# TECHNICAL MEMORANDUM:

# SWMM Modeling for Hydromodification Compliance of:

# HSC Lakeside LLC – Tractor Supply

Prepared for:

Woodcrest Homes, Inc.

October 23, 2014


Prepared by:

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MUP14-015

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RELIABLE SOLUTIONS IN WATER RESOURCES

# TECHNICAL MEMORANDUM

TO: Steve Powell
Woodcrest Homes, Inc.

FROM: Tory Walker, PE, CFM, LEED GA
Luis Parra, PhD, PE, CPSWQ, ToR, D.WRE.

DATE: October 23, 2014

RE: Summary of SWMM Modeling for Hydromodification Compliance for the HSC Lakeside, LLC – Tractor Supply Company Project, Lakeside, CA.

## INTRODUCTION

This memorandum summarizes the approach used to model the proposed industrial development project site in the County of San Diego using the Environmental Protection Agency (EPA) Storm Water Management Model 5.0 (SWMM). SWMM models were prepared for the pre and post-developed conditions at the site in order to determine if the proposed LID bioretention facilities have sufficient volume to meet Order R9-2007-001 requirements of the California Regional Water Quality Control Board San Diego Region (SDRWQCB), as explained in the Final Hydromodification Management Plan (HMP), dated March 2011, prepared for the County of San Diego by Brown and Caldwell.

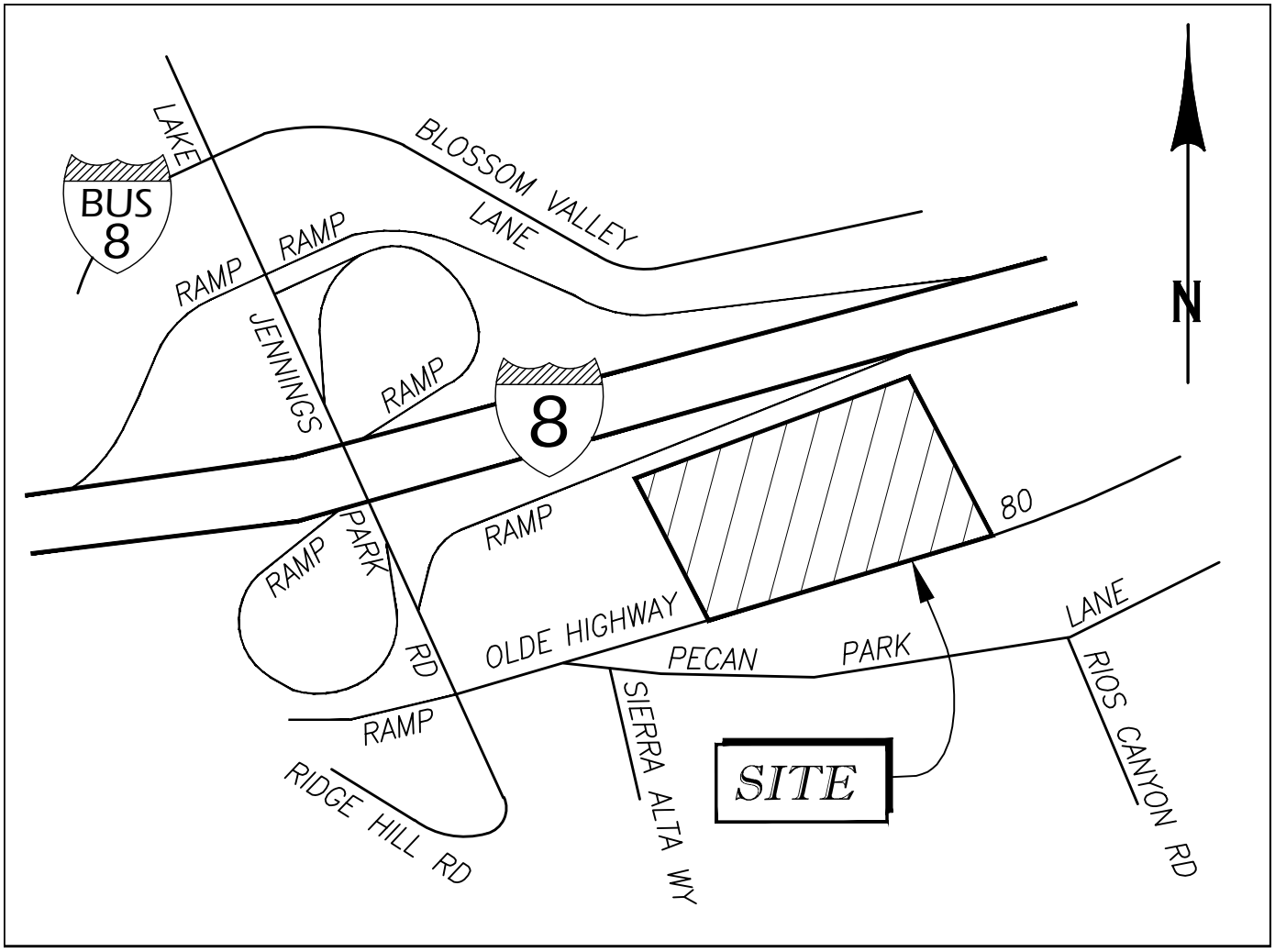
## SWMM MODEL DEVELOPMENT

The HSC Lakeside project proposes an industrial development on the currently vacant property, with structures and a servicing parking lot (see Vicinity Map). Two (2) SWMM models were prepared for this study: the first for the pre-development and the second for the post-developed conditions. The project site drains to two (2) Points of Compliance (POC) located to the south and south west of the project site.

The SWMM model was used since we have found it to be more comparable to San Diego area watersheds than the alternative San Diego Hydrology Model (SDHM) and also because it is a non-proprietary model approved by the HMP document. For both SWMM models, flow duration curves were prepared to determine if the proposed HMP facilities are sufficient to meet the current HMP requirements.

The inputs required to develop SWMM models include rainfall, watershed characteristics, and BMP configurations. The Flinn Gage from the Project Clean Water website was used for this study, since it is the most representative of the project site precipitation due to elevation and proximity to the project site.

Evaporation for the site was modeled using average monthly values from the County hourly dataset. The site was modeled with Type C hydrologic soil as this is the existing soil determined from the NRCS Soil Survey. Soils have been assumed to be uncompacted in the existing condition to represent the current natural condition of the site (with the exception of the existing developed portions of the neighboring sites that drain to the POCs), while fully compacted in the post developed conditions. Other




# VICINITY MAP

THOMAS BROS. MAP 1232–G5
NO SCALE

SWMM inputs for the subareas are discussed in the appendices to this document, where the selection of the parameters is explained in detail.

## HMP MODELING

### PRE DEVELOPED CONDITIONS

In current existing conditions, runoff from the project site (and adjacent neighboring properties including Hwy 80) discharges to two (2) points of compliance located to the south and south-west of the project site. The project site is undeveloped and lightly vegetated with steep natural drainage flowpaths conveying flow in a southerly direction to the aforementioned POC's. Runoff tributary to POC-1 is intercepted by an existing culvert and conveyed beneath Hwy 80, discharging to an existing drainage ditch. Flow the western portion of the project site does not drain to the culvert and is conveyed in a westerly direction along Hwy 80, confluencing with flow from the neighboring lot to the west to POC-2.

The adjacent lots are developed and are highly impervious, however as they are not part of the project site they will remain a constant in both hydrologic scenarios. Table 1 below illustrates the pre-developed areas and impervious percentages accordingly.

### TABLE 1 – SUMMARY OF PRE-DEVELOPED CONDITIONS

| DMA | Tributary Area, A (Ac) | Impervious Percentage, Ip |
|---|---|---|
| DMA-1-1 (POC1) | 2.530 | 0% |
| DMA-1-2 (POC1) | 1.221 | 0% |
| DMA-1-3 (POC1) | 0.410 | 100% |
| DMA-X2 (POC1) | 0.684 | 14.2% |
| DMA-OFF (POC2) | 1.720 | 90.0% |
| DMA-2 (POC2) | 1.438 | 5.5% |

### DEVELOPED CONDITIONS

Storm water runoff from the proposed project site is routed to two (2) POCs located to the south of the project site located at the adjacent Old Highway 80.

#### POC-1

Runoff from the developed project site is drained to four (4) onsite receiving bioretention LID BMPs. Once flows are routed via the proposed LID BMPs, all onsite flows are then conveyed via storm drain to a proposed detention basin located to the south of the project site adjacent to Old Hwy 80. Additional runoff from the proposed widening improvement of Old Hwy 80, and a portion of the existing lot to the east of the project site then confluences with developed site flow at this detention facility. These flows are then drained to a receiving storm drain located beneath Old Hwy 80 and discharged to POC-1.

**TABLE 2 – SUMMARY OF DEVELOPED CONDITIONS**

| BMP | Tributary Area, A (Ac) (2) | Impervious Percentage, Ip | WQ 85th Percentile(1) | |
|---|---|---|---|---|
| | | | Volume Required ($ft^3$) | Volume Provided ($ft^3$) (4) |
| LID A&F | 0.951 | 35.3% | 964 | 1,082 |
| LID B | 0.766 | 69.1% | 1,131 | 1,193 |
| LID C | 1.539 | 40.2% | 1,664 | 2,070 |
| LID D | 0.326 | 96.7% | 608 | 1,092 |
| DETENTION BASIN E (3) | 2.498 | 35% | N/A | N/A |

(1): 85th percentile required using a P85=0.77 in, C=0.9 for impervious and C=0.25 for pervious surfaces. 85th percentile required water quality volume corresponds to approximately 75% of the 85th percentile runoff volume generated from the area draining to the BMP per Order No. R9-2013-0001 pg. 86

(2): IMP Areas are subtracted from the overall DMA to ensure areas are not double counted.

(3): Basin E is directly tributary to offsite runoff only, all onsite runoff is treated by LID's A through D prior to draining to Basin E; as such, no WQ calculations are provided for this basin – a Modular Wetland will provide treatment for the offsite runoff prior to discharging to Basin E

(4): Detailed calculations provided in Attachment 4.

Four (4) LID bioretention basins are located within the project site and are responsible for handling hydromodification requirements for the project site. In developed conditions, the basins will have a surface depth and a riser spillway structure (see dimensions in Table 3). Flows will then discharge from the basins via a low flow orifice outlet within the gravel layer. The riser structure will act as a spillway such that peak flows can be safely discharged to the receiving storm drain system.

Beneath the basins' invert lies the proposed LID bioretention portion of the drainage facilities. This portion of the basin is comprised of a 3-inch layer of mulch, an 18-inch layer of amended soil (a highly sandy, organic rich composite with an infiltration capacity of at least 5 inches/hr) and a layer of gravel for additional detention and to accommodate the French drain system. These systems are to be located beneath the bioretention layers to intercept treated storm water and convey these flows to a small diameter lower outlet orifice. Once flows have been routed by the outlet structure, flows are then discharged to the detention basin located adjacent to Old Hwy 80. Offsite flows are conflucened with the onsite flows at the detention basin prior to discharging to POC-1.

The bioretention basins were modeled using the bioretention LID module within SWMM. The bioretention module can model the underground gravel storage layer, underdrain with an orifice plate, amended soil layer, and a surface storage pond up to the elevation of the invert of the spillway. It should be noted that detailed outlet structure location and elevations will be shown on the construction plans based on the recommendations of this study.

It should be noted that bioretention basin A is comprised of both basin A and basin F. These basins are bifurcated by the entrance driveway however are hydraulically connected by both surface and subsurface drains such that from a hydraulic modeling perspective they are a single facility. Both basins maintain the same surface elevations with the outlet for the dual basin configuration located in basin F.

**POC-2**

Runoff from the western portion of the improvement to Old Hwy 80 (an area unable to be intercepted by the aforementioned detention facility) drains to an existing curb and gutter, confluencing with runoff from the existing developed site to the west of the project site. These flows then surface discharge to POC-2 located to the south west of the project site, and downstream of the neighbor developed site. POC-2 is chosen downstream of the adjacent site to prove that before any runoff gets into a potential erodible creek, the negative effect of the additional impervious area of Old Hwy 80 that cannot drain to any BMP due to topographic constrains is smaller than the positive effect on POC-2 caused by the removal of existing areas that currently are part of the contributing area of POC-2. Further discussion is included in the Point of Comparison Discussion session.

**Water Quality**

It is assumed all storm water quality requirements for the project will be met by the bioretention LID BMPs (as the minimum required treatment volumes are met by the proposed BMP design). In order to address runoff from the public road improvement, a Modular Wetland (or approved, equivalent bio-retention based structural BMP) is proposed to intercept runoff prior to draining to the detention basin. However, detailed water quality requirements are not discussed within this technical memo. For further information in regards to storm water quality requirements for the project, please refer to the site specific Storm Water Management Plan (SWMP).

## BMP MODELING FOR HMP PURPOSES

**Modeling of dual purpose Water Quality/HMP BMPs, POC-1**

Four (4) LID BMP bioretention basins are proposed for water quality treatment and hydromodification conformance for the project site. Table 3 illustrates the dimensions required for HMP compliance according to the SWMM model that was undertaken for the project.

**TABLE 3 – SUMMARY OF DEVELOPED DUAL PURPOSE BMPS**

| BMP | Tributary Area (Ac) | DIMENSIONS | | | | | |
|---|---|---|---|---|---|---|---|
| | | BMP Area(1) ($ft^2$) | Gravel Depth(2) (in) | Lower Orif. D (in)(3) | Depth Riser Invert (in)(4) | Weir Perimeter Length(5) (ft) | Total Surface Depth(6) (in) |
| LID A&F | 0.951 | 698 | 6 | 1.50 | 24 | 12 | 30 |
| LID B | 0.766 | 630 | 18 | 1.00 | 9 | 12 | 12 |
| LID C | 1.539 | 1,133 | 6 | 1.75 | 38 | 8 | 42 |
| LID D | 0.326 | 536 | 6 | 1.00 | 12 | 12 | 24 |

Notes:
(1): Area of amended soil equal to area of gravel
(2): Gravel depth needed to comply with hydromodification purposes
(3): Diameter of orifice in gravel layer with invert at bottom of layer; tied with hydromod min threshold ($0.3 \cdot Q_2$).
(4): Depth of ponding beneath riser structure's surface spillway.
(5): Overflow length, the internal perimeter of the riser is 12 ft (3 ft x 3 ft internal dimensions) or 8ft (2 ft x 2 ft internal).
(6): Total surface depth of BMP from top crest elevation to surface invert.

Bioretention basins LID A&F and LID C feature outlet structures that incorporate intermediate orifices and slots to assist in dewatering the basins. Details of the outlet structures for these basins are provided in Table 4. It should be noted that LID's B and D do not feature an intermediate discharge; runoff is either drained via the LID orifice within the gravel layer of the subsurface or directly overtops the riser and discharges to the receiving storm drain.

**TABLE 4 – SUMMARY OF BIORETENTION BASIN RISER DETAILS:**

| BMP | Surface Orifice | | Surface Slot | | | Top Riser | |
|---|---|---|---|---|---|---|---|
| | Orifice Diameter (in) | Elevation(1) (ft) | Width (ft) | Height (ft) | Elevation(1) (ft) | Length(2) (ft) | Elev.(1) (ft) |
| LID A&F | N/A | N/A | 1.5 | 0.167 | 0.75 | 12 | 2.00 |
| LID C | 3 x 3-inch | 1.50 | 2.25 | 0.25 | 2.25 | 8 | 3.17 |

Notes: (1): Basin ground surface elevation assumed to be 0.00 ft elevation.
(2): Overflow length is the internal perimeter of the riser structure.

**Drawdown Calculations**

To ensure compliance with the 96 hour drawdown requirements per Section 6.4.6 of the Final HMP dated March 2011, drawdown calculations are provided in Attachment 4 of this report.

**Modeling of Detention Basin – POC-1**

A single detention basin is proposed for hydromodification conformance for the project site at POC-1. Table 5 illustrates the dimensions required for HMP compliance according to the SWMM model that was undertaken for the project. Table 6 provides further details of the basin riser outlet.

**TABLE 5 – SUMMARY OF DEVELOPED DETENTION BASIN**

| BASIN | Tributary Area (Ac)(2) | DIMENSIONS | | |
|---|---|---|---|---|
| | | Basin Area(1) ($ft^2$) | Depth Riser Invert (in)(3) | Total Surface Depth(4) (in) |
| BASIN E | 2.498 | 760 | 24 | 36 |

Notes: (1): Basin is to be constructed with vertical walls, as such 760 $ft^2$ is the uniform basin area.
(2): Direct tributary area only – the entire onsite area drains to this facility also.
(3): Depth of ponding beneath riser structure's surface spillway
(4): Total surface depth of Basin from top crest elevation to surface invert.

