratory Testing

Wash Sieve Test: Typical materials were washed over No. 200 sieve (ASTM Test Method D1140). The test results are presented below:

Sample Location	% Passing No. 200 Sieve
P-1 @ 0-5 feet	17.5%
P-2 @ 0-5 feet	14.5%
P-3 @ 0-5 feet	14.3%
P-4 @ 0-5 feet	15.2%

Percolation Testing

Percolation testing was performed at the subject site utilizing the Porchet Method. Presented below is the infiltration rate from the percolation tests performed at the subject site. These do not include any factor of safety.

- P-1 at 0-5 feet 22.18 inches per hour
- P-2 at 0-5 feet 7.05 inches per hour
- P-3 at 0-5 feet 3.46 inches per hour
- P-4 at 0-5 feet 5.98 inches per hour

The infiltration test rates were generally determined utilizing the County of San Bernardino Technical Guidance Document (2011). Details of calculations are presented in Table 1. Based on the percolation test results, the subject site is generally considered suitable for storm water infiltration from a geotechnical standpoint.

If you have any questions regarding this report, please do not hesitate to contact this office. We appreciate this opportunity to be of service.

Respectfully submitted,

TGR GEOTECHNICAL, INC.

Robert Aguilar

REGISTERED PROFESSIONAL ENGINEER SANJAY GOVIL No. GE2382 EXP. 6/30/2022 GEOTECHNICAL STATE OF CALIFORNIA

Robert Aguilar
Staff Engineer

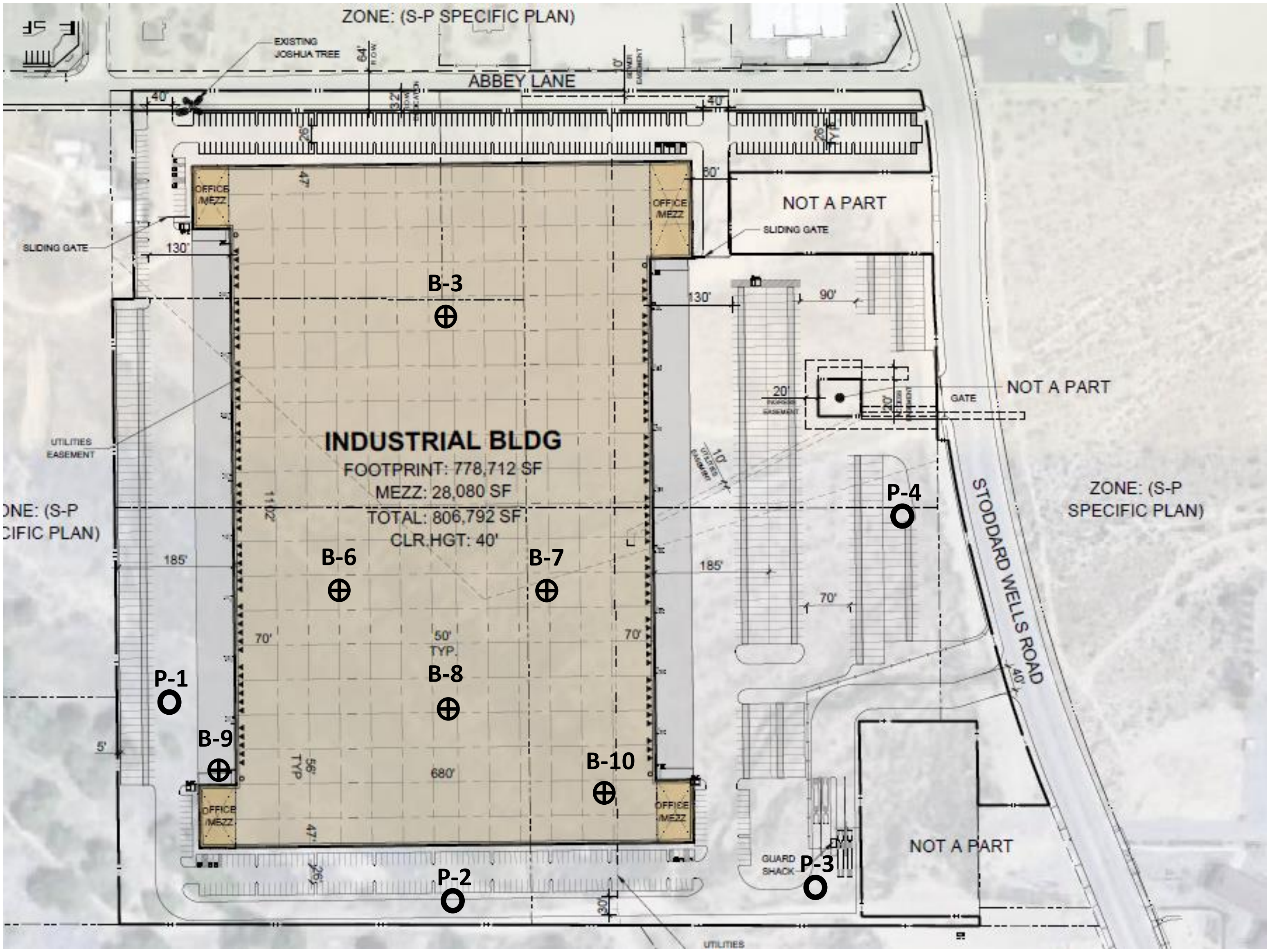
Sanjay Govil, PhD, PE, GE 2382
Principal Geotechnical Engineer

Attachments: Figure 1 – Boring Location Map
Figure 2 – Site Location Map

Plates 1 through 12 – Boring Logs

Table 1 – Percolation Test Worksheet

Distribution: (1) Addressee



B-10 ⊕ APPROXIMATE LOCATION OF EXPLORATORY BORING

P-4 ○ APPROXIMATE LOCATION OF PERCOLATION BORING

TGR Geotechnical Environmental Hydrogeology Material Testing Construction Inspection

BORING LOCATION MAP
SW CORNER OF ABBEY LANE AND STODDARD WELLS ROAD
VICTORVILLE, CALIFORNIA

PROJECT NO. 21-7253

FIGURE 1

Geotechnical
Environmental
Hydrogeology
Material Testing
Construction Inspection

SITE LOCATION MAP
SW CORNER OF ABBEY LANE AND STODDARD WELLS ROAD
VICTORVILLE, CALIFORNIA

PROJECT NO. 21-7253

FIGURE 2

LOG OF EXPLORATORY BORING B-3

Project Number:	**21-7253**	Logged By:	**RA**
Project Name:	**17198-17000 Abbey Lane, Victorville**	Project Engineer:	**SG**
Date Drilled:	**11/17/21 - 11/17/21**	Drill Type:	**CME 75 Hollow Stem**
Ground Elev:	**2722**	Drive Wt & Drop:	**140lbs / 30in**

Legend: Shelby Tube; Standard Split Spoon; No recovery; Modified California; Water Table ATD

Elevation (ft)	Depth (ft)	Graphic Log	Bulk Sample	Drive Sample	SPT blows/ft (or equivalent N)	Pocket Pen (tsf)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	Moisture Content (%)	Dry Density, (pcf)	Other Tests
								FIELD RESULTS / LAB RESULTS			
	0							Surface is sand and dry vegetation.			
2720								Silty SAND to Sandy SILT- tan to white, dry, medium dense, fine grained, trace coarse.			
2717	5			Modified California	9		SM	Silty SAND- tan, dry, medium dense, fine grained.	3	116	Consol
2712	10			Modified California	18		SP	SAND- light orange brown, dry, medium dense, fine to coarse grained.	1	114	Consol
2707	15			Modified California	31		SP	SAND- light brown, dry, dense, very fine to fine grained.	2	115	-200= 19.8%
2702	20			Standard Split Spoon	19		SP	...Same as above.	2		-200= 12.8%
2697	25			Standard Split Spoon	26		MLS	Sandy SILT- light pale brown, slightly moist, very stiff, very fine to fine grained.	5		-200= 60.3%

Elevation scale: 2720, 2715, 2710, 2705, 2700, 2695. Depth scale: 5, 10, 15, 20, 25.

This Boring Log should be evaluated in conjunction with the complete geotechnical report. This Boring Log represents conditions observed at the specific location and date indicated, it is not warranted to be representative of subsurface conditions at other locations and times.

PLATE 1

TGR GEOTECHNICAL, INC.

LOG OF EXPLORATORY BORING B-3

Project Number: **21-7253**
Project Name: **17198-17000 Abbey Lane, Victorville**
Date Drilled: **11/17/21 - 11/17/21**
Ground Elev: **2722**

Logged By: **RA**
Project Engineer: **SG**
Drill Type: **CME 75 Hollow Stem**
Drive Wt & Drop: **140lbs / 30in**

Legend: Shelby Tube; Standard Split Spoon; No recovery; Modified California; Water Table ATD

Elevation (ft)	Depth (ft)	Bulk Sample	Drive Sample	SPT blows/ft (or equivalent N)	Pocket Pen (tsf)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	Moisture Content (%)	Dry Density, (pcf)	Other Tests
2690			X	81		SPG	Gravelly SAND- orange brown, dry, very dense, fine to coarse sand, fine to coarse gravel.	1		-200= 5.4%
2685	35		X	56		SM	Silty SAND- orange brown, moist, very dense, fine to coarse sand, some fine to coarse gravel.	9		
2680	40		X	29		SP	SAND- dark grey brown, wet, medium dense, fine to coarse grained.	16		-200= 9.6%
2675	45		X	27		SP	...Same as above, reddish brown.	19		-200= 15.2%
2670	50		X	83		SP	...Same as above, grey brown, some gravel, very dense.	14		-200= 12.8%
2665	55						Total Depth: 51.5 feet. Groundwater encountered at 40 feet during drilling. No caving observed. Boring backfilled with soil cuttings upon completion. Ground elevation approximated with Google Earth.			

This Boring Log should be evaluated in conjunction with the complete geotechnical report. This Boring Log represents conditions observed at the specific location and date indicated, it is not warranted to be representative of subsurface conditions at other locations and times.

PLATE 2

TGR GEOTECHNICAL, INC.

LOG OF EXPLORATORY BORING B-6

Project Number: **21-7253**
Project Name: **17198-17000 Abbey Lane, Victorville**
Date Drilled: **11/16/21 - 11/16/21**
Ground Elev: **2704**
Logged By: **RA**
Project Engineer: **SG**
Drill Type: **CME 75 Hollow Stem**
Drive Wt & Drop: **140lbs / 30in**

Legend: Shelby Tube; Standard Split Spoon; No recovery; Modified California; Water Table ATD

Elevation (ft)	Depth (ft)	Graphic Log	FIELD RESULTS: Bulk Sample	Drive Sample	SPT blows/ft (or equivalent N)	Pocket Pen (tsf)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	LAB RESULTS: Moisture Content (%)	Dry Density, (pcf)	Other Tests
	0							Surface is sand and dry vegetation. Silty SAND to Sandy SILT- tan, dry, medium dense, very fine to coarse grained.			
2700	5			Modified California	20		SP	Silty SAND- light orange brown, dry, medium dense, fine to coarse grained, some gravel.	1	124	
2695	10			Modified California	>50		SP	...Same as above, very dense.	2	123	
2690	15			Modified California	31		SP	...Same as above, dense.	2	125	
								Total Depth: 16.5 feet. No groundwater encountered during drilling. No caving observed. Boring backfilled with soil cuttings upon completion. Ground elevation approximated with Google Earth.			
2685	20										
2680	25										
2675											

This Boring Log should be evaluated in conjunction with the complete geotechnical report. This Boring Log represents conditions observed at the specific location and date indicated, it is not warranted to be representative of subsurface conditions at other locations and times.

PLATE 3

TGR GEOTECHNICAL, INC.

LOG OF EXPLORATORY BORING B-7

Project Number:	**21-7253**	Logged By:	**RA**
Project Name:	**17198-17000 Abbey Lane, Victorville**	Project Engineer:	**SG**
Date Drilled:	**11/16/21 - 11/16/21**	Drill Type:	**CME 75 Hollow Stem**
Ground Elev:	**2723**	Drive Wt & Drop:	**140lbs / 30in**

Legend: Shelby Tube; Standard Split Spoon; No recovery; Modified California; Water Table ATD

Elevation (ft)	Depth (ft)	Graphic Log	FIELD RESULTS: Bulk Sample	Drive Sample	SPT blows/ft (or equivalent N)	Pocket Pen (tsf)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	LAB RESULTS: Moisture Content (%)	Dry Density, (pcf)	Other Tests
2723	0							Surface is sand and dry vegetation. Silty SAND- tan, slightly moist, medium dense, fine to coarse grained.			
2720											
	5			Modified California	12		SM	...Same as above, light reddish brown.	2	116	
2715											
	10			Modified California	21		SP	SAND- orange brown, moist, medium dense, fine to coarse grained.	3	117	
2710											
	15			Modified California	33		SM	Silty SAND to Sandy SILT- white, slightly moist, dense, fine to medium grained, cemented.	3	125	
2705											
	20			Standard Split Spoon	43		SM	...Same as above, tan, dry.	4		
2700											
	25			Standard Split Spoon	23		SM	...Same as above, medium dense.	3		
2695	26.5							Total Depth: 26.5 feet. No groundwater encountered during drilling. No caving observed. Boring backfilled with soil cuttings upon completion. Ground elevation approximated with Google Earth.			

This Boring Log should be evaluated in conjunction with the complete geotechnical report. This Boring Log represents conditions observed at the specific location and date indicated, it is not warranted to be representative of subsurface conditions at other locations and times.

PLATE 4

TGR GEOTECHNICAL, INC.

LOG OF EXPLORATORY BORING B-8

Project Number:	**21-7253**	Logged By:	**RA**
Project Name:	**17198-17000 Abbey Lane, Victorville**	Project Engineer:	**SG**
Date Drilled:	**11/16/21 - 11/16/21**	Drill Type:	**CME 75 Hollow Stem**
Ground Elev:	**2715**	Drive Wt & Drop:	**140lbs / 30in**

Legend: Shelby Tube; Standard Split Spoon; No recovery; Modified California; Water Table ATD

Elevation (ft)	Depth (ft)	Bulk Sample	Drive Sample	SPT blows/ft (or equivalent N)	Pocket Pen (tsf)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	Moisture Content (%)	Dry Density, (pcf)	Other Tests
	0	Bulk					Surface is sand and dry vegetation.			
						SM	Silty SAND- tan, dry, medium dense, fine to coarse grained.			Corrosion
2710	5		Modified California	29		SP	SAND- light orange brown, dry, medium dense, fine to coarse grained.	1	112	Consol -200= 12.8%
2705	10		Modified California	31		SP	...Same as above, dense.	2	121	
2700	15		Modified California	55		SP	...Same as above, very dense, fine to medium grained.	2	128	
2695	20		Standard Split Spoon	25		SP	...Same as above, medium dense.	2		-200= 11.4%%
2690	25		Standard Split Spoon	32		SM	Silty SAND- tan, dry, dense, very fine to fine grained.	3		-200= 26.6%

This Boring Log should be evaluated in conjunction with the complete geotechnical report. This Boring Log represents conditions observed at the specific location and date indicated, it is not warranted to be representative of subsurface conditions at other locations and times.

PLATE 5

TGR GEOTECHNICAL, INC.

LOG OF EXPLORATORY BORING B-8

Project Number:	**21-7253**	Logged By:	**RA**
Project Name:	**17198-17000 Abbey Lane, Victorville**	Project Engineer:	**SG**
Date Drilled:	**11/16/21 - 11/16/21**	Drill Type:	**CME 75 Hollow Stem**
Ground Elev:	**2715**	Drive Wt & Drop:	**140lbs / 30in**

Legend: Shelby Tube; Standard Split Spoon; No recovery; Modified California; Water Table ATD

Elevation (ft)	Depth (ft)	Graphic Log	FIELD RESULTS: Bulk Sample	Drive Sample	SPT blows/ft (or equivalent N)	Pocket Pen (tsf)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	LAB RESULTS: Moisture Content (%)	Dry Density, (pcf)	Other Tests
				Standard Split Spoon	18		SM	Silty SAND- tan, dry, dense, very fine to fine grained. *(continued)* ...Same as above, medium dense.	2		
2680	35			Standard Split Spoon	36		SPG	Gravelly SAND- light orange brown, dry, dense, fine to coarse sand, fine to medium gravel.	1		-200= 4.4%
2675	40			Standard Split Spoon	>50		SPG	...Same as above, very dense.	1		
2670	45							Total Depth: 41.5 feet due to refusal. No groundwater encountered during drilling. No caving observed. Boring backfilled with soil cuttings upon completion. Ground elevation approximated with Google Earth.			
2665	50										
2660	55										

LOG OF EXPLORATORY BORING B-9

Project Number:	**21-7253**	Logged By:	**RA**
Project Name:	**17198-17000 Abbey Lane, Victorville**	Project Engineer:	**SG**
Date Drilled:	**11/16/21 - 11/16/21**	Drill Type:	**CME 75 Hollow Stem**
Ground Elev:	**2393**	Drive Wt & Drop:	**140lbs / 30in**

Legend: Shelby Tube; Standard Split Spoon; No recovery; Modified California; Water Table ATD

Elevation (ft)	Depth (ft)	Graphic Log	FIELD RESULTS: Bulk Sample	Drive Sample	SPT blows/ft (or equivalent N)	Pocket Pen (tsf)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	LAB RESULTS: Moisture Content (%)	Dry Density, (pcf)	Other Tests
	0							Surface is sand and dry vegetation.			
2390								Sandy SILT- white, dry, firm to soft, fine to coarse grained sand.			
	5			Modified California	20		SM	Silty SAND- light orange brown, medium dense, fine to coarse grained, trace gravel.	2	119	
2385	10			Modified California	28		SM	...Same as above, slightly moist to moist.	3	125	
2380	15			Modified California	47		SP	SAND- light orange brown, slightly moist, dense, fine to coarse grained.	2	122	
2375	20			Standard Split Spoon	19		SM	Silty SAND- light brown, medium dense, dry, fine to medium grained.	3		
2370	25			Standard Split Spoon	15		SM	...Same as above, reddish brown, moist.	3		
2365								Total Depth: 26.5 feet. No groundwater encountered during drilling. No caving observed. Boring backfilled with soil cuttings upon completion. Ground elevation approximated with Google Earth.			

This Boring Log should be evaluated in conjunction with the complete geotechnical report. This Boring Log represents conditions observed at the specific location and date indicated, it is not warranted to be representative of subsurface conditions at other locations and times.

PLATE 7

TGR GEOTECHNICAL, INC.

LOG OF EXPLORATORY BORING B-10

Project Number:	**21-7253**	Logged By:	**RA**
Project Name:	**17198-17000 Abbey Lane, Victorville**	Project Engineer:	**SG**
Date Drilled:	**11/16/21 - 11/16/21**	Drill Type:	**CME 75 Hollow Stem**
Ground Elev:	**2720**	Drive Wt & Drop:	**140lbs / 30in**

Legend: Shelby Tube; Standard Split Spoon; No recovery; Modified California; Water Table ATD

Elevation (ft)	Depth (ft)	Graphic Log	FIELD RESULTS: Bulk Sample	Drive Sample	SPT blows/ft (or equivalent N)	Pocket Pen (tsf)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	LAB RESULTS: Moisture Content (%)	Dry Density, (pcf)	Other Tests
	0							Surface is sand and dry vegetation.			
								Silty SAND- tan, dry, medium dense, fine to coarse grained.			
2715	5			Modified California	21		SM	Silty SAND- light orange brown, dry, medium dense, fine to coarse grained, some gravel.	1	105	Consol
2710	10			Modified California	39		SM	...Same as above, dense.	2	128	
2705	15			Modified California	26		SM	...Same as above, no gravel.	2	121	
	16.5							Total Depth: 16.5 feet. No groundwater encountered during drilling. No caving observed. Boring backfilled with soil cuttings upon completion. Ground elevation approximated with Google Earth.			
2700	20										
2695	25										

This Boring Log should be evaluated in conjunction with the complete geotechnical report. This Boring Log represents conditions observed at the specific location and date indicated, it is not warranted to be representative of subsurface conditions at other locations and times.

PLATE 8

TGR GEOTECHNICAL, INC.

LOG OF EXPLORATORY BORING P-1

Project Number:	**21-7253**	Logged By:	**RA**
Project Name:	**17198-17000 Abbey Lane, Victorville**	Project Engineer:	**SG**
Date Drilled:	**11/16/21 - 11/16/21**	Drill Type:	**CME 75 Hollow Stem**
Ground Elev:	**2693**	Drive Wt & Drop:	**140lbs / 30in**

Legend: Shelby Tube; Standard Split Spoon; No recovery; Modified California; Water Table ATD

Elevation (ft)	Depth (ft)	Graphic Log	Bulk Sample	Drive Sample	SPT blows/ft (or equivalent N)	Pocket Pen (tsf)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	Moisture Content (%)	Dry Density, (pcf)	Other Tests
	0							Surface is sand and vegetation.			
2690	0–5		Bulk				SP	SAND- light brown, slightly moist to dry, loose, very fine to fine grained, some silt.	3		-200= 17.5%
	5							Total Depth: 5 feet. No groundwater encountered during drilling. No caving observed. Boring utilized for percolation testing. Boring backfilled with soil cuttings upon completion. Ground elevation approximated with Google Earth.			
2685											
	10										
2680											

This Boring Log should be evaluated in conjunction with the complete geotechnical report. This Boring Log represents conditions observed at the specific location and date indicated, it is not warranted to be representative of subsurface conditions at other locations and times.

PLATE 9

TGR GEOTECHNICAL, INC.

LOG OF EXPLORATORY BORING P-2

Project Number:	**21-7253**	Logged By:	**RA**
Project Name:	**17198-17000 Abbey Lane, Victorville**	Project Engineer:	**SG**
Date Drilled:	**11/16/21 - 11/16/21**	Drill Type:	**CME 75 Hollow Stem**
Ground Elev:	**2713**	Drive Wt & Drop:	**140lbs / 30in**

Legend: Shelby Tube; Standard Split Spoon; No recovery; Modified California; Water Table ATD

Elevation (ft)	Depth (ft)	Graphic Log	FIELD RESULTS: Bulk Sample	Drive Sample	SPT blows/ft (or equivalent N)	Pocket Pen (tsf)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	LAB RESULTS: Moisture Content (%)	Dry Density, (pcf)	Other Tests
	0							Surface is sand and dry vegetation.			
2710	0–5		Bulk				SP	SAND- tan, dry, medium dense, fine to medium grained, some silt.	1		-200= 14.5%
2708	5							Total Depth: 5 feet. No groundwater encountered during drilling. No caving observed. Boring utilized for percolation testing. Boring backfilled with soil cuttings upon completion. Ground elevation approximated with Google Earth.			
2705											
	10										
2700											

This Boring Log should be evaluated in conjunction with the complete geotechnical report. This Boring Log represents conditions observed at the specific location and date indicated, it is not warranted to be representative of subsurface conditions at other locations and times.

PLATE 10

TGR GEOTECHNICAL, INC.

LOG OF EXPLORATORY BORING P-3

Project Number:	**21-7253**	Logged By:	**RA**
Project Name:	**17198-17000 Abbey Lane, Victorville**	Project Engineer:	**SG**
Date Drilled:	**11/16/21 - 11/16/21**	Drill Type:	**CME 75 Hollow Stem**
Ground Elev:	**2717**	Drive Wt & Drop:	**140lbs / 30in**

Legend: Shelby Tube; Standard Split Spoon; No recovery; Modified California; Water Table ATD

Elevation (ft)	Depth (ft)	Graphic Log	FIELD RESULTS: Bulk Sample	Drive Sample	SPT blows/ft (or equivalent N)	Pocket Pen (tsf)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	LAB RESULTS: Moisture Content (%)	Dry Density, (pcf)	Other Tests
2717	0							Surface is sand and dry vegetation.			
	0–5		Bulk (0–5)				SP	SAND- tan, dry, medium dense, fine to medium grained, some silt.	2		-200= 14.3%
2712	5							Total Depth: 5 feet. No groundwater encountered during drilling. No caving observed. Boring utilized for percolation testing. Boring backfilled with soil cuttings upon completion. Ground elevation approximated with Google Earth.			

Elevation scale: 2715, 2710, 2705. Depth scale: 5, 10.

This Boring Log should be evaluated in conjunction with the complete geotechnical report. This Boring Log represents conditions observed at the specific location and date indicated, it is not warranted to be representative of subsurface conditions at other locations and times.

PLATE 11

TGR GEOTECHNICAL, INC.

LOG OF EXPLORATORY BORING P-4

Project Number:	**21-7253**	Logged By:	**RA**
Project Name:	**17198-17000 Abbey Lane, Victorville**	Project Engineer:	**SG**
Date Drilled:	**11/16/21 - 11/16/21**	Drill Type:	**CME 75 Hollow Stem**
Ground Elev:	**2741**	Drive Wt & Drop:	**140lbs / 30in**

Legend: Shelby Tube; Standard Split Spoon; No recovery; Modified California; Water Table ATD

Elevation (ft)	Depth (ft)	Graphic Log	Bulk Sample	Drive Sample	SPT blows/ft (or equivalent N)	Pocket Pen (tsf)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	Moisture Content (%)	Dry Density, (pcf)	Other Tests
	0							Surface is sand and dry vegetation.			
2740	0–5		X				SP	SAND- tan, dry, medium dense, fine to medium grained, some silt.	1		-200= 15.2%
2735	5							Total Depth: 5 feet. No groundwater encountered during drilling. No caving observed. Boring utilized for percolation testing. Boring backfilled with soil cuttings upon completion. Ground elevation approximated with Google Earth.			
2730	10										

This Boring Log should be evaluated in conjunction with the complete geotechnical report. This Boring Log represents conditions observed at the specific location and date indicated, it is not warranted to be representative of subsurface conditions at other locations and times.

PLATE 12

TGR GEOTECHNICAL, INC.

Test Hole	Total Depth (in)	Initial Depth (in)	Final Depth (in)	∆Water Level (in)	Initial Time (min)	Final Time (min)	∆ Time (min)	Initial Height of Water (in)	Final Height of Water (in)	Average Height of Water (in)	Infiltration Rate (in/hr)
P-1	60	8.4	32.4	24	0.0	2.0	2.0	51.6	27.6	39.60	26.28
	60	8.4	31.8	23.4	0.0	2.0	2.0	51.6	28.2	39.90	25.43
	60	8.4	31.8	23.4	0.0	2.0	2.0	51.6	28.2	39.90	25.43
	60	8.4	32.4	24	0.0	2.0	2.0	51.6	27.6	39.60	26.28
	60	8.4	30.6	22.2	0.0	2.0	2.0	51.6	29.4	40.50	23.79
	60	8.4	29.4	21	0.0	2.0	2.0	51.6	30.6	41.10	22.18
	60	8.4	30	21.6	0.0	2.0	2.0	51.6	30	40.80	22.98
	60	8.4	30	21.6	0.0	2.0	2.0	51.6	30	40.80	22.98
	60	8.4	30	21.6	0.0	2.0	2.0	51.6	30	40.80	22.98
P-2	60	21	48.6	27.6	0.0	10.0	10.0	39	11.4	25.20	9.30
	60	21	47.4	26.4	0.0	10.0	10.0	39	12.6	25.80	8.70
	60	21	45.5	24.5	0.0	10.0	10.0	39	14.5	26.75	7.81
	60	21	45.6	24.6	0.0	10.0	10.0	39	14.4	26.70	7.85
	60	21	43.8	22.8	0.0	10.0	10.0	39	16.2	27.60	7.05
	60	21	45.6	24.6	0.0	10.0	10.0	39	14.4	26.70	7.85
P-3	60	15	33	18	0.0	10.0	10.0	45	27	36.00	4.32
	60	15	31.2	16.2	0.0	10.0	10.0	45	28.8	36.90	3.80
	60	15	33	18	0.0	10.0	10.0	45	27	36.00	4.32
	60	15	30.1	15.1	0.0	10.0	10.0	45	29.9	37.45	3.49
	60	15	30.4	15.4	0.0	10.0	10.0	45	29.6	37.30	3.57
	60	15	30	15	0.0	10.0	10.0	45	30	37.50	3.46
P-4	60	18.6	43.3	24.7	0.0	10.0	10.0	41.4	16.7	29.05	7.28
	60	18.6	41.4	22.8	0.0	10.0	10.0	41.4	18.6	30.00	6.51
	60	18.6	41.4	22.8	0.0	10.0	10.0	41.4	18.6	30.00	6.51
	60	18.6	41.5	22.9	0.0	10.0	10.0	41.4	18.5	29.95	6.55
	60	18.6	41.4	22.8	0.0	10.0	10.0	41.4	18.6	30.00	6.51
	60	18.6	40	21.4	0.0	10.0	10.0	41.4	20	30.70	5.98
	60	18.6	41.4	22.8	0.0	10.0	10.0	41.4	18.6	30.00	6.51

$$I_t = \frac{\Delta H(60r)}{\Delta t(r + 2H_{avg})}$$

ΔH = Change in height

Δt = Time interval

r = Radius

I_t Infiltration Rate

H_{ave} Average Head Height over the time interval

Geotechnical
Environmental
Hydrogeology
Material Testing
Construction Inspection

December 8, 2021 Project No. 21-7253

Robert A. Martinez AIA, CASp, CASI
MOA Architects, Inc.
14467 Park Avenue,
Victorville, CA 92392

Subject: Preliminary Geotechnical Investigation Report, Proposed Industrial Building, 17198-17000 Abbey Lane, Victorville, California 92394

Robert,

In accordance with your request and authorization, TGR Geotechnical, Inc. (TGR) has performed a preliminary geotechnical investigation for the proposed development at the subject site in the City of Victorville, California. This report presents the findings of our geotechnical investigation including site seismicity, liquefaction analysis and provides geotechnical design recommendations for the proposed improvements. The work was performed in general accordance with our proposal dated September 22, 2021.

Based on our investigation the proposed development is feasible from a geotechnical viewpoint provided the recommendations presented in this report are implemented during design and construction.

If you have any questions regarding this report, please do not hesitate to contact this office. We appreciate this opportunity to be of service.

Respectfully submitted,

TGR GEOTECHNICAL, INC.

Robert Aguilar
Staff Engineer

Sanjay Govil, PhD, PE, GE 2382
Principal Geotechnical Engineer

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ATTACHMENTS

Plate 1 – Boring Location Map

Figure 1 – Site Location Map
Figure 2 – Regional Geology Map
Figure 3 – Regional Fault Map
Figure 4 – Geologic Hazards Map

Table 1 – Percolation Test Worksheet

Appendix A – References
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Appendix E – Liquefaction Analysis
Appendix F – Standard Grading Guidelines

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INTRODUCTION

Site Description and Proposed Project Development

The subject site is located on the southwest corner of Stoddard Wells Road and Abbey Lane in the City of Victorville, California. The subject site is relatively flat, approximately 39.56-acre, dirt and gravel vacant lot with sparse vegetation and a dry ravine (Mojave River) along the western edge of the property. The elevation in the northeast of the site is approximately 2744 feet and approximately 2690 feet in the southwest with a differential elevation of 54 feet and gradient of 2.25%. The subject site has multiple small dry stream beds as the result of sheet flow from east to west to the dry ravine. It is our understanding that the proposed development will consist of an approximately 794,500 square foot distribution center with associated truck docks, parking, drive aisles and stormwater infiltration basins.

Scope of Work

The scope of work for this geotechnical investigation included the following:

- Site reconnaissance to assess current site conditions and mark borings.
- Sampling and logging ten (10) hollow stem auger borings utilizing a hollow stem drill rig to approximate depths ranging from 16.5 to 51.5 feet at the subject site to evaluate subsurface soil conditions. The borings were backfilled with cuttings and any excess soil was disposed onsite.
- Percolation testing of the near surface soils at four (4) locations at a depth of 5 feet at the proposed infiltration locations. The testing procedures followed the County of San Bernardino guidelines.
- Laboratory testing of selected samples to include: in-situ moisture density, maximum density and optimum moisture content, shear, consolidation, passing No. 200 sieve, corrosion series and R-value.
- Engineering analysis including infiltration rates, site seismicity, seismic settlement, foundation design, soils engineering/earthwork and liquefaction analysis with respect to the suitability of the proposed development.
- Preparation of this report summarizing current subsurface soil conditions, findings, and presenting our recommendations for the proposed development.

Field Investigation

Field exploration was performed on November 16 and 17, 2021 by members from our firm who logged the borings and obtained representative samples, which were subsequently transported to the laboratory for further review and testing. The approximate locations of the borings are indicated on the enclosed Boring Location Map (Plate 1).

The subsurface conditions were explored by drilling, sampling, and logging twelve (10) borings with a truck mounted hollow stem drill rig to approximate depths ranging sixteen and one half (16.5) feet to fifty-one and one half (51.5) feet below existing grade. Subsequent to drilling, all borings were backfilled with cuttings. The logs of borings together with an explanation of symbols used are given in Appendix B.

The drill rig was equipped with a sampling apparatus to allow for recovery of driven modified California Ring Sampler (CRS), 3-inch outside diameter, and 2.42-inch inside diameter and SPT samples. Driven samples and bulk samples of the earth materials encountered at selected intervals were recovered from the borings.

The samples were driven using an automatic 140-pound hammer falling freely from a height of 30-inches. The blow counts for CRS were converted to equivalent SPT blow counts. Soil descriptions were entered on the logs in general accordance with the Unified Soil Classification System (USCS). The locations and depths of the soil samples recovered are indicated on the logs in Appendix B.

Four (4) percolation test borings P-1 through P-4 were advanced to a depth of approximately five (5) feet below existing ground surface in the areas of the proposed stormwater infiltration locations. Subsequent to percolation testing the borings were backfilled with excavated soils.

Percolation Testing

Percolation testing was performed at the subject site utilizing the Porchet Method. Presented below are the infiltration rates from the percolation tests performed within the upper five feet.

- P-1 at 0-5 feet 22.18 inches per hour
- P-2 at 0-5 feet 7.05 inches per hour
- P-3 at 0-5 feet 3.46 inches per hour
- P-4 at 0-5 feet 5.98 inches per hour

These do not include any factor of safety.

The infiltration testing was performed in general accordance with the County of San Bernardino Technical Guidance Document (2011).

Laboratory Testing

Laboratory tests were performed on representative samples to verify the field classification of the recovered samples and to evaluate the geotechnical properties of the subsurface soils. The following tests were performed:

- In-situ Moisture Content (ASTM D2216) and Dry Density (ASTM D7263);
- Maximum Dry Density and Optimum Moisture Content (ASTM D1557);
- Direct Shear Strength (ASTM D3080);
- Consolidation (ASTM D2435);
- Passing No. 200 Sieve (ASTM D1140);
- R-value (CAL 301); and
- Corrosion series:
    1. Soluble Sulfate (CAL.417A);
    2. Soluble Chlorides (CAL.422);
    3. Minimum Resistivity (CAL.643); and
    4. pH.

Laboratory tests for geotechnical characteristics were performed in general accordance with the ASTM procedures. The results of the in-situ moisture content and density tests are shown on the borings logs (Appendix B). The results of the laboratory tests are presented in Appendix C.

GEOTECHNICAL FINDINGS

Geology

Regional Geologic Setting

The proposed development is located in the western Mojave Desert, in San Bernardino County, California. The area is located within what is known as the Mojave Block, which is a tectonic region bounded by the San Andreas fault to the southwest, and the Garlock fault to the northeast (Dibblee, 1967). The mountains that border the Mojave Desert were uplifted along these faults and other secondary faults that generally trend to the northwest across the Mojave Desert. It is theorized that in the geologic past, much of this area was intermittently submerged with water, at which time a large amount of sediment was deposited along the valley floor (Dibblee, 1967). The entire region was then intruded by granitic rocks, elevated and subsequently deeply eroded. Finally, during the more recent geologic past, deformation occurred throughout the Mojave Block due to the very active San Andreas, Garlock and associated fault zones (Dibblee, 1967).

On a local scale, the site is underlain by relatively young alluvial silt, sand and gravel derived from adjacent higher ground and deposited in the site vicinity (Dibblee, 1960).

Earth Units

The upper 5 to 10 feet of soil generally consists of tan to light brown silty sand in a dry condition underlain by interbedded layers of silty sand and sand to 51.5 feet below existing grade, the maximum depth explored. Detailed descriptions of the earth units encountered in our exploratory borings are presented in the log of the borings. (Appendix B)

Groundwater

Groundwater was encountered during our subsurface exploration at a depth of 40 feet below existing grade in Boring B-3. Groundwater was not encountered in any other exploratory boring. Based on our review of available historical groundwater information (CDMG) regional historic high groundwater has not been mapped at the subject site.

