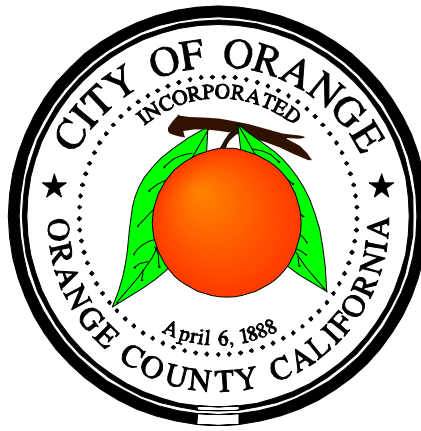




**PRIORITY
PRELIMINARY WATER QUALITY MANAGEMENT PLAN
(P-WQMP)**

For:

**Glassell Street Industrial Project
2411 N. Glassell Street**

**Prepared for:
Rexford Industrial
333 City Blvd, Suite 705
Orange, CA 92868
(310) 424-5115**

**Prepared by:
Huitt-Zollars, Inc.
Adam J. Lunzer, RCE 77396
2603 Main Street, Suite 400
Irvine, CA 92614
(949) 988-5815**

Date Prepared: 9/23/2024

Public Works Director

Date

City Engineer

Date

OWNER'S CERTIFICATION
WATER QUALITY MANAGEMENT PLAN
FOR
Glassell Street Industrial Project

This Preliminary Water Quality Management Plan (P-WQMP) for the Glassell Industrial Project has been prepared for Rexford Industrial. This P-WQMP is intended to comply with the requirements of the City of Orange's Site Development Permit/Application #TBD requiring the preparation of a Water Quality Management Plan.

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 City of Orange Local Implementation Plan (LIP), and the intent of NPDES Permit and Waste Discharge Requirements for the City of Orange, County of Orange, Orange County Flood Control District and the incorporated Cities of Orange County within the Santa Ana Region.

This P-WQMP will be reviewed with the facility operator, facility supervisors, employees, tenants, maintenance and service contractors, or any other party having responsibility for implementing portions of this P-WQMP. Maintenance requirements within Section V and Appendix D will be adhered to with particular emphasis on maintaining the BMPs described within Sections IV and V. The Owner's Annual Self Certification Statement along with a BMP maintenance implementation table will be submitted by June 30th every year following project completion. At least one copy of the approved P-WQMP shall be available on the subject property in perpetuity.

Once the undersigned transfers its interest in the property, its successors-in-interest shall bear the aforementioned responsibility to implement and amend the P-WQMP. The City of Orange will be notified of the change of ownership and the new owner will submit a new certification.

Signature: _____ Date: _____

Name: Ricardo Rivas

Title: Senior Project Manager

Company: Rexford Industrial

Address: 555 Anton Blvd, Suite 910, Costa Mesa, CA 92626

Telephone Number: (424) 256-2115

Notice of Transfer of Responsibility

Water Quality Management Plan (WQMP)

WQMP Number – As assigned by the City of Orange: _____

Submission of this Notice of Transfer of Responsibility constitutes notice to the City that responsibility for the Water Quality Management Plan (WQMP) for the subject property identified below, and implementation of that plan, is being transferred from the Previous Owner (and his/her agent) of the site (or portion thereof) to the New Owner, as further described below.

I. Owner/ Responsible Party Information

Company/ Individual: Rexford Industrial Contact Person: Ricardo Rivas
Street Address: 555 Anton Blvd, Suite 910 Title: Senior Project Manager
City Costa Mesa State CA Zip 92626 Phone: (424) 256-2115

II. Information about Site Relevant to WQMP

Name of Project: Glassell Street Industrial Project
Title of WQMP applicable to site: _____
Street Address of the site: 2411 N. Glassell Street
Date of Transfer of Responsibility: _____

III. New Owner (Upon Transfer)/ Responsible Party Information

Company/ Individual: _____ Contact Person: _____
Street Address: _____ Title: _____
City _____ State _____ Zip _____ Phone: _____

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- B. Educational Material
- C. BMP Details
 - C-1: OC TGD Rainfall Zones Map
 - C-2: Design Capture Volume Calculations
 - C-3: BMP Product Sheets
- D. BMP Maintenance Information
- E. Geotechnical Infiltration Testing (for reference only)
 - E-1: OC TGD Infiltration Worksheet (Worksheet I)
 - E-2: Leighton Geotechnical Report (Dated 08-25-2021)
- F. Hydrology Information (Q2 – Two-year frequency storm evaluation)
 - F-1: OC TGD Susceptibility Analysis
 - F-2: Existing & Proposed Hydrology Maps
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**I. Discretionary Permit Number(s), Water Quality Condition
Number(s) and Conditions of Approval**

APN No. 374-381-01 & 374-381-02

Legal Description: Parcels 1 and 2 in the City of Orange, County of Orange, State of California, as per map recorded in Book 3, page 25 of Miscellaneous Maps, in the office of the County Recorder of said county.

GPS Coordinates: 33.82852°N 117.85154°W

Water Quality Conditions (WQMP conditions listed below)

A complete copy of the signed Conditions of Approval, Resolution Number TBD dated XX/XX/202X are included as Appendix A

Conditions of Approval:

Insert text providing the conditions of approval related to water quality (stated verbatim).

TBD.

II. Project Description

Refer to Section 2.2 of the Technical Guidance Document for completion of this section.

Planning Area (Location): 2411 N. Glassell Street is not located in a City of Orange Specific Planning Area, and therefore is governed by the City of Orange General Plan.

Project Site Area (ac): 12.103 ac

Project Disturbed Area (ac): 12.103 ac

Percent Change in Impermeable Surfaces: +16.1%

SIC Code 1541: General Contractors – Industrial Buildings and Warehouses

General contractors primarily engaged in the construction (including new work, additions, alterations, remodeling, and repair) of industrial buildings and warehouses, such as aluminum plants, automobile assembly plants, pharmaceutical manufacturing plants, and commercial warehouses.

Project Description

Proposed site improvements include the construction of drain inlets and underground facilities to capture and convey runoff into existing storm drain infrastructure within Glassell Street. Drainage of the industrial structures, streets, and landscape facilities will include catch basin inlets that are designed to capture storm water runoff and convey the runoff to the proposed on-site storm drain pipes. The runoff in the storm drain pipes is then transported into its designated pre-treatment device and infiltration chamber. Trash enclosures are proposed for the project site and have been designed to minimize introduction of trash and pollutants into the proposed storm drain facilities. Trash enclosures shall meet OMC standard. Loading bays/docks are not recessed. Grates and catch basins will have filter inserts to reduce debris entering in the system.

Project Purpose and Activities

Project proposes to redevelop existing 12.103-acre site with a ~277,000 square foot light industrial building. The site will contain LID BMPs that are outlined in the WQMP. New industrial driveways, parking areas, truck bays, and landscaping will be constructed. The on-site landscape areas shall be recessed approximately 1" from adjacent finished surface to allow capture of smaller storm events.

Potential Storm Water Pollutants

According to OC TGD Table 2.2 and the California State Water Resources Control Board, the Santa Ana River Reach 2 does not have any listed pollutants of concern. Potential or expected pollutant regardless of 303(d) are indicator bacteria.

Hydrologic Conditions of Concern

Per the Orange County Watershed Master Planning Susceptibility Analysis Santa Ana River exhibit, the Project Site is not within an area of “Potential Areas of Erosion, Habitat & Physical Structure Susceptibility”. The exhibit shows that the runoff from the site is discharged onto “Earth (Stabilized)”, and “Stabilized” portions of channel infrastructure downstream of the Project Site.

Susceptibility Mapping Summary

Stream Name	Bed and Banks Composition	Susceptibility to Hydromodification
City 30” RCP	RCP	No
Collins Channel	Concrete Lined	No
Santa Ana River	River / Concrete Lined	No
Pacific Ocean	n/a	n/a

The implementation of the hydromodification BMPs are not required onsite. The project will capture and infiltrate the Design Capture Volume (DCV) calculated in IV.8 of this WQMP. The downstream conveyances are fully managed and engineered conveyances that vary from concrete-lined or rip-rap bottomed to sand-bottomed at discharge point into Santa Ana River Reach 2. Santa Ana River Reach 2 is also managed and engineered, and it is not susceptible to sedimentation and erosion.

For reference see Appendix F-1 for Susceptibility Map and Drainage Facilities Map.

Post Development Drainage Characteristics

Within the project site, proposed grading has designated the overall site hydrology into one Drainage Management Area (DMA). The DMA will contain a water quality and infiltration system with an overflow structure that conveys large storm events via storm drain line in Glassell Street. The DMA’s infiltration chamber has been sized according to the design capture volume (DCV) required in the Orange County Technical Guidance Document. Stormwater will be pretreated by grate/catch basin inlet filters prior to entering the Contech CDS unit that will remove trash, debris, and neutrally buoyant particles 5.0mm and larger. During the 100-year storm event the system begins to outlet once DCV is reached. The water will begin to back up to the Proposed 24-inch outlet connecting to the existing 30-in storm drain line in Glassell Street. When the system can no longer outlet it will begin to infiltrate and be empty within the 48-hour drawdown time after the peak event.

Commercial Projects

N/A

Site Ownership and any Easements

The project site is owned by Rexford Industrial. Contact information can be found below:

Name: Ricardo Rivas

Title: Senior Project Manager

Company: Rexford Industrial

Address: 555 Anton Blvd, Suite 910, Costa Mesa, CA 92626

Telephone Number: (424) 256-2115

Existing on-site easements include:

1. An easement for road purposes in favor of the county of orange recorded may 13, 1918, in book 324, page 4, of deeds.
2. An easement for public utility purposes in favor of the city of orange recorded august 20, 1986, as instrument no. 86-373397, official records.

Site Characteristics

Drainage runoff from the existing site outlets at the southwest corner into the back side of an existing catch basin on Glassell Street. There is existing on-site underground drainage infrastructure that includes storm drain pipe and catch basins that connects to the public storm drain on Glassell Street. The project site consists of two light industrial parcels (APN's 374-381-01 and 374-381-02) and one existing development. The two parcels are 73% impervious and are covered by 3 existing buildings and an existing parking area. The site is generally flat, with slopes ranging from 0-3%. Per the Leighton Geotechnical Exploration Report (Dated 12-20-2021), groundwater was not encountered to a maximum explored depth of 41 feet below existing grade. California Department of Water Resources monitoring well (State Well #04S09W07N001S) approximately 0.9 miles away from the project site indicates the shallowest groundwater level at 96.6 feet below existing grade. Two infiltration wells LP-1 and LP-2 were conducted in accordance with Orange County guidelines. Each well was dug to a depth of 5-10 feet below existing grade, and found a measured 12.5 inches per hour at well LP-1, and 7.6 inches per hour at well LP-2.

Watershed Characteristics

Watershed: Santa Ana River

Downstream Receiving Waters: Collins Channel, Reach 2 of Santa Ana River, Pacific Ocean

Water Quality Impairments (if applicable): N/A

Identify hydromodification susceptibility:

Susceptibility Mapping Summary

Stream Name	Bed and Banks Composition	Susceptibility to Hydromodification
City 30" RCP	RCP	No
Fletcher Channel	Concrete Lined	No
Santa Ana River	River / Concrete Lined	No
Pacific Ocean	n/a	n/a

The implementation of the hydromodification BMPs are not required onsite. The project will capture and infiltrate the Design Capture Volume (DCV) calculated in IV.8 of this WQMP. The downstream conveyances are fully managed and engineered conveyances that vary from concrete-lined or rip-rap bottomed to sand-bottomed at discharge point into Santa Ana River Reach 2. Santa Ana River Reach 2 is also managed and engineered, and it is not susceptible to sedimentation and erosion.

For reference see Appendix F-1 for Susceptibility Map and Drainage Facilities Map.

Identify watershed management priorities: N/A

IV. Best Management Practices

- Priority Projects must infiltrate, harvest and use, or biotreat/biofilter, the 85th percentile, 24-hour storm event (Design Capture Volume).
- A properly designed biotreatment system may only be considered if infiltration, harvest and use, and evapotranspiration (ET) cannot be feasibly implemented for the full design capture volume. In this case, infiltration, harvest and use, and ET practices must be implemented to the greatest extent feasible and biotreatment may be provided for the remaining Design Capture Volume. A diversity of controls will be provided, if feasible, to achieve the greatest feasible retention of the Design Capture Volume, then if necessary, biotreatment of the remaining Design Capture Volume.

Equivalent performance criteria have been synthesized from permit requirements with consideration of the MEP standard and analysis of local precipitation and ET patterns. The following performance criteria result in capture and retention and/or biotreatment of 80 percent of average annual stormwater runoff volume. The performance criteria for LID are stated as follows:

- LID BMPs must be design to retain, on-site, (infiltrate, harvest and use, or evapotranspire) stormwater runoff as feasible up to the Design Capture Volume, and
- Recover (i.e., draw down) the storage volume as soon as possible after a storm event (see criteria for maximizing drawdown rate in the TGD Appendix XI), and, if necessary
- Biotreat, on-site, additional runoff, as feasible, up to 80 percent average annual capture efficiency (cumulative, retention plus biotreatment), and, if necessary
- NOC Permit Area only – retain or biotreat, in a regional facility, the remaining runoff up to 80 percent average annual capture efficiency (cumulative, retention plus biotreatment, on-site plus off-site), and, if necessary
- Fulfill alternative compliance obligations for runoff volume not retained or biotreated up to 80 percent average annual capture efficiency using treatment controls or other alternative approaches as described in Section 7.II.3.

IV.1 Site Design and Drainage Characteristics

Table 1

Site Design BMPs

Technique	Included?		If no, state justification.
	Yes	No	
Minimize Directly Connected Impervious Areas (DCIAs) (C-Factor Reduction)		X	See below.
Create Reduced or "Zero Discharge" Areas (Runoff Volume Reduction) ¹	X		
Minimize Impervious Area/Maximize Permeability (C-Factor Reduction) ²		X	See below.
Conserve Natural Areas (C-Factor Reduction)		X	See below.

1 Detention and retention areas incorporated into landscape design provide areas for retaining and detaining stormwater flows, resulting in lower runoff rates and reductions in volume due to limited infiltration and evaporation. Such Site Design BMPs may reduce the size of Treatment Control BMPs.

2 The "C Factor" is a representation of the ability of a surface to produce runoff. Surfaces that produce higher volumes of runoff are represented by higher C Factors. By incorporating more pervious, lower C Factor surfaces into a development, lower volumes of runoff will be produced. Lower volumes and rates of runoff translate directly to lowering treatment requirements.

Minimize Directly Connected Impervious Areas: Traditional industrial projects regularly propose 90% site imperviousness, which makes disconnecting impervious areas not feasible.

Create Reduced or "Zero Discharge" Areas: Landscaping adjacent to both proposed industrial structures creates areas within the project that can be considered "zero discharge". Native soil conditions are favorable to infiltrate/convey small storm events. On-site landscape areas will be recessed approximately 1" from adjacent finished surface to allow capture of smaller storm events.

Minimize Impervious Area/Maximize Permeability: Proposed industrial site characteristics and activities will not maximize site permeability.

Conserve Natural Areas: Due to the site being previously developed, conservation of natural areas is not feasible.

IV.2 Source Control BMPs

IV.2.1 Routine Non-Structural BMPs

Table 2

Routine Non-Structural BMPs

BMP No.	Name	Check One		If not applicable, state brief reason.
		Included	Not Applicable	
N1	Education for Property Owners, Tenants and Occupants	X		
N2	Activity Restriction	X		
N3	Common Area Landscape Management	X		
N4	BMP Maintenance	X		
N5	Title 22 CCR Compliance		X	This project does not have recycled water.
N6	Local Water Quality Permit Compliance		X	This BMP is not applicable. The City of Orange does not issue water quality permits.
N7	Spill Contingency Plan		X	Proposed project will not contain hazardous materials or fueling operations, and will not require a spill contingency plan.
N8	Underground Storage Tank Compliance		X	This project does not have underground tanks.
N9	Hazardous Materials Disclosure Compliance		X	Proposed project will not contain hazardous materials. No disclosure is necessary.
N10	Uniform Fire Code Implementation		X	Proposed project does not include hazardous materials (toxic and highly toxic compressed gases).
N11	Common Area Litter Control	X		
N12	Employee Training	X		
N13	Housekeeping of Loading Docks	X		
N14	Common Area Catch Basin Inspection	X		
N15	Street Sweeping Private Streets and Parking Lots	X		

N1 Education of Property Owners, Tenants and Occupants:

Practical information will be provided to the tenants by the Property Manager on general housekeeping practices for each type of site occupancy that contribute to protection of storm water quality. Information will include, but not limited to the attachments provided in Attachment 8. The following resources can be contacted to obtain updated educational information at the County of Orange Stormwater Program website (<http://www.H2OC.org>) and the California Storm water Quality Association's (CASQA) BMP Handbooks (<http://www.casqa.org/resources/bmphandbooks>).

N2 Activity Restrictions:

The owner(s) are to develop continuous activity restrictions that include potential impacts to stormwater quality. The following is a list of activity restrictions, but are not limited:

- Do not wash water from concrete, mortar or other construction activities to enter the storm drain system.
- No unauthorized car washing will be permitted on the premises.
- No changing of car oil or other auto repairs will be permitted on the premises.
- On-Site Cleaning of trash dumpsters with water is prohibited.
- Do not sweep grass clippings, dead leaves into catch basins or other landscaping related debris into catch basins.
- Keep trash container areas free of litter.
- Do not perform paint cleanup activities in paved areas or allow rinse water from these activities to enter the storm drain system.
- Do not use detergents or other chemicals additives when washing concrete sidewalks or building exteriors, use potable water only when and collect wash water runoff using a vacuum truck, for proper offsite disposal.

N3 Common Area Landscape Management:

Maintenance activities for landscape areas shall be consistent with County/City and manufacturer guidelines for fertilizer and pesticide use. Maintenance includes trimming, weeding and debris removal and vegetation planting and replacement. Stockpiled materials during maintenance activities shall be placed away from drain inlets and runoff conveyance devices. Wastes shall be properly disposed of or recycled. Maintenance for common areas and landscape parking islands is scheduled by owner(s).

N4 BMP Maintenance:

Responsibility for implementation, inspection and maintenance of all BMPs (structural and non-structural) shall be consistent with the BMP Inspection and Maintenance Responsibilities Matrix provided in Section V of this WQMP, with documented records of inspections and maintenance activities completed. Cleaning of all structural BMP Facilities is scheduled by future owner(s).

N11 Common Area Litter Control:

Litter control onsite will include the use of litter patrols, violation reporting and clean up during landscaping maintenance activities and as needed to ensure good housekeeping of the project's common areas.

N12 Employee Training:

An Employee Training/Education program shall be provided annually to help educate employees about storm water quality management and practices that help prevent storm water pollution. Documentation of such training/education program implementation shall be kept by the owner for a minimum of ten years.

N13 Housekeeping of Loading Docks:

The project site will have lowered truck docks. The truck docks and inlets shall be inspected on a weekly basis to help ensure that any trash and debris are collected prior to being washed into the underground storm drain system. Documentation of such inspection/maintenance shall be kept by the owner in perpetuity. The truck dock inlets hydrocarbon filters shall be serviced no less than three times a year, and once prior to the start of rainy season (October 1st).

N14 Common Area Catch Basin Inspection:

The on-site catch basins shall be inspected on a quarterly basis. Inspection of the on-site catch basins shall consist of visual inspection of any sediment, trash, or debris collected in the bottom of the catch basin. Any sediment, trash, or debris shall be removed from the catch basins and disposed of in a legal manner. Documentation of such inspection/maintenance shall be kept by the owner in perpetuity.

N15 Street Sweeping Private Streets and Parking Lots:

The on-site parking lots, drive aisles, and loading dock areas shall be swept by a sweeper truck on a monthly basis. Documentation of such sweeping shall be kept by the owner in perpetuity. Frequency of sweeping shall be adjusted as needed to maintain a clean site.

IV.2.2 Routine Structural BMPs

Table 3

Routine Structural BMPs

Name	Check One		If not applicable, state brief reason
	Included	Not Applicable	
Provide storm drain system stenciling and signage- "No Dumping – Drains to Ocean"	X		
Design and construct outdoor material storage areas to reduce pollution introduction		X	No outdoor material storage.
Design and construct trash and waste storage areas to reduce pollution introduction	X		
Use efficient irrigation systems & landscape design	X		
Protect slopes and channels and provide energy dissipation		X	Project does not include slopes or channels.
Incorporate requirements applicable to individual project features			
a. Dock areas	X		
b. Maintenance bays		X	Project does not include maintenance bays.
c. Vehicle or community wash areas		X	Project does not include vehicle wash areas.
d. Outdoor processing areas		X	Project does not include outdoor equipment.
e. Equipment wash areas		X	Project does not include outdoor equipment.
f. Fueling areas		X	Project does not include fueling areas.
g. Hillside landscaping		X	Project does not include hillside landscaping.
h. Wash water control for food preparation areas		X	Project does not include food preparation areas.

Provide Storm Drain Stenciling:

The on-site storm drain catch basins shall be stenciled with the phrase "Do Not Dump – Drains to Ocean" or other approved language. The signage shall be inspected on an annual basis. Missing or faded signage shall be replaced. Documentation of such inspection/maintenance shall be kept by the owner in perpetuity.

Design and Construct Trash and Waste Storage Areas to Reduce Pollution:

Trash storage areas will be designed to have adjacent areas drain away from the trash storage areas. The trash storage areas shall be inspected and maintained on a weekly basis.

Collection of trash from the trash storage areas shall occur on a regular basis to ensure that the trash receptacles are not overflowing. Documentation of such inspection/maintenance and trash collection shall be kept by the owner in perpetuity. Trash enclose to be designed per Standard 409.

Loading Dock Areas:

Truck bays are depressed 4.0' from the finish floor elevation of the building, and shall contain inlets to prevent ponding of storm water. All loading dock inlets shall be FloGard storm drain inlets with absorbent pouches to limit contaminants/pollutants from entering the hydrodynamic separator, infiltration chamber, and groundwater. Alongside the FloGard inlets, loading dock areas shall be kept in accordance with N13 (Housekeeping of Loading Docks). Maintenance of FloGard inlets with absorbent pouches and Contech CDS hydrodynamic separator shall be in accordance with Table 8: Maintenance Frequency Matrix found in Section V of this WQMP.

Documentation of such inspection/maintenance activities shall be kept by the owner in perpetuity.

IV.3 Low Impact Development BMP Selection

Underground infiltration chambers with hydrodynamic separators as pretreatment were selected as the project LID BMPs due to on-site groundwater and soils conditions that are generally favorable for infiltration.

IV.3.1 Hydrologic Source Controls

No Hydrologic Source Controls were selected for this project. The proposed infiltration BMPs are able to address the calculated Design Capture Volume.

**Table 4
Hydrologic Source Control BMPs**

Name	Check If Used
Localized on-lot infiltration	☐
Impervious area dispersion (e.g. roof top disconnection)	☐
Street trees (canopy interception)	☐
Residential rain barrels (not actively managed)	☐
Green roofs/Brown roofs	☐
Blue roofs	☐
Other:	☐
Other:	☐
Other:	☐
Other:	☐
Other:	☐
Other:	☐
Other:	☐
Other:	☐

IV.3.2 Infiltration BMPs

Table 5

Infiltration BMPs

Name	Check If Used
Bioretention without underdrains	☐
Rain gardens	☐
Porous landscaping	☐
Infiltration planters	☐
Retention swales	☐
Infiltration trenches	☐
Infiltration basins	☐
Drywells	☐
Subsurface infiltration galleries	☒
French drains	☐
Permeable asphalt	☐
Permeable concrete	☐
Permeable concrete pavers	☐
Other:	☐
Other:	☐

Storm water runoff is proposed to be conveyed to on-site parking lot where it's captured by catch basins, and pre-treated by a Contech CDS hydrodynamic separator. Flow is then transported to underground storage chambers via proposed storm drain infrastructure. Retention depth provided by the underground infiltration chambers equals the depth that would drawdown down in 48 hours. The proposed infiltration chambers are designed to carry a maximum storage depth of 6.0' (not including the underlying rock layer) before high-water flows exit the system via a high point invert in proposed storm drain manhole (i.e. the invert of Infiltration Chamber 'A' is 188.00 and the tipping point for high-water flows existing the manhole is 194.00). After exiting the high point in the storm drain manhole, runoff will overflow into private, on-site storm drain facilities that convey large storm events into off-site drainage infrastructure.

According to Table 2.1 of the OC TGD, anticipated and potential pollutants from the proposed industrial site include: suspended solid/sediments, nutrients, pesticides, oil & grease, toxic organic compounds, and trash & debris. The proposed Contech CDS units for pre-treatment prior to infiltration will remove hydrocarbons (oil & grease), trash, and debris. According to Table 4.4 of the OC TGD, the proposed underground infiltration chambers will remove suspended solids / sediment, particulate-bound pollutants, nitrogen compounds, phosphorus, heavy metals, microbial / viral pathogens, oils, grease, and toxic organic compounds. All potential pollutants of concern are addressed by the proposed on-site BMPs.

TECHNICAL GUIDANCE DOCUMENT APPENDICES

Worksheet I: Summary of Groundwater-related Feasibility Criteria

1	Is project large or small? (as defined by Table VIII.2) circle one	☒ Large	☐ Small
2	What is the tributary area to the BMP?	A	12.103 acres
3	What type of BMP is proposed?	One infiltration chamber	
4	What is the infiltrating surface area of the proposed BMP?	A _{BMP}	X,XXX sq-ft
5	What land use activities are present in the tributary area (list all) Light Industrial		
6	What land use-based risk category is applicable?	L	☒ M ☐ H
7	If M or H, what pretreatment and source isolation BMPs have been considered and are proposed (describe all): All storm water runoff will be pre-treated by a Contech CDS hydrodynamic separator before going into each infiltration chamber.		
8	What minimum separation to mounded seasonally high groundwater applies to the proposed BMP? See Section VIII.2 (circle one)	5 ft	☒ 10 ft
9	Provide rationale for selection of applicable minimum separation to seasonally high mounded groundwater: Per the geotechnical report by Leighton (dated 12-20-2021), groundwater is at a maximum height of 41 feet below grade. The proposed infiltration chamber will be at a maximum depth of 10 feet below grade, which is greater than 15 feet.		
10	What is separation from the infiltrating surface to seasonally high groundwater?	SHGWT	N/A ft
11	What is separation from the infiltrating surface to mounded seasonally high groundwater?	Mounded SHGWT	N/A ft
12	Describe assumptions and methods used for mounding analysis: N/A		
13	Is the site within a plume protection boundary (See Figure	Y	☒ N ☐ N/A

TECHNICAL GUIDANCE DOCUMENT APPENDICES

Worksheet I: Summary of Groundwater-related Feasibility Criteria

	VIII.2)?	
14	Is the site within a selenium source area or other natural plume area (See Figure VIII.2)?	Y ☒ N N/A
15	Is the site within 250 feet of a contaminated site?	Y ☒ N N/A
16	If site-specific study has been prepared, provide citation and briefly summarize relevant findings: N/A	
17	Is the site within 100 feet of a water supply well, spring, septic system?	Y ☒ N N/A
18	Is infiltration feasible on the site relative to groundwater-related criteria?	☒ Y N
Provide rationale for feasibility determination: Per the Leighton geotechnical report (dated 12-20-2021), two infiltration wells (LP-1 & LP-2) were dug according to Orange County standards. Well LP-1 had a measured infiltration rate of 12.5 inches per hour, and well LP-2 had a measured infiltration rate of 7.6 inches per hour. The project site containing infiltration rates above the minimum feasibility criteria of 0.3 inch per hour shows that infiltration is feasible.		

Note: if a single criterion or group of criteria would render infiltration infeasible, it is not necessary to evaluate every question in this worksheet.

IV.3.3 Evapotranspiration, Rainwater Harvesting BMPs

**Table 6
Evapotranspiration, Rainwater Harvesting BMP**

Name	Check If Used
All HSCs; <i>See Section IV.3.1</i>	☐
Surface-based infiltration BMPs	☐
Biotreatment BMPs	☐
Above-ground cisterns and basins	☐
Underground detention	☐
Other:	☐
Other:	☐
Other:	☐

The proposed infiltration BMPs with pre-treatment are able to address the full Design Capture Volume from the project site, and therefore no additional LID BMPs are required.

IV.3.4 Biotreatment BMPs

**Table 7
Biotreatment BMPs**

Bioretention with underdrains	☐
Storm water planter boxes with underdrains	☐
Rain gardens with underdrains	☐
Constructed wetlands	☐
Vegetated swales	☐
Vegetated filter strips	☐
Proprietary vegetated biotreatment systems	☐
Wet extended detention basin	☐
Dry extended detention basins	☐
Other:	☐
Other:	☐

The proposed infiltration BMPs with pre-treatment are able to address the full Design Capture Volume from the project site, and therefore no additional LID BMPs are required.

IV.3.5 Hydromodification Control BMPs

The project site is hydromodification exempt, therefore additional hydromodification BMPs are not required.

IV.3.6 Regional/Sub-Regional LID BMPs

N/A

IV.3.7 Treatment Control BMPs

Hydrodynamic separators and filtered inlets are selected as the pre-treatment BMPs prior to stormwater entering the infiltration BMPs. BMP 'HS-A' is a Contech CDS unit that is capable of capturing 100% of particulate material, including trash and debris, greater than the screen aperture size. Medium to coarse sediments 5.0mm and larger that are neutrally buoyant will be suspended in the system without blinding the screen. FloGard inlets with absorbent pouches in the truck bays will effectively act as "pre-treatment" for the CDS units to prevent excess hydrocarbons, total suspended solids, and phosphorus from entering the hydrodynamic separator and infiltration chamber. Any further oil and hydrocarbons can be effectively captured when the CDS unit is equipped with an oil baffle.

IV. 4 Water Quality Credits

N/A

IV.5 Alternative Compliance Plan

N/A

IV.6 Vector Control

According to the Orange County Technical Guidance Document, all BMPs within the project site must drawdown within 48 hours. Infiltration Chamber 'A' has a drawdown depth well under the maximum (Dmax) to drawdown in 48 hours. See section IV.8 DCV calculation worksheets for exact drawdown calculations. Any standing water within proposed Contech CDS units must be removed according to the Operation & Maintenance Plan found in Section 5 of this WQMP.

IV.7 Drainage Management Area (DMA)

The project has one Drainage Management Area (DMA) to be utilized for defining drainage areas and sizing LID and other treatment control BMPs. The DMA has been delineated based on the proposed site grading patterns. DMA A collects runoff from mixed surface types (asphalt, concrete, roofs, landscape). The Design Capture Volume (DCV) calculations are found in the worksheets below. These have been derived using the North Orange county Technical Guidance Document. Locations of DMA and BMPs are identified on the BMP Exhibit.

DMA Number	BMPs	Area Treated
A	Pre-treatment, Infiltration	12.103 acres
Total Area		12.103 acres

Total Project Area= 12.103 acres

Infiltration systems have been sized to capture all landscaping around the building, but some adjacent landscaping areas will convey/contain runoff via swales and infiltration. Large storm events will overflow into adjacent street.

IV.8 Calculations

IV.8 Calculations

TECHNICAL GUIDANCE DOCUMENT APPENDICES

Worksheet B: Simple Design Capture Volume Sizing Method

Step 1: Determine the design capture storm depth used for calculating volume				
1	Enter design capture storm depth from Figure III.1, d (inches)	$d =$	0.85	inches
2	Enter the effect of provided HSCs, d_{HSC} (inches) (Worksheet A)	$d_{HSC} =$	0.00	inches
3	Calculate the remainder of the design capture storm depth, $d_{remainder}$ (inches) (Line 1 - Line 2)	$d_{remainder} =$	0.85	inches
Step 2: Calculate the DCV				
1	Enter Project area tributary to BMP (s), A (acres)	$A =$	12.103	acres
2	Enter Project Imperviousness, imp (unitless)	$imp =$	0.90	
3	Calculate runoff coefficient, $C = (0.75 \times imp) + 0.15$	$C =$	0.83	
4	Calculate runoff volume, $V_{design} = (C \times d_{remainder} \times A \times 43560 \times (1/12))$	$V_{design} =$	30,995	cu-ft
Step 3: Design BMPs to ensure full retention of the DCV				
Step 3a: Determine design infiltration rate				
1	Enter measured infiltration rate, $K_{observed}$ ¹ (in/hr) (Appendix VII)	$K_{observed} =$	7.6	In/hr
2	Enter combined safety factor from Worksheet H, S_{total} (unitless)	$S_{total} =$	3.06	
3	Calculate design infiltration rate, $K_{design} = K_{observed} / S_{total}$	$K_{design} =$	2.48	In/hr
Step 3b: Determine minimum BMP footprint				
4	Enter drawdown time, T (max 48 hours)	$T =$	48	Hours
5	Calculate max retention depth that can be drawn down within the drawdown time (feet), $D_{max} = K_{design} \times T \times (1/12)$	$D_{max} =$	9.92	feet
6	Calculate minimum area required for BMP (sq-ft), $A_{min} = V_{design} / d_{max}$	$A_{min} =$	3,124	sq-ft

¹ $K_{observed}$ is the vertical infiltration measured in the field, before applying a factor of safety. If field testing measures a rate that is different than the vertical infiltration rate (for example, three-dimensional borehole percolation rate), then this rate must be adjusted by an acceptable method (for example, Porchet method) to yield the field estimate of vertical infiltration rate, $K_{observed}$. See Appendix VII.

TECHNICAL GUIDANCE DOCUMENT APPENDICES

Worksheet H: Factor of Safety and Design Infiltration Rate and Worksheet

Factor Category		Factor Description	Assigned Weight (w)	Factor Value (v)	Product (p) p = w x v
A	Suitability Assessment	Soil assessment methods	0.25	2	0.5
		Predominant soil texture	0.25	1	0.25
		Site soil variability	0.25	2	0.5
		Depth to groundwater / impervious layer	0.25	2	0.5
		Suitability Assessment Safety Factor, S _A = Σp			
B	Design	Tributary area size	0.25	3	0.75
		Level of pretreatment/ expected sediment loads	0.25	1	0.25
		Redundancy	0.25	2	0.50
		Compaction during construction	0.25	1	0.25
		Design Safety Factor, S _B = Σp			
Combined Safety Factor, S _{Total} = S _A x S _B				3.06	
Observed Infiltration Rate, inch/hr, K _{observed} (corrected for test-specific bias)				7.6	
Design Infiltration Rate, in/hr, K _{DESIGN} = K _{Observed} / S _{Total}				2.48	
Supporting Data					
Briefly describe infiltration test and provide reference to test forms:					
Safety Factor of 3.06 will be used for BMP calculations.					

Note: The minimum combined adjustment factor shall not be less than 2.0 and the maximum combined adjustment factor shall not exceed 9.0.

WQMP for Glassell Street Industrial Project

Boring Percolation Test Data Sheet

Project Number:	13333.001	Test Hole Number:	LP-1
Project Name:	Rexford Glassell	Date Excavated:	11/4/2021
Earth Description:	Alluvium	Date Tested:	11/12/2021
Liquid Description:	Tap water	Depth of boring (ft):	10
Tested By:	MM	Radius of boring, r (in):	4
		Diameter of casing (in):	2
		Length of slotted of casing (ft):	5
		Depth to Initial Water Depth (ft):	7
		Porosity of Annulus Material, n:	0.35
		Bentonite Plug at Bottom:	No

Field Percolation Data

Reading	Time	Time Interval, Δt (minutes)	Depth to Water (feet bgs)	Water Height, H (inches)	Cumulative Water Volume Delivered (gallons)
1	10:40	-	-	-	0.0
2	10:50	10	6.53	41.6	10.0
3	11:00	10	6.49	42.1	19.9
4	11:10	10	6.47	42.4	29.9
5	11:20	10	6.50	42.0	39.9
6	11:30	10	6.51	41.9	49.8
7	11:40	10	6.51	41.9	59.8
8	11:50	10	6.49	42.1	69.8

Total Volume of Water Delivered (gallons)	69.8
Total Volume of Water Delivered (cubic inches)	16116.639
Average Water Height (inches)	42.0
Average Percolation Surface Area (cubic Inches)	1105.8
Duration of Test (minutes)	70
Duration of Test (hours)	1.17

Measured Infiltration Rate = (Total Volume)/(Test Duration)/(Surface Area)

Measured Infiltration Rate (inches per hour) = 12.5

**WQMP for
Glassell Street Industrial Project**

Boring Percolation Test Data Sheet

Project Number:	13333.001	Test Hole Number:	LP-2
Project Name:	Rexford Glassell	Date Excavated:	11/4/2021
Earth Description:	Alluvium	Date Tested:	11/12/2021
Liquid Description:	Tap water	Depth of boring (ft):	10
Tested By:	MM	Radius of boring, r (in):	4
		Diameter of casing (in):	2
		Length of slotted of casing (ft):	5
		Depth to Initial Water Depth (ft):	6
		Porosity of Annulus Material, n :	0.35
		Bentonite Plug at Bottom:	No

Field Percolation Data

Reading	Time	Time Interval, Δt (minutes)	Depth to Water (feet bgs)	Water Height, H (inches)	Cumulative Water Volume Delivered (gallons)
1	7:50	-	-	-	0.0
2	8:00	10	6.02	47.8	7.0
3	8:10	10	5.97	48.4	13.9
4	8:20	10	5.93	48.8	20.9
5	8:30	10	5.93	48.8	27.8
6	8:40	10	5.94	48.7	34.8
7	8:50	10	5.95	48.6	41.7
8	9:00	10	5.96	48.5	48.7

Total Volume of Water Delivered (gallons)	48.7
Total Volume of Water Delivered (cubic inches)	11238.15
Average Water Height (inches)	48.5
Average Percolation Surface Area (cubic Inches)	1269.6
Duration of Test (minutes)	70
Duration of Test (hours)	1.17

Measured Infiltration Rate = (Total Volume)/(Test Duration)/(Surface Area)

Measured Infiltration Rate (inches per hour) = 7.6

Phone Number: (424) 256-2115

**WQMP for
Glassell Street Industrial Project**

BMP	Responsible Party	*Maintenance Activity	*Inspection/Maintenance Frequency
Source Control BMPs (Structural and Non-structural)			
N1 Education for Property Owners, Tenants and Occupants	Owner	Educational Materials will be provided to the tenants. Owner shall distribute appropriate materials to owners and/or occupants via language, mailings, website, or meeting.	Annually
N2 Activity Restrictions	Owner	Conditions, covenants and restrictions must be prepared by the developer or building operator through terms and conditions to protect surface water quality.	On-going
N3 Common Area Landscape	Owner	On-going landscape maintenance requirements that are consistent with the County/City.	Monthly
N4 BMP Maintenance	Owner	Scheduled by the owner for all cleaning (structural and non-structural) BMP facilities. Maintenance of BMP's implemented at the project site shall be performed at the frequency prescribed in the final WQMP. Records of inspections and BMP maintenance shall be maintained by the owner and documented in the final WQMP, and shall be available for review upon request.	Monthly
N7 Spill Contingency	Owner	If chemicals are seen to be dumped into storm drain systems, or landscaping areas, report illegal dumping to the proper authorities.	On-going
N9 Hazardous Materials Disclosure Compliance	Owner	If hazardous materials are stored on-site, the Department of Toxic Substances Control must be notified.	On-going
N10 Uniform Fire	Owner	Compliance with Article 80 of the Uniform Fire Code.	On-going

**WQMP for
Glassell Street Industrial Project**

Code Implementation			
N11 Common Area Litter Control	Owner	Litter patrol, violation inspections, reporting and other litter control activities shall be in conjunction with maintenance activities to ensure good housekeeping of the project's common areas. Litter collection and removal shall be performed on a weekly basis.	On-going.
N12 Employee Training	Owner	Developer prepares manuals for initial purchasers/leasers of the site.	On-going
N13 Housekeeping of Loading Docks	Owner	Loading docks should be kept free of all spills.	On-going
N14 Common Area Catch Basin Inspection	Owner	On-site catch basin inlets and other drainage facilities shall be inspected at least once per year, prior to the start of the rainy season (October 1 st). Inlets and other facilities shall be cleaned when the sump is 40% full and annually at a minimum.	Once a month to clean debris and silt in the bottom of drainage facilities. Intensified around October 1 st of each year prior to the "first flush" storm.
N15 Street Sweeping Private Streets and Parking Lots	Owner	The project's private streets shall be swept, at minimum, prior to the start of the traditional rainy season and as needed.	Annually as needed.
S1 Provide Storm Drain Stenciling and Signage	Owner	Storm drains shall be inspected for legibility, at a minimum, once prior to the storm season, no later than October 1 st each year. Those determined to be illegible will be re-stenciled as soon as possible. Storm drain should be stenciled every other year.	Inspect for re-stenciling needs and re-stencil as necessary annually. Re-stencil every other year.
S3 Design and Construct Trash and waste	Owner	Sweep trash area at least once per week and before October 1 st each year. Maintain area clean of trash and debris at all times.	Weekly

**WQMP for
Glassell Street Industrial Project**

storage areas to reduce pollution introduction			
S4 Use efficient irrigation systems & landscape design, water conservation, smart controllers, and source control	Owner	In conjunction with routine landscaping maintenance activities, inspect irrigation for signs of leaks, overspray and repair or adjust accordingly. Adjust system cycle to accommodate seasonal fluctuations in water demand and temperatures. Ensure use of native or drought tolerant/non-invasive plant species to minimize water consumption.	On-going
S6 Dock Areas	Owner	Ensure material loaded and unloaded at the docks does not have potential to contribute to stormwater pollution.	On-going
Low Impact Development and Treatment BMPs			
Underground Infiltration Chambers ADS Stormtech MC-7200	Owner	Sediment and trash are evacuated through an access/inspection manhole. A record of each inspection is to be maintained for the life of the system.	Annually
Pre-Treatment Device Contech CDS 3020-6-C	Owner	Maintenance includes inspecting the system and minimum of once every six months. A standard vacuum truck is applied for the removal of trash, debris and hydrocarbon filter.	

*Attach in appendix additional inspection, maintenance and operations information if required.

Regulatory Permits

N/A

Funding

Rexford Property Management shall fund and maintain all proposed BMPs. Means and methods will be disclosed in the Final WQMP.

OWNER SELF CERTIFICATION STATEMENT

As the owner representative of the Glassell Street Industrial Project for which a Water Quality Management Plan (WQMP) was approved by the City, I hereby certify under penalty of law that all Best Management Practices contained within the approved Project WQMP have been maintained and inspected in accordance with the schedule and frequency outlined in the approved WQMP Maintenance Table.

The maintenance activities and inspections conducted are shown in the attached table and have been performed by qualified and knowledgeable individuals. Structural Treatment BMPs have been inspected and certified by a licensed professional engineer.

To the best of my knowledge, the information submitted is true and accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and citations for violating water quality regulations.

Signed: _____

Name: _____

Title: _____

Company: _____

Address: _____

Telephone Number: _____

Date: _____

BMP Implementation Tracking Table

BMP	Activity	Completion Dates or Frequency	Initial
Source Control BMPs (Structural and Nonstructural)			
Low Impact Development and Treatment BMPs			

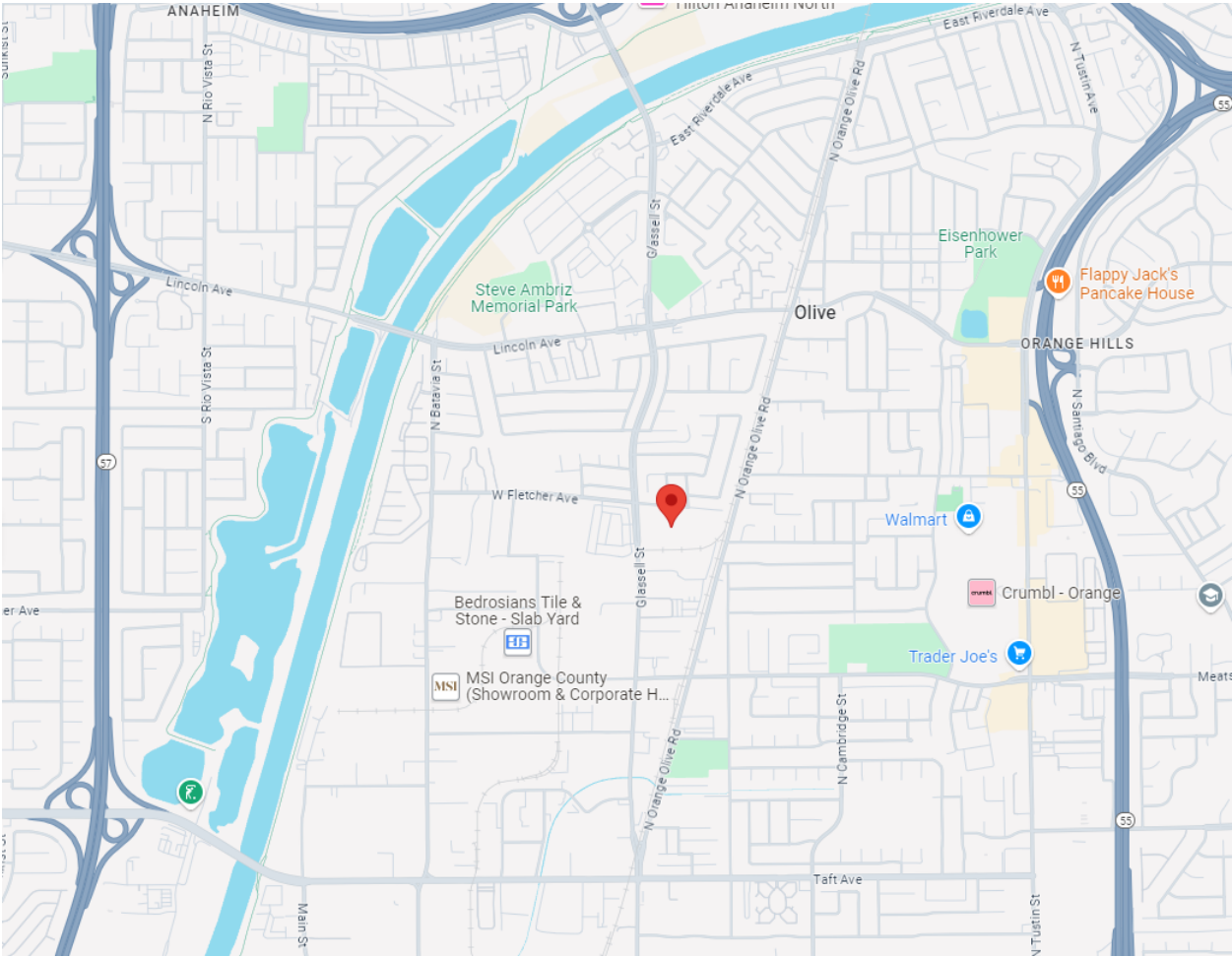
* This sheet is to be submitted annually with the Owner Self Certification Statement.

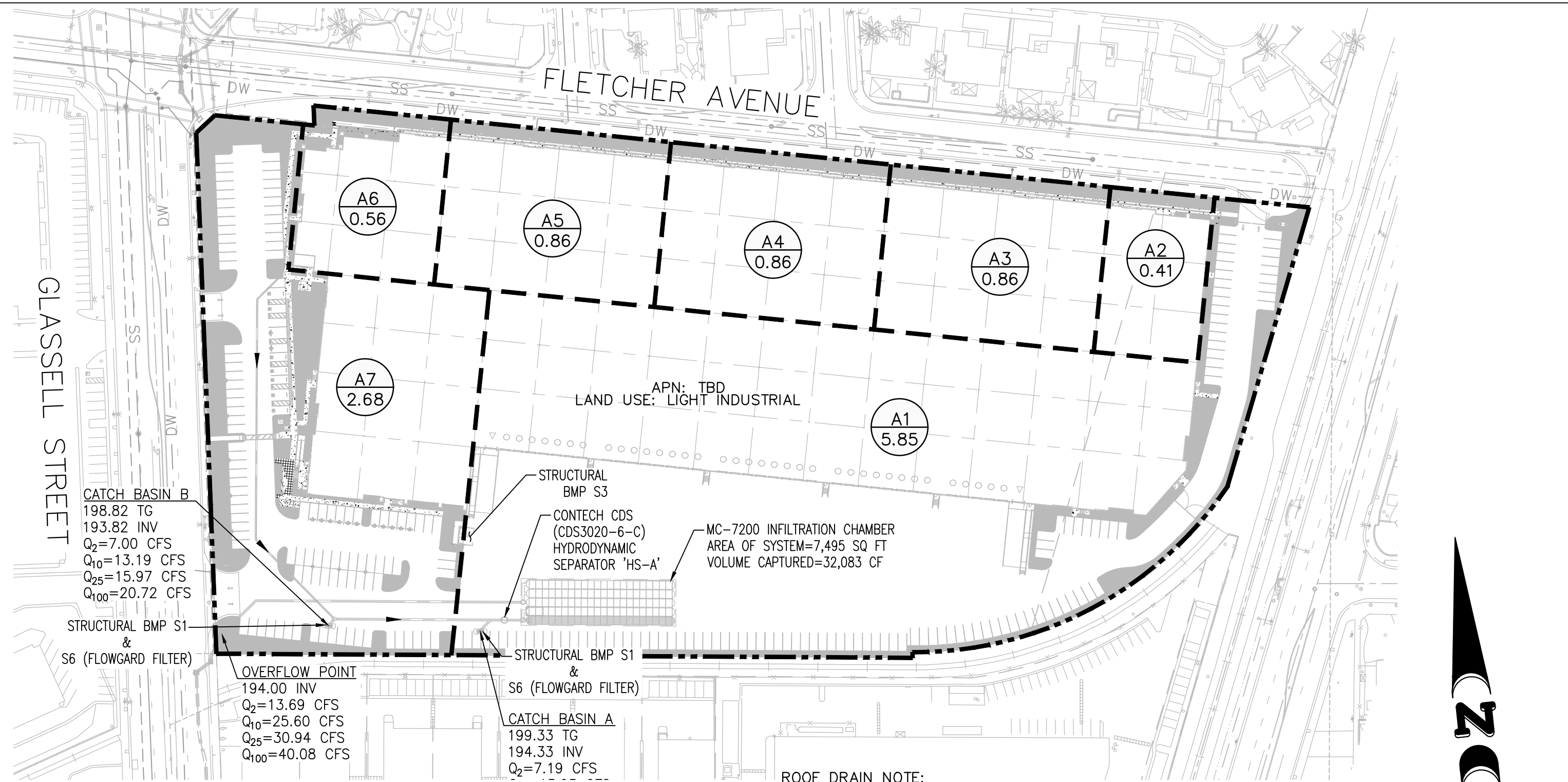
** Structural Treatment BMPs should be certified by a Licensed Professional Engineer.