**TABLE 6 – SUMMARY OF DETENTION BASIN RISER DETAILS:**

| Surface Orifice | | Middle Orifice | | Lower Weir | | Top Riser | |
|---|---|---|---|---|---|---|---|
| Orifice D (in) | Elevation(1) (ft) | Orifice Diameter (in) | Elevation(1) (ft) | Length (ft) | Elevation(1) (ft) | Length(2) (ft) | Elev.(1) (ft) |
| 1 X 3-inch | 0.00 | 12 X 2.5-inch | 1.50 | 1.00 | 2.00 | 11.00 | 2.50 |

Notes: (1): Basin ground surface elevation assumed to be 0.00 ft elevation.
(2): Overflow length, the internal perimeter of the riser is 12 ft (3 ft x 3 ft internal dimensions) less the 1ft weir length of the lower weir = 11 ft..

## POINTS OF COMPARISON DISCUSSION

For POC-1, the post-development are is increased from 4.84 acres to 6.16 acres because the 1.32 acres diverted reduce the contributing area to POC-2. POC-2 has no physical possibility to include a hydromodification facility due to topographic constrains (there is not an MS4 system in place and only an underground tank beneath the pavement can be built; such system cannot daylight into the street). In consequence, the only option to attenuate the hydromodification effect that the expansion of Old Hwy 80 will have on POC-2 is by compensating the small impervious area increase into POC-2 by a large reduction of pervious areas draining to POC-2. That's the reason POC-2 has reduced by 1.32 acres. The flow duration curve of POC-2 will display a large reduction of extreme peaks while it will show a small increase on the low flows due to the added impervious area; this increase will be smaller than the permissible variation allowed by the HMP document on the Flow Duration Curve (FDC).

The diversion of 1.32 acres into POC-1 will impose a larger burden into the HMP facilities draining to POC-1, but the facilities will be designed to mitigate to pre-development levels of a smaller area (POC-1 will reduce post-development runoff from 6.16 acres to pre-development runoff of 4.84 acres, in the range of analysis). The reader is referred to Table 7 for POC tributary areas.

**TABLE 7 – SUMMARY OF POC TRIBUTARY AREAS**

| POC | Pre-Developed Area (Ac) | Post-Developed Area (Ac) |
|---|---|---|
| POC-1 | 4.84 | 6.16 |
| POC-2 | 3.16 | 1.84 |
| **TOTAL** | **8.00** | **8.00** |

## FLOW DURATION CURVE COMPARISON

The Flow Duration Curve (FDC) for the site was compared at the POC by exporting the hourly runoff time series results from SWMM to a spreadsheet. The FDC was compared between 30% of the existing condition $Q_2$ up to the existing condition $Q_{10}$ for POC-1 because POC-1 discharges into a medium susceptibility creek (that we called Pecan Creek as it is an unnamed blue creek in the USGS maps), per the Susceptibility Analysis for Pecan Creek prepared by TRWE dated March, 2014. Regarding POC-2, the typical range of 10% of the existing condition $Q_2$ up to the existing condition $Q_{10}$ was used because no susceptibility analysis was carried out downstream of the basing receiving the runoff from POC-2.

$Q_2$ and $Q_{10}$ were determined with a partial duration statistical analysis of the runoff time series in an Excel spreadsheet using the Cunnane plotting position method (which is the preferred plotting methodology in the HMP Permit). As the SWMM Model includes a statistical analysis based on the Weibull Plotting Position Method, the Weibull Method was also used within the spreadsheet to ensure that the results were similar to those obtained by the SWMM Model.

The range between 30% of $Q_2$ and $Q_{10}$ (for POC-1) and between 10% of $Q_2$ and $Q_{10}$ (for POC-2) was divided into 100 equal time intervals; the number of hours that each flow rate was exceeded was counted from the hourly series. Additionally, the intermediate peaks with a return period "i" were obtained ($Q_i$ with i=3 to 9). For the purpose of the plot, the values were presented as percentage of time exceeded for each flow rate. FDC comparison at each POC is illustrated in Figure 1 in both normal

and logarithmic scale. Attachment 5 provides a detailed drainage exhibit for the post-developed condition.

As can be seen in Figures 1 and 2, the FDC for the proposed condition with the HMP BMPs is within 110% of the curve for the existing condition in both peak flows and durations. The additional runoff volume generated from developing the site will be released to the existing point of discharge at a flow rate below the 30% $Q_2$ lower threshold for POC-1 and at a flow rate below the 10% $Q_2$ lower threshold for POC-2. Additionally, the project will also not increase peak flow rates between the $Q_2$ and the $Q_{10}$, as shown in the peak flow tables in Attachment 1.

## SUMMARY

This study has demonstrated that the proposed HMP BMPs provided for the HSC Lakeside site is sufficient to meet the current HMP criteria for both Points of Compliance (POCs), if the cross-section areas and volumes recommended within this technical memorandum, and the respective orifices and outlet structures are incorporated as specified within the proposed project site.

## KEY ASSUMPTIONS

1. Type C Soil is representative of the existing condition site.

## ATTACHMENTS

1. $Q_2$ to $Q_{10}$ Comparison Tables
2. FDC Plots (log and natural "x" scale) and Flow Duration Table.
3. List of the "n" largest Peaks: Pre-Development and Post-Development Conditions
4. Elevations vs. Discharge Curves to be used in SWMM, Draw Down Calculations
5. Pre & Post Development Maps, Project plan and section sketches
6. SWMM Input Data in Input Format (Existing and Proposed Models)
7. SWMM Screens and Explanation of Significant Variables
8. Geotechnical Study & Soil Survey
9. Summary files from the SWMM Model
10. Response to Comments

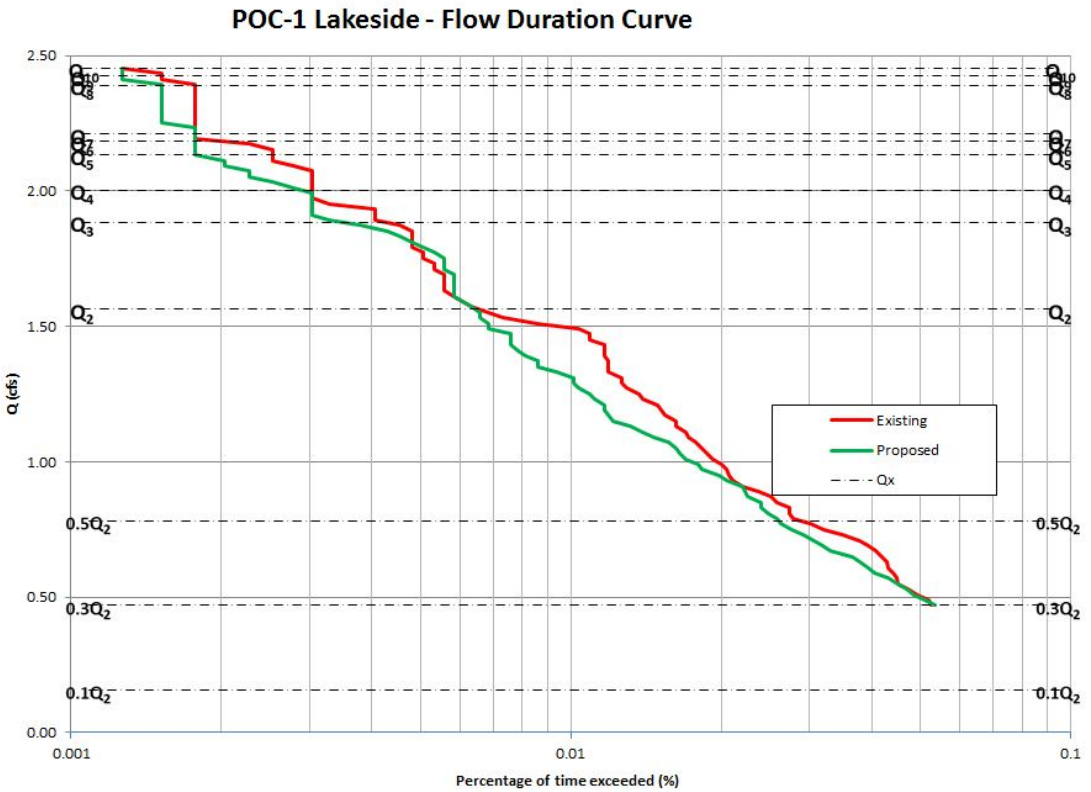
## REFERENCES

[1] – *"Review and Analysis of San Diego County Hydromodification Management Plan (HMP): Assumptions, Criteria, Methods, & Modeling Tools – Prepared for the Cities of San Marcos, Oceanside & Vista",* May 2012, TRW Engineering.

[2] – *"Final Hydromodification Management Plan (HMP) prepared for the County of San Diego",* March 2011, Brown and Caldwell.

[3] - Order R9-2007-001, California Regional Water Quality Control Board San Diego Region (SDRWQCB).

[4] – "*Handbook of Hydrology*", David R. Maidment, Editor in Chief. 1992, McGraw Hill.



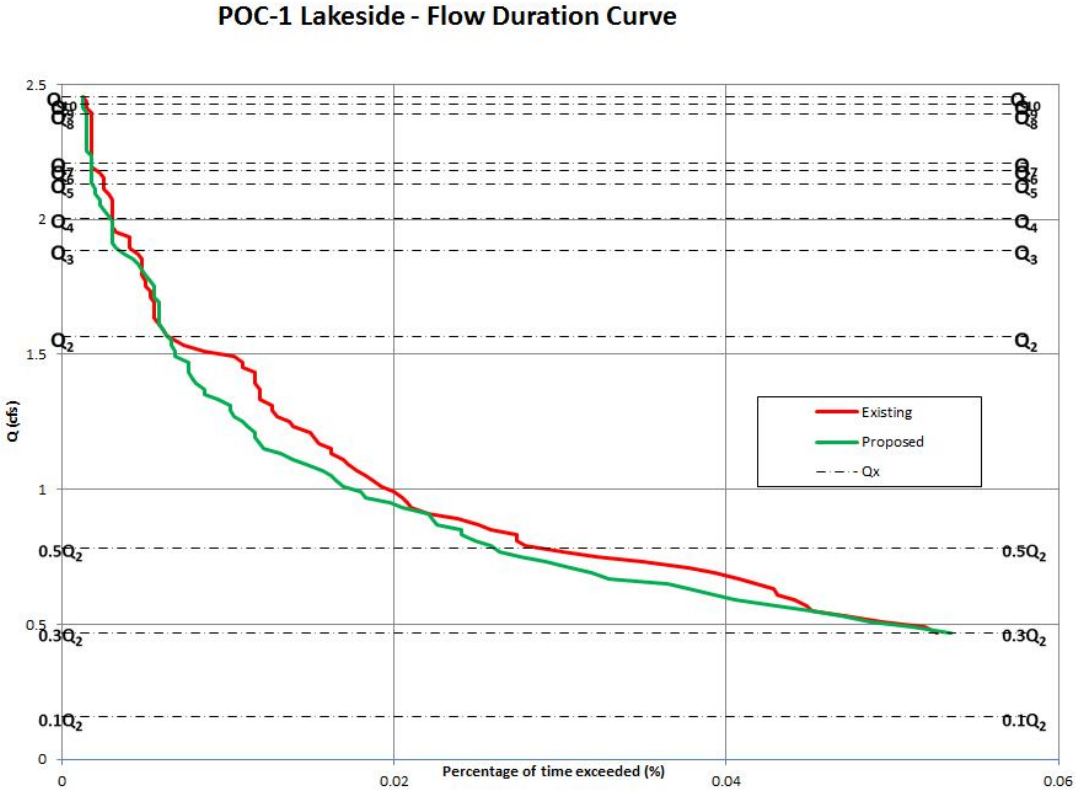
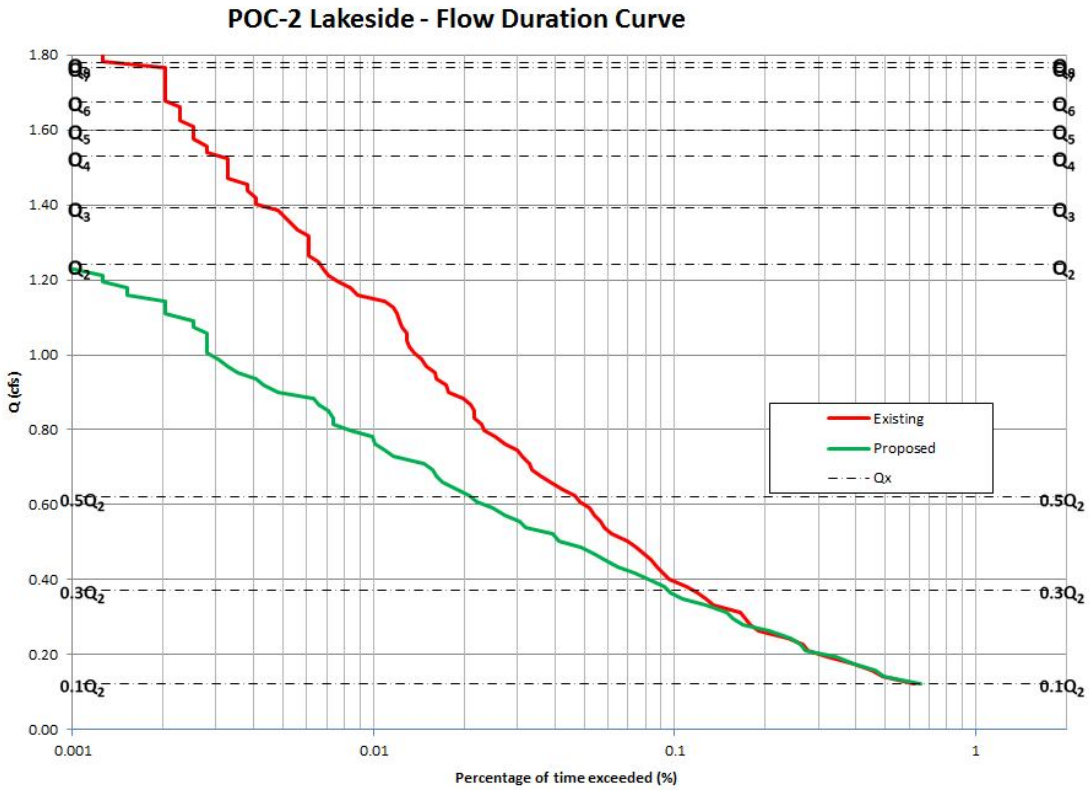




**Figure 1a and 1b.** Flow Duration Curve Comparison (logarithmic and normal "x" scale)



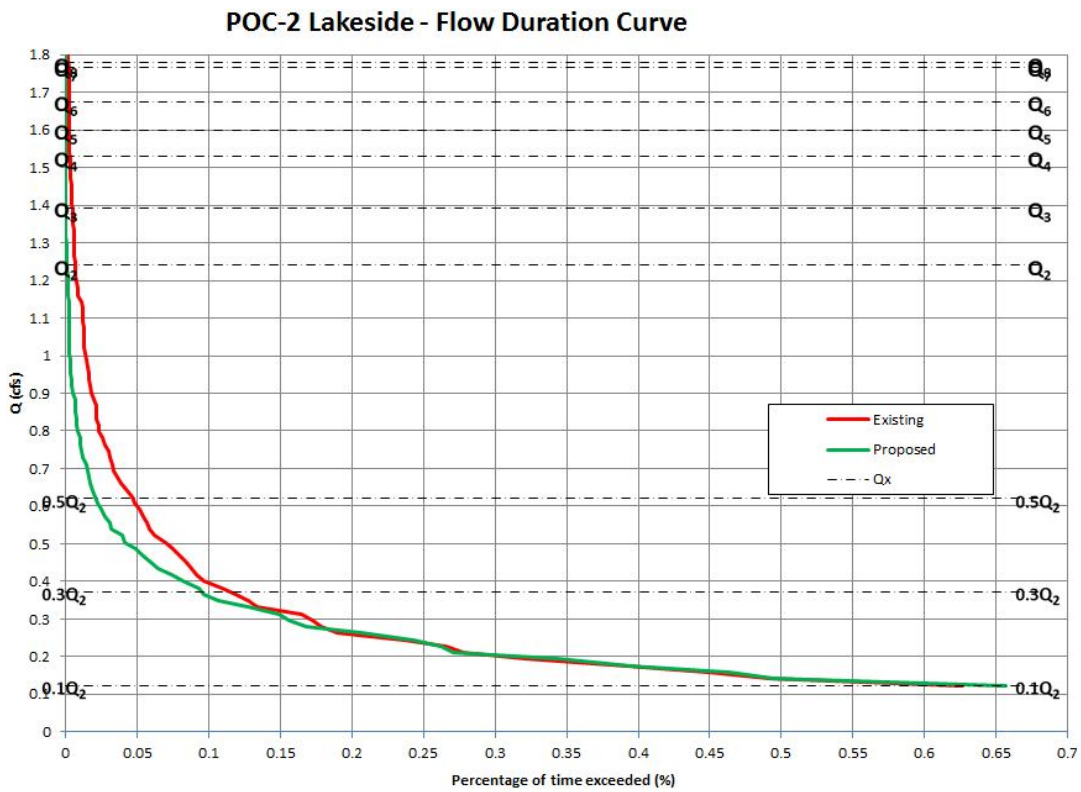




**Figure 2a and 2b.** Flow Duration Curve Comparison (logarithmic and normal "x" scale)

# ATTACHMENT 1.

**$Q_2$ to $Q_{10}$ Comparison Table – POC 1**

| Return Period | Existing Condition (cfs) | Mitigated Condition (cfs) | Reduction, Exist - Mitigated (cfs) |
|---|---|---|---|
| 2-year | 1.564 | 1.272 | 0.292 |
| 3-year | 1.886 | 1.685 | 0.200 |
| 4-year | 2.003 | 1.873 | 0.131 |
| 5-year | 2.133 | 2.007 | 0.126 |
| 6-year | 2.183 | 2.046 | 0.137 |
| 7-year | 2.211 | 2.092 | 0.118 |
| 8-year | 2.389 | 2.114 | 0.276 |
| 9-year | 2.425 | 2.185 | 0.240 |
| 10-year | 2.454 | 2.270 | 0.184 |