Per USGS groundwater well data for the nation, the historic high groundwater for the northern portion of the subject site is approximately 11.9 feet below existing grade and 2688.1 feet above NGVD 1929, and for the historic high groundwater for the southern portion (area of the proposed infiltration basins) of the subject site groundwater is approximately 48.25 feet below existing grade and 2671.75 feet above NGVD 1929, dating back to 1957.

Seasonal and long-term fluctuations in the groundwater may occur as a result of variations in subsurface conditions, rainfall, run-off conditions and other factors. Therefore, variations from our observations may occur.

Static groundwater is not anticipated to impact the proposed stormwater infiltration for the southern half of the subject site based upon review of USGS groundwater well data and absence of groundwater in the six exploratory borings in the southern portion of the subject site.

Seismic Review

Faulting and Seismicity

The subject site, like the rest of Southern California, is located within a seismically active region as a result of being located near the active margin between the North American and Pacific tectonic plates.

The principal source of seismic activity is movement along the northwest-trending regional faults such as the San Andreas, San Jacinto and Elsinore fault zones. These fault systems produce approximately 5 to 35 millimeters per year of slip between the plates.

By definition of the State Mining and Geology Board, an active fault is one which has had surface displacement within the Holocene Epoch (roughly the last 11,000 years). The State Mining and Geology Board has defined a potentially active fault as any fault which has been active during the Quaternary Period (approximately the last 1,600,000 years). These definitions are used in delineating Earthquake Fault Zones as mandated by the Alquist-Priolo Geologic Hazard Zones Act of 1972 and as subsequently revised in 1994 (Hart, 1997) as the Alquist-Priolo Geologic Hazard Zoning Act and Earthquake Fault Zones.

The intent of the act is to require fault investigations on sites located within Special Studies Zones to preclude new construction of certain inhabited structures across the trace of active faults.

The subject site is not included within any Earthquake Fault Zones as created by the Alquist-Priolo Earthquake Fault Zoning Act (Hart, 1997). Our review of geologic literature pertaining to the site area indicates that there are no known active or potentially active faults located within or immediately adjacent to the subject property. The lineament discussed in the literature review section of this report is considered not to be an active or potentially active fault.

The nearest fault to the subject site is the Helendale fault located approximately 9.4 miles northeast of the subject site. Other nearby faults are the Ocotillo Ridge fold, located approximately 10.7 miles southeast of the subject site, the Ord Mountains fault zone located approximately 11.1 miles southeast of the subject site, the Bowen Ranch fault located approximately 13.4 miles southeast of the subject site and the Mirage Valley fault located approximately 14.5 miles northwest of the subject site.

Secondary Seismic Hazards

Surface Fault Rupture and Ground Shaking

Since no known faults are located within the site, surface fault rupture is not anticipated. However, due to the close proximity of known active and potentially active faults, severe ground shaking should be expected during the life of the proposed structures.

Liquefaction

Liquefaction is a seismic phenomenon in which loose, saturated, fine-grained granular soils behave similarly to a fluid when subjected to high-intensity ground shaking. Liquefaction occurs when these ground conditions exist: 1) Shallow groundwater; 2) Low density, fine, clean sandy soils; and 3) High-intensity ground motion. Effects of liquefaction can include sand boils, settlement, and bearing capacity failures below foundations.

The subject site is not an area susceptible to liquefaction per the County of San Bernardino, Geologic Hazards Map (Figure 4) However, groundwater was encountered in Boring B-3 at a depth of approximately 40 feet below existing grade.

Liquefaction analyses were performed on the subsurface profiles represented by Borings B-3 and B-8. The analyses utilized site specific peak ground acceleration (PGA_M) of 0.52g, per ASCE 7-16 Section C21.5, a moment magnitude of 6.96 (based on deaggregation) and a historic high groundwater of 11.5 feet below existing grade. The total seismic saturated and dry settlement of sandy soils is estimated to be 0.11 inches and 0.15 inches for Borings B-3 and B-8, respectively. The differential seismic settlement may be taken as half of the total seismic settlement across the site. Details of calculations are presented in Appendix E.

Seismically Induced Settlement

Ground accelerations generated from a seismic event can produce settlements in sands or in granular earth materials both above and below the groundwater table. This phenomenon is often referred to as seismic settlement and is most common in relatively clean sands, although it can also occur in other soil materials. Based on the liquefaction analyses, the total seismic settlement is estimated to be 0.11 inches and 0.15 inches for borings B-3 and B-8, respectively. Details of calculations are presented in Appendix E. The differential seismic settlement may be taken as half of the total seismic settlement across the site

Lateral Spreading

Seismically induced lateral spreading involves primarily movement of earth materials due to earth shaking. Lateral spreading is demonstrated by near-vertical cracks with predominantly horizontal movement of the soil mass involved. The topography in the vicinity of the subject site is relatively flat and the potential for seismically induced liquefaction is considered negligible. Therefore, the potential for lateral spreading at the subject site is considered very low.

DISCUSSIONS AND CONCLUSIONS

General

Based on our field exploration, laboratory testing, and geotechnical engineering analysis, the proposed development is considered suitable from a geotechnical viewpoint, provided that the recommendations contained in this report are incorporated into the design and construction phases of the project.

Conclusions

Based on our findings and analyses, the subject site is likely to be subjected to moderate to severe ground shaking due to the proximity of known active and potentially active faults. This may reasonably be expected during the life of the structure and should be designed accordingly.

The primary conditions affecting the proposed project site development are as follows:

- Dry ravine along the western portion of the site contains loose and unsuitable soils.

The engineering evaluation performed concerning site preparation and the recommendations presented are based on information provided to us and obtained by us during our office and fieldwork. This report is prepared for the development of an approximately 794,500 square foot industrial building with associated parking, drive aisles, truck docks and infiltration locations. In the event that any significant changes are made to the proposed development, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed, and the recommendations of this report are verified or modified in writing by TGR.

RECOMMENDATIONS

Seismic Design Parameters

When reviewing the 2019 California Building Code the following data should be incorporated into the design:

Parameter	Value
Latitude (degree)	34.5592
Longitude (degree)	-117.2926
Site Class	D – Stiff Soil
Site Coefficient, F_a	1.074
Site Coefficient, F_v	N/A
Mapped Spectral Acceleration at 0.2-sec Period, S_s	1.066 g
Mapped Spectral Acceleration at 1.0-sec Period, S_1	0.412 g
Spectral Acceleration at 0.2-sec Period Adjusted for Site Class, S_{MS}	1.145 g
Spectral Acceleration at 1.0-sec Period Adjusted for Site Class, S_{M1}	N/A
Design Spectral Acceleration at 0.2-sec Period, S_{DS}	0.763 g
Design Spectral Acceleration at 1.0-sec Period, S_{D1}	N/A

Site Specific Response Spectra

The USGS Unified Hazard tool, the USGS RTGM Calculator and the USGS App for Deterministic Spectra Acceleration were utilized to develop site specific ground motion spectra. The analysis was performed utilizing the following attenuation relationships that are part of NGA as required by 2019 CBC code requirements.

- Campbell & Bozorgnia (2014)
- Boore, Stewart, Seyhan & Atkinson (2014)
- Chiou & Youngs (2014)
- Abrahamson, Silva & Kamal (2014)

The results of the Site Specific Response Spectra are incorporated in Tables 1 through 3 and on Figure 1 in Appendix D. The results include deterministic spectra at 5% damping, maximum rotated component at 0.84 fractile and the probabilistic spectra, maximum rotated component at 5% damping for a return period of 2475 year and subsequently multiplied by risk coefficient to obtain the MCER probabilistic spectral acceleration. The Vs30 utilized was 260 m/s.

The above generated spectral accelerations were compared against the minimum code requirements in ASCE7-16 (Chapters 11 and 21) resulting in the final design response spectra which is presented in Tables 1 through 3 and on Figure 1 in Appendix D.

Based on Tables 1 through 3 and Figure 1, the recommended Site Specific S_{DS} and S_{D1} are as follows:

$$S_{DS} = 0.952$$
$$S_{D1} = 0.870$$

The structural consultant should review the above parameters and the 2019 California Building Code to evaluate the seismic design.

Mapped values may be used in lieu of site-specific values to design structures on Site Class D sites with an S1 greater than or equal to 0.2, provided the value of the seismic response coefficient Cs is determined by Eq. (12.8-2) for values of $T \leq 1.5T_s$ and taken as equal to 1.5 times the value computed in accordance with either Eq. (12.8-3) for $T_L \geq T > 1.5T_s$ or Eq. (12.8-4) for $T > T_L$.

Conformance to the criteria presented in the above table for seismic design does not constitute any type of guarantee or assurance that significant structural damage or ground failure will not occur during a large earthquake event. The intent of the code is “life safety” and not to completely prevent damage of the structure, since such design may be economically prohibitive.

Foundation Design Recommendations

Based on similar projects, the anticipated building loads are approximately 100 kips for column loads and 7 kips per linear foot or less for continuous footing loads. The proposed buildings may be supported on continuous and/or spread footings. Bearing capacity recommendations for shallow foundations are presented below. These recommendations assume that the footings will be supported on a minimum of three (3) feet of engineered fill.

For foundations supported on three (3) feet of engineered fill with minimum ninety (90) percent relative compaction an allowable bearing pressure of 3,000 pounds per square foot may be used in design.

All shallow foundations should extend a minimum of twenty-four (24) inches below the lowest adjacent grade. The minimum recommended footing width is eighteen (18) inches for continuous footing and twenty-four (24) inches for pad footing. A minimum reinforcement of two (2) No. 4 steel bar top and two (2) No. 4 steel bar bottom is required for continuous footings from a geotechnical viewpoint.

A one-third (1/3) increase on the aforementioned bearing pressure may be used in design for short-term wind or seismic loads.

The total static settlement and total differential settlements between adjacent footings supported on compacted fill are not anticipated to exceed 1 inch and 0.50 inches over 60 feet, respectively.

Retaining Wall Recommendations

The following soil parameters may be used for the design of the retaining wall with level backfill and a maximum height of six (6) feet:

Conditions	**Parameters**
Active (Level)	35 psf/ft
Passive	300 (maximum 3,000 psf)
Friction Coefficient	0.45

- Unrestrained retaining wall, such as a cantilever wall, the active earth pressure shall be used.
- Any import backfill shall be granular non-expansive select fill with a minimum sand equivalent of 30 The import fill should be tested and approved by TGR prior to backfill.

- An allowable coefficient of friction between properly compacted on-site fill soil and concrete of 0.45 may be used with the dead-load forces.
- Passive pressure and frictional resistance could be combined in determining the total lateral resistance. However, one of them shall be reduced by 50 percent.
- The passive pressure in the upper 6 inches of soil not confined by slabs or pavement should be neglected.

Retaining structures should be provided with a drainage system to prevent buildup of hydrostatic pressure behind the walls. Provisions should be made to collect and dispose of excess water away from the wall. Wall drainage may be provided by a perforated pipe encased in gravel or crushed rock and enclosed by geo-synthetic filter fabric. We do not recommend omitting the drains behind walls.

In addition to the above lateral forces due to retained earth, surcharge due to improvements, such as an adjacent structure, should be considered in the design of the retaining wall. A minimum vertical surcharge load of 300 psf should be used in design of walls due to adjacent traffic unless the traffic is kept at least 6 feet from the walls. Loads applied within a 1:1 projection from any surcharging structure on the stem of the wall shall be considered as lateral surcharge.

For uniform lateral surcharge conditions applied to free-to-deflect walls and restrained walls, we recommend utilizing a minimum horizontal load equal to 33 percent and 50 percent of the vertical load, respectively, and should be applied uniformly over the entire height of the wall. This horizontal load should be applied below the 1:1 projection plane. To minimize the surcharge load from an adjacent footing, deepened footings may be considered.

Retaining wall footings should have a minimum embedment of twenty-four (24) inches below the lowest adjacent grade. The retaining walls footings shall be supported on a minimum three (3) feet of compacted engineered fill compacted to a minimum ninety (90) percent relative compaction as per ASTM D1557.

Slab-On-Grade

Subgrade material for the slab-on-grade should be compacted to a minimum of ninety (90) percent of the maximum laboratory dry density to a minimum depth of three (3) feet. Prior to placement of concrete, the subgrade soils should be moistened to near optimum moisture content and verified by our field representative.

The thickness and reinforcement of the slab shall be designed by the structural engineer and should include the anticipated loading condition (forklift etc.) and the anticipated use of the building. For moisture sensitive flooring, the floor slab should be underlain by minimum 15-mil impermeable polyethylene membrane (Stego Wrap, Moistop Plus, or any equivalent meeting the requirements of ASTM E1745, Class A rating) as a capillary break. Sand may be placed above and below the impermeable polyethylene membrane at the discretion of the project structural engineer/concrete contractor for proper curing and finish of the concrete slab-on-grade and protection of the membrane and is considered outside the scope of geotechnical engineering.

Flatwork

Flatwork should be a minimum of 4-inches thick should be reinforced with a minimum of No. 3 reinforcing bar on 24-inch centers in two horizontally perpendicular directions. Reinforcing should be properly supported to ensure placement near the vertical midpoint of the slab. "Hooking" of the reinforcement is not considered an acceptable method of positioning the steel. The subgrade material should be compacted to a minimum of ninety (90) percent of the maximum laboratory dry density

(ASTM D1557) to a minimum depth of two (2) feet. Prior to placement of concrete, the subgrade soils should be moistened to near percent of optimum moisture content and verified by our field representative. The actual thickness and reinforcement of the slab shall be designed by the structural engineer and should include the anticipated loading condition, the anticipated use of the flatwork and should incorporate mitigation measures for shrinkage, expansion and thermal cracking.

Modulus of Subgrade Reaction

The modulus of subgrade reaction may be taken as 175 pci (K_1) for one (1) square foot footing/slab founded on site soils. This value should be reduced for change in size per the following formula:

$$\boldsymbol{K = K_1\left(\frac{B+1}{B}\right)^2}$$

Where B = Width of Mat;
K = Coefficient of Subgrade Reaction of Footings Measuring B (ft) x B (ft).

Cement Type and Corrosion

Based on laboratory testing concrete used should be designed in accordance with the provisions of ACI 318-14, Chapter 19 for Exposure Class S0 with a minimum unconfined compressive strength of 2,500 psi and for Exposure Class C1 (Moderate) – Concrete exposed to moisture but not a significant source of chlorides, per ACI 318-14 Table 19.3.1.1.

Corrosion tests indicate onsite soils are moderately corrosive for ferrous metals exposed to site soils.

TGR does not practice corrosion engineering. If needed, a qualified specialist should review the site conditions and evaluate the corrosion potential of the site soil to the proposed improvements and to provide the appropriate corrosion mitigations for the project.

Expansive Soil

Onsite soils are granular in nature correlating to a “very low” expansion potential. The recommendations provided in this report account for the expansion potential of the onsite soils.

Shrinkage/Subsidence

Removal and recompaction of the near surface soils is estimated to result in shrinkage ranging from 10 to 15 percent. Minor ground subsidence is expected to occur in the soils below the zone of removal, due to settlement and machinery working. The subsidence is estimated to be between one and two tenths of a foot.

Site Development Recommendations

General

During earthwork construction, all site preparation and the general procedures of the contractor should be observed, and the fill selectively tested by a representative of TGR. If unusual or unexpected conditions are exposed in the field, they should be reviewed by this office and if warranted, modified and/or additional recommendations will be offered.

Grading

All grading should conform to the guidelines presented in the California Building Code (2019 edition), except where specifically superseded in the text of this report. Prior to grading, TGR’s representative should be present at the pre-construction meeting to provide grading guidelines, if needed, and review any earthwork.

Within the proposed building footprint areas, remedial overexcavation should extend at least three feet below the existing grade and within pavement areas overexcavation should extend at least two feet below existing grade. To support the foundation a minimum three (3) feet of approved engineered fill should be placed under the footings, a minimum of three (3) feet of engineered fill is recommended under slab-on-grade, and a minimum of two (2) feet of engineered fill is recommended under flatwork and pavement.

Along the western edge of the property, within the dry ravine and banks, soils shall be over excavated to a depth of approximately five (5) feet and replaced with engineered fill due to the loose nature of the alluvial deposits. Any fill slope constructed along this property lines shall be 2:1 (H:V) or flatter and shall comply with the grading guidelines presented in Appendix F.

Site soils may be reused as engineered fill provided the recommendations presented in this report are implemented. Exposed bottoms should be scarified a minimum of 6-inches, moisture conditioned and compacted to a minimum ninety (90) percent relative compaction. Subsequently, site fill soils should be re-compacted to a minimum of ninety (90) percent relative compaction at a minimum of optimum moisture content. The lateral extent of removals beyond the building/structure/footing limits should be equal to at least the depth of fill or 5 feet, whichever is greater.

The depth of over-excavation should be reviewed by the Geotechnical Consultant during the actual construction. Any subsurface obstruction buried structural elements, and unsuitable material encountered during grading, should be immediately brought to the attention of the Geotechnical Consultant for proper exposure, removal and processing, as recommended.

Fill Placement

Prior to any fill placement TGR should observe the exposed surface soils. The site soils may be re-used as engineered fill provided they are free of organic content and particle size greater than 4-inches. Fill shall be moisture-conditioned to a minimum of optimum and compacted to a minimum relative compaction of ninety (90) percent in accordance with ASTM D1557. Any import soils shall be non-expansive and approved by TGR.

Compaction

Prior to fill placement, the exposed surface should be scarified to a minimum depth of six (6) inches, fill placed in six (6) inches loose lifts, moisture conditioned to near optimum for and compacted to a minimum relative compaction of ninety (90) percent in accordance with ASTM D1557.

Trenching

All excavations should conform to CAL-OSHA and local safety codes.

Drainage

Positive site drainage should be maintained at all times. Water should be directed away from foundations and not allowed to pond and/or seep into the ground. Pad drainage should be directed towards street/parking or other approved area.

Utility Trench Backfill

All utility trench backfill in structural areas and beneath hardscape features should be brought to near-optimum moisture content and compacted to a minimum relative compaction of ninety (90) percent of the laboratory standard.

Sand backfill, (unless trench excavation material), should not be allowed in parallel exterior trenches adjacent to and within an area extending below a 1:1 plane projected from the outside bottom edge of the footing. All trench excavations should minimally conform to CAL-OSHA and local safety codes. Soils generated from utility trench excavations may be used provided it is moisture conditioned and compacted to ninety (90) percent minimum relative compaction.

Temporary Excavation and Shoring

Due to dry to slightly moist granular onsite soils, all cuts shall be properly shored or sloped back to at least 1H:1V (Horizontal: Vertical) or flatter. Some sloughing may be anticipated due to the granular nature of site soils. The exposed slope face should be kept moist (but not saturated) during construction to reduce local sloughing. No surcharge loads should be permitted within a horizontal distance equal to the height of cut from the toe of excavation unless the cut is properly shored. Excavations that extend below an imaginary plane inclined at 45 degrees below the edge of any nearby adjacent existing site facilities should be properly shored to maintain foundation support at the adjacent structures. Temporary excavation adjacent to existing footings may require A-B-C slot cuts.

Per Cal OSHA, site soils can be classified as “Type B” for temporary excavations based on field observation and testing.

Preliminary Pavement Design

The Caltrans method of design was utilized to develop the following asphalt pavement section. The section was developed based on a tested “R-Value” for compacted site subgrade soils of 78.

Traffic indices of 4.5, 5, 6 and 7 were assumed for use in the evaluation of automobile parking stalls and driveways, and medium and heavy truck driveways, respectively. The traffic indices are subject to approval by controlling authorities and shall be approved by the project civil engineer.

ASPHALT PAVEMENT SECTION					**PCC PAVEMENT SECTION**		
Pavement Utilization	Traffic Index	Asphalt (Inch)	Aggregate Base (Inch)	Total (Inch)	*PCC	Aggregate Base (Inch)	Total (Inch)
Parking Stalls	4.5	3.0	4.0	7.0	*5.0	--	5.0
Auto Driveways	5.0	3.0	6.0	9.0	*6.0	--	5.0
Truck Aisles/ Driveways	6.0	4.0	6.0	10.0	*7.0	-	7.0
Loading Dock	7.0	4.0	8.0	12.0	*7.0	-	7.0

*Minimum concrete compressive strength of 3,500 psi.

Aggregate base material for Asphalt Pavement should consist of CAB/CMB complying with the specifications in Section 200-2.2/200-2.4 of the current “Standard Specifications for Public Works Construction” and should be compacted to at least ninety-five (95) percent of the maximum dry density (ASTM D1557). The surface of the base should exhibit a firm and unyielding condition just prior to the placement of asphalt concrete paving. The asphalt concrete shall be compacted to a minimum of ninety-five (95) percent relative compaction.

The pavement subgrade should be constructed in accordance with the recommendations presented in the grading section of this report.

An increase in the PCC pavement slab thickness, placement of steel reinforcement (or other alternatives such as Fibermesh) and joint spacing due to loading conditions including shrinkage and thermal effects may be necessary and should be incorporated by the structural engineer as necessary to prevent adverse impact on pavement performance and maintenance.

The R-value and the associated pavement section should be confirmed at the completion of site grading.

Geotechnical Review of Plans

All grading and foundation plans should be reviewed and accepted by the geotechnical consultant prior to construction. If significant time elapses since preparation of this report, the geotechnical consultant should verify the current site conditions, and provide any additional recommendations (if necessary) prior to construction.

Geotechnical Observation/Testing During Construction

Per sections 1705.6 and table 1705.6 of the 2019 California Building Code, periodic special inspection shall be performed to:

- Verify materials below shallow foundations are adequate to achieve the design bearing capacity;
- Verify excavations are extended to the proper depth and have reached proper material;
- Verify classification and test compacted materials; and
- Prior to placement of compacted fill, inspect subgrade and verify that the site has been prepared properly.

Per sections 1705.6 and table 1705.6 of the 2019 California Building Code, continuous special inspection shall be performed to:

- Verify use of proper materials, densities and lift thickness during placement and compaction of compacted fill.

The geotechnical consultant should also perform observation and/or testing at the following stages:

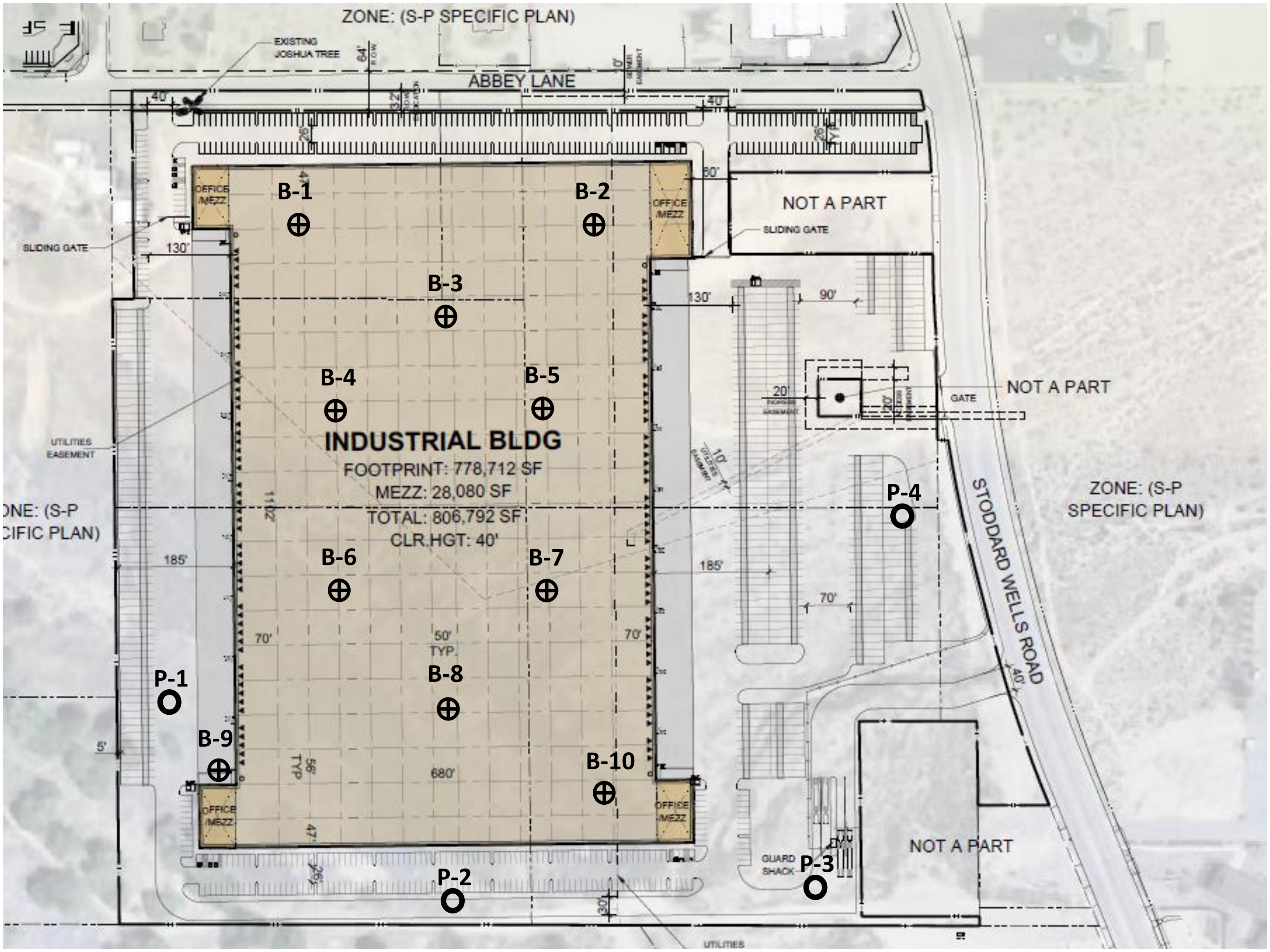
- During any grading and fill placement;
- After foundation excavation and prior to placing concrete;
- Prior to placing slab and flatwork concrete;
- During placement of aggregate base and asphalt concrete or Portland cement concrete;
- When any unusual soil conditions are encountered during any construction operation subsequent to issuance of this report.

Limitations

This report was prepared for a specific client and a specific project, based on the client's needs, directions and requirements at the time.

This report was necessarily based upon data obtained from a limited number of observances, site visits, soil and/or other samples, tests, analyses, histories of occurrences, spaced subsurface exploration and limited information on historical events and observations. Such information is necessarily incomplete. Variations can be experienced within small distances and under various climatic conditions. Changes in subsurface conditions can and do occur over time.

This report is not authorized for use by and is not to be relied upon by any party except the client with whom TGR contracted for the work. Use or reliance on this report by any other party is that party's sole risk. Unauthorized use of or reliance on this report constitutes an agreement to defend and indemnify TGR from and against any liability which may arise as a result of such use or reliance, regardless of any fault, negligence, or strict liability of TGR.



B-10 ⊕ APPROXIMATE LOCATION OF EXPLORATORY BORING

P-4 ○ APPROXIMATE LOCATION OF PERCOLATION BORING

NORTH

TGR Geotechnical Environmental Hydrogeology Material Testing Construction Inspection

BORING LOCATION MAP
SW CORNER OF ABBEY LANE AND STODDARD WELLS ROAD
VICTORVILLE, CALIFORNIA

PROJECT NO. 21-7253

PLATE 1

TGR
Geotechnical
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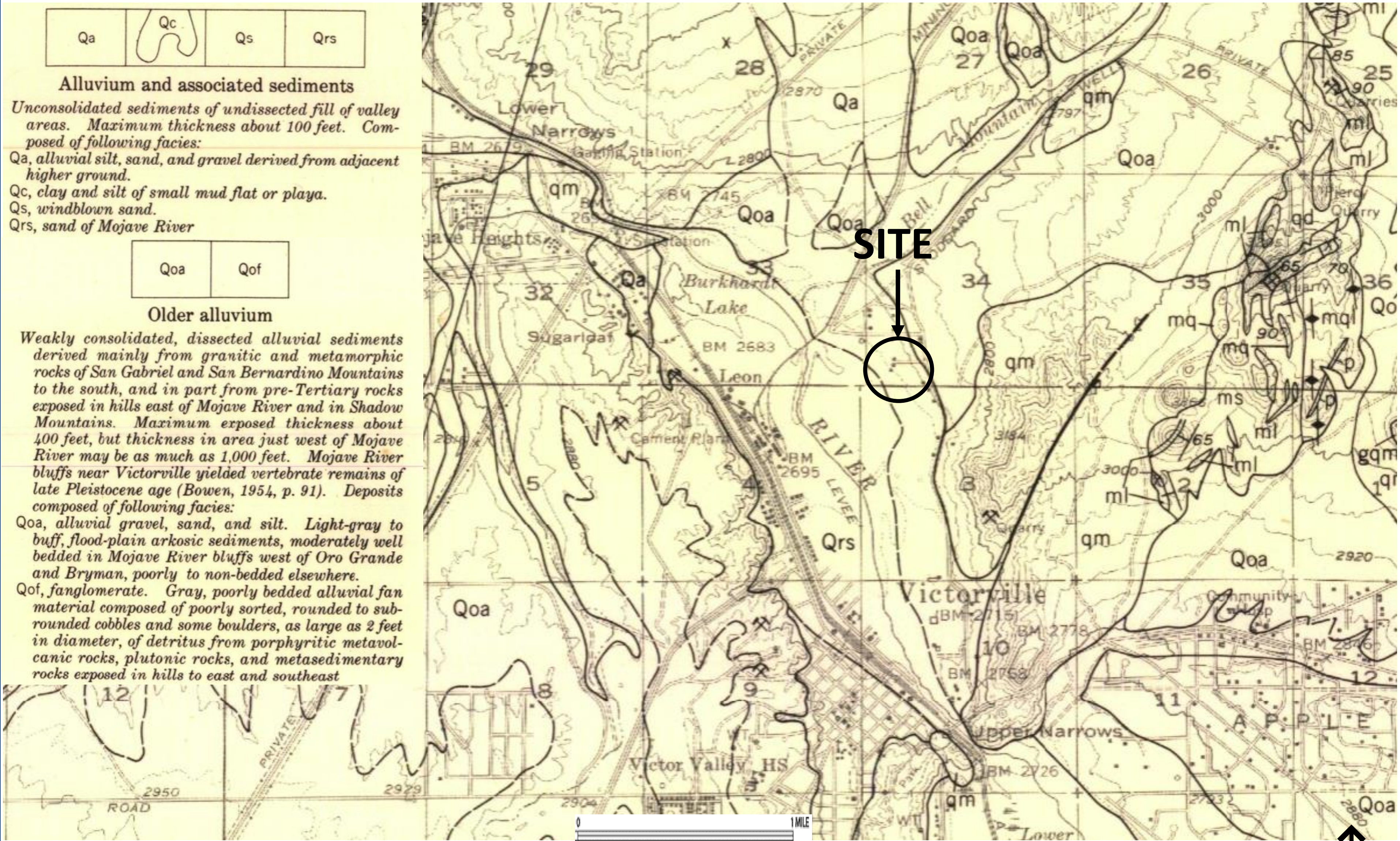
Hydrogeology
Material Testing
Construction Inspection

SITE LOCATION MAP
SW CORNER OF ABBEY LANE AND STODDARD WELLS ROAD
VICTORVILLE, CALIFORNIA

PROJECT NO. 21-7253

FIGURE 1



Modified From: Dibblee, T.W., 1960, Preliminary geologic map of the Victorville quadrangle, California: U.S. Geological Survey, MF-229, scale 1:62,500.

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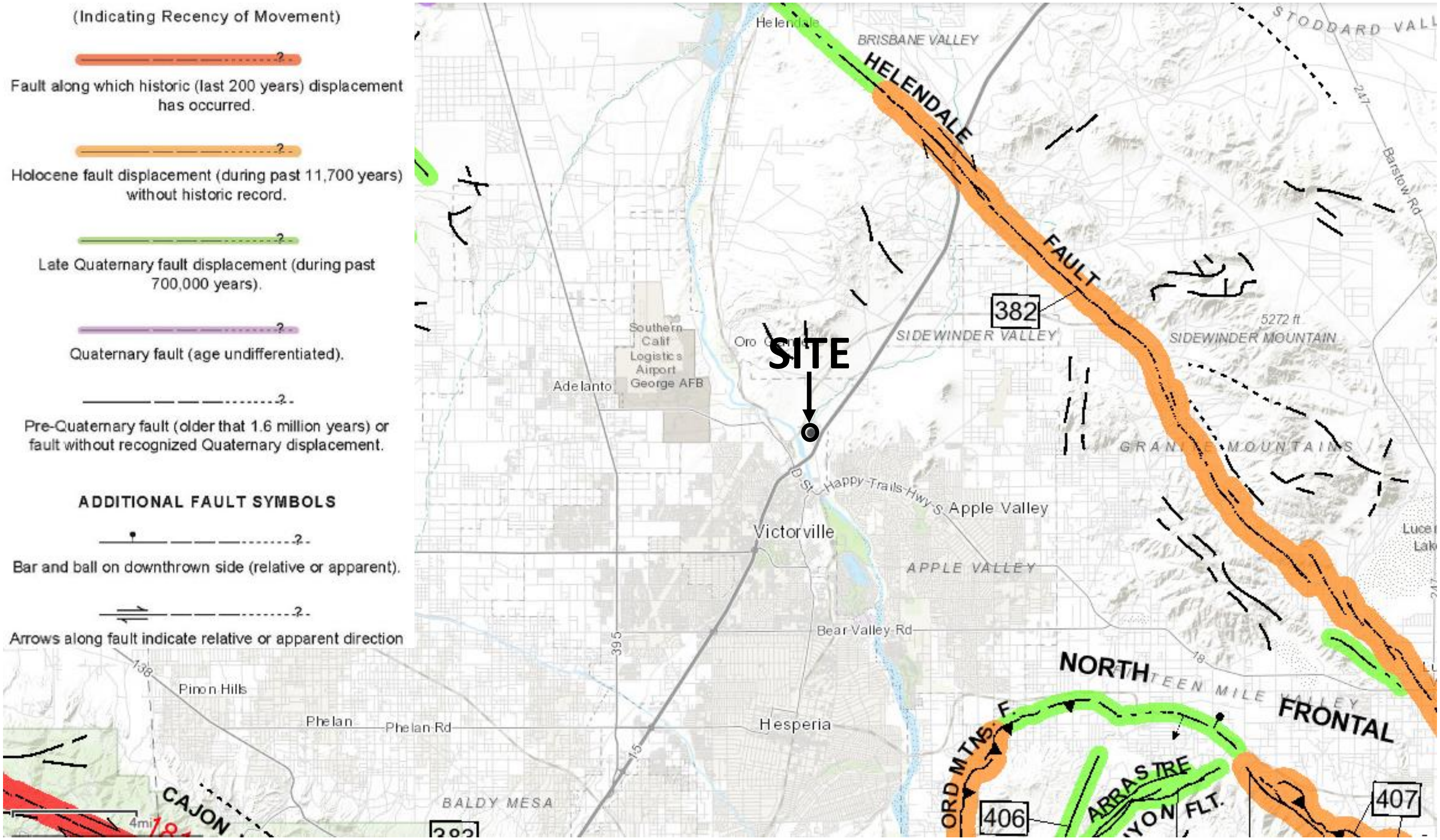
Material Testing
Construction Inspection

REGIONAL GEOLOGY MAP
SW CORNER OF ABBEY LANE AND STODDARD WELLS ROAD
VICTORVILLE, CALIFORNIA

PROJECT NO. 21-7253

FIGURE 2



Modified From: Jennings, C. W., 2010, Fault Activity Map of California and Adjacent Areas, California Division of Mines and Geology, Geologic Data Map Series, No. 6, Scale 1:750,000.