VI. Location Map, Site Plan, and BMP Details

Include a location map that identifies project location and proximity to nearby water bodies. In an 11X17 sheet Identify land use, cover, feasibility constraints, structures, buildings, number of units, landscape areas, storm drain inlets, storm drain facilities, drainage flow direction, structural and treatment BMP locations, dumpsters, trash enclosures, wash areas, etc.

Reference Location Map:





PREPARED BY:
HUITT ZOLLARS
2603 Main Street, Suite 400, Irvine, California 92614
Phone: 949.988.5815 | www.huitt-zollars.com



2411 GLASSELL STREET INDUSTRIAL BUILDING BMP EXHIBIT		SHEET No. 1 OF 1	
SCALE:	HORIZ.: NONE VERT.: NONE	PROJECT NUMBER SP-XXXX	
DRAWN BY:	DS		
CHECKED BY:	AL		

VII. Educational Materials

Refer to the City's website www.cityoforange.org or the Orange County Stormwater Program (h2oc.org) for a library of materials available. Attach *only* the educational materials specifically applicable to the project.

Education Materials			
Residential Material (http://www.h2oc.org)	Check If Applicable	Business Material (http://www.h2oc.org)	Check If Applicable
The Ocean Begins at Your Front Door	☒	Tips for the Automotive Industry	☐
Tips for Car Wash Fund-raisers	☐	Tips for Using Concrete and Mortar	☐
Tips for the Home Mechanic	☐	Tips for the Food Service Industry	☐
Homeowners Guide for Sustainable Water Use	☐	Proper Maintenance Practices for Your Business	☒
Household Tips	☐	Other Material	Check If Attached
Proper Disposal of Household Hazardous Waste	☐		
Recycle at Your Local Used Oil Collection Center (North County)	☐	R-3 Automobile Parking	☒
Recycle at Your Local Used Oil Collection Center (Central County)	☐	R-6 Disposal of Green Waste	☒
Recycle at Your Local Used Oil Collection Center (South County)	☐	R-8 Water Conservation	☒
Tips for Maintaining a Septic Tank System	☐	SD-10 Site Design & Landscape Planning	☒
Responsible Pest Control	☒	SD-11 Roof Runoff Controls	☒
Sewer Spill Response	☒	SD-12 Efficient Irrigation	☒
Tips for the Home Improvement Projects	☐	SD-13 Storm Drain Signage	☒
Tips for Horse Care	☐	SD-32 Trash Storage Area	☒
Tips for Landscaping and Gardening	☐		☐
Tips for Pet Care	☐		☐
Tips for Pool Maintenance	☐		☐
Tips for Residential Pool, Landscape and Hardscape Drains	☐		☐
Tips for Projects Using Paint	☐		☐

Appendix A:

Conditions of Approval

Resolution Number_____ **dated**_____

Final Conditions of Approval to be Included with Final WQMP

Appendix B:

Educational Material

(<http://www.h2oc.org>)

(<http://www.casqa.org/resources/bmp-handbooks>)

The Ocean Begins at Your Front Door

For More Information

California Environmental Protection Agency
www.calepa.ca.gov

- **Air Resources Board**
www.arb.ca.gov
- **Department of Pesticide Regulation**
www.cdpr.ca.gov
- **Department of Toxic Substances Control**
www.dtsc.ca.gov
- **Integrated Waste Management Board**
www.ciwm.ca.gov
- **Office of Environmental Health Hazard Assessment**
www.oehha.ca.gov
- **State Water Resources Control Board**
www.waterboards.ca.gov

Earth 911 - community-specific environmental information
1-800-cleanup or visit www.1800cleanup.org

**Health Care Agency's Ocean and Bay Water Closure
and Posting Hotline**
714-433-6400 or visit www.ocbeachinfo.com

Integrated Waste Management/Dept. of Orange County-
information on household hazardous waste collection
centers, recycling centers and solid waste collection
714-834-6752 or visit www.oclandfills.com

O.C. Agriculture Commissioner
714-447-7100 or visit www.ocagcomm.com

Stormwater Best Management Practice Handbook
Visit www.cabmphandbooks.com

UC Master Gardener Hotline
714-708-1646 or visit www.uccemg.org

The Orange County Stormwater Program has created and moderates an electronic mailing list to facilitate communications, take questions and exchange ideas among its users about issues and topics related to stormwater and urban runoff and the implementation of program elements. To join the list, please send an email to ocstormwaterinfo@list.ocwatersheds.com

Orange County Stormwater Program

Aliso Viejo	(949)	425-2535
Anaheim Public Works Operations	(714)	765-6860
Brea Engineering	(714)	990-7666
Buena Park Public Works	(714)	562-3655
Costa Mesa Public Services	(714)	754-5323
Cypress Public Works	(714)	229-6740
Dana Point Public Works	(949)	248-3584
Fountain Valley Public Works	(714)	593-4441
Fullerton Engineering Dept	(714)	738-6853
Garden Grove Public Works	(714)	741-5956
Huntington Beach Public Works	(714)	536-5431
Irvine Public Works	(949)	724-6315
La Habra Public Services	(562)	905-9792
La Palma Public Works	(714)	690-3310
Laguna Beach Water Quality	(949)	497-0378
Laguna Hills Public Service	(949)	707-2650
Laguna Niguel Public Works	(949)	362-4337
Laguna Woods Public Works	(949)	639-0500
Lake Forest Public Works	(949)	461-3480
Los Alamitos Community Dev	(562)	431-3538
Mission Viejo Public Works	(949)	470-3056
Newport Beach, Code & Water Quality Enforcement	(949)	644-3215
Orange Public Works	(714)	532-6480
Placentia Public Works	(714)	993-8245
Rancho Santa Margarita	(949)	635-1800
San Clemente Environmental Programs	(949)	361-6143
San Juan Capistrano Engineering	(949)	234-4413
Santa Ana Public Works	(714)	647-3380
Seal Beach Engineering	(562)	431-2527 x317
Stanton Public Works	(714)	379-9222 x204
Tustin Public Works Engineering	(714)	573-3150
Villa Park Engineering	(714)	998-1500
Westminster Public Works Engineering	(714)	898-3311 x446
Yorba Linda Engineering	(714)	961-7138
Orange County Stormwater Program	(714)	567-6363

Orange County 24-Hour
Water Pollution Problem Reporting Hotline
(714)-567-6363

On-line Water Pollution Problem Reporting form
www.ocwatersheds.com



Printed on Recycled Paper



PROJECT
Pollution
PREVENTION

Even if you live miles from the Pacific Ocean, you may be unknowingly polluting it.

Did You Know?

- Most people believe that the largest source of water pollution in urban areas comes from specific sources such as factories and sewage treatment plants. In fact the largest source of water pollution comes from city streets, neighborhoods, construction sites, and parking lots. This type of pollution is sometimes called “non-point source” pollution.
- There are two types of non-point source pollution: stormwater and urban runoff pollution.
- Stormwater runoff refers to runoff resulting from rainfall. It is very noticeable during heavy rainstorms when large volumes of water drain off the urban landscape picking up pollutants along the way.
- Urban runoff can happen anytime of the year when excessive water use from irrigation, vehicle washing and other sources carries trash, lawn clippings and other urban pollutants into storm drains.

Where Does It Go?

- Anything we use outside homes, vehicles and businesses – like motor oil, paint, pesticides, fertilizers, and cleaners – can be blown or washed into the storm drains.
- A little water from a garden hose or rain can also send materials into the storm drains.
- Storm drains are separate from our sanitary sewer systems; unlike water in sanitary sewers (from sinks or toilets) water in the storm drains is not treated before entering our waterways.

Sources of Non-Point Source Pollution

- Automotive leaks and spills.
- Improper disposal of used oil and other engine fluids.
- Metals found in vehicle exhaust, weathered paint, rust, metal plating, and tires.
- Pesticides and fertilizers from lawns, gardens and farms.
- Improper disposal of cleaners, paint and paint removers.
- Soil erosion and dust debris from landscape and construction activities.
- Litter, lawn clippings, animal waste, and other organic matter.
- Oil stains on parking lots and paved surfaces.

The Effect on the Ocean

Non-point source pollution can have a serious impact on water quality in Orange County. Pollutants from the storm drain system can harm marine life as well as coastal and wetland habitats. They can also degrade recreation areas such as beaches, harbors and bays.

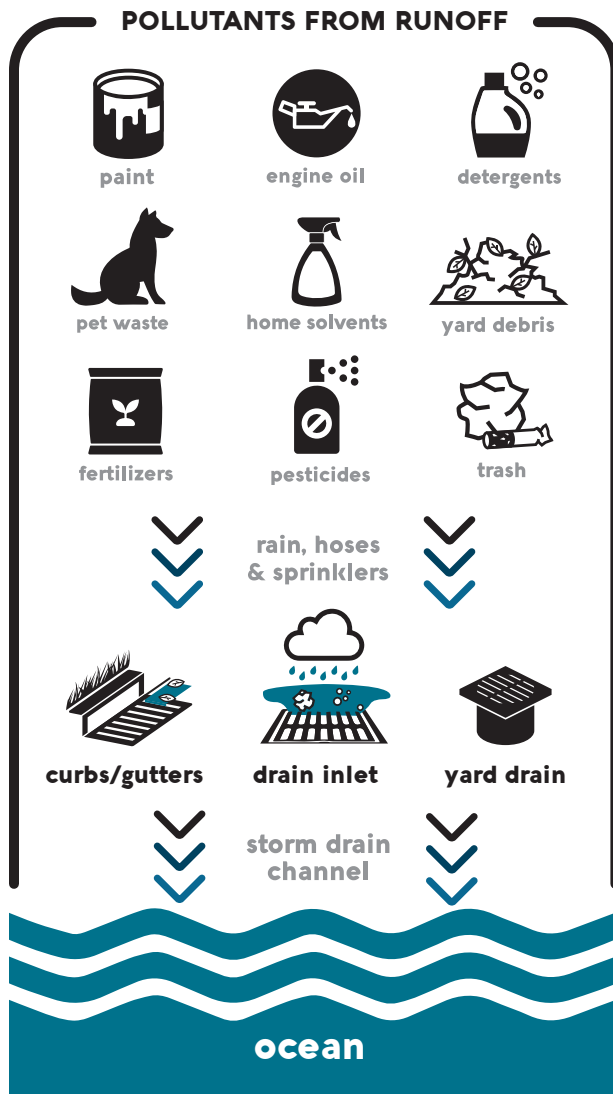
Stormwater quality management programs have been developed by the Orange County Stormwater Program under National Pollutant Discharge Elimination System (NPDES) permits. The program educates and encourages the public to protect water quality, monitor runoff in the storm drain system, manage NPDES permit process for municipalities, investigate illegal disposals, and maintain storm drains.

The support of Orange County residents, businesses and industries is needed to improve water quality and reduce the threat of stormwater and urban runoff pollution. Proper use and disposal of materials we use everyday will help stop this form of pollution before it reaches the storm drain and the ocean.

Dumping one quart of motor oil into a storm drain can contaminate 250,000 gallons of water.

What Common Pollutants are Found in Runoff?

Common runoff pollutants include trash, pet waste, yard debris, fertilizer, pesticides, engine oil, paint, home solvents, and detergents. Continue reading to learn how these pollutants affect our water resources and what you can do to help.



Who is H₂OC?

H₂OC is YOU! H₂OC is also a cooperative stormwater program which includes all 34 cities in Orange County, the County of Orange, and Orange County Flood Control District (OCFCD). Clean and healthy beaches, creeks, rivers, bays, wetlands, and ocean are important to Orange County. H₂OC provides resources to residents and businesses to encourage personal action and prevent polluted runoff from entering our waterways.

Join Us

Visit h2oc.org to learn more about runoff, water pollution, and how you can be the solution to runoff pollution and protect our water resources!

Contact

☎ **24-hour Pollution Reporting Hotline:**
1-877-89-SPILL (1-877-897-7455)

📱 **24-hour Reporting Website:**
myOCeServices.ocgov.com

For emergencies, dial 911

*For more information on household hazardous waste centers go to www.oclandfills.com/hazardous or call (714) 834-4000

**UCCE Master Gardeners: ucceocmghotline@ucanr.edu
mgorange.ucanr.edu/Gardening_Hotline/

YOU ARE THE SOLUTION TO RUNOFF POLLUTION



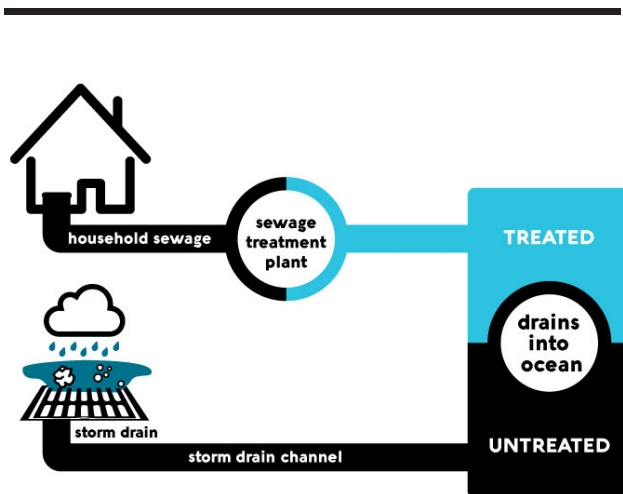
H₂OC
STORMWATER PROGRAM

What is Runoff?

Runoff is water from rain and outdoor water use that drains from roofs, driveways, sidewalks, and other surfaces, which does not soak into the ground. As runoff flows over surfaces it will pick up and carry pollutants it encounters, many of which come from waste we produce or mishandle. In Orange County, runoff is captured by storm drains where it flows untreated to the ocean.

Water that flows into storm drains is NOT TREATED

Runoff from homes and businesses may contain pollutants that have harmful effects on downstream creeks, rivers, bays, and ocean. Unlike household sewage, this water is not treated and can negatively impact recreational use, wildlife habitat, and even human health.



TRASH

If trash such as cigarette butts, straws, cups, and other debris enter our waterways, it can create water flow problems and contaminate aquatic habitats. Always properly dispose of waste and recyclables and secure your trash can lid to prevent trash from being released into the environment.



PET WASTE

Pet waste is a threat to human and environmental health because it contains harmful bacteria and pathogens. Being a responsible pet owner means picking up after your pet on walks and in your yard, especially before it rains.



YARD DEBRIS

If yard debris reaches local waterways, it can obstruct stormwater flow, clog storm drains, and cause other problems like flooding and erosion. Be sure to collect all debris when doing yard work and properly dispose of it in a green waste bin, or better yet, compost it.



ENGINE OIL

If engine oil enters our waterways, aquatic animals and plants can be negatively affected. It is important to repair leaking vehicles as soon as possible. Clean affected areas utilizing absorbents available at auto and home supply stores. Be sure to follow manufacturer's directions for proper use and disposal of absorbent. Used engine oil can be disposed of at a Household Hazardous Waste Center (HHWC*) or where oil was purchased.



FERTILIZER

If improperly applied, fertilizers can enter our waterways and cause ecological problems. For proper application, follow the manufacturer's instructions and stop applying fertilizers 48 hours before a forecasted rain event.



PESTICIDES

If pesticides, which include herbicides, insecticides, fungicides, and rodenticides, enter our waterways, they can be dangerous to human health and aquatic life. Be sure to limit pesticide use by using nonchemical methods or least-toxic pesticides whenever possible and contact the University of California Cooperative Extension (UCCE) Master Gardeners** with any questions. To properly apply pesticides, follow the manufacturer's instructions and stop applying 48 hours before a forecasted rain event.



PAINT

Paints, and related materials, contain a wide range of chemicals. These products should never be put in storm drains, sewers or septic systems. Instead, dispose of unused paint at your local HHWC*.



DETERGENTS

If phosphorus from detergents enters our waterways, it can cause ecological problems, including fish kills. Additionally, detergents can remove the protective mucous layer from fish, leaving them susceptible to disease. When using detergents for outdoor cleaning projects, do not allow wash water to reach the storm drain system.

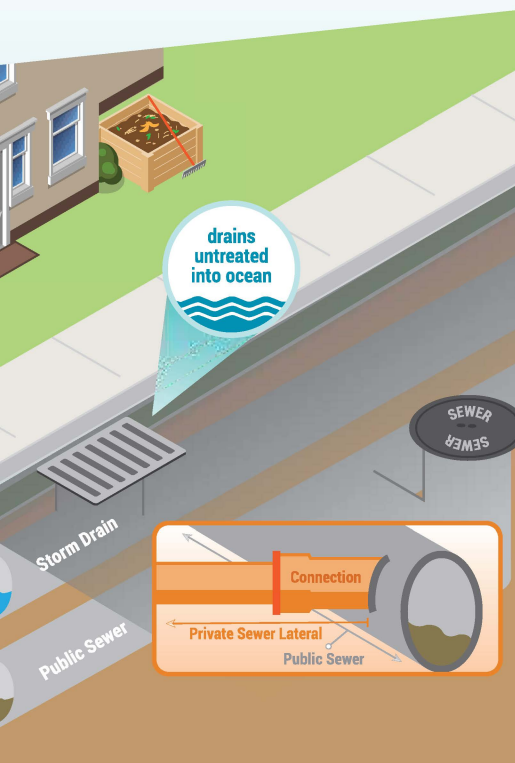


HOME SOLVENTS

Many common household cleaning products contain harmful chemicals which are toxic and volatile. If not used and disposed of properly, these chemicals enter our waterways and pose a threat to both human and aquatic life. Always follow the manufacturer's instructions and dispose of the material at your local HHWC*.

Sewer System Maintenance

Property owners are responsible for maintaining their private laterals from the connection at the home or business to the connection with the public sewer; this can include areas under the sidewalk and the street. Inadequate maintenance of laterals can result in sewer backups and spills. Operation and maintenance of the local, public, and regional sewer lines, on the other hand, are the responsibility of the sewer agency.* Visit the link inside for agency contact information.



Who is H₂OC?

H₂OC is YOU! H₂OC is also a cooperative stormwater program which includes all 34 cities in Orange County, the County of Orange, and Orange County Flood Control District (OCFCD). Clean and healthy beaches, creeks, rivers, bays, wetlands, and ocean are important to Orange County. H₂OC provides resources to residents and businesses to encourage personal action and prevent polluted runoff from entering our waterways.

Join Us

Visit h2oc.org to learn more about runoff, water pollution, and how you can be the solution to runoff pollution and protect our water resources!

Contact

📞 **24-hour Pollution Reporting Hotline:**
1-877-89-SPILL (1-877-897-7455)

📱 **24-hour Reporting Website:**
myOCeServices.ocgov.com

For emergencies, dial 911

HOW TO PREVENT & REPORT SEWAGE SPILLS

A PROPERTY OWNER'S GUIDE TO PRIVATE SEWER LATERALS



The Sanitary Sewer System

Every property with sewer service owns a private sewer line, also known as a "private lateral." The private lateral carries wastewater from indoor plumbing fixtures, like toilets, sinks, and dishwashers, to the public sewer line under the street. The sewer system transports wastewater to treatment plants before being released. It is important to maintain your private laterals to prevent sewage spills that can reach our storm drains. Unlike water in sanitary sewers, water that flows into storm drains is **not treated** before entering our waterways and should never contain sewage.



Developed in Collaboration
with Orange County's
Sewer Agencies

Backups and Sewage Spills

Sewage spills and backups occur when the wastewater being transported is blocked and overflows or leaks out of broken pipes inside or outside of your building. Once out of the pipe, the sewage can discharge to the curb, gutter, and storm drain system, which flows to local waterways. Sewage spills can cause health hazards, beach closures, damage to homes and businesses, and threaten the quality of our local waterways. As a property owner, if sewage from your property discharges to a gutter or storm drain, you may be subject to fines, penalties, or increased rates.

Common Causes

BLOCKAGES

Common causes of blockages include

- Flushing anything other than toilet paper, including: wipes (even those advertised as “flushable”), feminine products, rags, and other items.
- Fats, oils, and grease (FOG) can get into the private lateral from household drains, as well as from poorly maintained commercial grease traps and interceptors.
- Tree roots can find their way into cracked or broken sewer laterals and cause blockages.

STRUCTURAL PROBLEMS

Common structural problems include

- Broken/cracked pipes.
- Deteriorated, missing, or broken cleanout caps.
- Aging or undersized sewers.

Keep Your Private Laterals Functioning Properly

Prevent Blockages

Remember, **the drain is not a dump!**

- Only flush toilet paper down the toilet.
- Use a mesh sink strainer to catch food scraps before they go down the drain.
- Scrape food scraps into a designated food waste/organics receptacle before rinsing dishes and utensils in the sink.
- After cooking at home, let grease cool then pour or scrape it into a metal can. When the can is full, dispose of grease properly.
- For businesses, grease traps or interceptors must be serviced regularly. Have spill kits readily available for cleaning up spills.
- Do not plant trees or large shrubs above or within several feet of your sewer laterals.

Structural Maintenance

- Contact a licensed plumber to determine the optimal maintenance schedule.
- Perform periodic cleaning to eliminate grease, debris, and roots from private laterals.
- Repair or replace deteriorated or damaged private laterals as soon as possible.
- Install a backflow device to prevent sewage from ending up in your home or business.



Identify & Report Sewage Spills or Backups

Know the Signs

Sewage spills can cause damage to your property, the environment, and our local waterways. Look for potential signs of a spill, which may include:

- Drains are operating slower than normal and continuing to slow over time.
- Drains backup inside of buildings.
- Unusually wet or soggy ground in your yard that may be accompanied by odors.
- Leakage from sewer cleanouts, outside drains, or manhole lids.

Report Sewage Spills Immediately

- If you suspect a sewer backup or leak, contact a licensed plumber.
- If you observe a sewer spill from a cleanout or manhole, contact your sewer agency.*
- Plumbers should contact the sewer agency prior to pushing roots from private sewer laterals to the sewer main.

Alternatively, you can contact the **24-Hour Pollution Reporting Hotline** by calling **1-877-89-SPILL (1-877-897-7455)** or visiting **myOCeServices.ocgov.com**.

Spill Control & Containment

- Turn off main water supply or stop all water use.
- Have a plumbing professional clear the blockage and make necessary repairs.
- Keep people and pets away from the affected area.
- When safe, place sandbags or other material in the flow path of the spill to control, contain, and prevent sewage from entering the storm drain system.



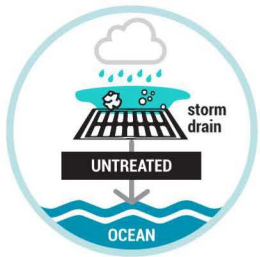
Sewer overflow



Plumber making repairs on private lateral



* Scan for more sewage spill resources or visit <https://h2oc.org/resources/pollution-prevention-for-residents/sewage-maintenance/>



Unlike water in sanitary sewers (from sinks and toilets), water in storm drains is **not treated or cleaned** before entering our waterways and should never contain any pollutants.

Waste & Storage Area Management



Parking Lots & Outdoor Areas

regularly sweep

drains untreated into ocean

This brochure will help you protect our water quality by using BMPs appropriate to your facility.

← Learn more inside

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* Some industrial facilities are also required to obtain coverage under the State's Industrial General Permit (IGP). To determine if your facility requires a permit, contact the State Water Resources Control Board at waterboards.ca.gov

** For more information about recycling and collection centers, visit oclandfills.com.

BEST MANAGEMENT PRACTICES
FOR BUSINESSES

WATER POLLUTION AND COMMERCIAL & INDUSTRIAL FACILITIES

YOU ARE THE SOLUTION TO RUNOFF POLLUTION



How is Water Quality Affected By Your Business?

Commercial and industrial facilities can generate a variety of waste products which can become pollutants. These can include metals, plastics, toxic chemicals, oil, grease, and bacteria. If not properly managed, these pollutants can be transported to Orange County's creeks, rivers, and ocean through our storm drain system.

As a business owner or manager, you are responsible for overseeing the work of employees and outside contractors to prevent runoff pollution.

Landscape Maintenance



Building Maintenance



contain, collect, dispose



By law, commercial and industrial facilities are required to implement best management practices (BMPs) to prevent runoff pollution.*

Best Management Practices for Commercial & Industrial Sites

Implement these required best management practices (BMPs) to be in compliance and avoid enforcement actions:



Inspect

-  Periodically inspect irrigation systems for leaks, overspray, and runoff. Repair and maintain as needed.
-  Periodically check parking lots for discharges from leaking vehicles.
-  Ensure lids on dumpsters are properly closed when not in use and sweep and pick up all debris daily.

Locate

-  Locate and protect all area drains, yard drains, and catch basins where washwater could potentially enter the storm drain system.
-  When working outdoors, conduct operations away from storm drains and waterbodies.
-  Mix paint and clean tools in a contained area.

Contain

-  Never allow washwater, sweepings, or sediment to enter storm drains.
-  Store materials indoors or under cover and away from storm drains.
-  Control, contain, and clean up all spills immediately with absorbents, rags, or mops. Never hose a spill.
-  Follow the manufacturer's directions when applying fertilizers and pesticides. Never apply 48 hours before a forecasted rain event.

Collect

-  Properly collect all washwater generated during business maintenance activities for disposal.
-  Collect grass clippings, leaves, and other debris and dispose in covered containers.
-  Use drop cloths underneath outdoor painting, scraping, and sandblasting work.
-  Regularly sweep areas like corners and along curbs, where debris tends to accumulate, and dispose in covered containers.

Dispose

-  Contact your waste hauler for proper waste, hazardous waste, and green waste disposal options.
-  Contact your waste and recycling service to repair or replace leaking or damaged dumpsters.
-  Recycle and dispose of materials as outlined by your local jurisdiction.**

What Pollutants Are Generated By Commercial & Industrial Sites?



Landscape Maintenance

When performing landscape maintenance, pollutants generated can include organic debris, trash, dirt, fertilizers, and pesticides.



Building Maintenance

When performing building maintenance, various types of pollutants can be generated including washwater, paint or paint chips, bacteria, and other toxic materials.



Parking Lots & Outdoor Areas

Pollutants in parking lots, patios, and outdoor areas can include trash, oil, grease, landscape debris, and bacteria.



Waste & Storage Area Management

Pollutants in waste and storage areas can include trash, oil, grease, bacteria, dirt, and other toxic materials.

Where Do I Go For Additional Assistance?

The Orange County Stormwater Program is a collaborative effort of all 34 Orange County cities, the Orange County Flood Control District and the County of Orange. Please visit the website below for guidance to help you comply with the new requirements, including:

The Model Water Quality Management Plan
(the “what, why, when” direction)

The Technical Guidance Document
(the “how to” details)

Training modules and frequently asked questions

Contact information for your City/County stormwater representative

www.h2oc.org/wqmp

Water Quality Requirements for Land Development

What Are The Requirements?

New water quality requirements for land development and significant redevelopment projects took effect August 17, 2011 for Northern Orange County (generally north of El Toro Road) and will likewise take effect for Southern Orange County in late 2012. While previous requirements focused on a treat-and-release approach to stormwater, the new requirements are centered around the goal of onsite capture by emphasizing:

Low Impact Development (LID):

LID works to manage stormwater as close to its source as possible by preserving and/or creating natural landscapes and minimizing impervious areas to create functional and appealing site drainage.

Hydromodification Controls:

Hydromodification Controls are implemented in order to prevent changes to the natural flow velocity and volume and sediment supply in streams and channels that are susceptible to erosion from increased runoff.

Why Are These Requirements in Place?

In 2009, the Santa Ana and San Diego Regional Water Quality Control Boards issued revised water quality permits to the Orange County Stormwater Program that resulted in these changes to the requirements for the planning and design of certain development projects. These requirements will positively impact Orange County in the following ways:

Cleaner Water:

LID practices focus on preventing toxic and polluted runoff from reaching our local beaches and waterways by managing rainfall and stormwater runoff.

Healthier Economy:

As a coastal region much of our local economy thrives on tourism. Clean beaches and waterways are vital to tourism and the overall health of our local economy.

Water Quality Requirements for Land Development

Orange County needs your help to build environmentally sound projects that protect our streams, bays and ocean water quality.



For Developers, Architects
and Contractors



What Does My Project Need to Do?

If your project needs to comply with these new requirements, there are many options available to make this possible.

Low Impact Development Practices

The following are some of the actual solutions you should apply to your project to ensure it is in compliance with the requirements.



Infiltration
(e.g. permeable pavement/pavers, bioretention, infiltration basins)



Evapotranspiration
(e.g. vegetated swales)



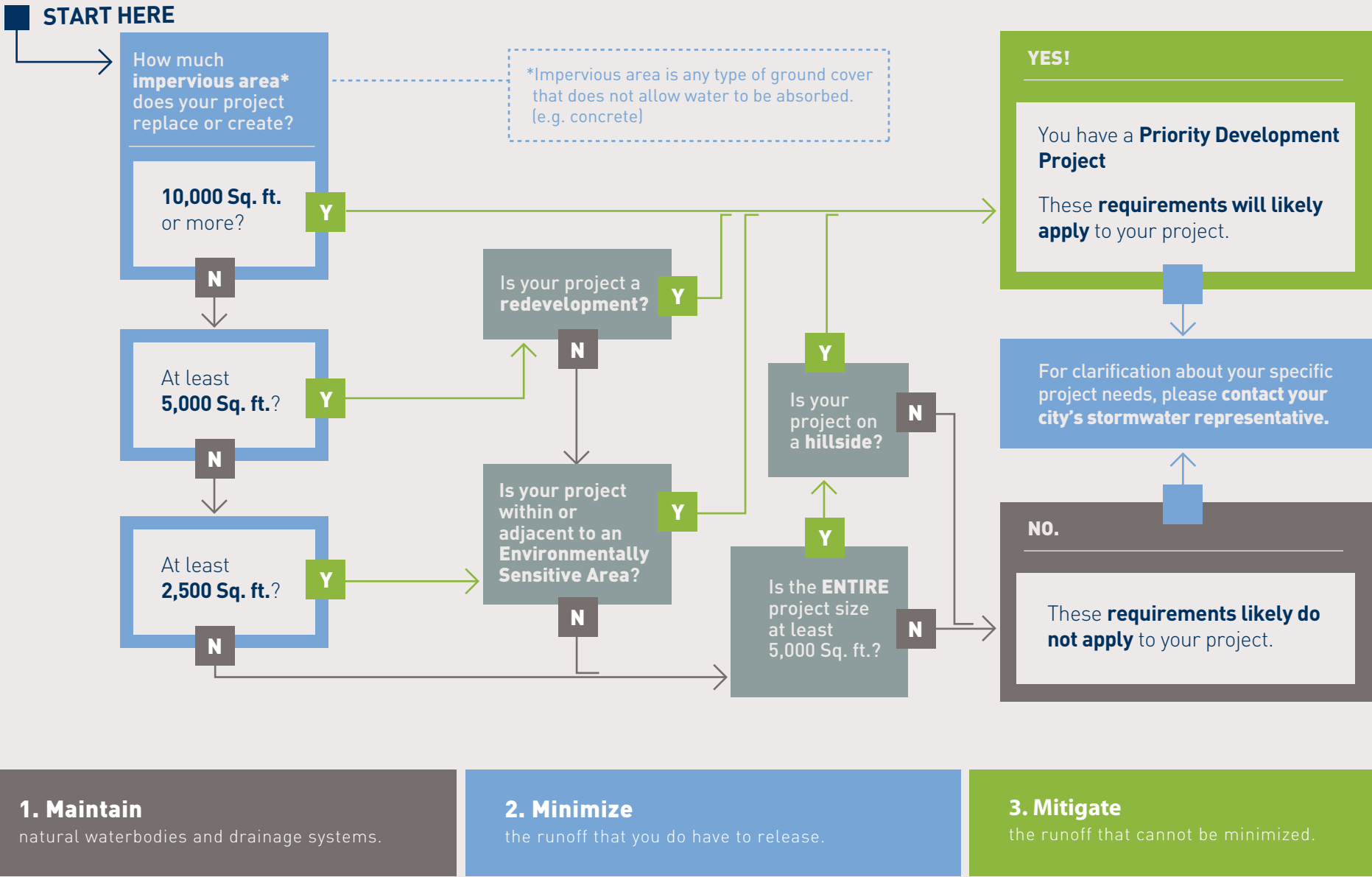
Harvest and Use
(e.g. cisterns and other storage for irrigation)



Biotreatment
(e.g. vegetated swales with an underdrain)

A Guide For Developers, Architects and Contractors

This chart is intended as a starting point to help you understand if the requirements apply to your project.



Site Design & Landscape Planning SD-10



Design Objectives

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

Description

Each project site possesses unique topographic, hydrologic, and vegetative features, some of which are more suitable for development than others. Integrating and incorporating appropriate landscape planning methodologies into the project design is the most effective action that can be done to minimize surface and groundwater contamination from stormwater.

Approach

Landscape planning should couple consideration of land suitability for urban uses with consideration of community goals and projected growth. Project plan designs should conserve natural areas to the extent possible, maximize natural water storage and infiltration opportunities, and protect slopes and channels.

Suitable Applications

Appropriate applications include residential, commercial and industrial areas planned for development or redevelopment.

Design Considerations

Design requirements for site design and landscapes planning should conform to applicable standards and specifications of agencies with jurisdiction and be consistent with applicable General Plan and Local Area Plan policies.



SD-10 Site Design & Landscape Planning

Designing New Installations

Begin the development of a plan for the landscape unit with attention to the following general principles:

- Formulate the plan on the basis of clearly articulated community goals. Carefully identify conflicts and choices between retaining and protecting desired resources and community growth.
- Map and assess land suitability for urban uses. Include the following landscape features in the assessment: wooded land, open unwooded land, steep slopes, erosion-prone soils, foundation suitability, soil suitability for waste disposal, aquifers, aquifer recharge areas, wetlands, floodplains, surface waters, agricultural lands, and various categories of urban land use. When appropriate, the assessment can highlight outstanding local or regional resources that the community determines should be protected (e.g., a scenic area, recreational area, threatened species habitat, farmland, fish run). Mapping and assessment should recognize not only these resources but also additional areas needed for their sustenance.

Project plan designs should conserve natural areas to the extent possible, maximize natural water storage and infiltration opportunities, and protect slopes and channels.

Conserve Natural Areas during Landscape Planning

If applicable, the following items are required and must be implemented in the site layout during the subdivision design and approval process, consistent with applicable General Plan and Local Area Plan policies:

- Cluster development on least-sensitive portions of a site while leaving the remaining land in a natural undisturbed condition.
- Limit clearing and grading of native vegetation at a site to the minimum amount needed to build lots, allow access, and provide fire protection.
- Maximize trees and other vegetation at each site by planting additional vegetation, clustering tree areas, and promoting the use of native and/or drought tolerant plants.
- Promote natural vegetation by using parking lot islands and other landscaped areas.
- Preserve riparian areas and wetlands.

Maximize Natural Water Storage and Infiltration Opportunities Within the Landscape Unit

- Promote the conservation of forest cover. Building on land that is already deforested affects basin hydrology to a lesser extent than converting forested land. Loss of forest cover reduces interception storage, detention in the organic forest floor layer, and water losses by evapotranspiration, resulting in large peak runoff increases and either their negative effects or the expense of countering them with structural solutions.
- Maintain natural storage reservoirs and drainage corridors, including depressions, areas of permeable soils, swales, and intermittent streams. Develop and implement policies and

Site Design & Landscape Planning SD-10

regulations to discourage the clearing, filling, and channelization of these features. Utilize them in drainage networks in preference to pipes, culverts, and engineered ditches.

- Evaluating infiltration opportunities by referring to the stormwater management manual for the jurisdiction and pay particular attention to the selection criteria for avoiding groundwater contamination, poor soils, and hydrogeological conditions that cause these facilities to fail. If necessary, locate developments with large amounts of impervious surfaces or a potential to produce relatively contaminated runoff away from groundwater recharge areas.

Protection of Slopes and Channels during Landscape Design

- Convey runoff safely from the tops of slopes.
- Avoid disturbing steep or unstable slopes.
- Avoid disturbing natural channels.
- Stabilize disturbed slopes as quickly as possible.
- Vegetate slopes with native or drought tolerant vegetation.
- Control and treat flows in landscaping and/or other controls prior to reaching existing natural drainage systems.
- Stabilize temporary and permanent channel crossings as quickly as possible, and ensure that increases in run-off velocity and frequency caused by the project do not erode the channel.
- Install energy dissipaters, such as riprap, at the outlets of new storm drains, culverts, conduits, or channels that enter unlined channels in accordance with applicable specifications to minimize erosion. Energy dissipaters shall be installed in such a way as to minimize impacts to receiving waters.
- Line on-site conveyance channels where appropriate, to reduce erosion caused by increased flow velocity due to increases in tributary impervious area. The first choice for linings should be grass or some other vegetative surface, since these materials not only reduce runoff velocities, but also provide water quality benefits from filtration and infiltration. If velocities in the channel are high enough to erode grass or other vegetative linings, riprap, concrete, soil cement, or geo-grid stabilization are other alternatives.
- Consider other design principles that are comparable and equally effective.

Redeveloping Existing Installations

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

SD-10 Site Design & Landscape Planning

Redevelopment may present significant opportunity to add features which had not previously been implemented. Examples include incorporation of depressions, areas of permeable soils, and swales in newly redeveloped areas. While some site constraints may exist due to the status of already existing infrastructure, opportunities should not be missed to maximize infiltration, slow runoff, reduce impervious areas, disconnect directly connected impervious areas.

Other Resources

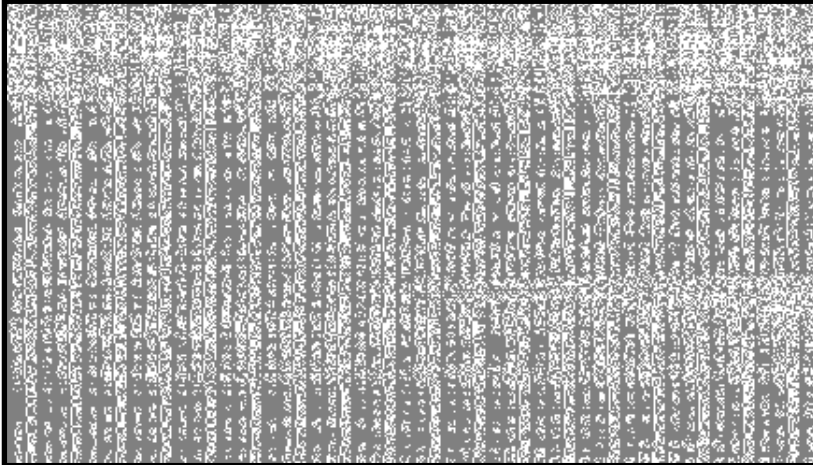
A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Stormwater Management Manual for Western Washington, Washington State Department of Ecology, August 2001.

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

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

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



Rain Garden

Design Objectives

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

Description

Various roof runoff controls are available to address stormwater that drains off rooftops. The objective is to reduce the total volume and rate of runoff from individual lots, and retain the pollutants on site that may be picked up from roofing materials and atmospheric deposition. Roof runoff controls consist of directing the roof runoff away from paved areas and mitigating flow to the storm drain system through one of several general approaches: cisterns or rain barrels; dry wells or infiltration trenches; pop-up emitters, and foundation planting. The first three approaches require the roof runoff to be contained in a gutter and downspout system. Foundation planting provides a vegetated strip under the drip line of the roof.

Approach

Design of individual lots for single-family homes as well as lots for higher density residential and commercial structures should consider site design provisions for containing and infiltrating roof runoff or directing roof runoff to vegetative swales or buffer areas. Retained water can be reused for watering gardens, lawns, and trees. Benefits to the environment include reduced demand for potable water used for irrigation, improved stormwater quality, increased groundwater recharge, decreased runoff volume and peak flows, and decreased flooding potential.

Suitable Applications

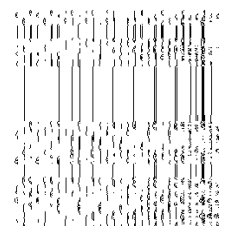
Appropriate applications include residential, commercial and industrial areas planned for development or redevelopment.

Design Considerations

Designing New Installations

Cisterns or Rain Barrels

One method of addressing roof runoff is to direct roof downspouts to cisterns or rain barrels. A cistern is an above ground storage vessel with either a manually operated valve or a permanently open outlet. Roof runoff is temporarily stored and then released for irrigation or infiltration between storms. The number of rain



barrels needed is a function of the rooftop area. Some low impact developers recommend that every house have at least 2 rain barrels, with a minimum storage capacity of 1000 liters. Roof barrels serve several purposes including mitigating the first flush from the roof which has a high volume, amount of contaminants, and thermal load. Several types of rain barrels are commercially available. Consideration must be given to selecting rain barrels that are vector proof and childproof. In addition, some barrels are designed with a bypass valve that filters out grit and other contaminants and routes overflow to a soak-away pit or rain garden.

If the cistern has an operable valve, the valve can be closed to store stormwater for irrigation or infiltration between storms. This system requires continual monitoring by the resident or grounds crews, but provides greater flexibility in water storage and metering. If a cistern is provided with an operable valve and water is stored inside for long periods, the cistern must be covered to prevent mosquitoes from breeding.

A cistern system with a permanently open outlet can also provide for metering stormwater runoff. If the cistern outlet is significantly smaller than the size of the downspout inlet (say $\frac{1}{4}$ to $\frac{1}{2}$ inch diameter), runoff will build up inside the cistern during storms, and will empty out slowly after peak intensities subside. This is a feasible way to mitigate the peak flow increases caused by rooftop impervious land coverage, especially for the frequent, small storms.

Dry wells and Infiltration Trenches

Roof downspouts can be directed to dry wells or infiltration trenches. A dry well is constructed by excavating a hole in the ground and filling it with an open graded aggregate, and allowing the water to fill the dry well and infiltrate after the storm event. An underground connection from the downspout conveys water into the dry well, allowing it to be stored in the voids. To minimize sedimentation from lateral soil movement, the sides and top of the stone storage matrix can be wrapped in a permeable filter fabric, though the bottom may remain open. A perforated observation pipe can be inserted vertically into the dry well to allow for inspection and maintenance.

In practice, dry wells receiving runoff from single roof downspouts have been successful over long periods because they contain very little sediment. They must be sized according to the amount of rooftop runoff received, but are typically 4 to 5 feet square, and 2 to 3 feet deep, with a minimum of 1-foot soil cover over the top (maximum depth of 10 feet).

To protect the foundation, dry wells must be set away from the building at least 10 feet. They must be installed in solids that accommodate infiltration. In poorly drained soils, dry wells have very limited feasibility.

Infiltration trenches function in a similar manner and would be particularly effective for larger roof areas. An infiltration trench is a long, narrow, rock-filled trench with no outlet that receives stormwater runoff. These are described under Treatment Controls.

Pop-up Drainage Emitter

Roof downspouts can be directed to an underground pipe that daylights some distance from the building foundation, releasing the roof runoff through a pop-up emitter. Similar to a pop-up irrigation head, the emitter only opens when there is flow from the roof. The emitter remains flush to the ground during dry periods, for ease of lawn or landscape maintenance.

Foundation Planting

Landscape planting can be provided around the base to allow increased opportunities for stormwater infiltration and protect the soil from erosion caused by concentrated sheet flow coming off the roof. Foundation plantings can reduce the physical impact of water on the soil and provide a subsurface matrix of roots that encourage infiltration. These plantings must be sturdy enough to tolerate the heavy runoff sheet flows, and periodic soil saturation.

Redeveloping Existing Installations

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

Supplemental Information

Examples

- City of Ottawa’s Water Links Surface –Water Quality Protection Program
- City of Toronto Downspout Disconnection Program
- City of Boston, MA, Rain Barrel Demonstration Program

Other Resources

Hager, Marty Catherine, Stormwater, “Low-Impact Development”, January/February 2003.
www.stormh2o.com

Low Impact Urban Design Tools, Low Impact Development Design Center, Beltsville, MD.
www.lid-stormwater.net

Start at the Source, Bay Area Stormwater Management Agencies Association, 1999 Edition



Design Objectives

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

Description

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

Approach

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

Suitable Applications

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

Design Considerations

Designing New Installations

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

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



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

Redeveloping Existing Installations

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

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Design Objectives

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

Description

Waste materials dumped into storm drain inlets can have severe impacts on receiving and ground waters. Posting notices regarding discharge prohibitions at storm drain inlets can prevent waste dumping. Storm drain signs and stencils are highly visible source controls that are typically placed directly adjacent to storm drain inlets.

Approach

The stencil or affixed sign contains a brief statement that prohibits dumping of improper materials into the urban runoff conveyance system. Storm drain messages have become a popular method of alerting the public about the effects of and the prohibitions against waste disposal.

Suitable Applications

Stencils and signs alert the public to the destination of pollutants discharged to the storm drain. Signs are appropriate in residential, commercial, and industrial areas, as well as any other area where contributions or dumping to storm drains is likely.

Design Considerations

Storm drain message markers or placards are recommended at all storm drain inlets within the boundary of a development project. The marker should be placed in clear sight facing toward anyone approaching the inlet from either side. All storm drain inlet locations should be identified on the development site map.

Designing New Installations

The following methods should be considered for inclusion in the project design and show on project plans:

- Provide stenciling or labeling of all storm drain inlets and catch basins, constructed or modified, within the project area with prohibitive language. Examples include “NO DUMPING



– DRAINS TO OCEAN” and/or other graphical icons to discourage illegal dumping.

- Post signs with prohibitive language and/or graphical icons, which prohibit illegal dumping at public access points along channels and creeks within the project area.

Note - Some local agencies have approved specific signage and/or storm drain message placards for use. Consult local agency stormwater staff to determine specific requirements for placard types and methods of application.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define “redevelopment” in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. If the project meets the definition of “redevelopment”, then the requirements stated under “designing new installations” above should be included in all project design plans.

Additional Information

Maintenance Considerations

- Legibility of markers and signs should be maintained. If required by the agency with jurisdiction over the project, the owner/operator or homeowner’s association should enter into a maintenance agreement with the agency or record a deed restriction upon the property title to maintain the legibility of placards or signs.

Placement

- Signage on top of curbs tends to weather and fade.
- Signage on face of curbs tends to be worn by contact with vehicle tires and sweeper brooms.

Supplemental Information

Examples

- Most MS4 programs have storm drain signage programs. Some MS4 programs will provide stencils, or arrange for volunteers to stencil storm drains as part of their outreach program.

Other Resources

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

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

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

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

Description

Trash storage areas are areas where a trash receptacle (s) are located for use as a repository for solid wastes. Stormwater runoff from areas where trash is stored or disposed of can be polluted. In addition, loose trash and debris can be easily transported by water or wind into nearby storm drain inlets, channels, and/or creeks. Waste handling operations that may be sources of stormwater pollution include dumpsters, litter control, and waste piles.

Approach

This fact sheet contains details on the specific measures required to prevent or reduce pollutants in stormwater runoff associated with trash storage and handling. Preventative measures including enclosures, containment structures, and impervious pavements to mitigate spills, should be used to reduce the likelihood of contamination.

Suitable Applications

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

Design Considerations

Design requirements for waste handling areas are governed by Building and Fire Codes, and by current local agency ordinances and zoning requirements. The design criteria described in this fact sheet are meant to enhance and be consistent with these code and ordinance requirements. Hazardous waste should be handled in accordance with legal requirements established in Title 22, California Code of Regulation.

Wastes from commercial and industrial sites are typically hauled by either public or commercial carriers that may have design or access requirements for waste storage areas. The design criteria in this fact sheet are recommendations and are not intended to be in conflict with requirements established by the waste hauler. The waste hauler should be contacted prior to the design of your site trash collection areas. Conflicts or issues should be discussed with the local agency.

Designing New Installations

Trash storage areas should be designed to consider the following structural or treatment control BMPs:

- Design trash container areas so that drainage from adjoining roofs and pavement is diverted around the area(s) to avoid run-on. This might include berming or grading the waste handling area to prevent run-on of stormwater.
- Make sure trash container areas are screened or walled to prevent off-site transport of trash.

Design Objectives

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



- Use lined bins or dumpsters to reduce leaking of liquid waste.
- Provide roofs, awnings, or attached lids on all trash containers to minimize direct precipitation and prevent rainfall from entering containers.
- Pave trash storage areas with an impervious surface to mitigate spills.
- Do not locate storm drains in immediate vicinity of the trash storage area.
- Post signs on all dumpsters informing users that hazardous materials are not to be disposed of therein.

Redeveloping Existing Installations

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

Additional Information***Maintenance Considerations***

The integrity of structural elements that are subject to damage (i.e., screens, covers, and signs) must be maintained by the owner/operator. Maintenance agreements between the local agency and the owner/operator may be required. Some agencies will require maintenance deed restrictions to be recorded of the property title. If required by the local agency, maintenance agreements or deed restrictions must be executed by the owner/operator before improvement plans are approved.