**$Q_2$ to $Q_{10}$ Comparison Table – POC 2**

| Return Period | Existing Condition (cfs) | Mitigated Condition (cfs) | Reduction, Exist - Mitigated (cfs) |
|---|---|---|---|
| 2-year | 1.564 | 1.228 | 0.336 |
| 3-year | 1.886 | 1.633 | 0.253 |
| 4-year | 2.003 | 1.862 | 0.142 |
| 5-year | 2.133 | 1.930 | 0.203 |
| 6-year | 2.183 | 1.992 | 0.190 |
| 7-year | 2.211 | 2.082 | 0.129 |
| 8-year | 2.389 | 2.084 | 0.306 |
| 9-year | 2.425 | 2.109 | 0.317 |
| 10-year | 2.454 | 2.143 | 0.312 |

# ATTACHMENT 2

## FLOW DURATION CURVE ANALYSIS

1) Flow duration curve shall not exceed the existing conditions by more than 10%, neither in peak flow nor duration.

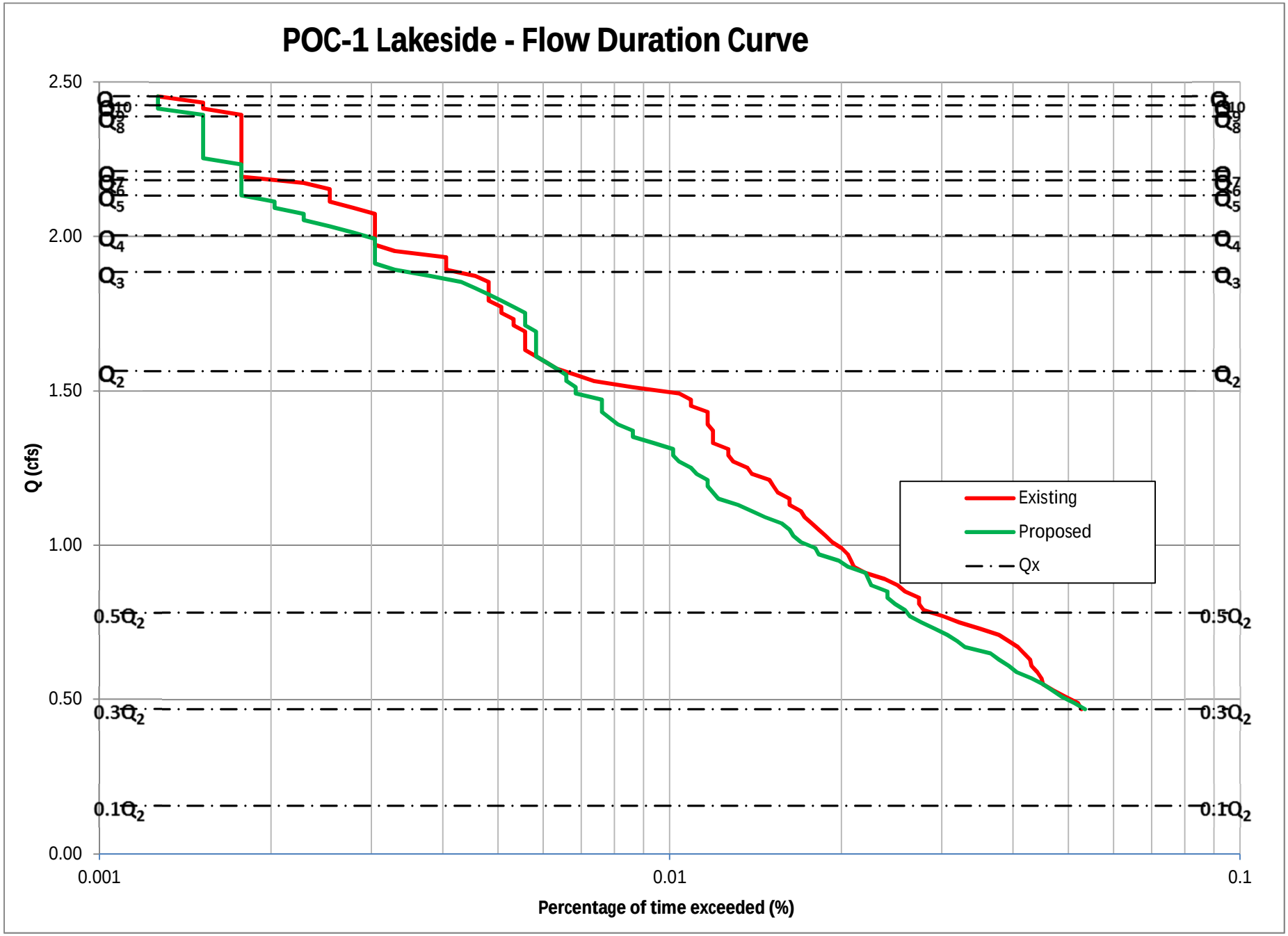
The figures on the following pages illustrate that the flow duration curve in post-development conditions after the proposed BMP is below the existing flow duration curve. The flow duration curve table following the curve shows that if the interval $0.10Q_2 – Q_{10}$ is divided in 100 sub-intervals, then a) the post development divided by pre-development durations are never larger than 110% (the permit allows up to 110%); and b) there are no more than 10 intervals in the range 101%-110% which would imply an excess over 10% of the length of the curve (the permit allows less than 10% of excesses measured as 101-110%).

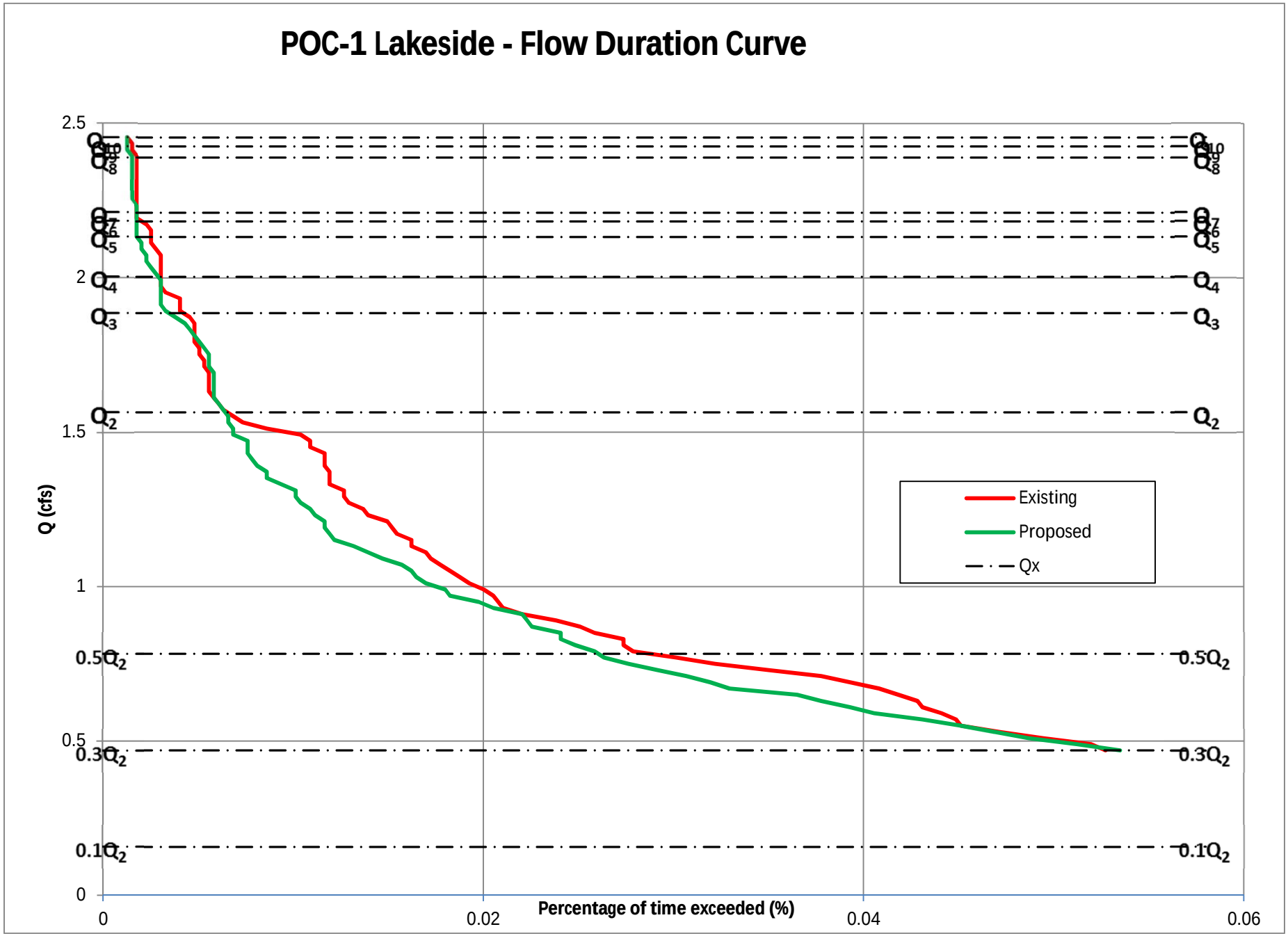
Consequently, the design passes the hydromodification test.

It is important to note that the flow duration curve can be expressed in the "x" axis as percentage of time, hours per year, total number of hours, or any other similar time variable. As those variables only differ by a multiplying constant, their plot in logarithmic scale is going to look exactly the same, and compliance can be observed regardless of the variable selected. However, in order to satisfy the County of San Diego HMP example, % of time exceeded is the variable of choice in the flow duration curve. The selection of a logarithmic scale in lieu of the normal scale is preferred, as differences between the pre-development and post-development curves can be seen more clearly in the entire range of analysis. Both graphics are presented just to prove the difference.

In terms of the "y" axis, the peak flow value is the variable of choice. As an additional analysis performed by TRWE, not only the range of analysis is clearly depicted (10% of $Q_2$ to $Q_{10}$) but also all intermediate flows are shown ($Q_2$, $Q_3$, $Q_4$, $Q_5$, $Q_6$, $Q_7$, $Q_8$ and $Q_9$) in order to demonstrate compliance at any range $Q_x – Q_{x+1}$. It must be pointed out that one of the limitations of both the SWMM and SDHM models is that the intermediate analysis is not performed (to obtain $Q_i$ from i = 2 to 10). TRWE performed the analysis using the Cunnane Plotting position Method (the preferred method in the HMP permit) from the "n" largest independent peak flows obtained from the continuous time series.

The largest "n" peak flows are attached in this appendix, as well as the values of $Q_i$ with a return period "i", from i=2 to 10. The $Q_i$ values are also added into the flow-duration plot.


POC-1 Lakeside - Flow Duration Curve
2.50
2.00
1.50
1.00
0.50
0.00
Q (cfs)
0.001
0.01
0.1
Percentage of time exceeded (%)
Q10
Q9
Q8
Q7
Q6
Q5
Q4
Q3
Q2
0.5Q2
0.3Q2
0.1Q2
Existing
Proposed
Qx


POC-1 Lakeside - Flow Duration Curve
Q (cfs)
Percentage of time exceeded (%)
2.5
2
1.5
1
0.5
0
0.02
0.04
0.06
Q10
Q9
Q8
Q7
Q6
Q5
Q4
Q3
Q2
0.5Q2
0.3Q2
0.1Q2
Existing
Proposed
Qx

**Flow Duration Curve Data for Tractor Supply POC-1 , Lakeside, CA**

| | | | | |
|---|---|---|---|---|
| Q2 = | 1.564 | cfs | Fraction | 30 % |
| Q10 = | 2.45 | cfs | | |
| Step = | 0.0201 | cfs | | |
| Count = | 394487 | hours | | |
| | 45.00 | years | | |