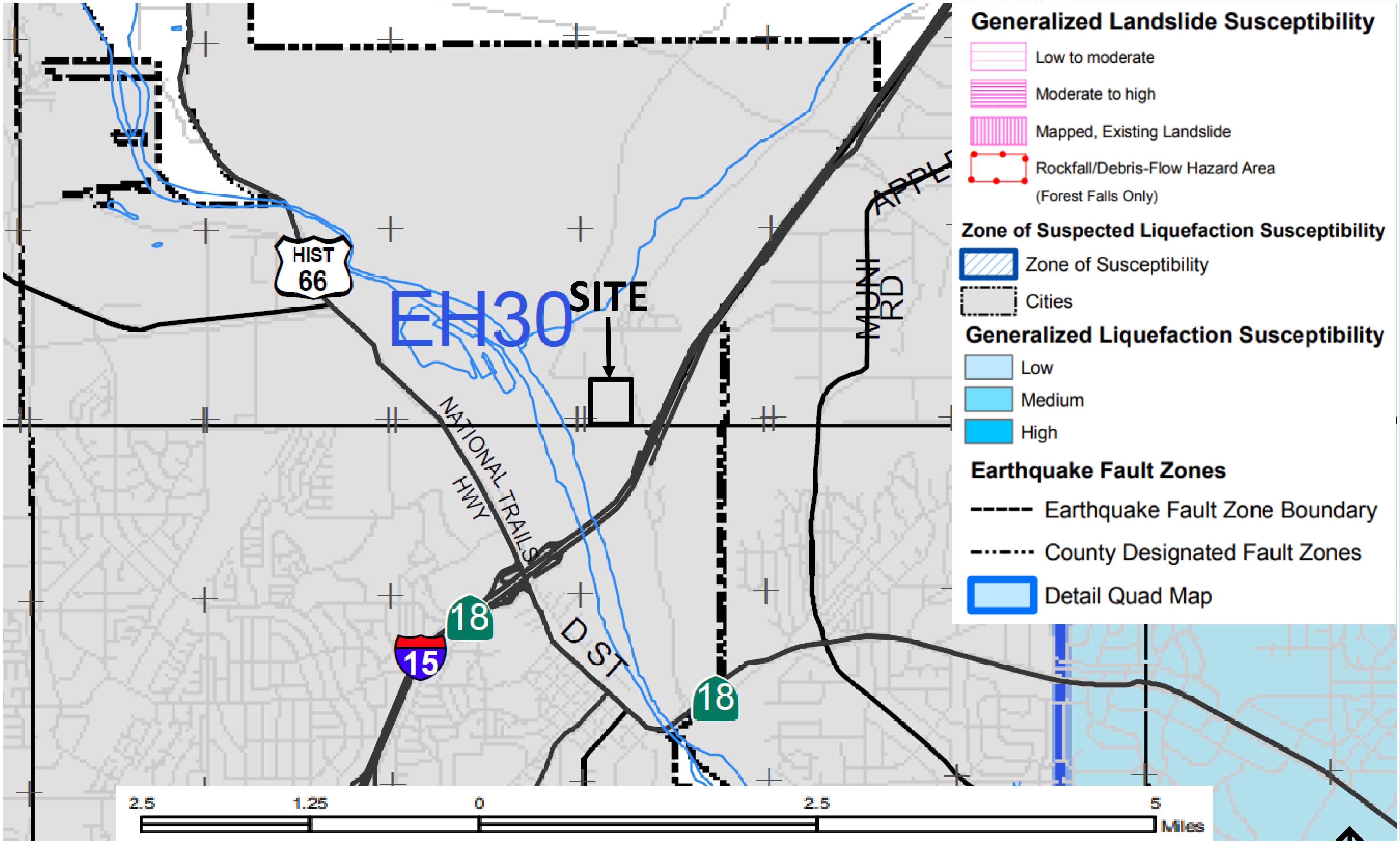
N

TGR Geotechnical Environmental Hydrogeology Material Testing Construction Inspection

REGIONAL FAULT MAP
SW CORNER OF ABBEY LANE AND STODDARD WELLS ROAD
VICTORVILLE, CALIFORNIA

PROJECT NO. 21-7253

FIGURE 3



Modified From: County of Sand Bernardino, Land Use Services, Geologic Hazard Maps Overlay, Map EH30

TGR Geotechnical Environmental Hydrogeology Material Testing Construction Inspection	GEOLOGIC HAZARDS MAP SW CORNER OF ABBEY LANE AND STODDARD WELLS ROAD VICTORVILLE, CALIFORNIA	PROJECT NO. 21-7253 FIGURE 4

Test Hole	Total Depth (in)	Initial Depth (in)	Final Depth (in)	∆Water Level (in)	Initial Time (min)	Final Time (min)	∆ Time (min)	Initial Height of Water (in)	Final Height of Water (in)	Average Height of Water (in)	Infiltration Rate (in/hr)
P-1	60	8.4	32.4	24	0.0	2.0	2.0	51.6	27.6	39.60	26.28
	60	8.4	31.8	23.4	0.0	2.0	2.0	51.6	28.2	39.90	25.43
	60	8.4	31.8	23.4	0.0	2.0	2.0	51.6	28.2	39.90	25.43
	60	8.4	32.4	24	0.0	2.0	2.0	51.6	27.6	39.60	26.28
	60	8.4	30.6	22.2	0.0	2.0	2.0	51.6	29.4	40.50	23.79
	60	8.4	29.4	21	0.0	2.0	2.0	51.6	30.6	41.10	22.18
	60	8.4	30	21.6	0.0	2.0	2.0	51.6	30	40.80	22.98
	60	8.4	30	21.6	0.0	2.0	2.0	51.6	30	40.80	22.98
	60	8.4	30	21.6	0.0	2.0	2.0	51.6	30	40.80	22.98
P-2	60	21	48.6	27.6	0.0	10.0	10.0	39	11.4	25.20	9.30
	60	21	47.4	26.4	0.0	10.0	10.0	39	12.6	25.80	8.70
	60	21	45.5	24.5	0.0	10.0	10.0	39	14.5	26.75	7.81
	60	21	45.6	24.6	0.0	10.0	10.0	39	14.4	26.70	7.85
	60	21	43.8	22.8	0.0	10.0	10.0	39	16.2	27.60	7.05
	60	21	45.6	24.6	0.0	10.0	10.0	39	14.4	26.70	7.85
P-3	60	15	33	18	0.0	10.0	10.0	45	27	36.00	4.32
	60	15	31.2	16.2	0.0	10.0	10.0	45	28.8	36.90	3.80
	60	15	33	18	0.0	10.0	10.0	45	27	36.00	4.32
	60	15	30.1	15.1	0.0	10.0	10.0	45	29.9	37.45	3.49
	60	15	30.4	15.4	0.0	10.0	10.0	45	29.6	37.30	3.57
	60	15	30	15	0.0	10.0	10.0	45	30	37.50	3.46
P-4	60	18.6	43.3	24.7	0.0	10.0	10.0	41.4	16.7	29.05	7.28
	60	18.6	41.4	22.8	0.0	10.0	10.0	41.4	18.6	30.00	6.51
	60	18.6	41.4	22.8	0.0	10.0	10.0	41.4	18.6	30.00	6.51
	60	18.6	41.5	22.9	0.0	10.0	10.0	41.4	18.5	29.95	6.55
	60	18.6	41.4	22.8	0.0	10.0	10.0	41.4	18.6	30.00	6.51
	60	18.6	40	21.4	0.0	10.0	10.0	41.4	20	30.70	5.98
	60	18.6	41.4	22.8	0.0	10.0	10.0	41.4	18.6	30.00	6.51

$$I_t = \frac{\Delta H(60r)}{\Delta t(r + 2H_{avg})}$$

ΔH = Change in height

Δt = Time interval

r = Radius

I_t Infiltration Rate

H_{ave} Average Head Height over the time interval

APPENDIX A
REFERENCES

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APPENDIX A

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APPENDIX B
LOG OF BORINGS

THE FOLLOWING DESCRIBES THE TERMS AND SYMBOLS USED ON THE LOG OF BORINGS TO SUMMARIZE THE RESULTS OBTAINED IN THE FIELD INVESTIGATION AND SUBSEQUENT LABORATORY TESTING

DENSITY AND CONSISTENCY

The consistency of fine grained soils and the density of coarse grained soils are described on the basis of the Standard Penetration Test as follows:

COARSE GRAINED SOILS		ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (Tsf)	FINE GRAINED SOILS	
Very Loose	< 4	< 0.25	Very Soft	< 2
Loose	4 – 10	0.35 – 0.50	Soft	2 – 4
Medium	10 – 30	0.50 – 1.0	Firm (Medium)	4 – 8
Dense	30 – 50	1.0 – 2.0	Stiff	8 – 15
Very Dense	> 50	2.0 – 4.0	Very Stiff	15 – 30
		> 4.0	Hard	> 30

PARTICLE SIZE DEFINITION (As per ASTM D2487 and D422)

Boulder	⇒ Larger than 12 inches	Coarse Sands	⇒ No. 10 to No. 4 sieve
Cobbles	⇒ 3 to 12 inches	Medium Sands	⇒ No. 40 to No. 10 sieve
Coarse Gravel	⇒ 3/4 to 3 inches	Fine Sands	⇒ No. 200 to 40 sieve
Fine Gravel	⇒ No. 4 to 3/4 inches	Silt	⇒ 5µm to No. 200 sieve
		Clay	⇒ Smaller than 5µm

SOIL CLASSIFICATION

Soils and bedrock are classified and described based on their engineering properties and characteristics using ASTM D2487 and D2488.

Percentage description of minor components:

Trace	1 – 10%	Some	20 – 35%
Little	10 – 20%	And or y	25 – 50%

Stratified soils description:

Parting	0 to 1/16 inch thick	Layer	½ to 12 inches thick
Seam	1/16 to ½ inch thick	Stratum	> 12 inches thick

SOIL CLASSIFICATION CHART

UNIFIED SOIL CLASSIFICATION AND SYMBOL CHART

COARSE-GRAINED SOILS (more than 50% of material is larger than No. 200 sieve size.)		
	Clean Gravels (Less than 5% fines)	
GRAVELS More than 50% of coarse fraction larger than No. 4 sieve size	GW	Well-graded gravels, gravel-sand mixtures, little or no fines
	GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines
	Gravels with fines (More than 12% fines)	
	GM	Silty gravels, gravel-sand-silt mixtures
	GC	Clayey gravels, gravel-sand-clay mixtures
	Clean Sands (Less than 5% fines)	
SANDS 50% or more of coarse fraction smaller than No. 4 sieve size	SW	Well-graded sands, gravelly sands, little or no fines
	SP	Poorly graded sands, gravelly sands, little or no fines
	Sands with fines (More than 12% fines)	
	SM	Silty sands, sand-silt mixtures
	SC	Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS (50% or more of material is smaller than No. 200 sieve size.)		
SILTS AND CLAYS Liquid limit less than 50%	ML	Inorganic silts and very fine sands, rock flour, silty of clayey fine sands or clayey silts with slight plasticity
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
	OL	Organic silts and organic silty clays of low plasticity
SILTS AND CLAYS Liquid limit 50% or greater	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
	CH	Inorganic clays of high plasticity, fat clays
	OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS	PT	Peat and other highly organic soils

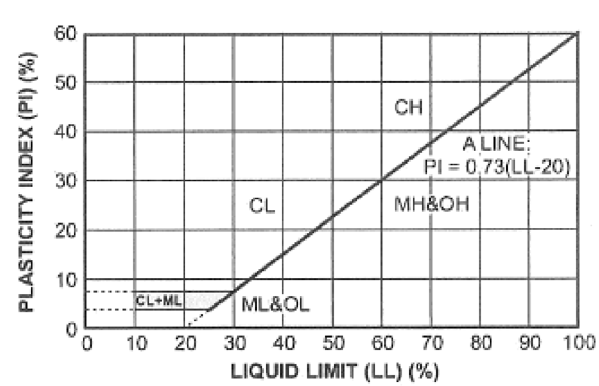
LABORATORY CLASSIFICATION CRITERIA

GW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
GP	Not meeting all gradation requirements for GW	
GM	Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
GC	Atterberg limits above "A" line with P.I. greater than 7	
SW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
SP	Not meeting all gradation requirements for GW	
SM	Atterberg limits below "A" line or P.I. less than 4	Limits plotting in shaded zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols.
SC	Atterberg limits above "A" line with P.I. greater than 7	

Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:

Less than 5 percent .... GW, GP, SW, SP
More than 12 percent .... GM, GC, SM, SC
5 to 12 percent .... Borderline cases requiring dual symbols

PLASTICITY CHART



PARTICLE SIZE LIMITS

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

3" ¾" NO. 4 NO. 10 NO. 40 NO. 200

TGR Geotechnical Environmental Hydrogeology Material Testing Construction Inspection

LOG OF BORING EXPLANATION

LOG OF EXPLORATORY BORING B-1

Project Number: **21-7253**
Project Name: **17198-17000 Abbey Lane, Victorville**
Date Drilled: **11/17/21 - 11/17/21**
Ground Elev: **2719**
Logged By: **RA**
Project Engineer: **SG**
Drill Type: **CME 75 Hollow Stem**
Drive Wt & Drop: **140lbs / 30in**

Legend: Shelby Tube; Standard Split Spoon; No recovery; Modified California; Water Table ATD

Elevation (ft)	Depth (ft)	Bulk Sample	Drive Sample	SPT blows/ft (or equivalent N)	Pocket Pen (tsf)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	Moisture Content (%)	Dry Density, (pcf)	Other Tests
2719	0	Bulk					Surface is sand and dry vegetation.			
	0–5	Bulk				SM	Silty <u>SAND</u>- tan, dry, medium dense, fine grained, some coarse.			Corrosion, R-Value
2714	5		Modified California	14		SP	<u>SAND</u>- light orange brown, dry, medium dense, fine to coarse grained.	3	111	Consol
2709	10		Modified California	20		SM	Silty <u>SAND</u>- orange brown, moist, medium dense, fine to medium grained.	5	126	
2704	15		Modified California	31		SM	...Same as above, very fine to fine grained, dense.	8	110	

Total Depth: 16.5 feet.
No groundwater encountered during drilling.
No caving observed.
Boring backfilled with soil cuttings upon completion.

Ground elevation approximated with Google Earth.

This Boring Log should be evaluated in conjunction with the complete geotechnical report. This Boring Log represents conditions observed at the specific location and date indicated, it is not warranted to be representative of subsurface conditions at other locations and times.

TGR GEOTECHNICAL, INC.

LOG OF EXPLORATORY BORING B-2

Project Number:	**21-7253**	Logged By:	**RA**
Project Name:	**17198-17000 Abbey Lane, Victorville**	Project Engineer:	**SG**
Date Drilled:	**11/17/21 - 11/17/21**	Drill Type:	**CME 75 Hollow Stem**
Ground Elev:	**2732**	Drive Wt & Drop:	**140lbs / 30in**

Legend: Shelby Tube; Standard Split Spoon; No recovery; Modified California; Water Table ATD

Elevation (ft)	Depth (ft)	Graphic Log	Bulk Sample	Drive Sample	SPT blows/ft (or equivalent N)	Pocket Pen (tsf)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	Moisture Content (%)	Dry Density, (pcf)	Other Tests
	0							Surface is wood chips.			
2730								SAND- light brown, slightly moist, medium dense, fine grained.			
	5			Modified California	19		SM	Silty SAND- orange brown, dry, medium dense, fine grained.	3	118	
2725											
2720	10			Modified California	25		SM	...Same as above.	3	119	
2715	15			Modified California	34		SP	SAND- light orange brown, dry, dense, fine to coarse grained.	3	129	
2710	20			Standard Split Spoon	15		SP	SAND- light brown, dry, medium dense, very fine to fine grained.	3		
	25			Standard Split Spoon	20		SP	...Same as above.	3		
2705								Total Depth: 26.5 feet. No groundwater encountered during drilling. No caving observed. Boring backfilled with soil cuttings upon completion. Ground elevation approximated with Google Earth.			

This Boring Log should be evaluated in conjunction with the complete geotechnical report. This Boring Log represents conditions observed at the specific location and date indicated, it is not warranted to be representative of subsurface conditions at other locations and times.

PLATE 3

TGR GEOTECHNICAL, INC.

LOG OF EXPLORATORY BORING B-3

Project Number:	**21-7253**	Logged By:	**RA**
Project Name:	**17198-17000 Abbey Lane, Victorville**	Project Engineer:	**SG**
Date Drilled:	**11/17/21 - 11/17/21**	Drill Type:	**CME 75 Hollow Stem**
Ground Elev:	**2722**	Drive Wt & Drop:	**140lbs / 30in**

Legend: Shelby Tube; Standard Split Spoon; No recovery; Modified California; Water Table ATD

Elevation (ft)	Depth (ft)	Graphic Log	FIELD RESULTS: Bulk Sample	Drive Sample	SPT blows/ft (or equivalent N)	Pocket Pen (tsf)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	LAB RESULTS: Moisture Content (%)	Dry Density, (pcf)	Other Tests
2722	0							Surface is sand and dry vegetation.			
								Silty SAND to Sandy SILT- tan to white, dry, medium dense, fine grained, trace coarse.			
2720											
	5			Modified California	9		SM	Silty SAND- tan, dry, medium dense, fine grained.	3	116	Consol
2715											
	10			Modified California	18		SP	SAND- light orange brown, dry, medium dense, fine to coarse grained.	1	114	Consol
2710											
	15			Modified California	31		SP	SAND- light brown, dry, dense, very fine to fine grained.	2	115	-200= 19.8%
2705											
	20			Standard Split Spoon	19		SP	...Same as above.	2		-200= 12.8%
2700											
	25			Standard Split Spoon	26		MLS	Sandy SILT- light pale brown, moist, very stiff, very fine to fine grained.	5		-200= 60.3%
2695											

TGR GEOTECHNICAL, INC.

LOG OF EXPLORATORY BORING B-3

Project Number:	**21-7253**	Logged By:	**RA**
Project Name:	**17198-17000 Abbey Lane, Victorville**	Project Engineer:	**SG**
Date Drilled:	**11/17/21 - 11/17/21**	Drill Type:	**CME 75 Hollow Stem**
Ground Elev:	**2722**	Drive Wt & Drop:	**140lbs / 30in**

Legend: Shelby Tube; Standard Split Spoon; No recovery; Modified California; Water Table ATD

Elevation (ft)	Depth (ft)	Bulk Sample	Drive Sample	SPT blows/ft (or equivalent N)	Pocket Pen (tsf)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	Moisture Content (%)	Dry Density, (pcf)	Other Tests
2690			Standard Split Spoon	81		SPG	Gravelly SAND- orange brown, dry, very dense, fine to coarse sand, fine to coarse gravel.	1		-200= 5.4%
2685	35		Standard Split Spoon	56		SM	Silty SAND- orange brown, moist, very dense, fine to coarse sand, some fine to coarse gravel.	9		
2680	40		Standard Split Spoon	29		SP	▼ SAND- dark grey brown, wet, medium dense, fine to coarse grained.	16		-200= 9.6%
2675	45		Standard Split Spoon	27		SP	...Same as above, reddish brown.	19		-200= 15.2%
2670	50		Standard Split Spoon	83		SP	...Same as above, grey brown, some gravel, very dense.	14		-200= 12.8%
2665	55						Total Depth: 51.5 feet. Groundwater encountered at 40 feet during drilling. No caving observed. Boring backfilled with soil cuttings upon completion. Ground elevation approximated with Google Earth.			

This Boring Log should be evaluated in conjunction with the complete geotechnical report. This Boring Log represents conditions observed at the specific location and date indicated, it is not warranted to be representative of subsurface conditions at other locations and times.

PLATE 5

TGR GEOTECHNICAL, INC.

LOG OF EXPLORATORY BORING B-4

Project Number:	**21-7253**	Logged By:	**RA**
Project Name:	**17198-17000 Abbey Lane, Victorville**	Project Engineer:	**SG**
Date Drilled:	**11/16/21 - 11/16/21**	Drill Type:	**CME 75 Hollow Stem**
Ground Elev:	**2715**	Drive Wt & Drop:	**140lbs / 30in**

Legend: Shelby Tube; Standard Split Spoon; No recovery; Modified California; Water Table ATD

Elevation (ft)	Depth (ft)	Graphic Log	Bulk Sample	Drive Sample	SPT blows/ft (or equivalent N)	Pocket Pen (tsf)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	Moisture Content (%)	Dry Density, (pcf)	Other Tests
	0							Surface is sand and dry vegetation.			
								Silty SAND- tan, dry, medium dense, fine to medium grained.			
2710	5			Modified California	14		SM	...Same as above, light reddish brown, fine to coarse grained.	2	114	
2705	10			Modified California	7		MLS	Sandy SILT to Silty SAND- light brown, slightly moist, firm, fine grained.	4	103	
2700	15			Modified California	21		SP	SAND- light brown, dry, medium dense, fine to coarse grained.	2	126	
2695	20			Standard Split Spoon	19		SP	...Same as above, reddish brown.	2		
2690	25			Standard Split Spoon	10		SP	...Same as above, moist.	5		
								Total Depth: 26.5 feet. No groundwater encountered during drilling. No caving observed. Boring backfilled with soil cuttings upon completion. Ground elevation approximated with Google Earth.			

This Boring Log should be evaluated in conjunction with the complete geotechnical report. This Boring Log represents conditions observed at the specific location and date indicated, it is not warranted to be representative of subsurface conditions at other locations and times.

PLATE 6

TGR GEOTECHNICAL, INC.

LOG OF EXPLORATORY BORING B-5

Project Number:	**21-7253**	Logged By:	**RA**
Project Name:	**17198-17000 Abbey Lane, Victorville**	Project Engineer:	**SG**
Date Drilled:	**11/16/21 - 11/16/21**	Drill Type:	**CME 75 Hollow Stem**
Ground Elev:	**2732**	Drive Wt & Drop:	**140lbs / 30in**

Legend: Shelby Tube; Standard Split Spoon; No recovery; Modified California; Water Table ATD

Elevation (ft)	Depth (ft)	Bulk Sample	Drive Sample	SPT blows/ft (or equivalent N)	Pocket Pen (tsf)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	Moisture Content (%)	Dry Density, (pcf)	Other Tests
2732–2727	0–5	Bulk				SM	Surface is sand and dry vegetation. Silty SAND- tan, dry, medium dense, fine to medium grained.			Max, Shear
	5		Modified California	18		SM	Silty SAND- light orange brown, dry, medium dense, fine to coarse grained.	1	113	
	10		Modified California	31		SM	...Same as above, dense, fine grained.	1	119	
	15		Modified California	46		SM	...Same as above.	3	130	

Total Depth: 16.5 feet.
No groundwater encountered during drilling.
No caving observed.
Boring backfilled with soil cuttings upon completion.

Ground elevation approximated with Google Earth.

TGR GEOTECHNICAL, INC.

LOG OF EXPLORATORY BORING B-6

Project Number:	**21-7253**	Logged By:	**RA**
Project Name:	**17198-17000 Abbey Lane, Victorville**	Project Engineer:	**SG**
Date Drilled:	**11/16/21 - 11/16/21**	Drill Type:	**CME 75 Hollow Stem**
Ground Elev:	**2704**	Drive Wt & Drop:	**140lbs / 30in**

Legend: Shelby Tube; Standard Split Spoon; No recovery; Modified California; Water Table ATD

Elevation (ft)	Depth (ft)	Graphic Log	FIELD RESULTS: Bulk Sample	Drive Sample	SPT blows/ft (or equivalent N)	Pocket Pen (tsf)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	LAB RESULTS: Moisture Content (%)	Dry Density, (pcf)	Other Tests
2704	0							Surface is sand and dry vegetation. Silty SAND to Sandy SILT- tan, dry, medium dense, very fine to coarse grained.			
2700											
	5			Modified California	20		SP	Silty SAND- light orange brown, dry, medium dense, fine to coarse grained, some gravel.	1	124	
2695											
	10			Modified California	>50		SP	...Same as above, very dense.	2	123	
2690											
	15			Modified California	31		SP	...Same as above, dense.	2	125	
	16.5							Total Depth: 16.5 feet. No groundwater encountered during drilling. No caving observed. Boring backfilled with soil cuttings upon completion. Ground elevation approximated with Google Earth.			
2685											
	20										
2680											
	25										
2675											

This Boring Log should be evaluated in conjunction with the complete geotechnical report. This Boring Log represents conditions observed at the specific location and date indicated, it is not warranted to be representative of subsurface conditions at other locations and times.

PLATE 8

TGR GEOTECHNICAL, INC.

LOG OF EXPLORATORY BORING B-7

Project Number:	**21-7253**	Logged By:	**RA**
Project Name:	**17198-17000 Abbey Lane, Victorville**	Project Engineer:	**SG**
Date Drilled:	**11/16/21 - 11/16/21**	Drill Type:	**CME 75 Hollow Stem**
Ground Elev:	**2723**	Drive Wt & Drop:	**140lbs / 30in**

Legend: Shelby Tube; Standard Split Spoon; No recovery; Modified California; Water Table ATD

Elevation (ft)	Depth (ft)	Graphic Log	Bulk Sample	Drive Sample	SPT blows/ft (or equivalent N)	Pocket Pen (tsf)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	Moisture Content (%)	Dry Density, (pcf)	Other Tests
2723	0							Surface is sand and dry vegetation.			
								Silty SAND- tan, dry, medium dense, fine to coarse grained.			
	5			Modified California	12		SM	...Same as above, light reddish brown.	2	116	
	10			Modified California	21		SP	SAND- orange brown, moist, medium dense, fine to coarse grained.	3	117	
	15			Modified California	33		SM	Silty SAND to Sandy SILT- white, dry, dense, fine to medium grained, cemented.	3	125	
	20			Standard Split Spoon	43		SM	...Same as above, tan, slightly moist.	4		
	25			Standard Split Spoon	23		SM	...Same as above, medium dense.	3		

Elevation scale: 2720, 2715, 2710, 2705, 2700, 2695

Total Depth: 26.5 feet.
No groundwater encountered during drilling.
No caving observed.
Boring backfilled with soil cuttings upon completion.

Ground elevation approximated with Google Earth.

This Boring Log should be evaluated in conjunction with the complete geotechnical report. This Boring Log represents conditions observed at the specific location and date indicated, it is not warranted to be representative of subsurface conditions at other locations and times.

PLATE 9

TGR GEOTECHNICAL, INC.

LOG OF EXPLORATORY BORING B-8

Project Number:	21-7253	Logged By:	RA
Project Name:	17198-17000 Abbey Lane, Victorville	Project Engineer:	SG
Date Drilled:	11/16/21 - 11/16/21	Drill Type:	CME 75 Hollow Stem
Ground Elev:	2715	Drive Wt & Drop:	140lbs / 30in

Legend: Shelby Tube; Standard Split Spoon; No recovery; Modified California; Water Table ATD

Elevation (ft)	Depth (ft)	Bulk Sample	Drive Sample	SPT blows/ft (or equivalent N)	Pocket Pen (tsf)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	Moisture Content (%)	Dry Density, (pcf)	Other Tests
	0	Bulk					Surface is sand and dry vegetation.			
						SM	Silty SAND- tan, dry, medium dense, fine to coarse grained.			Corrosion
2710	5		Modified California	29		SP	SAND- light orange brown, dry, medium dense, fine to coarse grained.	1	112	Consol -200= 12.8%
2705	10		Modified California	31		SP	...Same as above, dense.	2	121	Consol
2700	15		Modified California	55		SP	...Same as above, very dense, fine to medium grained.	2	128	
2695	20		Standard Split Spoon	25		SP	...Same as above, medium dense.	2		-200= 11.4%%
2690	25		Standard Split Spoon	32		SM	Silty SAND- tan, dry, dense, very fine to fine grained.	3		-200= 26.6%

This Boring Log should be evaluated in conjunction with the complete geotechnical report. This Boring Log represents conditions observed at the specific location and date indicated, it is not warranted to be representative of subsurface conditions at other locations and times.

PLATE 10

TGR GEOTECHNICAL, INC.

LOG OF EXPLORATORY BORING B-8

Project Number:	21-7253	Logged By:	RA
Project Name:	17198-17000 Abbey Lane, Victorville	Project Engineer:	SG
Date Drilled:	11/16/21 - 11/16/21	Drill Type:	CME 75 Hollow Stem
Ground Elev:	2715	Drive Wt & Drop:	140lbs / 30in

Legend: Shelby Tube; Standard Split Spoon; No recovery; Modified California; Water Table ATD

Elevation (ft)	Depth (ft)	Graphic Log	FIELD RESULTS: Bulk Sample	Drive Sample	SPT blows/ft (or equivalent N)	Pocket Pen (tsf)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	LAB RESULTS: Moisture Content (%)	Dry Density, (pcf)	Other Tests
				Standard Split Spoon	18		SM	Silty SAND- tan, dry, dense, very fine to fine grained. *(continued)* ...Same as above, medium dense.	2		
2680	35			Standard Split Spoon	36		SPG	Gravelly SAND- light orange brown, dry, dense, fine to coarse sand, fine to medium gravel.	1		-200= 4.4%
2675	40			Standard Split Spoon	>50		SPG	...Same as above, very dense.	1		
2670	45							Total Depth: 41.5 feet due to refusal in gravel. No groundwater encountered during drilling. No caving observed. Boring backfilled with soil cuttings upon completion. Ground elevation approximated with Google Earth.			
2665	50										
2660	55										

TGR GEOTECHNICAL, INC.

LOG OF EXPLORATORY BORING B-9

Project Number:	**21-7253**	Logged By:	**RA**
Project Name:	**17198-17000 Abbey Lane, Victorville**	Project Engineer:	**SG**
Date Drilled:	**11/16/21 - 11/16/21**	Drill Type:	**CME 75 Hollow Stem**
Ground Elev:	**2393**	Drive Wt & Drop:	**140lbs / 30in**

Legend: Shelby Tube; Standard Split Spoon; No recovery; Modified California; Water Table ATD

Elevation (ft)	Depth (ft)	Bulk Sample	Drive Sample	SPT blows/ft (or equivalent N)	Pocket Pen (tsf)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	Moisture Content (%)	Dry Density, (pcf)	Other Tests
2393	0						Surface is sand and dry vegetation.			
							Sandy SILT- white, dry, firm to soft, fine to coarse grained sand.			
2390										
	5		Modified California	20		SM	Silty SAND- light orange brown, dry, medium dense, fine to coarse grained, trace gravel.	2	119	
2385										
	10		Modified California	28		SM	...Same as above.	3	125	
2380										
	15		Modified California	47		SP	SAND- light orange brown, dry, dense, fine to coarse grained.	2	122	
2375										
	20		Standard Split Spoon	19		SM	Silty SAND- light brown, medium dense, dry, fine to medium grained.	3		
2370										
	25		Standard Split Spoon	15		SM	...Same as above, reddish brown.	3		
	26.5						Total Depth: 26.5 feet. No groundwater encountered during drilling. No caving observed. Boring backfilled with soil cuttings upon completion. Ground elevation approximated with Google Earth.			
2365										

This Boring Log should be evaluated in conjunction with the complete geotechnical report. This Boring Log represents conditions observed at the specific location and date indicated, it is not warranted to be representative of subsurface conditions at other locations and times.

PLATE 12

TGR GEOTECHNICAL, INC.

LOG OF EXPLORATORY BORING B-10

Sheet 1 of 1

Project Number:	**21-7253**	Logged By:	**RA**
Project Name:	**17198-17000 Abbey Lane, Victorville**	Project Engineer:	**SG**
Date Drilled:	**11/16/21 - 11/16/21**	Drill Type:	**CME 75 Hollow Stem**
Ground Elev:	**2720**	Drive Wt & Drop:	**140lbs / 30in**

Legend: Shelby Tube; Standard Split Spoon; No recovery; Modified California; Water Table ATD

Elevation (ft)	Depth (ft)	Graphic Log	FIELD RESULTS: Bulk Sample	Drive Sample	SPT blows/ft (or equivalent N)	Pocket Pen (tsf)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	LAB RESULTS: Moisture Content (%)	Dry Density, (pcf)	Other Tests
	0							Surface is sand and dry vegetation. Silty SAND- tan, dry, medium dense, fine to coarse grained.			
2715	5			Modified California	21		SM	Silty SAND- light orange brown, dry, medium dense, fine to coarse grained, some gravel.	1	105	
2710	10			Modified California	39		SM	...Same as above, dense.	2	128	Consol
2705	15			Modified California	26		SM	...Same as above, medium dense, no gravel.	2	121	
	16.5							Total Depth: 16.5 feet. No groundwater encountered during drilling. No caving observed. Boring backfilled with soil cuttings upon completion. Ground elevation approximated with Google Earth.			
2700	20										
2695	25										

This Boring Log should be evaluated in conjunction with the complete geotechnical report. This Boring Log represents conditions observed at the specific location and date indicated, it is not warranted to be representative of subsurface conditions at other locations and times.

PLATE 13

TGR GEOTECHNICAL, INC.

LOG OF EXPLORATORY BORING P-1

Project Number:	**21-7253**	Logged By:	**RA**
Project Name:	**17198-17000 Abbey Lane, Victorville**	Project Engineer:	**SG**
Date Drilled:	**11/16/21 - 11/16/21**	Drill Type:	**CME 75 Hollow Stem**
Ground Elev:	**2693**	Drive Wt & Drop:	**140lbs / 30in**

Legend: Shelby Tube; Standard Split Spoon; No recovery; Modified California; Water Table ATD

Elevation (ft)	Depth (ft)	Graphic Log	FIELD RESULTS: Bulk Sample	Drive Sample	SPT blows/ft (or equivalent N)	Pocket Pen (tsf)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	LAB RESULTS: Moisture Content (%)	Dry Density, (pcf)	Other Tests
	0							Surface is sand and vegetation.			
			Bulk				SP	SAND- light brown, dry, loose, very fine to fine grained, some silt.	3		-200= 17.5%
2690											
	5							Total Depth: 5 feet. No groundwater encountered during drilling. No caving observed. Boring utilized for percolation testing. Boring backfilled with soil cuttings upon completion. Ground elevation approximated with Google Earth.			
2685											
	10										
2680											

This Boring Log should be evaluated in conjunction with the complete geotechnical report. This Boring Log represents conditions observed at the specific location and date indicated, it is not warranted to be representative of subsurface conditions at other locations and times.

PLATE 14

TGR GEOTECHNICAL, INC.

LOG OF EXPLORATORY BORING P-2

Project Number:	**21-7253**	Logged By:	**RA**
Project Name:	**17198-17000 Abbey Lane, Victorville**	Project Engineer:	**SG**
Date Drilled:	**11/16/21 - 11/16/21**	Drill Type:	**CME 75 Hollow Stem**
Ground Elev:	**2713**	Drive Wt & Drop:	**140lbs / 30in**

Legend: Shelby Tube; Standard Split Spoon; No recovery; Modified California; Water Table ATD

Elevation (ft)	Depth (ft)	Graphic Log	Bulk Sample	Drive Sample	SPT blows/ft (or equivalent N)	Pocket Pen (tsf)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	Moisture Content (%)	Dry Density, (pcf)	Other Tests
	0							Surface is sand and dry vegetation.			
			X					SAND- tan, dry, medium dense, fine to medium grained, some silt.			
							SP		1		-200= 14.5%
2710											
	5							Total Depth: 5 feet. No groundwater encountered during drilling. No caving observed. Boring utilized for percolation testing. Boring backfilled with soil cuttings upon completion. Ground elevation approximated with Google Earth.			
2705											
	10										
2700											

This Boring Log should be evaluated in conjunction with the complete geotechnical report. This Boring Log represents conditions observed at the specific location and date indicated, it is not warranted to be representative of subsurface conditions at other locations and times.

PLATE 15

TGR GEOTECHNICAL, INC.

LOG OF EXPLORATORY BORING P-3

Sheet 1 of 1

Project Number:	**21-7253**	Logged By:	**RA**
Project Name:	**17198-17000 Abbey Lane, Victorville**	Project Engineer:	**SG**
Date Drilled:	**11/16/21 - 11/16/21**	Drill Type:	**CME 75 Hollow Stem**
Ground Elev:	**2717**	Drive Wt & Drop:	**140lbs / 30in**

Legend: Shelby Tube; Standard Split Spoon; No recovery; Modified California; Water Table ATD

Elevation (ft)	Depth (ft)	Graphic Log	Bulk Sample	Drive Sample	SPT blows/ft (or equivalent N)	Pocket Pen (tsf)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	Moisture Content (%)	Dry Density, (pcf)	Other Tests
								Surface is sand and dry vegetation.			
								SAND- tan, dry, medium dense, fine to medium grained, some silt.			
2715							SP		2		-200= 14.3%
	5							Total Depth: 5 feet. No groundwater encountered during drilling. No caving observed. Boring utilized for percolation testing. Boring backfilled with soil cuttings upon completion. Ground elevation approximated with Google Earth.			
2710											
	10										
2705											

This Boring Log should be evaluated in conjunction with the complete geotechnical report. This Boring Log represents conditions observed at the specific location and date indicated, it is not warranted to be representative of subsurface conditions at other locations and times.

PLATE 16

TGR GEOTECHNICAL, INC.