Other Resources

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

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

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

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

Appendix C:

BMP Details

PROJECT INFORMATION	
ENGINEERED PRODUCT MANAGER	
ADS SALES REP	
PROJECT NO.	



GLASSELL

ORANGE, CA, USA

MC-7200 STORMTECH CHAMBER SPECIFICATIONS

- CHAMBERS SHALL BE STORMTECH MC-7200.
- CHAMBERS SHALL BE ARCH-SHAPED AND SHALL BE MANUFACTURED FROM VIRGIN, IMPACT-MODIFIED POLYPROPYLENE COPOLYMERS.
- CHAMBERS SHALL MEET THE REQUIREMENTS OF ASTM F2418, "STANDARD SPECIFICATION FOR POLYPROPYLENE (PP) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS" CHAMBER CLASSIFICATION 60x101.
- CHAMBER ROWS SHALL PROVIDE CONTINUOUS, UNOBSTRUCTED INTERNAL SPACE WITH NO INTERNAL SUPPORTS THAT WOULD IMPEDE FLOW OR LIMIT ACCESS FOR INSPECTION.
- 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.
- 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.
- 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 SHALL BE GREATER THAN OR EQUAL TO 450 LBS/FT/%. THE ASC IS DEFINED IN SECTION 6.2.8 OF ASTM F2418. 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.
- 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.
- CHAMBERS AND END CAPS SHALL BE PRODUCED AT AN ISO 9001 CERTIFIED MANUFACTURING FACILITY.
- 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.
- ADS DOES NOT DESIGN OR PROVIDE MEMBRANE LINER SYSTEMS. TO MINIMIZE THE LEAKAGE POTENTIAL OF LINER SYSTEMS, THE MEMBRANE LINER SYSTEM SHOULD BE DESIGNED BY A KNOWLEDGEABLE GEOTEXTILE PROFESSIONAL AND INSTALLED BY A QUALIFIED CONTRACTOR.

IMPORTANT - NOTES FOR THE BIDDING AND INSTALLATION OF MC-7200 CHAMBER SYSTEM

- STORMTECH MC-7200 CHAMBERS SHALL NOT BE INSTALLED UNTIL THE MANUFACTURER'S REPRESENTATIVE HAS COMPLETED A PRE-CONSTRUCTION MEETING WITH THE INSTALLERS.
- STORMTECH MC-7200 CHAMBERS SHALL BE INSTALLED IN ACCORDANCE WITH THE "STORMTECH MC-7200 CONSTRUCTION GUIDE".
- CHAMBERS ARE NOT TO BE BACKFILLED WITH A DOZER OR 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.
- THE FOUNDATION STONE SHALL BE LEVELED AND COMPACTED PRIOR TO PLACING CHAMBERS.
- JOINTS BETWEEN CHAMBERS SHALL BE PROPERLY SEATED PRIOR TO PLACING STONE.
- MAINTAIN MINIMUM - 9" (230 mm) SPACING BETWEEN THE CHAMBER ROWS.
- INLET AND OUTLET MANIFOLDS MUST BE INSERTED A MINIMUM OF 12" (300 mm) INTO CHAMBER END CAPS.
- EMBEDMENT STONE SURROUNDING CHAMBERS MUST BE A CLEAN, CRUSHED, ANGULAR STONE OR RECYCLED CONCRETE; AASHTO M43 #3, 357, 4, 467, 5, 56, OR 57.
- STONE SHALL BE BROUGHT UP EVENLY AROUND CHAMBERS SO AS NOT TO DISTORT THE CHAMBER SHAPE. STONE DEPTHS SHOULD NEVER DIFFER BY MORE THAN 12" (300 mm) BETWEEN ADJACENT CHAMBER ROWS.
- STONE MUST BE PLACED ON THE TOP CENTER OF THE CHAMBER TO ANCHOR THE CHAMBERS IN PLACE AND PRESERVE ROW SPACING.
- THE CONTRACTOR MUST REPORT ANY DISCREPANCIES WITH CHAMBER FOUNDATION MATERIAL BEARING CAPACITIES TO THE SITE DESIGN ENGINEER.
- 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

- STORMTECH MC-7200 CHAMBERS SHALL BE INSTALLED IN ACCORDANCE WITH THE "STORMTECH MC-7200 CONSTRUCTION GUIDE".
- THE USE OF EQUIPMENT OVER MC-7200 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-7200 CONSTRUCTION GUIDE".
 - WEIGHT LIMITS FOR CONSTRUCTION EQUIPMENT CAN BE FOUND IN THE "STORMTECH MC-7200 CONSTRUCTION GUIDE".
- 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.

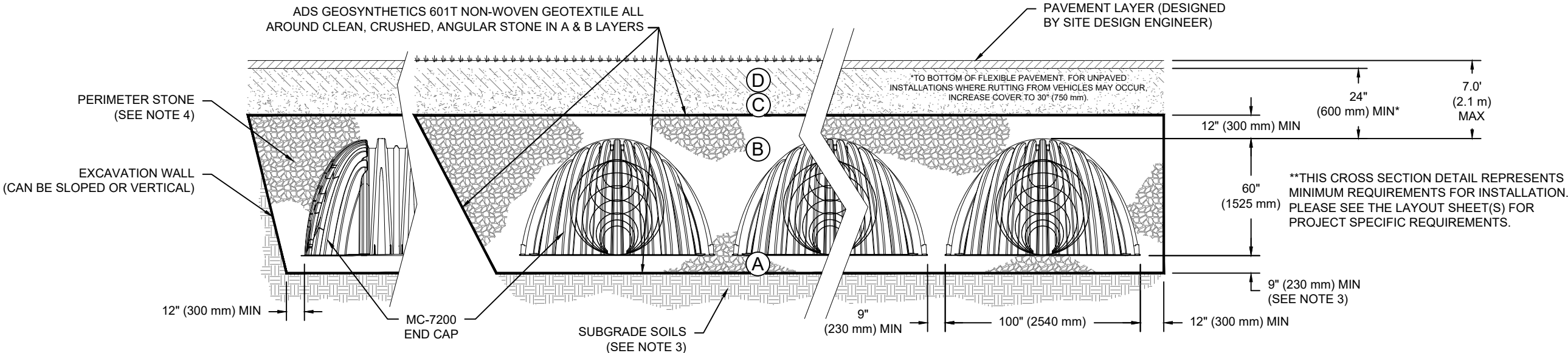
CONTACT STORMTECH AT 1-800-821-6710 WITH ANY QUESTIONS ON INSTALLATION REQUIREMENTS OR WEIGHT LIMITS FOR CONSTRUCTION EQUIPMENT.

ACCEPTABLE FILL MATERIALS: STORMTECH MC-7200 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 OR RECYCLED CONCRETE ⁵	AASHTO M43 ¹ 3, 357, 4, 467, 5, 56, 57	NO COMPACTION REQUIRED.
A	FOUNDATION STONE: FILL BELOW CHAMBERS FROM THE SUBGRADE UP TO THE FOOT (BOTTOM) OF THE CHAMBER.	CLEAN, CRUSHED, ANGULAR STONE OR RECYCLED CONCRETE ⁵	AASHTO M43 ¹ 3, 357, 4, 467, 5, 56, 57	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.
5. WHERE RECYCLED CONCRETE AGGREGATE IS USED IN LAYERS 'A' OR 'B' THE MATERIAL SHOULD ALSO MEET THE ACCEPTABILITY CRITERIA OUTLINED IN TECHNICAL NOTE 6.20 "RECYCLED CONCRETE STRUCTURAL BACKFILL".



NOTES:

1. CHAMBERS SHALL MEET THE REQUIREMENTS OF ASTM F2418, "STANDARD SPECIFICATION FOR POLYPROPYLENE (PP) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS" CHAMBER CLASSIFICATION 60x101
2. MC-7200 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. REFERENCE STORMTECH DESIGN MANUAL FOR BEARING CAPACITY GUIDANCE.
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 SHALL BE GREATER THAN OR EQUAL TO 450 LBS/FT/%. THE ASC IS DEFINED IN SECTION 6.2.8 OF ASTM F2418. 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.

GLASSELL

ORANGE, CA, USA

DRAWN: DS

CHECKED: N/A

PROJECT #:

DESCRIPTION

CHK

DR	
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DAT

StormTech®
Chamber System

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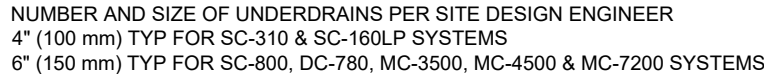
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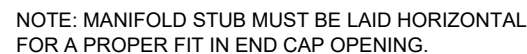
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NTS



NTS



NTS



SIZE (W X H X INSTALLED LENGTH)

CHAMBER STORAGE

MINIMUM INSTALLED STORAGE*

WEIGHT (NOMINAL)

SIZE (W X H X INSTALLED LENGTH)

END CAP STORAGE

MINIMUM INSTALLED STORAGE*

WEIGHT (NOMINAL)

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

PARTIAL CUT HOLES AT BOTTOM OF END CAP FOR PART NUMBERS ENDING WITH "B"

PARTIAL CUT HOLES AT TOP OF END CAP FOR PART NUMBERS ENDING WITH "T"

END CAPS WITH A PREFABRICATED WELDED STUB END WITH "W"

CUSTOM PREFABRICATED 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-7200 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.



StormTech MC-7200 Specifications

Storage Volume Per Chamber

	Bare Chamber Storage ft ³ (m ³)	Chamber and Stone Foundation Depth in. (mm)			
		9 in (230 mm)	12 in (300 mm)	15 in (375 mm)	18 in (450 mm)
Chamber	175.9 (4.98)	267.3 (7.57)	273.3 (7.74)	279.3 (7.91)	285.3 (8.08)
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 in front of end cap.

Amount of Stone Per Chamber

English Tons (yds ³)	Stone Foundation Depth			
	9 in	12 in	15 in	18 in
Chamber	12.1 (8.5)	12.9 (9.0)	13.6 (9.6)	14.3 (10.1)
End Cap	9.8 (7.0)	10.2 (7.3)	10.6 (7.6)	11.1 (7.9)
Metric Kilograms (m ³)	230 mm	300 mm	375 mm	450 mm
Chamber	10977 (6.5)	11703 (6.9)	12338 (7.3)	12973 (7.7)
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. 1 yd³ = 1.42 english tons.

Volume Excavation Per Chamber yd³ (m³)

	Stone Foundation Depth			
	9 in (230 mm)	12 in (300 mm)	15 in (375mm)	18 in (450 mm)
Chamber	17.2 (13.2)	17.7 (13.5)	18.3 (14.0)	18.8 (14.4)
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.

Working on a project?

Visit us at www.stormtech.com and utilize the Design Tool

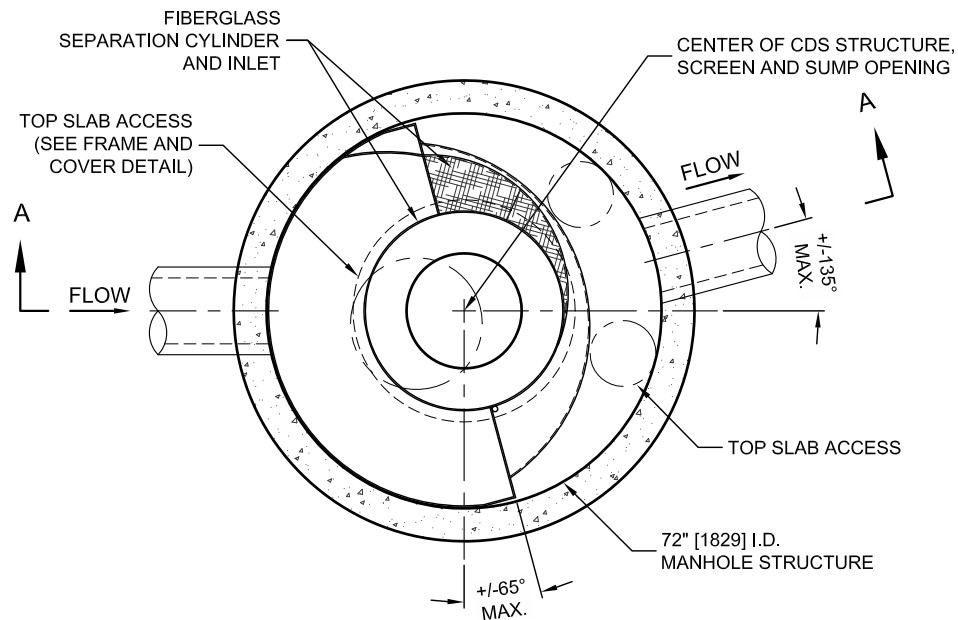


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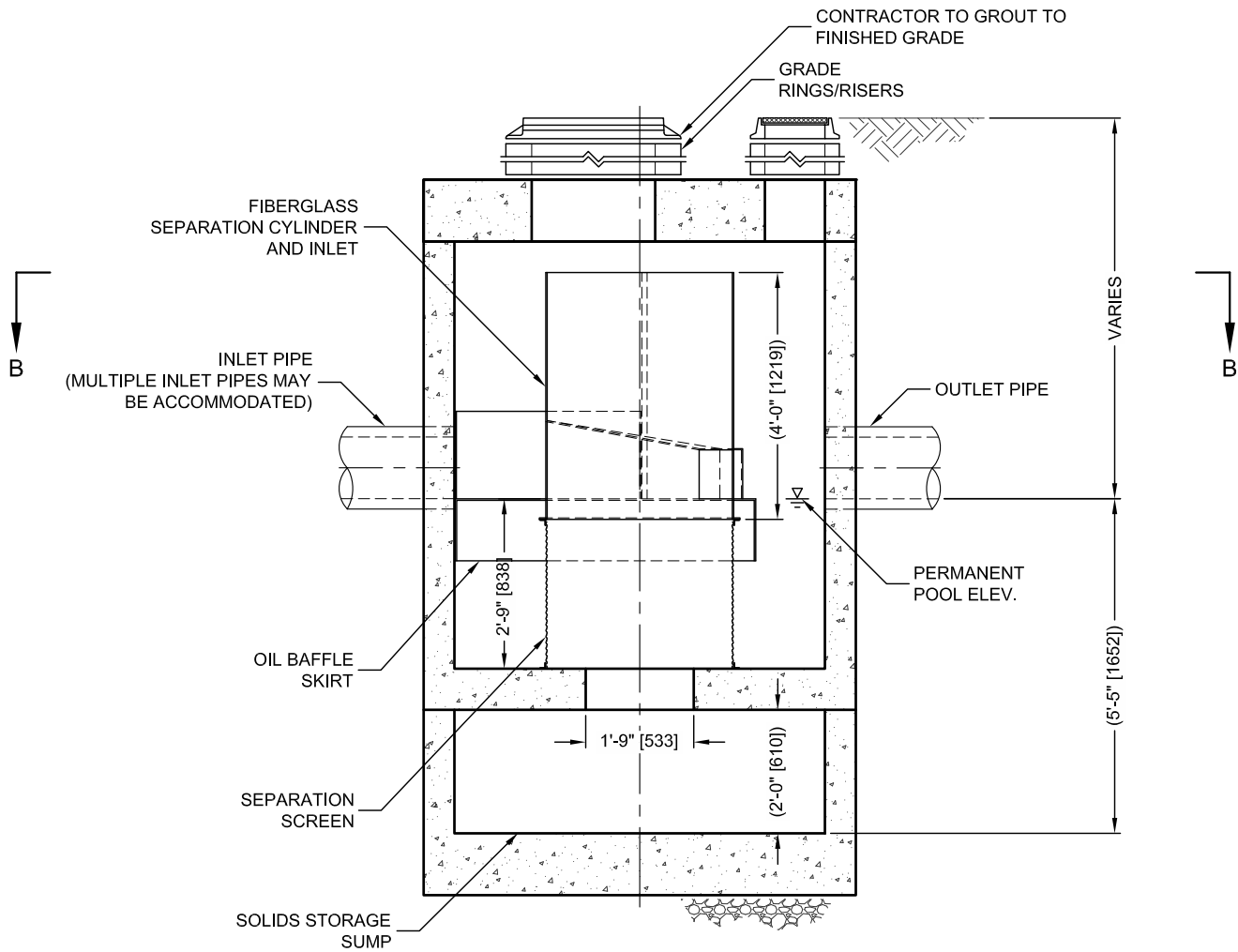
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PLAN VIEW B-B
N.T.S.



ELEVATION A-A
N.T.S.



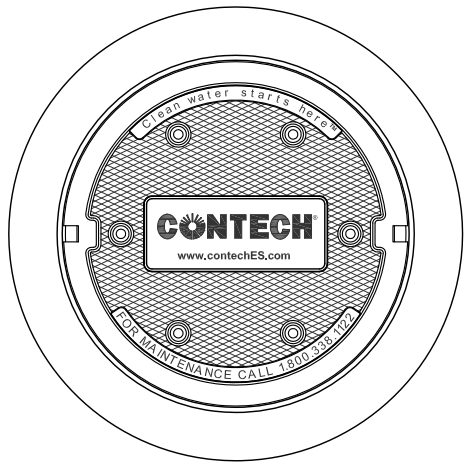
THIS PRODUCT MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS: 6,768,846; 6,841,720; 6,911,595; 6,981,762. RELATED FOREIGN PATENTS, OR OTHER PATENTS PENDING.

CDS3020-6-C DESIGN NOTES

THE STANDARD CDS3020-6-C CONFIGURATION IS SHOWN. ALTERNATE CONFIGURATIONS ARE AVAILABLE AND ARE LISTED BELOW. SOME CONFIGURATIONS MAY BE COMBINED TO SUIT SITE REQUIREMENTS.

CONFIGURATION DESCRIPTION

GRATED INLET ONLY (NO INLET PIPE)
GRATED INLET WITH INLET PIPE OR PIPES
CURB INLET ONLY (NO INLET PIPE)
CURB INLET WITH INLET PIPE OR PIPES
SEPARATE OIL BAFFLE (SINGLE INLET PIPE REQUIRED FOR THIS CONFIGURATION)
SEDIMENT WEIR FOR NJDEP / NJCAT CONFORMING UNITS



FRAME AND COVER
(DIAMETER VARIES)
N.T.S.

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID				
WATER QUALITY FLOW RATE (CFS OR L/s)				*
PEAK FLOW RATE (CFS OR L/s)				*
RETURN PERIOD OF PEAK FLOW (YRS)				*
SCREEN APERTURE (2400 OR 4700)				*
PIPE DATA:	I.E.	MATERIAL	DIAMETER	
INLET PIPE 1	*	*	*	
INLET PIPE 2	*	*	*	
OUTLET PIPE	*	*	*	
RIM ELEVATION				*
ANTI-FLOTATION BALLAST		WIDTH	HEIGHT	
		*	*	
NOTES/SPECIAL REQUIREMENTS:				
* PER ENGINEER OF RECORD				

GENERAL NOTES

1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. DIMENSIONS MARKED WITH () ARE REFERENCE DIMENSIONS. ACTUAL DIMENSIONS MAY VARY.
3. FOR FABRICATION DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHTS, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.contechES.com
4. CDS WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING.
5. STRUCTURE SHALL MEET AASHTO HS20 AND CASTINGS SHALL MEET HS20 (AASHTO M 306) LOAD RATING, ASSUMING GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION.
6. PVC HYDRAULIC SHEAR PLATE IS PLACED ON SHELF AT BOTTOM OF SCREEN CYLINDER. REMOVE AND REPLACE AS NECESSARY DURING MAINTENANCE CLEANING.

INSTALLATION NOTES

- A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
- B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE CDS MANHOLE STRUCTURE (LIFTING CLUTCHES PROVIDED).
- C. CONTRACTOR TO ADD JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS, AND ASSEMBLE STRUCTURE.
- D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT PIPES. MATCH PIPE INVERTS WITH ELEVATIONS SHOWN.
- E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.

CONTECH
ENGINEERED SOLUTIONS LLC

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CDS3020-6-C
INLINE CDS
STANDARD DETAIL

CDS Guide Operation, Design, Performance and Maintenance



CDS®

Using patented continuous deflective separation technology, the CDS system screens, separates and traps debris, sediment, and oil and grease from stormwater runoff. The indirect screening capability of the system allows for 100% removal of floatables and neutrally buoyant material without blinding. Flow and screening controls physically separate captured solids, and minimize the re-suspension and release of previously trapped pollutants. Inline units can treat up to 6 cfs, and internally bypass flows in excess of 50 cfs (1416 L/s). Available precast or cast-in-place, offline units can treat flows from 1 to 300 cfs (28.3 to 8495 L/s). The pollutant removal capacity of the CDS system has been proven in lab and field testing.

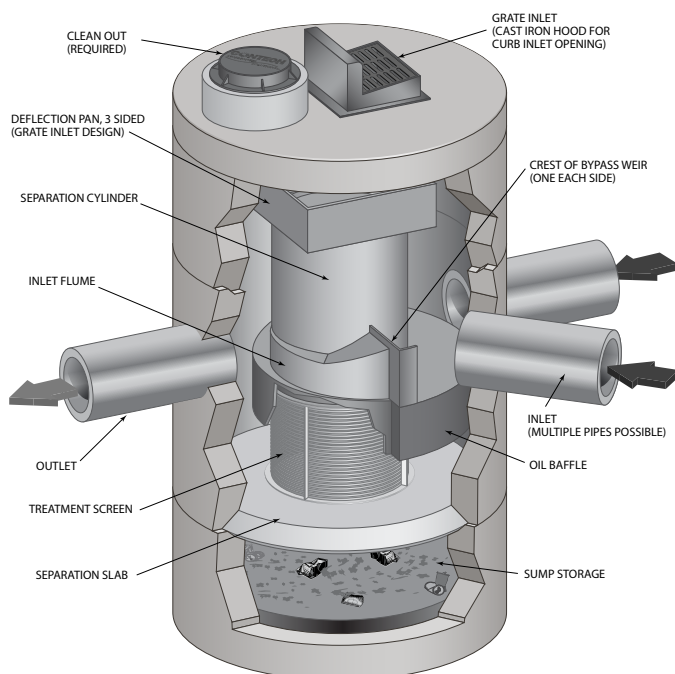
Operation Overview

Stormwater enters the diversion chamber where the diversion weir guides the flow into the unit's separation chamber and pollutants are removed from the flow. All flows up to the system's treatment design capacity enter the separation chamber and are treated.

Swirl concentration and screen deflection force floatables and solids to the center of the separation chamber where 100% of floatables and neutrally buoyant debris larger than the screen apertures are trapped.

Stormwater then moves through the separation screen, under the oil baffle and exits the system. The separation screen remains clog free due to continuous deflection.

During the flow events exceeding the treatment design capacity, the diversion weir bypasses excessive flows around the separation chamber, so captured pollutants are retained in the separation cylinder.



Design Basics

There are three primary methods of sizing a CDS system. The Water Quality Flow Rate Method determines which model size provides the desired removal efficiency at a given flow rate for a defined particle size. The Rational Rainfall Method™ or the Probabilistic Method is used when a specific removal efficiency of the net annual sediment load is required.

Typically in the United States, CDS systems are designed to achieve an 80% annual solids load reduction based on lab generated performance curves for a gradation with an average particle size (d50) of 125 microns (μm). For some regulatory environments, CDS systems can also be designed to achieve an 80% annual solids load reduction based on an average particle size (d50) of 75 microns (μm) or 50 microns (μm).

Water Quality Flow Rate Method

In some cases, regulations require that a specific treatment rate, often referred to as the water quality design flow (WQQ), be treated. This WQQ represents the peak flow rate from either an event with a specific recurrence interval, e.g. the six-month storm, or a water quality depth, e.g. 1/2-inch (13 mm) of rainfall.

The CDS is designed to treat all flows up to the WQQ. At influent rates higher than the WQQ, the diversion weir will direct most flow exceeding the WQQ around the separation chamber. This allows removal efficiency to remain relatively constant in the separation chamber and eliminates the risk of washout during bypass flows regardless of influent flow rates.

Treatment flow rates are defined as the rate at which the CDS will remove a specific gradation of sediment at a specific removal efficiency. Therefore the treatment flow rate is variable, based on the gradation and removal efficiency specified by the design engineer.

Rational Rainfall Method™

Differences in local climate, topography and scale make every site hydraulically unique. It is important to take these factors into consideration when estimating the long-term performance of any stormwater treatment system. The Rational Rainfall Method combines site-specific information with laboratory generated performance data, and local historical precipitation records to estimate removal efficiencies as accurately as possible.

Short duration rain gauge records from across the United States and Canada were analyzed to determine the percent of the total annual rainfall that fell at a range of intensities. US stations' depths were totaled every 15 minutes, or hourly, and recorded in 0.01-inch increments. Depths were recorded hourly with 1-mm resolution at Canadian stations. One trend was consistent at all sites; the vast majority of precipitation fell at low intensities and high intensity storms contributed relatively little to the total annual depth.

These intensities, along with the total drainage area and runoff coefficient for each specific site, are translated into flow rates using the Rational Rainfall Method. Since most sites are relatively small and highly impervious, the Rational Rainfall Method is appropriate. Based on the runoff flow rates calculated for each intensity, operating rates within a proposed CDS system are

determined. Performance efficiency curve determined from full scale laboratory tests on defined sediment PSDs is applied to calculate solids removal efficiency. The relative removal efficiency at each operating rate is added to produce a net annual pollutant removal efficiency estimate.

Probabilistic Rational Method

The Probabilistic Rational Method is a sizing program Contech developed to estimate a net annual sediment load reduction for a particular CDS model based on site size, site runoff coefficient, regional rainfall intensity distribution, and anticipated pollutant characteristics.

The Probabilistic Method is an extension of the Rational Method used to estimate peak discharge rates generated by storm events of varying statistical return frequencies (e.g. 2-year storm event). Under the Rational Method, an adjustment factor is used to adjust the runoff coefficient estimated for the 10-year event, correlating a known hydrologic parameter with the target storm event. The rainfall intensities vary depending on the return frequency of the storm event under consideration. In general, these two frequency dependent parameters (rainfall intensity and runoff coefficient) increase as the return frequency increases while the drainage area remains constant.

These intensities, along with the total drainage area and runoff coefficient for each specific site, are translated into flow rates using the Rational Method. Since most sites are relatively small and highly impervious, the Rational Method is appropriate. Based on the runoff flow rates calculated for each intensity, operating rates within a proposed CDS are determined. Performance efficiency curve on defined sediment PSDs is applied to calculate solids removal efficiency. The relative removal efficiency at each operating rate is added to produce a net annual pollutant removal efficiency estimate.

Treatment Flow Rate

The inlet throat area is sized to ensure that the WQQ passes through the separation chamber at a water surface elevation equal to the crest of the diversion weir. The diversion weir bypasses excessive flows around the separation chamber, thus preventing re-suspension or re-entrainment of previously captured particles.

Hydraulic Capacity

The hydraulic capacity of a CDS system is determined by the length and height of the diversion weir and by the maximum allowable head in the system. Typical configurations allow hydraulic capacities of up to ten times the treatment flow rate. The crest of the diversion weir may be lowered and the inlet throat may be widened to increase the capacity of the system at a given water surface elevation. The unit is designed to meet project specific hydraulic requirements.

Performance

Full-Scale Laboratory Test Results

A full-scale CDS system (Model CDS2020-5B) was tested at the facility of University of Florida, Gainesville, FL. This CDS unit was evaluated under controlled laboratory conditions of influent flow rate and addition of sediment.

Two different gradations of silica sand material (UF Sediment & OK-110) were used in the CDS performance evaluation. The particle size distributions (PSDs) of the test materials were analyzed using standard method "Gradation ASTM D-422 "Standard Test Method for Particle-Size Analysis of Soils" by a certified laboratory.

UF Sediment is a mixture of three different products produced by the U.S. Silica Company: "Sil-Co-Sil 106", "#1 DRY" and "20/40 Oil Frac". Particle size distribution analysis shows that the UF Sediment has a very fine gradation ($d_{50} = 20$ to $30 \mu\text{m}$) covering a wide size range (Coefficient of Uniformity, C_u averaged at 10.6). In comparison with the hypothetical TSS gradation specified in the NJDEP (New Jersey Department of Environmental Protection) and NJCAT (New Jersey Corporation for Advanced Technology) protocol for lab testing, the UF Sediment covers a similar range of particle size but with a finer d_{50} (d_{50} for NJDEP is approximately $50 \mu\text{m}$) (NJDEP, 2003).

The OK-110 silica sand is a commercial product of U.S. Silica Sand. The particle size distribution analysis of this material, also included in Figure 1, shows that 99.9% of the OK-110 sand is finer than 250 microns, with a mean particle size (d_{50}) of 106 microns. The PSDs for the test material are shown in Figure 1.

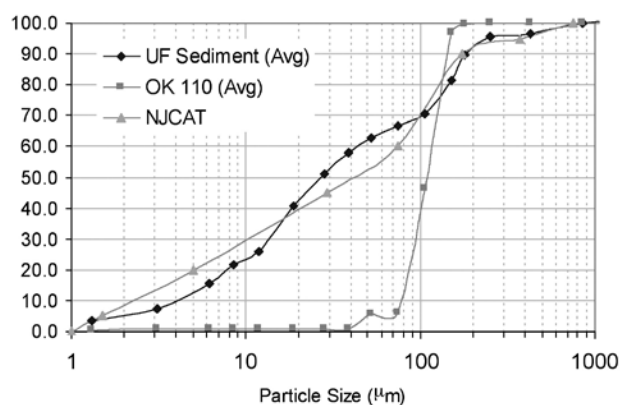


Figure 1. Particle size distributions

Tests were conducted to quantify the performance of a specific CDS unit (1.1 cfs (31.3-L/s) design capacity) at various flow rates, ranging from 1% up to 125% of the treatment design capacity of the unit, using the 2400 micron screen. All tests were conducted with controlled influent concentrations of approximately 200 mg/L. Effluent samples were taken at equal time intervals across the entire duration of each test run. These samples were then processed with a Dekaport Cone sample splitter to obtain representative sub-samples for Suspended Sediment Concentration (SSC) testing using ASTM D3977-97 "Standard Test Methods for Determining Sediment Concentration in Water Samples", and particle size distribution analysis.

Results and Modeling

Based on the data from the University of Florida, a performance model was developed for the CDS system. A regression analysis was used to develop a fitting curve representative of the scattered data points at various design flow rates. This model, which demonstrated good agreement with the laboratory data, can then be used to predict CDS system performance with respect

to SSC removal for any particle size gradation, assuming the particles are inorganic sandy-silt. Figure 2 shows CDS predictive performance for two typical particle size gradations (NJCAT gradation and OK-110 sand) as a function of operating rate.

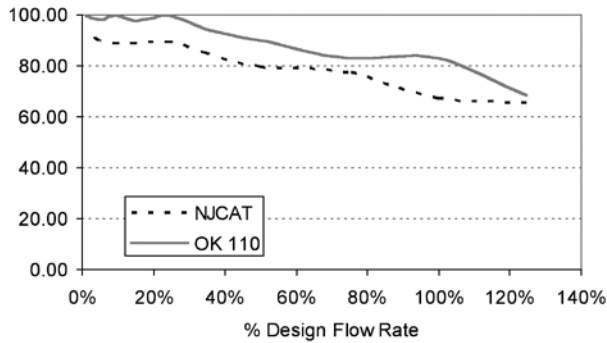


Figure 2. CDS stormwater treatment predictive performance for various particle gradations as a function of operating rate.

Many regulatory jurisdictions set a performance standard for hydrodynamic devices by stating that the devices shall be capable of achieving an 80% removal efficiency for particles having a mean particle size (d_{50}) of 125 microns (e.g. Washington State Department of Ecology — WASDOE - 2008). The model can be used to calculate the expected performance of such a PSD (shown in Figure 3). The model indicates (Figure 4) that the CDS system with 2400 micron screen achieves approximately 80% removal at the design (100%) flow rate, for this particle size distribution ($d_{50} = 125 \mu m$).

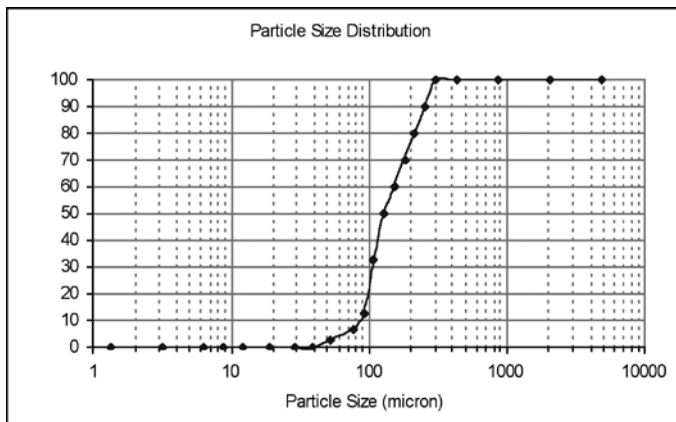


Figure 3. WASDOE PSD

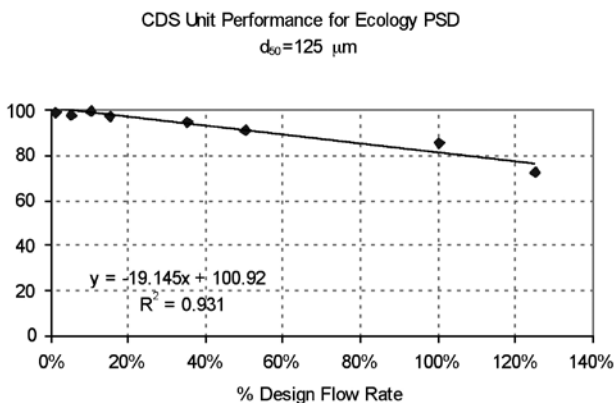


Figure 4. Modeled performance for WASDOE PSD.

Maintenance

The CDS system should be inspected at regular intervals and maintained when necessary to ensure optimum performance. The rate at which the system collects pollutants will depend more heavily on site activities than the size of the unit. For example, unstable soils or heavy winter sanding will cause the grit chamber to fill more quickly but regular sweeping of paved surfaces will slow accumulation.

Inspection

Inspection is the key to effective maintenance and is easily performed. Pollutant transport and deposition may vary from year to year and regular inspections will help ensure that the system is cleaned out at the appropriate time. At a minimum, inspections should be performed twice per year (e.g. spring and fall) however more frequent inspections may be necessary in climates where winter sanding operations may lead to rapid accumulations, or in equipment washdown areas. Installations should also be inspected more frequently where excessive amounts of trash are expected.

The visual inspection should ascertain that the system components are in working order and that there are no blockages or obstructions in the inlet and separation screen. The inspection should also quantify the accumulation of hydrocarbons, trash, and sediment in the system. Measuring pollutant accumulation can be done with a calibrated dipstick, tape measure or other measuring instrument. If absorbent material is used for enhanced removal of hydrocarbons, the level of discoloration of the sorbent material should also be identified



during inspection. It is useful and often required as part of an operating permit to keep a record of each inspection. A simple form for doing so is provided.

Access to the CDS unit is typically achieved through two manhole access covers. One opening allows for inspection and cleanout of the separation chamber (cylinder and screen) and isolated sump. The other allows for inspection and cleanout of sediment captured and retained outside the screen. For deep units, a single manhole access point would allow both sump cleanout and access outside the screen.

The CDS system should be cleaned when the level of sediment has reached 75% of capacity in the isolated sump or when an appreciable level of hydrocarbons and trash has accumulated. If absorbent material is used, it should be replaced when significant discoloration has occurred. Performance will not be impacted until 100% of the sump capacity is exceeded; however, it is recommended that the system be cleaned prior to that for easier removal of sediment. The level of sediment is easily determined by measuring from finished grade down to the top of the sediment pile. To avoid underestimating the level of sediment in the chamber, the measuring device must be lowered to the top of the sediment pile carefully. Particles at the top of the pile typically offer less resistance to the end of the rod than consolidated particles toward the bottom of the pile. Once this measurement is recorded, it should be compared to the as-built drawing for the unit to determine whether the height of the sediment pile off the bottom of the sump floor exceeds 75% of the total height of isolated sump.

Cleaning

Cleaning of a CDS system should be done during dry weather conditions when no flow is entering the system. The use of a vacuum truck is generally the most effective and convenient method of removing pollutants from the system. Simply remove the manhole covers and insert the vacuum hose into the sump. The system should be completely drained down and the sump fully evacuated of sediment. The area outside the screen should also be cleaned out if pollutant build-up exists in this area.

In installations where the risk of petroleum spills is small, liquid contaminants may not accumulate as quickly as sediment. However, the system should be cleaned out immediately in the event of an oil or gasoline spill. Motor oil and other hydrocarbons that accumulate on a more routine basis should be removed when an appreciable layer has been captured. To remove these pollutants, it may be preferable to use absorbent pads since they are usually less expensive to dispose than the oil/water emulsion that may be created by vacuuming the oily layer. Trash and debris can be netted out to separate it from the other pollutants. The screen should be cleaned to ensure it is free of trash and debris.

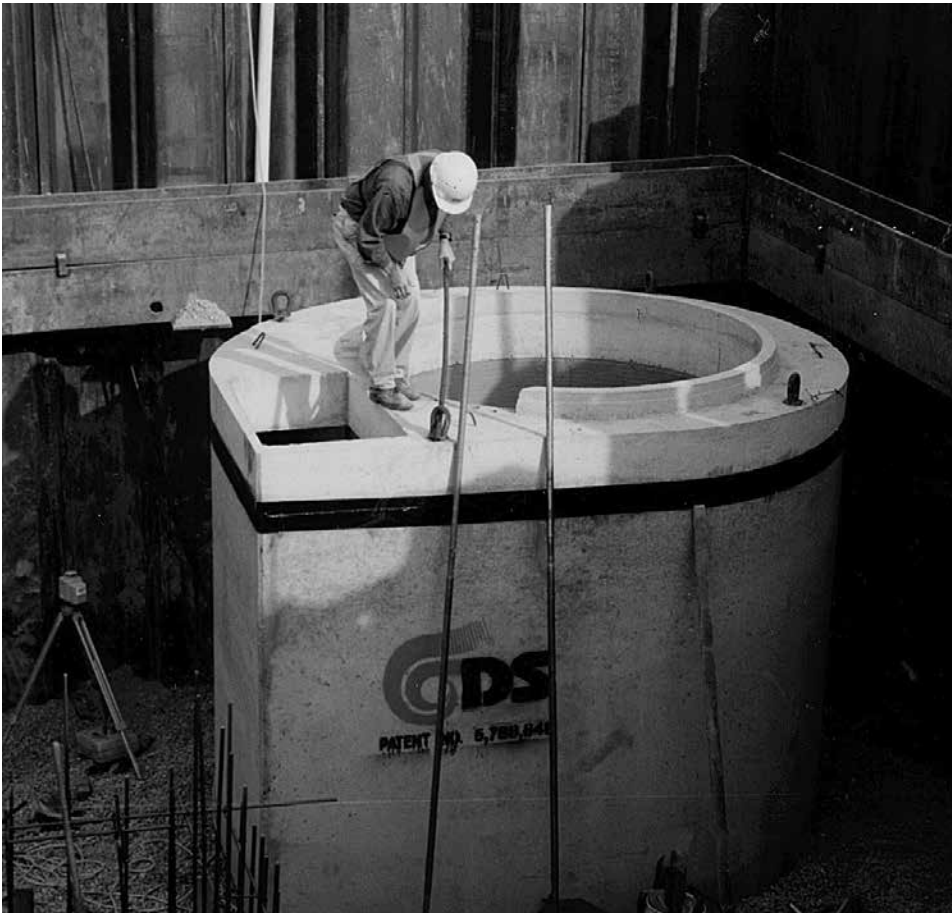
Manhole covers should be securely seated following cleaning activities to prevent leakage of runoff into the system from above and also to ensure that proper safety precautions have been followed. Confined space entry procedures need to be followed if physical access is required. Disposal of all material removed from the CDS system should be done in accordance with local regulations. In many jurisdictions, disposal of the sediments may be handled in the same manner as the disposal of sediments removed from catch basins or deep sump manholes. Check your local regulations for specific requirements on disposal.



CDS Model	Diameter		Distance from Water Surface to Top of Sediment Pile		Sediment Storage Capacity	
	ft	m	ft	m	y ³	m ³
CDS1515	3	0.9	3.0	0.9	0.5	0.4
CDS2015	4	1.2	3.0	0.9	0.9	0.7
CDS2015	5	1.5	3.0	0.9	1.3	1.0
CDS2020	5	1.5	3.5	1.1	1.3	1.0
CDS2025	5	1.5	4.0	1.2	1.3	1.0
CDS3020	6	1.8	4.0	1.2	2.1	1.6
CDS3025	6	1.8	4.0	1.2	2.1	1.6
CDS3030	6	1.8	4.6	1.4	2.1	1.6
CDS3035	6	1.8	5.0	1.5	2.1	1.6
CDS4030	8	2.4	4.6	1.4	5.6	4.3
CDS4040	8	2.4	5.7	1.7	5.6	4.3
CDS4045	8	2.4	6.2	1.9	5.6	4.3
CDS5640	10	3.0	6.3	1.9	8.7	6.7
CDS5653	10	3.0	7.7	2.3	8.7	6.7
CDS5668	10	3.0	9.3	2.8	8.7	6.7
CDS5678	10	3.0	10.3	3.1	8.7	6.7

Table 1: CDS Maintenance Indicators and Sediment Storage Capacities

Note: To avoid underestimating the volume of sediment in the chamber, carefully lower the measuring device to the top of the sediment pile. Finer silty particles at the top of the pile may be more difficult to feel with a measuring stick. These finer particles typically offer less resistance to the end of the rod than larger particles toward the bottom of the pile.



CDS Inspection & Maintenance Log

CDS Model: _____ Location: _____

Date	Water depth to sediment ¹	Floatable Layer Thickness ²	Describe Maintenance Performed	Maintenance Personnel	Comments

1. The water depth to sediment is determined by taking two measurements with a stadia rod: one measurement from the manhole opening to the top of the sediment pile and the other from the manhole opening to the water surface. If the difference between these measurements is less than the values listed in table 1 the system should be cleaned out. **Note: to avoid underestimating the volume of sediment in the chamber, the measuring device must be carefully lowered to the top of the sediment pile.**
2. For optimum performance, the system should be cleaned out when the floating hydrocarbon layer accumulates to an appreciable thickness. In the event of an oil spill, the system should be cleaned immediately.

SUPPORT

- Drawings and specifications are available at www.ContechES.com.
- Site-specific design support is available from our engineers.



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STORM WATER

PUT A STOP to TSS

Removes Pollutants from Runoff Prior to Entering Waterways

Efficient System

Catches pollutants where they are easiest to catch, at the inlet.

Variable Design

Able to be retrofitted or used in new projects.

Treatment Train

Can be incorporated as part of a "Treatment Train".

No Standing Water

Helps to minimize bacteria and odor problems.

Focused Treatment

Removes petroleum hydrocarbons, trash and Total Suspended Solids (TSS).

Maximum Flexibility

Available in a variety of standard sizes to fit round and square inlets.

Economical

Earn a higher return on system investment.

Two-part stainless-steel insert to filter solids and oils/grease.



Easy to install, inspect and maintain, even on small and confined sites.

By the Numbers*:

Filter will remove up to 80% of Total Suspended Solids (TSS), at least 70% of oils and grease, and up to 40% of Total Phosphorus (TP) associated with organic debris as well as Polycyclic Aromatic Hydrocarbons (PAH) from oil leaks and spills.

*Approximate for urban street application.

CATCH BASIN FILTER TEST RESULTS SUMMARY

Testing Agency	% TSS Removal	% Oil & Grease Removal	% PAH Removal
UCLA	80	70 to 80	
U of Auckland Tonking & Taylor, Ltd (for City of Auckland)	78 to 95		
U of Hawaii (for City of Honolulu)	80		20 to 40

INLET FILTRATION

Multi-Purpose Catch Basin Insert Retains Sediment, Debris, Trash and Oils/Grease

FloGard® catch basin insert filters are recommended for areas subject to silt and debris as well as low-to-moderate levels of petroleum hydrocarbons (oils and grease). Examples of such areas include vehicle parking lots, aircraft ramps, truck and bus storage yards, business parks, residential and public streets.

CATCH BASIN FILTER COMPETITIVE FEATURE COMPARISON		
Evaluation of Catch Basin Filters (Based on flow-comparable units) (Scale 1-10)	Oldcastle	Other Insert Filter Types**
Flow Rate	10	7
Removal Efficiency*	80%	45%
Capacity - Sludge & Oil	7	7
Service Life	10	3
Installation - Ease of Handling / Installation	8	6
Ease of Inspections & Maintenance	7	7
Value	10	2

*Approximate, based on field sediment removal testing in urban street application

**Average

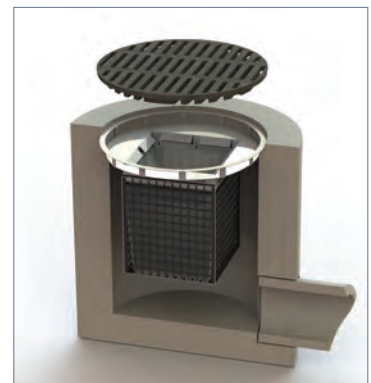
Long-Term Value Comparison (Based on flow-comparable units) (Scale 1-10)	Oldcastle	Other Insert Filter Types**
Unit Value - Initial (\$/cfs treated)	10	4
Installation Value (\$/cfs treated)	10	7
Absorbent Replacement (annual avg (\$/cfs treated))	10	2
Materials Replacement Value (annual avg (\$/cfs treated))	10	10
Maintenance Value (annual avg (\$/cfs treated))	10	7
Total First Year ROI (\$/cfs treated)	10	5
Total Annual Avg Value (\$/cfs treated, avg over 20 yrs)*	10	5



Combination Inlet



Flat-Grated Inlet



Circular Frame Inlet



Captured debris from FloGard catch basin insert filter in Dana Point, California.



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Appendix D:

BMP Maintenance Information

Isolator[®] Row O&M Manual



THE ISOLATOR[®] ROW

INTRODUCTION

An important component of any Stormwater Pollution Prevention Plan is inspection and maintenance. The StormTech Isolator Row is a technique to inexpensively enhance Total Suspended Solids (TSS) and Total Phosphorus (TP) removal with easy access for inspection and maintenance.

THE ISOLATOR ROW

The Isolator Row is a row of StormTech chambers, either SC-160, SC-310, SC-310-3, SC-740, DC-780, MC-3500 or MC-4500 models, that is surrounded with filter fabric and connected to a closely located manhole for easy access. The fabric-wrapped chambers provide for settling and filtration of sediment as storm water rises in the Isolator Row and ultimately passes through the filter fabric. The open bottom chambers and perforated sidewalls (SC-310, SC-310-3 and SC-740 models) allow storm water to flow both vertically and horizontally out of the chambers. Sediments are captured in the Isolator Row protecting the storage areas of the adjacent stone and chambers from sediment accumulation.

A woven geotextile fabric is placed between the stone and the Isolator Row chambers. The woven geotextile provides a media for stormwater filtration, a durable surface for maintenance, prevents scour of the underlying stone and remains intact during high pressure jetting. A non-woven fabric is placed over the chambers to provide a filter media for flows passing through the perforations in the sidewall of the chamber. The non-woven fabric is not required over the SC-160, DC-780, MC-3500 or MC-4500 models as these chambers do not have perforated side walls.

The Isolator Row is typically designed to capture the “first flush” and offers the versatility to be sized on a volume basis or flow rate basis. An upstream manhole provides access to the Isolator Row and typically includes a high flow weir. When flow rates or volumes exceed the Isolator Row weir capacity the water will flow over the weir and discharge through a manifold to the other chambers.

Another acceptable design uses one open grate inlet structure. Using a “high/low” design (low invert elevation on the Isolator Row and a higher invert elevation on the manifold) an open grate structure can provide the advantages of the Isolator Row by creating a differential between the Isolator Row and manifold thus allowing for settlement in the Isolator Row.

The Isolator Row may be part of a treatment train system. The design of the treatment train and selection of pretreatment devices by the design engineer is often driven by regulatory requirements. Whether pretreatment is used or not, the Isolator Row is recommended by StormTech as an effective means to minimize maintenance requirements and maintenance costs.

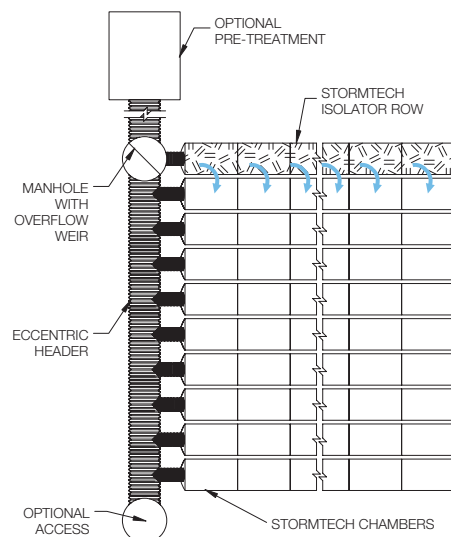
Note: See the StormTech Design Manual for detailed information on designing inlets for a StormTech system, including the Isolator Row.



Looking down the Isolator Row from the manhole opening, woven geotextile is shown between the chamber and stone base.



StormTech Isolator Row with Overflow Spillway (not to scale)





ISOLATOR ROW INSPECTION/MAINTENANCE

INSPECTION

The frequency of inspection and maintenance varies by location. A routine inspection schedule needs to be established for each individual location based upon site specific variables. The type of land use (i.e. industrial, commercial, residential), anticipated pollutant load, percent imperviousness, climate, etc. all play a critical role in determining the actual frequency of inspection and maintenance practices.