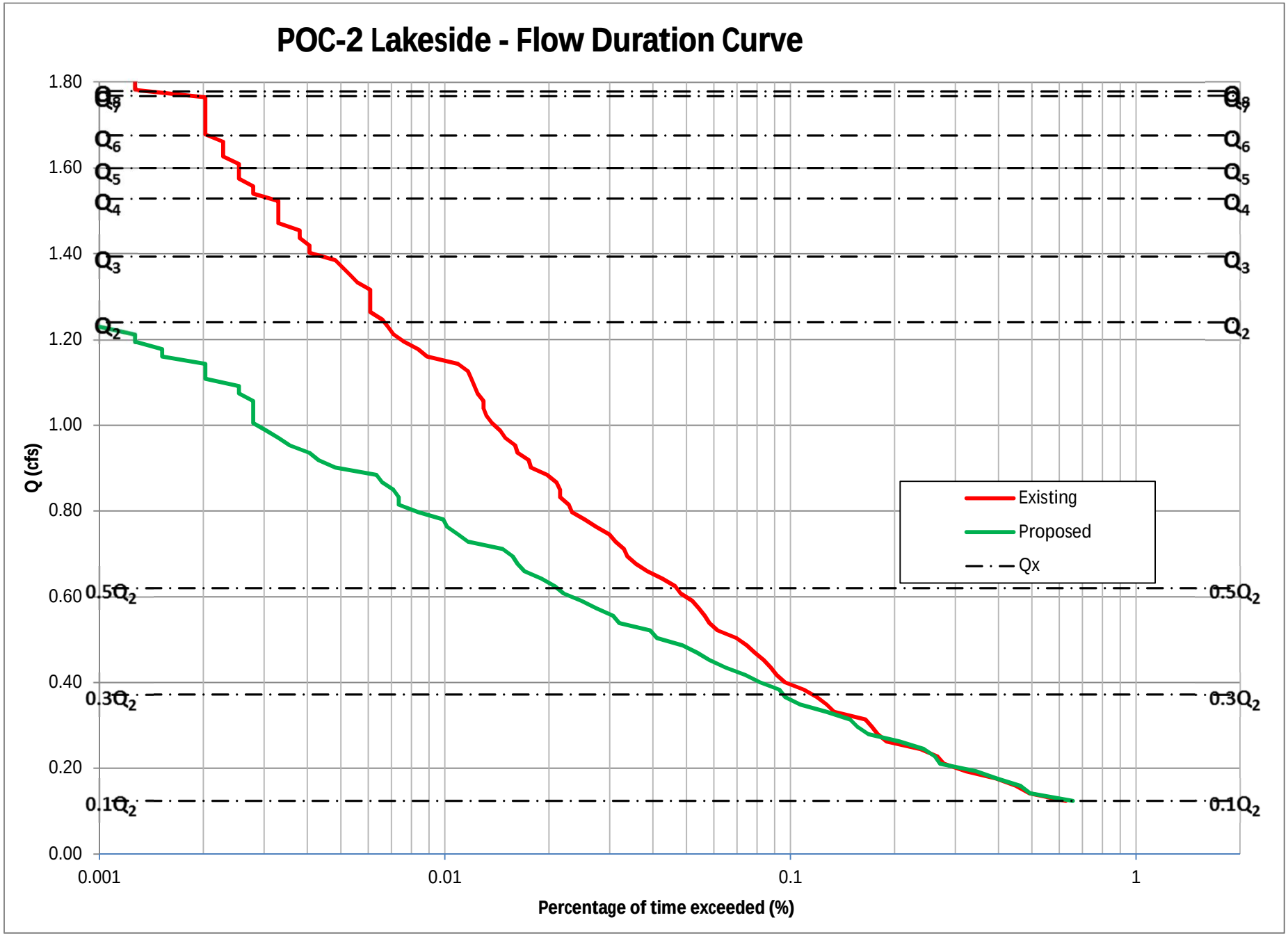
| | Existing Condition | | | Detention Optimized | | | Pass or |
|---|---|---|---|---|---|---|---|
| Interval | Q (cfs) | Hours > Q | % time | Hours>Q | % time | Post/Pre | Fail? |
| 1 | 0.469 | 208 | 5.27E-02 | 211 | 5.35E-02 | 101% | Pass |
| 2 | 0.489 | 205 | 5.20E-02 | 202 | 5.12E-02 | 99% | Pass |
| 3 | 0.509 | 195 | 4.94E-02 | 192 | 4.87E-02 | 98% | Pass |
| 4 | 0.529 | 186 | 4.71E-02 | 185 | 4.69E-02 | 99% | Pass |
| 5 | 0.549 | 178 | 4.51E-02 | 178 | 4.51E-02 | 100% | Pass |
| 6 | 0.570 | 177 | 4.49E-02 | 170 | 4.31E-02 | 96% | Pass |
| 7 | 0.590 | 174 | 4.41E-02 | 160 | 4.06E-02 | 92% | Pass |
| 8 | 0.610 | 170 | 4.31E-02 | 155 | 3.93E-02 | 91% | Pass |
| 9 | 0.630 | 169 | 4.28E-02 | 149 | 3.78E-02 | 88% | Pass |
| 10 | 0.650 | 165 | 4.18E-02 | 144 | 3.65E-02 | 87% | Pass |
| 11 | 0.670 | 161 | 4.08E-02 | 130 | 3.30E-02 | 81% | Pass |
| 12 | 0.690 | 155 | 3.93E-02 | 126 | 3.19E-02 | 81% | Pass |
| 13 | 0.710 | 149 | 3.78E-02 | 121 | 3.07E-02 | 81% | Pass |
| 14 | 0.730 | 138 | 3.50E-02 | 115 | 2.92E-02 | 83% | Pass |
| 15 | 0.750 | 127 | 3.22E-02 | 109 | 2.76E-02 | 86% | Pass |
| 16 | 0.770 | 119 | 3.02E-02 | 104 | 2.64E-02 | 87% | Pass |
| 17 | 0.790 | 110 | 2.79E-02 | 102 | 2.59E-02 | 93% | Pass |
| 18 | 0.810 | 108 | 2.74E-02 | 98 | 2.48E-02 | 91% | Pass |
| 19 | 0.830 | 108 | 2.74E-02 | 95 | 2.41E-02 | 88% | Pass |
| 20 | 0.850 | 102 | 2.59E-02 | 95 | 2.41E-02 | 93% | Pass |
| 21 | 0.870 | 99 | 2.51E-02 | 89 | 2.26E-02 | 90% | Pass |
| 22 | 0.890 | 94 | 2.38E-02 | 88 | 2.23E-02 | 94% | Pass |
| 23 | 0.910 | 87 | 2.21E-02 | 87 | 2.21E-02 | 100% | Pass |
| 24 | 0.930 | 83 | 2.10E-02 | 81 | 2.05E-02 | 98% | Pass |
| 25 | 0.951 | 82 | 2.08E-02 | 78 | 1.98E-02 | 95% | Pass |
| 26 | 0.971 | 81 | 2.05E-02 | 72 | 1.83E-02 | 89% | Pass |
| 27 | 0.991 | 79 | 2.00E-02 | 71 | 1.80E-02 | 90% | Pass |
| 28 | 1.011 | 76 | 1.93E-02 | 67 | 1.70E-02 | 88% | Pass |
| 29 | 1.031 | 74 | 1.88E-02 | 65 | 1.65E-02 | 88% | Pass |
| 30 | 1.051 | 72 | 1.83E-02 | 64 | 1.62E-02 | 89% | Pass |
| 31 | 1.071 | 70 | 1.77E-02 | 62 | 1.57E-02 | 89% | Pass |
| 32 | 1.091 | 68 | 1.72E-02 | 58 | 1.47E-02 | 85% | Pass |
| 33 | 1.111 | 67 | 1.70E-02 | 55 | 1.39E-02 | 82% | Pass |
| 34 | 1.131 | 64 | 1.62E-02 | 52 | 1.32E-02 | 81% | Pass |
| 35 | 1.151 | 64 | 1.62E-02 | 48 | 1.22E-02 | 75% | Pass |
| 36 | 1.171 | 61 | 1.55E-02 | 47 | 1.19E-02 | 77% | Pass |

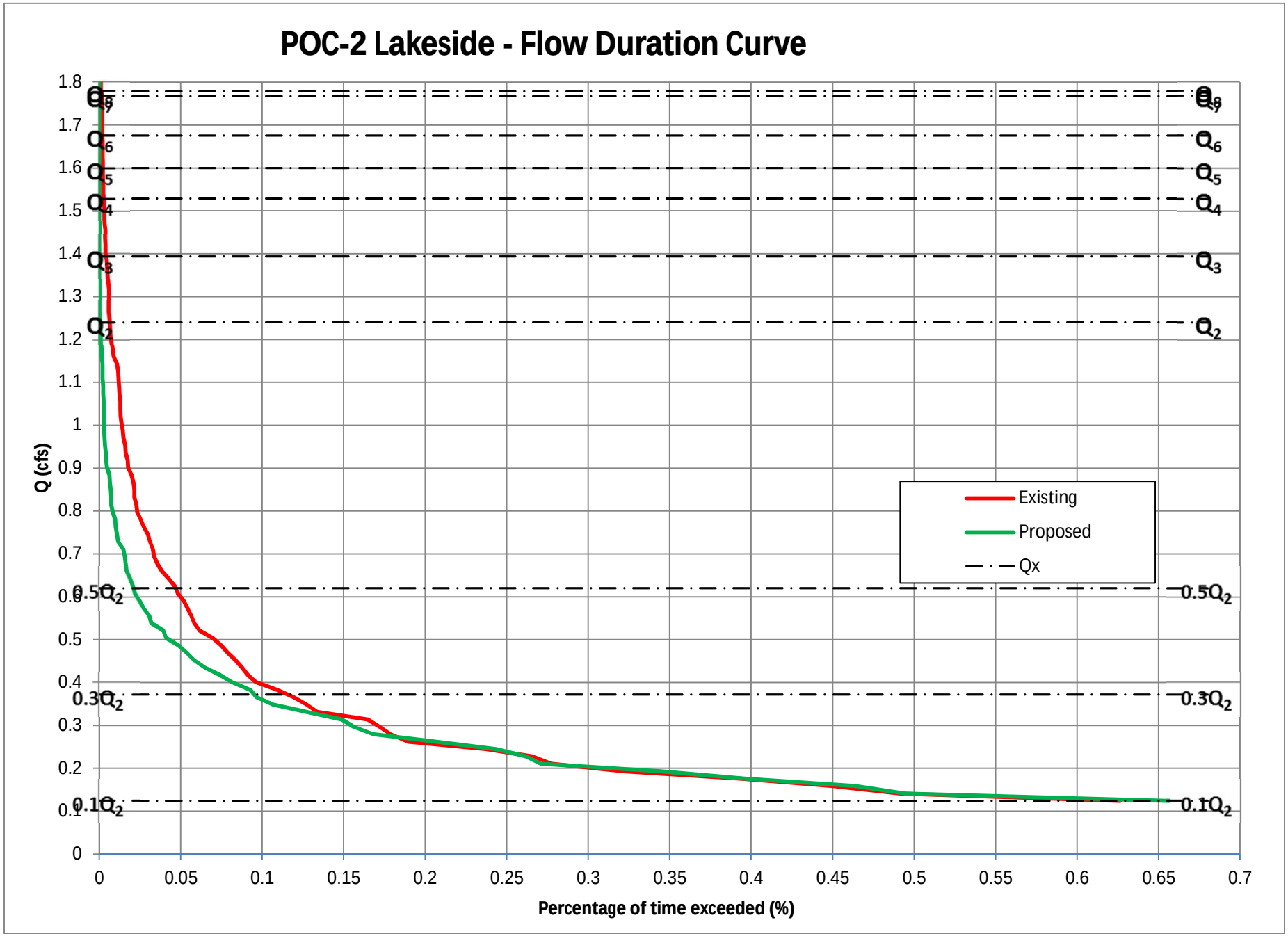
| Interval | Existing Condition | | | Detention Optimized | | | Pass or Fail? |
|---|---|---|---|---|---|---|---|
| | Q (cfs) | Hours > Q | % time | Hours>Q | % time | Post/Pre | |
| 37 | 1.191 | 60 | 1.52E-02 | 46 | 1.17E-02 | 77% | Pass |
| 38 | 1.211 | 59 | 1.50E-02 | 46 | 1.17E-02 | 78% | Pass |
| 39 | 1.231 | 55 | 1.39E-02 | 44 | 1.12E-02 | 80% | Pass |
| 40 | 1.251 | 54 | 1.37E-02 | 43 | 1.09E-02 | 80% | Pass |
| 41 | 1.271 | 51 | 1.29E-02 | 41 | 1.04E-02 | 80% | Pass |
| 42 | 1.291 | 50 | 1.27E-02 | 40 | 1.01E-02 | 80% | Pass |
| 43 | 1.311 | 50 | 1.27E-02 | 40 | 1.01E-02 | 80% | Pass |
| 44 | 1.332 | 47 | 1.19E-02 | 37 | 9.38E-03 | 79% | Pass |
| 45 | 1.352 | 47 | 1.19E-02 | 34 | 8.62E-03 | 72% | Pass |
| 46 | 1.372 | 47 | 1.19E-02 | 34 | 8.62E-03 | 72% | Pass |
| 47 | 1.392 | 46 | 1.17E-02 | 32 | 8.11E-03 | 70% | Pass |
| 48 | 1.412 | 46 | 1.17E-02 | 31 | 7.86E-03 | 67% | Pass |
| 49 | 1.432 | 46 | 1.17E-02 | 30 | 7.60E-03 | 65% | Pass |
| 50 | 1.452 | 43 | 1.09E-02 | 30 | 7.60E-03 | 70% | Pass |
| 51 | 1.472 | 43 | 1.09E-02 | 30 | 7.60E-03 | 70% | Pass |
| 52 | 1.492 | 41 | 1.04E-02 | 27 | 6.84E-03 | 66% | Pass |
| 53 | 1.512 | 34 | 8.62E-03 | 27 | 6.84E-03 | 79% | Pass |
| 54 | 1.532 | 29 | 7.35E-03 | 26 | 6.59E-03 | 90% | Pass |
| 55 | 1.552 | 27 | 6.84E-03 | 26 | 6.59E-03 | 96% | Pass |
| 56 | 1.572 | 25 | 6.34E-03 | 25 | 6.34E-03 | 100% | Pass |
| 57 | 1.592 | 24 | 6.08E-03 | 24 | 6.08E-03 | 100% | Pass |
| 58 | 1.612 | 23 | 5.83E-03 | 23 | 5.83E-03 | 100% | Pass |
| 59 | 1.632 | 22 | 5.58E-03 | 23 | 5.83E-03 | 105% | Pass |
| 60 | 1.652 | 22 | 5.58E-03 | 23 | 5.83E-03 | 105% | Pass |
| 61 | 1.672 | 22 | 5.58E-03 | 23 | 5.83E-03 | 105% | Pass |
| 62 | 1.692 | 22 | 5.58E-03 | 23 | 5.83E-03 | 105% | Pass |
| 63 | 1.713 | 21 | 5.32E-03 | 22 | 5.58E-03 | 105% | Pass |
| 64 | 1.733 | 21 | 5.32E-03 | 22 | 5.58E-03 | 105% | Pass |
| 65 | 1.753 | 20 | 5.07E-03 | 22 | 5.58E-03 | 110% | Pass |
| 66 | 1.773 | 20 | 5.07E-03 | 21 | 5.32E-03 | 105% | Pass |
| 67 | 1.793 | 19 | 4.82E-03 | 20 | 5.07E-03 | 105% | Pass |
| 68 | 1.813 | 19 | 4.82E-03 | 19 | 4.82E-03 | 100% | Pass |
| 69 | 1.833 | 19 | 4.82E-03 | 18 | 4.56E-03 | 95% | Pass |
| 70 | 1.853 | 19 | 4.82E-03 | 17 | 4.31E-03 | 89% | Pass |
| 71 | 1.873 | 18 | 4.56E-03 | 15 | 3.80E-03 | 83% | Pass |
| 72 | 1.893 | 16 | 4.06E-03 | 13 | 3.30E-03 | 81% | Pass |
| 73 | 1.913 | 16 | 4.06E-03 | 12 | 3.04E-03 | 75% | Pass |
| 74 | 1.933 | 16 | 4.06E-03 | 12 | 3.04E-03 | 75% | Pass |
| 75 | 1.953 | 13 | 3.30E-03 | 12 | 3.04E-03 | 92% | Pass |
| 76 | 1.973 | 12 | 3.04E-03 | 12 | 3.04E-03 | 100% | Pass |
| 77 | 1.993 | 12 | 3.04E-03 | 12 | 3.04E-03 | 100% | Pass |
| 78 | 2.013 | 12 | 3.04E-03 | 11 | 2.79E-03 | 92% | Pass |
| 79 | 2.033 | 12 | 3.04E-03 | 10 | 2.53E-03 | 83% | Pass |
| 80 | 2.053 | 12 | 3.04E-03 | 9 | 2.28E-03 | 75% | Pass |
| 81 | 2.073 | 12 | 3.04E-03 | 9 | 2.28E-03 | 75% | Pass |

| Interval | Existing Condition | | | Detention Optimized | | | Pass or Fail? |
|---|---|---|---|---|---|---|---|
| | Q (cfs) | Hours > Q | % time | Hours>Q | % time | Post/Pre | |
| 82 | 2.093 | 11 | 2.79E-03 | 8 | 2.03E-03 | 73% | Pass |
| 83 | 2.114 | 10 | 2.53E-03 | 8 | 2.03E-03 | 80% | Pass |
| 84 | 2.134 | 10 | 2.53E-03 | 7 | 1.77E-03 | 70% | Pass |
| 85 | 2.154 | 10 | 2.53E-03 | 7 | 1.77E-03 | 70% | Pass |
| 86 | 2.174 | 9 | 2.28E-03 | 7 | 1.77E-03 | 78% | Pass |
| 87 | 2.194 | 7 | 1.77E-03 | 7 | 1.77E-03 | 100% | Pass |
| 88 | 2.214 | 7 | 1.77E-03 | 7 | 1.77E-03 | 100% | Pass |
| 89 | 2.234 | 7 | 1.77E-03 | 7 | 1.77E-03 | 100% | Pass |
| 90 | 2.254 | 7 | 1.77E-03 | 6 | 1.52E-03 | 86% | Pass |
| 91 | 2.274 | 7 | 1.77E-03 | 6 | 1.52E-03 | 86% | Pass |
| 92 | 2.294 | 7 | 1.77E-03 | 6 | 1.52E-03 | 86% | Pass |
| 93 | 2.314 | 7 | 1.77E-03 | 6 | 1.52E-03 | 86% | Pass |
| 94 | 2.334 | 7 | 1.77E-03 | 6 | 1.52E-03 | 86% | Pass |
| 95 | 2.354 | 7 | 1.77E-03 | 6 | 1.52E-03 | 86% | Pass |
| 96 | 2.374 | 7 | 1.77E-03 | 6 | 1.52E-03 | 86% | Pass |
| 97 | 2.394 | 7 | 1.77E-03 | 6 | 1.52E-03 | 86% | Pass |
| 98 | 2.414 | 6 | 1.52E-03 | 5 | 1.27E-03 | 83% | Pass |
| 99 | 2.434 | 6 | 1.52E-03 | 5 | 1.27E-03 | 83% | Pass |
| 100 | 2.454 | 5 | 1.27E-03 | 5 | 1.27E-03 | 100% | Pass |

**Peak Flows calculated with Cunnane Plotting Position**

| Return Period (years) | Pre-dev. Q (cfs) | Post-Dev. Q (cfs) | Reduction (cfs) |
|---|---|---|---|
| 10 | 2.454 | 2.270 | 0.184 |
| 9 | 2.425 | 2.185 | 0.240 |
| 8 | 2.389 | 2.114 | 0.276 |
| 7 | 2.211 | 2.092 | 0.118 |
| 6 | 2.183 | 2.046 | 0.137 |
| 5 | 2.133 | 2.007 | 0.126 |
| 4 | 2.003 | 1.873 | 0.131 |
| 3 | 1.886 | 1.685 | 0.200 |
| 2 | 1.564 | 1.272 | 0.292 |