LOG OF EXPLORATORY BORING P-4

Project Number:	21-7253	Logged By:	RA
Project Name:	17198-17000 Abbey Lane, Victorville	Project Engineer:	SG
Date Drilled:	11/16/21 - 11/16/21	Drill Type:	CME 75 Hollow Stem
Ground Elev:	2741	Drive Wt & Drop:	140lbs / 30in

Legend: Shelby Tube; Standard Split Spoon; No recovery; Modified California; Water Table ATD

Elevation (ft)	Depth (ft)	Graphic Log	Bulk Sample	Drive Sample	SPT blows/ft (or equivalent N)	Pocket Pen (tsf)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	Moisture Content (%)	Dry Density, (pcf)	Other Tests
								Surface is sand and dry vegetation.			
2740							SP	SAND- tan, dry, medium dense, fine to medium grained, some silt.	1		-200= 15.2%
	5							Total Depth: 5 feet. No groundwater encountered during drilling. No caving observed. Boring utilized for percolation testing. Boring backfilled with soil cuttings upon completion. Ground elevation approximated with Google Earth.			
2735											
	10										
2730											

This Boring Log should be evaluated in conjunction with the complete geotechnical report. This Boring Log represents conditions observed at the specific location and date indicated, it is not warranted to be representative of subsurface conditions at other locations and times.

PLATE 17

TGR GEOTECHNICAL, INC.

APPENDIX C
LABORATORY TEST RESULTS

APPENDIX C

Laboratory Testing Procedures and Results

In-Situ Moisture and Dry Density Determination (ASTM D2216 and D7263): Moisture content and dry density determinations were performed on relatively undisturbed samples obtained from the test borings. The results of these tests are presented in the boring logs. Where applicable, only moisture content was determined from "undisturbed" or disturbed samples.

Maximum Density and Optimum Moisture Content (ASTM D1557): The maximum dry density and optimum moisture content of typical materials were determined in accordance with ASTM Test Method D1557. The results of these tests are presented in the table below:

Sample Location	Sample Description	Maximum Dry Density (Pcf)	Optimum Moisture Content (%)
B-5 @ 0-5 feet	Silty Sand	128.5	8.0

Direct Shear Strength (ASTM D3080): Direct shear test was performed on selected remolded samples, which were soaked for a minimum of 24 hours under a surcharge equal to the applied normal force during testing. After transfer of the sample to the shear box, and reloading the sample, pore pressures set up in the sample due to the transfer were allowed to dissipate for a period of approximately 1-hour prior to application of shearing force. The sample was tested under various normal loads, a motor-driven, strain-controlled, direct-shear testing apparatus at a strain rate of less than 0.001 to 0.5 inches per minute (depending upon the soil type). The test results are presented in the test data and in the table below:

Sample Location	Sample Description	Friction Angle (degrees)	Apparent Cohesion (psf)
B-5 @ 0-5 feet	Silty Sand (Remolded)	34	102

Consolidation Tests (ASTM D2435): Consolidation test were performed on selected, relatively undisturbed ring samples. Samples were placed in a consolidometer and loads were applied in geometric progression. The percent consolidation for each load cycle was recorded as the ratio of the amount of vertical compression to the original 1-inch height. The consolidation pressure curves are presented in the test data.

Soluble Sulfate (CAL 417A): The soluble sulfate content of selected sample was determined by standard geochemical methods. The test results are presented in the test data and in the table below:

Sample Location	Sample Description	Water Soluble Sulfate in Soil, (% by Weight)	Sulfate Content (ppm)	Exposure Class*
B-1 @ 0-5 feet	Silty Sand	0.0144	144	S0
B-8 @ 0-5 feet	Silty Sand	0.0123	123	S0

* Based on the current version of ACI 318-14 Building Code, Table No. 19.3.1.1; Exposure Categories and Classes.

Corrosivity Tests (CAL 422, CAL 643 and CAL 747): Electrical conductivity, pH, and soluble chloride tests were conducted on representative samples and the results are provided in the test data and in the table below:

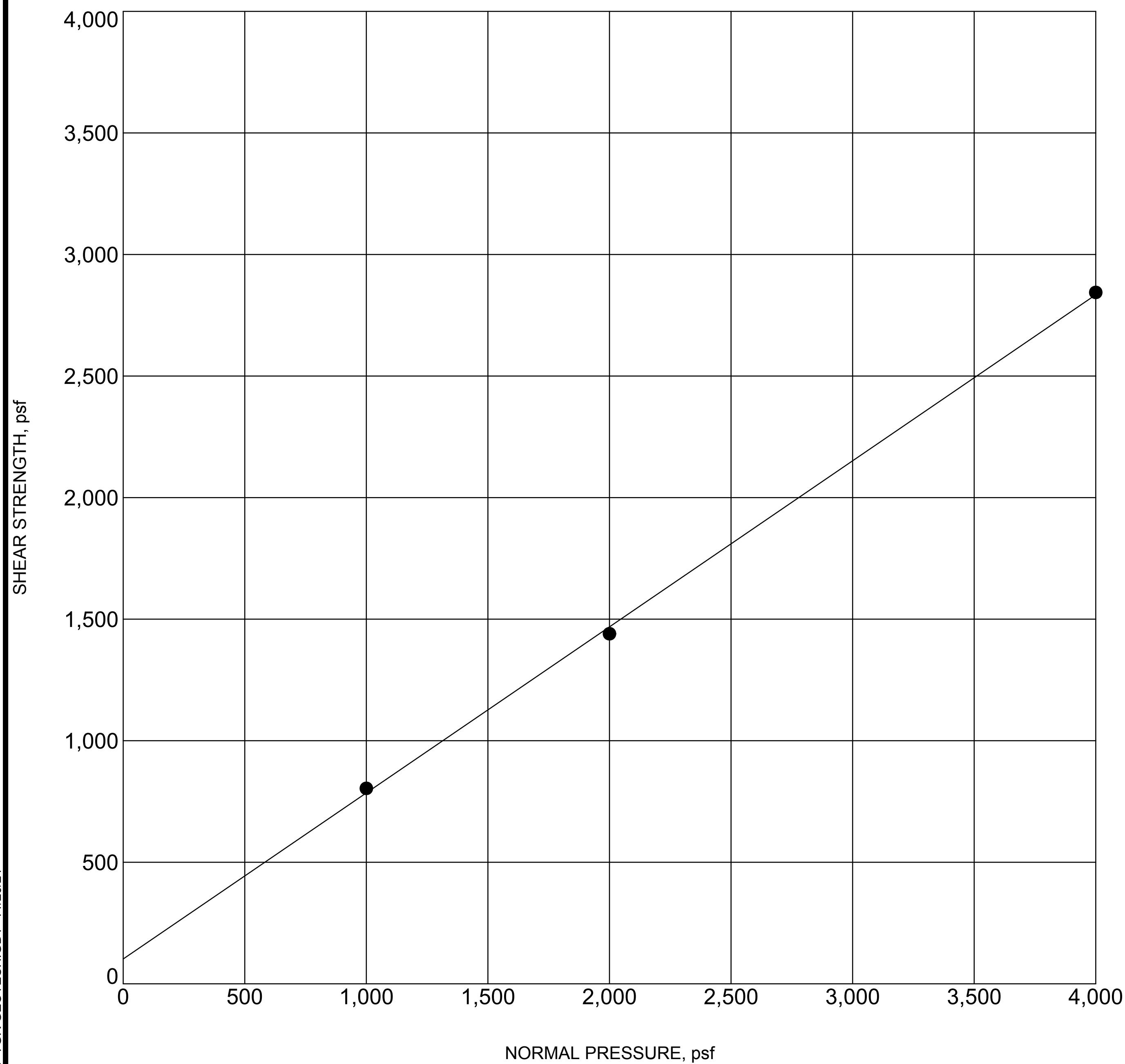
Sample Location	Sample Description	Soluble Chloride (CAL 422) (ppm)	Electrical Resistivity (CAL 643) (ohm-cm)	pH (CAL 747)	Potential Degree of Attack on Steel
B-1 @ 0-5 feet	Silty Sand	59	8,900	7.8	Moderate
B-8 @ 0-5 feet	Silty Sand	76	7,000	7.6	Moderate

R-Value (CAL 301): The resistance "R"-Value was determined by the California Materials Method No. 301 for subgrade soils. Samples were prepared and exudation pressure and "R"-Value determined. The graphically determined "R"-Values at exudation pressure of 300 psi are shown in the test data and summarized in the table below:

Sample Location	Sample Description	R-Value
B-1 @ 0-5 feet	Silty Sand	78

Passing No. 200 Sieve (ASTM D1140): Typical materials were washed over No. 200 sieve. The test results are presented below:

Sample Location	% Passing No. 200 Sieve
B-3 @ 15 feet	19.8
B-3 @ 20 feet	12.8
B-3 @ 25 feet	60.3
B-3 @ 30 feet	5.4
B-3 @ 40 feet	9.6
B-3 @ 45 feet	15.2
B-3 @ 50 feet	12.8
B-8 @ 5 feet	12.8
B-8 @ 20 feet	11.4
B-8 @ 25 feet	26.6
B-8 @ 35 feet	4.4
P-1 @ 0-5 feet	17.5
P-2 @ 0-5 feet	14.5
P-3 @ 0-5 feet	14.3
P-4 @ 0-5 feet	15.2



	Specimen Identification		Classification	γ_d	MC%	c	ϕ
●	**B-5**	**0-5**	**Silty Sand - Remolded - 90% RC**	**116**	**8**	**102**	**34**

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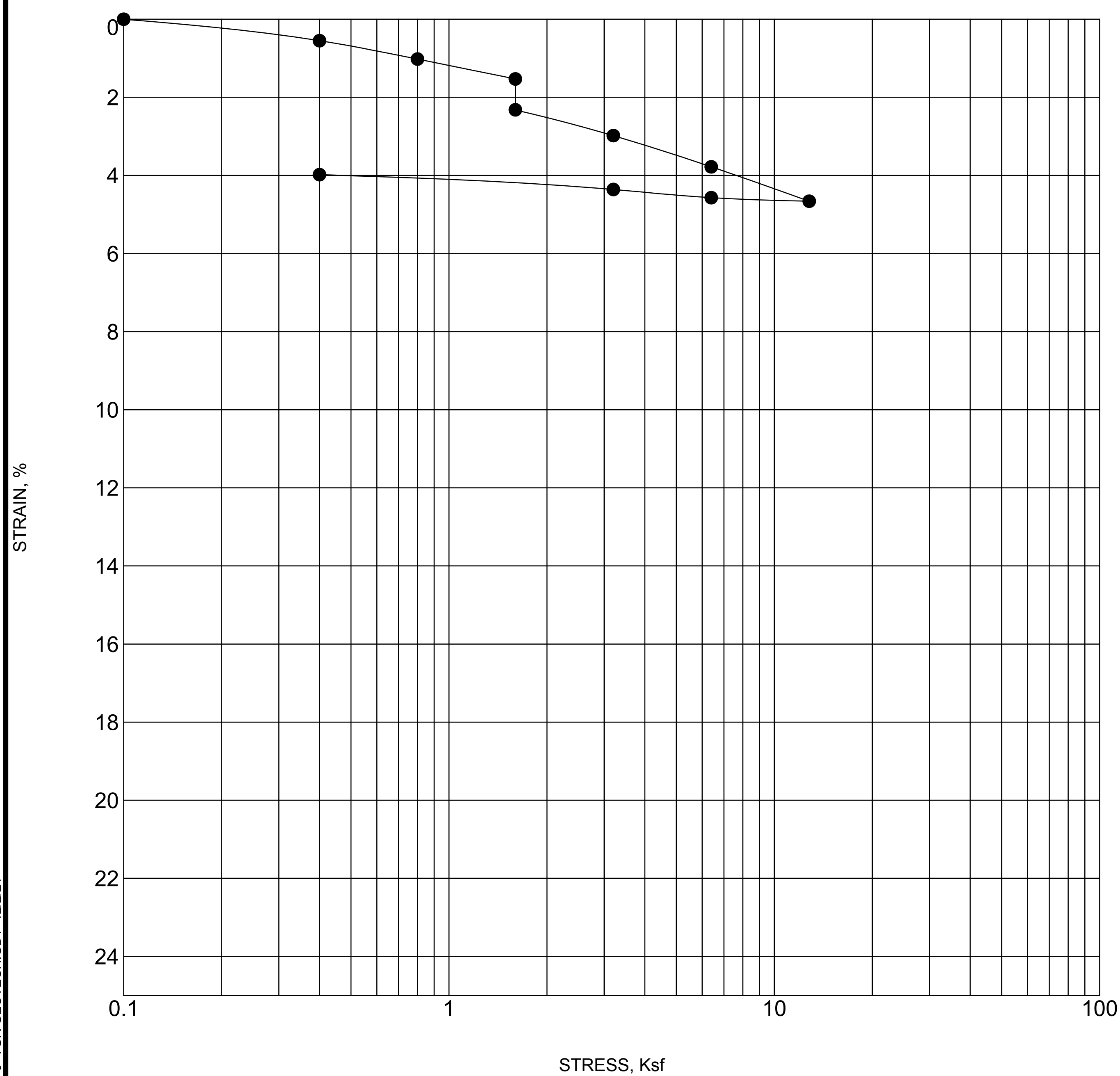
DIRECT SHEAR TEST

Project Number: 21-7253

Project Name: 17198-17000 Abbey Lane, Victorville



Specimen Identification			Classification	γ_d	MC%
●	**B-1**	**5.0**	**Sand**	**111**	**3**

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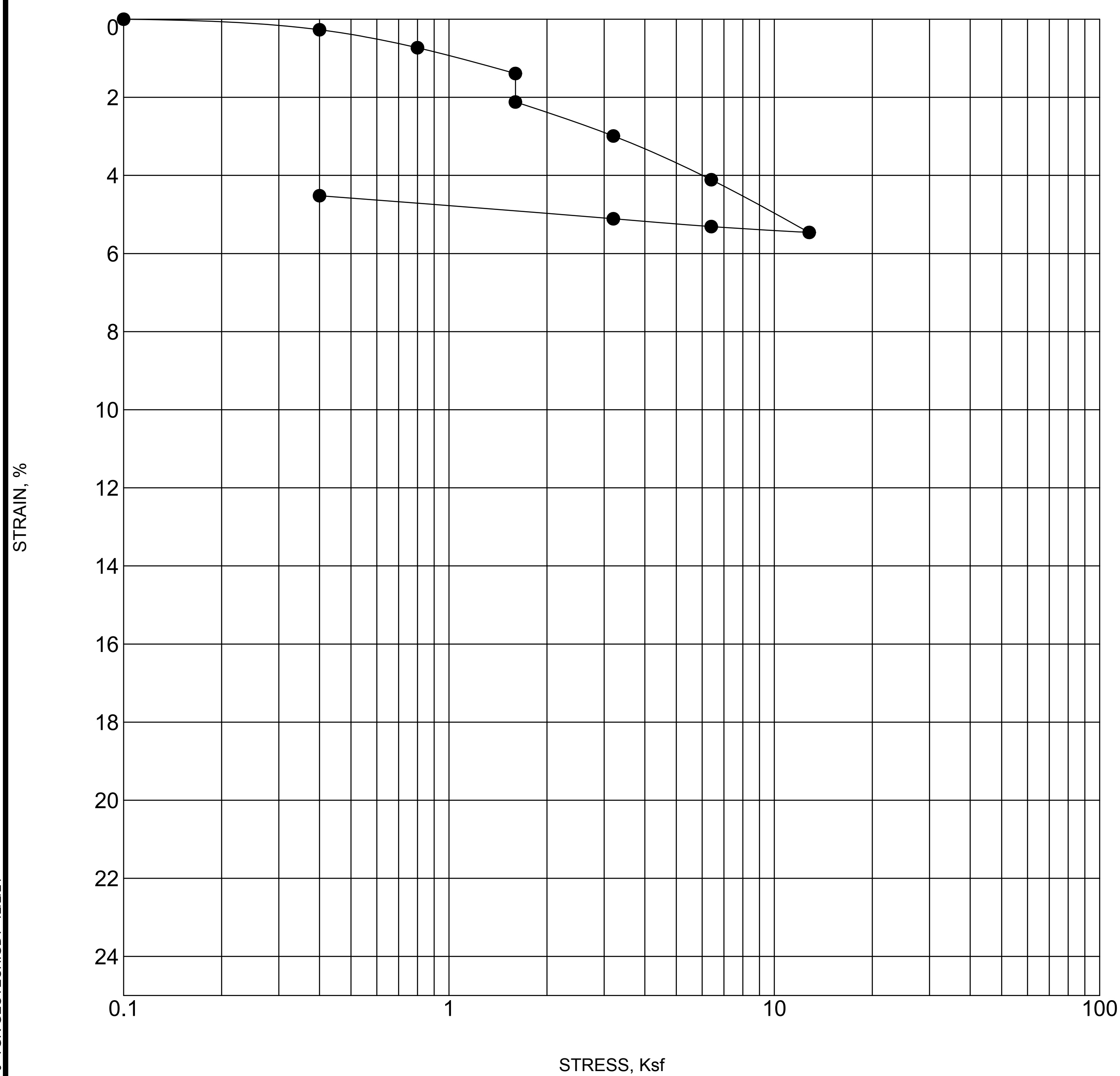
Fax: 714-641-7190

CONSOLIDATION TEST

Project Number: 21-7253

Project Name: 17198-17000 Abbey Lane, Victorville



Specimen Identification		Classification	γ_d	MC%
● **B-3**	**5.0**	**Silty Sand**	**116**	**3**

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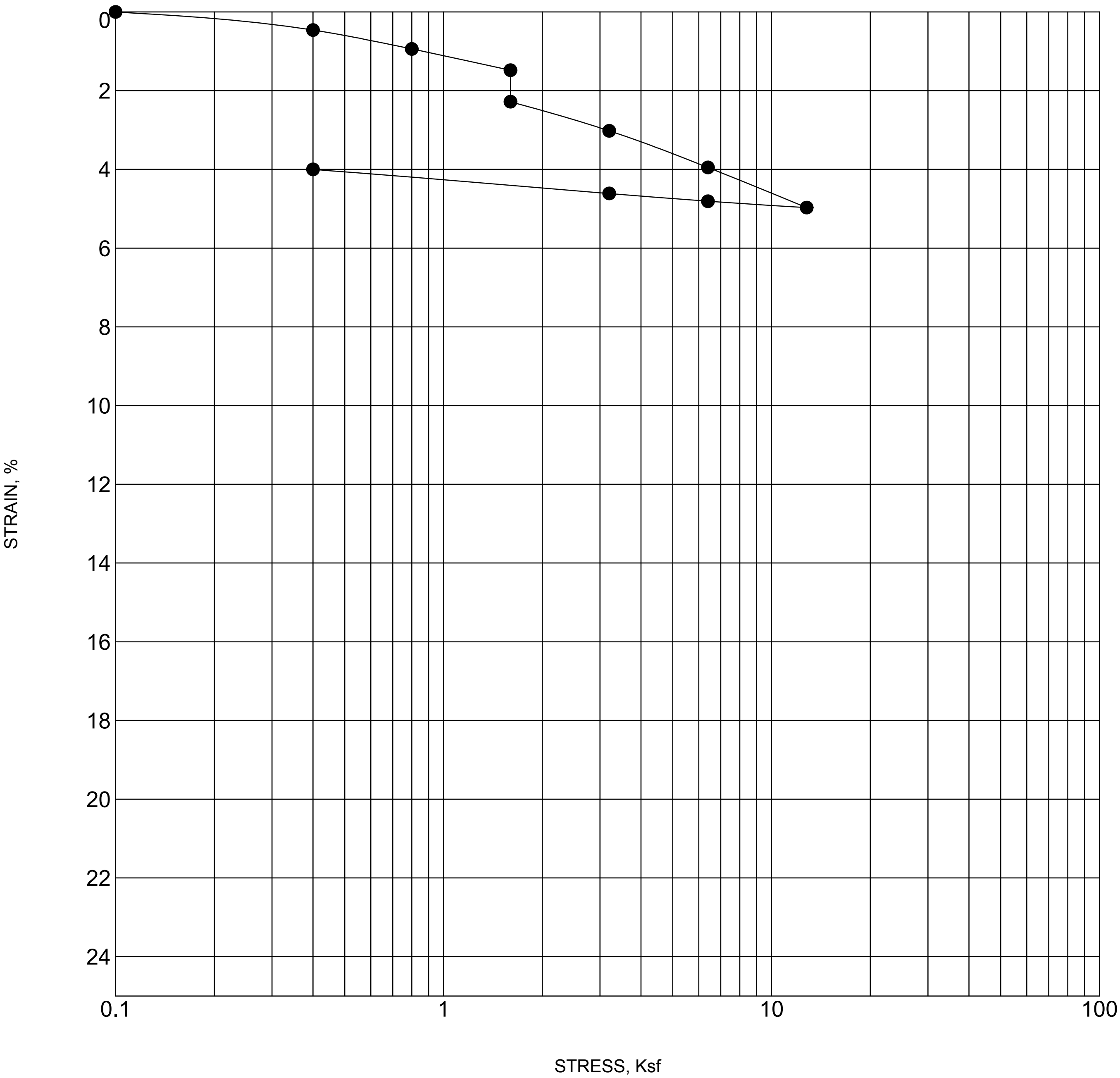
Fax: 714-641-7190

CONSOLIDATION TEST

Project Number: 21-7253

Project Name: 17198-17000 Abbey Lane, Victorville



	Specimen Identification		Classification	γ_d	MC%
●	**B-3**	**10.0**	**Sand**	**114**	**1**

US CONSOL STRAIN 21-7253 STODDARD WELLS ROAD AND ABBEY LANE.GPJ TGR GEOTECH.GDT 12/2/21

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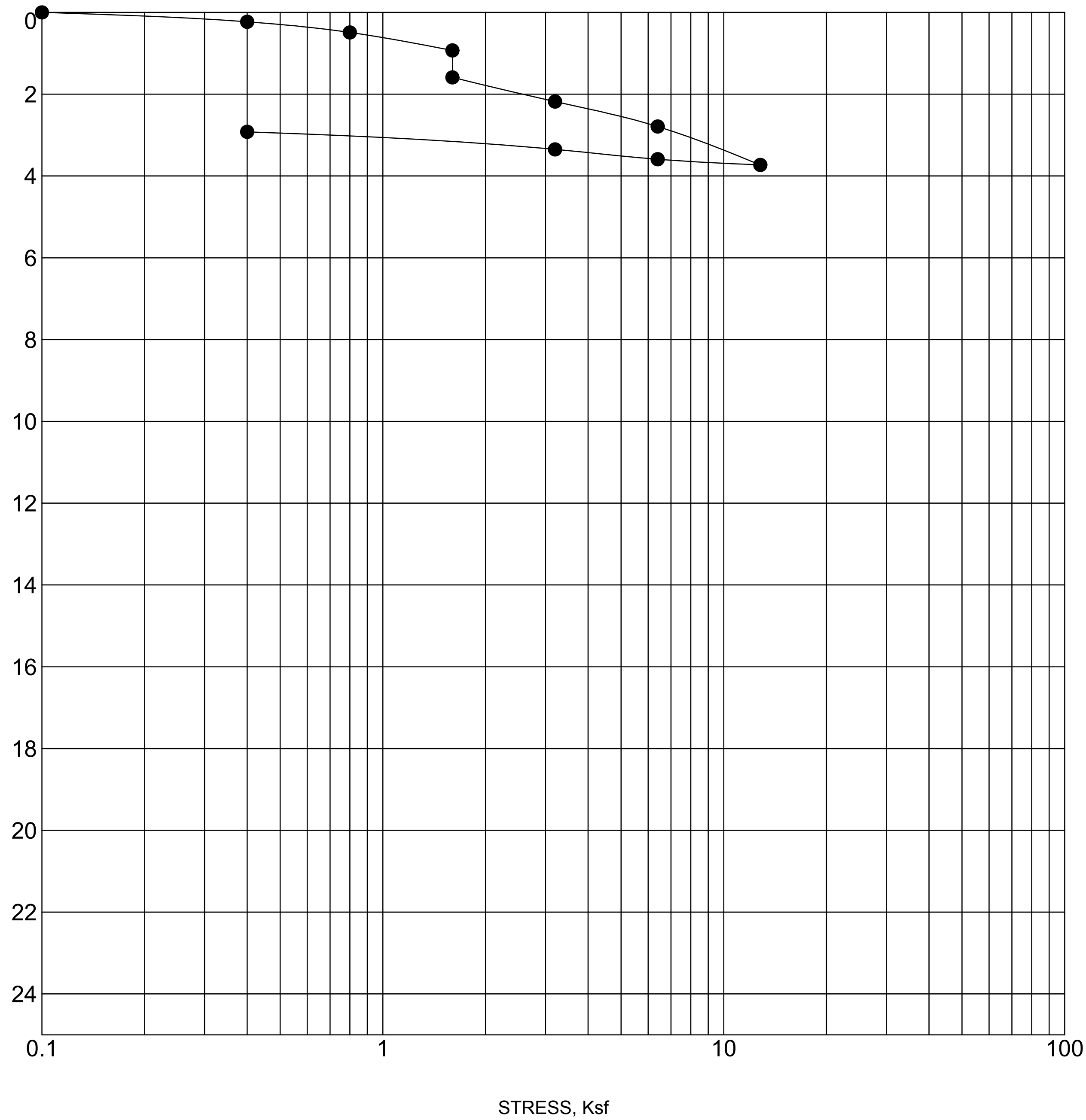
CONSOLIDATION TEST

Project Number: 21-7253

Project Name: 17198-17000 Abbey Lane, Victorville



	Specimen Identification		Classification	γ_d	MC%
●	**B-8**	**5.0**	**Sand**	**112**	**1**

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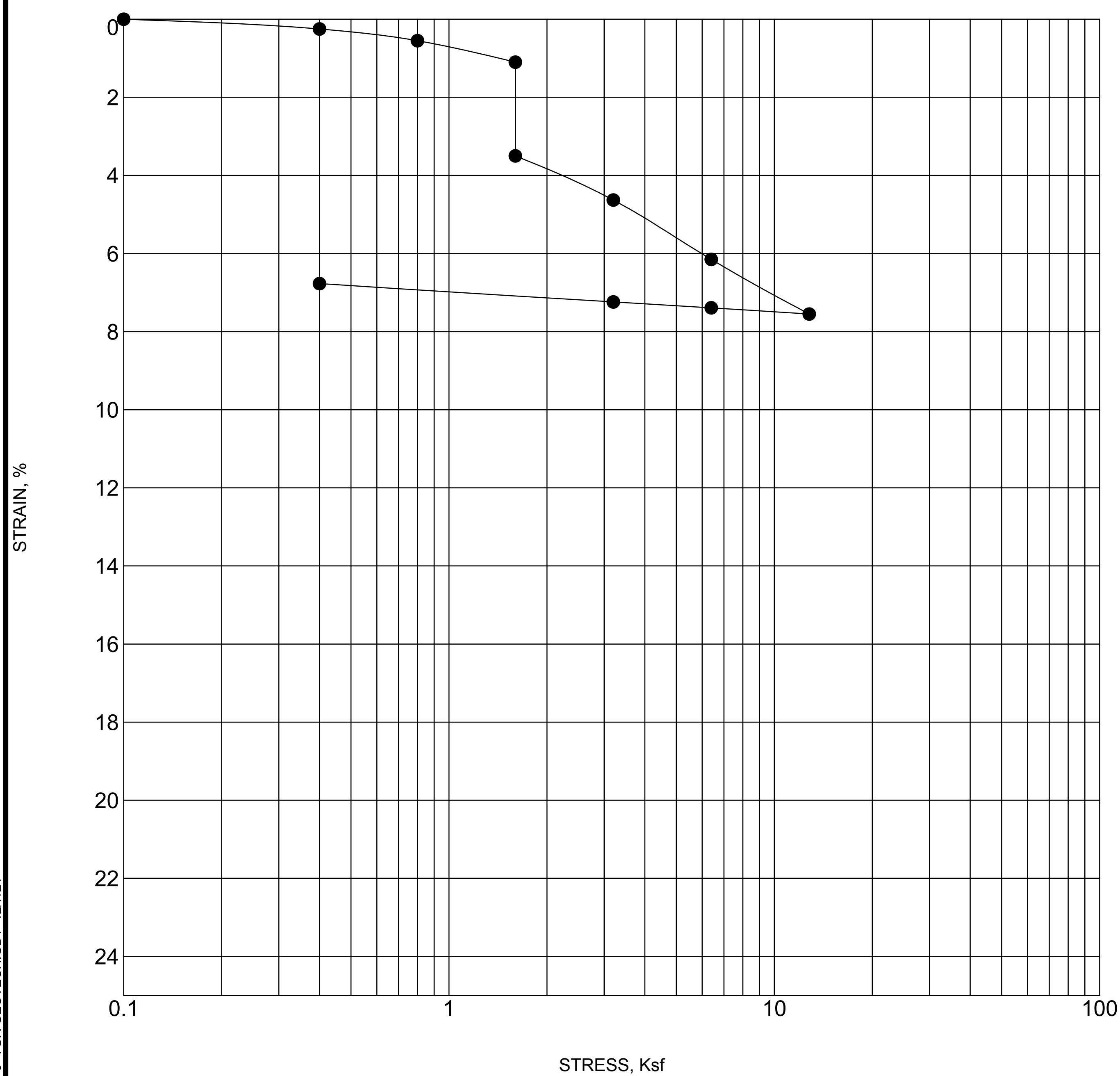
Telephone: 714-641-7189
Fax: 714-641-7190

CONSOLIDATION TEST

Project Number: 21-7253

Project Name: 17198-17000 Abbey Lane, Victorville



Specimen Identification		Classification	γ_d	MC%
● **B-8**	**10.0**	**Sand**	**121**	**2**

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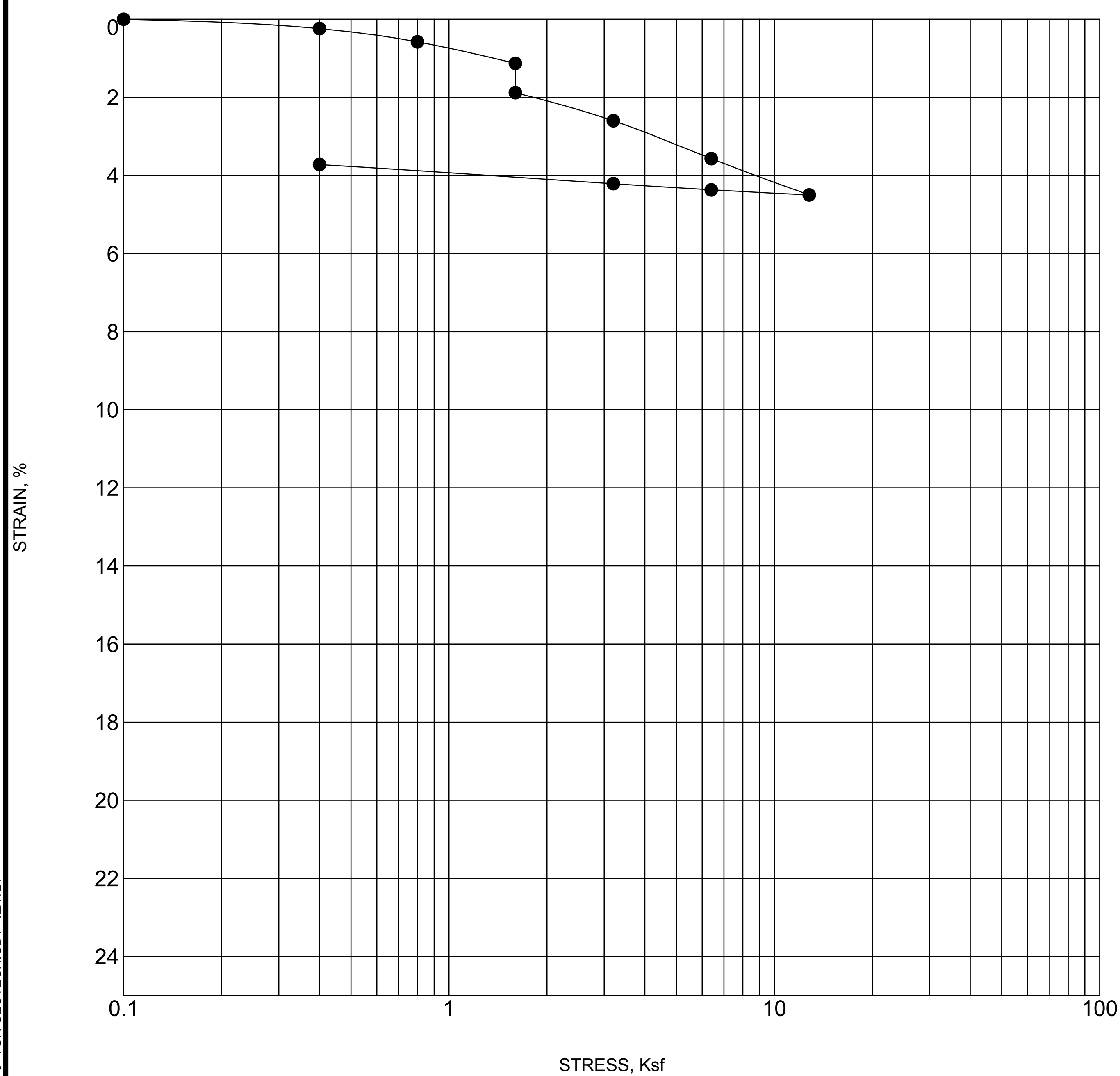
CONSOLIDATION TEST

Project Number: 21-7253

Project Name: 17198-17000 Abbey Lane, Victorville



	Specimen Identification		Classification	γ_d	MC%
●	**B-10**	**10.0**	**Silty Sand**	**128**	**2**

TGR GEOTECHNICAL, INC.
3037 S. Harbor Blvd
Santa Ana, CA 92704
Telephone: 714-641-7189
Fax: 714-641-7190

CONSOLIDATION TEST

Project Number: 21-7253

Project Name: 17198-17000 Abbey Lane, Victorville

ANAHEIM TEST LAB, INC

196 Technology Dr., Unit D
Irvine, CA 92618
Phone (949)336-6544

TO:

TGR GEOTECHNICAL
3037 S. HARBOR BLVD.
SANTA ANA, CA 92704

DATE: 11/23/2021

P.O. NO: VERBAL

LAB NO: C-5437, 1-2

SPECIFICATION: CTM-643/417/422

MATERIAL: Soil

Project No.: 21-7253
Project: Abbey Lane

ANALYTICAL REPORT

CORROSION SERIES

SUMMARY OF DATA

	pH	MIN. RESISTIVITY per CT. 643 ohm-cm	SOLUBLE SULFATES per CT. 417 ppm	SOLUBLE CHLORIDES per CT. 422 ppm
1) B1 @ 0-5’	7.8	8,900	144	59
2) B8 @ 0-5’	7.6	7,000	123	76

RESPECTFULLY SUBMITTED

WES BRIDGER LAB MANAGER

ANAHEIM TEST LAB, INC

196 Technology Drive, Unit D
Irvine, CA 92618
Phone (949) 336-6544

TO:

TGR GEOTECHNICAL
3037 S. HARBOR BLVD.
SANTA ANA, CA. 92704

DATE: 11/24/2021

P.O. NO.: VERBAL

LAB NO.: C-5438

SPECIFICATION: CTM- 301

MATERIAL: Brown, Silty Sand

Project No.: 21-7253
Project: Abbey Lane
Sample ID: B1 @ 0-5'

ANALYTICAL REPORT

"R" VALUE

BY EXUDATION	BY EXPANSION
78	N/A

RESPECTFULLY SUBMITTED

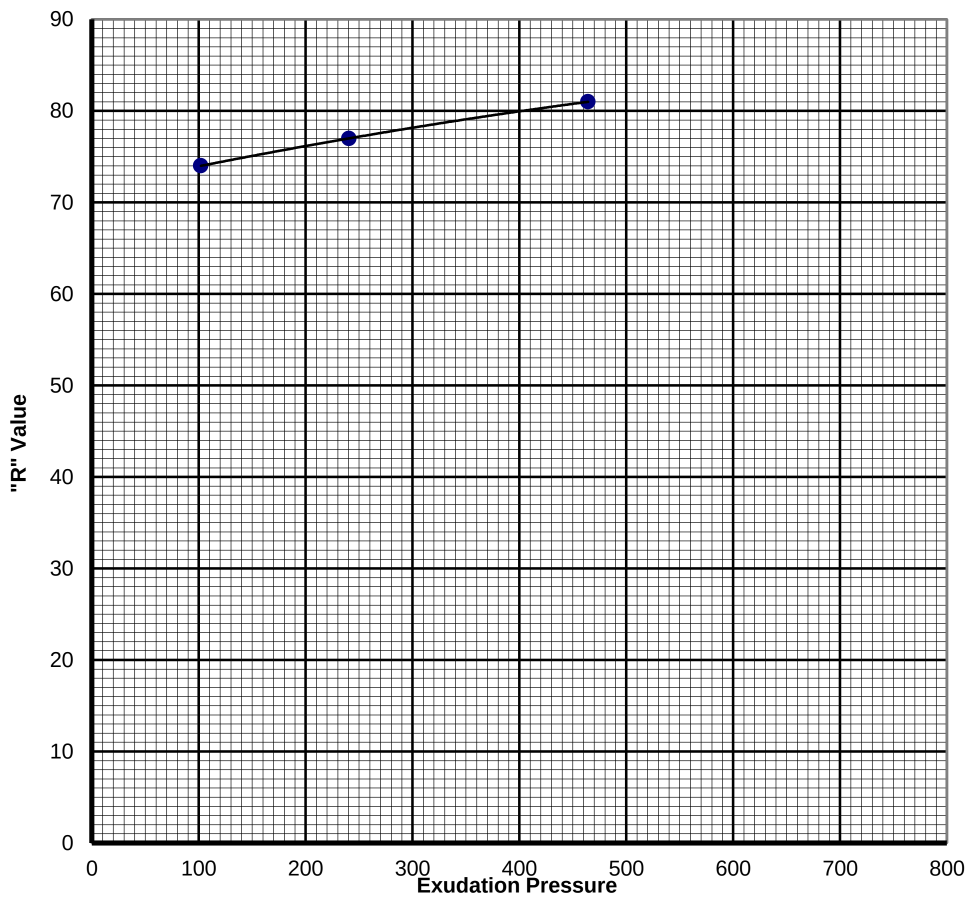
WES BRIDGER LAB MANAGER

"R" VALUE CA 301

Client: TGR Geotechnical **ATL No.:** C 5438 **Date:** 11/24/2021
Client Reference No.: 21-7253
Sample: B1 @ 0-5' **Soil Type:** Brown, Silty Sand
.