At a minimum, StormTech recommends annual inspections. Initially, the Isolator Row should be inspected every 6 months for the first year of operation. For subsequent years, the inspection should be adjusted based upon previous observation of sediment deposition.

The Isolator Row incorporates a combination of standard manhole(s) and strategically located inspection ports (as needed). The inspection ports allow for easy access to the system from the surface, eliminating the need to perform a confined space entry for inspection purposes.

If upon visual inspection it is found that sediment has accumulated, a stadia rod should be inserted to determine the depth of sediment. When the average depth of sediment exceeds 3 inches throughout the length of the Isolator Row, clean-out should be performed.

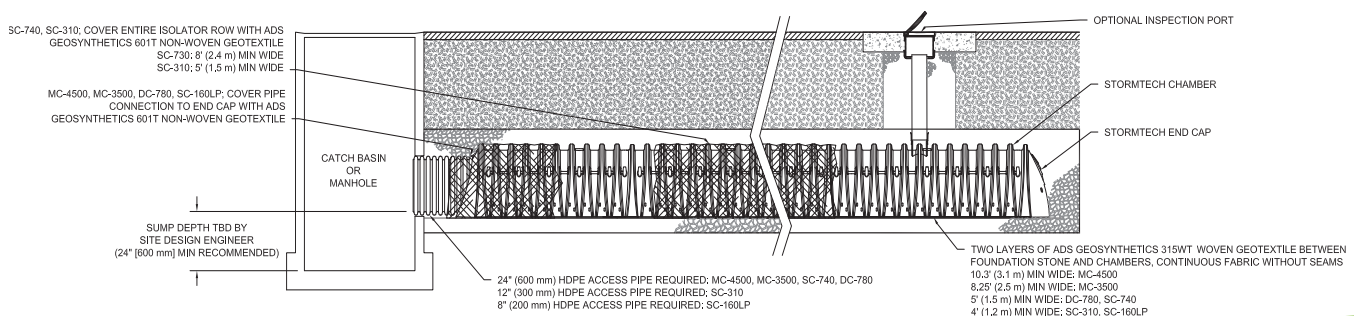
MAINTENANCE

The Isolator Row was designed to reduce the cost of periodic maintenance. By “isolating” sediments to just one row, costs are dramatically reduced by eliminating the need to clean out each row of the entire storage bed. If inspection indicates the potential need for maintenance, access is provided via a manhole(s) located on the end(s) of the row for cleanout. If entry into the manhole is required, please follow local and OSHA rules for a confined space entries.

Maintenance is accomplished with the JetVac process. The JetVac process utilizes a high pressure water nozzle to propel itself down the Isolator Row while scouring and suspending sediments. As the nozzle is retrieved, the captured pollutants are flushed back into the manhole for vacuuming. Most sewer and pipe maintenance companies have vacuum/JetVac combination vehicles. Selection of an appropriate JetVac nozzle will improve maintenance efficiency. Fixed nozzles designed for culverts or large diameter pipe cleaning are preferable. Rear facing jets with an effective spread of at least 45° are best. Most JetVac reels have 400 feet of hose allowing maintenance of an Isolator Row up to 50 chambers long. **The JetVac process shall only be performed on StormTech Isolator Rows that have AASHTO class 1 woven geotextile (as specified by StormTech) over their angular base stone.**

StormTech Isolator Row (not to scale)

Note: Non-woven fabric is only required over the inlet pipe connection into the end cap for SC-160LP, DC-780, MC-3500 and MC-4500 chamber models and is not required over the entire Isolator Row.



ISOLATOR ROW STEP BY STEP MAINTENANCE PROCEDURES

STEP 1

Inspect Isolator Row for sediment.

- A) Inspection ports (if present)
 - i. Remove lid from floor box frame
 - ii. Remove cap from inspection riser
 - iii. Using a flashlight and stadia rod, measure depth of sediment and record results on maintenance log.
 - iv. If sediment is at or above 3 inch depth, proceed to Step 2. If not, proceed to Step 3.
- B) All Isolator Rows
 - i. Remove cover from manhole at upstream end of Isolator Row
 - ii. Using a flashlight, inspect down Isolator Row through outlet pipe
 1. Mirrors on poles or cameras may be used to avoid a confined space entry
 2. Follow OSHA regulations for confined space entry if entering manhole
 - iii. If sediment is at or above the lower row of sidewall holes (approximately 3 inches), proceed to Step 2. If not, proceed to Step 3.

STEP 2

Clean out Isolator Row using the JetVac process.

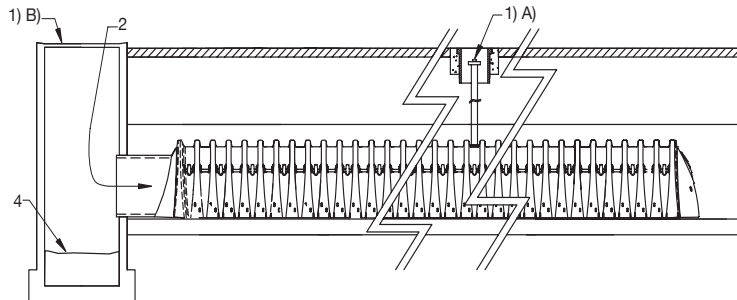
- A) A fixed floor cleaning nozzle with rear facing nozzle spread of 45 inches or more is preferable
- B) Apply multiple passes of JetVac until backflush water is clean
- C) Vacuum manhole sump as required

STEP 3

Replace all caps, lids and covers, record observations and actions.

STEP 4

Inspect & clean catch basins and manholes upstream of the StormTech system.



SAMPLE MAINTENANCE LOG

Date	Stadia Rod Readings		Sediment Depth (1)-(2)	Observations/Actions	Inspector
	Fixed point to chamber bottom (1)	Fixed point to top of sediment (2)			
3/15/11	6.3 ft	none		New installation. Fixed point is CI frame at grade	DJM
9/24/11		6.2	0.1 ft	Some grit felt	SM
6/20/13		5.8	0.5 ft	Mucky feel, debris visible in manhole and in Isolator Row, maintenance due	NV
7/7/13	6.3 ft		0	System jetted and vacuumed	DJM

CDS® Inspection and Maintenance Guide



Maintenance

The CDS system should be inspected at regular intervals and maintained when necessary to ensure optimum performance. The rate at which the system collects pollutants will depend more heavily on site activities than the size of the unit. For example, unstable soils or heavy winter sanding will cause the grit chamber to fill more quickly but regular sweeping of paved surfaces will slow accumulation.

Inspection

Inspection is the key to effective maintenance and is easily performed. Pollutant transport and deposition may vary from year to year and regular inspections will help ensure that the system is cleaned out at the appropriate time. At a minimum, inspections should be performed twice per year (e.g. spring and fall) however more frequent inspections may be necessary in climates where winter sanding operations may lead to rapid accumulations, or in equipment washdown areas. Installations should also be inspected more frequently where excessive amounts of trash are expected.

The visual inspection should ascertain that the system components are in working order and that there are no blockages or obstructions in the inlet and separation screen. The inspection should also quantify the accumulation of hydrocarbons, trash, and sediment in the system. Measuring pollutant accumulation can be done with a calibrated dipstick, tape measure or other measuring instrument. If absorbent material is used for enhanced removal of hydrocarbons, the level of discoloration of the sorbent material should also be identified during inspection. It is useful and often required as part of an operating permit to keep a record of each inspection. A simple form for doing so is provided.

Access to the CDS unit is typically achieved through two manhole access covers. One opening allows for inspection and cleanout of the separation chamber (cylinder and screen) and isolated sump. The other allows for inspection and cleanout of sediment captured and retained outside the screen. For deep units, a single manhole access point would allow both sump cleanout and access outside the screen.

The CDS system should be cleaned when the level of sediment has reached 75% of capacity in the isolated sump or when an appreciable level of hydrocarbons and trash has accumulated. If absorbent material is used, it should be replaced when significant discoloration has occurred. Performance will not be impacted until 100% of the sump capacity is exceeded however it is recommended that the system be cleaned prior to that for easier removal of sediment. The level of sediment is easily determined by measuring from finished grade down to the top of the sediment pile. To avoid underestimating the level of sediment in the chamber, the measuring device must be lowered to the top of the sediment pile carefully. Particles at the top of the pile typically offer less resistance to the end of the rod than consolidated particles toward the bottom of the pile. Once this measurement is recorded, it should be compared to the as-built drawing for the unit to determine whether the height of the sediment pile off the bottom of the sump floor exceeds 75% of the total height of isolated sump.

Cleaning

Cleaning of a CDS system should be done during dry weather conditions when no flow is entering the system. The use of a vacuum truck is generally the most effective and convenient method of removing pollutants from the system. Simply remove the manhole covers and insert the vacuum hose into the sump. The system should be completely drained down and the sump fully evacuated of sediment. The area outside the screen should also be cleaned out if pollutant build-up exists in this area.

In installations where the risk of petroleum spills is small, liquid contaminants may not accumulate as quickly as sediment. However, the system should be cleaned out immediately in the event of an oil or gasoline spill should be cleaned out immediately. Motor oil and other hydrocarbons that accumulate on a more routine basis should be removed when an appreciable layer has been captured. To remove these pollutants, it may be preferable to use absorbent pads since they are usually less expensive to dispose than the oil/water emulsion that may be created by vacuuming the oily layer. Trash and debris can be netted out to separate it from the other pollutants. The screen should be power washed to ensure it is free of trash and debris.

Manhole covers should be securely seated following cleaning activities to prevent leakage of runoff into the system from above and also to ensure that proper safety precautions have been followed. Confined space entry procedures need to be followed if physical access is required. Disposal of all material removed from the CDS system should be done in accordance with local regulations. In many jurisdictions, disposal of the sediments may be handled in the same manner as the disposal of sediments removed from catch basins or deep sump manholes.



CDS Model	Diameter		Distance from Water Surface to Top of Sediment Pile		Sediment Storage Capacity	
	ft	m	ft	m	y ³	m ³
CDS1515	3	0.9	3.0	0.9	0.5	0.4
CDS2015	4	1.2	3.0	0.9	0.9	0.7
CDS2015	5	1.3	3.0	0.9	1.3	1.0
CDS2020	5	1.3	3.5	1.1	1.3	1.0
CDS2025	5	1.3	4.0	1.2	1.3	1.0
CDS3020	6	1.8	4.0	1.2	2.1	1.6
CDS3025	6	1.8	4.0	1.2	2.1	1.6
CDS3030	6	1.8	4.6	1.4	2.1	1.6
CDS3035	6	1.8	5.0	1.5	2.1	1.6
CDS4030	8	2.4	4.6	1.4	5.6	4.3
CDS4040	8	2.4	5.7	1.7	5.6	4.3
CDS4045	8	2.4	6.2	1.9	5.6	4.3
CDS5640	10	3.0	6.3	1.9	8.7	6.7
CDS5653	10	3.0	7.7	2.3	8.7	6.7
CDS5668	10	3.0	9.3	2.8	8.7	6.7
CDS5678	10	3.0	10.3	3.1	8.7	6.7

Table 1: CDS Maintenance Indicators and Sediment Storage Capacities



Support

- Drawings and specifications are available at www.contechstormwater.com.
- Site-specific design support is available from our engineers.

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CDS Inspection & Maintenance Log

CDS Model: _____ Location: _____

[illegible]

1. The water depth to sediment is determined by taking two measurements with a stadia rod: one measurement from the manhole opening to the top of the sediment pile and the other from the manhole opening to the water surface. If the difference between these measurements is less than the values listed in table 1 the system should be cleaned out. **Note: to avoid underestimating the volume of sediment in the chamber, the measuring device must be carefully lowered to the top of the sediment pile.**
2. For optimum performance, the system should be cleaned out when the floating hydrocarbon layer accumulates to an appreciable thickness. In the event of an oil spill, the system should be cleaned immediately.



FLOGARD® CATCH BASIN INSERT FILTER

Submittal Package

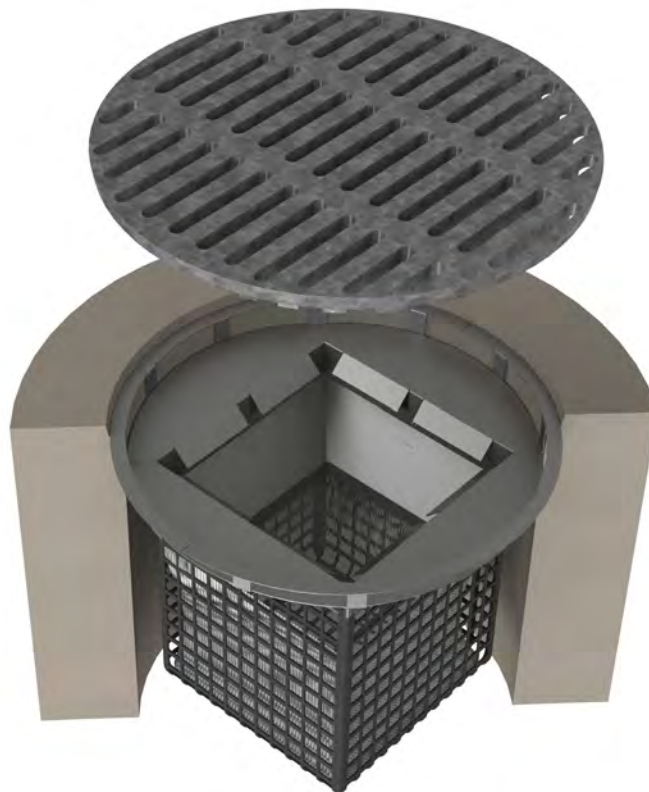


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Geotechnical Information

(Leighton Geotechnical Report: dated 12-20-2021)



**GEOTECHNICAL EXPLORATION REPORT
PROPOSED INDUSTRIAL BUILDING
2411 N. GLASSELL STREET
CITY OF ORANGE, CALIFORNIA**

Prepared For **REXFORD INDUSTRIAL REALTY & MANAGEMENT, INC.**
11620 Wilshire Boulevard, 10th Floor
Los Angeles, California 90025

Prepared By **LEIGHTON CONSULTING, INC.**
17781 Cowan
Irvine, California 92614

Project No. 13333.001

December 20, 2021
(Revised January 12, 2022)

December 20, 2021
(Revised January 12, 2022)

Project No. 13333.001

Rexford Industrial Realty & Management, Inc.
11620 Wilshire Boulevard, 10th Floor
Los Angeles, California 90025

Attention: Mr. Michael Ramirez

**Subject: Geotechnical Exploration Report
Proposed Industrial Building
2411 N. Glassell Street
City of Orange, California**

Per our July 12, 2021 proposal, authorized on October 27, 2021, Leighton Consulting, Inc. (Leighton) has prepared this geotechnical exploration report for the subject project. We understand the proposed development concept includes demolition of the existing buildings and site improvements to allow construction of a new one-story industrial building. Based on review of the *Conceptual Site Plan (Scheme A1-0) by Rexford Industrial Realty*, dated August 9, 2021 (delta 3 revision), and discussions with you, we understand the proposed development consists of a new one-story industrial building with a total building area of 277,000 square feet. The proposed concrete tilt-up building will be constructed at grade with associated truck parking, truck loading and surface parking. Ancillary improvements likely consist of utility infrastructure, pavement, flatwork, and landscaping.

The purpose of our geotechnical exploration was to evaluate the subsurface conditions at the site, identify potential geologic and seismic hazards that may impact the project, and provide geotechnical recommendations for design and construction of the proposed improvements as currently planned.

The project is considered feasible from a geotechnical standpoint. The results of our exploration, conclusions and recommendations are presented in this report.

We appreciate the opportunity to be of service to you on this project. If you have any questions or if we can be of further service, please contact us at **(866) LEIGHTON**; or specifically at the phone extensions or e-mail addresses listed below.

Respectfully submitted,

LEIGHTON CONSULTING, INC.



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Distribution: (1) Addressee

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1.0 INTRODUCTION

1.1 Site Description and Proposed Development

The project site is located at 2411 N. Glassell Street in the city of Orange, Orange County, California. The site location (latitude 33.82838°, longitude -117.85110°) and immediate vicinity are shown on Figure 1, *Site Location Map*.

The project site is a 12.5-acre, irregularly shaped parcel of land currently occupied by four (4) existing commercial buildings and associated paved access and surface parking. The site is bordered by N. Glassell Street to the west, Fletcher Avenue to the north, the Burlington Northern Santa Fe (BNSF) railroad to the east, and a former railroad spur followed by existing commercial properties to the south. Access to the site is via two (2) drive approaches that connect the property to N. Glassell Street.

The project site is relatively flat with sheet flow generally directed to the southwest. Review of the United States Geological Survey (USGS) 7.5-Minute Orange Quadrangle (USGS, 1981) indicates the ground surface at the site is between approximately Elevation (El.) +200 and +210 feet mean sea level (msl).

Based on review of historical aerial photographs (NETR, 2021), the site was an orchard until at least 1963. Between approximately 1966 and 1980, the site remained vacant and undeveloped. The existing buildings were constructed between 1980 and 1992. The site appears to have the same configuration since 1992.

Based on discussions with you, we understand the proposed development concept includes demolition of the existing buildings and site improvements to allow construction of a new one-story industrial building. Based on our review of the *Conceptual Site Plan (Sheet A1-0)* by Rexford Industrial Realty, dated August 9, 2021 (delta 3 revision), and discussions with you, we understand the proposed development consists of a new one-story industrial building with a total building area of 277,000 square feet. The proposed concrete tilt-up building will be constructed at grade with associated truck loading, surface parking, and Orange County Fire Department access. Ancillary improvements likely consist of utility infrastructure, pavement, flatwork, and landscaping. Preliminary structural data was not available at the time of this report.

1.2 **Purpose and Scope**

The purpose of our geotechnical exploration was to evaluate the subsurface conditions at the site relative to the proposed development concept and provide geotechnical recommendations to aid in the design and construction for the project as currently planned. The scope of this geotechnical exploration included the following tasks:

- **Background Review** – We reviewed readily available in-house geotechnical reports, literature, aerial photographs, and maps relevant to the site. We evaluated geological hazards and potential geotechnical issues that may significantly impact the site. The documents reviewed are listed in Section 5.0.
- **Pre-Field Exploration Activities** – A site visit was performed by a member of our technical staff to mark the proposed exploration locations. Dig Alert (811) was notified to locate and mark existing underground utilities prior to our subsurface exploration.
- **Field Exploration** – Our subsurface exploration was performed on November 4 and November 12, 2021, and included drilling, logging, and sampling a total of five (5) hollow-stem auger borings (designated LB-1 through LB-5) to approximate depths between 22 and 41 feet below the existing ground surface (bgs). Refusal was encountered at LB-2, LB-4, and LB-5 at 25.5, 41, and 22 feet bgs, respectively, prior to reaching target depth. Two (2) additional borings (designated LP-1 and LP-2) were each drilled to an approximate depth of 10 feet bgs for subsequent percolation testing. The approximate locations of the explorations are shown on Figure 2, *Exploration Location Map*. The boring logs are presented in Appendix A, *Exploration Logs*.

During drilling of the borings, bulk and drive samples were obtained for geotechnical laboratory testing. Driven ring samples were collected from the borings using a Modified California ring-lined sampler conducted in accordance with ASTM Test Method D 3550. Standard Penetration Tests (SPTs) were also performed within the borings in accordance with ASTM Test Method D 1586. Samples were collected at 5-foot intervals throughout the depth of exploration. In both test methods, the sampler is driven below the bottom of the borehole by a 140-pound weight (hammer) free-falling 30 inches. The drilling rig was equipped with an automatic hammer to provide greater consistency in the drop height and striking frequency. The number of blows to drive the sampler the

final 12 inches of the 18-inch drive interval is termed the “blowcount” or SPT N-value. The N-values provide a measure of relative density in granular (non-cohesive) soils and comparative consistency in cohesive soils. The number of blows per 6 inches of penetration was recorded on the boring logs, see Appendix A.

The borings were logged in the field by a geologist from our firm. Each soil sample collected was reviewed and described in accordance with the Unified Soil Classification System (USCS). The samples were sealed and packaged for transportation to our laboratory for testing. After completion of drilling, the borings were backfilled to the ground surface with soil cuttings and patched with cold-mix asphalt concrete at the surface to match existing conditions.

- *Percolation Testing* – Borings LP-1 and LP-2 were converted to temporary percolation test wells upon completion of drilling and sampling. The test wells consisted of 2-inch slotted (0.020”) PVC well casing surrounded by #3 Monterey Sand placed in the annulus of the well within the test zone. In-situ percolation testing was performed in general accordance with the *Orange County Technical Guidance Document (TGD) for the Preparation of Conceptual/Preliminary and/or Project Water Quality Management Programs (WQMPs)* (OCPW, 2013). The results of the percolation testing are presented in Appendix B, *Percolation Test Data*. Refer to the discussion of infiltration rate presented in Section 2.4.1, *Infiltration*. Upon completion of the percolation testing, the well casing was removed from each boring and the borings were backfilled with soil cuttings and patched at the surface with cold-mix asphalt concrete to match existing site conditions.
- *Laboratory Testing* – Laboratory tests were performed on selected soil samples obtained from the borings during our field investigation. The laboratory testing program was designed to evaluate the physical and engineering characteristics of the onsite soils. Tests performed during this investigation include:
 - In-situ Moisture Content and Dry Density (ASTM D 2216 and ASTM D 2937);
 - Atterberg Limits (ASTM D 4318);
 - Direct Shear (ASTM D 3080);
 - Consolidation (ASTM D 2435);
 - Maximum Dry Density (ASTM D 1557);

-
- Expansion Index (ASTM D 4829);
 - R-value; and
 - Corrosivity Suite – pH, Sulfate, Chloride, and Resistivity (California Test Methods 417, 422, and 532/643).

Results of the in-situ moisture content and dry density testing are presented on the boring logs in Appendix A. Other laboratory test results are presented in Appendix C, *Laboratory Test Results*.

- *Engineering Analysis* – The data obtained from our background review and field exploration were evaluated and analyzed to develop recommendations for the proposed development.
- *Report Preparation* – This report presents our findings, conclusions, and recommendations for the proposed development.

2.0 GEOTECHNICAL FINDINGS

2.1 Regional Geologic Setting

The project site is located on the lowest reach of the Santa Ana River basin within the Peninsular Ranges geomorphic province. The Peninsular Ranges geomorphic province extends southward from the Los Angeles Basin to the tip of Baja California (Yerkes et al., 1965) and is characterized by elongated northwest-trending mountain ranges separated by sediment-floored valleys. The most dominant structural features of the province are the northwest trending fault zones, most of which die out, merge with, or are terminated by the steep reverse faults at the southern margin of the Transverse Ranges geomorphic province. East of the site are the northwest-trending Santa Ana Mountains, a large range which has been uplifted on its eastern side along the Whittier-Elsinore Fault Zone, producing a tilted, irregular highland that slopes westward toward the sea.

The area south and west of the Santa Ana Mountains is generally characterized as a broad, complex, alluvial fan, which receives sediments from the Santa Ana River and its tributaries draining the Santa Ana and San Bernardino Mountains. These sediments are comprised of relatively flat-lying, unconsolidated to loosely consolidated clastic deposits that are approximately 3,000 feet thick beneath the site (Sprotte et al., 1980; Real, 1985).

2.2 Surficial Geology

The site is located approximately 0.7 miles east of the Santa Ana River. The surficial deposits at the site are mapped to primarily consist of Quaternary-aged old alluvial fan deposits (Bedrossian and Roffers, 2010; Morton and Miller, 2006). A small area in the northwestern portion of the site is mapped to consist of Quaternary-aged young alluvial deposits deposited by the Santa Ana River and tributaries. The older alluvial deposits consist of slightly to moderately consolidated alluvial sediments are generally comprised of relatively flat-lying, non-marine deposits of boulder, cobble, gravel, sand, and silt. The Quaternary-age young alluvial fan deposits mapped in the northwestern portion of the site consist of unconsolidated alluvial sediments that are generally comprised of sand, silt, and clay. The surficial geologic units mapped in the vicinity of the project site are presented on Figure 3, *Regional Geology Map*.

2.3 **Subsurface Conditions**

Based on our subsurface explorations, the site is underlain by a layer of undocumented artificial fill materials (Afu) overlying Quaternary-aged old alluvial fan deposits (Qof). The artificial fill encountered in our borings at the explored locations is generally between 3 and 7 feet in thickness across the site, likely associated with the existing and previous site improvements. The fill soils consist primarily of locally derived clayey sand, clayey silt, silty clay, and clay with variable amounts of gravel. Localized thicker accumulations of the fill materials should be anticipated between explored locations during future earthwork construction, particularly below the existing buildings. Below the artificial fill materials, older alluvial fan deposits (Qof) were encountered in the borings to the maximum depth explored (41 feet bgs). The alluvial sediments generally consist of light brown to brown, moist, medium dense to very dense, clayey sand with gravel, gravelly sand, silty sand and sandy gravel. A layer of brown, medium stiff, lean clay to sandy clay was encountered in the eastern portion of the site between approximately 15 to 20 feet bgs in boring LB-3 and between approximately 18 to 20 and 25 to 40 feet bgs in boring LB-4.

Detailed descriptions of the subsurface materials encountered in the borings are presented on the logs included in Appendix A. Some of the engineering properties of these soils are described in the following sections. The locations of the borings are shown on Figure 2, *Exploration Location Map*.

2.3.1 **Expansive Soil Characteristics**

Expansive soils contain significant amounts of clay particles that swell considerably when wetted and which shrink when dried. Foundations constructed on these soils are subject to uplifting forces caused by the swelling. Without proper mitigation measures, heaving and cracking of both building foundations and slabs-on-grade could result.

Two (2) near-surface bulk soil samples obtained during our subsurface exploration were tested for expansion potential. Test results indicate Expansion Index (EI) values of 24 and 26 (“low” potential for expansion). The Expansion Index laboratory test results are included in Appendix C of this report.

Variance in expansion potential of onsite soil is anticipated; therefore, additional testing is recommended upon completion of site grading and excavation to confirm the expansion potential presented in this report. For purposes of this report and based upon visual characterization of alluvial materials at approximate foundation depth, low expansion potential of site materials may be considered to support design and verified upon completion of earthwork grading.

2.3.2 Soil Corrosivity

Two (2) near-surface bulk soil samples obtained during our subsurface exploration was tested for corrosivity to assess corrosion potential to buried concrete. The chemical analysis test results for the onsite soil from our geotechnical exploration are included in Appendix C of this report.

The test results indicate soluble sulfate concentrations of 33 and 99 parts per million (ppm), chloride content of 40 ppm, pH values of 8.18 and 8.49, and minimum resistivity value of 2,197 and 2,498 ohm-cm.

The results of the resistivity test indicate the underlying soil is moderately to severely corrosive to buried ferrous metals per ASTM STP 1013. Based on the measured water-soluble sulfate content from the soil sample, concrete in contact with the soil is expected to have negligible exposure to sulfate attack per ACI 318 (ACI, 2014). The sample tested for water-soluble chloride content indicate a low potential for corrosion of steel in concrete due to the chloride content of the soil.

2.3.3 Soil Compressibility

Two (2) near-surface samples of the onsite soils recovered from the borings were remolded to 90 percent relative compaction and subjected to consolidation testing to evaluate the compressibility of these materials under assumed loads representative of anticipated structural bearing stresses. The results of testing indicate these soils exhibit low compressibility potential. The results of testing are presented in Appendix C.

2.3.4 Shear Strength

Evaluation of the shear strength characteristics of the soils included laboratory direct shear testing. The results of testing are included in Appendix C as well as summary graphs that provide values of angle of internal friction (ϕ) and cohesion (c) for use in geotechnical analysis.

2.3.5 Excavation Characteristics

Based on our subsurface explorations performed at the site and our experience from grading jobs in the vicinity of the site, we anticipate the onsite artificial fill and native earth materials can generally be excavated using conventional excavation equipment in good operating condition.

2.4 Groundwater Conditions

Groundwater was not encountered at the site during our subsurface exploration performed at the site to the maximum depth of 41 feet bgs. Based on review of the *Seismic Hazard Zone Report for the Orange Quadrangle* (CGS, 1997), the historically shallowest groundwater depth at the site is greater than 40 feet bgs. Based on review of available groundwater information from the California Department of Water Resources for a nearby groundwater monitoring well located approximately 0.9 miles northwest of the project site (State Well # 04S09W07N001S), the shallowest groundwater level measured for a monitoring period between June 1988 and February 2021 was approximately 96.6 feet bgs.

Based on these findings, groundwater is not expected to pose a constraint during or after construction. Fluctuations of the groundwater level, localized zones of perched water, and an increase in soil moisture, should be anticipated during and following the rainy seasons or periods of locally intense rainfall or storm water runoff, or from stormwater infiltration.

2.4.1 Infiltration

Percolation testing was performed in temporary wells installed within borings LP-1 and LP-2 located in the northern and southern portions of the site for a test zone at depths of approximately 5 to 10 feet bgs to evaluate the infiltration characteristics of subsurface soils. The percolation tests were conducted in general accordance with Orange County guidelines (OCPW,

2013). Results of the percolation testing are presented in Appendix B. The test locations and zones tested are shown on Figure 2.

A boring percolation test is useful for field measurements of the infiltration rate of soils and is suited for testing when the design depth of the infiltration device is deeper than current existing grades, especially in areas where it is difficult to dig test pits, or where the depths of these test pits would be considerably deep. At the subject site, testing consisted of advancing the borings to general depths anticipated for the invert of typical infiltration devices.

The percolation tests were performed using a constant-head method similar to the well permeameter test method (USBR 7300-89), which records the volumetric flow rate of water delivered to the test zone while maintaining a relatively constant height of water in the well. Since the subsurface materials at this location were generally favorable for percolation (sandy soils), a water source was used to deliver water to the well at a relatively constant rate while recording the water height in the well. The measured infiltration rate for the constant-head percolation test was calculated by dividing the total volume of water infiltrated by the total duration of the test and dividing by the percolation surface area.

Detailed results of the field testing data and measured infiltration rate for the test well are presented in Appendix B. The test results are summarized in the table below:

Table 1 – Measured (Unfactored) Infiltration Rate

Test Well Designation	Approximate Depth of Test Zone (feet bgs)	Measured Infiltration Rate (inches per hour)
LP-1	5 to 10	12.5
LP-2	5 to 10	7.6

Based on the results of our field percolation testing that was performed at the site, the measured (unfactored) infiltration rates for the two (2) tests performed were 12.5 inches per hour (LP-1) and 7.6 inches per hour (LP-2), respectively. According to Orange County guidelines (OCPW, 2013), the

measured infiltration rate at test wells LP-1 and LP-2 are well above the minimum feasibility criteria of 0.3 inch per hour.

2.5 **Surface Fault Rupture**

Our review of available literature indicates that no known active faults have been mapped across the site, and the site is **not** located within a currently established *Alquist-Priolo Earthquake Fault Zone* (Bryant and Hart, 2007). Therefore, a surface fault rupture hazard evaluation is not mandated for this site and the potential for surface fault rupture at the site is considered low.

The location of the closest active faults to the site was evaluated using the United States Geological Survey (USGS) Earthquake Hazards Program National Seismic Hazard Maps (USGS, 2008). The closest active fault to the site with the potential for surface fault rupture is the Elsinore, located approximately 6.3 miles from the site. The San Andreas fault, which is the largest active fault in California, is approximately 37.7 miles northeast of the site on the north side of the San Gabriel Mountains. Major regional faults with surface expression in proximity to the site are shown on Figure 4, *Regional Fault and Historical Seismicity Map*.

2.6 **Strong Ground Shaking**

The principal seismic hazard to the site is ground shaking resulting from an earthquake occurring along any of several major active and potentially active faults in southern California (Figure 4). The intensity of ground shaking at a given location depends primarily upon the earthquake magnitude, the distance from the source, and the site response characteristics.

Accordingly, design of the project should be performed in accordance with all applicable current codes and standards utilizing the appropriate seismic design parameters to reduce seismic risk as defined by California Geological Survey (CGS) Chapter 2 of Special Publication 117A (CGS, 2008). The 2019 edition of the California Building Code (CBC) is the current edition of the code. Through compliance with these regulatory requirements and the utilization of appropriate seismic design parameters selected by the design professionals, potential effects relating to seismic shaking can be reduced.

The following code-based seismic parameters should be considered for design under the 2019 CBC:

Table 2 – 2019 CBC Based Ground Motion Parameters (Mapped Values)

Categorization/Coefficient	Code-Based
Site Latitude	33.82838°
Site Longitude	-117.85110°
Site Class	D
Mapped Spectral Response Acceleration at Short Period (0.2 sec), S_s	1.495 g
Mapped Spectral Response Acceleration at Long Period (1 sec), S_1	0.529 g
Short Period (0.2 sec) Site Coefficient, F_a	1
Long Period (1 sec) Site Coefficient, F_v	null ¹
Adjusted Spectral Response Acceleration at Short Period (0.2 sec), S_{MS}	1.495 g
Adjusted Spectral Response Acceleration at Long Period (1 sec), S_{M1}	null ¹
Design Spectral Response Acceleration at Short Period (0.2 sec), S_{DS}	0.997 g
Design Spectral Response Acceleration at Long Period (1 sec), S_{D1}	null ¹
Site-adjusted geometric mean Peak Ground Acceleration, PGA_M	0.694 g
¹ Per Exception 2 in Section 11.4.8 of ASCE 7-16, seismic response coefficient C_s to be 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 $T > T_L$	

2.7 Liquefaction Potential

The term liquefaction is generally referenced to loss of strength and stiffness in soils due to build-up of pore water pressure when subject to cyclic or monotonic loading. Both sandy and clayey soils are susceptible to loss of strength and stiffness. Because of the difference in strength characteristic and methods for evaluating strength loss potential for granular and clayey soils, the term liquefaction is used for granular soils while cyclic softening is used for fine-grained soils (i.e. clays and plastic silts).

In general, adverse effects of liquefaction or cyclic softening include excessive ground settlement, loss of bearing support for structural foundations, and seismically-induced lateral ground deformations such as lateral spreading. Depending upon the relative thickness of the liquefied strata with respect to overlying non-liquefiable soils, other potentially adverse effects such as ground oscillation and ground fissuring may occur.

As shown on the *Seismic Hazard Zones* map for the Orange Quadrangle (CGS, 1998), the project site is **not** located within a seismically-induced landslide hazard zone identified by the State of California as being potentially susceptible to liquefaction (Figure 5, *Seismic Hazard Map*). Based on this consideration, the potential for seismically-induced landslide hazards at the site is not considered a hazard at the site.

2.8 **Seismically-Induced Settlement**

Seismically-induced settlement consists of dynamic settlement of unsaturated soil (above groundwater) and liquefaction-induced settlement (below groundwater). These settlements occur primarily within low density sandy soil due to reduction in volume during and shortly after an earthquake event.

Based on our evaluation of the alluvial site soils, the total seismically-induced settlement is estimated to be less than ½ inch. The differential settlement can be taken as half the total settlement over a horizontal distance of 30 feet.

2.9 **Lateral Spreading**

Liquefaction may also cause lateral spreading. For lateral spreading to occur, the liquefiable zone must be continuous, unconstrained laterally, and free to move along gently sloping ground toward an unconfined area. Since liquefaction is not considered a hazard at the site and the site is relatively flat and constrained laterally, earthquake-induced lateral spreading is also not considered a hazard at the site.

2.10 **Earthquake-Induced Landsliding**

As shown on the *Seismic Hazard Zones* map for the Orange Quadrangle (CGS, 1998), the site is **not** mapped within a seismically-induced landslide hazard zone identified by the State of California (Figure 5, *Seismic Hazard Map*). Based on this consideration and since the site is relatively flat, the potential for seismically-induced landslides is not considered a hazard at the site.

2.11 **Flooding**

According to a Federal Emergency Management Agency (FEMA) flood insurance rate map (FEMA, 2009), the project site is located within a flood hazard area identified as “Zone X”. A majority of the site is defined as an area of minimal flood

hazard, and the western portion of the site is located in an area that is defined as an area with reduced flood risk due to levee. As shown on Figure 6, *Flood Hazard Zone Map*, the western portion of the site is located within a 500-year flood hazard zone. Regionally, storm runoff flow is generally directed to the southwest.

Earthquake-induced flooding can be caused by failure of dams or other water-retaining structures as a result of earthquakes. According to information obtained from the State of California Division of Safety of Dams (DSOD) and shown on Figure 7, *Dam Inundation Map*, a majority of the site is mapped within a dam inundation zone associated with Prado Dam. However, due to the location and distance of the site from Prado Dam, the potential for earthquake-induced flooding to occur due to a failure of this dam is considered low. Catastrophic failure of this dam is expected to be a very unlikely event in that dam safety regulations exist and are enforced by the DOSD, Army Corps of Engineers and Department of Water Resources. Inspectors may require dam owners to perform work, maintenance or implement controls if issues are found with the safety of the dam.

2.12 Seiches and Tsunamis

Seiches are large waves generated in enclosed bodies of water in response to ground shaking. Tsunamis are waves generated in large bodies of water by fault displacement or major ground movement. Based on the absence of an enclosed water body near the site and the inland location of the site, seiche and tsunami risks at the site are considered negligible.

2.13 Methane

Based on review of State of California Geologic Energy Management Division (CalGEM) records, the project site is not located within a documented oil field and there are no documented oil wells onsite (CalGEM, 2021). Based on these findings, methane is not considered a hazard at the site.

3.0 GEOTECHNICAL DESIGN RECOMMENDATIONS

Based on this study, we conclude that the proposed development for the subject site is feasible from a geotechnical standpoint, provided that the recommendations presented in this report are properly incorporated in design and construction.

The proposed structures may be supported on shallow spread-type foundations established in engineered fill or undisturbed natural soils. The floor slab may be supported directly on grade. There may be existing underground utilities that will also be impacted. Information on these utilities should be provided to Leighton for evaluation. All existing undocumented fill is recommended to be removed from below the proposed building pad prior to placement of engineered fill.

The recommendations below are based upon the exhibited geotechnical engineering properties of the soils and their anticipated response both during and after construction. The recommendations are also based upon proper field observation and testing during construction. The project geotechnical engineer should be notified of suspected variances in field conditions to determine the effect upon the recommendations subsequently presented. These recommendations are considered minimal and may be superseded by more restrictive requirements of the civil and structural engineers, the City of Orange, the County of Orange, and other governing agencies.

Leighton should review the grading plans, foundation plans and project specifications as they become available to verify that the recommendations presented in this report have been incorporated into the plans for this project.

3.1 Site Grading

All site grading should be performed in accordance with the applicable local codes and in accordance with the project specifications that are prepared by the appropriate design professional. Earthwork for the project is expected to include overexcavation and recompaction of existing fill soils below new improvement footprints. Leighton should review the final grading plan and landscape plan when it becomes available to verify the recommendations in this report.

3.1.1 Site Preparation

Prior to construction, the site should be cleared of any vegetation, trash, former foundation remnants and/or debris within the area of proposed grading. These materials should be removed from the site. Any

underground obstructions onsite should be removed. Efforts should be made to locate any existing utility lines to be removed or rerouted where interfering with the proposed construction. Any resulting cavities should be properly backfilled and compacted. After the site is cleared, the soils should be carefully observed for the removal of all unsuitable deposits.

3.1.2 Removals and Overexcavations

To provide uniform foundation support and reduce the potential for excessive static settlement, all existing undocumented fill and any unsuitable soil, as deemed by the geotechnical engineer, should be removed to expose suitable native soils and replaced as engineered fill below the proposed building and other structural improvements. Based on our field explorations, we estimate removals of existing undocumented fill will be approximately 3 to 7 feet below existing grade across most of the site. Localized areas will require deeper removals. Unexplored portions of the site including areas beneath existing buildings and in areas of existing utilities, and areas disturbed during demolition of existing buildings and improvements may also require deeper removals.

Removals should be performed such that all undocumented fill is removed to expose suitable natural soils (alluvium) and replaced as engineered fill. The lateral extent of overexcavation beyond foundations should be equal to the depth of removals below the proposed foundations. The depth of overexcavation in non-structural areas planned for new pavement and concrete slabs on grade is recommended to be 2 feet below the current grade or planned subgrade elevation, whichever is lower, to develop a suitable bearing subgrade for support. Deeper overexcavations in localized areas may be recommended during grading by a representative of the geotechnical engineer depending on observed subsurface conditions.

3.1.3 Excavation Bottom Preparation

All excavation bottoms or removal bottoms should be observed by a representative of the geotechnical engineer prior to placement of fill or other improvements to determine that geotechnically suitable soil is exposed. Excavation bottoms observed to be suitable for fill placement or other improvements should be scarified to a depth of at least 8 inches, moisture-conditioned as necessary to achieve a moisture content within 2 percentage

points of optimum moisture content, and then compacted to a minimum of 90 percent of the laboratory derived maximum density as determined by ASTM Test Method D 1557 (Modified Proctor).

3.1.4 Fill Materials

On-site soil that is free of construction debris, organics, cobbles, boulders, rubble, or rock larger than 4-inches in largest dimension is suitable to be used as fill for support of structures. Any imported fill soil should be approved by the geotechnical engineer prior to import or use onsite.

3.1.5 Fill Placement and Compaction

Fill soils should be placed in loose lifts not exceeding 8 inches, moisture-conditioned to within 2 percent of optimum moisture content and compacted to a minimum of 90 percent of the maximum dry density as determined by ASTM Test Method D 1557. Aggregate base should be compacted to a minimum of 95 percent relative compaction.

When grading is interrupted by heavy rains, fill operations should not be resumed until the moisture content and the dry density of the placed fill are satisfactory.

3.1.6 Shrinkage

The change in volume of excavated and recompacted soil varies according to soil type and location. This volume change is represented as a percentage increase (bulking) or decrease (shrinkage) in volume of fill after removal and recompaction. Field and laboratory data used in our calculations included laboratory-measured maximum dry density for the general soil type encountered at the subject site, the measured in-place densities of near surface soils encountered and our experience.

Based upon the results of the in-place density and the moisture-density relationship exhibited by representative bulk samples of the near surface soils, recompaction of the soils is anticipated to result in volume shrinkage in the range of 10 to 15 percent. The estimated shrinkage does not include material losses due to removal of organic material or other unsuitable bearing materials (debris, rubble, oversize material greater than 6-inches)

and the actual shrinkage that occurs during grading may vary throughout the site.

3.1.7 Reuse of Concrete and Asphalt Rubble

If encountered during site clearing and/or during preparation activities, construction rubble (i.e., Portland cement concrete and asphalt concrete) may be incorporated in the proposed development. For use as structural fill, the processed material should be crushed to develop a relatively well-graded mixture with a maximum particle size of 3-inch nominal diameter. Concrete rubble should be free of rebar and processed asphalt pavement rubble may be used if mixed with the existing base course (where present). Processed material may be used as structural fill if uniformly mixed with onsite soils in proportion of 1 part processed asphalt to 3 parts soil. For use as pavement base course, rubble should be crushed to satisfy gradation requirements of Section 200-2.4 of the Standard Specifications for Public Works Construction. Such materials must be free of and segregated from any hazardous materials and/or organic material of any kind.

3.2 Foundation Design

Conventional spread footings established in engineered fill or undisturbed natural soils may be used to support proposed building. Footings should be embedded a minimum 18 inches below the lowest adjacent grade. An allowable soil bearing pressure of 3,000 pounds per square foot (psf) may be used for footings with a minimum width of 18 inches for continuous footings and 24 inches for isolated footings. A one-third increase in the bearing value for short duration loading, such as wind or seismic forces may be used. The recommended bearing value is a net value, and the weight of concrete in the footings can be taken as 50 pounds per cubic foot (pcf); the weight of soil backfill can be neglected when determining the downward loads.

The ultimate bearing capacity can be taken as 9,000 psf, which does not incorporate a factor of safety. A resistance factor of 0.45 should be used for initial bearing capacity evaluation with factored loads.

The allowable bearing capacity for shallow footings is based on a total static settlement of $\frac{1}{2}$ inch. Differential settlement can be taken as half the total settlement over a horizontal distance of 30 feet.

For static loading, 50 pounds per cubic inch (pci) may be assumed as the modulus of subgrade reaction (k). For seismic loading, a k value of 150 pci may be assumed.

Since settlement is a function of footing size and contact bearing pressure, differential settlement can be expected between adjacent columns or walls where a large differential loading condition exists. Once developed by the structural engineer, we should review total dead and sustained live loads for each column including plan location and span distance, to evaluate if differential settlements between dissimilarly loaded columns will be tolerable. Excessive differential settlement can be mitigated with the use of reduced bearing pressures, deeper footing embedment, possibly changing overexcavation schemes and using imported base material under spread footings, or possibly other methods.

Resistance to lateral loads will be provided by a combination of friction between the soil and structure interface and passive pressure acting against the vertical portion of the footings structures. For calculating lateral resistance, a passive pressure of 300 psf per foot of depth to a maximum of 3,000 psf and a frictional coefficient of 0.30 may be used. Note that the passive and frictional coefficients do not include a factor of safety. The frictional resistance and the passive resistance of the soils can be combined without reduction in determining the total lateral resistance.

3.3 Slabs-on-Grade

Concrete slabs may be designed using a modulus of subgrade reaction of 100 pci provided the subgrade is prepared as described in Section 3.1. From a geotechnical standpoint, we recommend slab-on-grade be a minimum 5 inches thick with No. 3 rebar placed at the center of the slab at 24 inches on center in each direction. The structural engineer should design the actual thickness and reinforcement based on anticipated loading conditions. Where moisture-sensitive floor coverings or equipment is planned, the slabs should be protected by a minimum 10-mil-thick vapor barrier between the slab and subgrade. A coefficient of friction of 0.35 can be used between the floor slab and the vapor barrier.

Minor cracking of concrete after curing due to drying and shrinkage is normal and should be expected; however, concrete is often aggravated by a high water/cement ratio, high concrete temperature at the time of placement, small nominal aggregate size, and rapid moisture loss due to hot, dry, and/or windy weather conditions during placement and curing. Cracking due to temperature and moisture fluctuations can also be expected. The use of low-slump concrete or low water/cement ratios can reduce the potential for shrinkage cracking. Additionally, our experience indicates that the use of reinforcement in slabs and foundations can generally reduce the potential but not eliminate for concrete cracking.

To reduce the potential for excessive cracking, concrete slabs-on-grade should be provided with construction or weakened plane joints at frequent intervals. Joints should be laid out to form approximately square panels.

3.4 Cement Type and Corrosion Protection

Based on the results of laboratory testing, concrete structures in contact with the onsite soil are expected to have negligible exposure to water-soluble sulfates in the soil. Common Type II cement may be used for concrete construction onsite and the concrete should be designed in accordance with 2019 CBC requirements. However, concrete exposed to recycled water should be designed using Type V cement.

Based on our laboratory testing, the onsite soil is considered severely to very severely corrosive to ferrous metals. Ferrous pipe should be avoided by using high-density polyethylene (HDPE) or other non-ferrous pipe when possible. Ferrous pipe, if used, should be protected by polyethylene bags, tap or coatings, di-electric fittings or other means to separate the pipe from onsite soils.

3.5 Retaining Walls

Recommended lateral earth pressures are provided as equivalent fluid unit weights, in psf/ft. or pcf. These values do not contain an appreciable factor of safety, so the structural engineer should apply the applicable factors of safety and/or load factors during design.

Onsite soils are likely suitable to be used as retaining wall backfill due to its very low expansion potential; however, field and laboratory verification are

recommended before use. Should site soil be considered for reuse behind retaining walls, it should be tested to ensure Expansion potential is less than 20 ($EI < 20$). Recommended lateral earth pressures for retaining walls backfilled with sandy soils with drained conditions as shown on Figure 8, *Retaining Wall Backfill and Subdrain Detail* are as follows:

Table 3 – Retaining Wall Design Earth Pressures

Retaining Wall Condition (Level Backfill)	Equivalent Fluid Pressure (pounds-per-cubic-foot)*
Active (cantilever)	35
At-Rest (braced)	60
Passive Resistance (compacted fill)	300
Seismic Increment (add to active pressure)	20

Walls that are free to rotate or deflect may be designed using active earth pressure. For basement walls or walls that are fixed against rotation, the at-rest pressure should be used. For seismic condition, the pressure should be distributed as an inverted triangular distribution and the dynamic thrust should be applied at a height of 0.6H above the base of the wall. In addition to the recommended earth pressures, walls below grade adjacent to existing structures or streets and areas of traffic should be designed to accommodate surcharge loads. For traffic surcharge, a uniform lateral pressure of 100 pounds per square foot acting as a result of an assumed 300 pounds per square foot surcharge behind the wall due to normal traffic; the traffic surcharge load may be neglected provided a minimum of 10-foot clearance between the wall and the traffic is maintained. We will provide surcharge loading from adjacent foundations after reviewing details of the planned basement walls in relation to existing foundations

3.5.1 Sliding and Overturning

Total depth of retained earth for design of walls and for uplift resistance, should be measured as the vertical height of the stem below the ground surface at the wall face for stem design, or measured at the heel of the footing for overturning and sliding. A soil unit weight of 120 pcf may be assumed for calculating the actual weight of the soil over the wall footing, if drained, or 60 pcf if submerged, for properly compacted backfill.

3.5.2 Drainage

Adequate drainage may be provided by a subdrain system positioned behind the walls. Typically, this system consists of a 4-inch minimum diameter perforated pipe placed near the base of the wall (perforations placed downward). The pipe should be bedded and backfilled with pervious backfill material described in Section 300-3.5.2 of the Standard Specifications for Public Works Construction (Green Book), 2018 Edition. This pervious backfill should extend at least 2 feet out from the wall and to within 2 feet of the outside finished grade. This pervious backfill and pipe should be wrapped in filter fabric, such as Mirafi 140N or equivalent, placed as described in Section 300-8.1 of the Standard Specifications for Public Works Construction (Green Book), 2018 Edition. The subdrain outlet should be connected to a free-draining outlet or sump.