POC-2 Lakeside - Flow Duration Curve
Q (cfs)
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Q9
Q8
Q6
Q5
Q4
Q3
Q2
0.5Q2
0.3Q2
0.1Q2
0.001
0.01
0.1
1
Percentage of time exceeded (%)
Existing
Proposed
Qx


POC-2 Lakeside - Flow Duration Curve
Q (cfs)
Percentage of time exceeded (%)
Existing
Proposed
Qx
$Q_8$
$Q_7$
$Q_6$
$Q_5$
$Q_4$
$Q_3$
$Q_2$
$0.5Q_2$
$0.3Q_2$
$0.1Q_2$
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7

**Flow Duration Curve Data for Tractor Supply POC-2 , Lakeside, CA**

| | | | | |
|---|---|---|---|---|
| Q2 = | 1.240 | cfs | Fraction | 10 % |
| Q10 = | 1.83 | cfs | | |
| Step = | 0.0173 | cfs | | |
| Count = | 394487 | hours | | |
| | 45.00 | years | | |

| | Existing Condition | | | Developed Conditions | | | Pass or |
|---|---|---|---|---|---|---|---|
| Interval | Q (cfs) | Hours > Q | % time | Hours>Q | % time | Post/Pre | Fail? |
| 1 | 0.124 | 2471 | 6.26E-01 | 2590 | 6.57E-01 | 105% | Pass |
| 2 | 0.141 | 1939 | 4.92E-01 | 1951 | 4.95E-01 | 101% | Pass |
| 3 | 0.159 | 1775 | 4.50E-01 | 1830 | 4.64E-01 | 103% | Pass |
| 4 | 0.176 | 1553 | 3.94E-01 | 1564 | 3.96E-01 | 101% | Pass |
| 5 | 0.193 | 1270 | 3.22E-01 | 1359 | 3.44E-01 | 107.0% | Pass |
| 6 | 0.210 | 1095 | 2.78E-01 | 1069 | 2.71E-01 | 98% | Pass |
| 7 | 0.228 | 1049 | 2.66E-01 | 1033 | 2.62E-01 | 98% | Pass |
| 8 | 0.245 | 936 | 2.37E-01 | 960 | 2.43E-01 | 103% | Pass |
| 9 | 0.262 | 748 | 1.90E-01 | 816 | 2.07E-01 | 109% | Pass |
| 10 | 0.279 | 705 | 1.79E-01 | 663 | 1.68E-01 | 94% | Pass |
| 11 | 0.297 | 679 | 1.72E-01 | 616 | 1.56E-01 | 91% | Pass |
| 12 | 0.314 | 650 | 1.65E-01 | 587 | 1.49E-01 | 90% | Pass |
| 13 | 0.331 | 528 | 1.34E-01 | 502 | 1.27E-01 | 95% | Pass |
| 14 | 0.349 | 502 | 1.27E-01 | 421 | 1.07E-01 | 84% | Pass |
| 15 | 0.366 | 471 | 1.19E-01 | 381 | 9.66E-02 | 81% | Pass |
| 16 | 0.383 | 431 | 1.09E-01 | 366 | 9.28E-02 | 85% | Pass |
| 17 | 0.400 | 380 | 9.63E-02 | 322 | 8.16E-02 | 85% | Pass |
| 18 | 0.418 | 360 | 9.13E-02 | 292 | 7.40E-02 | 81% | Pass |
| 19 | 0.435 | 346 | 8.77E-02 | 256 | 6.49E-02 | 74% | Pass |
| 20 | 0.452 | 330 | 8.37E-02 | 230 | 5.83E-02 | 70% | Pass |
| 21 | 0.469 | 311 | 7.88E-02 | 212 | 5.37E-02 | 68% | Pass |
| 22 | 0.487 | 295 | 7.48E-02 | 192 | 4.87E-02 | 65% | Pass |
| 23 | 0.504 | 275 | 6.97E-02 | 162 | 4.11E-02 | 59% | Pass |
| 24 | 0.521 | 243 | 6.16E-02 | 155 | 3.93E-02 | 64% | Pass |
| 25 | 0.539 | 230 | 5.83E-02 | 126 | 3.19E-02 | 55% | Pass |
| 26 | 0.556 | 223 | 5.65E-02 | 121 | 3.07E-02 | 54% | Pass |
| 27 | 0.573 | 214 | 5.42E-02 | 108 | 2.74E-02 | 50% | Pass |
| 28 | 0.590 | 205 | 5.20E-02 | 98 | 2.48E-02 | 48% | Pass |
| 29 | 0.608 | 190 | 4.82E-02 | 87 | 2.21E-02 | 46% | Pass |
| 30 | 0.625 | 183 | 4.64E-02 | 82 | 2.08E-02 | 45% | Pass |
| 31 | 0.642 | 168 | 4.26E-02 | 75 | 1.90E-02 | 45% | Pass |
| 32 | 0.659 | 152 | 3.85E-02 | 67 | 1.70E-02 | 44% | Pass |
| 33 | 0.677 | 141 | 3.57E-02 | 64 | 1.62E-02 | 45% | Pass |
| 34 | 0.694 | 133 | 3.37E-02 | 62 | 1.57E-02 | 47% | Pass |
| 35 | 0.711 | 130 | 3.30E-02 | 58 | 1.47E-02 | 45% | Pass |
| 36 | 0.729 | 123 | 3.12E-02 | 46 | 1.17E-02 | 37% | Pass |

| Interval | Existing Condition | | | Developed Conditions | | | Pass or Fail? |
|---|---|---|---|---|---|---|---|
| | Q (cfs) | Hours > Q | % time | Hours>Q | % time | Post/Pre | |
| 37 | 0.746 | 118 | 2.99E-02 | 43 | 1.09E-02 | 36% | Pass |
| 38 | 0.763 | 108 | 2.74E-02 | 40 | 1.01E-02 | 37% | Pass |
| 39 | 0.780 | 100 | 2.53E-02 | 39 | 9.89E-03 | 39% | Pass |
| 40 | 0.798 | 92 | 2.33E-02 | 33 | 8.37E-03 | 36% | Pass |
| 41 | 0.815 | 90 | 2.28E-02 | 29 | 7.35E-03 | 32% | Pass |
| 42 | 0.832 | 85 | 2.15E-02 | 29 | 7.35E-03 | 34% | Pass |
| 43 | 0.849 | 85 | 2.15E-02 | 28 | 7.10E-03 | 33% | Pass |
| 44 | 0.867 | 83 | 2.10E-02 | 26 | 6.59E-03 | 31% | Pass |
| 45 | 0.884 | 78 | 1.98E-02 | 25 | 6.34E-03 | 32% | Pass |
| 46 | 0.901 | 70 | 1.77E-02 | 19 | 4.82E-03 | 27% | Pass |
| 47 | 0.919 | 69 | 1.75E-02 | 17 | 4.31E-03 | 25% | Pass |
| 48 | 0.936 | 64 | 1.62E-02 | 16 | 4.06E-03 | 25% | Pass |
| 49 | 0.953 | 63 | 1.60E-02 | 14 | 3.55E-03 | 22% | Pass |
| 50 | 0.970 | 59 | 1.50E-02 | 13 | 3.30E-03 | 22% | Pass |
| 51 | 0.988 | 57 | 1.44E-02 | 12 | 3.04E-03 | 21% | Pass |
| 52 | 1.005 | 54 | 1.37E-02 | 11 | 2.79E-03 | 20% | Pass |
| 53 | 1.022 | 52 | 1.32E-02 | 11 | 2.79E-03 | 21% | Pass |
| 54 | 1.039 | 51 | 1.29E-02 | 11 | 2.79E-03 | 22% | Pass |
| 55 | 1.057 | 51 | 1.29E-02 | 11 | 2.79E-03 | 22% | Pass |
| 56 | 1.074 | 49 | 1.24E-02 | 10 | 2.53E-03 | 20% | Pass |
| 57 | 1.091 | 48 | 1.22E-02 | 10 | 2.53E-03 | 21% | Pass |
| 58 | 1.109 | 47 | 1.19E-02 | 8 | 2.03E-03 | 17% | Pass |
| 59 | 1.126 | 46 | 1.17E-02 | 8 | 2.03E-03 | 17% | Pass |
| 60 | 1.143 | 43 | 1.09E-02 | 8 | 2.03E-03 | 19% | Pass |
| 61 | 1.160 | 35 | 8.87E-03 | 6 | 1.52E-03 | 17% | Pass |
| 62 | 1.178 | 33 | 8.37E-03 | 6 | 1.52E-03 | 18% | Pass |
| 63 | 1.195 | 30 | 7.60E-03 | 5 | 1.27E-03 | 17% | Pass |
| 64 | 1.212 | 28 | 7.10E-03 | 5 | 1.27E-03 | 18% | Pass |
| 65 | 1.229 | 27 | 6.84E-03 | 4 | 1.01E-03 | 15% | Pass |
| 66 | 1.247 | 26 | 6.59E-03 | 3 | 7.60E-04 | 12% | Pass |
| 67 | 1.264 | 24 | 6.08E-03 | 2 | 5.07E-04 | 8% | Pass |
| 68 | 1.281 | 24 | 6.08E-03 | 2 | 5.07E-04 | 8% | Pass |
| 69 | 1.299 | 24 | 6.08E-03 | 2 | 5.07E-04 | 8% | Pass |
| 70 | 1.316 | 24 | 6.08E-03 | 1 | 2.53E-04 | 4% | Pass |
| 71 | 1.333 | 22 | 5.58E-03 | 1 | 2.53E-04 | 5% | Pass |
| 72 | 1.350 | 21 | 5.32E-03 | 1 | 2.53E-04 | 5% | Pass |
| 73 | 1.368 | 20 | 5.07E-03 | 1 | 2.53E-04 | 5% | Pass |
| 74 | 1.385 | 19 | 4.82E-03 | 1 | 2.53E-04 | 5% | Pass |
| 75 | 1.402 | 16 | 4.06E-03 | 1 | 2.53E-04 | 6% | Pass |
| 76 | 1.419 | 16 | 4.06E-03 | 1 | 2.53E-04 | 6% | Pass |
| 77 | 1.437 | 15 | 3.80E-03 | 1 | 2.53E-04 | 7% | Pass |
| 78 | 1.454 | 15 | 3.80E-03 | 1 | 2.53E-04 | 7% | Pass |
| 79 | 1.471 | 13 | 3.30E-03 | 1 | 2.53E-04 | 8% | Pass |
| 80 | 1.489 | 13 | 3.30E-03 | 1 | 2.53E-04 | 8% | Pass |
| 81 | 1.506 | 13 | 3.30E-03 | 1 | 2.53E-04 | 8% | Pass |

| Interval | Existing Condition | | | Developed Conditions | | | Pass or Fail? |
|---|---|---|---|---|---|---|---|
| | Q (cfs) | Hours > Q | % time | Hours>Q | % time | Post/Pre | |
| 82 | 1.523 | 13 | 3.30E-03 | 1 | 2.53E-04 | 8% | Pass |
| 83 | 1.540 | 11 | 2.79E-03 | 1 | 2.53E-04 | 9% | Pass |
| 84 | 1.558 | 11 | 2.79E-03 | 1 | 2.53E-04 | 9% | Pass |
| 85 | 1.575 | 10 | 2.53E-03 | 1 | 2.53E-04 | 10% | Pass |
| 86 | 1.592 | 10 | 2.53E-03 | 1 | 2.53E-04 | 10% | Pass |
| 87 | 1.609 | 10 | 2.53E-03 | 1 | 2.53E-04 | 10% | Pass |
| 88 | 1.627 | 9 | 2.28E-03 | 1 | 2.53E-04 | 11% | Pass |
| 89 | 1.644 | 9 | 2.28E-03 | 1 | 2.53E-04 | 11% | Pass |
| 90 | 1.661 | 9 | 2.28E-03 | 1 | 2.53E-04 | 11% | Pass |
| 91 | 1.679 | 8 | 2.03E-03 | 1 | 2.53E-04 | 13% | Pass |
| 92 | 1.696 | 8 | 2.03E-03 | 1 | 2.53E-04 | 13% | Pass |
| 93 | 1.713 | 8 | 2.03E-03 | 1 | 2.53E-04 | 13% | Pass |
| 94 | 1.730 | 8 | 2.03E-03 | 1 | 2.53E-04 | 13% | Pass |
| 95 | 1.748 | 8 | 2.03E-03 | 1 | 2.53E-04 | 13% | Pass |
| 96 | 1.765 | 8 | 2.03E-03 | 1 | 2.53E-04 | 13% | Pass |
| 97 | 1.782 | 5 | 1.27E-03 | 1 | 2.53E-04 | 20% | Pass |
| 98 | 1.799 | 5 | 1.27E-03 | 1 | 2.53E-04 | 20% | Pass |
| 99 | 1.817 | 5 | 1.27E-03 | 1 | 2.53E-04 | 20% | Pass |
| 100 | 1.834 | 4 | 1.01E-03 | 1 | 2.53E-04 | 25% | Pass |

**Peak Flows calculated with Cunnane Plotting Position**

| Return Period (years) | Pre-dev. Q (cfs) | Post-Dev. Q (cfs) | Reduction (cfs) |
|---|---|---|---|
| 10 | 1.834 | 1.225 | 0.609 |
| 9 | 1.806 | 1.208 | 0.599 |
| 8 | 1.779 | 1.187 | 0.592 |
| 7 | 1.768 | 1.157 | 0.610 |
| 6 | 1.676 | 1.150 | 0.526 |
| 5 | 1.600 | 1.082 | 0.517 |
| 4 | 1.529 | 0.984 | 0.545 |
| 3 | 1.394 | 0.934 | 0.459 |
| 2 | 1.240 | 0.866 | 0.374 |

# ATTACHMENT 3

## List of the "n" Largest Peaks: Pre & Post-Developed Conditions

**Basic Probabilistic Equation:**

R = 1/P R: Return period (years).

P: Probability of a flow to be equaled or exceeded any given year (dimensionless).

**Cunnane Equation:**

$$P = \frac{i-0.4}{n+0.2}$$

**Weibull Equation:**

$$P = \frac{i}{n+1}$$

i: Position of the peak whose probability is desired (sorted from large to small)

n: number of years analyzed.

## Explanation of Variables for the Tables in this Attachment

Peak: Refers to the peak flow at the date given, taken from the continuous simulation hourly results of the n year analyzed.

Posit: If all peaks are sorted from large to small, the position of the peak in a sorting analysis is included under the variable Posit.

Date: Date of the occurrence of the peak at the outlet from the continuous simulation

Note: all peaks are not annual maxima; instead they are defined as event maxima, with a threshold to separate peaks of at least 12 hours. In other words, any peak P in a time series is defined as a value where dP/dt = 0, and the peak is the largest value in 25 hours (12 hours before, the hour of occurrence and 12 hours after the occurrence, so it is in essence a daily peak).