TEST SPECIMEN		A	B	C	D
Compactor Air Pressure	psi	350	300	350	
Initial Moisture Content	%	1.6	1.6	1.6	
Moisture at Compaction	%	9.6	9.2	8.9	
Briquette Height	in.	2.46	2.50	2.51	
Dry Density	pcf	123.3	124.1	124.8	
EXUDATION PRESSURE	psi	102	240	464	
EXPANSION PRESSURE	psf	0	0	0	
Ph at 1000 pounds	psi	16	14	12	
Ph at 2000 pounds	psi	27	22	19	
Displacement	turns	4.41	4.6	4.22	
"R" Value		74	77	81	
CORRECTED "R" VALUE		74	77	81	

Final "R" Value	
BY EXUDATION: @ 300 psi	**78**
BY EXPANSION: TI = 5.0	**N/A**



APPENDIX D
SITE SEISMICITY AND DE-AGGREGATED PARAMETERS

TGR GEOTECHNICAL
DBE & 8(a) firm
3037 S. HARBOR BLVD
SANTA ANA, CA 92704
P 714.641.7189 F 714.641.7190
www.tgrgeotech.com

TABLE 1
SITE SPECIFIC GROUND MOTION ANALYSIS
21-7253 - Abbey Lane, Victorville

SA Period (sec)	Probabilistic Spectral Acceleration MCER (g)	Deterministic Spectral Acceleration (g)	Is Largest Deterministic Spectral Acceleration <1.5*Fa	Deterministic MCER	Site Specific MCER	2/3 of Site Specific MCER	80% Code Design	Site Specific Design Response Spectrum
	Rotated Maximum	Rotated Maximum 84th Percentile						
0	0.6127	0.3828	Yes	0.6316	0.6127	0.4085	0.2442	0.4085
0.1	1.0879	0.6028		0.9946	0.9946	0.6630	0.4479	0.6630
0.2	1.4685	0.8250		1.3612	1.3612	0.9074	0.6106	0.9074
0.3	1.6234	0.9619		1.5870	1.5870	1.0580	0.6106	1.0580
0.5	1.5557	0.9764		1.6110	1.5557	1.0371	0.6106	1.0371
0.75	1.2957	0.8415		1.3884	1.2957	0.8638	0.6106	0.8638
1	1.0985	0.7319		1.2076	1.0985	0.7323	0.5493	0.7323
2	0.6143	0.4482		0.7395	0.6143	0.4095	0.2747	0.4095
3	0.4270	0.3262		0.5382	0.4270	0.2847	0.1831	0.2847
4	0.3263	0.2509		0.4139	0.3263	0.2175	0.1373	0.2175
5	0.2610	0.1980		0.3267	0.2610	0.1740	0.1099	0.1740

Code Sds	0.763	Crs = 0.934	Code Ss = 1.066	**Site Specific SDS = 0.952**
Code Sd1	0.687	Cr1 = 0.92	Code S1 = 0.412	**Site Specific SD1 = 0.870**
To	0.18	Code Fa = 1.074	Sms = 1.144884	
Ts	0.90	Code Fv = 2.5	Sm1 = 1.03	
TL	12			
Input				

FIGURE 1
Site Specific Design Response Spectra
21-7253 - Abbey Lane, Victorville

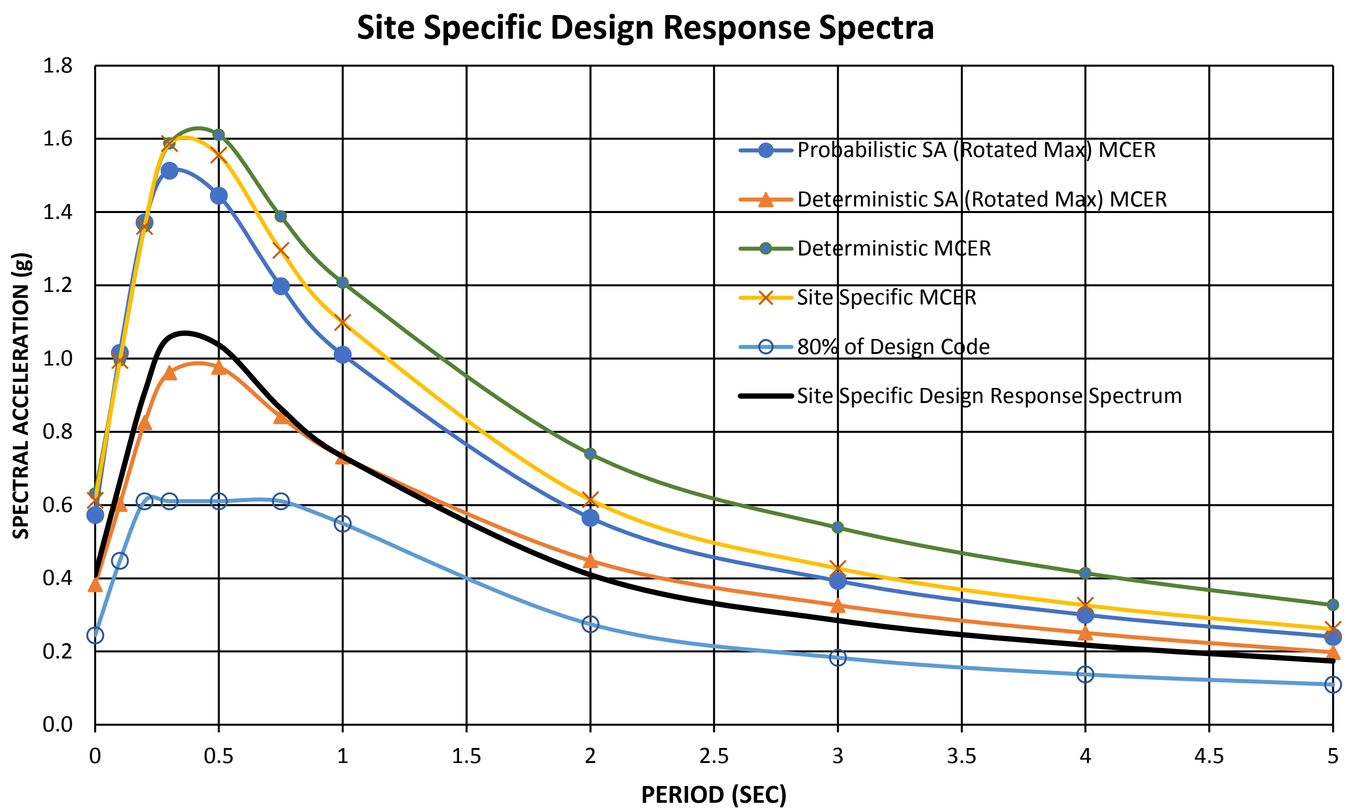


TABLE 2

Probabilistic Response Spectrum ASCE 7-16 Method 2

21-7253 - Abbey Lane, Victorville

Period (g)	UHGM (g)	RTGM (g)	Max Dir Scale factor	Max Dir RTGM (g)
0	0.571	0.557	1.1	0.613
0.1	1.003	0.989	1.1	1.088
0.2	1.349	1.335	1.1	1.469
0.3	1.492	1.443	1.125	1.623
0.5	1.397	1.324	1.175	1.556
0.75	1.113	1.047	1.2375	1.296
1	0.910	0.845	1.3	1.099
2	0.499	0.455	1.35	0.614
3	0.337	0.305	1.4	0.427
4	0.251	0.225	1.45	0.326
5	0.197	0.174	1.5	0.261

Probabilistic Response Spectra per ASCE 7-16

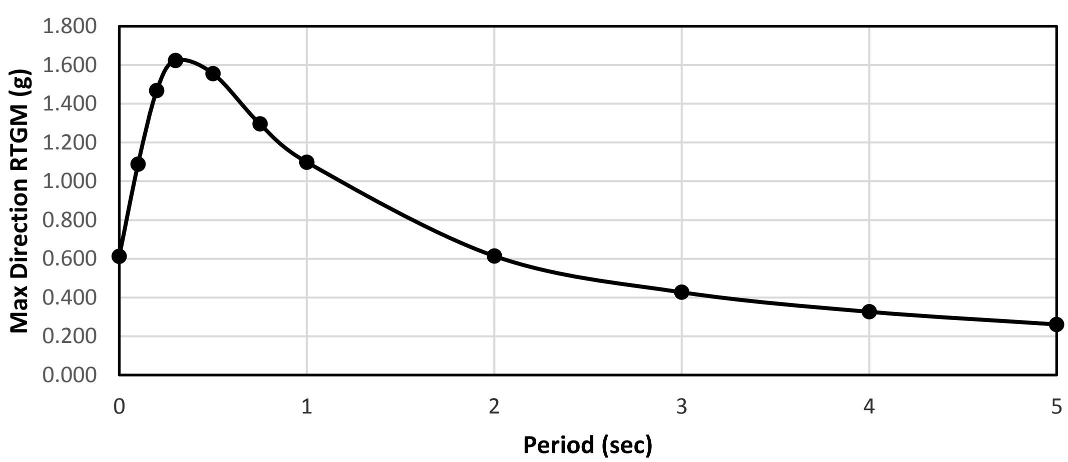
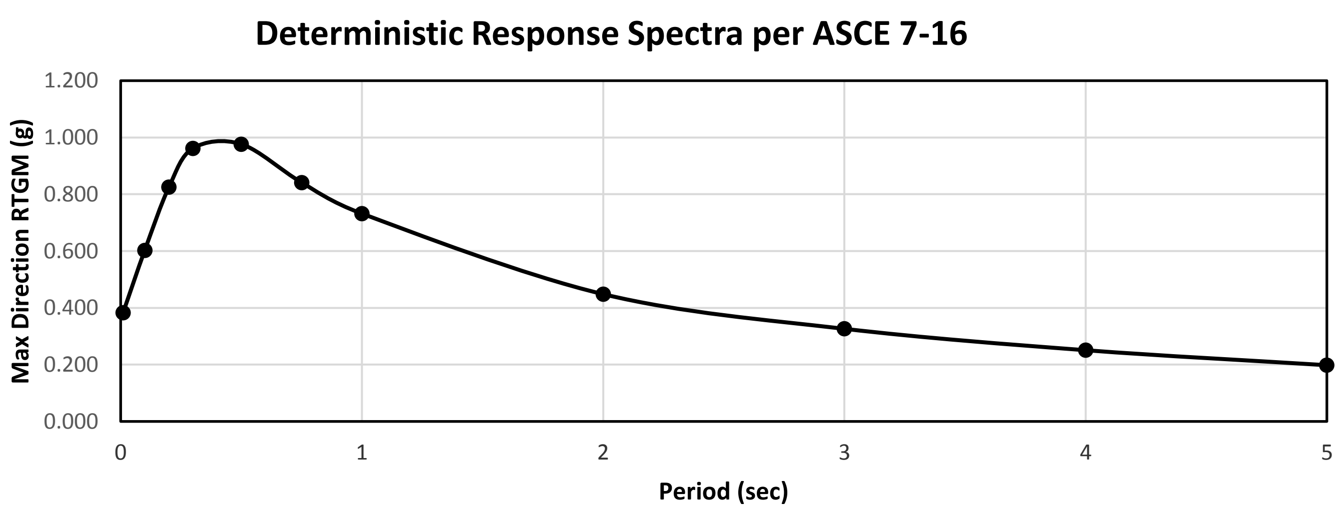


TABLE 3

Deterministic Response Spectrum ASCE 7-16

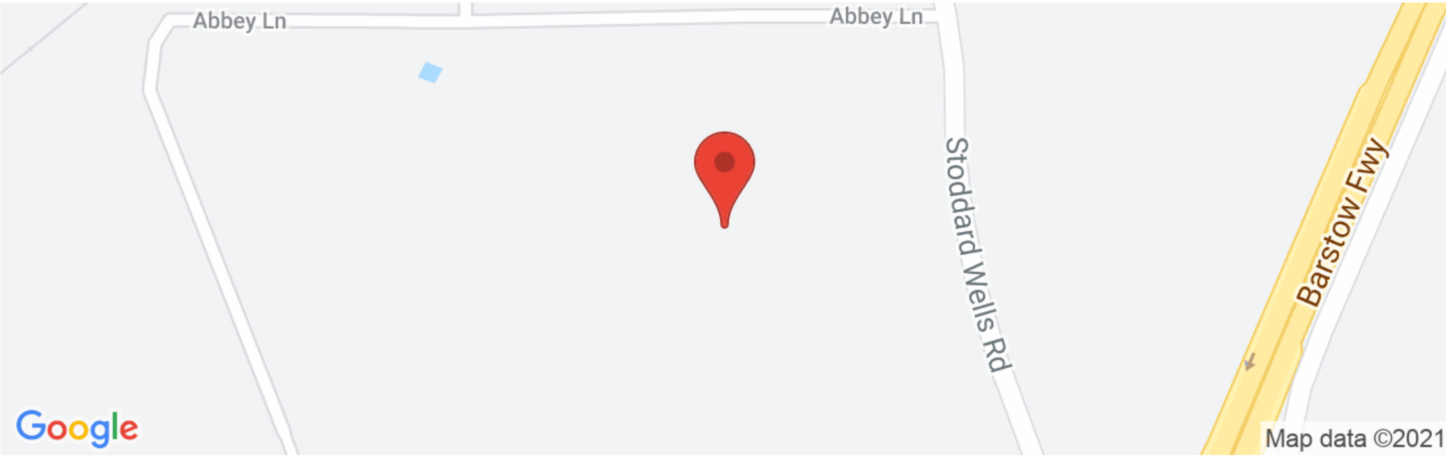
21-7253 - Abbey Lane, Victorville

Period (g)	84th-Percentile Spectral Acceleration (g)	Max Dir Scale factor	Max Dir Deterministic SA (g)
0.01	0.348	1.1	0.383
0.1	0.548	1.1	0.603
0.2	0.750	1.1	0.825
0.3	0.855	1.125	0.962
0.5	0.831	1.175	0.976
0.75	0.680	1.2375	0.842
1	0.563	1.3	0.732
2	0.332	1.35	0.448
3	0.233	1.4	0.326
4	0.173	1.45	0.251
5	0.132	1.5	0.198



Abbey Lane, Victorville

Latitude, Longitude: 34.5592, -117.2926



Date	11/29/2021, 9:28:55 AM
Design Code Reference Document	ASCE7-16
Risk Category	III
Site Class	D - Stiff Soil

Type	Value	Description
S_S	1.066	MCE_R ground motion. (for 0.2 second period)
S_1	0.412	MCE_R ground motion. (for 1.0s period)
S_{MS}	1.145	Site-modified spectral acceleration value
S_{M1}	null -See Section 11.4.8	Site-modified spectral acceleration value
S_{DS}	0.763	Numeric seismic design value at 0.2 second SA
S_{D1}	null -See Section 11.4.8	Numeric seismic design value at 1.0 second SA

Type	Value	Description
SDC	null -See Section 11.4.8	Seismic design category
F_a	1.074	Site amplification factor at 0.2 second
F_v	null -See Section 11.4.8	Site amplification factor at 1.0 second
PGA	0.458	MCE_G peak ground acceleration
F_{PGA}	1.142	Site amplification factor at PGA
PGA_M	0.523	Site modified peak ground acceleration
T_L	12	Long-period transition period in seconds
SsRT	1.066	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	1.141	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	1.5	Factored deterministic acceleration value. (0.2 second)
S1RT	0.412	Probabilistic risk-targeted ground motion. (1.0 second)
S1UH	0.448	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
S1D	0.6	Factored deterministic acceleration value. (1.0 second)
PGAd	0.5	Factored deterministic acceleration value. (Peak Ground Acceleration)
C_{RS}	0.934	Mapped value of the risk coefficient at short periods
C_{R1}	0.92	Mapped value of the risk coefficient at a period of 1 s

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U.S. Geological Survey - Earthquake Hazards Program

Unified Hazard Tool

Please do not use this tool to obtain ground motion parameter values for the design code reference documents covered by the U.S. Seismic Design Maps web tools (e.g., the International Building Code and the ASCE 7 or 41 Standard). The values returned by the two applications are not identical.

Input

Edition

Dynamic: Conterminous U.S. 2014 (upd…

Spectral Period

Peak Ground Acceleration

Latitude

Decimal degrees

34.5592

Time Horizon

Return period in years

2475

Longitude

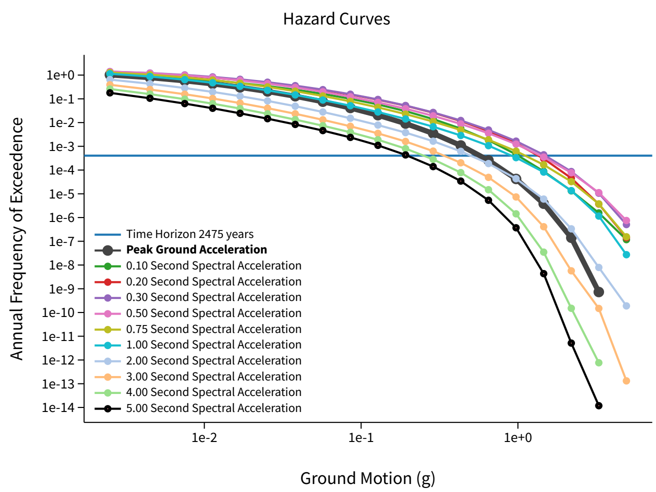
Decimal degrees, negative values for western longitudes

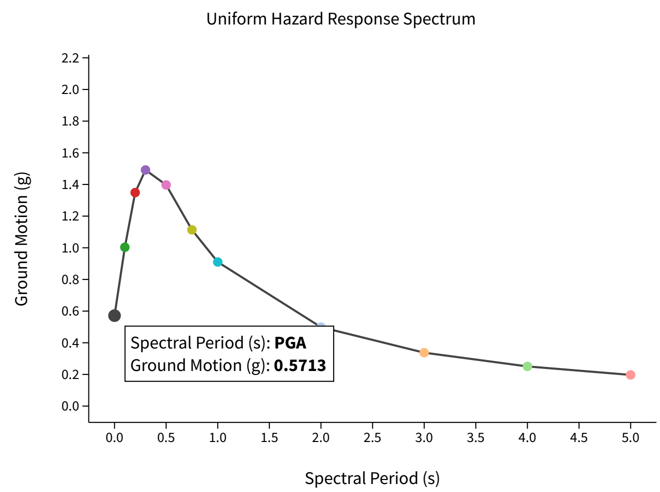
-117.2926

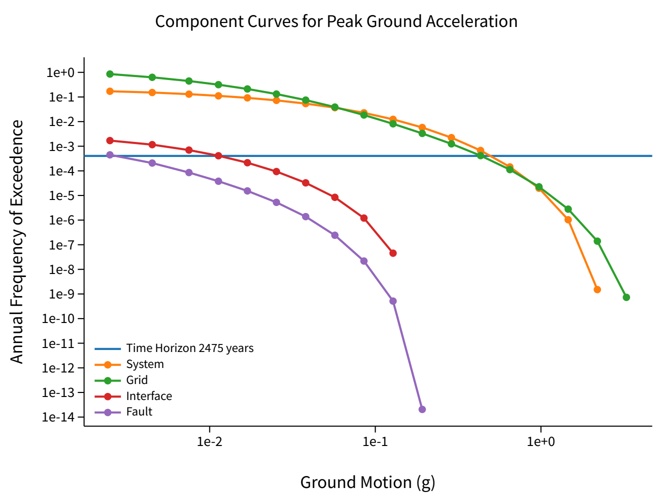
Site Class

259 m/s (Site class D)

Hazard Curve





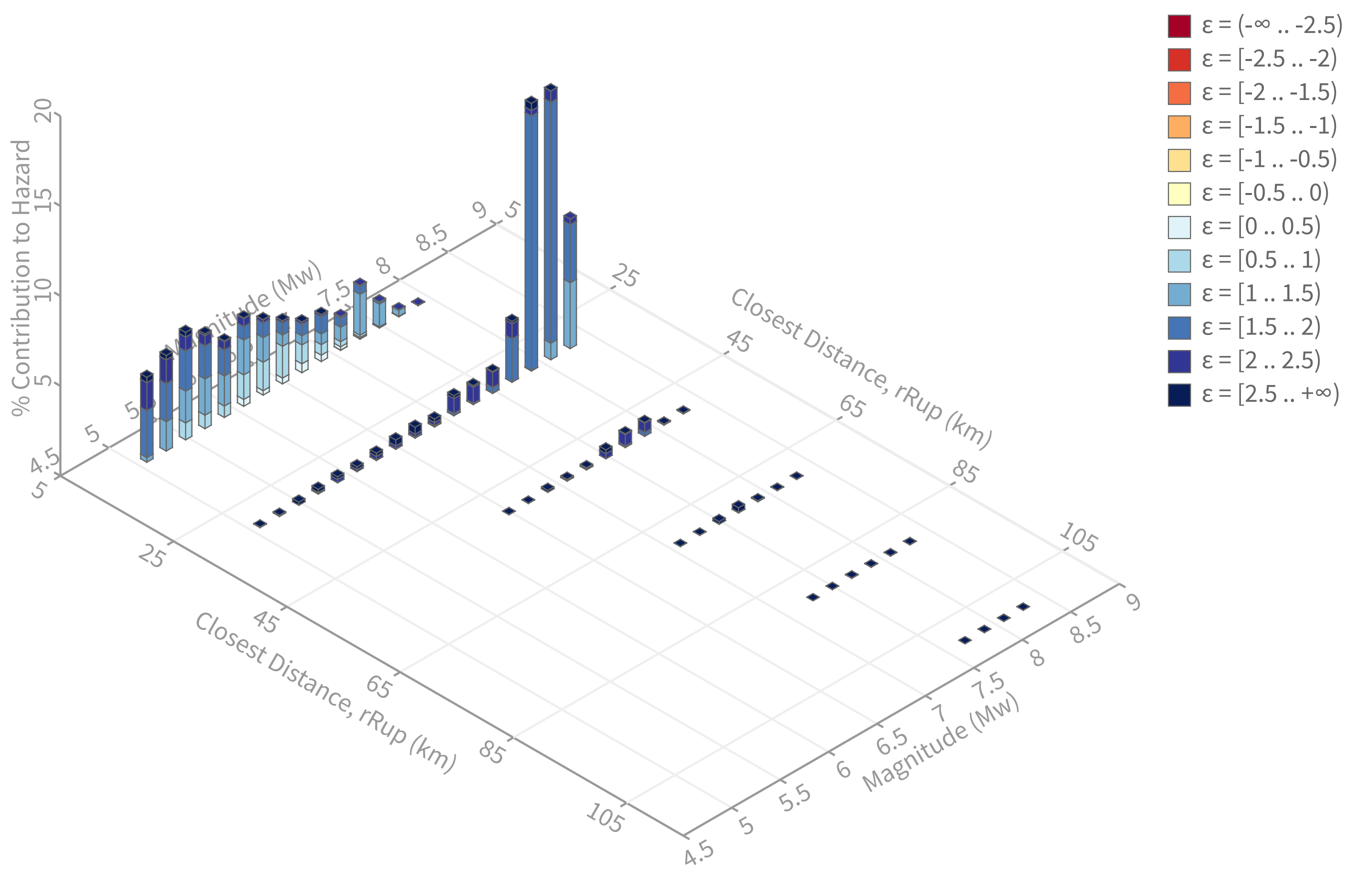


View Raw Data

Deaggregation

Component

Total



Summary statistics for, Deaggregation: Total

Deaggregation targets

Return period: 2475 yrs
Exceedance rate: 0.0004040404 yr^{-1}
PGA ground motion: 0.57132731 g

Recovered targets

Return period: 2970.5985 yrs
Exceedance rate: 0.0003366325 yr^{-1}

Totals

Binned: 100 %
Residual: 0 %
Trace: 0.11 %

Mean (over all sources)

m: 6.96
r: 23.07 km
ε_0: 1.62 σ

Mode (largest m-r bin)

m: 8.09
r: 35.06 km
ε_0: 1.66 σ
Contribution: 14.94 %

Mode (largest m-r-ε_0 bin)

m: 7.91
r: 35.14 km
ε_0: 1.77 σ
Contribution: 14.15 %

Discretization

r: min = 0.0, max = 1000.0, Δ = 20.0 km
m: min = 4.4, max = 9.4, Δ = 0.2
ε: min = -3.0, max = 3.0, Δ = 0.5 σ

Epsilon keys

ε0: [-∞ .. -2.5)
ε1: [-2.5 .. -2.0)
ε2: [-2.0 .. -1.5)
ε3: [-1.5 .. -1.0)
ε4: [-1.0 .. -0.5)
ε5: [-0.5 .. 0.0)
ε6: [0.0 .. 0.5)
ε7: [0.5 .. 1.0)
ε8: [1.0 .. 1.5)
ε9: [1.5 .. 2.0)
ε10: [2.0 .. 2.5)
ε11: [2.5 .. +∞]

Deaggregation Contributors

Source Set ↳ Source	Type	r	m	ε_0	lon	lat	az	%
UC33brAvg_FM32	System							27.68
San Andreas (San Bernardino N) [1]		35.07	8.00	1.73	117.484°W	34.286°N	210.05	19.04
Helendale-So Lockhart [7]		15.65	7.19	1.43	117.172°W	34.658°N	45.15	1.99
North Frontal (West) [1]		19.05	7.30	1.50	117.161°W	34.427°N	140.45	1.20
UC33brAvg_FM31	System							27.58
San Andreas (San Bernardino N) [1]		35.07	8.00	1.73	117.484°W	34.286°N	210.05	18.98
Helendale-So Lockhart [7]		15.65	7.19	1.43	117.172°W	34.658°N	45.15	2.01
North Frontal (West) [1]		19.05	7.31	1.49	117.161°W	34.427°N	140.45	1.18
UC33brAvg_FM31 (opt)	Grid							22.38
PointSourceFinite: -117.293, 34.600		6.68	5.70	1.12	117.293°W	34.600°N	0.00	2.76
PointSourceFinite: -117.293, 34.600		6.68	5.70	1.12	117.293°W	34.600°N	0.00	2.76
PointSourceFinite: -117.293, 34.618		7.73	5.85	1.21	117.293°W	34.618°N	0.00	2.75
PointSourceFinite: -117.293, 34.618		7.73	5.85	1.21	117.293°W	34.618°N	0.00	2.75
PointSourceFinite: -117.293, 34.654		10.43	5.96	1.50	117.293°W	34.654°N	0.00	2.09
PointSourceFinite: -117.293, 34.654		10.43	5.96	1.50	117.293°W	34.654°N	0.00	2.09
UC33brAvg_FM32 (opt)	Grid							22.36
PointSourceFinite: -117.293, 34.600		6.68	5.70	1.12	117.293°W	34.600°N	0.00	2.76
PointSourceFinite: -117.293, 34.600		6.68	5.70	1.12	117.293°W	34.600°N	0.00	2.76
PointSourceFinite: -117.293, 34.618		7.73	5.85	1.21	117.293°W	34.618°N	0.00	2.74
PointSourceFinite: -117.293, 34.618		7.73	5.85	1.21	117.293°W	34.618°N	0.00	2.74
PointSourceFinite: -117.293, 34.654		10.43	5.96	1.50	117.293°W	34.654°N	0.00	2.09
PointSourceFinite: -117.293, 34.654		10.43	5.96	1.50	117.293°W	34.654°N	0.00	2.09

APPENDIX E
LIQUEFACTION ANALYSIS

TGR Geotechnical
3037 S. Harbor Blvd
Santa Ana, CA 92704

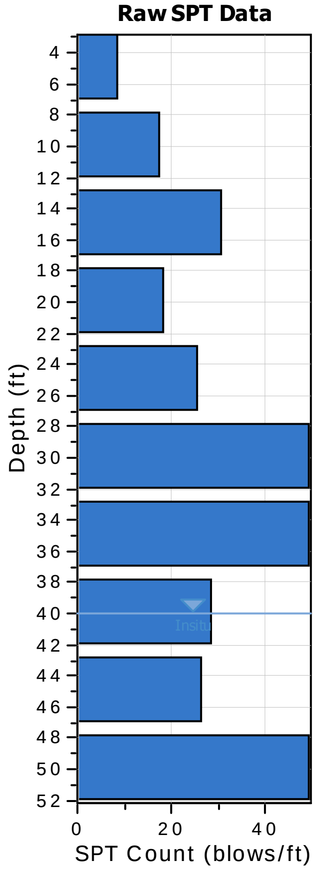
SPT BASED LIQUEFACTION ANALYSIS REPORT

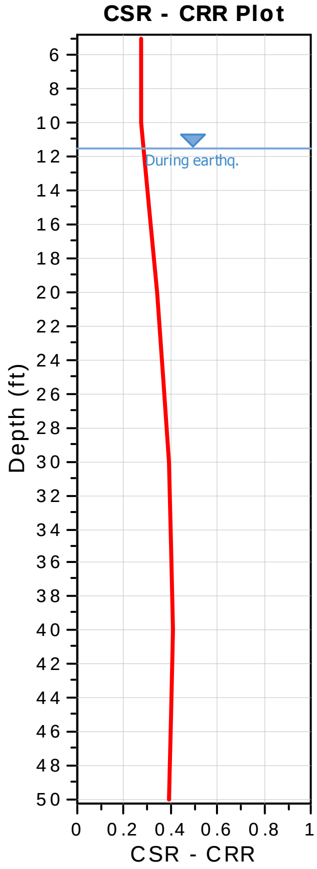
Project title : 21-7253 17198-17000 Abbey Lane **SPT Name: B-3**

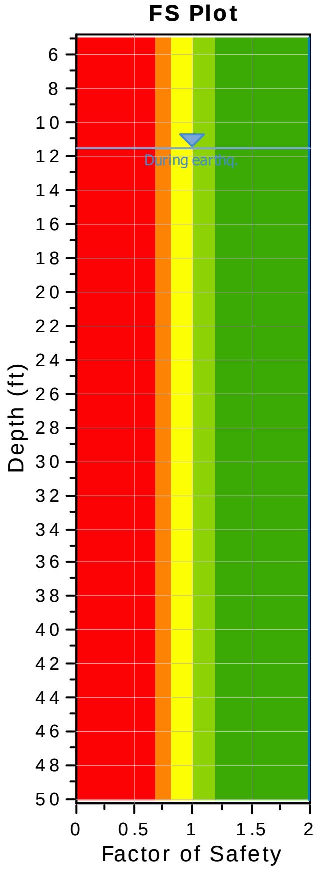
Location : Victorville, California

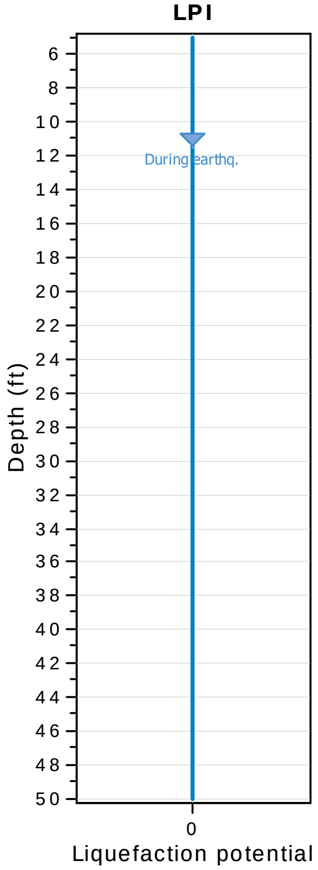
:: Input parameters and analysis properties ::

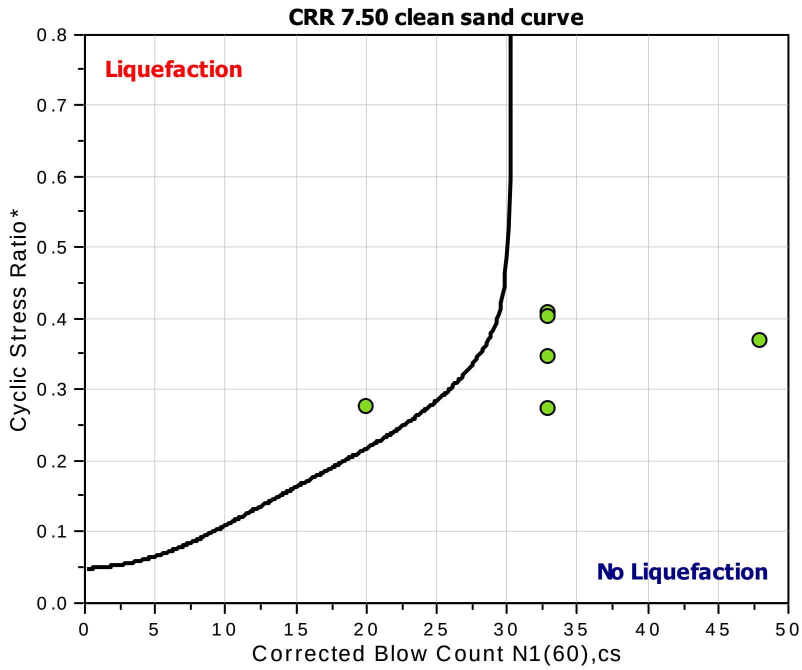
Analysis method:	NCEER 1998	G.W.T. (in-situ):	40.00 ft
Fines correction method:	NCEER 1998	G.W.T. (earthq.):	11.50 ft
Sampling method:	Sampler wo liners	Earthquake magnitude M_w:	6.96
Borehole diameter:	200mm	Peak ground acceleration:	0.52 g
Rod length:	3.28 ft	Eq. external load:	0.00 tsf
Hammer energy ratio:	1.25		