Miradrain, Geotech Drainage Panels, or Enkadrain drainage geocomposites, or similar, may be used for wall drainage as an alternative to the Class 2 Permeable Material or drain rock backfill, particularly where horizontal space is limited adjacent to shoring (where walls are cast against shoring). These drainage panels should be connected to the perforated drainpipe at the base of the wall.

3.6 Paving

To provide support for paving, the subgrade soils should be prepared as recommended in the Section 3.1. Compaction of the subgrade, including trench backfills, to at least 90 percent of the maximum dry density as determined by ASTM Test Method D 1557, and achieving a firm, hard, and unyielding surface will be important for paving support. The preparation of the paving area subgrade should be performed immediately prior to placement of the base course.

Adequate drainage (both surface and subsurface) should be provided such that the subgrade soils and aggregate base materials are not allowed to become wet. Landscape areas must be separated from pavements with concrete curbs and/or edge drains. Excessive over-irrigation will have an adverse impact on adjacent pavements. Irrigation adjacent to pavements, without a deep curb or other cutoff to separate landscaping from paving, will result in premature pavement failure.

3.6.1 Asphalt Concrete

The required paving and base thicknesses will depend on the expected wheel loads and volume of traffic (Traffic Index or TI). Assuming that the paving subgrade will consist of engineered fill with an R-value greater than 15, compacted to at least 90 percent as recommended, the minimum recommended paving thicknesses are presented in the following table. Results of R-value testing on two (2) near surface samples of existing onsite soils indicate values of 16 and 18.

Table 4 – Asphalt Concrete Pavement Sections

Traffic Index	Asphalt Concrete (inches)	Base Course (inches)
5	4	6½
6	4	9½
7	5	11
8	6	13
9	6	16½

The asphalt paving sections were determined using the Caltrans design method. We can determine the recommended paving and base course thicknesses for other Traffic Indices if required. Careful inspection is recommended to verify that the recommended thicknesses or greater are achieved, and that proper construction procedures are followed.

3.6.2 Portland Cement Concrete Paving

We have assumed that the subgrade below paving will have an R-value of at least 15. Portland cement concrete (PCC) paving sections were determined in accordance with procedures developed by the Portland Cement Association. Concrete paving sections for a range of Traffic Indices are presented in the following table. We have assumed that the Portland cement concrete will have a compressive strength of at least 4,000 pounds per square inch.

Table 5 – PCC Pavement Sections

Traffic Index	PCC (inches)	Base Course (inches)
5	6	4
6	6½	4
7	7	4
8	7½	4
9	8½	4

The paving should be provided with expansion joints at regular intervals no more than 15 feet in each direction. Load transfer devices, such as dowels or keys, are recommended at joints in the paving to reduce possible offsets. The paving sections in the above table have been developed based on the strength of unreinforced concrete. Steel reinforcing may be added to the paving to reduce cracking and to prolong the life of the paving.

3.6.3 Base Course

The base course for both asphalt concrete and Portland cement concrete paving should meet the specifications for Class 2 Aggregate Base as defined in Section 26 of the latest edition of the State of California, Department of Transportation, Standard Specifications. Alternatively, the base course could meet the specifications for untreated base as defined in Section 200-2 of the latest edition of the Standard Specifications for Public Works Construction. The base course should be compacted to a minimum of 95 percent of the maximum dry density as determined by ASTM Test Method D 1557.

3.7 Infiltration BMP Design Considerations

It should be noted that the measured infiltration rates presented herein may degrade over time due to complete saturation of underlying soils, and fines build-up and plugging if pretreatment of the storm water is not performed. As such, a reduction of the measured infiltration rates using a factor of safety of at least 2 or more should be considered to establish a conservative infiltration rate for the service life of the system. This factor should not be less than 2, but may be higher at the discretion of the design engineer.

In general, a vast majority of geotechnical distress issues are related to improper drainage. Distress in the form of foundation movement could occur. Direct infiltration to the subsurface is not recommended adjacent to curb and gutter, public pavements or within 10 feet away from the design saturation zone as soil saturation could lead to a loss of soil support, settlement or collapse, and internal erosion (piping). The design saturation zone may be assumed as a 1:1 plane projected downward from the top of an infiltration device's discharge zone. Additionally, infiltration water will migrate along pipe backfill (typically sand or gravel bedding) affecting improvements far from the point of infiltration. Proposed direct open bottom infiltration systems, should be located as far away from existing or proposed foundations, rigid improvements and utilities as is practical in order to reduce the geotechnical distress issues related to water. Where sufficient distance from improvements cannot be achieved, additional recommendations may be warranted and can be provided during plan review.

Prior to construction of any infiltration device intended for the site, the plans should be reviewed by the geotechnical consultant to verify that our geotechnical recommendations have been appropriately incorporated into the plans and not compromised by the addition of an infiltration system to the site. The designer of any infiltration system should contact the geotechnical consultant for geotechnical input during the design process as they feel necessary.

3.8 Temporary Excavations

All temporary excavations, including utility trenches, retaining wall excavations, and foundation excavations should be performed in accordance with project plans, specifications, and all OSHA requirements. Excavations 4 feet or deeper should be laid back or shored in accordance with OSHA requirements before personnel are allowed to enter.

No surcharge loads should be permitted within a horizontal distance equal to the height of cut or 5 feet, whichever is greater from the top of the cut, unless the cut is shored appropriately. Excavations that extend below an imaginary plane inclined at 45 degrees below the edge of any adjacent existing site foundation should be properly shored to maintain support of the adjacent structure.

Temporary excavations should be treated in accordance with the State of California version of OSHA excavation regulations, Construction Safety Orders for Excavation General Requirements, Article 6, Section 1541, effective October 1,

1995. The sides of excavations should be shored or sloped in accordance with OSHA regulations. OSHA allows the sides of unbraced excavations, up to a maximum height of 20 feet, to be cut to a $\frac{3}{4}$ H:1V (horizontal:vertical) slope for Type A soils, 1H:1V for Type B soils, and $1\frac{1}{2}$ H:1V for Type C soils. Near-surface onsite soils are to be considered Type B soils.

During construction, the soil conditions should be regularly evaluated to verify that conditions are as anticipated. The contractor shall be responsible for providing the “competent person” required by OSHA standards to evaluate soil conditions. Close coordination between the competent person and the geotechnical engineer should be maintained to facilitate construction while providing safe excavations.

3.9 **Trench Backfill**

Utility trenches should be backfilled with compacted fill in accordance with Sections 306-1 and 306-6 of the Standard Specifications for Public Works Construction, (“Greenbook”), 2018 Edition. Utility trenches can be backfilled with onsite sandy material free of rubble, debris, organic and oversized material up to ($\leq$) 3-inches in largest dimension. Prior to backfilling trenches, pipes should be bedded in and covered with either:

- (1) **Sand:** A uniform, sand material that has a Sand Equivalent (SE) greater-than-or-equal-to ($\geq$) 30, passing the No. 4 U.S. Standard Sieve (or as specified by the pipe manufacturer), water densified in place, or
- (2) **CLSM:** Controlled Low Strength Material (CLSM) conforming to Section 201-6 of the *Standard Specifications for Public Works Construction*, (“Greenbook”), 2018 Edition. CLSM should not be jetted.

Pipe bedding should extend at least 4 inches below the pipeline invert and at least 12 inches over the top of the pipeline. Native and clean fill soils can be used as backfill over the pipe bedding zone, and should be placed in thin lifts, moisture conditioned above optimum, and mechanically compacted to at least 90 percent relative compaction, relative to the ASTM D 1557 laboratory maximum density.

3.10 **Drainage and Landscaping**

Building walls below grade should be waterproofed or at least damp proofed, depending upon the degree of moisture protection desired. Surface drainage

should be designed to direct water away from foundations and toward approved drainage devices. Irrigation of landscaping should be controlled to maintain, as much as possible, consistent moisture content sufficient to provide healthy plant growth without overwatering.

3.11 Additional Geotechnical Services

Leighton should review the grading plans, foundation plans, and specifications when they are available to verify that the recommendations presented in this report have been properly interpreted and incorporated.

Geotechnical observation and testing should be provided during the following activities:

- Grading and excavation of the site;
- Subgrade Preparation;
- Compaction of all fill materials;
- Utility trench backfilling and compaction;
- Footing excavation and slab-on-grade preparation;
- Pavement subgrade and base preparation;
- Placement of asphalt concrete and/or concrete; and
- When any unusual conditions are encountered.

4.0 LIMITATIONS

This geotechnical exploration does not address the potential for encountering hazardous soil at this site. In addition, this report was necessarily based in part upon data obtained from a limited number of observances, site visits, soil samples, tests, analyses, histories of occurrences, spaced subsurface explorations and limited information on historical events and observations. Such information is, by necessity, incomplete. Please also refer GBA's *Important Information About Your Geotechnical Report* (included at the rear of the text), presenting additional information and limitations regarding geotechnical engineering studies and reports. The nature of many sites is such that differing soil or geologic conditions can be present within small distances and under varying climatic conditions. Changes in subsurface conditions can and do occur over time. Therefore, the findings, conclusions, and recommendations presented in this report are only valid if Leighton Consulting, Inc. has the opportunity to observe subsurface conditions during grading and construction, to confirm that our data are representative for the site. Leighton Consulting, Inc. should also review the construction plans and project specifications, when available, to comment on the geotechnical aspects.

This report was prepared using the degree of care and skill ordinarily exercised, under similar circumstances, by reputable geotechnical consultants practicing at this time in Orange County. We do not make any warranty, either expressed or implied.

5.0 REFERENCES

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Important Information about This Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer

will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.*

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept*

responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.

Most of the “Findings” Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site’s subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual site-wide subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

This Report’s Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are not final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals’ misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals’ plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note*

conspicuously that you’ve included the material for information purposes only. To avoid misunderstanding, you may also want to note that “informational purposes” means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled “limitations,” many of these provisions indicate where geotechnical engineers’ responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a “phase-one” or “phase-two” environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

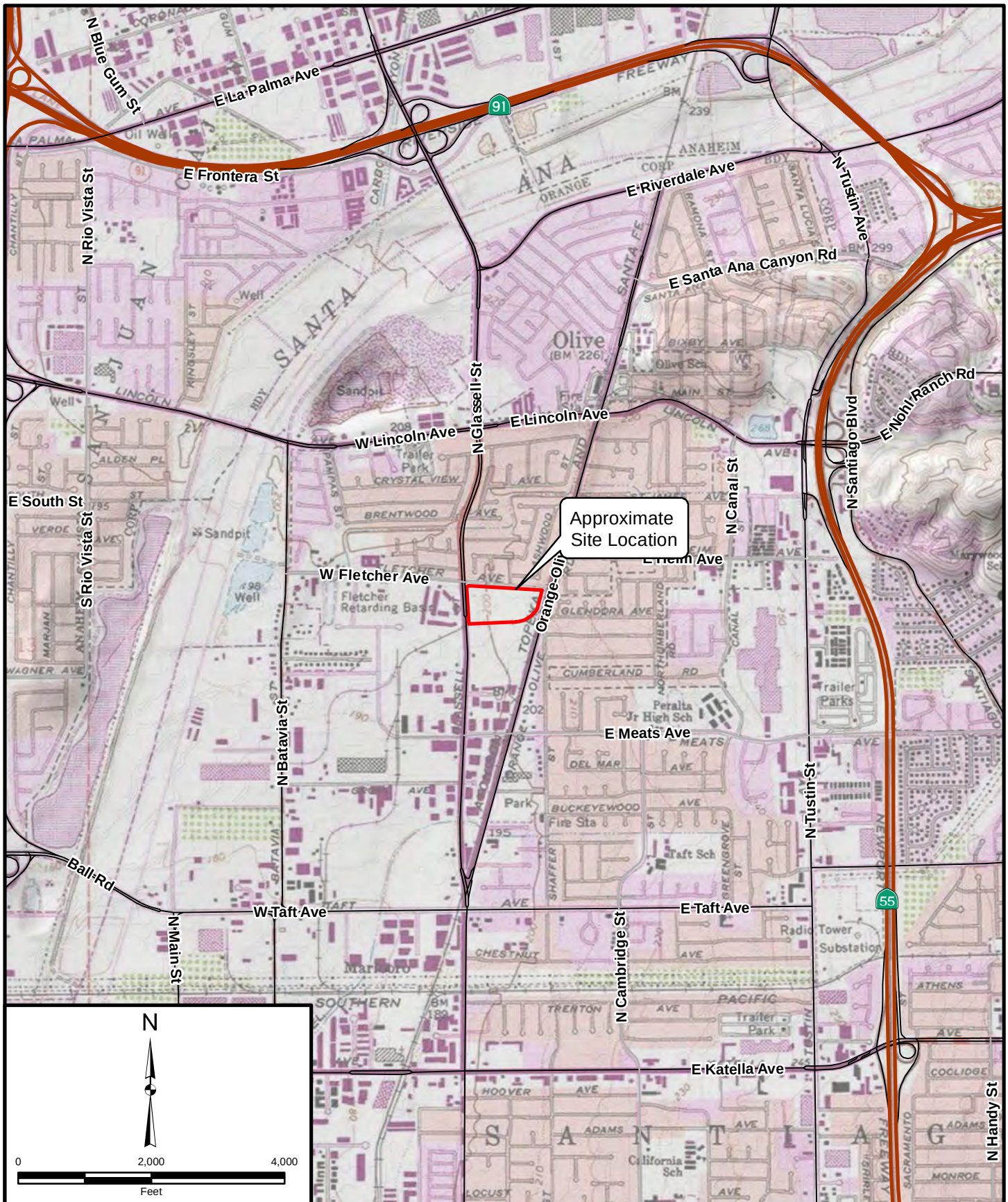
While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer’s services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, *proper implementation of the geotechnical engineer’s recommendations will not of itself be sufficient to prevent moisture infiltration.* Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. *Geotechnical engineers are not building-envelope or mold specialists.*



GEOPROFESSIONAL
BUSINESS
ASSOCIATION

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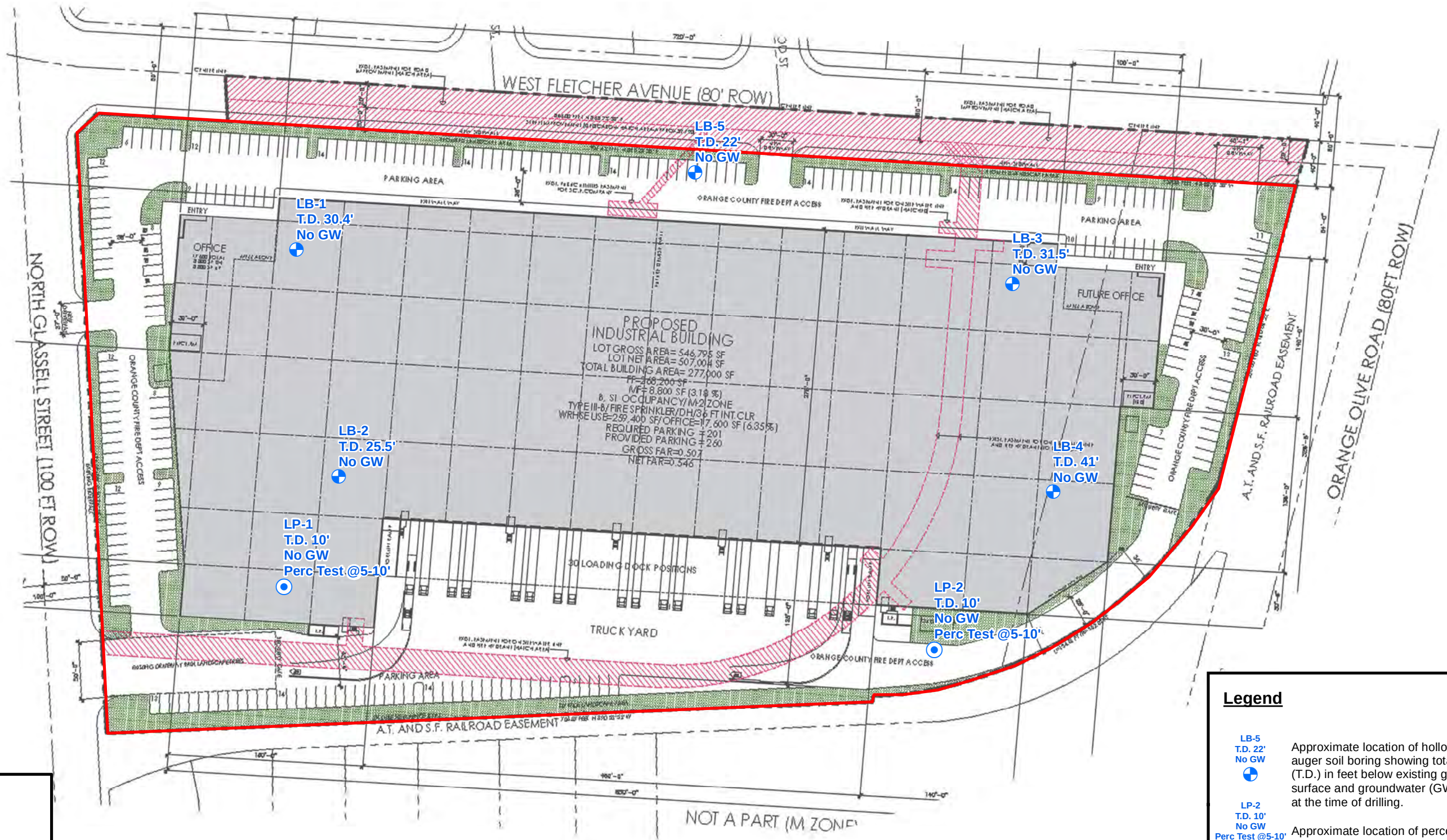


Project: 13333.001	Eng/Geol: CCK/JMP
Scale: 1" = 2,000'	Date: December 2021
Base Map: ESRI ArcGIS Online 2021	

SITE LOCATION MAP Proposed Industrial Building 2411 N. Glassell Street City of Orange, California

FIGURE 1





Legend

LB-5
T.D. 22'
No GW
⊕

LB-2
T.D. 10'
No GW
⊕

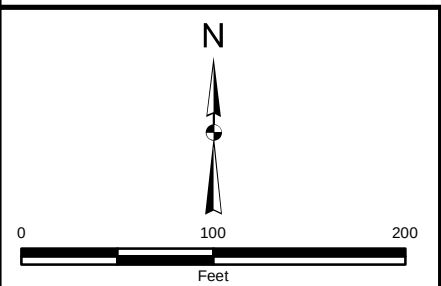
Approximate location of hollow-stem auger soil boring showing total depth (T.D.) in feet below existing ground surface and groundwater (GW) condition at the time of drilling.

LP-2
T.D. 10'
No GW
Perc Test @5-10'
⊙

Approximate location of percolation test boring showing total depth (T.D.) and depth of percolation test in feet below existing ground surface.

⬜

Approximate site boundary

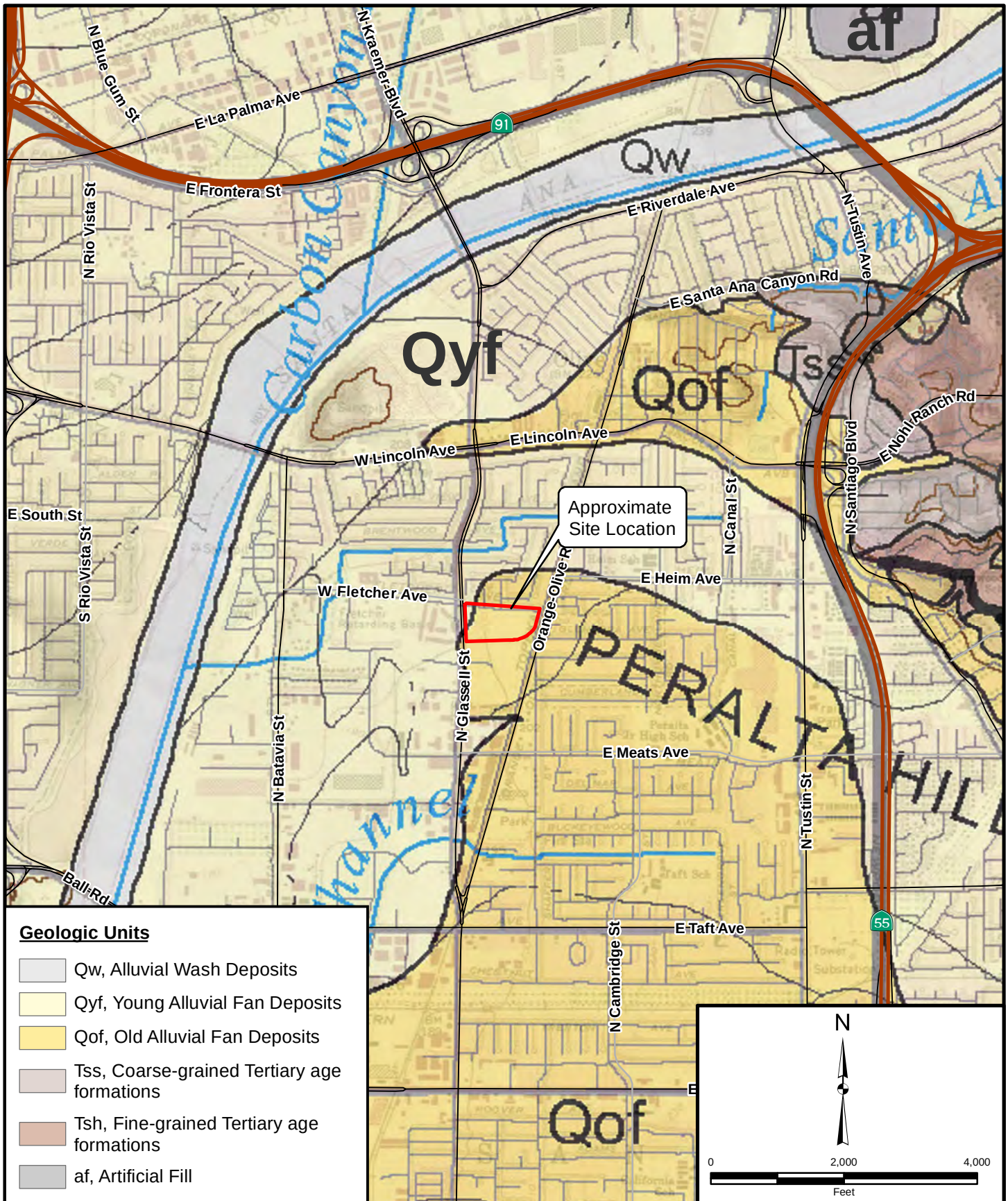


Project: 13333.001	Eng/Geol: CCK/JMP
Scale: 1" = 100'	Date: December 2021
Base Map: ESRI ArcGIS Online 2021	

EXPLORATION LOCATION MAP

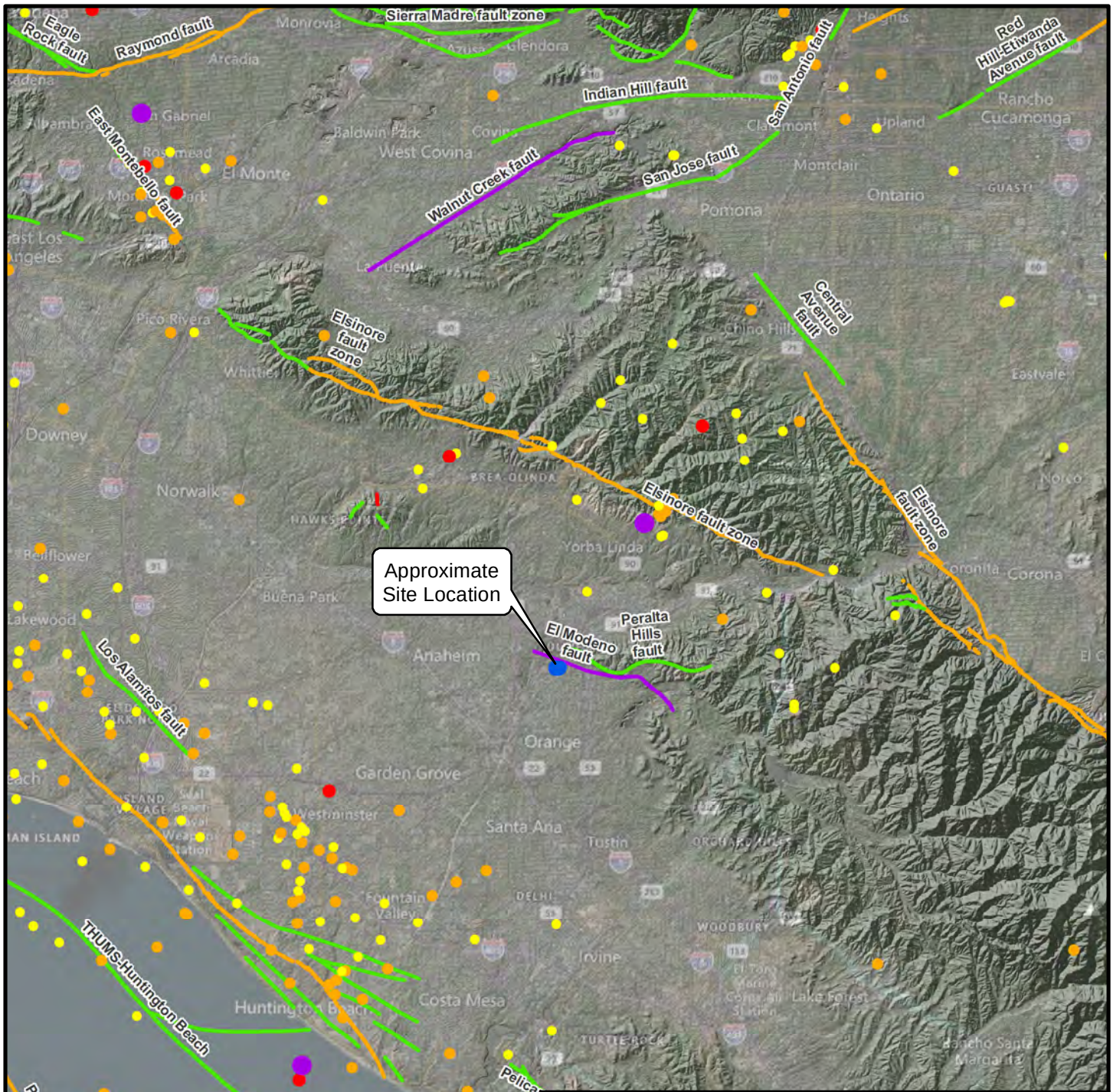
Proposed Industrial Building
2411 N. Glassell Street
City of Orange, California

FIGURE 2

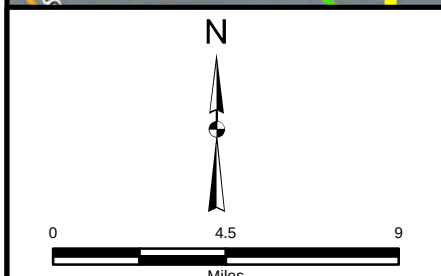


Project: 13333.001 Eng/Geol: CCK/JMP
 Scale: 1" = 2,000' Date: December 2021

Basemap: USGS Topo Map Service from Esri, 2021
 Reference: Geologic Compilation of Quaternary Surficial
 Deposits in Southern California, Orange County,
 Bedrossian et. al., 2010



Approximate
Site Location

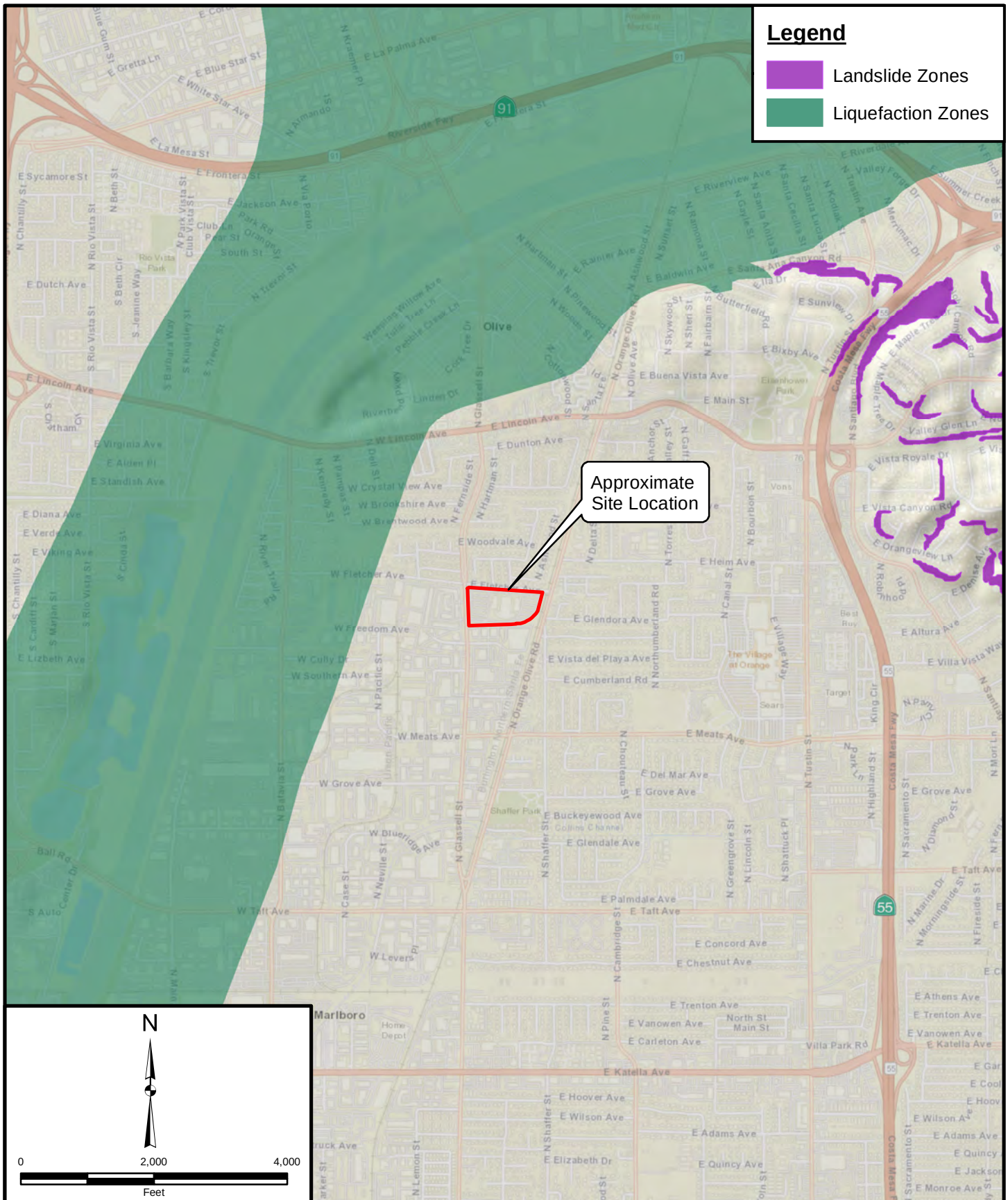


Legend	
Fault activity	Historical Earthquakes ($\geq M3.5$)
Recency of Movement	
— Historic (<200 years)	● 3.5 - 3.99
— Holocene (<11,700 years)	● 4.0 - 4.99
— Late Quaternary (last 700,000 years)	● 5.0 - 5.99
— Quaternary (<1.6M years)	● 6.0 - 6.99

Project: 13333.001	Eng/Geol: CCK/JMP
Scale: 1" = 5 miles	Date: December 2021
Base Map: ESRI ArcGIS Online 2021 Reference: maps.conservation.ca.gov	

**REGIONAL FAULTS AND
HISTORIC SEISMICITY MAP**
Proposed Industrial Building
2411 N. Glassell Street
City of Orange, California

FIGURE 4



Project: 13333.001	Eng/Geol: CCK/JMP
Scale: 1" = 2,000'	Date: December 2021
Base Map: ESRI ArcGIS Online 2021 Reference: maps.conservation.ca.gov	

SEISMIC HAZARD MAP

Proposed Industrial Building
2411 N. Glassell Street
City of Orange, California

FIGURE 5

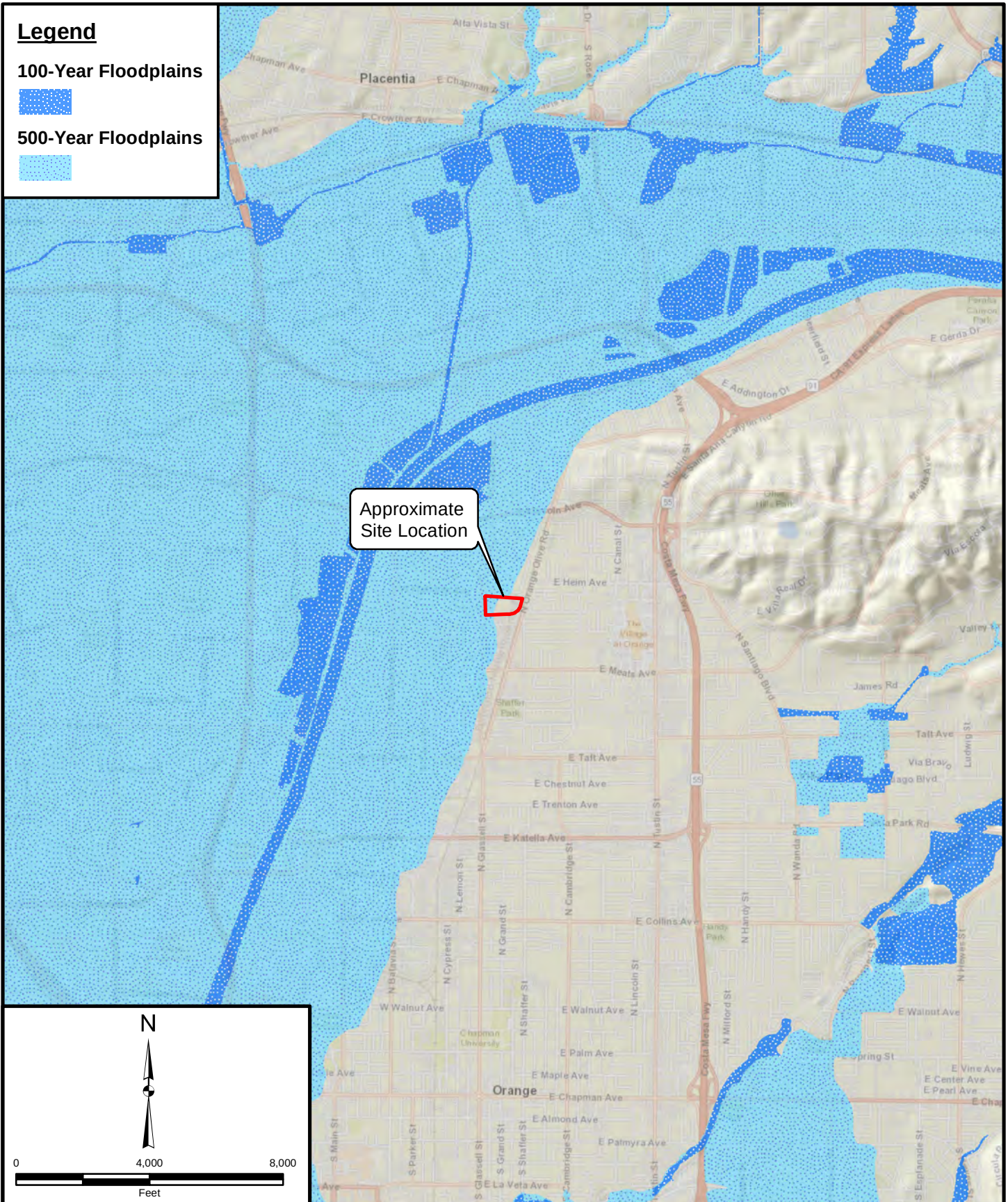


Legend

100-Year Floodplains



500-Year Floodplains



Approximate
Site Location

Project: 13333.001

Eng/Geol: CCK/JMP

Scale: 1" = 4,000'

Date: December 2021

Base Map: ESRI ArcGIS Online 2021

Reference: FEMA, DWR

FLOOD HAZARD ZONE MAP

Proposed Industrial Building
2411 N. Glassell Street
City of Orange, California

FIGURE 6



Legend

National Inventory of Dams

Downstream Hazard Potential (NID, 2021)

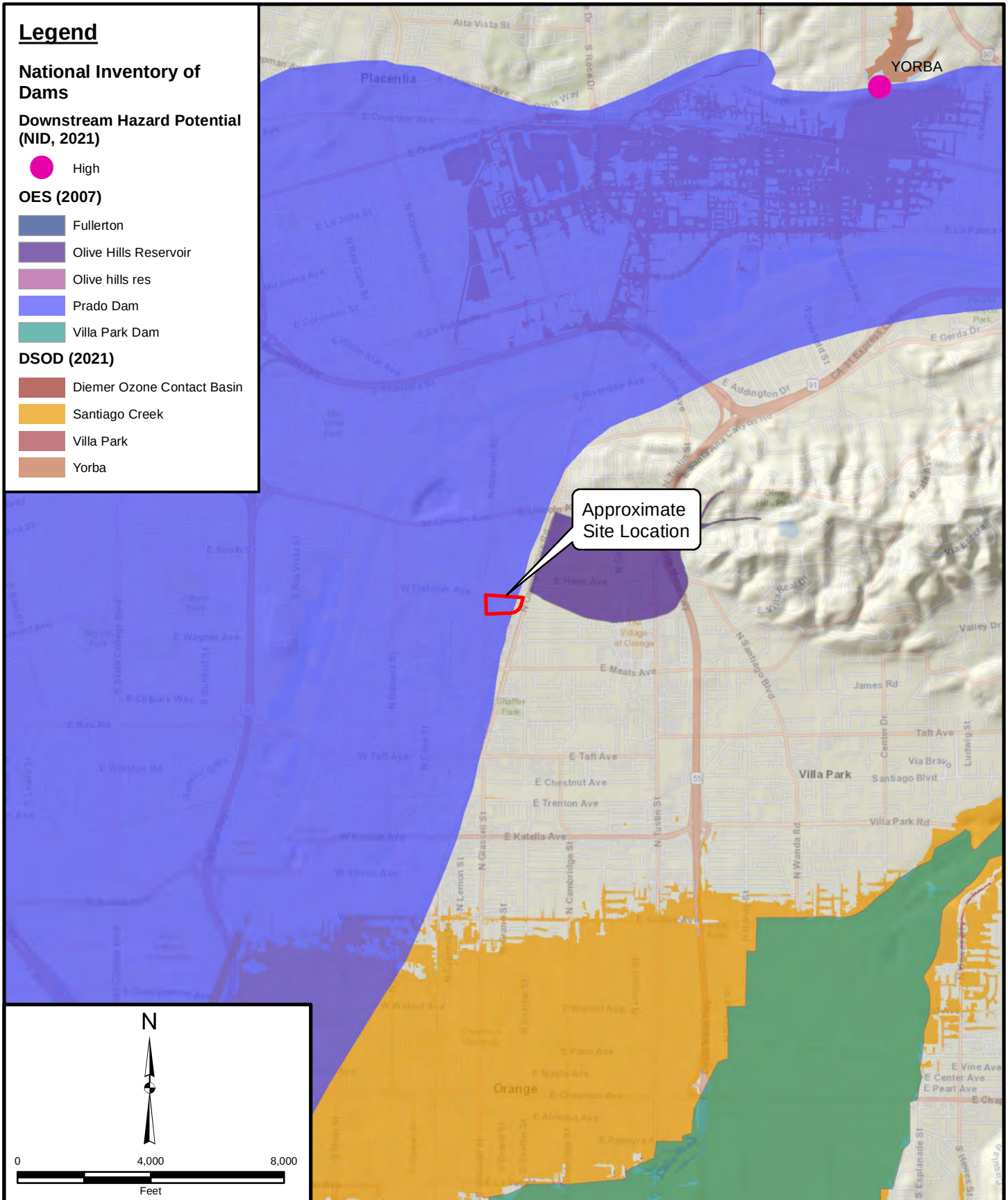
High

OES (2007)

Fullerton
Olive Hills Reservoir
Olive hills res
Prado Dam
Villa Park Dam

DSOD (2021)

Diemer Ozone Contact Basin
Santiago Creek
Villa Park
Yorba



Project: 13333.001

Eng/Geol: CCK/JMP

Scale: 1" = 4,000'

Date: December 2021

Base Map: ESRI ArcGIS Online 2021
Reference: Office of Emergency Services (2007),
Dept of Safety of Dams (2021)
National Inventory of Dams, Army Corps of Engrs (2021)

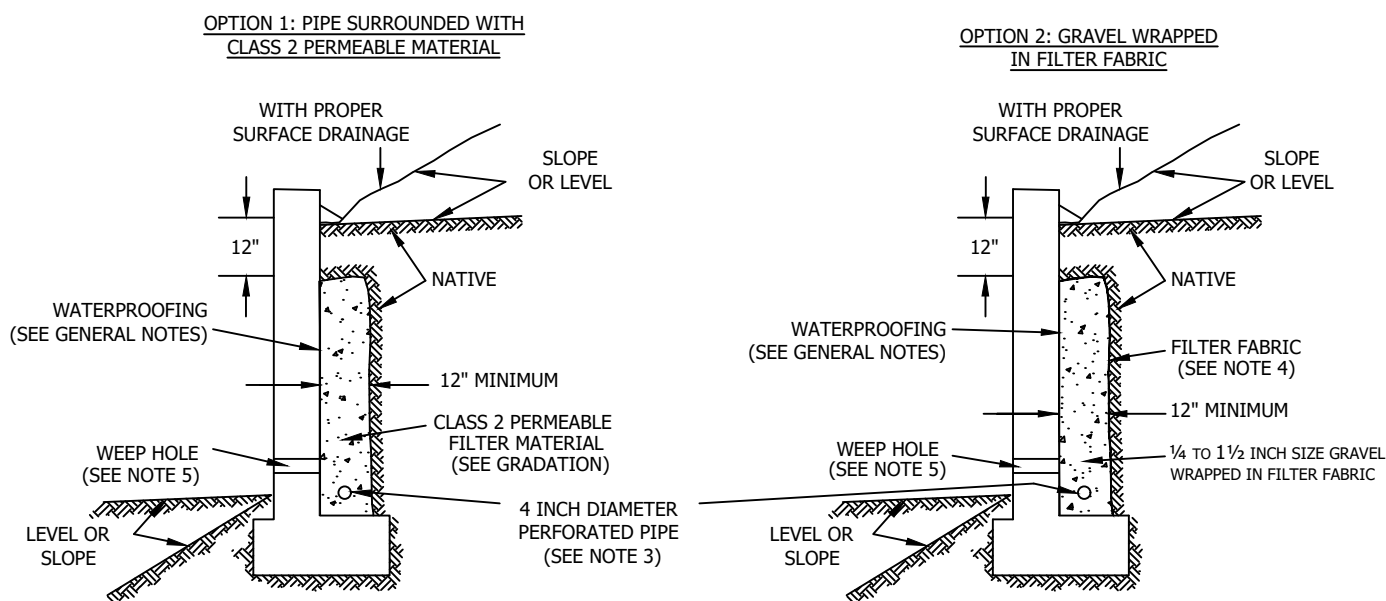
DAM INUNDATION MAP

Proposed Industrial Building
2411 N. Glassell Street
City of Orange, California

FIGURE 7



SUBDRAIN OPTIONS AND BACKFILL WHEN NATIVE MATERIAL HAS EXPANSION INDEX OF ≤ 50



Class 2 Filter Permeable Material Gradation
Per Caltrans Specifications

Sieve Size	Percent 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

GENERAL NOTES:

- * Waterproofing should be provided where moisture nuisance problem through the wall is undesirable.
- * Water proofing of the walls is not under purview of the geotechnical engineer
- * All drains should have a gradient of 1 percent minimum
- * Outlet portion of the subdrain should have a 4-inch diameter solid pipe discharged into a suitable disposal area designed by the project engineer. The subdrain pipe should be accessible for maintenance (rodding)
- * Other subdrain backfill options are subject to the review by the geotechnical engineer and modification of design parameters.

Notes:

- 1) Sand should have a sand equivalent of 30 or greater and may be densified by water jetting.
- 2) 1 Cu. ft. per ft. of 1/4- to 1 1/2-inch size gravel wrapped in filter fabric
- 3) Pipe type should be ASTM D1527 Acrylonitrile Butadiene Styrene (ABS) SDR35 or ASTM D1785 Polyvinyl Chloride plastic (PVC), Schedule 40, Armco A2000 PVC, or approved equivalent. Pipe should be installed with perforations down. Perforations should be 3/8 inch in diameter placed at the ends of a 120-degree arc in two rows at 3-inch on center (staggered)
- 4) Filter fabric should be Mirafi 140NC or approved equivalent.
- 5) Weephole should be 3-inch minimum diameter and provided at 10-foot maximum intervals. If exposure is permitted, weepholes should be located 12 inches above finished grade. If exposure is not permitted such as for a wall adjacent to a sidewalk/curb, a pipe under the sidewalk to be discharged through the curb face or equivalent should be provided. For a basement-type wall, a proper subdrain outlet system should be provided.
- 6) Retaining wall plans should be reviewed and approved by the geotechnical engineer.
- 7) Walls over six feet in height are subject to a special review by the geotechnical engineer and modifications to the above requirements.