**List of Peak events and Determination of P2 and P10 (Post-Development)**
**Tractor Supply POC 1 - Lakeside**

| T (Year) | Cunnane (cfs) | Weibull (cfs) |
|---|---|---|
| **10** | **2.27** | **2.37** |
| **9** | **2.19** | **2.23** |
| **8** | **2.11** | **2.14** |
| **7** | **2.09** | **2.10** |
| **6** | **2.05** | **2.06** |
| **5** | **2.01** | **2.01** |
| **4** | **1.87** | **1.88** |
| **3** | **1.69** | **1.72** |
| **2** | **1.27** | **1.27** |

Note:
Cunnane is the preferred method by the HMP permit.

| Peaks (cfs) | Date | Posit | Period of Return (Years) Weibull | Period of Return (Years) Cunnane |
|---|---|---|---|---|
| 0.9477 | 1/31/1996 | 45 | 1.02 | 1.01 |
| 0.9551 | 3/4/1978 | 44 | 1.05 | 1.04 |
| 0.965 | 2/13/1973 | 43 | 1.07 | 1.06 |
| 0.9696 | 2/14/1998 | 42 | 1.10 | 1.09 |
| 0.9819 | 1/3/1977 | 41 | 1.12 | 1.11 |
| 0.9935 | 2/28/1978 | 40 | 1.15 | 1.14 |
| 1.0045 | 2/20/1980 | 39 | 1.18 | 1.17 |
| 1.0058 | 10/28/1974 | 38 | 1.21 | 1.20 |
| 1.021 | 3/13/1996 | 37 | 1.24 | 1.23 |
| 1.0515 | 12/18/1967 | 36 | 1.28 | 1.27 |
| 1.0837 | 1/29/1980 | 35 | 1.31 | 1.31 |
| 1.094 | 2/8/1976 | 34 | 1.35 | 1.35 |
| 1.1014 | 11/30/1982 | 33 | 1.39 | 1.39 |
| 1.1252 | 4/1/1982 | 32 | 1.44 | 1.43 |
| 1.1262 | 3/1/1978 | 31 | 1.48 | 1.48 |
| 1.1341 | 3/24/1983 | 30 | 1.53 | 1.53 |
| 1.1855 | 1/13/1993 | 29 | 1.59 | 1.58 |
| 1.214 | 1/29/1980 | 28 | 1.64 | 1.64 |
| 1.2176 | 2/3/1998 | 27 | 1.70 | 1.70 |
| 1.2324 | 9/10/1976 | 26 | 1.77 | 1.77 |
| 1.2607 | 11/20/1983 | 25 | 1.84 | 1.84 |
| 1.2704 | 3/3/1980 | 24 | 1.92 | 1.92 |
| 1.2719 | 2/6/1969 | 23 | 2.00 | 2.00 |
| 1.3157 | 1/9/2005 | 22 | 2.09 | 2.09 |
| 1.3315 | 2/15/1986 | 21 | 2.19 | 2.19 |
| 1.3768 | 2/8/1998 | 20 | 2.30 | 2.31 |
| 1.3844 | 11/11/1985 | 19 | 2.42 | 2.43 |
| 1.4314 | 1/7/1993 | 18 | 2.56 | 2.57 |
| 1.4778 | 8/17/1977 | 17 | 2.71 | 2.72 |
| 1.5592 | 3/5/1995 | 16 | 2.88 | 2.90 |
| 1.803 | 2/16/1980 | 15 | 3.07 | 3.10 |
| 1.8379 | 2/10/1978 | 14 | 3.29 | 3.32 |
| 1.8532 | 11/30/2007 | 13 | 3.54 | 3.59 |
| 1.8648 | 11/29/1970 | 12 | 3.83 | 3.90 |
| 1.8929 | 3/1/1991 | 11 | 4.18 | 4.26 |
| 1.9951 | 1/14/1969 | 10 | 4.60 | 4.71 |
| 2.0166 | 3/1/1983 | 9 | 5.11 | 5.26 |
| 2.0433 | 1/25/1995 | 8 | 5.75 | 5.95 |
| 2.0892 | 1/4/1995 | 7 | 6.57 | 6.85 |
| 2.1152 | 10/20/2004 | 6 | 7.67 | 8.07 |
| 2.2471 | 2/22/2004 | 5 | 9.20 | 9.83 |
| 2.6129 | 2/14/1995 | 4 | 11.50 | 12.56 |
| 2.8537 | 1/31/1979 | 3 | 15.33 | 17.38 |
| 3.0416 | 11/23/1965 | 2 | 23.00 | 28.25 |
| 5.9768 | 2/20/1980 | 1 | 46.00 | 75.33 |

**List of Peak events and Determination of P2 and P10 (Pre-Development)**
**Tractor Supply POC 1 - Lakeside**

| T (Year) | Cunnane (cfs) | Weibull (cfs) | Peaks (cfs) | Date | Posit | Period of Return (Years) | |
|---|---|---|---|---|---|---|---|
| **10** | **2.45** | **2.49** | | | | Weibull | Cunnane |
| **9** | **2.43** | **2.44** | 1.1929 | 1/31/1996 | 45 | 1.02 | 1.01 |
| **8** | **2.39** | **2.41** | 1.2144 | 2/18/1980 | 44 | 1.05 | 1.04 |
| **7** | **2.21** | **2.27** | 1.2231 | 3/8/1973 | 43 | 1.07 | 1.06 |
| **6** | **2.18** | **2.18** | 1.2535 | 3/14/1982 | 42 | 1.10 | 1.09 |
| **5** | **2.13** | **2.15** | 1.2554 | 2/8/1993 | 41 | 1.12 | 1.11 |
| **4** | **2.00** | **2.03** | 1.2658 | 10/31/1987 | 40 | 1.15 | 1.14 |
| **3** | **1.89** | **1.89** | 1.2762 | 2/21/2005 | 39 | 1.18 | 1.17 |
| **2** | **1.56** | **1.56** | 1.3284 | 11/11/1985 | 38 | 1.21 | 1.20 |
| | | | 1.3913 | 2/19/1980 | 37 | 1.24 | 1.23 |
| | | | 1.4502 | 12/28/1977 | 36 | 1.28 | 1.27 |
| | | | 1.4722 | 8/17/1977 | 35 | 1.31 | 1.31 |
| | | | 1.4791 | 3/18/1983 | 34 | 1.35 | 1.35 |
| | | | 1.4975 | 1/13/1993 | 33 | 1.39 | 1.39 |
| | | | 1.4976 | 3/13/1996 | 32 | 1.44 | 1.43 |
| | | | 1.5027 | 12/18/1967 | 31 | 1.48 | 1.48 |
| | | | 1.5034 | 2/16/1980 | 30 | 1.53 | 1.53 |
| | | | 1.5132 | 1/3/1977 | 29 | 1.59 | 1.58 |
| | | | 1.5138 | 2/13/1973 | 28 | 1.64 | 1.64 |
| | | | 1.515 | 2/10/1978 | 27 | 1.70 | 1.70 |
| | | | 1.5169 | 1/4/1995 | 26 | 1.77 | 1.77 |
| | | | 1.5448 | 3/1/1991 | 25 | 1.84 | 1.84 |
| | | | 1.5488 | 2/14/1998 | 24 | 1.92 | 1.92 |
| | | | 1.5642 | 11/29/1970 | 23 | 2.00 | 2.00 |
| | | | 1.5843 | 3/4/1978 | 22 | 2.09 | 2.09 |
| | | | 1.5993 | 1/30/1980 | 21 | 2.19 | 2.19 |
| | | | 1.6207 | 1/7/1993 | 20 | 2.30 | 2.31 |
| | | | 1.6943 | 4/1/1982 | 19 | 2.42 | 2.43 |
| | | | 1.7422 | 2/28/1978 | 18 | 2.56 | 2.57 |
| | | | 1.7826 | 3/1/1983 | 17 | 2.71 | 2.72 |
| | | | 1.8804 | 2/22/2004 | 16 | 2.88 | 2.90 |
| | | | 1.8903 | 3/24/1983 | 15 | 3.07 | 3.10 |
| | | | 1.9504 | 2/3/1998 | 14 | 3.29 | 3.32 |
| | | | 1.952 | 2/6/1969 | 13 | 3.54 | 3.59 |
| | | | 1.9683 | 11/20/1983 | 12 | 3.83 | 3.90 |
| | | | 2.0931 | 1/9/2005 | 11 | 4.18 | 4.26 |
| | | | 2.0985 | 2/8/1998 | 10 | 4.60 | 4.71 |
| | | | 2.1624 | 3/3/1980 | 9 | 5.11 | 5.26 |
| | | | 2.1825 | 2/14/1995 | 8 | 5.75 | 5.95 |
| | | | 2.1835 | 1/31/1979 | 7 | 6.57 | 6.85 |
| | | | 2.402 | 1/14/1969 | 6 | 7.67 | 8.07 |
| | | | 2.4464 | 11/23/1965 | 5 | 9.20 | 9.83 |
| | | | 2.5725 | 11/30/2007 | 4 | 11.50 | 12.56 |
| | | | 2.867 | 10/20/2004 | 3 | 15.33 | 17.38 |
| | | | 3.0403 | 1/25/1995 | 2 | 23.00 | 28.25 |
| | | | 4.691 | 2/20/1980 | 1 | 46.00 | 75.33 |

Note:
Cunnane is the preferred method by the HMP permit.

**List of Peak events and Determination of P2 and P10 (Post-Development)**
**Tractor Supply POC-2 - Lakeside**

| T (Year) | Cunnane (cfs) | Weibull (cfs) | Peaks (cfs) | Date | Posit | Period of Return (Years) | |
|---|---|---|---|---|---|---|---|
| **10** | **1.23** | **1.23** | | | | Weibull | Cunnane |
| **9** | **1.21** | **1.22** | 0.7215 | 2/13/1973 | 45 | 1.02 | 1.01 |
| **8** | **1.19** | **1.20** | 0.7233 | 1/13/1993 | 44 | 1.05 | 1.04 |
| **7** | **1.16** | **1.17** | 0.7237 | 1/4/1995 | 43 | 1.07 | 1.06 |
| **6** | **1.15** | **1.15** | 0.7241 | 12/18/1967 | 42 | 1.10 | 1.09 |
| **5** | **1.08** | **1.09** | 0.7388 | 2/16/1980 | 41 | 1.12 | 1.11 |
| **4** | **0.98** | **0.99** | 0.74 | 2/14/1998 | 40 | 1.15 | 1.14 |
| **3** | **0.93** | **0.94** | 0.7407 | 11/29/1970 | 39 | 1.18 | 1.17 |
| **2** | **0.87** | **0.87** | 0.753 | 2/25/1996 | 38 | 1.21 | 1.20 |
| | | | 0.7546 | 3/4/1978 | 37 | 1.24 | 1.23 |
| | | | 0.7582 | 4/1/1968 | 36 | 1.28 | 1.27 |
| | | | 0.7852 | 8/16/1983 | 35 | 1.31 | 1.31 |
| | | | 0.7863 | 3/1/1991 | 34 | 1.35 | 1.35 |
| | | | 0.7886 | 5/11/1989 | 33 | 1.39 | 1.39 |
| | | | 0.7938 | 4/1/1982 | 32 | 1.44 | 1.43 |
| | | | 0.7953 | 1/9/1980 | 31 | 1.48 | 1.48 |
| | | | 0.7957 | 1/7/1993 | 30 | 1.53 | 1.53 |
| | | | 0.8018 | 3/18/1983 | 29 | 1.59 | 1.58 |
| | | | 0.8023 | 12/4/1987 | 28 | 1.64 | 1.64 |
| | | | 0.8103 | 1/3/1977 | 27 | 1.70 | 1.70 |
| | | | 0.8124 | 1/30/1980 | 26 | 1.77 | 1.77 |
| | | | 0.8484 | 11/11/1985 | 25 | 1.84 | 1.84 |
| | | | 0.8552 | 1/29/1983 | 24 | 1.92 | 1.92 |
| | | | 0.8663 | 3/24/1983 | 23 | 2.00 | 2.00 |
| | | | 0.8685 | 2/22/2004 | 22 | 2.09 | 2.09 |
| | | | 0.8881 | 2/3/1998 | 21 | 2.19 | 2.19 |
| | | | 0.8907 | 9/3/1976 | 20 | 2.30 | 2.31 |
| | | | 0.8948 | 2/28/1978 | 19 | 2.42 | 2.43 |
| | | | 0.8963 | 3/1/1983 | 18 | 2.56 | 2.57 |
| | | | 0.8972 | 11/20/1983 | 17 | 2.71 | 2.72 |
| | | | 0.9244 | 3/13/1996 | 16 | 2.88 | 2.90 |
| | | | 0.9436 | 2/8/1998 | 15 | 3.07 | 3.10 |
| | | | 0.9459 | 1/9/2005 | 14 | 3.29 | 3.32 |
| | | | 0.9612 | 4/28/2005 | 13 | 3.54 | 3.59 |
| | | | 0.9775 | 2/8/1993 | 12 | 3.83 | 3.90 |
| | | | 1.001 | 1/31/1979 | 11 | 4.18 | 4.26 |
| | | | 1.0717 | 1/14/1969 | 10 | 4.60 | 4.71 |
| | | | 1.0917 | 11/23/1965 | 9 | 5.11 | 5.26 |
| | | | 1.1496 | 2/14/1995 | 8 | 5.75 | 5.95 |
| | | | 1.1528 | 3/3/1980 | 7 | 6.57 | 6.85 |
| | | | 1.1891 | 12/23/1995 | 6 | 7.67 | 8.07 |
| | | | 1.2244 | 11/30/2007 | 5 | 9.20 | 9.83 |
| | | | 1.2348 | 10/20/2004 | 4 | 11.50 | 12.56 |
| | | | 1.2488 | 2/6/1969 | 3 | 15.33 | 17.38 |
| | | | 1.3152 | 1/25/1995 | 2 | 23.00 | 28.25 |
| | | | 1.9246 | 2/20/1980 | 1 | 46.00 | 75.33 |

Note:
Cunnane is the preferred method by the HMP permit.

**List of Peak events and Determination of P2 and P10 (Pre-Development)**
**Tractor Supply POC-2 - Lakeside**

| T (Year) | Cunnane (cfs) | Weibull (cfs) | Peaks (cfs) | Date | Posit | Period of Return (Years) | |
|---|---|---|---|---|---|---|---|
| **10** | **1.83** | **1.85** | | | | Weibull | Cunnane |
| **9** | **1.81** | **1.82** | 0.9911 | 10/31/1987 | 45 | 1.02 | 1.01 |
| **8** | **1.78** | **1.79** | 1.001 | 11/14/1993 | 44 | 1.05 | 1.04 |
| **7** | **1.77** | **1.77** | 1.0354 | 4/28/2005 | 43 | 1.07 | 1.06 |
| **6** | **1.68** | **1.70** | 1.0663 | 2/19/1980 | 42 | 1.10 | 1.09 |
| **5** | **1.60** | **1.61** | 1.0664 | 3/31/1992 | 41 | 1.12 | 1.11 |
| **4** | **1.53** | **1.53** | 1.0752 | 1/9/1980 | 40 | 1.15 | 1.14 |
| **3** | **1.39** | **1.39** | 1.1048 | 12/28/1977 | 39 | 1.18 | 1.17 |
| **2** | **1.24** | **1.24** | 1.1192 | 8/17/1977 | 38 | 1.21 | 1.20 |
| | | | 1.1431 | 12/18/1967 | 37 | 1.24 | 1.23 |
| | | | 1.1448 | 1/13/1993 | 36 | 1.28 | 1.27 |
| | | | 1.1466 | 2/13/1973 | 35 | 1.31 | 1.31 |
| | | | 1.1471 | 2/10/1978 | 34 | 1.35 | 1.35 |
| | | | 1.1478 | 1/4/1995 | 33 | 1.39 | 1.39 |
| | | | 1.15 | 2/16/1980 | 32 | 1.44 | 1.43 |
| | | | 1.1725 | 2/14/1998 | 31 | 1.48 | 1.48 |
| | | | 1.1741 | 2/8/1993 | 30 | 1.53 | 1.53 |
| | | | 1.1796 | 11/29/1970 | 29 | 1.59 | 1.58 |
| | | | 1.18 | 4/1/1982 | 28 | 1.64 | 1.64 |
| | | | 1.1868 | 3/4/1978 | 27 | 1.70 | 1.70 |
| | | | 1.2039 | 11/11/1985 | 26 | 1.77 | 1.77 |
| | | | 1.2067 | 3/18/1983 | 25 | 1.84 | 1.84 |
| | | | 1.2139 | 3/1/1991 | 24 | 1.92 | 1.92 |
| | | | 1.2401 | 1/3/1977 | 23 | 2.00 | 2.00 |
| | | | 1.2509 | 1/30/1980 | 22 | 2.09 | 2.09 |
| | | | 1.2558 | 1/7/1993 | 21 | 2.19 | 2.19 |
| | | | 1.3322 | 12/23/1995 | 20 | 2.30 | 2.31 |
| | | | 1.3485 | 2/28/1978 | 19 | 2.42 | 2.43 |
| | | | 1.3669 | 3/13/1996 | 18 | 2.56 | 2.57 |
| | | | 1.3691 | 11/20/1983 | 17 | 2.71 | 2.72 |
| | | | 1.3928 | 3/24/1983 | 16 | 2.88 | 2.90 |
| | | | 1.3944 | 2/22/2004 | 15 | 3.07 | 3.10 |
| | | | 1.3967 | 3/1/1983 | 14 | 3.29 | 3.32 |
| | | | 1.4325 | 2/3/1998 | 13 | 3.54 | 3.59 |
| | | | 1.5285 | 2/8/1998 | 12 | 3.83 | 3.90 |
| | | | 1.5297 | 1/9/2005 | 11 | 4.18 | 4.26 |
| | | | 1.5723 | 1/14/1969 | 10 | 4.60 | 4.71 |
| | | | 1.624 | 1/31/1979 | 9 | 5.11 | 5.26 |
| | | | 1.67 | 3/3/1980 | 8 | 5.75 | 5.95 |
| | | | 1.7658 | 2/14/1995 | 7 | 6.57 | 6.85 |
| | | | 1.7796 | 11/23/1965 | 6 | 7.67 | 8.07 |
| | | | 1.8301 | 2/6/1969 | 5 | 9.20 | 9.83 |
| | | | 1.8918 | 11/30/2007 | 4 | 11.50 | 12.56 |
| | | | 2.0284 | 10/20/2004 | 3 | 15.33 | 17.38 |
| | | | 2.1585 | 1/25/1995 | 2 | 23.00 | 28.25 |
| | | | 3.2173 | 2/20/1980 | 1 | 46.00 | 75.33 |

Note:
Cunnane is the preferred method by the HMP permit.