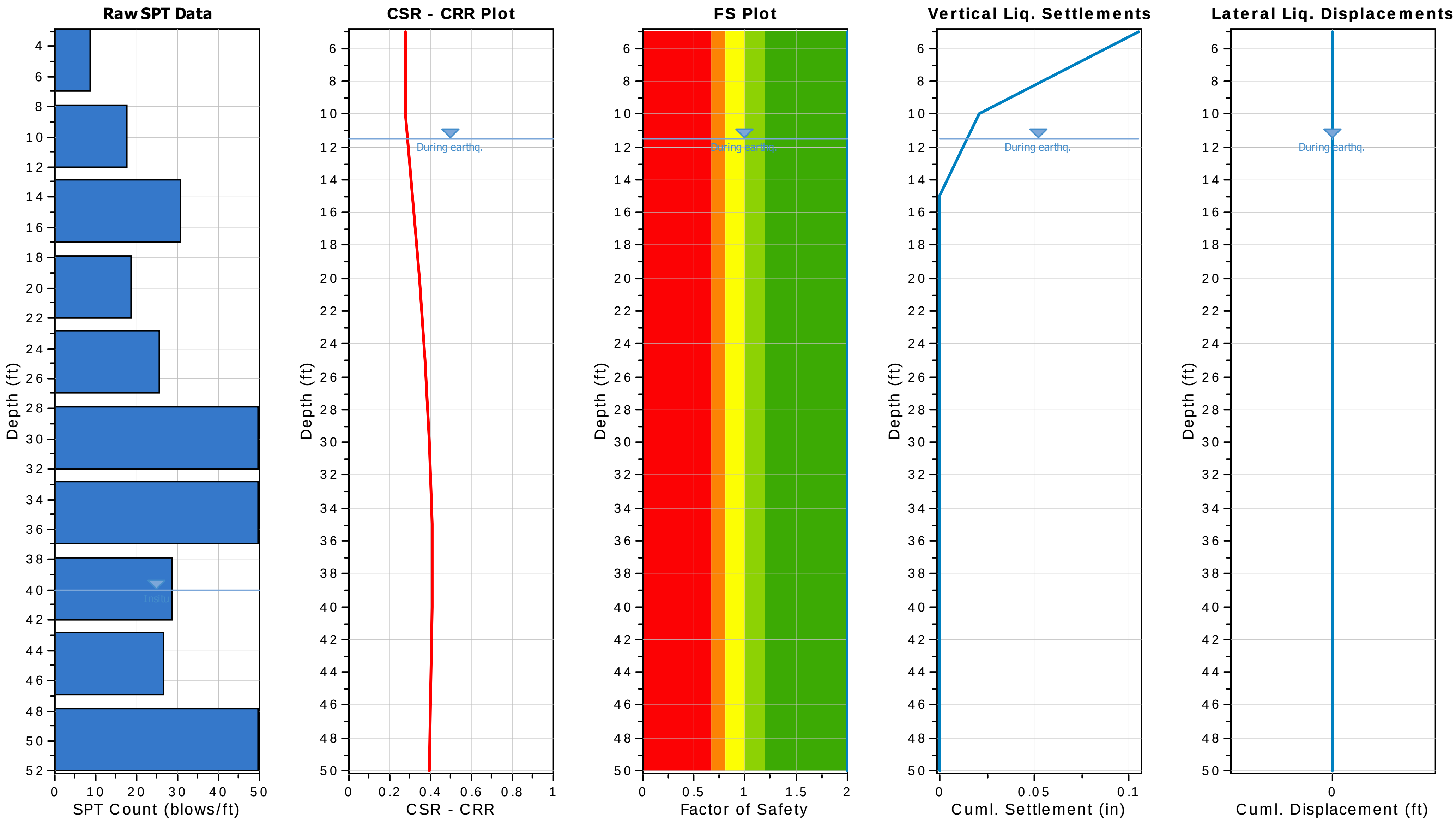
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

:: Overall Liquefaction Assessment Analysis Plots ::



:: Field input data ::

Test Depth (ft)	SPT Field Value (blows)	Fines Content (%)	Unit Weight (pcf)	Infl. Thickness (ft)	Can Liquefy
5.00	9	15.00	119.50	10.00	Yes
10.00	18	5.00	115.00	5.00	Yes
15.00	31	19.80	117.30	5.00	Yes
20.00	19	12.80	117.30	5.00	Yes
25.00	26	60.30	117.30	5.00	No
30.00	50	5.40	117.30	5.00	Yes
35.00	50	15.00	117.30	5.00	Yes
40.00	29	9.60	117.30	5.00	Yes
45.00	27	15.20	117.30	5.00	Yes
50.00	50	12.80	117.30	1.50	Yes

Abbreviations

Depth: Depth at which test was performed (ft)
SPT Field Value: Number of blows per foot
Fines Content: Fines content at test depth (%)
Unit Weight: Unit weight at test depth (pcf)
Infl. Thickness: Thickness of the soil layer to be considered in settlements analysis (ft)
Can Liquefy: User defined switch for excluding/including test depth from the analysis procedure

:: Cyclic Resistance Ratio (CRR) calculation data ::

Depth (ft)	SPT Field Value	Unit Weight (pcf)	σ_v (tsf)	u_o (tsf)	σ'_{vo} (tsf)	C_N	C_E	C_B	C_R	C_S	$(N_1)_{60}$	Fines Content (%)	α	β	$(N_1)_{60cs}$	$CRR_{7.5}$
5.00	9	119.50	0.30	0.00	0.30	1.48	1.25	1.15	0.75	1.20	17	15.00	2.50	1.05	20	4.000
10.00	18	115.00	0.59	0.00	0.59	1.25	1.25	1.15	0.85	1.20	33	5.00	0.00	1.00	33	4.000
15.00	31	117.30	0.88	0.00	0.88	1.08	1.25	1.15	0.85	1.20	49	19.80	3.58	1.08	56	4.000
20.00	19	117.30	1.17	0.00	1.17	0.95	1.25	1.15	0.95	1.20	30	12.80	1.82	1.04	33	4.000
25.00	26	117.30	1.47	0.00	1.47	0.85	1.25	1.15	0.95	1.20	36	60.30	5.00	1.20	48	4.000
30.00	50	117.30	1.76	0.00	1.76	0.77	1.25	1.15	1.00	1.20	66	5.40	0.01	1.00	66	4.000
35.00	50	117.30	2.05	0.00	2.05	0.70	1.25	1.15	1.00	1.20	60	15.00	2.50	1.05	65	4.000
40.00	29	117.30	2.35	0.00	2.35	0.64	1.25	1.15	1.00	1.20	32	9.60	0.74	1.02	33	4.000
45.00	27	117.30	2.64	0.16	2.48	0.62	1.25	1.15	1.00	1.20	29	15.20	2.55	1.05	33	4.000
50.00	50	117.30	2.93	0.31	2.62	0.60	1.25	1.15	1.00	1.20	52	12.80	1.82	1.04	56	4.000

Abbreviations

σ_v: Total stress during SPT test (tsf)
u_o: Water pore pressure during SPT test (tsf)
σ'_{vo}: Effective overburden pressure during SPT test (tsf)
C_N: Overburden corretion factor
C_E: Energy correction factor
C_B: Borehole diameter correction factor
C_R: Rod length correction factor
C_S: Liner correction factor
$N_{1(60)}$: Corrected N_{SPT} to a 60% energy ratio
α, β: Clean sand equivalent clean sand formula coefficients
$N_{1(60)cs}$: Corected $N_{1(60)}$ value for fines content
$CRR_{7.5}$: Cyclic resistance ratio for M=7.5

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS	
5.00	119.50	0.30	0.00	0.30	0.99	1.00	0.335	1.21	0.277	1.00	0.277	2.000	●
10.00	115.00	0.59	0.00	0.59	0.98	1.00	0.331	1.21	0.273	1.00	0.273	2.000	●

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS	
15.00	117.30	0.88	0.11	0.77	0.97	1.00	0.374	1.21	0.309	1.00	0.309	2.000	●
20.00	117.30	1.17	0.27	0.91	0.96	1.00	0.418	1.21	0.345	1.00	0.345	2.000	●
25.00	117.30	1.47	0.42	1.04	0.94	1.00	0.447	1.21	0.369	1.00	0.369	2.000	●
30.00	117.30	1.76	0.58	1.18	0.92	1.00	0.463	1.21	0.383	0.98	0.391	2.000	●
35.00	117.30	2.05	0.73	1.32	0.89	1.00	0.468	1.21	0.387	0.96	0.404	2.000	●
40.00	117.30	2.35	0.89	1.46	0.85	1.00	0.463	1.21	0.383	0.94	0.408	2.000	●
45.00	117.30	2.64	1.05	1.59	0.80	1.00	0.450	1.21	0.372	0.92	0.403	2.000	●
50.00	117.30	2.93	1.20	1.73	0.75	1.00	0.431	1.21	0.356	0.91	0.393	2.000	●

Abbreviations

$\sigma_{v,eq}$:	Total overburden pressure at test point, during earthquake (tsf)
$u_{o,eq}$:	Water pressure at test point, during earthquake (tsf)
$\sigma'_{vo,eq}$:	Effective overburden pressure, during earthquake (tsf)
r_d :	Nonlinear shear mass factor
α:	Improvement factor due to stone columns
CSR :	Cyclic Stress Ratio (adjusted for improvement)
MSF :	Magnitude Scaling Factor
$CSR_{eq,M=7.5}$:	CSR adjusted for M=7.5
K_{sigma}:	Effective overburden stress factor
CSR^*:	CSR fully adjusted
FS:	Calculated factor of safety against soil liquefaction

:: Liquefaction potential according to Iwasaki ::

Depth (ft)	FS	F	wz	Thickness (ft)	I_L
5.00	2.000	0.00	9.24	5.00	0.00
10.00	2.000	0.00	8.48	5.00	0.00
15.00	2.000	0.00	7.71	5.00	0.00
20.00	2.000	0.00	6.95	5.00	0.00
25.00	2.000	0.00	6.19	5.00	0.00
30.00	2.000	0.00	5.43	5.00	0.00
35.00	2.000	0.00	4.67	5.00	0.00
40.00	2.000	0.00	3.90	5.00	0.00
45.00	2.000	0.00	3.14	5.00	0.00
50.00	2.000	0.00	2.38	5.00	0.00

Overall potential I_L : 0.00

I_L = 0.00 - No liquefaction
I_L between 0.00 and 5 - Liquefaction not probable
I_L between 5 and 15 - Liquefaction probable
I_L > 15 - Liquefaction certain

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)
5.00	17	0.10	0.20	542.84	0.14	13212.81	0.00	0.00	10.54	0.04	10.00	0.085
10.00	33	0.19	0.39	898.58	0.15	8817.19	0.00	0.00	10.54	0.02	5.00	0.021

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)

Cumulative settlemetns: 0.106

Abbreviations

τ_{av}: Average cyclic shear stress
p: Average stress
G_{max}: Maximum shear modulus (tsf)
α, b: Shear strain formula variables
γ: Average shear strain
ε_{15}: Volumetric strain after 15 cycles
N_c: Number of cycles
ε_{Nc}: Volumetric strain for number of cycles N_c (%)
Δh: Thickness of soil layer (in)
ΔS: Settlement of soil layer (in)

:: Vertical settlements estimation for saturated sands ::

Depth (ft)	D_{50} (in)	q_c/N	e_v (%)	Δh (ft)	s (in)
15.00	0.30	5.58	0.00	5.00	0.000
20.00	0.30	5.58	0.00	5.00	0.000
25.00	0.07	3.64	0.00	5.00	0.000
30.00	0.30	5.58	0.00	5.00	0.000
35.00	0.30	5.58	0.00	5.00	0.000
40.00	0.30	5.58	0.00	5.00	0.000
45.00	0.30	5.58	0.00	5.00	0.000
50.00	0.30	5.58	0.00	1.50	0.000

Cumulative settlements: 0.000

Abbreviations

D_{50}: Median grain size (in)
q_c/N: Ratio of cone resistance to SPT
e_v: Post liquefaction volumetric strain (%)
Δh: Thickness of soil layer to be considered (ft)
s: Estimated settlement (in)

:: Lateral displacements estimation for saturated sands ::

Depth (ft)	$(N_1)_{60}$	D_r (%)	γ_{max} (%)	d_z (ft)	LDI	LD (ft)
5.00	17	57.72	0.00	10.00	0.000	0.00
10.00	33	80.42	0.00	5.00	0.000	0.00
15.00	49	100.00	0.00	5.00	0.000	0.00
20.00	30	76.68	0.00	5.00	0.000	0.00
25.00	36	84.00	0.00	5.00	0.000	0.00
30.00	66	100.00	0.00	5.00	0.000	0.00
35.00	60	100.00	0.00	5.00	0.000	0.00
40.00	32	79.20	0.00	5.00	0.000	0.00
45.00	29	75.39	0.00	5.00	0.000	0.00
50.00	52	100.00	0.00	1.50	0.000	0.00

:: Lateral displacements estimation for saturated sands ::

Depth (ft)	$(N_1)_{60}$	D_r (%)	γ_{max} (%)	d_z (ft)	LDI	LD (ft)

Cumulative lateral displacements: 0.00

Abbreviations

D_r: Relative density (%)
γ_{max}: Maximum amplitude of cyclic shear strain (%)
d_z: Soil layer thickness (ft)
LDI: Lateral displacement index (ft)
LD: Actual estimated displacement (ft)

TGR Geotechnical
3037 S. Harbor Blvd
Santa Ana, CA 92704

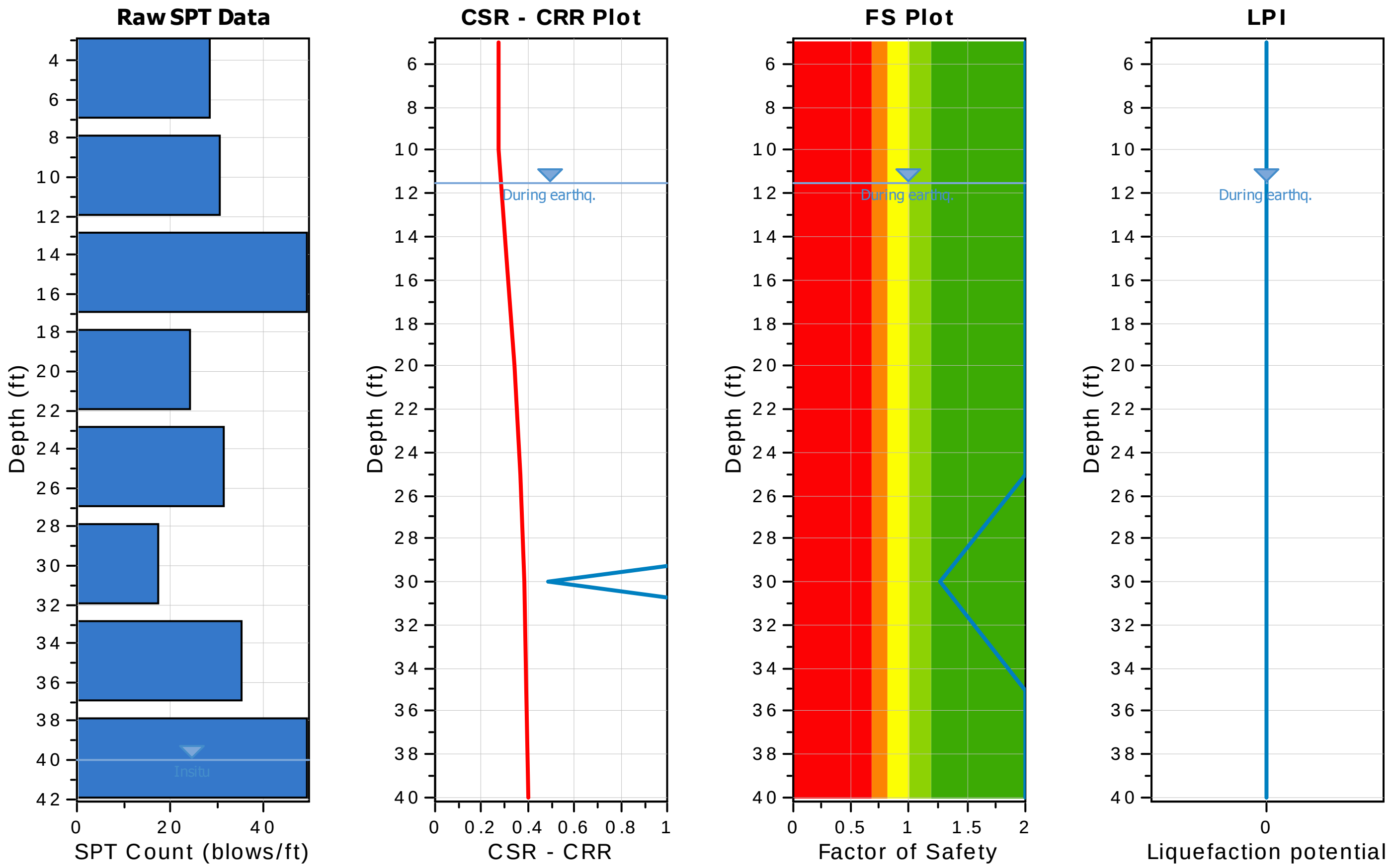
SPT BASED LIQUEFACTION ANALYSIS REPORT

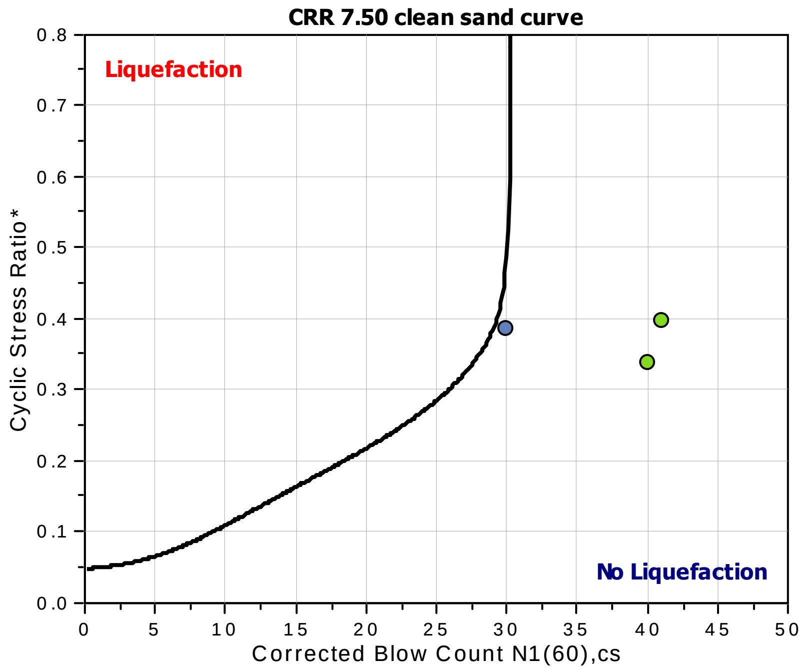
Project title : 21-7253 17198-17000 Abbey Lane **SPT Name: B-8**

Location : Victorville, California

:: Input parameters and analysis properties ::

Analysis method:	NCEER 1998	G.W.T. (in-situ):	40.00 ft
Fines correction method:	NCEER 1998	G.W.T. (earthq.):	11.50 ft
Sampling method:	Sampler wo liners	Earthquake magnitude M_w:	6.96
Borehole diameter:	200mm	Peak ground acceleration:	0.52 g
Rod length:	3.28 ft	Eq. external load:	0.00 tsf
Hammer energy ratio:	1.25		

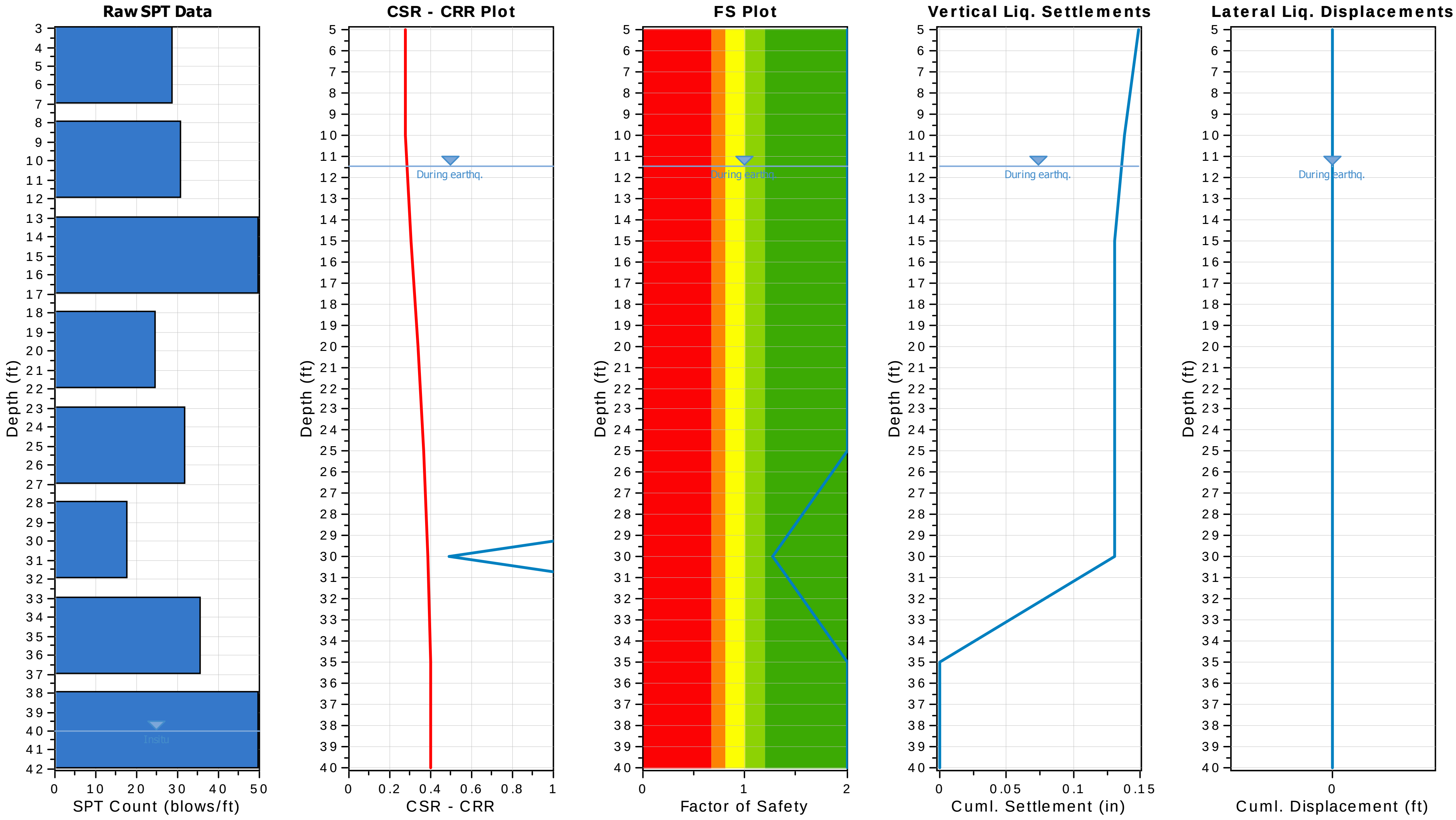




F.S. color scheme
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme
- Very high risk
- High risk
- Low risk

:: Overall Liquefaction Assessment Analysis Plots ::



:: Field input data ::

Test Depth (ft)	SPT Field Value (blows)	Fines Content (%)	Unit Weight (pcf)	Infl. Thickness (ft)	Can Liquefy
5.00	29	12.80	113.10	10.00	Yes
10.00	31	12.80	124.60	5.00	Yes
15.00	50	12.80	130.60	5.00	Yes
20.00	25	11.40	130.60	5.00	Yes
25.00	32	26.60	130.60	5.00	Yes
30.00	18	26.60	130.60	5.00	Yes
35.00	36	4.40	130.60	5.00	Yes
40.00	50	4.40	130.60	1.50	Yes

Abbreviations

Depth:	Depth at which test was performed (ft)
SPT Field Value:	Number of blows per foot
Fines Content:	Fines content at test depth (%)
Unit Weight:	Unit weight at test depth (pcf)
Infl. Thickness:	Thickness of the soil layer to be considered in settlements analysis (ft)
Can Liquefy:	User defined switch for excluding/including test depth from the analysis procedure

:: Cyclic Resistance Ratio (CRR) calculation data ::

Depth (ft)	SPT Field Value	Unit Weight (pcf)	σ_v (tsf)	u_o (tsf)	σ'_{vo} (tsf)	C_N	C_E	C_B	C_R	C_S	$(N_1)_{60}$	Fines Content (%)	α	β	$(N_1)_{60cs}$	$CRR_{7.5}$
5.00	29	113.10	0.28	0.00	0.28	1.50	1.25	1.15	0.75	1.20	56	12.80	1.82	1.04	60	4.000
10.00	31	124.60	0.59	0.00	0.59	1.25	1.25	1.15	0.85	1.20	57	12.80	1.82	1.04	61	4.000
15.00	50	130.60	0.92	0.00	0.92	1.06	1.25	1.15	0.85	1.20	78	12.80	1.82	1.04	83	4.000
20.00	25	130.60	1.25	0.00	1.25	0.92	1.25	1.15	0.95	1.20	38	11.40	1.35	1.03	40	4.000
25.00	32	130.60	1.57	0.00	1.57	0.82	1.25	1.15	0.95	1.20	43	26.60	4.44	1.13	53	4.000
30.00	18	130.60	1.90	0.00	1.90	0.73	1.25	1.15	1.00	1.20	23	26.60	4.44	1.13	30	0.488
35.00	36	130.60	2.23	0.00	2.23	0.67	1.25	1.15	1.00	1.20	41	4.40	0.00	1.00	41	4.000
40.00	50	130.60	2.55	0.00	2.55	0.61	1.25	1.15	1.00	1.20	53	4.40	0.00	1.00	53	4.000

Abbreviations

σ_v:	Total stress during SPT test (tsf)
u_o:	Water pore pressure during SPT test (tsf)
σ'_{vo}:	Effective overburden pressure during SPT test (tsf)
C_N:	Overburden corretion factor
C_E:	Energy correction factor
C_B:	Borehole diameter correction factor
C_R:	Rod length correction factor
C_S:	Liner correction factor
$N_{1(60)}$:	Corrected N_{SPT} to a 60% energy ratio
α, β:	Clean sand equivalent clean sand formula coefficients
$N_{1(60)cs}$:	Corected $N_{1(60)}$ value for fines content
$CRR_{7.5}$:	Cyclic resistance ratio for M=7.5

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS
5.00	113.10	0.28	0.00	0.28	0.99	1.00	0.335	1.21	0.277	1.00	0.277	2.000
10.00	124.60	0.59	0.00	0.59	0.98	1.00	0.331	1.21	0.273	1.00	0.273	2.000
15.00	130.60	0.92	0.11	0.81	0.97	1.00	0.371	1.21	0.307	1.00	0.307	2.000
20.00	130.60	1.25	0.27	0.98	0.96	1.00	0.411	1.21	0.339	1.00	0.339	2.000
25.00	130.60	1.57	0.42	1.15	0.94	1.00	0.435	1.21	0.359	0.98	0.365	2.000
30.00	130.60	1.90	0.58	1.32	0.92	1.00	0.447	1.21	0.369	0.96	0.386	1.264

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS	
35.00	130.60	2.23	0.73	1.49	0.89	1.00	0.449	1.21	0.371	0.93	0.397	2.000	●
40.00	130.60	2.55	0.89	1.66	0.85	1.00	0.442	1.21	0.365	0.91	0.399	2.000	●

Abbreviations

$\sigma_{v,eq}$: Total overburden pressure at test point, during earthquake (tsf)
$u_{o,eq}$: Water pressure at test point, during earthquake (tsf)
$\sigma'_{vo,eq}$: Effective overburden pressure, during earthquake (tsf)
r_d : Nonlinear shear mass factor
α: Improvement factor due to stone columns
CSR : Cyclic Stress Ratio (adjusted for improvement)
MSF : Magnitude Scaling Factor
$CSR_{eq,M=7.5}$: CSR adjusted for M=7.5
K_{sigma}: Effective overburden stress factor
CSR^*: CSR fully adjusted
FS: Calculated factor of safety against soil liquefaction

:: Liquefaction potential according to Iwasaki ::

Depth (ft)	FS	F	wz	Thickness (ft)	I_L
5.00	2.000	0.00	9.24	5.00	0.00
10.00	2.000	0.00	8.48	5.00	0.00
15.00	2.000	0.00	7.71	5.00	0.00
20.00	2.000	0.00	6.95	5.00	0.00
25.00	2.000	0.00	6.19	5.00	0.00
30.00	1.264	0.00	5.43	5.00	0.00
35.00	2.000	0.00	4.67	5.00	0.00
40.00	2.000	0.00	3.90	5.00	0.00

Overall potential I_L : 0.00

I_L = 0.00 - No liquefaction
I_L between 0.00 and 5 - Liquefaction not probable
I_L between 5 and 15 - Liquefaction probable
I_L > 15 - Liquefaction certain

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)
5.00	56	0.09	0.19	761.66	0.13	13656.47	0.00	0.00	10.54	0.00	10.00	0.010
10.00	57	0.20	0.40	1110.30	0.15	8745.78	0.00	0.00	10.54	0.01	5.00	0.007

Cumulative settlemetns: 0.017

Abbreviations

τ_{av}: Average cyclic shear stress
p: Average stress
G_{max}: Maximum shear modulus (tsf)
α, b: Shear strain formula variables
γ: Average shear strain
ε_{15}: Volumetric strain after 15 cycles
N_c: Number of cycles
ε_{Nc}: Volumetric strain for number of cycles N_c (%)
Δh: Thickness of soil layer (in)
ΔS: Settlement of soil layer (in)

:: Vertical settlements estimation for saturated sands ::

Depth (ft)	D_{50} (in)	q_c/N	e_v (%)	Δh (ft)	s (in)
15.00	0.30	5.58	0.00	5.00	0.000
20.00	0.30	5.58	0.00	5.00	0.000
25.00	0.20	4.95	0.00	5.00	0.000
30.00	0.20	4.95	0.22	5.00	0.131
35.00	0.30	5.58	0.00	5.00	0.000
40.00	0.30	5.58	0.00	1.50	0.000

Cumulative settlements: 0.131

Abbreviations

D_{50}: Median grain size (in)
q_c/N: Ratio of cone resistance to SPT
e_v: Post liquefaction volumetric strain (%)
Δh: Thickness of soil layer to be considered (ft)
s: Estimated settlement (in)

:: Lateral displacements estimation for saturated sands ::

Depth (ft)	$(N_1)_{60}$	D_r (%)	γ_{max} (%)	d_z (ft)	LDI	LD (ft)
5.00	56	100.00	0.00	10.00	0.000	0.00
10.00	57	100.00	0.00	5.00	0.000	0.00
15.00	78	100.00	0.00	5.00	0.000	0.00
20.00	38	86.30	0.00	5.00	0.000	0.00
25.00	43	100.00	0.00	5.00	0.000	0.00
30.00	23	67.14	1.63	5.00	0.000	0.00
35.00	41	89.64	0.00	5.00	0.000	0.00
40.00	53	100.00	0.00	1.50	0.000	0.00

Cumulative lateral displacements: 0.00

Abbreviations

D_r: Relative density (%)
γ_{max}: Maximum amplitude of cyclic shear strain (%)
d_z: Soil layer thickness (ft)
LDI: Lateral displacement index (ft)
LD: Actual estimated displacement (ft)

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APPENDIX F
STANDARD GRADING GUIDELINES

TGR GEOTECHNICAL
DBE & 8(a) firm
3037 S. HARBOR BLVD
SANTA ANA, CA 92704
P 714.641.7189 F 714.641.7190
www.tgrgeotech.com

STANDARD GRADING SPECIFICATIONS

These specifications present the usual and minimum requirements for grading operations performed under the observation and testing of TGR Geotechnical, Inc.

No deviation from these specifications will be allowed, except where specifically superseded in the Preliminary Geotechnical Investigation report, or in other written communication signed by the Soils Engineer or Engineering Geologist.

1.0 GENERAL

- The Soils Engineer and Engineering Geologist are the Owner's or Builder's representatives on the project. For the purpose of these specifications, observation and testing by the Soils Engineer includes that observation and testing performed by any person or persons employed by, and responsible to, the licensed Geotechnical Engineer or Geologist signing the grading report.

- All clearing, site preparation or earth work performed on the project shall be conducted by the Contractor under the observation of the Geotechnical Engineer.

- It is the Contractor's responsibility to prepare the ground surface to receive the fills to the satisfaction of the Geotechnical Engineer and to place, spread, mix, water and compact the fill in accordance with the specifications of the Geotechnical Engineer. The Contractor shall also remove all material considered unsatisfactory by the Geotechnical Engineer.

- It is also the Contractor's responsibility to have suitable and sufficient compaction equipment on the job site to handle the amount of fill being placed. If necessary, excavation equipment will be shut down to permit completion of Compaction. Sufficient watering apparatus will also be provided by the Contractor, with due consideration for the fill material, rate of placement and time of year.

- A final report will be issued by the Geotechnical Engineer and Engineering Geologist attesting to the Contractor's conformance with these specifications.

2.0 SITE PREPARATION

- All vegetation and deleterious material such as rubbish shall be disposed of off-site. The removal must be concluded prior to placing fill.

- The Civil Engineer shall locate all houses, sheds, sewage disposal systems, large trees or structures on the site, or on the grading plan to the best of his knowledge prior to preparing the ground surface.

- Soil, alluvium or rock materials determined by the Geotechnical Engineer as being unsuitable for placement in compacted fills shall be removed and wasted from the site. Any material incorporated as part of a compacted fill must be approved by the Geotechnical Engineer.

- After the ground surface to receive fill has been cleared, it shall be scarified, disced or bladed by the Contractor until it is uniform and free from ruts, hollows, hummocks or other uneven features which may prevent uniform compaction.

  The scarified ground surface shall then be brought to optimum moisture content, mixed as required, and compacted as specified. If the scarified zone is greater than twelve inches in depth, the excess shall be removed and placed in lifts restricted to six inches. Prior to placing fill, the ground surface to receive fill shall be inspected, tested and approved by the Geotechnical Engineer.

- Any underground structures such as cesspools, cisterns, mining shafts, tunnels, septic tanks, wells, pipe lines or others not located prior to grading are to be removed or treated in a manner prescribed by the Geotechnical Engineer.

3.0 COMPACTED FILLS

- Any material imported or excavated on the property may be utilized in the fill, provided each material has been determined to be suitable by the Geotechnical Engineer. Roots, tree branches and other matter missed during clearing shall be removed from the fill as directed by the Geotechnical Engineer.
- Rock fragments less than six inches in diameter may be utilized in the fill, provided:

- They are not placed in concentrated pockets.
- There is a sufficient percentage of fine-grained material to surround the rocks.
- The distribution of the rocks is observed by the Geotechnical Engineer.

- Rocks greater than six inches in diameter shall be taken off-site, or placed in accordance with the recommendations of the Geotechnical Engineer in areas designated as suitable for rock disposal. Details for rock disposal such as location, moisture control, percentage of the rock placed, etc., will be referred to in the "Conclusions and Recommendations" section of the Geotechnical Report, if applicable.

  If rocks greater than six inches in diameter were not anticipated in the Preliminary Geotechnical report, rock disposal recommendations may not have been made in the "Conclusions and Recommendations" section. In this case, the Contractor shall notify the Geotechnical Engineer if rocks greater than six inches in diameter are encountered. The Geotechnical Engineer will then prepare a rock disposal recommendation or request that such rocks be taken off-site.

- Material that is spongy, subject to decay or otherwise considered unsuitable shall not be used in the compacted fill.

- Representative samples of materials to be utilized as compacted fill shall be analyzed in the laboratory by the Geotechnical Engineer to determine their physical properties. If any material other than that previously tested is encountered during grading, the appropriate analysis of this material shall be conducted by the Geotechnical Engineer as soon as possible.

- Material used in the compacting process shall be evenly spread, watered or dried, processed and compacted in thin lifts not to exceed six inches in thickness to obtain a uniformly dense layer. The fill shall be placed and compacted on a horizontal plane, unless otherwise approved by the Geotechnical Engineer.

- If the moisture content or relative compaction varies from that required by the Geotechnical Engineer, the Contractor shall rework the fill until it is approved by the Geotechnical Engineer.

- Each layer shall be compacted to 90 percent of the maximum dry density in compliance with the testing method specified by the controlling governmental agency; (in general, ASTM D1557 will be used.)

  If compaction to a lesser percentage is authorized by the controlling governmental agency because of a specific land use of expansive soil conditions, the area to receive fill compacted to less than 90 percent shall either be delineated on the grading plan or appropriate reference made to the area in the grading report.

- All fill shall be keyed and benched through all topsoil, colluvium, alluvium or creep material, into sound bedrock or firm material where the slope receiving fill exceeds a ratio of five horizontal to one vertical, in accordance with the recommendations of the Geotechnical Engineer.

- The key for side hill fills shall be a minimum of 15 feet within bedrock or firm materials, unless otherwise specified in the Preliminary report. (See details)

- Drainage terraces and subdrainage devices shall be constructed in compliance with the ordinances of the controlling governmental agency, or with the recommendation of the Geotechnical Engineer and Engineer Geologist.

- The Contractor will be required to obtain a minimum relative compaction of 90 percent out to the finish slope face of fill slopes, buttresses and stabilization fills. This may be achieved by either overbuilding the slope and cutting back to the compacted core, or by direct compaction of the slope face with suitable equipment, or by any other procedure which produces the required compaction.