RETAINING WALL BACKFILL AND SUBDRAIN DETAIL FOR WALLS 6 FEET OR LESS IN HEIGHT

WHEN NATIVE MATERIAL HAS EXPANSION INDEX OF ≤ 50



FIGURE 8

APPENDIX A

EXPLORATION LOGS

GEOTECHNICAL BORING LOG LB-1

Project No. 13333.001
Project Rexford Glassell St. Orange
Drilling Co. Martini Drilling Corp.
Drilling Method Hollow Stem Auger - 140lb - Autohammer - 30" Drop
Location See Figure 2- Exploration Location Map

Date Drilled 11-4-21
Logged By MM
Hole Diameter 8"
Ground Elevation ~203'
Sampled By MM

Elevation Feet	Depth Feet	Graphic Log	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
		N S							<i>This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.</i>	
	0			B-1				CL-ML	@Surface: 3.5 inches of asphalt over 4 inches of base Artificial Fill, Undocumented (Afu): @0.625': Sandy Silty CLAY, dark brown, moist, low plasticity	
	5			S-1	5 4 3		7	SP	@5': Poor recovery. Poorly-graded SAND, loose to medium dense, brown, moist, fine to medium sand, fine gravel, little to some silt	
									Quaternary Old Alluvium (Qof): @7': Gravelly SAND, brown, moist	
	10			R-2	23 50/5"			SC	@10': Gravelly Clayey SAND, very dense, brown, moist, fine to coarse sand, fine to coarse gravel, subangular	
	15			S-3	32 43 50/5"		3		@15': Gravelly Clayey SAND, very dense, brown, moist, fine to coarse sand, fine to coarse gravel, subangular gravel, mechanically fractured gravel	
	20			R-4	6 12 12			SC	@20': Clayey SAND with Gravel, medium dense, brown, moist, fine to coarse sand, fine gravel, clay layer in shoe	
	25			S-5	14 24 50/4"		3	SP	@25': Gravelly SAND, very dense, brown, moist, fine to coarse sand, fine to coarse gravel @26': Difficult drilling due to gravel	
	30									

SAMPLE TYPES:

B BULK SAMPLE
 C CORE SAMPLE
 G GRAB SAMPLE
 R RING SAMPLE
 S SPLIT SPOON SAMPLE
 T TUBE SAMPLE

TYPE OF TESTS:

-200 % FINES PASSING
 AL ATTERBERG LIMITS
 CN CONSOLIDATION
 CO COLLAPSE
 CR CORROSION
 CU UNDRAINED TRIAXIAL

DS DIRECT SHEAR
 EI EXPANSION INDEX
 H HYDROMETER
 MD MAXIMUM DENSITY
 PP POCKET PENETROMETER
 RV R VALUE

SA SIEVE ANALYSIS
 SE SAND EQUIVALENT
 SG SPECIFIC GRAVITY
 UC UNCONFINED COMPRESSIVE STRENGTH



GEOTECHNICAL BORING LOG LB-1

Project No.	13333.001	Date Drilled	11-4-21
Project	Rexford Glassell St. Orange	Logged By	MM
Drilling Co.	Martini Drilling Corp.	Hole Diameter	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	Ground Elevation	~203'
Location	See Figure 2- Exploration Location Map	Sampled By	MM

Elevation Feet	Depth Feet	Graphic Log	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
30	N S			R-6	50/5"	132	4		<div><div>@30': Gravelly SAND, very dense, fine cobble, rounded</div><div>Total Depth: 30.4 feet</div><div>No groundwater encountered during drilling.</div><div>Backfilled with soil cuttings and patched with cold-mix asphalt.</div></div>	
35										
40										
45										
50										
55										
60										

SAMPLE TYPES:

B BULK SAMPLE
C CORE SAMPLE
G GRAB SAMPLE
R RING SAMPLE
S SPLIT SPOON SAMPLE
T TUBE SAMPLE

TYPE OF TESTS:

-200 % FINES PASSING
AL ATTERBERG LIMITS
CN CONSOLIDATION
CO COLLAPSE
CR CORROSION
CU UNDRAINED TRIAXIAL

DS DIRECT SHEAR
EI EXPANSION INDEX
H HYDROMETER
MD MAXIMUM DENSITY
PP POCKET PENETROMETER
RV R VALUE

SA SIEVE ANALYSIS
SE SAND EQUIVALENT
SG SPECIFIC GRAVITY
UC UNCONFINED COMPRESSIVE STRENGTH

*** This log is a part of a report by Leighton and should not be used as a stand-alone document. *** Page 2 of 2

GEOTECHNICAL BORING LOG LB-2

Project No. 13333.001
Project Rexford Glassell St. Orange
Drilling Co. Martini Drilling Corp.
Drilling Method Hollow Stem Auger - 140lb - Autohammer - 30" Drop
Location See Figure 2- Exploration Location Map

Date Drilled 11-4-21
Logged By MM
Hole Diameter 8"
Ground Elevation ~202'
Sampled By MM

Elevation Feet	Depth Feet	Graphic Log	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
									<i>This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.</i>	
	0	N S		B-1				ML-CL	@Surface: 3.5 inches of asphalt over 5 inches of base Artificial Fill, Undocumented (Afu): @0.71': Silty CLAY, dark brown, moist, low plasticity	
	5			R-1	4 8 8	123	12	CL	@5': CLAY, stiff, dark brown, moist, medium plasticity, fine to coarse gravel, trace asphalt pieces	
								SC	Quaternary Old Alluvium (Qof): @7': Clayey SAND with Gravel, brown, moist	
	10			S-2	14 34 32		4		@10': Clayey SAND with Gravel, very dense, moist, brown, fine sand, fine to coarse gravel, FeO staining on gravel @11': Encountered gravel	
	15			R-3	50/3"				@15': No recovery. Very dense, possible fine cobbles @16': Gravelly soil cuttings	
	20			S-4	50/5"		6		@20': Gravelly Clayey SAND, very dense, brown, moist	
	25			R-5	50/0"				@25': No recovery. Very dense	
									Total Depth: 25.5 feet No groundwater encountered during drilling. Backfilled with soil cuttings and patched with cold-mix asphalt.	
	30									

SAMPLE TYPES:

B BULK SAMPLE
 C CORE SAMPLE
 G GRAB SAMPLE
 R RING SAMPLE
 S SPLIT SPOON SAMPLE
 T TUBE SAMPLE

TYPE OF TESTS:

-200 % FINES PASSING
 AL ATTERBERG LIMITS
 CN CONSOLIDATION
 CO COLLAPSE
 CR CORROSION
 CU UNDRAINED TRIAXIAL

DS DIRECT SHEAR
 EI EXPANSION INDEX
 H HYDROMETER
 MD MAXIMUM DENSITY
 PP POCKET PENETROMETER
 RV R VALUE

SA SIEVE ANALYSIS
 SE SAND EQUIVALENT
 SG SPECIFIC GRAVITY
 UC UNCONFINED COMPRESSIVE STRENGTH



GEOTECHNICAL BORING LOG LB-3

Project No. 13333.001
Project Rexford Glassell St. Orange
Drilling Co. Martini Drilling Corp.
Drilling Method Hollow Stem Auger - 140lb - Autohammer - 30" Drop
Location See Figure 2- Exploration Location Map

Date Drilled 11-4-21
Logged By MM
Hole Diameter 8"
Ground Elevation ~205'
Sampled By MM

Elevation Feet	Depth Feet	Graphic Log	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	0	N S							<i>This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.</i>	
				B-1				ML	@Surface: 5 inches of asphalt over 4 inches of base Artificial Fill, Undocumented (Afu): @0.75': Clayey SILT with Gravel, brown, moist, fine to coarse gravel, trace cobbles	
	5			S-1	5 23 44		5	SC	Quaternary Old Alluvium (Qof): @3': Gravelly Clayey SAND, brown, moist, fine to coarse sand and gravel, some silt @5': Gravelly Clayey SAND, very dense, brown, moist, fine to coarse sand and gravel, subangular, angular from mechanical fracturing. Difficult drilling from 5' to 15'	
	10			R-2	29 50/5"	122	5		@10': Gravelly SAND with Clay, very dense, brown, moist, fine to coarse sand & gravel, subangular, clayey at ~11'	
	15			S-3	6 4 2		19	CL	@15': CLAY, medium stiff, brown, moist, medium plasticity	
	20							GP	@18': Refusal. Stepped over and redrilled to 20' @20': No recovery. Encountered difficult drilling	
	25			R-4	50/4"	90	3		@25': Sandy GRAVEL, very dense, brown, moist, fine sand, mostly cobble fragments in sampler, fine to coarse gravel, some cobbles, fine to coarse cobble	
	30									

SAMPLE TYPES:

B BULK SAMPLE
 C CORE SAMPLE
 G GRAB SAMPLE
 R RING SAMPLE
 S SPLIT SPOON SAMPLE
 T TUBE SAMPLE

TYPE OF TESTS:

-200 % FINES PASSING
 AL ATTERBERG LIMITS
 CN CONSOLIDATION
 CO COLLAPSE
 CR CORROSION
 CU UNDRAINED TRIAXIAL

DS DIRECT SHEAR
 EI EXPANSION INDEX
 H HYDROMETER
 MD MAXIMUM DENSITY
 PP POCKET PENETROMETER
 RV R VALUE

SA SIEVE ANALYSIS
 SE SAND EQUIVALENT
 SG SPECIFIC GRAVITY
 UC UNCONFINED COMPRESSIVE STRENGTH



GEOTECHNICAL BORING LOG LB-3

Project No.	13333.001	Date Drilled	11-4-21
Project	Rexford Glassell St. Orange	Logged By	MM
Drilling Co.	Martini Drilling Corp.	Hole Diameter	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	Ground Elevation	~205'
Location	See Figure 2- Exploration Location Map	Sampled By	MM

Elevation Feet	Depth Feet	Graphic Log	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	30	N S		S-5	17 14 8		14	ML-CL	<p><i>This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.</i></p> <p>@30': Silty CLAY, hard, moist, brown, low to medium plasticity, few fine to coarse gravel fragments, angular to subangular</p> <p>Total Depth: 31.5 feet No groundwater encountered during drilling. Backfilled with soil cuttings and patched with cold-mix asphalt.</p>	
	35									
	40									
	45									
	50									
	55									
	60									

SAMPLE TYPES:	TYPE OF TESTS:
B BULK SAMPLE	-200 % FINES PASSING
C CORE SAMPLE	AL ATTERBERG LIMITS
G GRAB SAMPLE	CN CONSOLIDATION
R RING SAMPLE	CO COLLAPSE
S SPLIT SPOON SAMPLE	CR CORROSION
T TUBE SAMPLE	CU UNDRAINED TRIAXIAL
	DS DIRECT SHEAR
	EI EXPANSION INDEX
	H HYDROMETER
	MD MAXIMUM DENSITY
	PP POCKET PENETROMETER
	RV R VALUE
	SA SIEVE ANALYSIS
	SE SAND EQUIVALENT
	SG SPECIFIC GRAVITY
	UC UNCONFINED COMPRESSIVE STRENGTH



GEOTECHNICAL BORING LOG LB-4

Project No. 13333.001
Project Rexford Glassell St. Orange
Drilling Co. Martini Drilling Corp.
Drilling Method Hollow Stem Auger - 140lb - Autohammer - 30" Drop
Location See Figure 2- Exploration Location Map

Date Drilled 11-4-21
Logged By MM
Hole Diameter 8"
Ground Elevation ~204'
Sampled By MM

Elevation Feet	Depth Feet	Graphic Log	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
		N S							<i>This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.</i>	
	0			B-1				SC	@Surface: 4 inches of asphalt over 4 inches of base Artificial Fill, Undocumented (Afu): @0.67': Clayey SAND with gravel, brown, moist, low to medium plasticity	
	5			R-1	50/4"	95	6	SC	Quaternary Old Alluvium (Qof): @5': Gravelly Clayey SAND, very dense, moist, brown, fine to coarse sand, fine to coarse gravel, subangular gravel, some silt. Difficult drilling	
	10			S-2	50/4"		5		@10': Low recovery. Very dense @11': Increased gravel and cobbles	
	15			R-3	10 8 8				@15': No recovery. Gravelly SAND, medium dense, brown, moist, fine to coarse sand and gravel	
	20			S-4-1	31 34		19	CL	@18': Cuttings become CLAY, brown, moist, medium plasticity	
				S-4-2	50/6"		5	SP	@21': Becomes Gravelly SAND with Clay, brown, moist, fine to coarse sand and gravel, subangular gravel, decrease in fines with depth	
	25			R-5	50/4"	112	16	CL SP-CL	@25': CLAY, hard, brown, moist @26': Becomes Sandy CLAY, hard, moist, brown, fine to coarse sand, fine gravel, coarse gravel in shoe	
	30									

SAMPLE TYPES:

B BULK SAMPLE
 C CORE SAMPLE
 G GRAB SAMPLE
 R RING SAMPLE
 S SPLIT SPOON SAMPLE
 T TUBE SAMPLE

TYPE OF TESTS:

-200 % FINES PASSING
 AL ATTERBERG LIMITS
 CN CONSOLIDATION
 CO COLLAPSE
 CR CORROSION
 CU UNDRAINED TRIAXIAL

DS DIRECT SHEAR
 EI EXPANSION INDEX
 H HYDROMETER
 MD MAXIMUM DENSITY
 PP POCKET PENETROMETER
 RV R VALUE

SA SIEVE ANALYSIS
 SE SAND EQUIVALENT
 SG SPECIFIC GRAVITY
 UC UNCONFINED COMPRESSIVE STRENGTH



GEOTECHNICAL BORING LOG LB-4

Project No. 13333.001
Project Rexford Glassell St. Orange
Drilling Co. Martini Drilling Corp.
Drilling Method Hollow Stem Auger - 140lb - Autohammer - 30" Drop
Location See Figure 2- Exploration Location Map

Date Drilled 11-4-21
Logged By MM
Hole Diameter 8"
Ground Elevation ~204'
Sampled By MM

Elevation Feet	Depth Feet	Graphic Log	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
		N S							<i>This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.</i>	
30				S-6	3 5 6		19		@30': Sandy CLAY, very stiff, brown, moist, fine to coarse sand, fine gravel, medium plasticity	
35				R-7	50/5"	100	16	CL	@35': CLAY, hard, moist, brown, medium plasticity, fine gravel, subangular	
40				S-8	50/0"				@40': No recovery	
								COBBLES	@41: Grinding on cobble	
									Total Depth: 41 feet No groundwater encountered during drilling. Backfilled with soil cuttings and patched with cold-mix asphalt.	
45										
50										
55										
60										

SAMPLE TYPES:

B BULK SAMPLE
 C CORE SAMPLE
 G GRAB SAMPLE
 R RING SAMPLE
 S SPLIT SPOON SAMPLE
 T TUBE SAMPLE

TYPE OF TESTS:

-200 % FINES PASSING
 AL ATTERBERG LIMITS
 CN CONSOLIDATION
 CO COLLAPSE
 CR CORROSION
 CU UNDRAINED TRIAXIAL

DS DIRECT SHEAR
 EI EXPANSION INDEX
 H HYDROMETER
 MD MAXIMUM DENSITY
 PP POCKET PENETROMETER
 RV R VALUE

SA SIEVE ANALYSIS
 SE SAND EQUIVALENT
 SG SPECIFIC GRAVITY
 UC UNCONFINED COMPRESSIVE STRENGTH



GEOTECHNICAL BORING LOG LB-5

Project No. 13333.001
Project Rexford Glassell St. Orange
Drilling Co. Martini Drilling Corp.
Drilling Method Hollow Stem Auger - 140lb - Autohammer - 30" Drop
Location See Figure 2- Exploration Location Map

Date Drilled 11-4-21
Logged By MM
Hole Diameter 8"
Ground Elevation ~200'
Sampled By MM

Elevation Feet	Depth Feet	Graphic Log	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	0	N S							<i>This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.</i>	
				B-1				ML	@Surface: 4.5 inches of asphalt over 4.5 inches of base Artificial Fill, Undocumented (Afu): @0.75': SILT with Gravel and Sand, brown, moist, fine gravel, little fine sand	
	5			R-1	50/6"	114	5	SC-SM SM	Quaternary Old Alluvium (Qof): @3': Gravelly Clayey SAND to Silty SAND, light brown @5': Silty SAND, very dense, brown, moist, fine sand, fine to coarse gravel @6': Encountered increase in gravel	
	10			S-2	14 26 28		3	SP SP-GP	@10': Poorly-graded SAND with Gravel, very dense, moist, fine to coarse sand, mostly fine sand, fine to coarse gravel, angular from mechanical fracturing @11: Cuttings appear to be Sandy GRAVEL	
	15			R-3	43 50/3"	122	4		@15': Gravelly SAND to Sandy GRAVEL, very dense, light brown, moist, fine to coarse gravel, fine cobble, subangular gravel	
	20			S-4	25 50/5"		4		@20': Very dense. Difficult drilling from ~20' to 22'	
	25								Total Depth: 22 feet No groundwater encountered during drilling. Backfilled with soil cuttings and patched with cold-mix asphalt.	
	30									

SAMPLE TYPES:

B BULK SAMPLE
 C CORE SAMPLE
 G GRAB SAMPLE
 R RING SAMPLE
 S SPLIT SPOON SAMPLE
 T TUBE SAMPLE

TYPE OF TESTS:

-200 % FINES PASSING
 AL ATTERBERG LIMITS
 CN CONSOLIDATION
 CO COLLAPSE
 CR CORROSION
 CU UNDRAINED TRIAXIAL

DS DIRECT SHEAR
 EI EXPANSION INDEX
 H HYDROMETER
 MD MAXIMUM DENSITY
 PP POCKET PENETROMETER
 RV R VALUE

SA SIEVE ANALYSIS
 SE SAND EQUIVALENT
 SG SPECIFIC GRAVITY
 UC UNCONFINED COMPRESSIVE STRENGTH



GEOTECHNICAL BORING LOG LP-1

Project No. 13333.001
Project Rexford Glassell St. Orange
Drilling Co. Martini Drilling Corp.
Drilling Method Hollow Stem Auger - 140lb - Autohammer - 30" Drop
Location See Figure 2- Exploration Location Map

Date Drilled 11-4-21
Logged By MM
Hole Diameter 8"
Ground Elevation ~202'
Sampled By MM

Elevation Feet	Depth Feet	Graphic Log	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
									<i>This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.</i>	
	0	N S						SC	@Surface: 3.5 inches of asphalt over 5 inches of base Artificial Fill, Undocumented (Afu): @0.71': Clayey SAND, light brown, moist, fine sand	
	5			S-1	10 22 25		6	SM	Quaternary Old Alluvium (Qof): @3': Gravelly Clayey SAND, brown, moist, fine sand @5': Silty SAND, very dense, brown, moist, fine to medium sand, fine to coarse gravel, little to some silt	
	10			R-2	29 42 50/6"	119	4		@8.5': Silty SAND, very dense, fine to coarse sand, mostly fine to medium sand, FeO staining on gravel surfaces	
	15								Total Depth: 10 feet No groundwater encountered during drilling Temporary percolation well installed. Blank 2-inch PVC installed from 0 to 5 feet and 0.020-inch slotted 2-inch PVC installed from 5 to 10 feet. Annulus filled with No. 3 Monterey SAND from 4 to 10 feet. Upon completion of percolation test, well casing removed, boring backfilled with soil cuttings and patched with cold-mix asphalt.	
	20									
	25									
	30									

SAMPLE TYPES:

B BULK SAMPLE
 C CORE SAMPLE
 G GRAB SAMPLE
 R RING SAMPLE
 S SPLIT SPOON SAMPLE
 T TUBE SAMPLE

TYPE OF TESTS:

-200 % FINES PASSING
 AL ATTERBERG LIMITS
 CN CONSOLIDATION
 CO COLLAPSE
 CR CORROSION
 CU UNDRAINED TRIAXIAL

DS DIRECT SHEAR
 EI EXPANSION INDEX
 H HYDROMETER
 MD MAXIMUM DENSITY
 PP POCKET PENETROMETER
 RV R VALUE

SA SIEVE ANALYSIS
 SE SAND EQUIVALENT
 SG SPECIFIC GRAVITY
 UC UNCONFINED COMPRESSIVE STRENGTH



GEOTECHNICAL BORING LOG LP-2

Project No. 13333.001
Project Rexford Glassell St. Orange
Drilling Co. Martini Drilling Corp.
Drilling Method Hollow Stem Auger - 140lb - Autohammer - 30" Drop
Location See Figure 2- Exploration Location Map

Date Drilled 11-4-21
Logged By MM
Hole Diameter 8"
Ground Elevation ~204'
Sampled By MM

Elevation Feet	Depth Feet	Graphic Log	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	0	N S							<i>This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.</i>	
								SM	@Surface: 3.5 inches of asphalt over 5.5 inches of base Artificial Fill, Undocumented (Afu):	
								CL	@2.5': Gravelly SILT with Sand to Silty SAND Quaternary Old Alluvium (Qof): @3': Gravelly SILT with Sand, brown, moist	
	5			S-1	15 12 29		11		@5': Silty CLAY, hard, slightly moist, brown, little fine sand, fine subangular gravel, porous	
				R-2	21 50/4"	120	6	ML	@7': Refusal. Stepped over and drilled down to 8.5' and sampled @8.5': Sandy SILT, hard, brown, slightly moist, fine sand, subangular, fine to coarse gravel	
	10								Total Depth: 10 feet No groundwater encountered during drilling Temporary percolation well installed. Blank 2-inch PVC installed from 0 to 5 feet and 0.020-inch slotted 2-inch PVC installed from 5 to 10 feet. Annulus filled with No. 3 Monterey SAND from 4 to 10 feet. Upon completion of percolation test, well casing removed, boring backfilled with soil cuttings and patched with cold-mix asphalt.	
	15									
	20									
	25									
	30									

SAMPLE TYPES:

B BULK SAMPLE
 C CORE SAMPLE
 G GRAB SAMPLE
 R RING SAMPLE
 S SPLIT SPOON SAMPLE
 T TUBE SAMPLE

TYPE OF TESTS:

-200 % FINES PASSING
 AL ATTERBERG LIMITS
 CN CONSOLIDATION
 CO COLLAPSE
 CR CORROSION
 CU UNDRAINED TRIAXIAL

DS DIRECT SHEAR
 EI EXPANSION INDEX
 H HYDROMETER
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 RV R VALUE

SA SIEVE ANALYSIS
 SE SAND EQUIVALENT
 SG SPECIFIC GRAVITY
 UC UNCONFINED COMPRESSIVE STRENGTH



APPENDIX B

PERCOLATION TEST DATA

Boring Percolation Test Data Sheet

Project Number:	13333.001	Test Hole Number:	LP-1
Project Name:	Rexford Glassell	Date Excavated:	11/4/2021
Earth Description:	Alluvium	Date Tested:	11/12/2021
Liquid Description:	Tap water	Depth of boring (ft):	10
Tested By:	MM	Radius of boring, r (in):	4
		Diameter of casing (in):	2
		Length of slotted of casing (ft):	5
		Depth to Initial Water Depth (ft):	7
		Porosity of Annulus Material, n:	0.35
		Bentonite Plug at Bottom:	No

Field Percolation Data

Reading	Time	Time Interval, Δt (minutes)	Depth to Water (feet bgs)	Water Height, H (inches)	Cumulative Water Volume Delivered (gallons)
1	10:40	-	-	-	0.0
2	10:50	10	6.53	41.6	10.0
3	11:00	10	6.49	42.1	19.9
4	11:10	10	6.47	42.4	29.9
5	11:20	10	6.50	42.0	39.9
6	11:30	10	6.51	41.9	49.8
7	11:40	10	6.51	41.9	59.8
8	11:50	10	6.49	42.1	69.8

Total Volume of Water Delivered (gallons)	69.8
Total Volume of Water Delivered (cubic inches)	16116.639
Average Water Height (inches)	42.0
Average Percolation Surface Area (cubic Inches)	1105.8
Duration of Test (minutes)	70
Duration of Test (hours)	1.17

Measured Infiltration Rate = (Total Volume)/(Test Duration)/(Surface Area)

Measured Infiltration Rate (inches per hour) = 12.5

Boring Percolation Test Data Sheet

Project Number:	13333.001	Test Hole Number:	LP-2
Project Name:	Rexford Glassell	Date Excavated:	11/4/2021
Earth Description:	Alluvium	Date Tested:	11/12/2021
Liquid Description:	Tap water	Depth of boring (ft):	10
Tested By:	MM	Radius of boring, r (in):	4
		Diameter of casing (in):	2
		Length of slotted of casing (ft):	5
		Depth to Initial Water Depth (ft):	6
		Porosity of Annulus Material, n :	0.35
		Bentonite Plug at Bottom:	No

Field Percolation Data

Reading	Time	Time Interval, Δt (minutes)	Depth to Water (feet bgs)	Water Height, H (inches)	Cumulative Water Volume Delivered (gallons)
1	7:50	-	-	-	0.0
2	8:00	10	6.02	47.8	7.0
3	8:10	10	5.97	48.4	13.9
4	8:20	10	5.93	48.8	20.9
5	8:30	10	5.93	48.8	27.8
6	8:40	10	5.94	48.7	34.8
7	8:50	10	5.95	48.6	41.7
8	9:00	10	5.96	48.5	48.7

Total Volume of Water Delivered (gallons)	48.7
Total Volume of Water Delivered (cubic inches)	11238.15
Average Water Height (inches)	48.5
Average Percolation Surface Area (cubic Inches)	1269.6
Duration of Test (minutes)	70
Duration of Test (hours)	1.17

Measured Infiltration Rate = (Total Volume)/(Test Duration)/(Surface Area)

Measured Infiltration Rate (inches per hour) = 7.6

APPENDIX C

LABORATORY TEST RESULTS



MODIFIED PROCTOR COMPACTION TEST

ASTM D 1557

Project Name: Rexford Glassell Tested By: J. Gonzalez Date: 11/09/21
Project No.: 13333.001 Checked By: A. Santos Date: 12/12/21
Boring No.: LB-1 Depth (ft.): 0-5
Sample No.: B-1
Soil Identification: Yellowish brown sandy silty clay s(CL-ML)

Note: Corrected dry density calculation assumes specific gravity of 2.70 and moisture content of 1.0% for oversize particles

Preparation Method:	☒	Moist	Scalp Fraction (%)	Rammer Weight (lb.) =	10.0
		Dry	#3/4	Height of Drop (in.) =	18.0
Compaction Method	☒	Mechanical Ram	#3/8		
		Manual Ram	#4	Mold Volume (ft ³)	0.03330

TEST NO.	1	2	3	4	5	6
Wt. Compacted Soil + Mold (g)	3865	3989	3890			
Weight of Mold (g)	1850	1850	1850			
Net Weight of Soil (g)	2015	2139	2040			
Wet Weight of Soil + Cont. (g)	546.0	527.0	463.5			
Dry Weight of Soil + Cont. (g)	514.4	485.6	415.9			
Weight of Container (g)	40.1	39.0	40.1			
Moisture Content (%)	6.66	9.27	12.67			
Wet Density (pcf)	133.4	141.6	135.1			
Dry Density (pcf)	125.1	129.6	119.9			

Maximum Dry Density (pcf) **129.6**

Optimum Moisture Content (%) **9.2**

Corrected Dry Density (pcf) **133.1**

Corrected Moisture Content (%) **8.3**

☒ Procedure A

Soil Passing No. 4 (4.75 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)
May be used if + #4 is 20% or less

☐ Procedure B

Soil Passing 3/8 in. (9.5 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)
Use if + #4 is >20% and +3/8 in. is 20% or less

☐ Procedure C

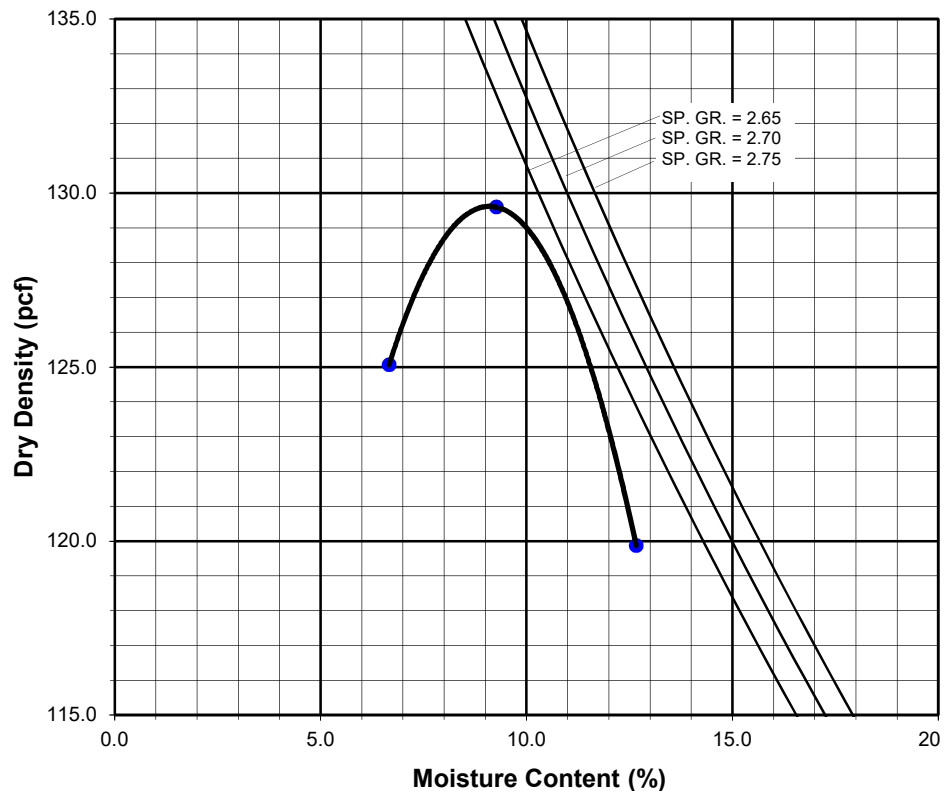
Soil Passing 3/4 in. (19.0 mm) Sieve
Mold : 6 in. (152.4 mm) diameter
Layers : 5 (Five)
Blows per layer : 56 (fifty-six)
Use if +3/8 in. is >20% and +3/4 in. is <30%

Particle-Size Distribution:

GR:SA:FI

Atterberg Limits:

LL,PL,PI





MODIFIED PROCTOR COMPACTION TEST

ASTM D 1557

Project Name: Rexford Glassell Tested By: J. Gonzalez Date: 11/08/21
Project No.: 13333.001 Checked By: A. Santos Date: 12/12/21
Boring No.: LB-4 Depth (ft.): 0-5
Sample No.: B-1
Soil Identification: Yellowish brown clayey sand with gravel (SC)g

Note: Corrected dry density calculation assumes specific gravity of 2.70 and moisture content of 1.0% for oversize particles

Preparation Method:	☒	Moist	Scalp Fraction (%)	Rammer Weight (lb.) =	10.0
		Dry	#3/4	Height of Drop (in.) =	18.0
Compaction Method	☒	Mechanical Ram	#3/8		
		Manual Ram	#4	Mold Volume (ft ³)	0.03330

TEST NO.	1	2	3	4	5	6
Wt. Compacted Soil + Mold (g)	3774	3941	3951			
Weight of Mold (g)	1850	1850	1850			
Net Weight of Soil (g)	1924	2091	2101			
Wet Weight of Soil + Cont. (g)	537.4	495.6	446.3			
Dry Weight of Soil + Cont. (g)	519.2	467.0	413.3			
Weight of Container (g)	39.0	39.8	38.4			
Moisture Content (%)	3.79	6.69	8.80			
Wet Density (pcf)	127.4	138.4	139.1			
Dry Density (pcf)	122.7	129.7	127.8			

Maximum Dry Density (pcf) **129.8**

Optimum Moisture Content (%) **7.1**

Corrected Dry Density (pcf) **136.3**

Corrected Moisture Content (%) **5.8**

☒ Procedure A

Soil Passing No. 4 (4.75 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)
May be used if + #4 is 20% or less

☐ Procedure B

Soil Passing 3/8 in. (9.5 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)
Use if + #4 is >20% and +3/8 in. is 20% or less

☐ Procedure C

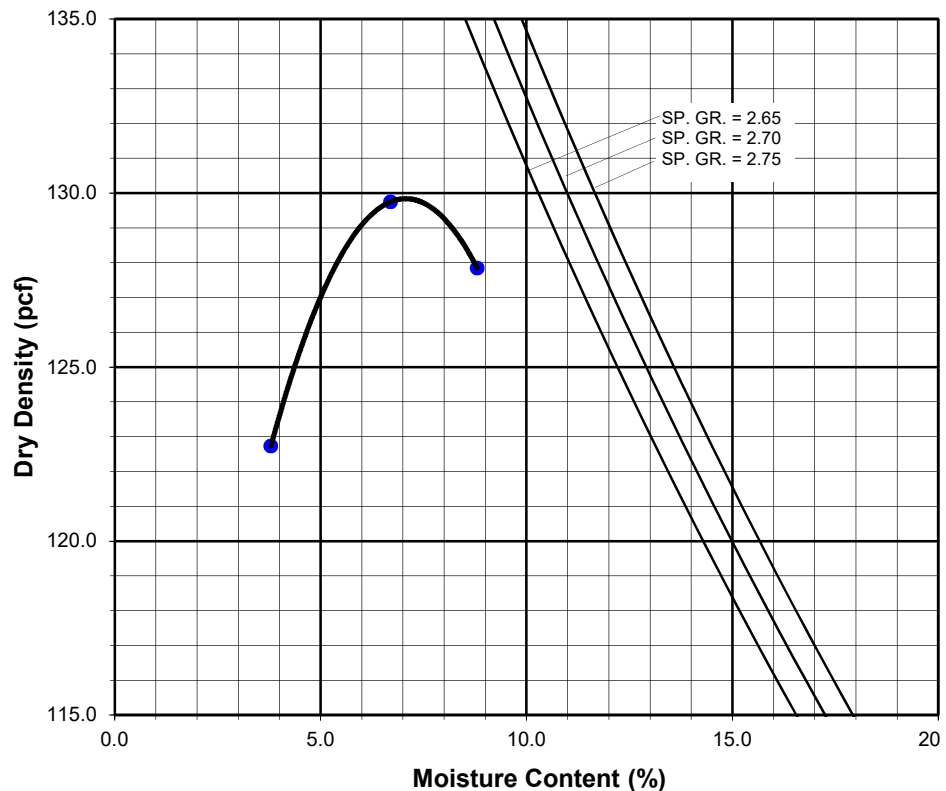
Soil Passing 3/4 in. (19.0 mm) Sieve
Mold : 6 in. (152.4 mm) diameter
Layers : 5 (Five)
Blows per layer : 56 (fifty-six)
Use if +3/8 in. is >20% and +3/4 in. is <30%

Particle-Size Distribution:

GR:SA:FI

Atterberg Limits:

LL,PL,PI





EXPANSION INDEX of SOILS
ASTM D 4829

Project Name: Rexford Glassell Street Tested By: S. Felter Date: 11/10/21
Project No.: 13333.001 Checked By: A. Santos Date: 12/12/21
Boring No.: LB-1 Depth (ft.): 0-5
Sample No.: B-1
Soil Identification: Yellowish brown sandy silty clay s(CL-ML)

Dry Wt. of Soil + Cont.	(g)	1000.00
Wt. of Container No.	(g)	0.00
Dry Wt. of Soil	(g)	1000.00
Weight Soil Retained on #4 Sieve		0.00
Percent Passing # 4		100.00

MOLDED SPECIMEN	Before Test	After Test
Specimen Diameter (in.)	4.01	4.01
Specimen Height (in.)	1.0000	1.0235
Wt. Comp. Soil + Mold (g)	605.90	448.60
Wt. of Mold (g)	184.40	0.00
Specific Gravity (Assumed)	2.70	2.70
Container No.	0	0
Wet Wt. of Soil + Cont. (g)	842.70	633.00
Dry Wt. of Soil + Cont. (g)	780.30	574.68
Wt. of Container (g)	0.00	184.40
Moisture Content (%)	8.00	14.94
Wet Density (pcf)	127.1	132.2
Dry Density (pcf)	117.7	115.0
Void Ratio	0.432	0.466
Total Porosity	0.302	0.318
Pore Volume (cc)	62.4	67.3
Degree of Saturation (%) [S meas]	50.0	86.6

SPECIMEN INUNDATION in distilled water for the period of 24 h or expansion rate < 0.0002 in./h

Date	Time	Pressure (psi)	Elapsed Time (min.)	Dial Readings (in.)
11/10/21	8:51	1.0	0	0.5740
11/10/21	9:01	1.0	10	0.5735
Add Distilled Water to the Specimen				
11/10/21	12:25	1.0	204	0.5960
11/11/21	6:41	1.0	1300	0.5975
11/11/21	7:45	1.0	1364	0.5975

Expansion Index (EI _{meas}) = ((Final Rdg - Initial Rdg) / Initial Thick.) x 1000	24
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EXPANSION INDEX of SOILS

ASTM D 4829

Project Name: Rexford Glassell Street Tested By: S. Felter Date: 11/11/21
Project No.: 13333.001 Checked By: A. Santos Date: 12/12/21
Boring No.: LB-4 Depth (ft.): 0-5
Sample No.: B-1
Soil Identification: Yellowish brown clayey sand (SC)

Dry Wt. of Soil + Cont.	(g)	1000.00
Wt. of Container No.	(g)	0.00
Dry Wt. of Soil	(g)	1000.00
Weight Soil Retained on #4 Sieve		0.00
Percent Passing # 4		100.00

MOLDED SPECIMEN	Before Test	After Test
Specimen Diameter (in.)	4.01	4.01
Specimen Height (in.)	1.0000	1.0260
Wt. Comp. Soil + Mold (g)	607.80	450.50
Wt. of Mold (g)	190.10	0.00
Specific Gravity (Assumed)	2.70	2.70
Container No.	0	0
Wet Wt. of Soil + Cont. (g)	842.70	640.60
Dry Wt. of Soil + Cont. (g)	780.30	576.86
Wt. of Container (g)	0.00	190.10
Moisture Content (%)	8.00	16.48
Wet Density (pcf)	126.0	132.4
Dry Density (pcf)	116.7	113.7
Void Ratio	0.445	0.483
Total Porosity	0.308	0.326
Pore Volume (cc)	63.7	69.1
Degree of Saturation (%) [S meas]	48.5	92.2

SPECIMEN INUNDATION in distilled water for the period of 24 h or expansion rate < 0.0002 in./h

Date	Time	Pressure (psi)	Elapsed Time (min.)	Dial Readings (in.)
11/11/21	8:40	1.0	0	0.5880
11/11/21	8:50	1.0	10	0.5880
Add Distilled Water to the Specimen				
11/11/21	10:35	1.0	105	0.6115
11/12/21	6:50	1.0	1320	0.6140
11/12/21	7:50	1.0	1380	0.6140

Expansion Index (EI _{meas}) = ((Final Rdg - Initial Rdg) / Initial Thick.) x 1000	26
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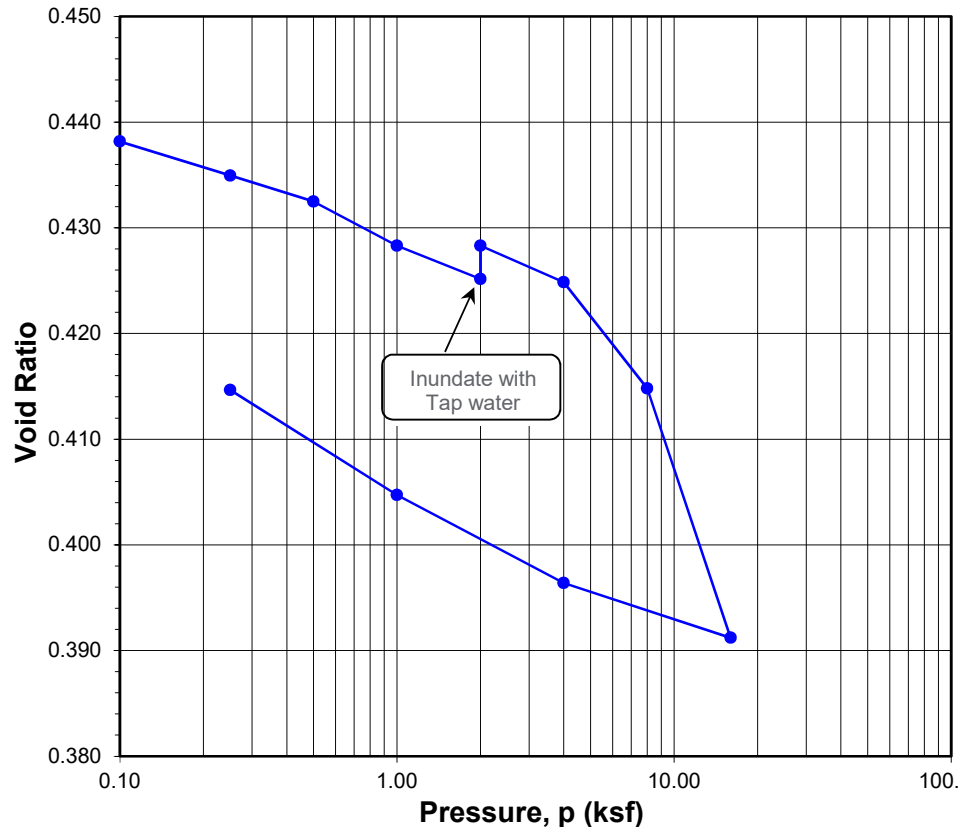


ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS ASTM D 2435

Project Name: Rexford Glassell Street
 Project No.: 13333.001
 Boring No.: LB-1
 Sample No.: B-1
 Soil Identification: Yellowish brown sandy silty clay s(CL-ML)

Tested By: GB/YN Date: 11/10/21
 Checked By: A. Santos Date: 12/12/21
 Depth (ft.): 0-5
 Sample Type: 90% Remold

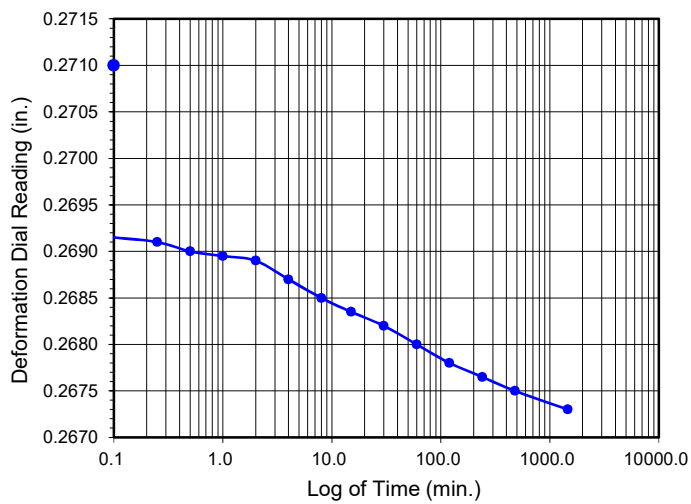
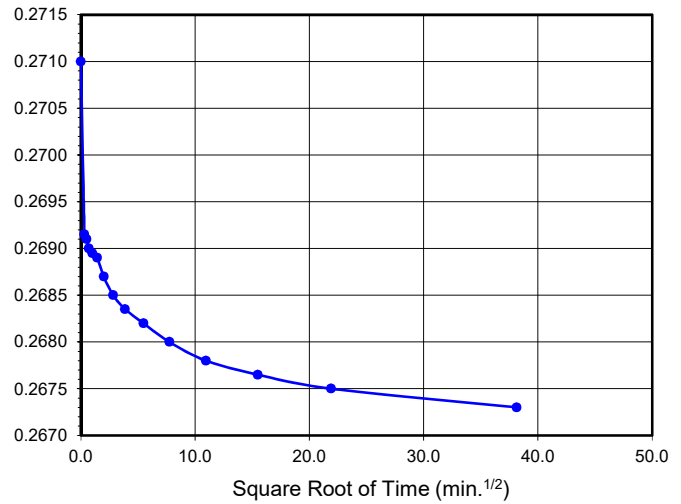
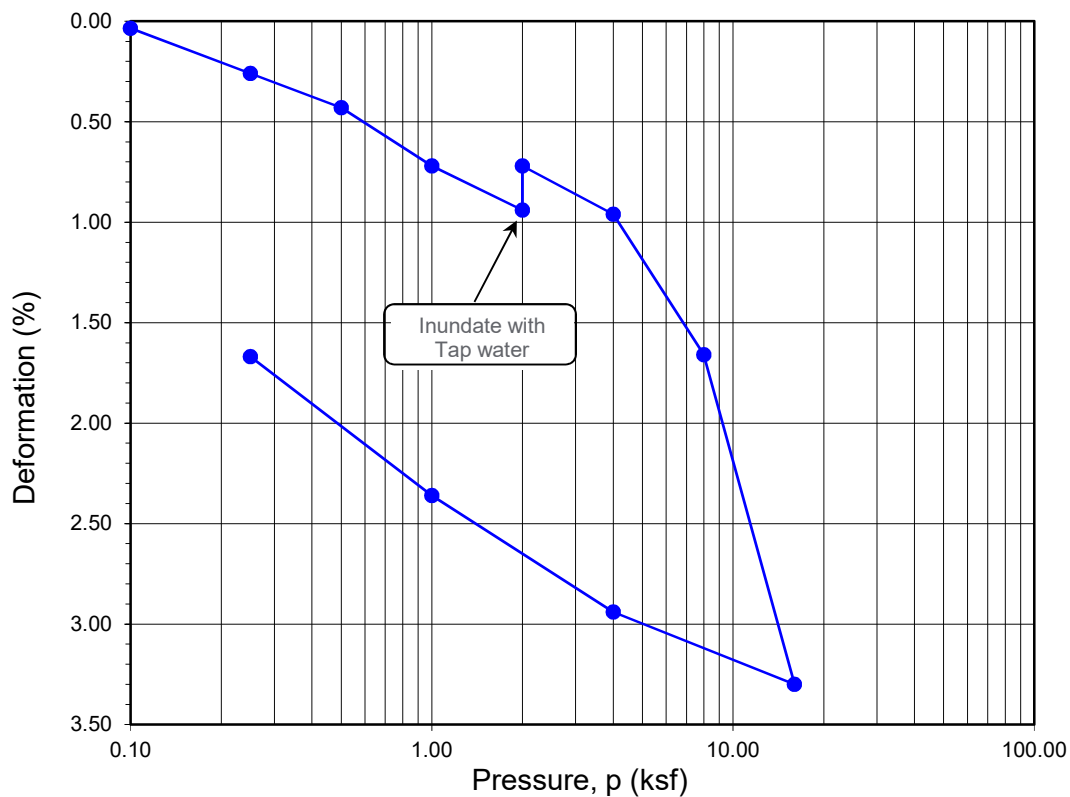
Sample Diameter (in.)	2.415
Sample Thickness (in.)	1.000
Wt. of Sample + Ring (g)	198.00
Weight of Ring (g)	44.25
Height after consol. (in.)	0.9833
Before Test	
Wt. Wet Sample+Cont. (g)	158.54
Wt. of Dry Sample+Cont. (g)	148.33
Weight of Container (g)	36.57
Initial Moisture Content (%)	9.1
Initial Dry Density (pcf)	117.2
Initial Saturation (%)	56
Initial Vertical Reading (in.)	0.2815
After Test	
Wt. of Wet Sample+Cont. (g)	263.08
Wt. of Dry Sample+Cont. (g)	244.02
Weight of Container (g)	58.97
Final Moisture Content (%)	13.54
Final Dry Density (pcf)	119.1
Final Saturation (%)	88
Final Vertical Reading (in.)	0.2611
Specific Gravity (assumed)	2.70
Water Density (pcf)	62.43



Pressure (p) (ksf)	Final Reading (in.)	Apparent Thickness (in.)	Load Compliance (%)	Deformation % of Sample Thickness	Void Ratio	Corrected Deformation (%)
0.10	0.2812	0.9997	0.00	0.03	0.438	0.03
0.25	0.2782	0.9967	0.07	0.33	0.435	0.26
0.50	0.2759	0.9944	0.13	0.56	0.432	0.43
1.00	0.2722	0.9907	0.21	0.93	0.428	0.72
2.00	0.2688	0.9873	0.33	1.27	0.425	0.94
2.00	0.2710	0.9895	0.33	1.05	0.428	0.72
4.00	0.2673	0.9858	0.46	1.42	0.425	0.96
8.00	0.2585	0.9770	0.64	2.30	0.415	1.66
16.00	0.2399	0.9584	0.86	4.16	0.391	3.30
4.00	0.2453	0.9638	0.68	3.62	0.396	2.94
1.00	0.2529	0.9714	0.50	2.86	0.405	2.36
0.25	0.2611	0.9796	0.37	2.04	0.415	1.67

Time Readings @ 4 ksf				
Date	Time	Elapsed Time (min)	Square Root of Time	Dial Rdgs. (in.)
11/15/21	8:20:00	0.0	0.0	0.2710
11/15/21	8:20:06	0.1	0.3	0.2692
11/15/21	8:20:15	0.2	0.5	0.2691
11/15/21	8:20:30	0.5	0.7	0.2690
11/15/21	8:21:00	1.0	1.0	0.2690
11/15/21	8:22:00	2.0	1.4	0.2689
11/15/21	8:24:00	4.0	2.0	0.2687
11/15/21	8:28:00	8.0	2.8	0.2685
11/15/21	8:35:00	15.0	3.9	0.2684
11/15/21	8:50:00	30.0	5.5	0.2682
11/15/21	9:20:00	60.0	7.7	0.2680
11/15/21	10:20:00	120.0	11.0	0.2678
11/15/21	12:20:00	240.0	15.5	0.2677
11/15/21	16:20:00	480.0	21.9	0.2675
11/16/21	8:36:00	1456.0	38.2	0.2673

Time Readings @ 4 ksf



Boring No.	Sample No.	Depth (ft.)	Moisture Content (%)		Dry Density (pcf)		Void Ratio		Degree of Saturation (%)	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
LB-1	B-1	0-5	9.1	13.5	117.2	119.1	0.439	0.415	56	88

Soil Identification: Yellowish brown sandy silty clay s(CL-ML)



**ONE-DIMENSIONAL CONSOLIDATION
PROPERTIES of SOILS**
ASTM D 2435

Project No.: 13333.001

Rexford Glassell Street

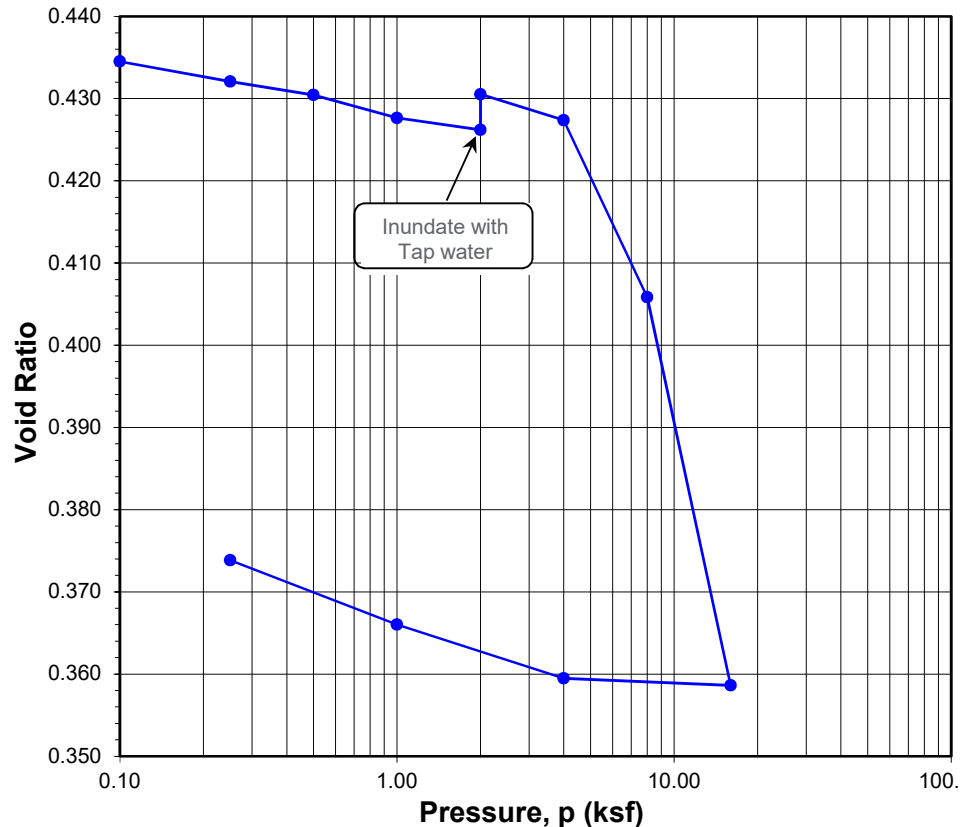


ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS ASTM D 2435

Project Name: Rexford Glassell Street
 Project No.: 13333.001
 Boring No.: LB-4
 Sample No.: B-1
 Soil Identification: Yellowish brown clayey sand (SC)

Tested By: GB/YN Date: 11/10/21
 Checked By: A. Santos Date: 12/12/21
 Depth (ft.): 0-5
 Sample Type: 90% Remold