# ATTACHMENT 4

## AREA VS ELEVATION

The area vs. elevation curve in the model is calculated in Excel and imported into the model. Stage-storage relationships are only needed for basins A&F ,C and E, however due to the fact that basin E has vertical walls; a relationship was not required to be calculated for it as the area vs elevation remains constant. For basins A&F and C an area vs elevation was calculated in Excel and is provided on the following pages.

To satisfy water quality criteria – a stage storage calculation verifying water quality volume containment is provided on the following pages.

## DISCHARGE VS ELEVATION

The total discharge peak flow is imported from an Excel spreadsheet that calculates the discharge vs. elevation of the multiple outlet systems. Discharge vs. elevation relationships are only needed for detention basin E, because that is the only basin where a Modified Puls routing procedure will be taken into account in the continuous simulation model.

The orifices have been selected to maximize their size while still restricting flows to conform with the required 30% of the Q2 event flow as mandated in the Final Hydromodification Management Plan by Brown & Caldwell, dated March 2011. While TRWE acknowledges that these orifices are small, to increase the size of these outlets would impact the basin's ability to restrict flows beneath the HMP thresholds, thus preventing the BMP from conformance with HMP requirements.

In order to further reduce the risk of blockage of the orifices, regular maintenance of the riser and orifices must be performed to ensure potential blockages are minimized. A detail of the orifice and riser structure is provided in Attachment 5 of this memorandum.

A stage-discharge relationship was developed to represent the outlet structure for the detention basin and is provided on the following pages.

## DRAWDOWN CALCULATIONS

Drawdown calculations are provided on the following pages to illustrate the LID BMPs ability to not exceed the 96 hour requirement for standing water.

## DISCHARGE EQUATIONS

1) Weir:

$$Q_W = C_W \cdot L \cdot H^{3/2} \qquad (1)$$

2) Slot:

As an orifice: $$Q_s = B_s \cdot h_s \cdot c_g \cdot \sqrt{2g\left(H - \frac{h_s}{2}\right)} \qquad (2.a)$$

As a weir: $$Q_s = C_W \cdot B_s \cdot H^{3/2} \qquad (2.b)$$

For H > $h_s$ slot works as weir until orifice equation provides a smaller discharge. The elevation such that equation (2.a) = equation (2.b) is the elevation at which the behavior changes from weir to orifice.

3) Vertical Orifices

As an orifice: $$Q_o = 0.25 \cdot \pi D^2 \cdot c_g \cdot \sqrt{2g\left(H - \frac{D}{2}\right)} \qquad (3.a)$$

As a weir: Critical depth and geometric family of circular sector must be solved to determined Q as a function of H:

$$\frac{Q_O^2}{g} = \frac{A_{cr}^3}{T_{cr}}; \quad H = y_{cr} + \frac{A_{cr}}{2 \cdot T_{cr}}; \; T_{cr} = 2\sqrt{y_{cr}(D - y_{cr})}; \quad A_{cr} = \frac{D^2}{8}[\alpha_{cr} - sin(\alpha_{cr})];$$

$$y_{cr} = \frac{D}{2}[1 - sin(0.5 \cdot \alpha_{cr})] \qquad (3.b.1, 3.b.2, 3.b.3, 3.b.4 \text{ and } 3.b.5)$$

There is a value of H (approximately H = 110% D) from which orifices no longer work as weirs as critical depth is not possible at the entrance of the orifice. This value of H is obtained equaling the discharge using critical equations and equations (3.b).

A mathematical model is prepared with the previous equations depending on the type o discharge.

The following are the variables used above:

$Q_W$, $Q_s$, $Q_O$ = Discharge of weir, slot or orifice (cfs)

$C_W$, $c_g$ : Coefficients of discharge of weir (typically 3.1) and orifice (0.61 to 0.62)

L, $B_s$, D, $h_s$ : Length of weir, width of slot, diameter of orifice and height of slot, respectively; (ft)

H: Level of water in the pond over the invert of slot, weir or orifice (ft)

$A_{cr}$, $T_{cr}$, $y_{cr}$, $\alpha_{cr}$: Critical variables for circular sector: area (sq-ft), top width (ft), critical depth (ft), and angle to the center, respectively.

## STAGE STORAGE CALCULATIONS A & F

| Elevation (ft) | Area (ft^2) | Volume (ft^3) | |
|---|---|---|---|
| 0.00 | 698.0 | 0.0 | BIORETENTION (1) |
| 0.75 | 977.9 | 628.5 | SURFACE OUTLET (2) |
| 1.00 | 1078.8 | 885.6 | |
| 1.50 | 1292.0 | 1478.3 | |
| 2.50 | 1764.0 | 3006.3 | |

### SUB SURFACE STORAGE BASIN A

| Elevation (ft) | Area (ft^2) | Volume (ft^3) | |
|---|---|---|---|
| -1.50 | 698.0 | 314.1 | Amended Soil Base (0.3 voids) |
| -2.00 | 698.0 | 139.6 | Gravel Base (0.4 voids) |
| **Gravel & Amended Soil** | **TOTAL =** | 453.7 | (ft^3) |
| **Surface Total** | **TOTAL =** | 628.5 | **(ft^3)** |
| **BMP** | **TOTAL =** | **1082.2** | |

## STAGE STORAGE CALCULATIONS C

| Elevation (ft) | Area (ft^2) | Volume (ft^3) | | |
|---|---|---|---|---|
| 0.00 | 627.0 | 0.0 | | |
| 1.00 | 966.6 | 796.8 | | |
| 1.50 | 1133.3 | 1321.7 | BIORETENTION (1)(2) | 0.00 |
| 2.00 | 1298.0 | 1929.6 | | 0.50 |
| 3.00 | 1621.4 | 3389.3 | | 1.50 |
| 3.50 | 1780.0 | 4239.6 | | 2.00 |

### SUB SURFACE STORAGE BASIN C

| Elevation (ft) | Area (ft^2) | Volume (ft^3) | |
|---|---|---|---|
| -1.50 | 1151.5 | 518.2 | Amended Soil Base (0.3 voids) |
| -2.00 | 1151.5 | 230.3 | Gravel Base (0.4 voids) |
| **Gravel & Amended Soil** | **TOTAL =** | 748.5 | (ft^3) |
| **Surface Total** | **TOTAL =** | 1321.7 | (ft^3) |
| **BMP** | **TOTAL =** | **2070.2** | **(ft^3)** |

(1): The area at this surface elevation corresponds to the area of gravel and amended soil (Bio-retention layer)
(2): Volume at this elevation coresponds with surface volume for WQ purposes (invert of lowest surface outlet)

## STAGE STORAGE CALCULATIONS B

| Elevation (ft) | Area (ft^2) | Volume (ft^3) | |
|---|---|---|---|
| 0.00 | 630.0 | 0.0 | BIORETENTION (1) |
| 0.75 | 787.5 | 531.6 | SURFACE OUTLET (2) |
| 1.00 | 840.0 | 735.0 | |

### SUB SURFACE STORAGE BASIN B

| Elevation (ft) | Area (ft^2) | Volume (ft^3) | |
|---|---|---|---|
| -1.50 | 630.0 | 283.5 | Amended Soil Base (0.3 voids) |
| -3.00 | 630.0 | 378.0 | Gravel Base (0.4 voids) |
| **Gravel & Amended Soil** | **TOTAL =** | 661.5 | (ft^3) |
| **Surface Total** | **TOTAL =** | 531.6 | (ft^3) |
| **BMP** | **TOTAL =** | **1193.1** | **(ft^3)** |

## STAGE STORAGE CALCULATIONS D

| Elevation (ft) | Area (ft^2) | Volume (ft^3) | |
|---|---|---|---|
| 0.00 | 370.0 | 0.0 | |
| 1.00 | 536.0 | 453.0 | BIORETENTION (1) |
| 1.50 | 629.5 | 744.4 | SURFACE OUTLET (2) |
| 2.00 | 730.0 | 1084.3 | |

### SUB SURFACE STORAGE BASIN D

| Elevation (ft) | Area (ft^2) | Volume (ft^3) | |
|---|---|---|---|
| -1.50 | 536.0 | 241.2 | Amended Soil Base (0.3 voids) |
| -2.00 | 536.0 | 107.2 | Gravel Base (0.4 voids) |
| **Gravel & Amended Soil** | **TOTAL =** | 348.4 | (ft^3) |
| **Surface Total** | **TOTAL =** | 744.4 | (ft^3) |
| **BMP** | **TOTAL =** | **1092.8** | **(ft^3)** |

# DRAW DOWN CALCULATIONS

## DRAW DOWN CALCULATIONS A

| Elevation (ft) | Area (ft^2) | Volume (ft^3) |
|---|---|---|
| 0.00 | 698.0 | 0.0 |
| 0.75 | 977.9 | 628.5 |
| 1.00 | 1078.8 | 885.6 |
| 1.50 | 1292.0 | 1478.3 |
| 2.00 | 1520.4 | **2181.4** |
| 2.50 | 1764.0 | 3002.5 |

**Drawdown Rate** 0.03716 cfs (1.5" in orifice)
**Time to Drain Surface** 16.3060 hrs

## DRAW DOWN CALCULATIONS C

| Elevation (ft) | Area (ft^2) | Volume (ft^3) |
|---|---|---|
| 0.00 | 627.0 | 0.0 |
| 1.00 | 966.6 | 796.8 |
| 1.50 | 1133.3 | 1321.7 |
| 2.00 | 1298.0 | 1929.6 |
| 2.25 | 1379.6 | 2264.3 |
| 3.00 | 1621.4 | 3389.6 |
| 3.17 | 1675.5 | **3669.9** |
| 3.50 | 1780.0 | 4240.0 |

**Drawdown Rate** 0.04915 cfs (1.75" in orifice)
**Time to Drain Surface** 20.7418 hrs

## DRAW DOWN CALCULATIONS B

| Elevation (ft) | Area (ft^2) | Volume (ft^3) |
|---|---|---|
| 0.00 | 630.0 | 0.0 |
| 0.75 | 787.5 | **531.6** |
| 1.00 | 840.0 | 735.0 |

**Drawdown Rate** 0.0321 cfs (1" in orifice)
**Time to Drain Surface** 4.5999 hrs

## DRAW DOWN CALCULATIONS D

| Elevation (ft) | Area (ft^2) | Volume (ft^3) |
|---|---|---|
| 0.00 | 482.0 | 0.0 |
| 1.00 | 555.0 | 518.5 |
| 1.50 | 591.0 | **805.0** |
| 2.00 | 627.0 | 1109.5 |

**Drawdown Rate** 0.0321 cfs (1" in orifice)
**Time to Drain Surface** 6.9661 hrs

**Note:** Volume in excess of the riser elevation will discharge via the riser opening
Also - it has been conservatively estimated that **ALL** surface orifices & slots are not functional, thus these are LID drawdown times only.

## Outlet structure for Discharge of Detention Basin A

**Discharge vs Elevation Table**

| | | | | | |
|---|---|---|---|---|---|
| Low orifice: | 3 " | Lower slot | | Emergency Weir | |
| Number: | 0 | Invert: | 0.00 ft | Invert: | 1.25 ft |
| Cg-low: | 0.62 | B | 1.50 ft | B: | 12 ft |
| Middle orifice: | 3.5 " | h | 0.167 ft | | |
| number of orif: | 0 | Upper slot | | | |
| Cg-middle: | 0.62 | Invert: | 0.00 ft | | |
| invert elev: | 0.75 ft | B: | 0.00 ft | | |
| | | h | 0.000 ft | | |

| h (ft) | H/D-low - | H/D-mid - | Qlow-orif (cfs) | Qlow-weir (cfs) | Qtot-low (cfs) | Qmid-orif (cfs) | Qmid-weir (cfs) | Qtot-med (cfs) | Qslot-low (cfs) | Qslot-upp (cfs) | Qemer (cfs) | Qtot (cfs) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | | 0.000 |
| 0.042 | 0.167 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.039 | 0.000 | | 0.039 |
| 0.083 | 0.333 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.112 | 0.000 | | 0.112 |
| 0.125 | 0.500 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.205 | 0.000 | | 0.205 |
| 0.167 | 0.667 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.316 | 0.000 | | 0.316 |
| 0.208 | 0.833 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.433 | 0.000 | | 0.433 |
| 0.250 | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.499 | 0.000 | | 0.499 |
| 0.292 | 1.167 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.558 | 0.000 | | 0.558 |
| 0.333 | 1.333 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.612 | 0.000 | | 0.612 |
| 0.375 | 1.500 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.661 | 0.000 | | 0.661 |
| 0.417 | 1.667 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.706 | 0.000 | | 0.706 |
| 0.458 | 1.833 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.749 | 0.000 | | 0.749 |
| 0.500 | 2.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.790 | 0.000 | | 0.790 |
| 0.542 | 2.167 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.828 | 0.000 | | 0.828 |
| 0.583 | 2.333 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.865 | 0.000 | | 0.865 |
| 0.625 | 2.500 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.901 | 0.000 | | 0.901 |
| 0.667 | 2.667 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.935 | 0.000 | | 0.935 |
| 0.708 | 2.833 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.967 | 0.000 | | 0.967 |
| 0.750 | 3.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.999 | 0.000 | | 0.999 |
| 0.792 | 3.167 | 0.143 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.030 | 0.000 | | 1.030 |
| 0.833 | 3.333 | 0.286 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.060 | 0.000 | | 1.060 |
| 0.875 | 3.500 | 0.429 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.089 | 0.000 | | 1.089 |
| 0.917 | 3.667 | 0.571 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.117 | 0.000 | | 1.117 |
| 0.958 | 3.833 | 0.714 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.145 | 0.000 | | 1.145 |
| 1.000 | 4.000 | 0.857 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.172 | 0.000 | | 1.172 |
| 1.042 | 4.167 | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.198 | 0.000 | | 1.198 |
| 1.083 | 4.333 | 1.143 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.224 | 0.000 | | 1.224 |
| 1.125 | 4.500 | 1.286 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.249 | 0.000 | | 1.249 |
| 1.167 | 4.667 | 1.429 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.274 | 0.000 | | 1.274 |
| 1.208 | 4.833 | 1.571 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.298 | 0.000 | | 1.298 |
| 1.250 | 5.000 | 1.714 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.322 | 0.000 | | 1.322 |
| 1.292 | 5.167 | 1.857 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.345 | 0.000 | | 1.345 |
| 1.333 | 5.333 | 2.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.368 | 0.000 | | 1.368 |
| 1.375 | 5.500 | 2.143 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.391 | 0.000 | 1.644 | 1.391 |
| 1.417 | 5.667 | 2.286 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.413 | 0.000 | 2.531 | 1.413 |
| 1.458 | 5.833 | 2.429 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.435 | 0.000 | 3.537 | 4.972 |
| 1.500 | 6.000 | 2.571 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.457 | 0.000 | 4.650 | 6.107 |
| 1.542 | 6.167 | 2.714 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.478 | 0.000 | 5.860 | 7.337 |
| 1.583 | 6.333 | 2.857 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.499 | 0.000 | 7.159 | 8.658 |
| 1.625 | 6.500 | 3.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.519 | 0.000 | 8.543 | 10.062 |
| 1.667 | 6.667 | 3.143 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.540 | 0.000 | 10.005 | 11.545 |
| 1.708 | 6.833 | 3.286 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.560 | 0.000 | 11.543 | 13.103 |
| 1.750 | 7.000 | 3.429 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.580 | 0.000 | 13.152 | 14.732 |