The Contractor shall prepare a written detailed description of the method or methods he will employ to obtain the required slope compaction. Such documents shall be submitted to the Geotechnical Engineer for review and comments prior to the start of grading.

If a method other than overbuilding and cutting back to the compacted core is to be employed, slope tests will be made by the Geotechnical Engineer during construction of the slopes to determine if the required compaction is being achieved. Where failing tests occur or other field problems arise, the contractor will be notified by the Geotechnical Engineer.

If the method of achieving the required slope compaction selected by the Contractor fails to produce the necessary results, the Contractor shall rework or rebuild such slopes until the required degree of compaction is obtained, at no additional cost to the Owner or Geotechnical Engineer.

- All fill slopes should be planted or protected from erosion by methods specified in the preliminary report or by means approved by the governing authorities.

- Fill-over-cut slopes shall be properly keyed through topsoil, colluvium or creep material into rock or firm materials; and the transition shall be stripped of all soil prior to placing fill. (See detail)

4.0 CUT SLOPES

- The Engineering Geologist shall inspect all cut slopes excavated in rock, lithified or formation material at vertical intervals not exceeding ten feet.

- If any conditions not anticipated in the preliminary report such as perched water, seepage, lenticular or confined strata of a potentially adverse nature, unfavorably inclined bedding, joints or fault planes are encountered during grading, these conditions shall be analyzed by the Engineering Geologist and Geotechnical Engineer; and recommendations shall be made to treat these problems.

- Cut slopes that face in the same direction as the prevailing drainage shall be protected from slope wash by a non-erosive interceptor swale placed at the top of the slope.

- Unless otherwise specified in the soils and geological report, no cut slopes shall be excavated higher or steeper than that allowed by the ordinances of controlling governmental agencies.

- Drainage terraces shall be constructed in compliance with the ordinances of controlling governmental agencies, or with the recommendations of the Geotechnical Engineer or Engineering Geologist.

5.0 GRADING CONTROL

- Inspection of the fill placement shall be provided by the Geotechnical Engineer during the progress of grading.

- In general, density tests should be made at intervals not exceeding two feet of fill height or every 500 cubic yards of fill placed. This criteria will vary depending on soil conditions and the size of the job. In any event, an adequate number of field density tests shall be made to verify that the required compaction of being achieved.
- Density tests should be made on the surface material to receive fill as required by the Geotechnical Engineer.

- All cleanout, processed ground to receive fill, key excavations, subdrains and rock disposal must be inspected and approved by the Geotechnical Engineer (and often by the governing authorities) prior to placing any fill. It shall be the Contractor's responsibility to notify the Geotechnical Engineer and governing authorities when such areas are ready for inspection.

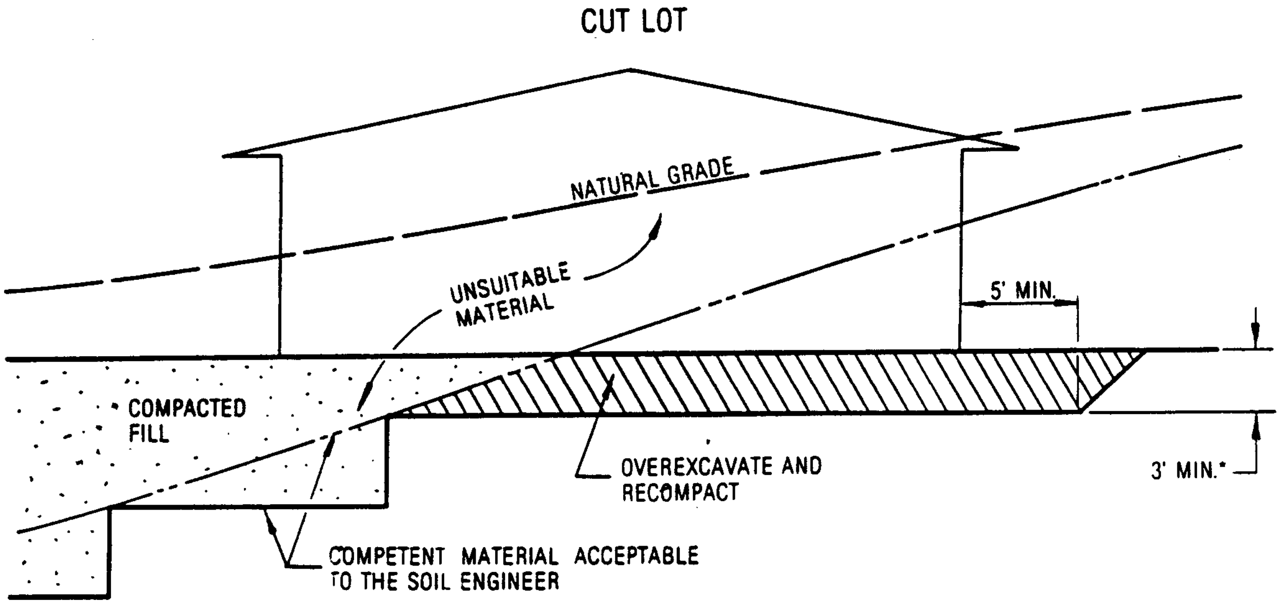
6.0 CONSTRUCTION CONSIDERATIONS

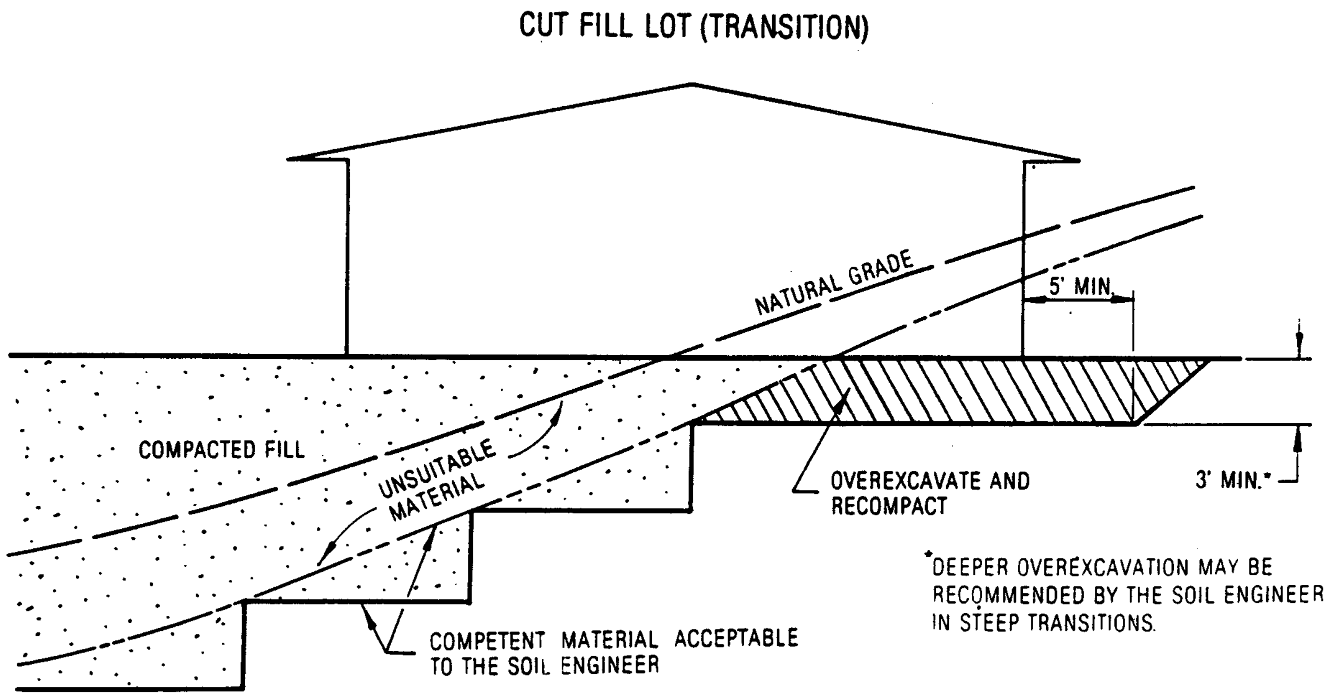
- Erosion control measures, when necessary, shall be provided by the Contractor during grading and prior to the completion and construction of permanent drainage controls.

- Upon completion of grading and termination of observations by the Geotechnical Engineer, no further filling or excavating, including that necessary for footings, foundations, large tree wells, retaining walls, or other features shall be performed without the approval of the Geotechnical Engineer or Engineering Geologist.

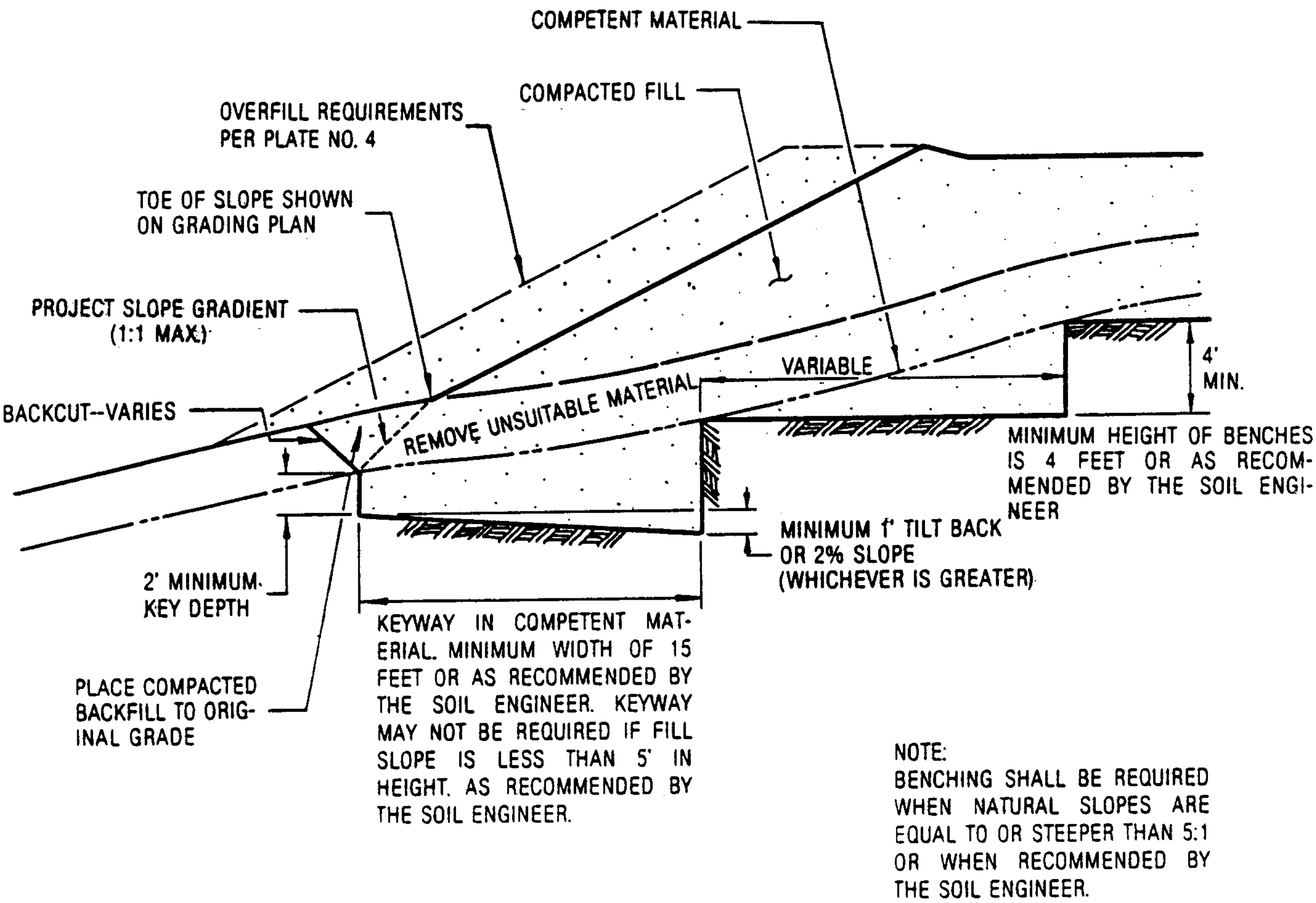
- Care shall be taken by the Contractor during final grading to preserve any berms, drainage terraces, interceptor swales, or other devices of a permanent nature on or adjacent to the property.

TYPICAL OVEREXCAVATION OF DAYLIGHT LINE

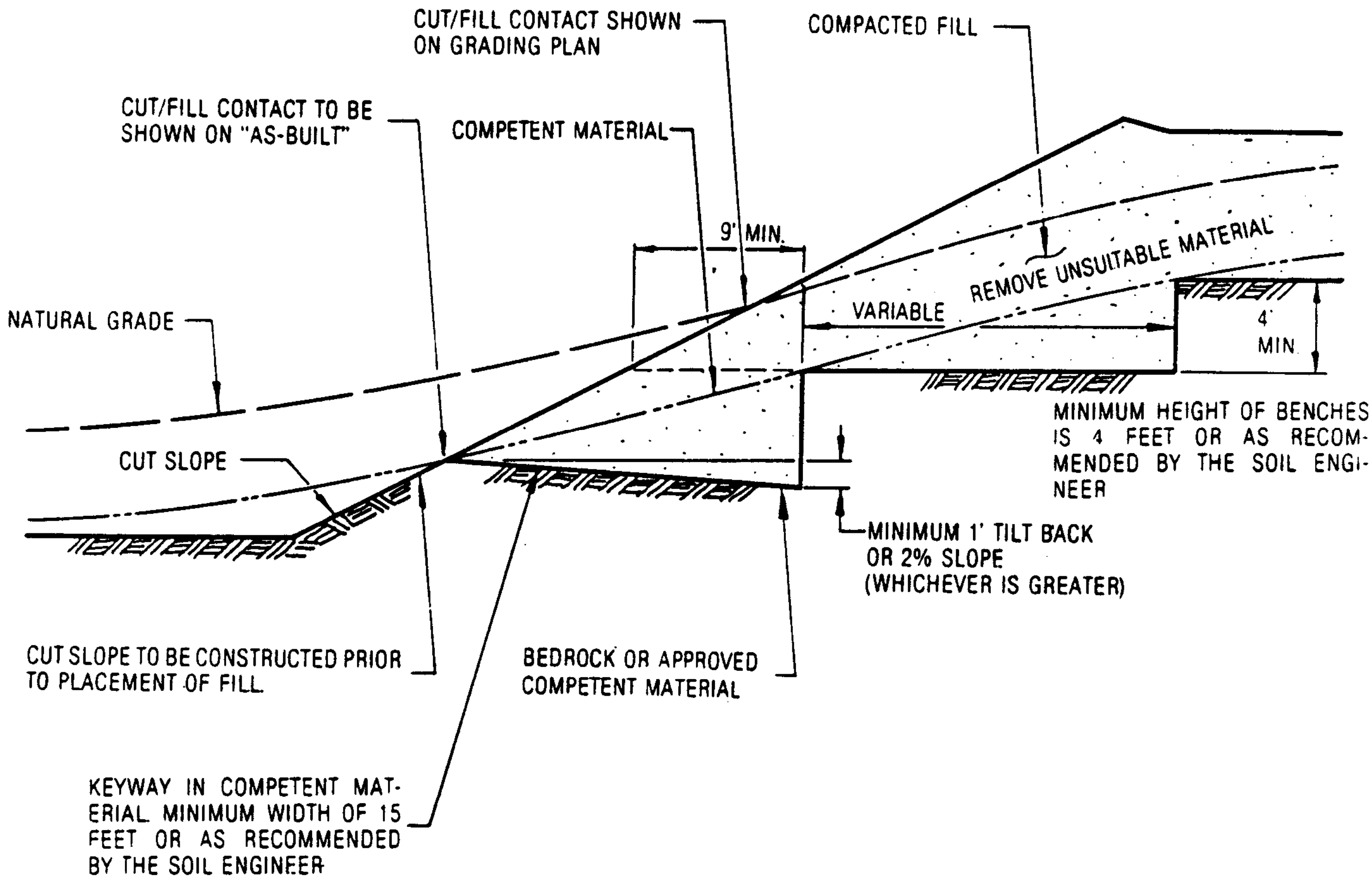




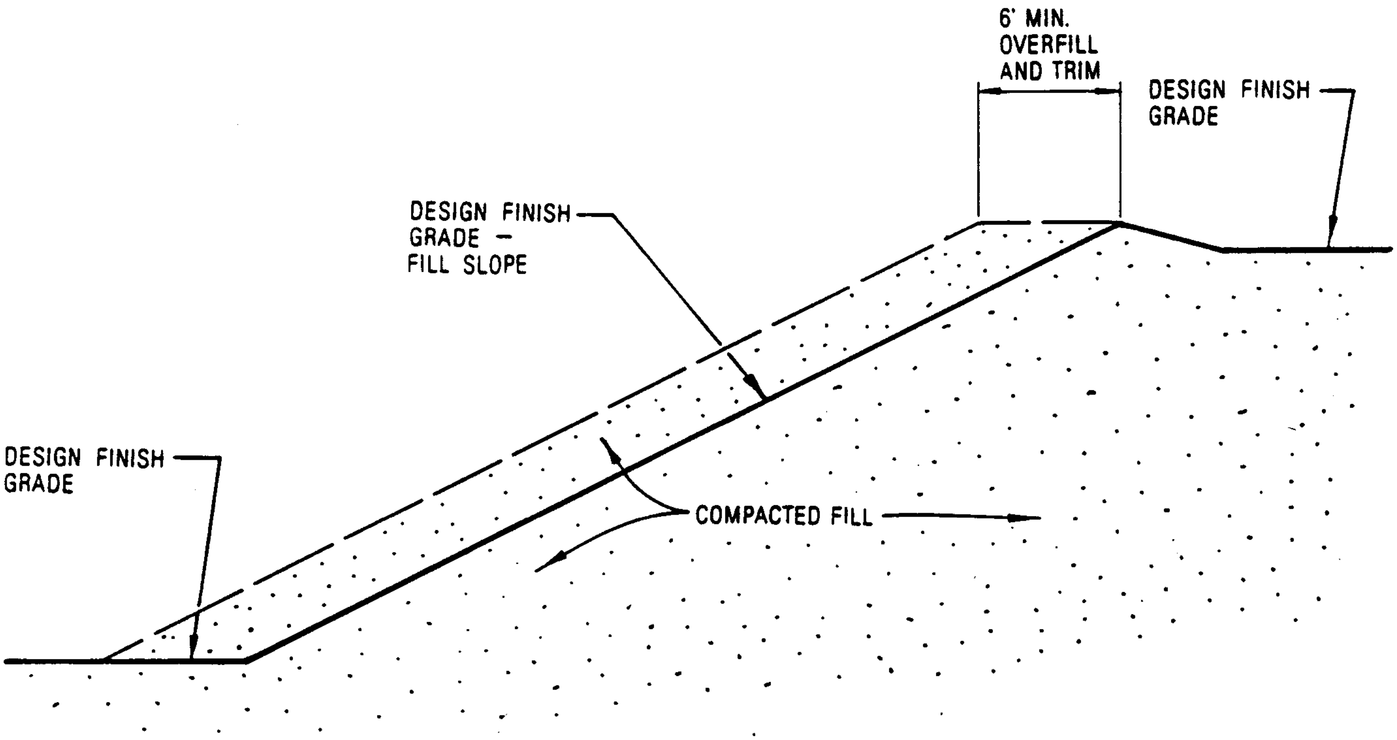
TYPICAL FILL OVER NATURAL SLOPE



TYPICAL FILL-OVER-CUT SLOPE



TYPICAL FILL SLOPE CONSTRUCTION



NOTES:

1. ALL FILL SLOPES, INCLUDING BUTTRESS AND STABILIZATION FILLS, SHALL BE OVERFILLED A MINIMUM OF SIX FEET HORIZONTALLY WITH COMPACTED FILL AND TRIMMED TO THE DESIGN FINISH GRADE.

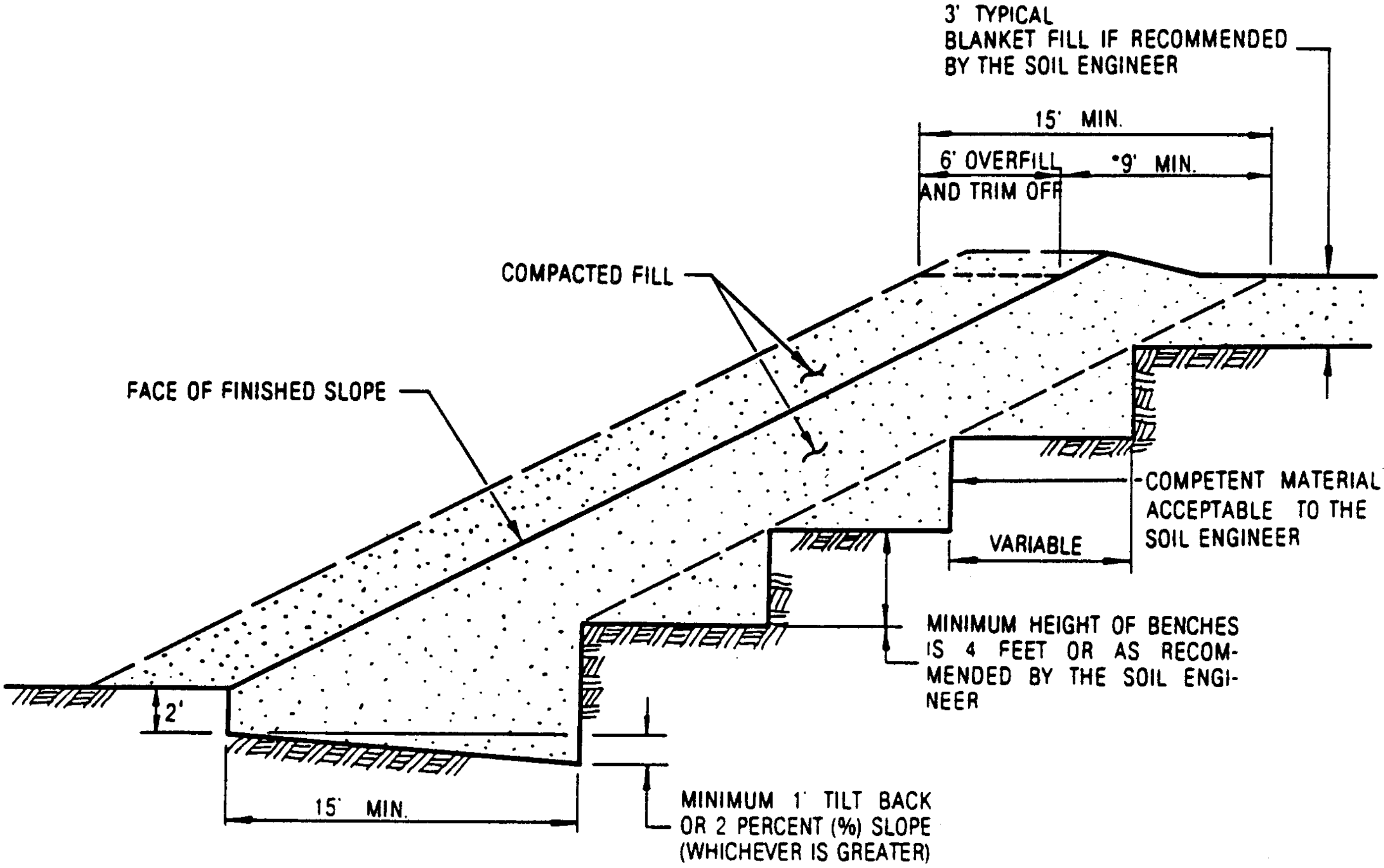
   EXCEPTIONS:

   A. FILL SLOPE OVER CUT SLOPE.

   B. FILL SLOPE ADJACENT TO EXISTING IMPROVEMENTS.

2. THE EXCEPTIONS ABOVE WHICH DO NOT HAVE THE 6 FOOT SLOPE OVERFILL AND TRIM SHALL BE COMPACTED AS STATED IN THE PROJECT SPECIFICATIONS.

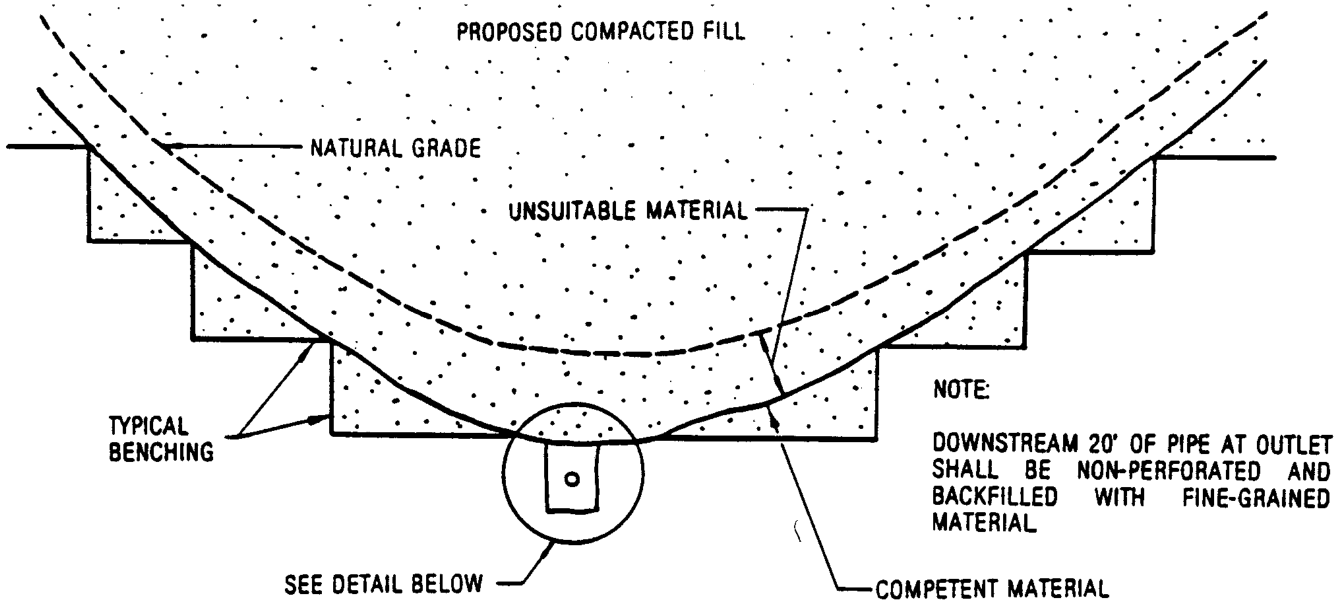
TYPICAL STABILIZATION FILL



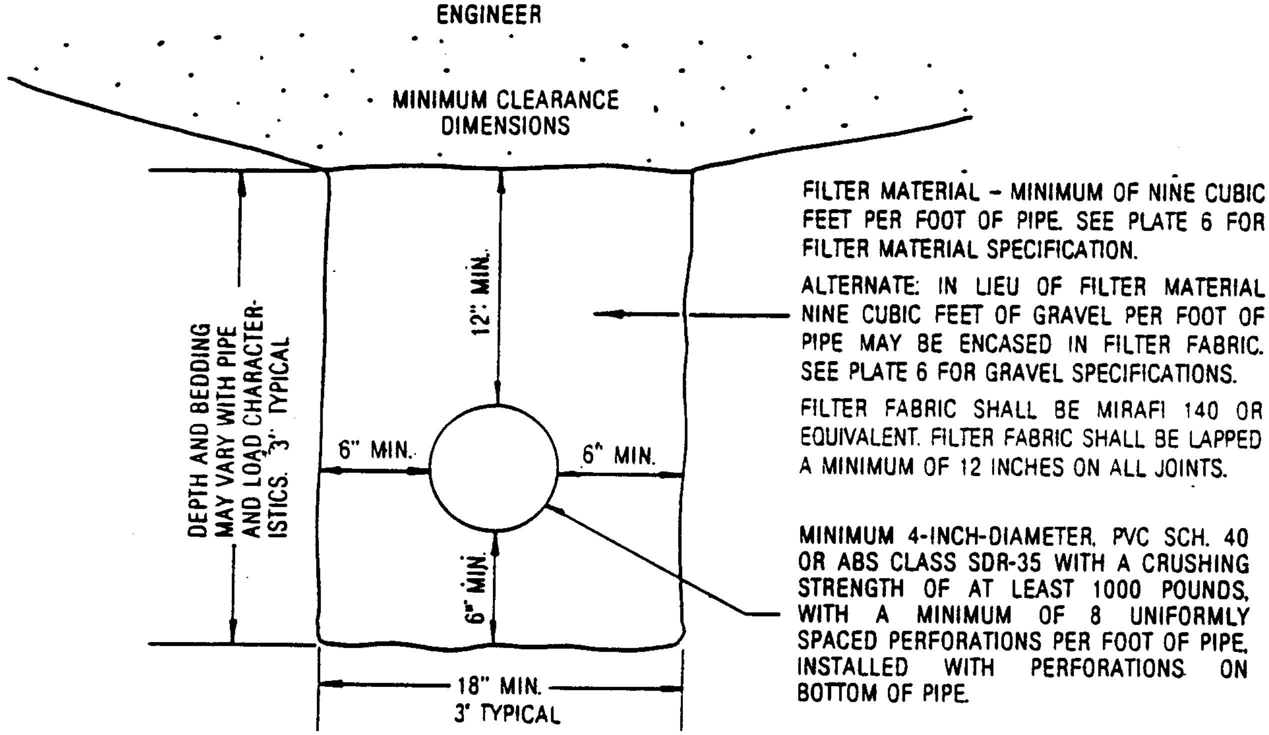
NOTE:
SEE PLATE 6 FOR TYPICAL SUBDRAIN DETAILS FOR STABILIZATION FILLS, IF RECOMMENDED BY THE SOIL ENGINEER.

*GREATER THAN 9' IF RECOMMENDED BY THE SOIL ENGINEER: 15' WHERE NO 6' OVERFILL

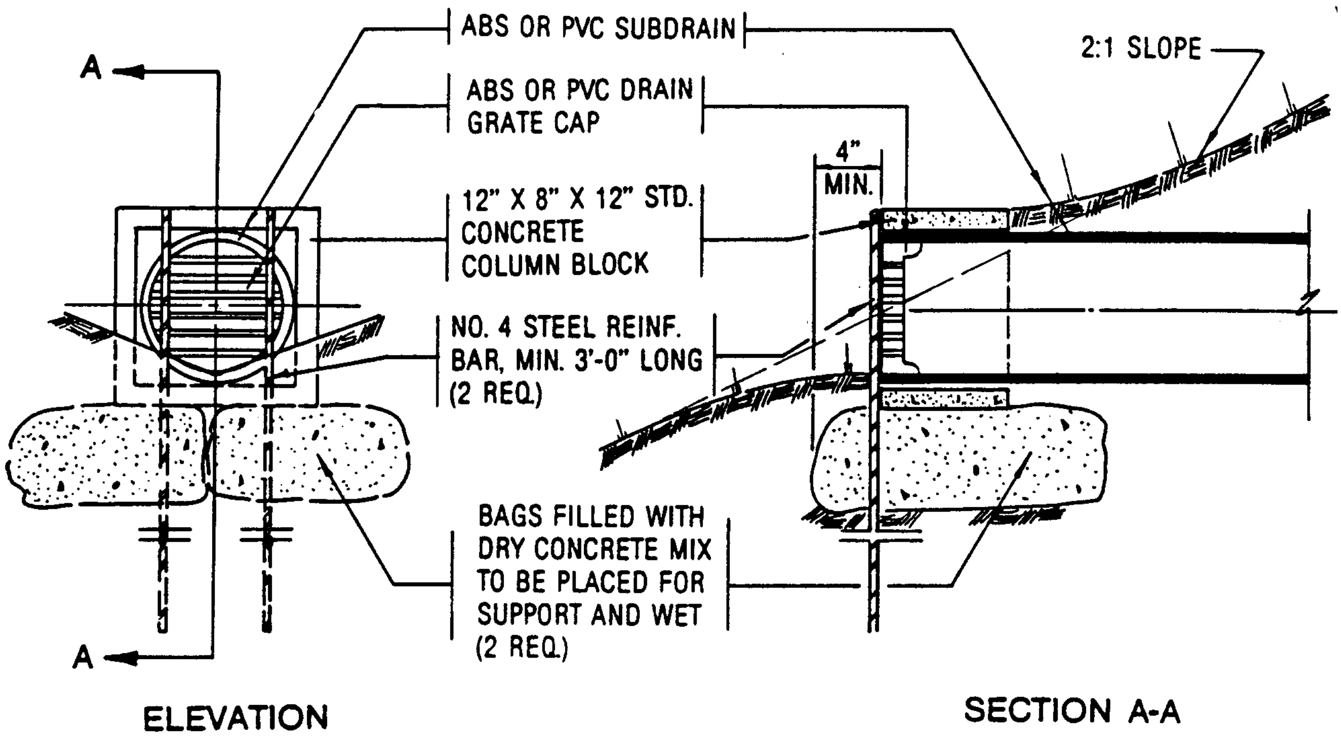
TYPICAL CANYON SUBDRAIN



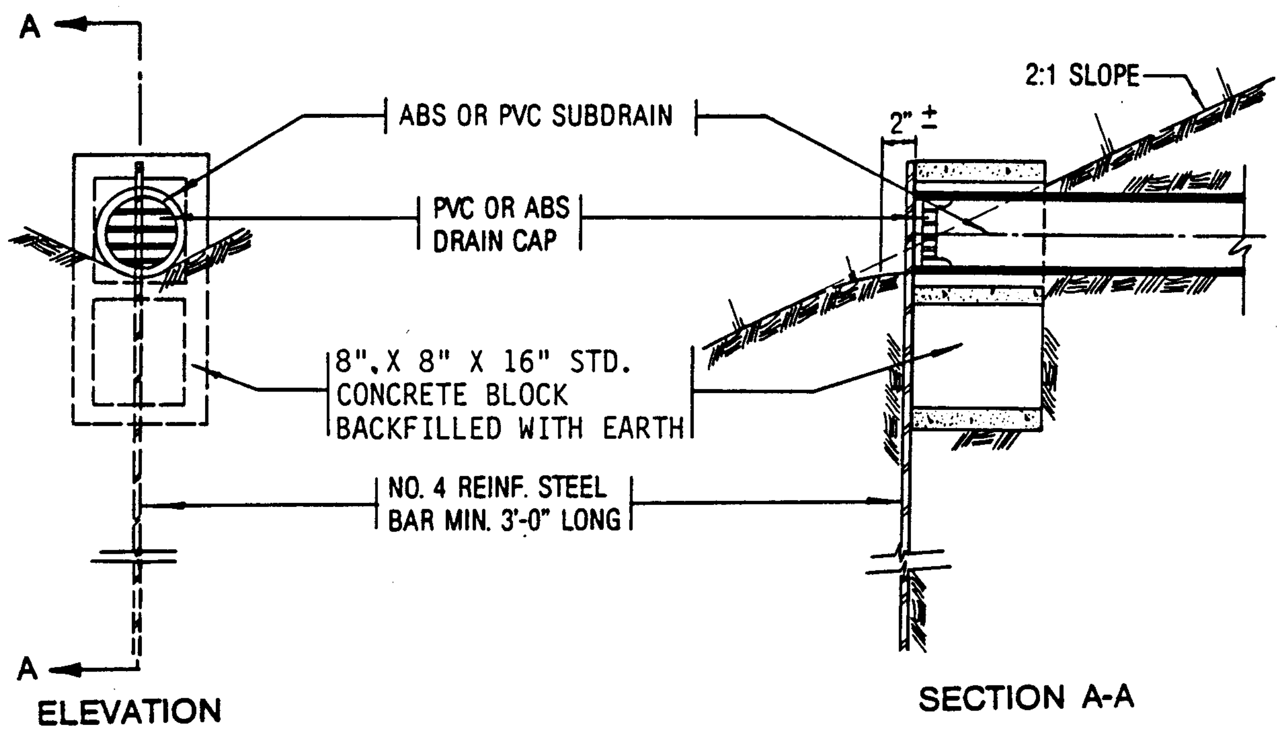
NOTES:
PIPE SHALL BE A MINIMUM OF 4 INCHES DIAMETER AND RUNS OF 500 FEET OR MORE USE 6-INCH DIAMETER PIPE, OR AS RECOMMENDED BY THE SOIL ENGINEER



SUBDRAIN OUTLET MARKER

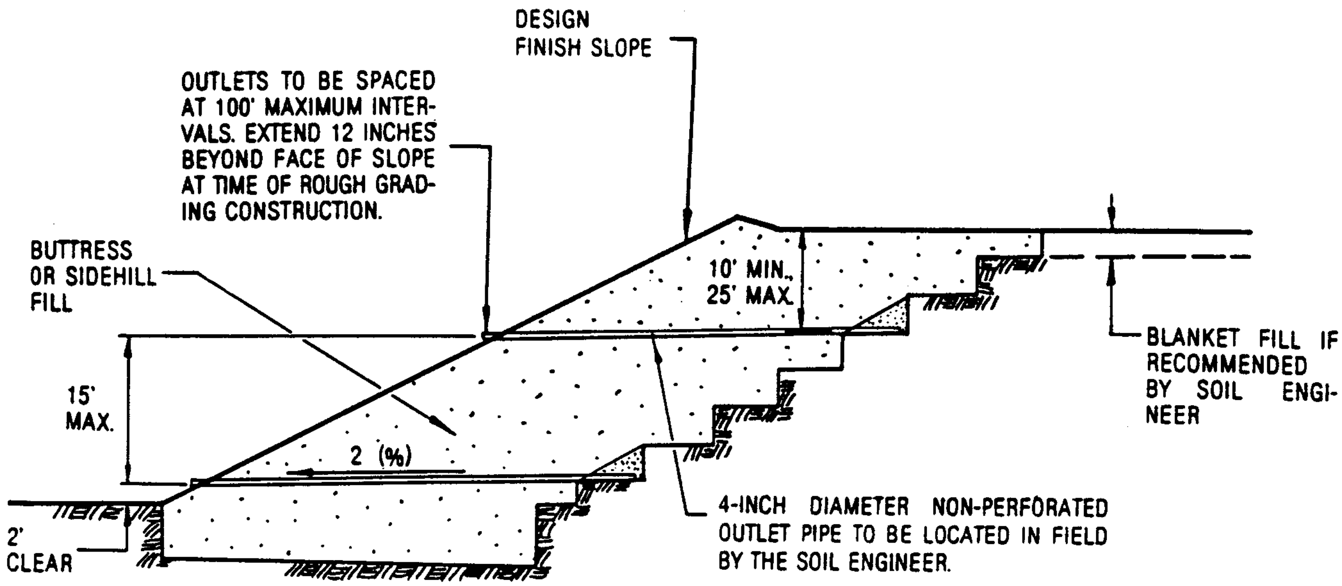


SUBDRAIN OUTLET MARKER FOR 6" AND 8" PIPES



SUBDRAIN OUTLET MARKER – 4" PIPE

TYPICAL STABILIZATION AND BUTTRESS FILL SUBDRAIN



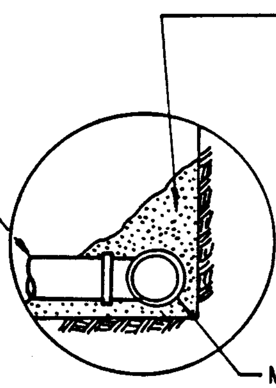
FILTER MATERIAL" TO MEET FOLLOWING SPECIFI- :ATION OR APPROVED EQUIVALENT: (CONFORMS TO :MA STD. PLAN 323)

SIEVE SIZE	PERCENTAGE PASSING
1"	100
3/4"	90-100
3/8"	40-100
NO. 4	25-40
NO. 8	18-33
NO. 30	5-15
NO. 50	0-7
NO. 200	0-3

"GRAVEL" TO MEET FOLLOWING SPECIFICATION OR APPROVED EQUIVALENT:

SIEVE SIZE	MAXIMUM PERCENTAGE PASSING
1½"	100
NO. 4	50
NO. 200	8

SAND EQUIVALENT = MINIMUM OF 50



FILTER MATERIAL – MINIMUM OF FIVE CUBIC FEET PER FOOT OF PIPE. SEE ABOVE FOR FILTER MATERIAL SPECIFICATION.