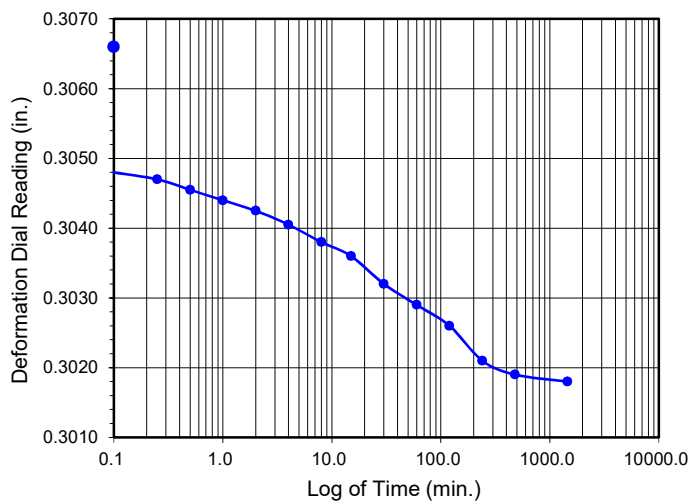
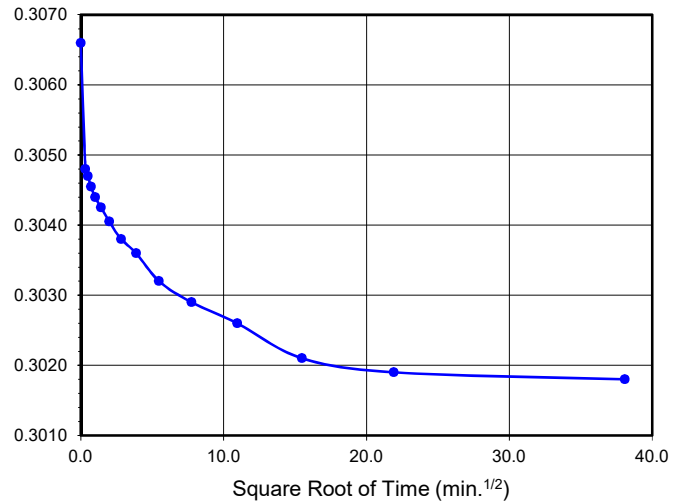
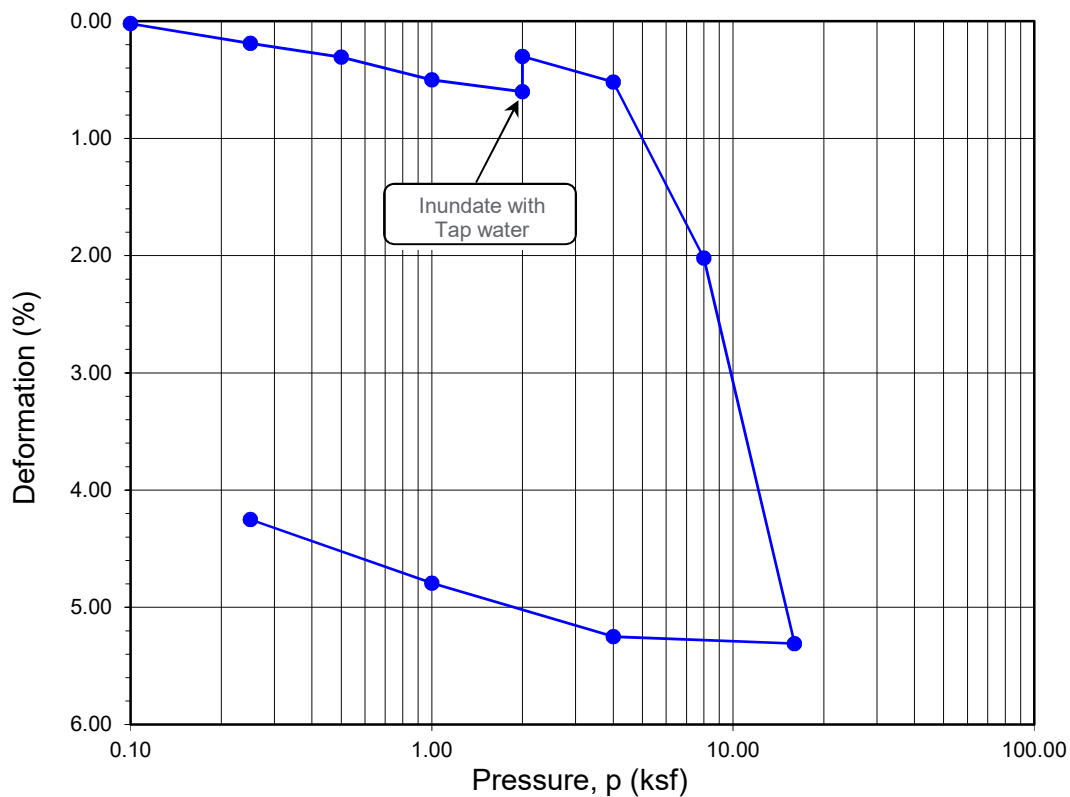
Sample Diameter (in.)	2.415
Sample Thickness (in.)	1.000
Wt. of Sample + Ring (g)	194.07
Weight of Ring (g)	42.87
Height after consol. (in.)	0.9575
Before Test	
Wt. Wet Sample+Cont. (g)	169.50
Wt. of Dry Sample+Cont. (g)	162.36
Weight of Container (g)	60.90
Initial Moisture Content (%)	7.0
Initial Dry Density (pcf)	117.5
Initial Saturation (%)	44
Initial Vertical Reading (in.)	0.3143
After Test	
Wt. of Wet Sample+Cont. (g)	266.28
Wt. of Dry Sample+Cont. (g)	248.38
Weight of Container (g)	64.60
Final Moisture Content (%)	12.70
Final Dry Density (pcf)	122.4
Final Saturation (%)	91
Final Vertical Reading (in.)	0.2657
Specific Gravity (assumed)	2.70
Water Density (pcf)	62.43



Pressure (p) (ksf)	Final Reading (in.)	Apparent Thickness (in.)	Load Compliance (%)	Deformation % of Sample Thickness	Void Ratio	Corrected Deformation (%)
0.10	0.3141	0.9998	0.00	0.02	0.435	0.02
0.25	0.3117	0.9974	0.07	0.26	0.432	0.19
0.50	0.3097	0.9954	0.16	0.47	0.430	0.31
1.00	0.3066	0.9923	0.27	0.77	0.428	0.50
2.00	0.3036	0.9893	0.47	1.07	0.426	0.60
2.00	0.3066	0.9923	0.47	0.77	0.431	0.30
4.00	0.3018	0.9875	0.73	1.25	0.427	0.52
8.00	0.2841	0.9698	1.00	3.02	0.406	2.02
16.00	0.2477	0.9334	1.35	6.66	0.359	5.31
4.00	0.2517	0.9374	1.01	6.26	0.359	5.25
1.00	0.2588	0.9445	0.76	5.56	0.366	4.80
0.25	0.2657	0.9514	0.61	4.86	0.374	4.25

Time Readings @ 4 ksf				
Date	Time	Elapsed Time (min)	Square Root of Time	Dial Rds. (in.)
11/15/21	8:25:00	0.0	0.0	0.3066
11/15/21	8:25:06	0.1	0.3	0.3048
11/15/21	8:25:15	0.2	0.5	0.3047
11/15/21	8:25:30	0.5	0.7	0.3046
11/15/21	8:26:00	1.0	1.0	0.3044
11/15/21	8:27:00	2.0	1.4	0.3043
11/15/21	8:29:00	4.0	2.0	0.3041
11/15/21	8:33:00	8.0	2.8	0.3038
11/15/21	8:40:00	15.0	3.9	0.3036
11/15/21	8:55:00	30.0	5.5	0.3032
11/15/21	9:25:00	60.0	7.7	0.3029
11/15/21	10:25:00	120.0	11.0	0.3026
11/15/21	12:25:00	240.0	15.5	0.3021
11/15/21	16:25:00	480.0	21.9	0.3019
11/16/21	8:35:00	1450.0	38.1	0.3018

Time Readings @ 4 ksf



Boring No.	Sample No.	Depth (ft.)	Moisture Content (%)		Dry Density (pcf)		Void Ratio		Degree of Saturation (%)	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
LB-4	B-1	0-5	7.0	12.7	117.5	122.4	0.435	0.374	44	91

Soil Identification: Yellowish brown clayey sand (SC)



**ONE-DIMENSIONAL CONSOLIDATION
PROPERTIES of SOILS**
ASTM D 2435

Project No.: 13333.001

Rexford Glassell Street



DIRECT SHEAR TEST
Consolidated Drained - ASTM D 3080

Project Name: [Rexford Glassell Street](#)
Project No.: [13333.001](#)
Boring No.: [LB-1](#)
Sample No.: [B-1](#)
Soil Identification: [Yellowish brown sandy silty clay s\(CL-ML\)](#)

Tested By: [G. Bathala](#)
Checked By: [A. Santos](#)
Sample Type: [90% Remold](#)
Depth (ft.): [0-5](#)

Date: [11/18/21](#)
Date: [12/12/21](#)

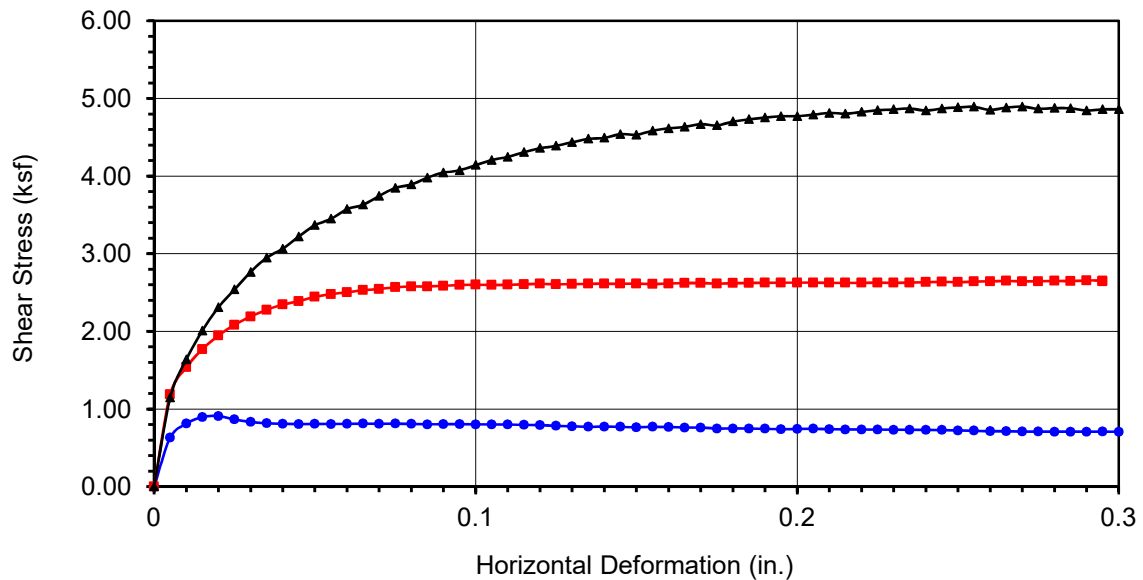
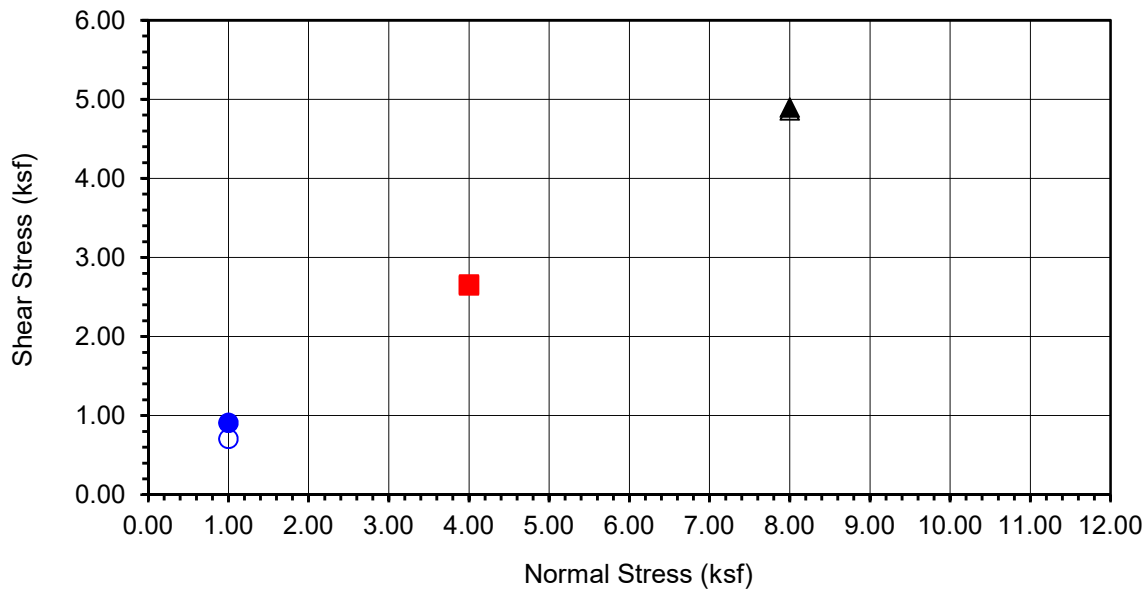
Sample Diameter(in):	2.415	2.415	2.415
Sample Thickness(in.):	1.000	1.000	1.000
Weight of Sample + ring(gm):	199.03	198.93	198.80
Weight of Ring(gm):	45.58	45.35	44.88

Before Shearing

Weight of Wet Sample+Cont.(gm):	158.54	158.54	158.54
Weight of Dry Sample+Cont.(gm):	148.33	148.33	148.33
Weight of Container(gm):	36.57	36.57	36.57
Vertical Rdg.(in): Initial	0.0000	0.2397	0.2420
Vertical Rdg.(in): Final	-0.0024	0.2583	0.2666

After Shearing

Weight of Wet Sample+Cont.(gm):	211.45	219.85	214.57
Weight of Dry Sample+Cont.(gm):	190.86	201.05	197.00
Weight of Container(gm):	51.14	61.75	58.97
Specific Gravity (Assumed):	2.70	2.70	2.70
Water Density(pcf):	62.43	62.43	62.43



Boring No.	LB-1
Sample No.	B-1
Depth (ft)	0-5
<u>Sample Type:</u>	
90% Remold	
<u>Soil Identification:</u>	
Yellowish brown sandy silty clay s(CL-ML)	

Normal Stress (kip/ft ²)	1.000	4.000	8.000
Peak Shear Stress (kip/ft ²)	● 0.909	■ 2.656	▲ 4.895
Shear Stress @ End of Test (ksf)	○ 0.707	□ 2.644	△ 4.860
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	9.14	9.14	9.14
Dry Density (pcf)	116.9	117.0	117.3
Saturation (%)	55.9	56.0	56.4
Soil Height Before Shearing (in.)	0.9976	0.9814	0.9754
Final Moisture Content (%)	14.7	13.5	12.7



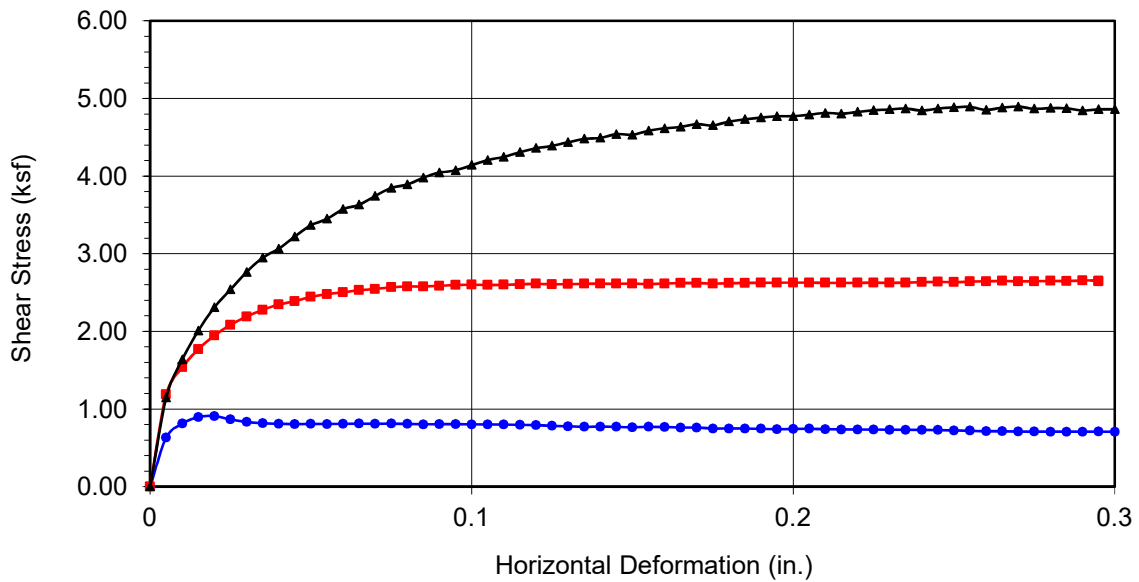
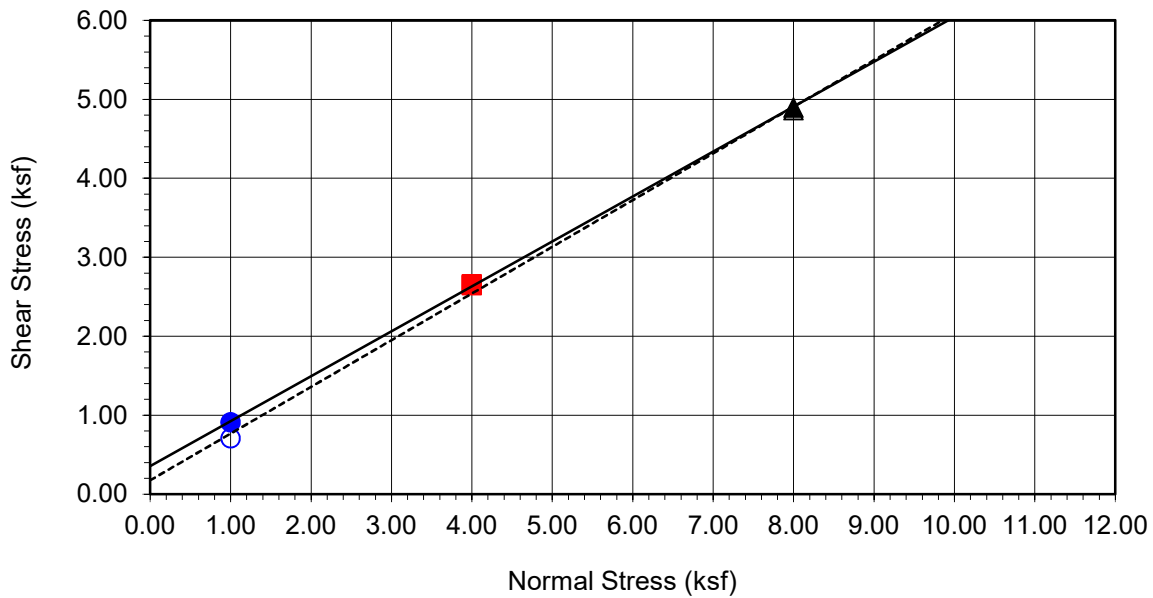
DIRECT SHEAR TEST RESULTS

Consolidated Drained - ASTM D 3080

Project No.: 13333.001

Rexford Glassell Street

11-21



Boring No.	LB-1	
Sample No.	B-1	
Depth (ft)	0-5	
<u>Sample Type:</u> 90% Remold		
<u>Soil Identification:</u> Yellowish brown sandy silty clay s(CL-ML)		
<u>Strength Parameters</u>		
	C (psf)	ϕ (°)
Peak	355	30
Ultimate	175	31

Normal Stress (kip/ft ²)	1.000	4.000	8.000
Peak Shear Stress (kip/ft ²)	● 0.909	■ 2.656	▲ 4.895
Shear Stress @ End of Test (ksf)	○ 0.707	□ 2.644	△ 4.860
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	9.14	9.14	9.14
Dry Density (pcf)	116.9	117.0	117.3
Saturation (%)	55.9	56.0	56.4
Soil Height Before Shearing (in.)	0.9976	0.9814	0.9754
Final Moisture Content (%)	14.7	13.5	12.7



DIRECT SHEAR TEST RESULTS

Consolidated Drained - ASTM D 3080

Project No.: 13333.001

Rexford Glassell Street

11-21



DIRECT SHEAR TEST
Consolidated Drained - ASTM D 3080

Project Name: [Rexford Glassell Street](#)
Project No.: [13333.001](#)
Boring No.: [LB-4](#)
Sample No.: [B-1](#)
Soil Identification: [Yellowish brown clayey sand \(SC\)](#)

Tested By: [G. Bathala](#)
Checked By: [A. Santos](#)
Sample Type: [90% Remold](#)
Depth (ft.): [0-5](#)

Date: [11/18/21](#)
Date: [12/06/21](#)

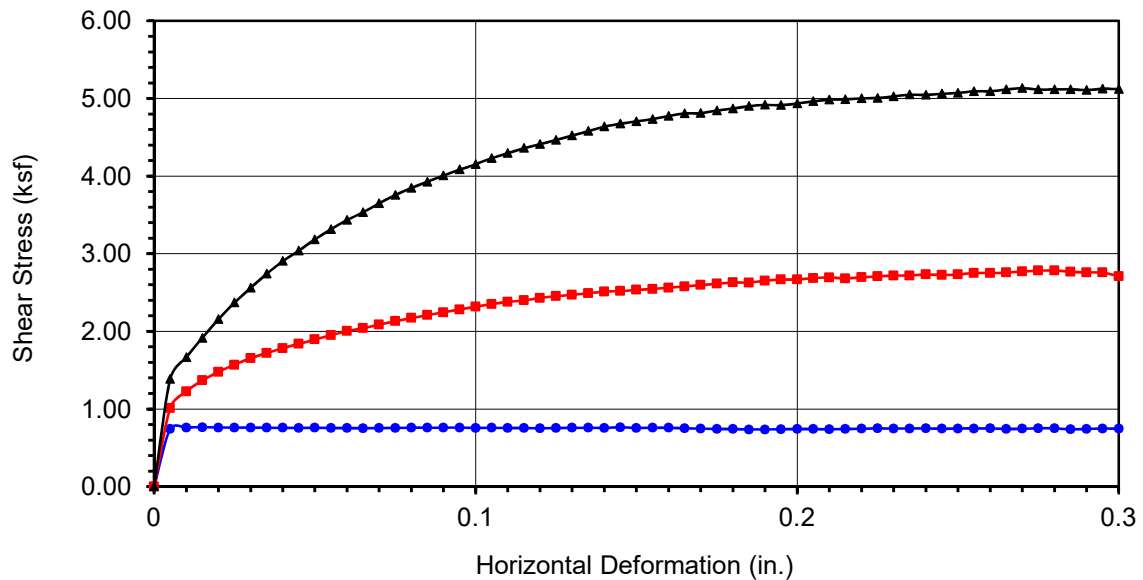
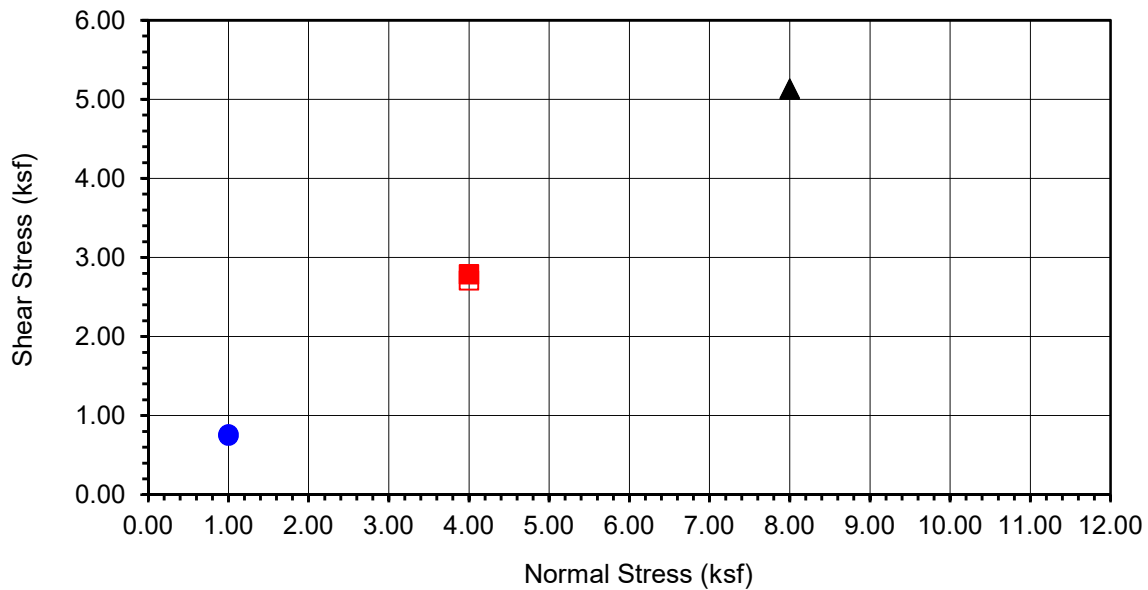
Sample Diameter(in):	2.415	2.415	2.415
Sample Thickness(in.):	1.000	1.000	1.000
Weight of Sample + ring(gm):	195.53	196.47	196.70
Weight of Ring(gm):	44.88	45.59	45.34

Before Shearing

Weight of Wet Sample+Cont.(gm):	169.50	169.50	169.50
Weight of Dry Sample+Cont.(gm):	162.36	162.36	162.36
Weight of Container(gm):	60.90	60.90	60.90
Vertical Rdg.(in): Initial	0.2739	0.2689	0.0000
Vertical Rdg.(in): Final	0.2708	0.2841	-0.0320

After Shearing

Weight of Wet Sample+Cont.(gm):	218.37	194.86	215.13
Weight of Dry Sample+Cont.(gm):	198.00	177.02	198.75
Weight of Container(gm):	59.15	38.30	59.16
Specific Gravity (Assumed):	2.70	2.70	2.70
Water Density(pcf):	62.43	62.43	62.43



Boring No.	LB-4
Sample No.	B-1
Depth (ft)	0-5
<u>Sample Type:</u>	
90% Remold	
<u>Soil Identification:</u>	
Yellowish brown clayey sand (SC)	

Normal Stress (kip/ft ²)	1.000	4.000	8.000
Peak Shear Stress (kip/ft ²)	● 0.764	■ 2.785	▲ 5.134
Shear Stress @ End of Test (ksf)	○ 0.745	□ 2.710	△ 5.121
Deformation Rate (in./min.)	0.0025	0.0025	0.0025
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	7.04	7.04	7.04
Dry Density (pcf)	117.1	117.2	117.6
Saturation (%)	43.2	43.4	43.9
Soil Height Before Shearing (in.)	1.0031	0.9848	0.9680
Final Moisture Content (%)	14.7	12.9	11.7



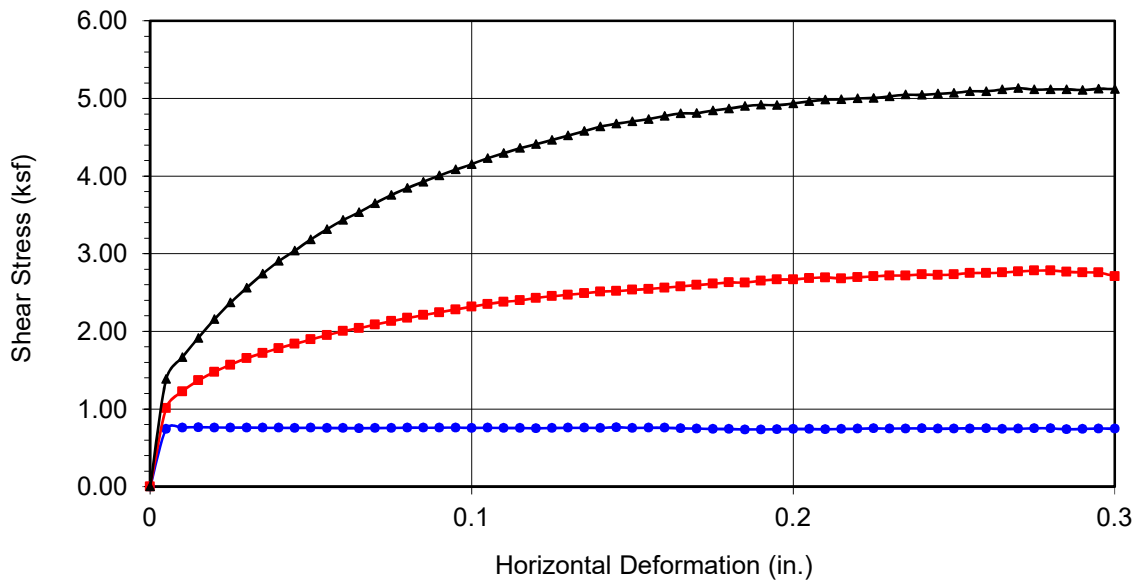
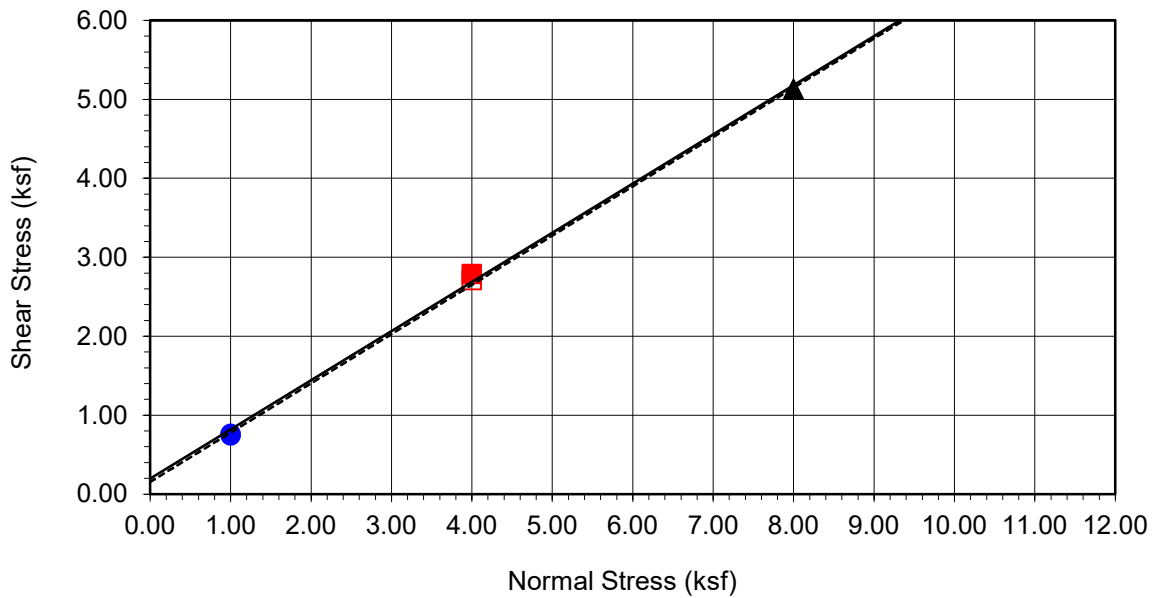
DIRECT SHEAR TEST RESULTS

Consolidated Drained - ASTM D 3080

Project No.: 13333.001

Rexford Glassell Street

11-21



Boring No.	LB-4	
Sample No.	B-1	
Depth (ft)	0-5	
<u>Sample Type:</u> 90% Remold		
<u>Soil Identification:</u> Yellowish brown clayey sand (SC)		
<u>Strength Parameters</u>		
	C (psf)	ϕ (°)
Peak	198	32
Ultimate	155	32

Normal Stress (kip/ft ²)	1.000	4.000	8.000
Peak Shear Stress (kip/ft ²)	● 0.764	■ 2.785	▲ 5.134
Shear Stress @ End of Test (ksf)	○ 0.745	□ 2.710	△ 5.121
Deformation Rate (in./min.)	0.0025	0.0025	0.0025
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	7.04	7.04	7.04
Dry Density (pcf)	117.1	117.2	117.6
Saturation (%)	43.2	43.4	43.9
Soil Height Before Shearing (in.)	1.0031	0.9848	0.9680
Final Moisture Content (%)	14.7	12.9	11.7



DIRECT SHEAR TEST RESULTS

Consolidated Drained - ASTM D 3080

Project No.: 13333.001

Rexford Glassell Street

11-21



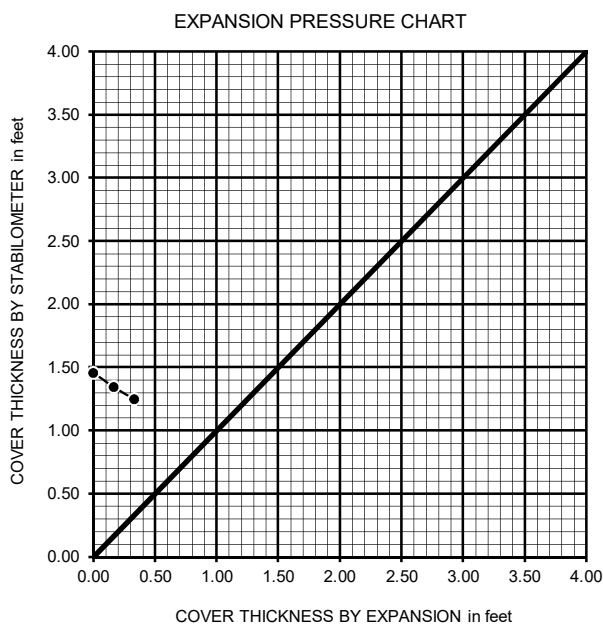
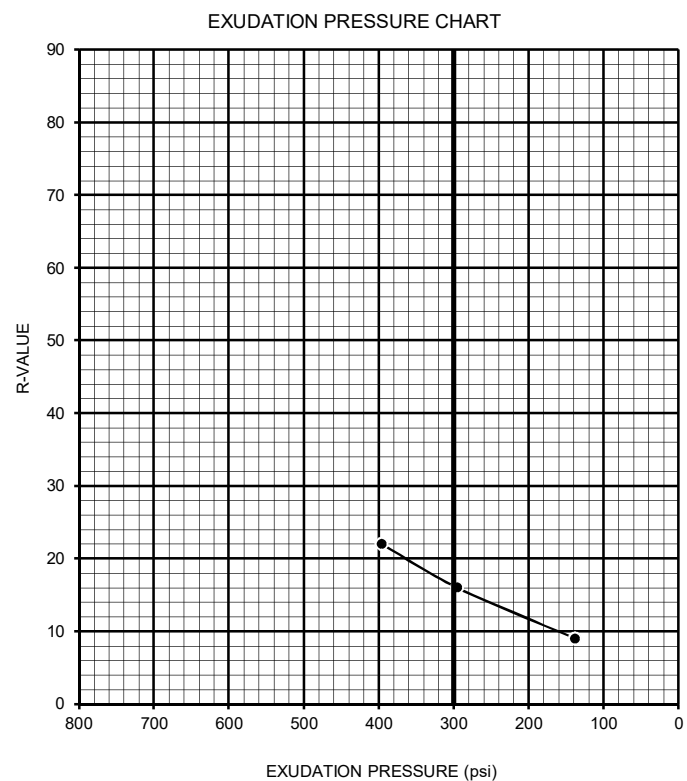
R-VALUE TEST RESULTS

DOT CA Test 301

PROJECT NAME:	Rexford Glassell Street	PROJECT NUMBER:	13333.001
BORING NUMBER:	LB-1	DEPTH (FT.):	0-5
SAMPLE NUMBER:	B-1	TECHNICIAN:	O. Figueroa
SAMPLE DESCRIPTION:	Yellowish brown sandy silty clay s(CL-ML)	DATE COMPLETED:	11/18/2021

TEST SPECIMEN	a	b	c
MOISTURE AT COMPACTION %	12.0	12.9	14.3
HEIGHT OF SAMPLE, Inches	2.47	2.51	2.55
DRY DENSITY, pcf	124.5	123.9	119.7
COMPACTOR PRESSURE, psi	110	70	65
EXUDATION PRESSURE, psi	396	295	138
EXPANSION, Inches x 10exp-4	10	5	0
STABILITY Ph 2,000 lbs (160 psi)	108	120	136
TURNS DISPLACEMENT	4.32	4.45	4.52
R-VALUE UNCORRECTED	22	16	9
R-VALUE CORRECTED	22	16	9

DESIGN CALCULATION DATA	a	b	c
GRAVEL EQUIVALENT FACTOR	1.0	1.0	1.0
TRAFFIC INDEX	5.0	5.0	5.0
STABILOMETER THICKNESS, ft.	1.25	1.34	1.46
EXPANSION PRESSURE THICKNESS, ft.	0.33	0.17	0.00



R-VALUE BY EXPANSION:	34
R-VALUE BY EXUDATION:	16
EQUILIBRIUM R-VALUE:	16



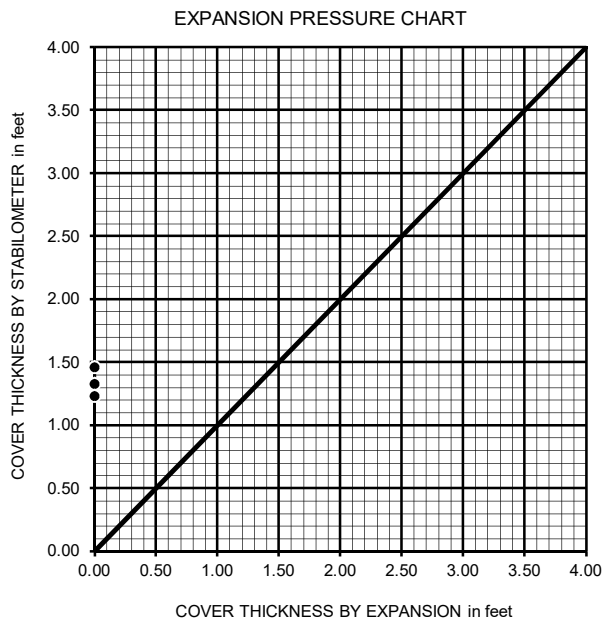
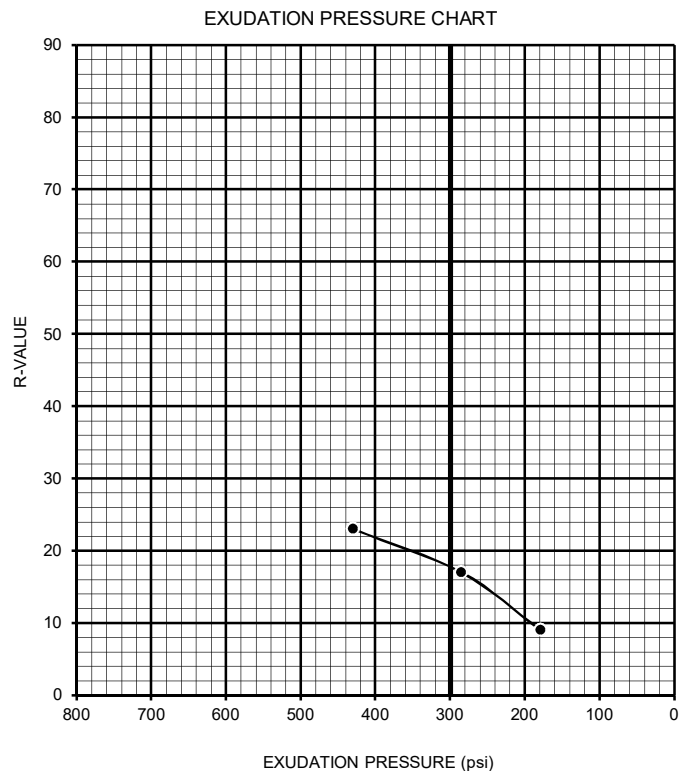
R-VALUE TEST RESULTS

DOT CA Test 301

PROJECT NAME: Rexford Glassell Street PROJECT NUMBER: 13333.001
BORING NUMBER: LB-4 DEPTH (FT.): 0-5
SAMPLE NUMBER: B-1 TECHNICIAN: O. Figueroa
SAMPLE DESCRIPTION: Yellowish brn clayey sand with gravel (SC)g DATE COMPLETED: 11/18/2021

TEST SPECIMEN	a	b	c
MOISTURE AT COMPACTION %	10.6	11.5	12.7
HEIGHT OF SAMPLE, Inches	2.49	2.53	2.50
DRY DENSITY, pcf	128.9	127.2	123.6
COMPACTOR PRESSURE, psi	100	70	50
EXUDATION PRESSURE, psi	430	285	179
EXPANSION, Inches x 10exp-4	0	0	0
STABILITY Ph 2,000 lbs (160 psi)	110	120	136
TURNS DISPLACEMENT	3.80	4.20	4.32
R-VALUE UNCORRECTED	23	17	9
R-VALUE CORRECTED	23	17	9

DESIGN CALCULATION DATA	a	b	c
GRAVEL EQUIVALENT FACTOR	1.0	1.0	1.0
TRAFFIC INDEX	5.0	5.0	5.0
STABILOMETER THICKNESS, ft.	1.23	1.33	1.46
EXPANSION PRESSURE THICKNESS, ft.	0.00	0.00	0.00



R-VALUE BY EXPANSION: N/A
R-VALUE BY EXUDATION: 18
EQUILIBRIUM R-VALUE: 18



**TESTS for SULFATE CONTENT
CHLORIDE CONTENT and pH of SOILS**

Project Name: Rexford Glassell Street Tested By : JD/GB Date: 11/10/21
Project No. : 13333.001 Checked By: A. Santos Date: 12/12/21

Boring No.	LB-1	LB-4		
Sample No.	B-1	B-1		
Sample Depth (ft)	0-5	0-5		
Soil Identification:	Yellowish brown s(CL-ML)	Yellowish brown (SC)		
Wet Weight of Soil + Container (g)	0.00	0.00		
Dry Weight of Soil + Container (g)	0.00	0.00		
Weight of Container (g)	1.00	1.00		
Moisture Content (%)	0.00	0.00		
Weight of Soaked Soil (g)	100.47	100.67		

SULFATE CONTENT, DOT California Test 417, Part II

Beaker No.	95	200A		
Crucible No.	16	14		
Furnace Temperature (°C)	860	860		
Time In / Time Out	7:00/7:45	6:35/7:20		
Duration of Combustion (min)	45	45		
Wt. of Crucible + Residue (g)	18.4737	19.6848		
Wt. of Crucible (g)	18.4713	19.6840		
Wt. of Residue (g) (A)	0.0024	0.0008		
PPM of Sulfate (A) x 41150	98.76	32.92		
PPM of Sulfate, Dry Weight Basis	99	33		

CHLORIDE CONTENT, DOT California Test 422

ml of Extract For Titration (B)	30	15		
ml of AgNO ₃ Soln. Used in Titration (C)	0.6	0.4		
PPM of Chloride (C - 0.2) * 100 * 30 / B	40	40		
PPM of Chloride, Dry Wt. Basis	40	40		

pH TEST, DOT California Test 643

pH Value	8.49	8.18		
Temperature °C	21.4	22.3		



SOIL RESISTIVITY TEST

DOT CA TEST 643

Project Name: Rexford Glassell Street

Project No. : 13333.001

Boring No.: LB-1

Sample No. : B-1

Tested By : A. Santos Date: 11/22/21

Checked By: G. Bathala Date: 12/07/21

Depth (ft.) : 0-5

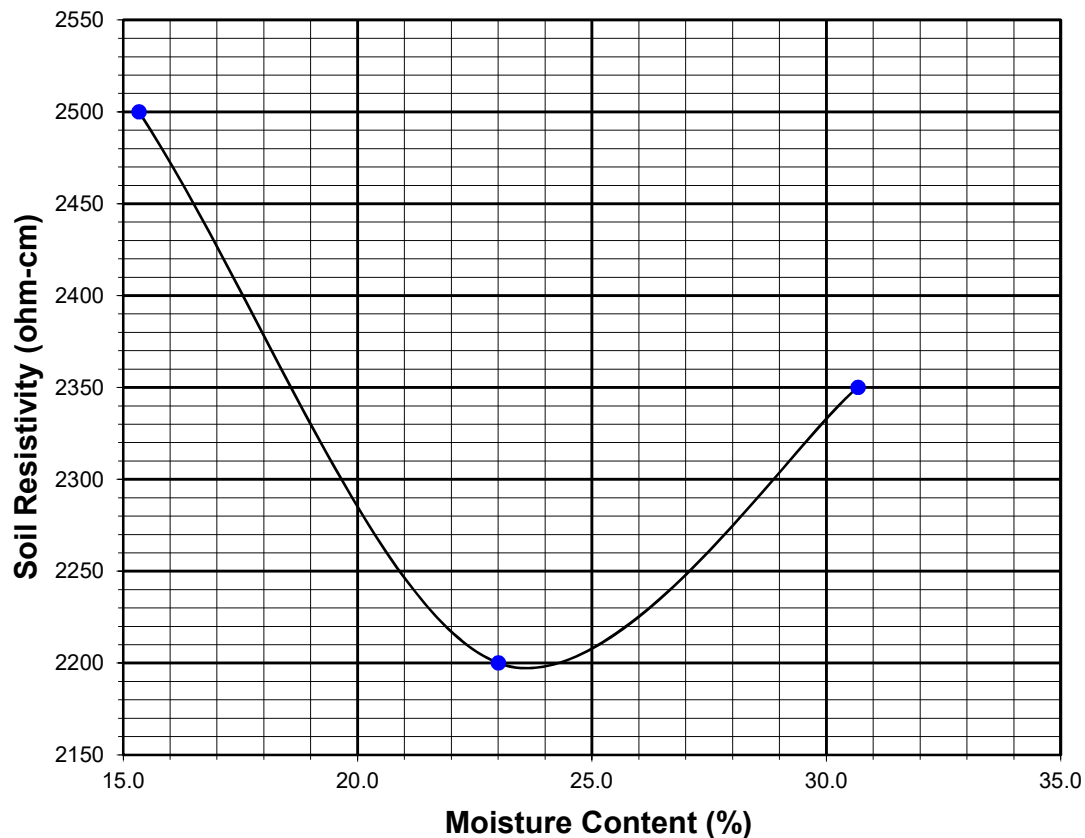
Soil Identification:* Yellowish brown s(CL-ML)

*California Test 643 requires soil specimens to consist only of portions of samples passing through the No. 8 US Standard Sieve before resistivity testing. Therefore, this test method may not be representative for coarser materials.

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	20	15.34	2500	2500
2	30	23.01	2200	2200
3	40	30.67	2350	2350
4				
5				

Moisture Content (%) (Mci)	0.00
Wet Wt. of Soil + Cont. (g)	0.00
Dry Wt. of Soil + Cont. (g)	0.00
Wt. of Container (g)	1.00
Container No.	
Initial Soil Wt. (g) (Wt)	130.40
Box Constant	1.000
$MC = (((1 + Mci / 100) \times (Wa / Wt + 1)) - 1) \times 100$	

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 643	
2197	23.6	99	40	8.49	21.4





SOIL RESISTIVITY TEST

DOT CA TEST 643

Project Name: Rexford Glassell Street
Project No. : 13333.001
Boring No.: LB-4
Sample No. : B-1

Tested By : A. Santos Date: 11/22/21
Checked By: G. Bathala Date: 12/12/21
Depth (ft.) : 0-5

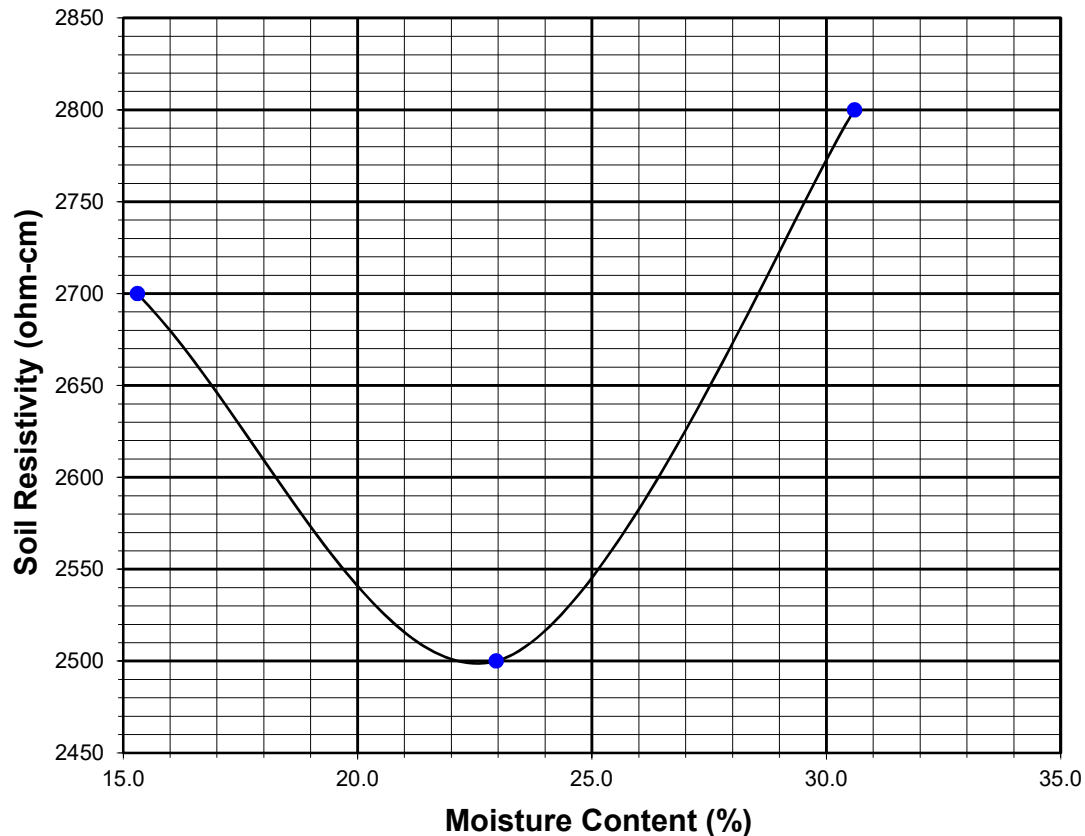
Soil Identification:* Yellowish brown (SC)

*California Test 643 requires soil specimens to consist only of portions of samples passing through the No. 8 US Standard Sieve before resistivity testing. Therefore, this test method may not be representative for coarser materials.