ALTERNATIVE: IN LIEU OF FILTER MATERIAL, FIVE CUBIC FEET OF GRAVEL PER FOOT OF PIPE MAY BE ENCASED IN FILTER FABRIC. SEE ABOVE FOR GRAVEL SPECIFICATION.

FILTER FABRIC SHALL BE MIRAFI 140 OR EQUIVALENT. FILTER FABRIC SHALL BE LAPPED A MINIMUM OF 12 INCHES ON ALL JOINTS.

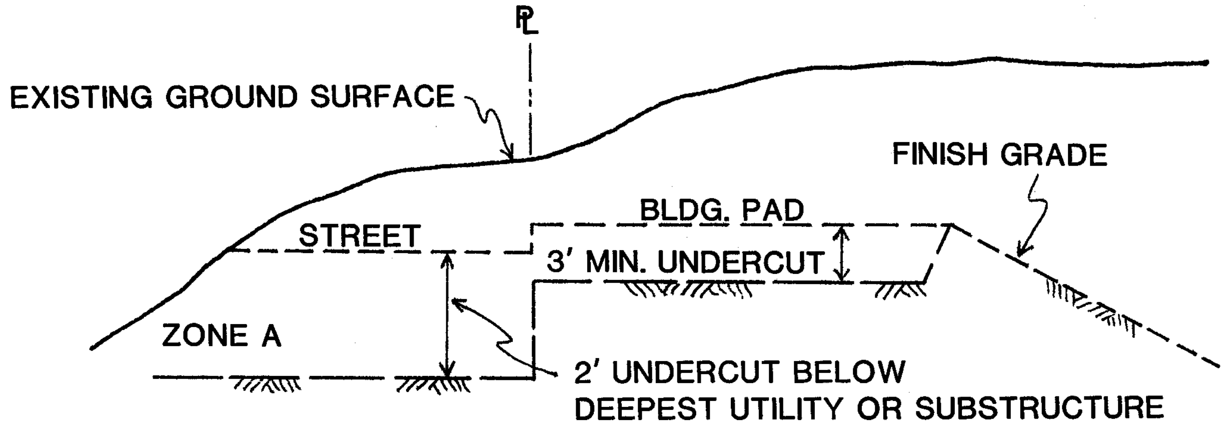
MINIMUM 4-INCH DIAMETER PVC SCH 40 OR ABS CLASS SDR 35 WITH A CRUSHING STRENGTH OF AT LEASE 1,000 POUNDS, WITH A MINIMUM OF 8 UNIFORMLY SPACED PERFORATIONS PER FOOT OF PIPE INSTALLED WITH PERFORATIONS ON BOTTOM OF PIPE. PROVIDE CAP AT UPSTREAM END OF PIPE. SLOPE AT 2 PERCENT TO OUTLET PIPE.

NOTES:

1. TRENCH FOR OUTLET PIPES TO BE BACKFILLED WITH ON-SITE SOIL.

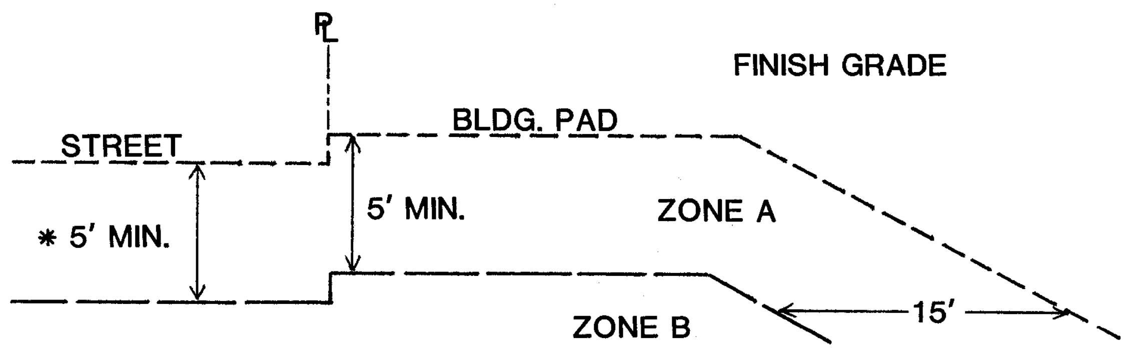
TYPICAL CUT AND FILL GRADING DETAILS

TYPICAL GRADING WITHIN PROPOSED DEEP BEDROCK CUT AREAS



NO SCALE

TYPICAL GRADING WITHIN PROPOSED FILL AREAS



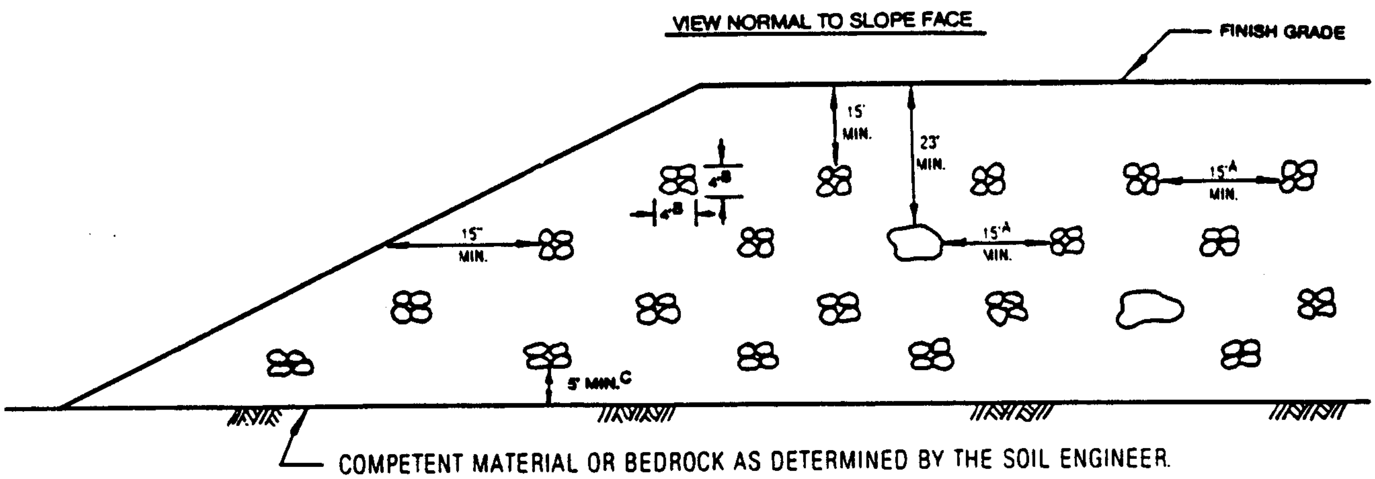
LEGEND

ZONE A ......"SOIL" FILL PLACED IN ACCORDANCE WITH THE RECOMMENDATIONS PRESENTED IN SECTION 11.2.3 OF THIS REPORT

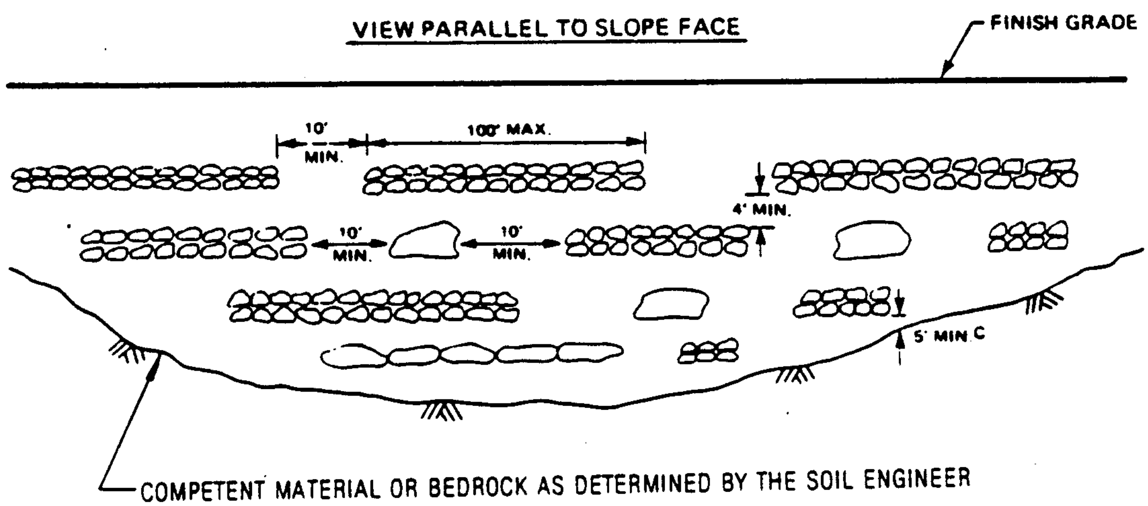
ZONE B ......"SOIL-ROCK" AND/OR "ROCK" FILL PLACED IN ACCORDANCE WITH THE RECOMMENDATIONS PRESENTED IN SECTION 11.2.3 OF THIS REPORT

* 5' OR 1' BELOW DEEPEST UTILITY, WHICHEVER IS GREATER

TYPICAL OVERSIZE ROCK DISPOSAL – "SOIL-ROCK" FILL



NOTE:
ORIENTATION OF WINDROWS MAY VARY BUT SHALL BE AS RECOMMENDED BY SOIL ENGINEER.



NOTES:

A. ONE EQUIPMENT WIDTH OR A MINIMUM OF 15 FEET.
B. HEIGHT AND WIDTH MAY VARY DEPENDING ON ROCK SIZE AND TYPE OF EQUIPMENT.
C. IF APPROVED BY THE SOIL ENGINEER, WINDROWS MAY BE PLACED DIRECTLY ON COMPETENT MATERIALS OR BEDROCK PROVIDING ADEQUATE SPACE IS AVAILABLE FOR COMPACTION.
D. VOIDS IN WINDROW TO BE FILLED BY FLOODING GRANULAR SOIL INTO PLACE. GRANULAR SOIL SHALL MEAN ANY SOIL WHICH HAS A UNIFIED SOIL CLASSIFICATION SYSTEM (UBC 29-1) DESIGNATION OF SM, SP, SW, GM, GP, OR GW.
E. AFTER FILL BETWEEN WINDROWS IS PLACED AND COMPACTED WITH THE LIFT OF FILL COVERING WINDROW, WINDROW SHALL BE PROOF-ROLLED WITH D-9 DOZER OR EQUIVALENT.
F. OVERSIZED ROCK IS DEFINED AS LARGER THAN 12" IN SIZE.

Appendix F - O&M Plan

Will be provided in Final WQMP.

Appendix G - Maintenance Agreements

RECORDING REQUESTED BY:

City of Victorville
Engineering Department

AND WHEN RECORDED MAIL TO:

City of Victorville
Engineering Department
14343 Civic Drive
Victorville, CA 92392

SPACE ABOVE THIS LINE FOR RECORDER'S USE

AGREEMENT

THIS PAGE ADDED TO PROVIDE ADEQUATE SPACE FOR RECORDING INFORMATION

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

OWNER NAME: ____

PROPERTY ADDRESS: ____

APN: ____

THIS AGREEMENT is made and entered into in

________________________________, California, this ______ day of

________________________________, by and between

________________________________, hereinafter

referred to as Owner, and the CITY OF VICTORVILLE, a municipal corporation, located in the County of San Bernardino, State of California, hereinafter referred to as CITY;

WHEREAS, the Owner owns real property ("Property") in the City of Victorville, State of California, more specifically described in Exhibit "A" and depicted in Exhibit "B", each of which exhibits is attached hereto and incorporated herein by this reference;

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

_____________________________________ within the Property described herein, the CITY required the project to employ Best Management Practices, hereinafter referred to as "BMPs," to minimize pollutants in urban runoff;

WHEREAS, the Owner has chosen to install and/or implement BMPs as described in the Water Quality Management Plan, on file with the CITY, hereinafter referred to as "WQMP", to minimize pollutants in urban runoff and to minimize other adverse impacts of urban runoff;

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

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

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

1. All maintenance or replacement of BMPs proposed as part of the WQMP are the sole responsibility of the Owner in accordance with the terms of this Agreement.

2. Owner hereby provides the City of Victorville's designee complete access, of any duration, to the BMPs and their immediate vicinity at any time, upon reasonable notice, or in the event of emergency, as determined by the City's Director of Public Works, no advance notice, for the purpose of inspection, sampling, testing of the Device, and in case of emergency, to undertake all necessary repairs or other preventative measures at owner's expense as provided in paragraph 3 below. The City shall make every effort at all times to minimize or avoid interference with Owner's use of the Property. Denial of access to any premises or facility that contains WQMP features is a violation of the City Stormwater Ordinance. If there is reasonable cause to believe that an illicit discharge or breach of the WQMP operation and maintenance commitments is occurring on the premises then the authorized enforcement agency may seek issuance of a search warrant from any court of competent jurisdiction in addition to other enforcement actions.

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

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

5. The City may require the owner to post security in form and for a time period satisfactory to the City to guarantee the performance of the obligations stated herein. Should the Owner fail to perform the obligations under the Agreement, the City may, in the case of a cash bond, act for the Owner using the proceeds from it, or in the case of a surety bond, require the sureties to perform the obligations of the Agreement. As an additional remedy, the Director of Public Works may withdraw any previous stormwater-related approval with respect to the property on which BMPs have been installed and/or implemented until such time as Owner repays to City its reasonable costs incurred in accordance with paragraph 3 above.

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

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

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

9. The obligations herein undertaken shall be binding upon the heirs, successors, executors, administrators and assigns of the parties hereto. The term "Owner" shall include not only the present Owner, but also its heirs, successors, executors, administrators, and assigns. Owner shall notify any successor to title of all or part of the Property about the existence of this Agreement. Owner shall provide such notice prior to such successor obtaining an interest in all or part of the Property. Owner shall provide a copy of such notice to the City at the same time such notice is provided to the successor.

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

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

12. The Owner its successors and assigns, hereby agrees to save and hold harmless the City, any of its departments, agencies, officers or employees, all of whom while working within their respective authority, from all cost, injury and damage incurred by any of the above, and from any other injury or damage to any person or property whatsoever, any of which is caused by an activity, condition or event arising out of the performance, preparation for performance or nonperformance of any provision of this agreement by the Owner, its agents, or any of its independent contractors.

IF TO CITY:
City of Victorville – Engineering Department

14343 Civic Drive,

Victorville, CA 92392

IF TO OWNER:
Suraj Victorville, LLC - Kevin Wadhwani

1560 E. 6th Street, Suite 101

Corona, CA 92879

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

OWNER:

Signature: ______________________________

Name: Suraj Victorville, LLC - Kevin Wadhwani

Title: Chief Executive Officer

OWNER:

Signature: ______________________________

Name: ______________________________

Title: ______________________________

NOTARIES ON FOLLOWING PAGE

A notary acknowledgement is required for recordation (attach appropriate acknowledgement).

ACCEPTED BY:

____

Brian W. Gengler., City Engineer for City of Victorville

Date: ______________________________

Attachment: Standard Notary Acknowledgement

EXHIBIT A
(Legal Description)

THE LAND REFERRED TO HEREIN BELOW IS SITUATED IN THE CITY OF VICTORVILLE, IN THE COUNTY OF SAN BERNARDINO, STATE OF CALIFORNIA, AND IS DESCRIBED AS FOLLOWS:

PARCEL 1:

THE SOUTHWEST ¼ OF THE SOUTHWEST ¼ OF SECTION 34, TOWNSHIP 6 NORTH, RANGE 4 WEST, SAN BERNARDINO BASE AND MERIDIAN, IN THE CITY OF VICTORVILLE, COUNTY OF SAN BERNARDINO, STATE OF CALIFORNIA, ACCORDING TO THE GOVERNMENT SURVEY, AND THAT PORTION OF THE SOUTHEAST ¼ OF THE SOUTHWEST ¼ OF SECTION 34, TOWNSHIP 6 NORTH, RANGE 4 WEST, SAN BERNARDINO BASE AND MERIDIAN, LYING WESTERLY OF THE WESTERLY LINE OF STODDARD WELLS ROAD, 88 FEET WIDE, AS ESTABLISHED BY A GRANT OF EASEMENT TO THE COUNTY OF SAN BERNARDINO RECORDED APRIL 8, 1964 IN BOOK 6124, PAGE 479, OFFICIAL RECORDS.

EXCEPTING FROM SAID SOUTHEAST ¼ OF THE SOUTHWEST ¼ OF SECTION 34, THE WEST 58 FEET OF THE NORTH 315 FEET OF THE SOUTH 330 FEET THEREOF.

ALSO EXCEPTING FROM SAID SOUTHEAST ¼ OF THE SOUTHWEST ¼ OF SAID SECTION 34, THE NORTH 165 FEET OF THE SOUTH 195 FEET THEREOF, AS MEASURED ALONG THE WESTERLY LINE OF THE SOUTHEAST ¼ OF THE SOUTHWEST ¼ OF SECTION 34.

ALSO EXCEPTING FROM SAID SOUTHEAST ¼ OF THE SOUTHWEST ¼ OF SECTION 34, THE NORTH 264 FEET.

ALSO EXCEPTING FROM SAID SOUTHWEST ¼ OF THE SOUTHWEST ¼ OF SECTION 34, THE NORTH 264 FEET OF THE EAST 330 FEET THEREOF.

ALSO EXCEPTING FROM SAID SOUTHWEST ¼ OF THE SOUTHWEST ¼ OF SECTION 34, THE NORTH 315 FEET OF THE SOUTH 330 FEET OF THE EAST 132 FEET THEREOF.

ALSO EXCEPTING FROM SAID SOUTHWEST ¼ OF THE SOUTHWEST ¼ OF SECTION 34, THE NORTH ½ OF THE NORTH ½ OF THE WEST ½ THEREOF.

ALSO EXCEPTING FROM THAT CERTAIN WELL SITE LOCATED ON THAT PORTION OF THE SOUTHWEST ¼ OF THE SOUTHWEST ¼ OF SECTION 34, TOWNSHIP 6 NORTH, RANGE 4 WEST, SAN BERNARDINO BASE AND MERIDIAN, DESCRIBED AS FOLLOWS:

COMMENCING AT THE NORTHEAST CORNER OF SAID SOUTHWEST ¼ OF THE SOUTHWEST ¼ OF SECTION 34;
THENCE SOUTH 89° 36' 58" WEST ALONG THE NORTH LINE OF SAID SOUTHWEST ¼ OF THE SOUTHWEST ¼ OF SECTION 34, A DISTANCE OF 185.05 FEET;
THENCE SOUTH 0° 23' 02" EAST 465.79 FEET TO THE TRUE POINT OF BEGINNING;
THENCE CONTINUING SOUTH 0° 23' 02" EAST 60.00 FEET;
THENCE NORTH 89° 36' 58" EAST 70.00 FEET;
THENCE NORTH 0° 23' 02" WEST 60.00 FEET;
THENCE SOUTH 89° 36' 58" WEST 70.00 FEET TO THE TRUE POINT OF BEGINNING.

EXHIBIT A
(Legal Description)

ALSO EXCEPTING A PORTION OF THE SOUTHEAST ¼ SOUTHWEST ¼ OF SECTION 34 TOWNSHIP 6 NORTH, RANGE 4 WEST, LYING WESTERLY OF THE WEST LINE OF STODDARD WELLS ROAD, EXCEPTING THE NORTHERLY 564 FEET THEREOF AND EXCEPTING THE WEST 58 FEET OF THE NORTH 315 FEET OF THE SOUTH 330 FEET AND EXCEPTING A PORTION OF THE SOUTH 195 FEET LYING EASTERLY OF SAID WEST 58 FEET.

ALSO EXCEPTING FROM THE WEST ½ OF THE WEST ½ OF THE SOUTHWEST ¼ OF THE SOUTHWEST ¼ OF SAID SECTION 34, AN UNDIVIDED ½ INTEREST IN ALL OIL, GAS, AND OTHER HYDROCARBONS AND MINERALS AS RESERVED BY LOUIS C. HOEGSTED, ET UX., IN THE DEED RECORDED DECEMBER 15, 1959 IN BOOK 5009, PAGE 505, OFFICIAL RECORDS.

APN 0472-181-44-0-000, APN 0472-181-45-0-000, APN 0472-181-61-0-000

PARCEL 2:

THAT PORTION OF THE SOUTHWEST ¼ OF THE SOUTHWEST ¼ OF SECTION 34, TOWNSHIP 6 NORTH, RANGE 4 WEST, SAN BERNARDINO BASE AND MERIDIAN, IN THE CITY OF VICTORVILLE, COUNTY OF SAN BERNARDINO, STATE OF CALIFORNIA, ACCORDING TO THE OFFICIAL PLAT OF SAID LAND, APPROVED BY THE SURVEYOR GENERAL SEPTEMBER 3, 1885, DESCRIBED AS FOLLOWS:

COMMENCING AT THE NORTHEAST CORNER OF SAID SOUTHWEST ¼ OF THE SOUTHWEST ¼ OF SECTION 34;
THENCE SOUTH 89° 36’ 58” WEST ALONG THE NORTH LINE OF SAID SOUTHWEST ¼ OF THE SOUTHWEST ¼ OF SECTION 34, A DISTANCE OF 185.05 FEET;
THENCE SOUTH 00° 23’ 02” EAST, 465.79 FEET TO THE TRUE PORTION;
THENCE CONTINUING SOUTH 00° 23’ 02” EAST 60.00 FEET;
THENCE NORTH 89° 36’ 58” EAST, 70.00 FEET;
THENCE NORTH 00° 23’ 02” WEST, 60 FEET;
THENCE SOUTH 89° 36’ 58” WEST, 70.00 FEET TO THE POINT OF BEGINNING.

APN 0472-181-43-0-000

PARCEL 3:

THAT PORTION OF THE SOUTHWEST ¼ OF THE SOUTHWEST ¼ OF SECTION 34, TOWNSHIP 6 NORTH, RANGE 4 WEST, SAN BERNARDINO BASE AND MERIDIAN, IN THE CITY OF VICTORVILLE, COUNTY OF SAN BERNARDINO, STATE OF CALIFORNIA, ACCORDING TO THE OFFICIAL PLAT THEREOF, DESCRIBED AS FOLLOWS:

BEGINNING AT THE NORTHEAST CORNER OF SAID SOUTHWEST ¼ OF THE SOUTHWEST ¼;
THENCE WEST ALONG THE NORTH LINE OF SAID SOUTHWEST ¼ OF THE SOUTHWEST ¼ 330 FEET;
THENCE SOUTH AT RIGHT ANGLES 132 FEET;
THENCE EAST AT RIGHT ANGLES 330 FEET TO THE EAST LINE OF SAID SOUTHWEST ¼ OF THE SOUTHWEST ¼;
THENCE NORTH 132 FEET TO THE POINT OF BEGINNING.

EXHIBIT A
(Legal Description)

EXCEPT ANY MOBILE HOME OR MANUFACTURED HOUSING UNIT AND APPURTENANCES, IF ANY, LOCATED ON SAID LAND.

APN 0472-181-12-0-000

PARCEL 4:

THAT PORTION OF THE SOUTHEAST ¼ OF THE SOUTHWEST 1/4 , SECTION 34, TOWNSHIP 6 NORTH, RANGE 4 WEST, SAN BERNARDINO BASE AND MERIDIAN, IN THE CITY OF VICTORVILLE, COUNTY OF SAN BERNARDINO, STATE OF CALIFORNIA, ACCORDING TO THE OFFICIAL PLAT THEREOF, LYING WESTERLY OF THE WESTERLY LINE OF STODDARD WELLS ROAD, 88 FEET WIDE, AS ESTABLISHED BY A GRANT OF EASEMENT TO THE COUNTY OF SAN BERNARDINO RECORDED APRIL 8, 1964 IN BOOK 6124, PAGE 479, OFFICIAL RECORDS.

EXCEPTING FROM SAID SOUTHEAST ¼ OF THE SOUTHWEST ¼ OF SECTION 34, THE WEST 58 FEET OF THE NORTH 315 FEET OF THE SOUTH 330 FEET THEREOF.

ALSO EXCEPTING FROM SAID SOUTHEAST ¼ OF THE SOUTHWEST ¼ OF SECTION 34, THE NORTH 165 FEET OF THE SOUTH 195 FEET THEREOF, AS MEASURED ALONG THE WESTERLY LINE OF THE SOUTHEAST ¼ OF THE SOUTHWEST ¼ OF SAID SECTION 34.

ALSO EXCEPTING FROM SAID SOUTHEAST ¼ OF THE SOUTHWEST ¼ OF SECTION 34, THE NORTH 264 FEET.

ALSO EXCEPT THAT PORTION CONVEYED TO HOMER DOYLE DYER AND REBECCA DYER BY DEED RECORDED DECEMBER 15, 1959 IN BOOK 5009, PAGE 505, OFFICIAL RECORDS.

APN 0472-181-47-0-000

PARCEL 5:

THE EAST 132 FEET OF THE NORTH ½ OF THE NORTHWEST ¼ OF THE SOUTHWEST ¼ OF THE SOUTHWEST ¼ OF SECTION 34, TOWNSHIP 6 NORTH, RANGE 4 WEST, SAN BERNARDINO BASE AND MERIDIAN, IN THE CITY OF VICTORVILLE, COUNTY OF SAN BERNARDINO, STATE OF CALIFORNIA, ACCORDING TO THE OFFICIAL PLAT THEREOF.

APN 0472-181-13-0-000

PARCEL 6:

THAT PORTION OF THE SOUTHWEST ¼ OF THE SOUTHWEST ¼ OF SECTION 34, TOWNSHIP 6 NORTH, RANGE 4 WEST, SAN BERNARDINO BASE AND MERIDIAN, IN THE CITY OF VICTORVILLE, COUNTY OF SAN BERNARDINO, STATE OF CALIFORNIA, ACCORDING TO THE OFFICIAL PLAT THEREOF, DESCRIBED AS FOLLOWS:

EXHIBIT A
(Legal Description)

COMMENCING AT THE NORTHEAST CORNER OF THE SOUTHWEST ¼ OF THE SOUTHWEST ¼ OF SAID SECTION;
THENCE SOUTH 132 FEET FROM THE TRUE POINT OF BEGINNING;
THENCE SOUTH 132 FEET;
THENCE WEST AT RIGHT ANGLES 330 FEET;
THENCE NORTH 132 FEET TO A POINT 132 FEET SOUTH OF THE NORTH LINE OF SAID SOUTHWEST ¼ OF THE SOUTHWEST ¼ OF SAID SECTION;
THENCE EAST 330 FEET TO THE POINT OF BEGINNING.

APN 0472-181-11-0-000

PARCEL 7:

THE NORTH ½ OF THE NORTHWEST ¼ OF THE SOUTHWEST ¼ OF THE SOUTHWEST ¼ OF SECTION 34, TOWNSHIP 6 NORTH, RANGE 4 WEST, SAN BERNARDINO BASE AND MERIDIAN, ACCORDING TO THE OFFICIAL PLAT THEREOF, IN THE CITY OF VICTORVILLE, COUNTY OF SAN BERNARDINO, STATE OF CALIFORNIA.

EXCEPTING THEREFROM THE EAST 132.00 FEET AND THE WEST 35.00 FEET THEREOF, MORE PARTICULARLY DESCRIBED AS FOLLOWS:

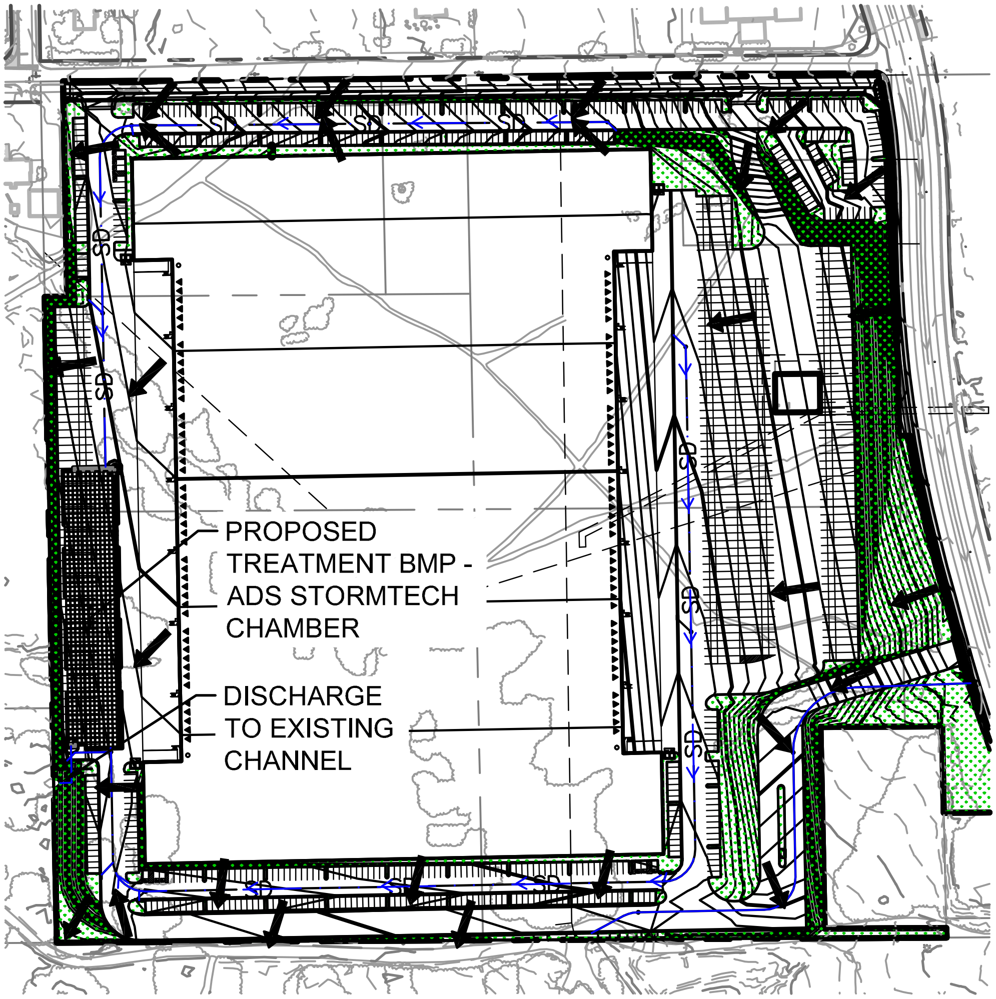
COMMENCING AT THE SOUTHWEST CORNER OF SAID SECTION 34;
THENCE NORTH 00° 41’ 21” WEST, ALONG THE WEST LINE OF SAID SOUTHWEST ¼ OF THE SOUTHWEST ¼ OF SECTION 34, A DISTANCE OF 1345.71 FEET TO THE SOUTH 1/6 CORNER OF SAID SECTION 34;
THENCE NORTH 89° 56’ 42” EAST ALONG THE NORTH LINE OF SAID NORTH ½, A DISTANCE OF 35.00 FEET TO THE TRUE POINT OF BEGINNING;
THENCE CONTINUING ALONG THE NORTH LINE NORTH 89° 56’ 42” EAST, A DISTANCE OF 479.03 FEET TO A POINT ON THE NORTH LINE OF SAID NORTH ½, A DISTANCE OF 132.01 FEET FORM THE NORTHEAST CORNER OF SAID NORTH ½;
THENCE SOUTH 00° 44’ 51” EAST, A DISTANCE OF 336.68 FEET TO A POINT ON THE SOUTH LINE OF SAID NORTH ½, A DISTANCE OF 132.01 FEET FROM THE SOUTHEAST CORNER OF SAID NORTH ½;
THENCE SOUTH 89° 58’ 17” WEST ALONG SAID SOUTH LINE, A DISTANCE OF 497.37 FEET TO A POINT ON A LINE 35.00 FEET EAST AND PARALLEL TO THE WEST LINE OF SAID SOUTHWEST ¼ OF THE SOUTHWEST ¼ OF SECTION 34;
THENCE NORTH 00° 51’ 21” WEST ALONG SAID PARALLEL LINE A DISTANCE OF 336.45 FEET TO THE TRUE POINT OF BEGINNING.

SAID LEGAL IS MADE PURSUANT TO LOT LINE ADJUSTMENT LA-04-019, RECORDED DECEMBER 16, 2004 AS INSTRUMENT NO. 20040928936 OF OFFICIAL RECORDS.

APN 0472-181-72-0-000

EXHIBIT B
(Map/illustration)

EXHIBIT B



LEGEND

IMPERMEABLE AREA

PERMEABLE AREA

DMA BOUNDARY

DRAINAGE FLOW PATH

PIPE FLOW PATH

WARE MALCOMB CIVIL ENGINEERING & SURVEYING	PROJECT NAME: AMRAPUR STODDARD WELLS			SHEET
	JOB NO.: IRV21-0068	DATE : 03/04/2022		1
	DRAWN: JP	PA/PM: LC	SCALE: 1" = 300'	