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	20	15.30	2700	2700
2	30	22.95	2500	2500
3	40	30.60	2800	2800
4				
5				

Moisture Content (%) (Mci)	0.00
Wet Wt. of Soil + Cont. (g)	0.00
Dry Wt. of Soil + Cont. (g)	0.00
Wt. of Container (g)	1.00
Container No.	
Initial Soil Wt. (g) (Wt)	130.70
Box Constant	1.000
$MC = (((1 + Mci / 100) \times (Wa / Wt + 1)) - 1) \times 100$	

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 643	
2498	22.5	33	40	8.18	22.3



Appendix E-1:

**OC TGD Infiltration Worksheet
(Worksheet I)**

Appendix F:

Hydrology Information

(Q2 – Two-year frequency storm evaluation)

WATERSHED E

**PROJECT SITE.
COLLINS CHANNEL
IS CONCRETE LINED.**

E01 Santa Ana River Channel
E01P01 Prado Infiltration Line
E01P02 Harbor-Edinger Storm Drain
E01P14 Esperanza Road Storm Drain
E01P63 Yorba Park Storm Drain
E01P79 Southpark Storm Drain
E01P80 Harbor Storm Drain
E01PS1 Harbor-Edinger Pump Station
E01PS2 Southpark Pump Station
E01S01 East Richfield Storm Drain
E01S02 Chantilly Storm Channel
E01S04 Deerfield Storm Channel
E01S09 Walnut Canyon Storm Channel
E01S13 Eucalyptus Storm Channel

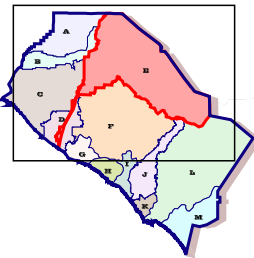
E02 Carbon Creek Diver Channel
E02B01 Miller Retarding Basin
E03 Carbon Canyon Channel
E03D01 Carbon Canyon Dam
E03P01 Palm-Valencia Storm Drain
E03S01 Rose Storm Channel
E04 Atwood Channel
E04D01 Yorba Linda Reservoir
E04P01 Glenview Storm Drain
E05 Richfield Channel
E07S05 Nixon Storm Drain
E08 Carlton Storm Drain
E08B01 Esperanza Channel
E08D01 Blue Mud Storm Channel
E08D02 Collins Channel
E08P01 Chapman-Beach Storm Drain
E08P02 Marlboro Storm Channel
E08P03 Wanda Storm Channel
E08P04 Buckeye Storm Channel
E08P06 Santiago Creek Channel
E08P12 Santiago Creek Retarding Basin
E08P14 Villa Park Dam
E05P02 Santiago Dam
E05P07 La Veta Storm Drain
E06 Villa Park Storm Drain

CITIES IN THE WATERSHED:

ANAHEIM
BREA
COSTA MESA
FOUNTAIN VALLEY
GARDEN GROVE
HUNTINGTON BEACH

ORANGE
PLACENTIA
SANTA ANA
UNINCORPORATED
VILLA PARK
YORBA LINDA

E08S01 Center Street Storm Drain
E07 Mesa Drive Storm Drain
E07S01 El Modena Storm Drain
E07S02 Cambridge Storm Drain
E07S03 Chapman Grande Storm Drain
E08P47 Lemon-Taft Storm Drain
E08S01 Walnut Storm Channel
E08S02 Alameda Storm Channel
E08S06 Handy Creek Storm Channel
E09 Gypsum Creek Channel
E10 Fletcher Channel
E10B01 Fletcher Retarding Basin
E10P01 Fletcher Street Storm Drain
E11 Bitterbush Channel
E12 Southeast Anaheim Channel
E12P01 State College Storm Drain
E13 Telegraph Canyon
E14 Limestone Canyon
E15 Black Star Canyon
E17 Silverado Canyon
E18 Ladd Canyon
E19 Modjeska Canyon
E20 Fremont Canyon
E21 Weir Canyon
E22 Blind Canyon

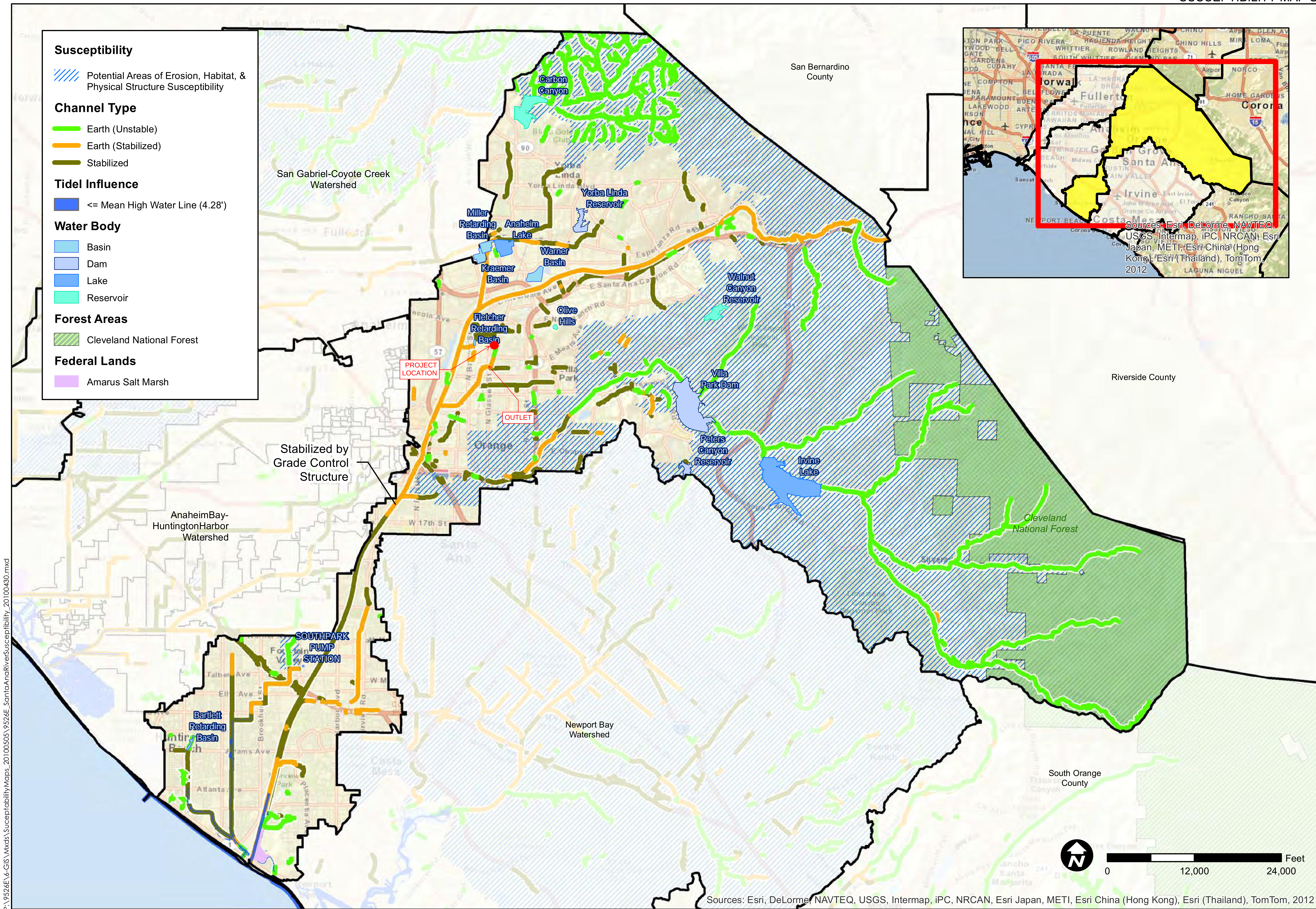
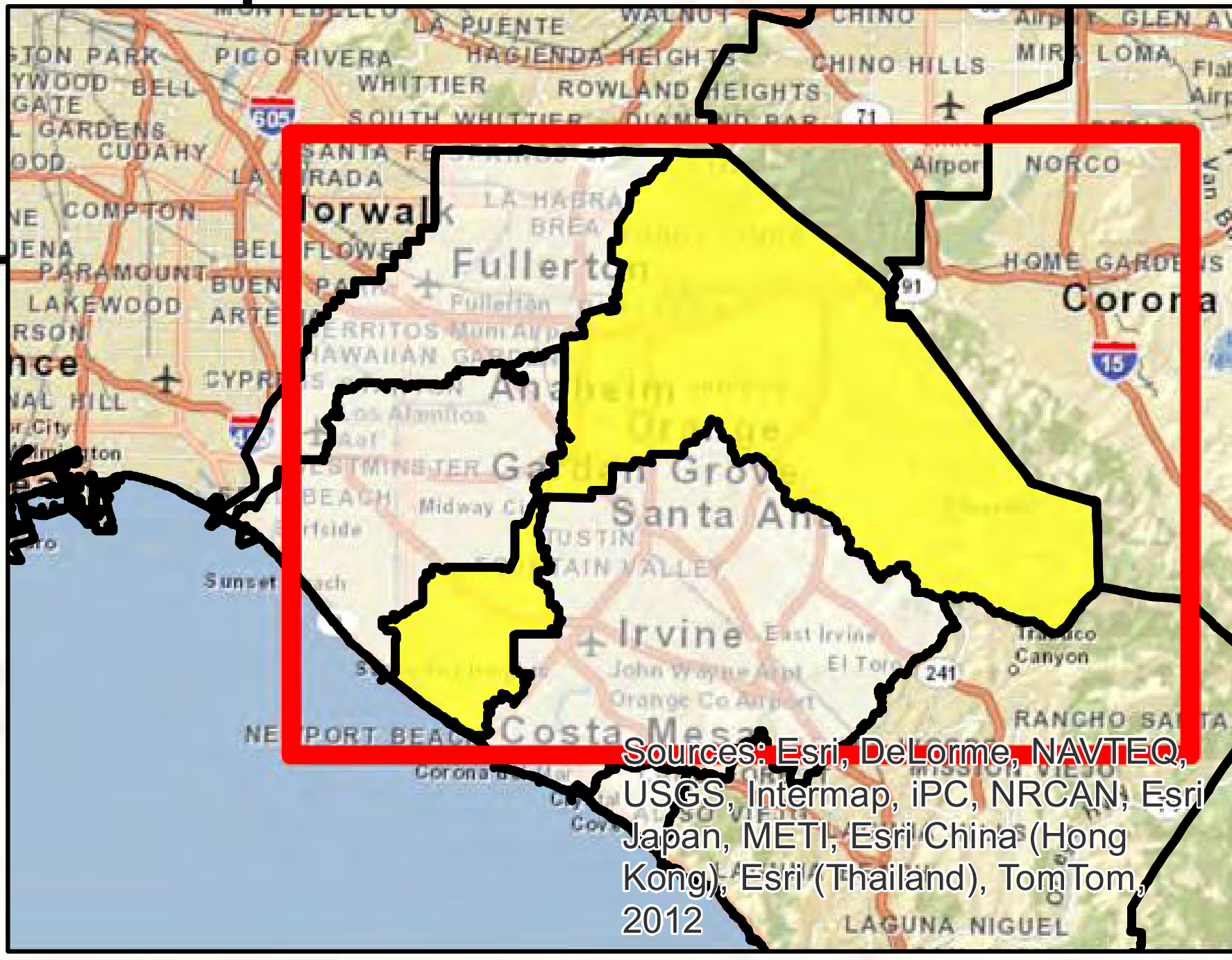


DESIGNED AND PRODUCED BY:
GIS Mapping Unit
Public Facilities and Resources Department
Carmen Copi-Carrasco

DATA SOURCE:
Geographic Information System Division
Esri, ArcView, 2001

DATE: March 10, 2005

11500 0 11500 Feet



Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012

Susceptibility

Potential Areas of Erosion, Habitat, & Physical Structure Susceptibility

Channel Type

- Earth (Unstable)
- Earth (Stabilized)
- Stabilized

Tidel Influence

<= Mean High Water Line (4.28')

Water Body

- Basin
- Dam
- Lake
- Reservoir

Forest Areas

Cleveland National Forest

Federal Lands

Amarus Salt Marsh

SUSCEPTIBILITY ANALYSIS
SANTA ANA RIVER

ORANGE COUNTY
WATERSHED
MASTER PLANNING

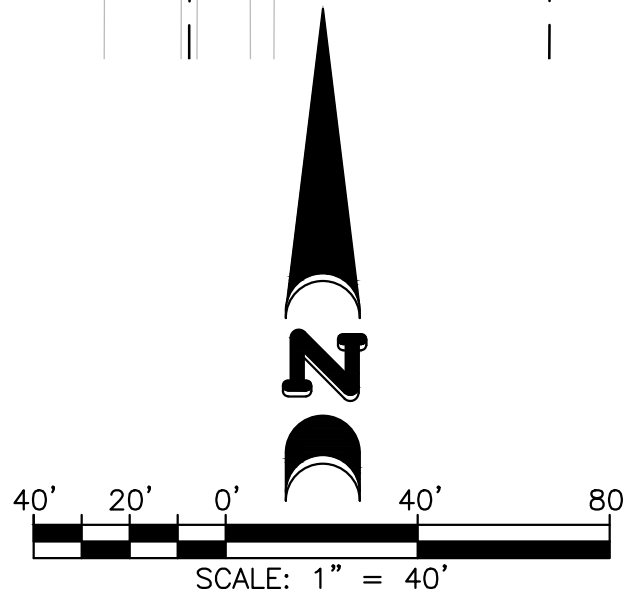
SCALE	1" = 12000'
DESIGNED	TH
DRAWING	TH
CHECKED	BMP
DATE	04/30/10
JOB NO.	9236-E



FIGURE

3

2411 GLASSELL STREET
EXISTING CONDITION HYDROLOGY MAP



LEGEND

SUBAREA DESTINATION - SUBAREA ACREAGE -	E-1 XX.XX	100-YR DISCHARGE AT NODE FOR SINGLE TRIBUTARY AREA	Q ₁₀₀
HYDRAULIC NODE DESIGNATION	300	HYDROLOGIC SUBAREA BOUNDARY	---
HYDROLOGIC FLOW PATH	→	PROPERTY LINE	- - -

PREPARED BY:
HUITT ZOLLARS
2603 Main Street, Suite 400, Irvine, California 92614
Phone: 949.988.5815 | www.huilt-zollars.com



EXISTING DRAINAGE MAP

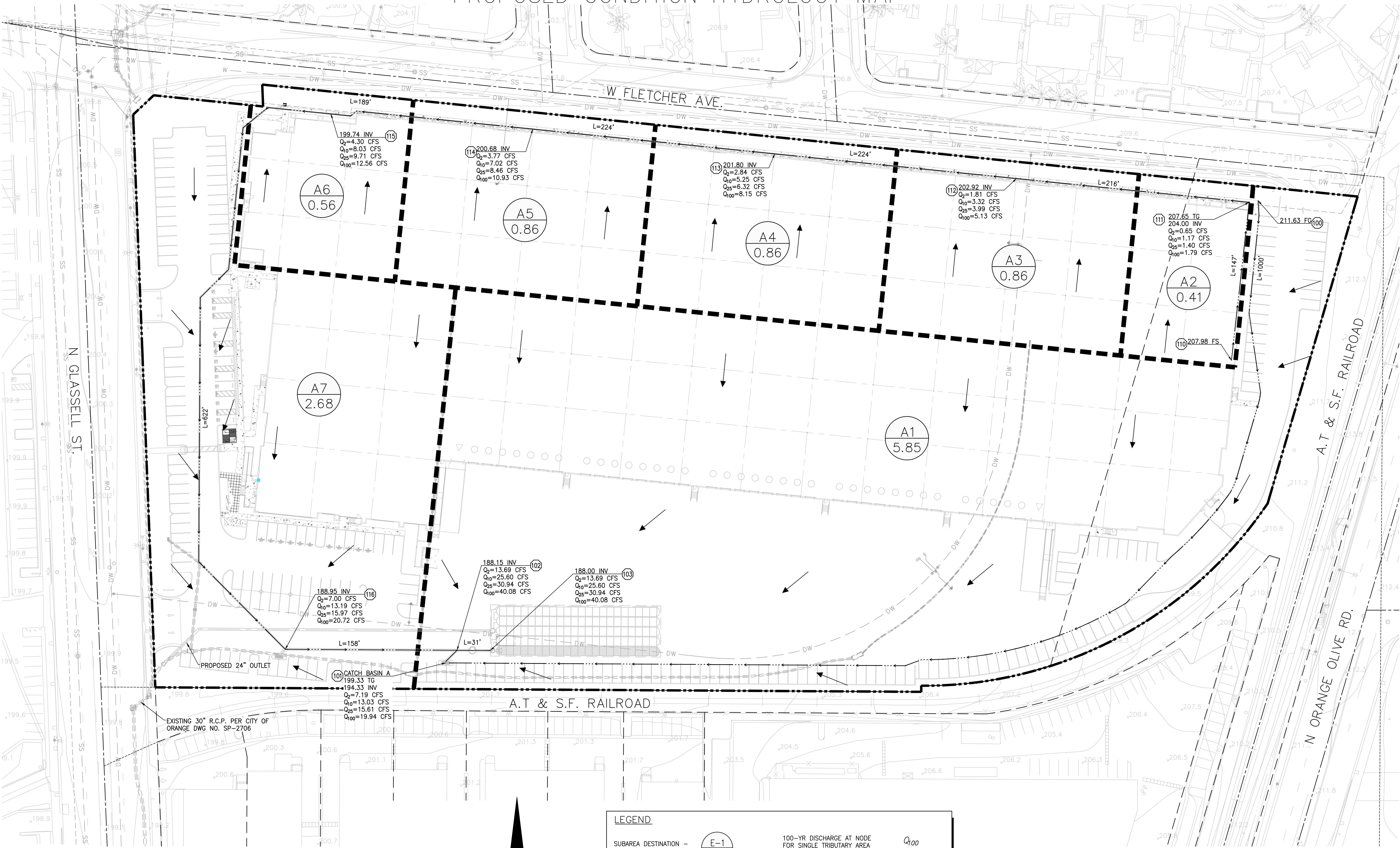
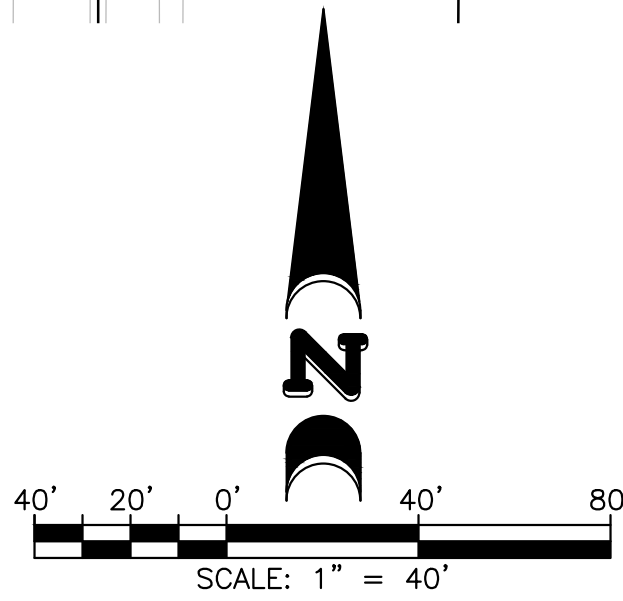
SCALE: HORIZ.: NONE VERT.: NONE	SHEET No. 1 OF 1
DRAWN BY:	PROJECT NUMBER SP-XXXX
CHECKED BY:	

ADAM J. LUNZER, P.E. (R.C.E. NO. 77396)

DATE

SEAL

2411 GLASSELL STREET
PROPOSED CONDITION HYDROLOGY MAP



LEGEND

SUBAREA DESTINATION - SUBAREA ACREAGE -	E-1 XX.XX	100-YR DISCHARGE AT NODE FOR SINGLE TRIBUTARY AREA	Q ₁₀₀
HYDRAULIC NODE DESIGNATION	300	HYDROLOGIC SUBAREA BOUNDARY	---
HYDROLOGIC FLOW PATH	→	PROPERTY LINE	---

PREPARED BY:
HUITT ZOLLARS
2603 Main Street, Suite 400, Irvine, California 92614
Phone: 949.988.5815 | www.huittzollars.com



PROPOSED DRAINAGE MAP			
SCALE: HORIZ.: NONE VERT.: NONE	SHEET No. 1 OF 1	PROJECT NUMBER	SP-XXXX
DRAWN BY:	CHECKED BY:		

ADAM J. LUNZER, P.E. (R.C.E. NO. 77396)

DATE

SEAL

RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
(Reference: 1986 ORANGE COUNTY HYDROLOGY CRITERION)
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Ver. 21.0 Release Date: 06/01/2014 License ID 1202

Analysis prepared by:

HUITT-ZOLLARS, INC
3990 CONCOURS
SUITE 330
909-941-7799

***** DESCRIPTION OF STUDY *****
* GLASSELL STREET - CITY OF ORANGE *
* RATIONAL METHOD - EXISTING CONDITION *
* 2 YEAR AMC I - 2024-09-18 CBORUNDA *

FILE NAME: 4787Q2E.DAT
TIME/DATE OF STUDY: 14:10 09/18/2024

=====

USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:

=====

--*TIME-OF-CONCENTRATION MODEL*--

USER SPECIFIED STORM EVENT(YEAR) = 2.00
SPECIFIED MINIMUM PIPE SIZE(INCH) = 18.00
SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.90
DATA BANK RAINFALL USED
ANTECEDENT MOISTURE CONDITION (AMC) I ASSUMED FOR RATIONAL METHOD

USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL

NO.	HALF- WIDTH (FT)	CROWN TO CROSSFALL (FT)	STREET-CROSSFALL: IN- / OUT- / PARK- SIDE / SIDE / WAY	CURB HEIGHT (FT)	GUTTER-GEOMETRIES: WIDTH (FT)	LIP (FT)	HIKE (FT)	MANNING FACTOR (n)
1	30.0	20.0	0.018/0.018/0.020	0.67	2.00	0.0312	0.167	0.0150

GLOBAL STREET FLOW-DEPTH CONSTRAINTS:

1. Relative Flow-Depth = 0.00 FEET
as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
2. (Depth)*(Velocity) Constraint = 6.0 (FT*FT/S)
*SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*
*USER-SPECIFIED MINIMUM TOPOGRAPHIC SLOPE ADJUSTMENT NOT SELECTED

FLOW PROCESS FROM NODE 100.00 TO NODE 101.00 IS CODE = 21

>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
>>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<

=====

INITIAL SUBAREA FLOW-LENGTH(FEET) = 754.00
ELEVATION DATA: UPSTREAM(FEET) = 212.40 DOWNSTREAM(FEET) = 203.00

$T_c = K * [(LENGTH ** 3.00) / (ELEVATION CHANGE)] ** 0.20$

SUBAREA ANALYSIS USED MINIMUM T_c (MIN.) = 10.344

* 2 YEAR RAINFALL INTENSITY(INCH/HR) = 1.491

SUBAREA T_c AND LOSS RATE DATA(AMC I):

DEVELOPMENT TYPE/ LAND USE	SCS SOIL GROUP	AREA (ACRES)	Fp (INCH/HR)	Ap (DECIMAL)	SCS CN	T_c (MIN.)
-------------------------------	-------------------	-----------------	-----------------	-----------------	-----------	-----------------

```

COMMERCIAL          B          4.65          0.30          0.100          36          10.34
SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) = 0.30
SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap = 0.100
SUBAREA RUNOFF(CFS) = 6.12
TOTAL AREA(ACRES) = 4.65 PEAK FLOW RATE(CFS) = 6.12

*****
FLOW PROCESS FROM NODE 101.00 TO NODE 102.00 IS CODE = 31
-----
>>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
>>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
=====
ELEVATION DATA: UPSTREAM(FEET) = 197.80 DOWNSTREAM(FEET) = 195.50
FLOW LENGTH(FEET) = 413.00 MANNING'S N = 0.013
DEPTH OF FLOW IN 18.0 INCH PIPE IS 12.4 INCHES
PIPE-FLOW VELOCITY(FEET/SEC.) = 4.70
ESTIMATED PIPE DIAMETER(INCH) = 18.00 NUMBER OF PIPES = 1
PIPE-FLOW(CFS) = 6.12
PIPE TRAVEL TIME(MIN.) = 1.46 Tc(MIN.) = 11.81
LONGEST FLOWPATH FROM NODE 100.00 TO NODE 102.00 = 1167.00 FEET.

*****
FLOW PROCESS FROM NODE 102.00 TO NODE 102.00 IS CODE = 81
-----
>>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
=====
MAINLINE Tc(MIN.) = 11.81
* 2 YEAR RAINFALL INTENSITY(INCH/HR) = 1.382
SUBAREA LOSS RATE DATA(AMC I ):
DEVELOPMENT TYPE/ SCS SOIL AREA Fp Ap SCS
LAND USE GROUP (ACRES) (INCH/HR) (DECIMAL) CN
COMMERCIAL B 2.54 0.30 0.100 36
SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) = 0.30
SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap = 0.100
SUBAREA AREA(ACRES) = 2.54 SUBAREA RUNOFF(CFS) = 3.09
EFFECTIVE AREA(ACRES) = 7.19 AREA-AVERAGED Fm(INCH/HR) = 0.03
AREA-AVERAGED Fp(INCH/HR) = 0.30 AREA-AVERAGED Ap = 0.10
TOTAL AREA(ACRES) = 7.2 PEAK FLOW RATE(CFS) = 8.75

*****
FLOW PROCESS FROM NODE 102.00 TO NODE 103.00 IS CODE = 31
-----
>>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
>>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
=====
ELEVATION DATA: UPSTREAM(FEET) = 195.50 DOWNSTREAM(FEET) = 194.20
FLOW LENGTH(FEET) = 204.00 MANNING'S N = 0.013
DEPTH OF FLOW IN 21.0 INCH PIPE IS 13.3 INCHES
PIPE-FLOW VELOCITY(FEET/SEC.) = 5.44
ESTIMATED PIPE DIAMETER(INCH) = 21.00 NUMBER OF PIPES = 1
PIPE-FLOW(CFS) = 8.75
PIPE TRAVEL TIME(MIN.) = 0.62 Tc(MIN.) = 12.43
LONGEST FLOWPATH FROM NODE 100.00 TO NODE 103.00 = 1371.00 FEET.

*****
FLOW PROCESS FROM NODE 103.00 TO NODE 103.00 IS CODE = 81
-----
>>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
=====
MAINLINE Tc(MIN.) = 12.43
* 2 YEAR RAINFALL INTENSITY(INCH/HR) = 1.342
SUBAREA LOSS RATE DATA(AMC I ):
DEVELOPMENT TYPE/ SCS SOIL AREA Fp Ap SCS

```

LAND USE	GROUP	(ACRES)	(INCH/HR)	(DECIMAL)	CN
COMMERCIAL	B	4.39	0.30	0.100	36
SUBAREA AVERAGE PERVIOUS LOSS RATE, F_p (INCH/HR) = 0.30					
SUBAREA AVERAGE PERVIOUS AREA FRACTION, A_p = 0.100					
SUBAREA AREA (ACRES) =		4.39	SUBAREA RUNOFF (CFS) =		5.18
EFFECTIVE AREA (ACRES) =		11.58	AREA-AVERAGED F_m (INCH/HR) =		0.03
AREA-AVERAGED F_p (INCH/HR) =		0.30	AREA-AVERAGED A_p =		0.10
TOTAL AREA (ACRES) =		11.6	PEAK FLOW RATE (CFS) =		13.67

FLOW PROCESS FROM NODE 103.00 TO NODE 103.00 IS CODE = 81

>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<

=====

MAINLINE T_c (MIN.) = 12.43

* 2 YEAR RAINFALL INTENSITY (INCH/HR) = 1.342

SUBAREA LOSS RATE DATA (AMC I):

DEVELOPMENT TYPE/ LAND USE	SCS SOIL GROUP	AREA (ACRES)	F_p (INCH/HR)	A_p (DECIMAL)	SCS CN
COMMERCIAL	B	0.52	0.30	0.100	36
SUBAREA AVERAGE PERVIOUS LOSS RATE, F_p (INCH/HR) = 0.30					
SUBAREA AVERAGE PERVIOUS AREA FRACTION, A_p = 0.100					
SUBAREA AREA (ACRES) =		0.52	SUBAREA RUNOFF (CFS) =		0.61
EFFECTIVE AREA (ACRES) =		12.10	AREA-AVERAGED F_m (INCH/HR) =		0.03
AREA-AVERAGED F_p (INCH/HR) =		0.30	AREA-AVERAGED A_p =		0.10
TOTAL AREA (ACRES) =		12.1	PEAK FLOW RATE (CFS) =		14.29

=====

END OF STUDY SUMMARY:

TOTAL AREA (ACRES)	=	12.1	T_c (MIN.)	=	12.43
EFFECTIVE AREA (ACRES)	=	12.10	AREA-AVERAGED F_m (INCH/HR)	=	0.03
AREA-AVERAGED F_p (INCH/HR)	=	0.30	AREA-AVERAGED A_p	=	0.100
PEAK FLOW RATE (CFS)	=	14.29			

=====

END OF RATIONAL METHOD ANALYSIS

RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
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Ver. 21.0 Release Date: 06/01/2014 License ID 1202

Analysis prepared by:

HUITT-ZOLLARS, INC
3990 CONCOURS
SUITE 330
909-941-7799

***** DESCRIPTION OF STUDY *****

* GLASSELL STREET - CITY OF ORANGE *
* RATIONAL METHOD - PROPOSED CONDITION *
* 2 YEAR AMC I - 2025-03-21 BPOP *

FILE NAME: 4787Q2P.DAT
TIME/DATE OF STUDY: 10:51 03/21/2025

=====

USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:

=====

--*TIME-OF-CONCENTRATION MODEL*--

USER SPECIFIED STORM EVENT(YEAR) = 2.00
SPECIFIED MINIMUM PIPE SIZE(INCH) = 18.00
SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.90
DATA BANK RAINFALL USED
ANTECEDENT MOISTURE CONDITION (AMC) I ASSUMED FOR RATIONAL METHOD

USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL

NO.	HALF- WIDTH (FT)	CROWN TO CROSSFALL (FT)	STREET-CROSSFALL: IN- / OUT- / PARK- SIDE / SIDE / WAY	CURB HEIGHT (FT)	GUTTER-GEOMETRIES: WIDTH (FT)	LIP (FT)	HIKE (FT)	MANNING FACTOR (n)
1	30.0	20.0	0.018/0.018/0.020	0.67	2.00	0.0313	0.167	0.0150

GLOBAL STREET FLOW-DEPTH CONSTRAINTS:

1. Relative Flow-Depth = 0.00 FEET
as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
2. (Depth)*(Velocity) Constraint = 6.0 (FT*FT/S)

*SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*

*USER-SPECIFIED MINIMUM TOPOGRAPHIC SLOPE ADJUSTMENT NOT SELECTED

FLOW PROCESS FROM NODE 100.00 TO NODE 101.00 IS CODE = 21

>>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<

>>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<

=====

INITIAL SUBAREA FLOW-LENGTH(FEET) = 1000.00

ELEVATION DATA: UPSTREAM(FEET) = 211.63 DOWNSTREAM(FEET) = 199.33

$T_c = K * [(LENGTH ** 3.00) / (ELEVATION CHANGE)] ** 0.20$

SUBAREA ANALYSIS USED MINIMUM T_c (MIN.) = 11.612

* 2 YEAR RAINFALL INTENSITY(INCH/HR) = 1.396

SUBAREA T_c AND LOSS RATE DATA(AMC I):

DEVELOPMENT TYPE/ LAND USE	SCS SOIL GROUP	AREA (ACRES)	Fp (INCH/HR)	Ap (DECIMAL)	SCS CN	T_c (MIN.)
COMMERCIAL	B	5.85	0.30	0.100	36	11.61

SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) = 0.30

SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap = 0.100

SUBAREA RUNOFF(CFS) = 7.19

TOTAL AREA(ACRES) = 5.85 PEAK FLOW RATE(CFS) = 7.19

FLOW PROCESS FROM NODE 101.00 TO NODE 102.00 IS CODE = 31

>>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<

>>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<

=====

ELEVATION DATA: UPSTREAM(FEET) = 194.33 DOWNSTREAM(FEET) = 188.15

FLOW LENGTH(FEET) = 15.00 MANNING'S N = 0.013

ESTIMATED PIPE DIAMETER(INCH) INCREASED TO 18.000

DEPTH OF FLOW IN 18.0 INCH PIPE IS 4.1 INCHES

PIPE-FLOW VELOCITY(FEET/SEC.) = 23.95

ESTIMATED PIPE DIAMETER(INCH) = 18.00 NUMBER OF PIPES = 1

PIPE-FLOW(CFS) = 7.19

PIPE TRAVEL TIME(MIN.) = 0.01 T_c (MIN.) = 11.62

LONGEST FLOWPATH FROM NODE 100.00 TO NODE 102.00 = 1015.00 FEET.

FLOW PROCESS FROM NODE 102.00 TO NODE 102.00 IS CODE = 1

>>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<

=====

TOTAL NUMBER OF STREAMS = 2

CONFLUENCE VALUES USED FOR INDEPENDENT STREAM 1 ARE:

TIME OF CONCENTRATION(MIN.) = 11.62

RAINFALL INTENSITY(INCH/HR) = 1.39

AREA-AVERAGED Fm(INCH/HR) = 0.03

AREA-AVERAGED Fp(INCH/HR) = 0.30

AREA-AVERAGED Ap = 0.10

EFFECTIVE STREAM AREA(ACRES) = 5.85

TOTAL STREAM AREA(ACRES) = 5.85

PEAK FLOW RATE(CFS) AT CONFLUENCE = 7.19

FLOW PROCESS FROM NODE 110.00 TO NODE 111.00 IS CODE = 21

>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
>>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
=====

INITIAL SUBAREA FLOW-LENGTH(FEET) = 147.00
ELEVATION DATA: UPSTREAM(FEET) = 207.98 DOWNSTREAM(FEET) = 207.65

$T_c = K * [(LENGTH ** 3.00) / (ELEVATION CHANGE)] ** 0.20$

SUBAREA ANALYSIS USED MINIMUM T_c (MIN.) = 7.578

* 2 YEAR RAINFALL INTENSITY(INCH/HR) = 1.783

SUBAREA T_c AND LOSS RATE DATA(AMC I):

DEVELOPMENT TYPE/ LAND USE	SCS SOIL GROUP	AREA (ACRES)	Fp (INCH/HR)	Ap (DECIMAL)	SCS CN	T_c (MIN.)
COMMERCIAL	B	0.41	0.30	0.100	36	7.58

SUBAREA AVERAGE PERVIOUS LOSS RATE, F_p (INCH/HR) = 0.30

SUBAREA AVERAGE PERVIOUS AREA FRACTION, A_p = 0.100

SUBAREA RUNOFF(CFS) = 0.65

TOTAL AREA(ACRES) = 0.41 PEAK FLOW RATE(CFS) = 0.65

FLOW PROCESS FROM NODE 111.00 TO NODE 112.00 IS CODE = 31

>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
=====

ELEVATION DATA: UPSTREAM(FEET) = 204.00 DOWNSTREAM(FEET) = 202.92

FLOW LENGTH(FEET) = 216.00 MANNING'S N = 0.013

ESTIMATED PIPE DIAMETER(INCH) INCREASED TO 18.000

DEPTH OF FLOW IN 18.0 INCH PIPE IS 3.7 INCHES

PIPE-FLOW VELOCITY(FEET/SEC.) = 2.50

ESTIMATED PIPE DIAMETER(INCH) = 18.00 NUMBER OF PIPES = 1

PIPE-FLOW(CFS) = 0.65

PIPE TRAVEL TIME(MIN.) = 1.44 T_c (MIN.) = 9.02

LONGEST FLOWPATH FROM NODE 110.00 TO NODE 112.00 = 363.00 FEET.

FLOW PROCESS FROM NODE 112.00 TO NODE 112.00 IS CODE = 81

>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
=====

MAINLINE T_c (MIN.) = 9.02

* 2 YEAR RAINFALL INTENSITY(INCH/HR) = 1.613

SUBAREA LOSS RATE DATA(AMC I):

DEVELOPMENT TYPE/ LAND USE	SCS SOIL GROUP	AREA (ACRES)	Fp (INCH/HR)	Ap (DECIMAL)	SCS CN
COMMERCIAL	B	0.86	0.30	0.100	36

SUBAREA AVERAGE PERVIOUS LOSS RATE, F_p (INCH/HR) = 0.30

SUBAREA AVERAGE PERVIOUS AREA FRACTION, $A_p = 0.100$
SUBAREA AREA(ACRES) = 0.86 SUBAREA RUNOFF(CFS) = 1.23
EFFECTIVE AREA(ACRES) = 1.27 AREA-AVERAGED F_m (INCH/HR) = 0.03
AREA-AVERAGED F_p (INCH/HR) = 0.30 AREA-AVERAGED $A_p = 0.10$
TOTAL AREA(ACRES) = 1.3 PEAK FLOW RATE(CFS) = 1.81

FLOW PROCESS FROM NODE 112.00 TO NODE 113.00 IS CODE = 31

>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<

=====

ELEVATION DATA: UPSTREAM(Feet) = 202.92 DOWNSTREAM(Feet) = 201.80
FLOW LENGTH(Feet) = 224.00 MANNING'S N = 0.013
ESTIMATED PIPE DIAMETER(INCH) INCREASED TO 18.000
DEPTH OF FLOW IN 18.0 INCH PIPE IS 6.2 INCHES
PIPE-FLOW VELOCITY(Feet/Sec.) = 3.35
ESTIMATED PIPE DIAMETER(INCH) = 18.00 NUMBER OF PIPES = 1
PIPE-FLOW(CFS) = 1.81
PIPE TRAVEL TIME(Min.) = 1.12 T_c (Min.) = 10.14
LONGEST FLOWPATH FROM NODE 110.00 TO NODE 113.00 = 587.00 FEET.

FLOW PROCESS FROM NODE 113.00 TO NODE 113.00 IS CODE = 81

>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<

=====

MAINLINE T_c (Min.) = 10.14
* 2 YEAR RAINFALL INTENSITY(INCH/HR) = 1.509
SUBAREA LOSS RATE DATA(AMC I):

DEVELOPMENT TYPE/ LAND USE	SCS SOIL GROUP	AREA (ACRES)	F_p (INCH/HR)	A_p (DECIMAL)	SCS CN
COMMERCIAL	B	0.86	0.30	0.100	36

SUBAREA AVERAGE PERVIOUS LOSS RATE, F_p (INCH/HR) = 0.30
SUBAREA AVERAGE PERVIOUS AREA FRACTION, $A_p = 0.100$
SUBAREA AREA(ACRES) = 0.86 SUBAREA RUNOFF(CFS) = 1.14
EFFECTIVE AREA(ACRES) = 2.13 AREA-AVERAGED F_m (INCH/HR) = 0.03
AREA-AVERAGED F_p (INCH/HR) = 0.30 AREA-AVERAGED $A_p = 0.10$
TOTAL AREA(ACRES) = 2.1 PEAK FLOW RATE(CFS) = 2.84

FLOW PROCESS FROM NODE 113.00 TO NODE 114.00 IS CODE = 31

>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<

=====

ELEVATION DATA: UPSTREAM(Feet) = 201.80 DOWNSTREAM(Feet) = 200.68
FLOW LENGTH(Feet) = 224.00 MANNING'S N = 0.013
ESTIMATED PIPE DIAMETER(INCH) INCREASED TO 18.000
DEPTH OF FLOW IN 18.0 INCH PIPE IS 7.9 INCHES

PIPE-FLOW VELOCITY(FEET/SEC.) = 3.77
ESTIMATED PIPE DIAMETER(INCH) = 18.00 NUMBER OF PIPES = 1
PIPE-FLOW(CFS) = 2.84
PIPE TRAVEL TIME(MIN.) = 0.99 Tc(MIN.) = 11.13
LONGEST FLOWPATH FROM NODE 110.00 TO NODE 114.00 = 811.00 FEET.

FLOW PROCESS FROM NODE 114.00 TO NODE 114.00 IS CODE = 81

>>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<

=====

MAINLINE Tc(MIN.) = 11.13
* 2 YEAR RAINFALL INTENSITY(INCH/HR) = 1.430
SUBAREA LOSS RATE DATA(AMC I):

DEVELOPMENT TYPE/ LAND USE	SCS SOIL GROUP	AREA (ACRES)	Fp (INCH/HR)	Ap (DECIMAL)	SCS CN
COMMERCIAL	B	0.86	0.30	0.100	36

SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) = 0.30
SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap = 0.100
SUBAREA AREA(ACRES) = 0.86 SUBAREA RUNOFF(CFS) = 1.08
EFFECTIVE AREA(ACRES) = 2.99 AREA-AVERAGED Fm(INCH/HR) = 0.03
AREA-AVERAGED Fp(INCH/HR) = 0.30 AREA-AVERAGED Ap = 0.10
TOTAL AREA(ACRES) = 3.0 PEAK FLOW RATE(CFS) = 3.77

FLOW PROCESS FROM NODE 114.00 TO NODE 115.00 IS CODE = 31

>>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<

>>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<

=====

ELEVATION DATA: UPSTREAM(FEET) = 200.68 DOWNSTREAM(FEET) = 199.74
FLOW LENGTH(FEET) = 189.00 MANNING'S N = 0.013
ESTIMATED PIPE DIAMETER(INCH) INCREASED TO 18.000
DEPTH OF FLOW IN 18.0 INCH PIPE IS 9.4 INCHES
PIPE-FLOW VELOCITY(FEET/SEC.) = 4.05
ESTIMATED PIPE DIAMETER(INCH) = 18.00 NUMBER OF PIPES = 1
PIPE-FLOW(CFS) = 3.77
PIPE TRAVEL TIME(MIN.) = 0.78 Tc(MIN.) = 11.90
LONGEST FLOWPATH FROM NODE 110.00 TO NODE 115.00 = 1000.00 FEET.

FLOW PROCESS FROM NODE 115.00 TO NODE 115.00 IS CODE = 81

>>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<

=====

MAINLINE Tc(MIN.) = 11.90
* 2 YEAR RAINFALL INTENSITY(INCH/HR) = 1.376
SUBAREA LOSS RATE DATA(AMC I):

DEVELOPMENT TYPE/ LAND USE	SCS SOIL GROUP	AREA (ACRES)	Fp (INCH/HR)	Ap (DECIMAL)	SCS CN
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COMMERCIAL B 0.56 0.30 0.100 36
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) = 0.30
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap = 0.100
 SUBAREA AREA(ACRES) = 0.56 SUBAREA RUNOFF(CFS) = 0.68
 EFFECTIVE AREA(ACRES) = 3.55 AREA-AVERAGED Fm(INCH/HR) = 0.03
 AREA-AVERAGED Fp(INCH/HR) = 0.30 AREA-AVERAGED Ap = 0.10
 TOTAL AREA(ACRES) = 3.6 PEAK FLOW RATE(CFS) = 4.30

FLOW PROCESS FROM NODE 115.00 TO NODE 116.00 IS CODE = 31

>>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<

ELEVATION DATA: UPSTREAM(FEET) = 199.74 DOWNSTREAM(FEET) = 189.95
 FLOW LENGTH(FEET) = 622.00 MANNING'S N = 0.013
 ESTIMATED PIPE DIAMETER(INCH) INCREASED TO 18.000
 DEPTH OF FLOW IN 18.0 INCH PIPE IS 7.3 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) = 6.42
 ESTIMATED PIPE DIAMETER(INCH) = 18.00 NUMBER OF PIPES = 1
 PIPE-FLOW(CFS) = 4.30
 PIPE TRAVEL TIME(MIN.) = 1.62 Tc(MIN.) = 13.52
 LONGEST FLOWPATH FROM NODE 110.00 TO NODE 116.00 = 1622.00 FEET.

FLOW PROCESS FROM NODE 116.00 TO NODE 116.00 IS CODE = 81

>>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<

MAINLINE Tc(MIN.) = 13.52
 * 2 YEAR RAINFALL INTENSITY(INCH/HR) = 1.279
 SUBAREA LOSS RATE DATA(AMC I):

DEVELOPMENT TYPE/ LAND USE	SCS SOIL GROUP	AREA (ACRES)	Fp (INCH/HR)	Ap (DECIMAL)	SCS CN
COMMERCIAL	B	2.68	0.30	0.100	36

 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) = 0.30
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap = 0.100
 SUBAREA AREA(ACRES) = 2.68 SUBAREA RUNOFF(CFS) = 3.01
 EFFECTIVE AREA(ACRES) = 6.23 AREA-AVERAGED Fm(INCH/HR) = 0.03
 AREA-AVERAGED Fp(INCH/HR) = 0.30 AREA-AVERAGED Ap = 0.10
 TOTAL AREA(ACRES) = 6.2 PEAK FLOW RATE(CFS) = 7.00

FLOW PROCESS FROM NODE 116.00 TO NODE 102.00 IS CODE = 31

>>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<

ELEVATION DATA: UPSTREAM(FEET) = 189.95 DOWNSTREAM(FEET) = 188.15
 FLOW LENGTH(FEET) = 158.00 MANNING'S N = 0.013

DEPTH OF FLOW IN 18.0 INCH PIPE IS 10.7 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) = 6.43
 ESTIMATED PIPE DIAMETER(INCH) = 18.00 NUMBER OF PIPES = 1
 PIPE-FLOW(CFS) = 7.00
 PIPE TRAVEL TIME(MIN.) = 0.41 Tc(MIN.) = 13.93
 LONGEST FLOWPATH FROM NODE 110.00 TO NODE 102.00 = 1780.00 FEET.

FLOW PROCESS FROM NODE 102.00 TO NODE 102.00 IS CODE = 1

>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
 >>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<

=====

TOTAL NUMBER OF STREAMS = 2
 CONFLUENCE VALUES USED FOR INDEPENDENT STREAM 2 ARE:
 TIME OF CONCENTRATION(MIN.) = 13.93
 RAINFALL INTENSITY(INCH/HR) = 1.26
 AREA-AVERAGED Fm(INCH/HR) = 0.03
 AREA-AVERAGED Fp(INCH/HR) = 0.30
 AREA-AVERAGED Ap = 0.10
 EFFECTIVE STREAM AREA(ACRES) = 6.23
 TOTAL STREAM AREA(ACRES) = 6.23
 PEAK FLOW RATE(CFS) AT CONFLUENCE = 7.00

** CONFLUENCE DATA **

STREAM NUMBER	Q (CFS)	Tc (MIN.)	Intensity (INCH/HR)	Fp(Fm) (INCH/HR)	Ap	Ae (ACRES)	HEADWATER NODE
1	7.19	11.62	1.395	0.30(0.03)	0.10	5.8	100.00
2	7.00	13.93	1.257	0.30(0.03)	0.10	6.2	110.00

RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
 CONFLUENCE FORMULA USED FOR 2 STREAMS.

** PEAK FLOW RATE TABLE **

STREAM NUMBER	Q (CFS)	Tc (MIN.)	Intensity (INCH/HR)	Fp(Fm) (INCH/HR)	Ap	Ae (ACRES)	HEADWATER NODE
1	13.69	11.62	1.395	0.30(0.03)	0.10	11.0	100.00
2	13.47	13.93	1.257	0.30(0.03)	0.10	12.1	110.00

COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:

PEAK FLOW RATE(CFS) = 13.69 Tc(MIN.) = 11.62
 EFFECTIVE AREA(ACRES) = 11.05 AREA-AVERAGED Fm(INCH/HR) = 0.03
 AREA-AVERAGED Fp(INCH/HR) = 0.30 AREA-AVERAGED Ap = 0.10
 TOTAL AREA(ACRES) = 12.1
 LONGEST FLOWPATH FROM NODE 110.00 TO NODE 102.00 = 1780.00 FEET.

FLOW PROCESS FROM NODE 102.00 TO NODE 103.00 IS CODE = 31

>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<

>>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<

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=====
ELEVATION DATA: UPSTREAM(FEET) = 188.15 DOWNSTREAM(FEET) = 188.00
FLOW LENGTH(FEET) = 31.00 MANNING'S N = 0.013
DEPTH OF FLOW IN 24.0 INCH PIPE IS 18.1 INCHES
PIPE-FLOW VELOCITY(FEET/SEC.) = 5.39
ESTIMATED PIPE DIAMETER(INCH) = 24.00 NUMBER OF PIPES = 1
PIPE-FLOW(CFS) = 13.69
PIPE TRAVEL TIME(MIN.) = 0.10 Tc(MIN.) = 11.72
LONGEST FLOWPATH FROM NODE 110.00 TO NODE 103.00 = 1811.00 FEET.
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END OF STUDY SUMMARY:

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TOTAL AREA(ACRES) = 12.1 TC(MIN.) = 11.72
EFFECTIVE AREA(ACRES) = 11.05 AREA-AVERAGED Fm(INCH/HR)= 0.03
AREA-AVERAGED Fp(INCH/HR) = 0.30 AREA-AVERAGED Ap = 0.100
PEAK FLOW RATE(CFS) = 13.69
```

** PEAK FLOW RATE TABLE **

STREAM NUMBER	Q (CFS)	Tc (MIN.)	Intensity (INCH/HR)	Fp(Fm) (INCH/HR)	Ap	Ae (ACRES)	HEADWATER NODE
1	13.69	11.72	1.388	0.30(0.03)	0.10	11.0	100.00
2	13.47	14.02	1.252	0.30(0.03)	0.10	12.1	110.00

END OF RATIONAL METHOD ANALYSIS