## Outlet structure for Discharge of Detention Basin C

**Discharge vs Elevation Table**

| | | | | | |
|---|---|---|---|---|---|
| Low orifice: | 3 " | Lower slot | | Emergency Weir | |
| Number: | 3 | Invert: | 0.75 ft | Invert: | 1.67 ft |
| Cg-low: | 0.62 | B | 2.25 ft | B: | 8 ft |
| Middle orifice: | 2.25 " | h | 0.250 ft | | |
| number of orif: | 0 | Upper slot | | | |
| Cg-middle: | 0.62 | Invert: | 0.00 ft | | |
| invert elev: | 0.50 ft | B: | 0.00 ft | | |
| | | h | 0.000 ft | | |

| h (ft) | H/D-low - | H/D-mid - | Qlow-orif (cfs) | Qlow-weir (cfs) | Qtot-low (cfs) | Qmid-orif (cfs) | Qmid-weir (cfs) | Qtot-med (cfs) | Qslot-low (cfs) | Qslot-upp (cfs) | Qemer (cfs) | Qtot (cfs) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | | 0.000 |
| 0.042 | 0.167 | 0.000 | 0.000 | 0.009 | 0.009 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | | 0.009 |
| 0.083 | 0.333 | 0.000 | 0.000 | 0.033 | 0.033 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | | 0.033 |
| 0.125 | 0.500 | 0.000 | 0.000 | 0.072 | 0.072 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | | 0.072 |
| 0.167 | 0.667 | 0.000 | 0.150 | 0.122 | 0.122 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | | 0.122 |
| 0.208 | 0.833 | 0.000 | 0.212 | 0.180 | 0.180 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | | 0.180 |
| 0.250 | 1.000 | 0.000 | 0.259 | 0.244 | 0.244 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | | 0.244 |
| 0.292 | 1.167 | 0.000 | 0.299 | 0.310 | 0.299 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | | 0.299 |
| 0.333 | 1.333 | 0.000 | 0.334 | 0.376 | 0.334 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | | 0.334 |
| 0.375 | 1.500 | 0.000 | 0.366 | 0.438 | 0.366 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | | 0.366 |
| 0.417 | 1.667 | 0.000 | 0.396 | 0.496 | 0.396 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | | 0.396 |
| 0.458 | 1.833 | 0.000 | 0.423 | 0.545 | 0.423 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | | 0.423 |
| 0.500 | 2.000 | 0.000 | 0.449 | 0.586 | 0.449 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | | 0.449 |
| 0.542 | 2.167 | 0.222 | 0.473 | 0.617 | 0.473 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | | 0.473 |
| 0.583 | 2.333 | 0.444 | 0.496 | 0.639 | 0.496 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | | 0.496 |
| 0.625 | 2.500 | 0.667 | 0.518 | 0.652 | 0.518 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | | 0.518 |
| 0.667 | 2.667 | 0.889 | 0.539 | 0.658 | 0.539 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | | 0.539 |
| 0.708 | 2.833 | 1.111 | 0.560 | 0.659 | 0.560 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | | 0.560 |
| 0.750 | 3.000 | 1.333 | 0.579 | 0.662 | 0.579 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | | 0.579 |
| 0.792 | 3.167 | 1.556 | 0.598 | 0.670 | 0.598 | 0.000 | 0.000 | 0.000 | 0.059 | 0.000 | | 0.658 |
| 0.833 | 3.333 | 1.778 | 0.617 | 0.691 | 0.617 | 0.000 | 0.000 | 0.000 | 0.168 | 0.000 | | 0.784 |
| 0.875 | 3.500 | 2.000 | 0.635 | 0.734 | 0.635 | 0.000 | 0.000 | 0.000 | 0.308 | 0.000 | | 0.943 |
| 0.917 | 3.667 | 2.222 | 0.652 | 0.810 | 0.652 | 0.000 | 0.000 | 0.000 | 0.475 | 0.000 | | 1.127 |
| 0.958 | 3.833 | 2.444 | 0.669 | 0.929 | 0.669 | 0.000 | 0.000 | 0.000 | 0.663 | 0.000 | | 1.332 |
| 1.000 | 4.000 | 2.667 | 0.685 | 1.107 | 0.685 | 0.000 | 0.000 | 0.000 | 0.872 | 0.000 | | 1.557 |
| 1.042 | 4.167 | 2.889 | 0.702 | 1.359 | 0.702 | 0.000 | 0.000 | 0.000 | 1.099 | 0.000 | | 1.800 |
| 1.083 | 4.333 | 3.111 | 0.717 | 1.704 | 0.717 | 0.000 | 0.000 | 0.000 | 1.257 | 0.000 | | 1.974 |
| 1.125 | 4.500 | 3.333 | 0.733 | 2.163 | 0.733 | 0.000 | 0.000 | 0.000 | 1.377 | 0.000 | | 2.109 |
| 1.167 | 4.667 | 3.556 | 0.748 | 2.758 | 0.748 | 0.000 | 0.000 | 0.000 | 1.487 | 0.000 | | 2.235 |
| 1.208 | 4.833 | 3.778 | 0.763 | 3.516 | 0.763 | 0.000 | 0.000 | 0.000 | 1.590 | 0.000 | | 2.352 |
| 1.250 | 5.000 | 4.000 | 0.777 | 4.463 | 0.777 | 0.000 | 0.000 | 0.000 | 1.686 | 0.000 | | 2.463 |
| 1.292 | 5.167 | 4.222 | 0.791 | 5.631 | 0.791 | 0.000 | 0.000 | 0.000 | 1.777 | 0.000 | | 2.569 |
| 1.333 | 5.333 | 4.444 | 0.805 | 7.054 | 0.805 | 0.000 | 0.000 | 0.000 | 1.864 | 0.000 | | 2.670 |
| 1.375 | 5.500 | 4.667 | 0.819 | 8.192 | 0.819 | 0.000 | 0.000 | 0.000 | 1.947 | 0.000 | 0.000 | 2.766 |
| 1.417 | 5.667 | 4.889 | 0.833 | 8.327 | 0.833 | 0.000 | 0.000 | 0.000 | 2.027 | 0.000 | 0.000 | 2.859 |
| 1.458 | 5.833 | 5.111 | 0.846 | 8.460 | 0.846 | 0.000 | 0.000 | 0.000 | 2.103 | 0.000 | 0.000 | 2.949 |
| 1.500 | 6.000 | 5.333 | 0.859 | 8.592 | 0.859 | 0.000 | 0.000 | 0.000 | 2.177 | 0.000 | 0.000 | 3.036 |
| 1.542 | 6.167 | 5.556 | 0.872 | 8.721 | 0.872 | 0.000 | 0.000 | 0.000 | 2.248 | 0.000 | 0.000 | 3.120 |
| 1.583 | 6.333 | 5.778 | 0.885 | 8.848 | 0.885 | 0.000 | 0.000 | 0.000 | 2.317 | 0.000 | 0.000 | 3.202 |
| 1.625 | 6.500 | 6.000 | 0.897 | 8.974 | 0.897 | 0.000 | 0.000 | 0.000 | 2.385 | 0.000 | 0.000 | 3.282 |
| 1.667 | 6.667 | 6.222 | 0.910 | 9.097 | 0.910 | 0.000 | 0.000 | 0.000 | 2.450 | 0.000 | 0.000 | 3.360 |
| 1.708 | 6.833 | 6.444 | 0.922 | 9.220 | 0.922 | 0.000 | 0.000 | 0.000 | 2.514 | 0.000 | 0.211 | 3.647 |
| 1.750 | 7.000 | 6.667 | 0.934 | 9.340 | 0.934 | 0.000 | 0.000 | 0.000 | 2.576 | 0.000 | 0.597 | 4.106 |
| 1.792 | 7.167 | 6.889 | 0.946 | 9.459 | 0.946 | 0.000 | 0.000 | 0.000 | 2.636 | 0.000 | 1.096 | 4.678 |
| 1.833 | 7.333 | 7.111 | 0.958 | 9.577 | 0.958 | 0.000 | 0.000 | 0.000 | 2.696 | 0.000 | 1.687 | 5.341 |
| 1.875 | 7.500 | 7.333 | 0.969 | 9.693 | 0.969 | 0.000 | 0.000 | 0.000 | 2.754 | 0.000 | 2.358 | 6.081 |
| 1.917 | 7.667 | 7.556 | 0.981 | 9.807 | 0.981 | 0.000 | 0.000 | 0.000 | 2.810 | 0.000 | 3.100 | 6.891 |
| 1.958 | 7.833 | 7.778 | 0.992 | 9.921 | 0.992 | 0.000 | 0.000 | 0.000 | 2.866 | 0.000 | 3.906 | 7.765 |
| 2.000 | 8.000 | 8.000 | 1.003 | 10.033 | 1.003 | 0.000 | 0.000 | 0.000 | 2.921 | 0.000 | 4.773 | 8.697 |

## Outlet structure for Discharge of Detention Basin E

**Discharge vs Elevation Table**

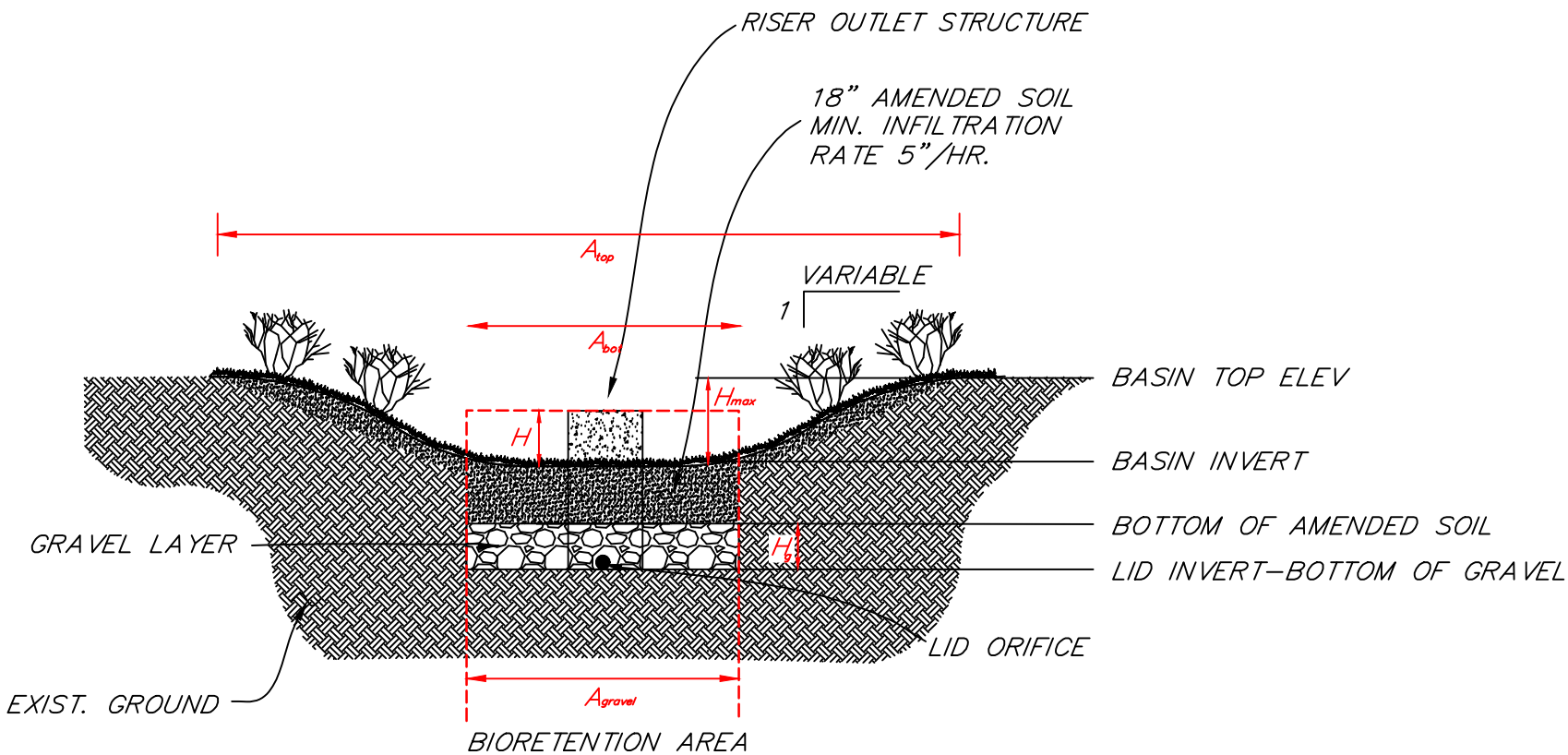
| | | | |
|---|---|---|---|
| Low orifice: | 3 " | Lower weir: | |
| Number: | 1 | Invert: | 2.00 ft |
| Cg-low: | 0.62 | B | 1.00 ft |
| Middle orifice: | 2.5 " | | |
| number of orif: | 12 | Emergency weir: | |
| Cg-middle: | 0.62 | Invert: | 2.50 ft |
| invert elev: | 1.50 ft | B: | 11.00 ft |

| h (ft) | H/D-low - | H/D-mid - | Qlow-orif (cfs) | Qlow-weir (cfs) | Qtot-low (cfs) | Qmid-orif (cfs) | Qmid-weir (cfs) | Qtot-med (cfs) | Qweir (cfs) | Qemerg (cfs) | Qtot (cfs) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 0.042 | 0.167 | 0.000 | 0.000 | 0.003 | 0.003 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.003 |
| 0.083 | 0.333 | 0.000 | 0.000 | 0.011 | 0.011 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.011 |
| 0.125 | 0.500 | 0.000 | 0.000 | 0.024 | 0.024 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.024 |
| 0.167 | 0.667 | 0.000 | 0.050 | 0.041 | 0.041 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.041 |
| 0.208 | 0.833 | 0.000 | 0.071 | 0.060 | 0.060 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.060 |
| 0.250 | 1.000 | 0.000 | 0.086 | 0.081 | 0.081 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.081 |
| 0.292 | 1.167 | 0.000 | 0.100 | 0.103 | 0.100 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.100 |
| 0.333 | 1.333 | 0.000 | 0.111 | 0.125 | 0.111 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.111 |
| 0.375 | 1.500 | 0.000 | 0.122 | 0.146 | 0.122 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.122 |
| 0.417 | 1.667 | 0.000 | 0.132 | 0.165 | 0.132 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.132 |
| 0.458 | 1.833 | 0.000 | 0.141 | 0.182 | 0.141 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.141 |
| 0.500 | 2.000 | 0.000 | 0.150 | 0.195 | 0.150 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.150 |
| 0.542 | 2.167 | 0.000 | 0.158 | 0.206 | 0.158 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.158 |
| 0.583 | 2.333 | 0.000 | 0.165 | 0.213 | 0.165 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.165 |
| 0.625 | 2.500 | 0.000 | 0.173 | 0.217 | 0.173 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.173 |
| 0.667 | 2.667 | 0.000 | 0.180 | 0.219 | 0.180 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.180 |
| 0.708 | 2.833 | 0.000 | 0.187 | 0.220 | 0.187 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.187 |
| 0.750 | 3.000 | 0.000 | 0.193 | 0.221 | 0.193 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.193 |
| 0.792 | 3.167 | 0.000 | 0.199 | 0.223 | 0.199 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.199 |
| 0.833 | 3.333 | 0.000 | 0.206 | 0.230 | 0.206 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.206 |
| 0.875 | 3.500 | 0.000 | 0.212 | 0.245 | 0.212 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.212 |
| 0.917 | 3.667 | 0.000 | 0.217 | 0.270 | 0.217 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.217 |
| 0.958 | 3.833 | 0.000 | 0.223 | 0.310 | 0.223 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.223 |
| 1.000 | 4.000 | 0.000 | 0.228 | 0.369 | 0.228 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.228 |
| 1.042 | 4.167 | 0.000 | 0.234 | 0.453 | 0.234 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.234 |
| 1.083 | 4.333 | 0.000 | 0.239 | 0.568 | 0.239 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.239 |
| 1.125 | 4.500 | 0.000 | 0.244 | 0.721 | 0.244 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.244 |
| 1.167 | 4.667 | 0.000 | 0.249 | 0.919 | 0.249 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.249 |
| 1.208 | 4.833 | 0.000 | 0.254 | 1.172 | 0.254 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.254 |
| 1.250 | 5.000 | 0.000 | 0.259 | 1.488 | 0.259 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.259 |
| 1.292 | 5.167 | 0.000 | 0.264 | 1.877 | 0.264 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.264 |
| 1.333 | 5.333 | 0.000 | 0.268 | 2.351 | 0.268 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.268 |
| 1.375 | 5.500 | 0.000 | 0.273 | 2.731 | 0.273 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.273 |
| 1.417 | 5.667 | 0.000 | 0.278 | 2.776 | 0.278 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.278 |
| 1.458 | 5.833 | 0.000 | 0.282 | 2.820 | 0.282 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.282 |
| 1.500 | 6.000 | 0.000 | 0.286 | 2.864 | 0.286 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.286 |
| 1.542 | 6.167 | 0.200 | 0.291 | 2.907 | 0.291 | 0.000 | 0.032 | 0.032 | 0.000 | 0.000 | 0.322 |
| 1.583 | 6.333 | 0.400 | 0.295 | 2.949 | 0.295 | 0.000 | 0.120 | 0.120 | 0.000 | 0.000 | 0.415 |
| 1.625 | 6.500 | 0.600 | 0.299 | 2.991 | 0.299 | 0.294 | 0.255 | 0.255 | 0.000 | 0.000 | 0.554 |
| 1.667 | 6.667 | 0.800 | 0.303 | 3.032 | 0.303 | 0.509 | 0.425 | 0.425 | 0.000 | 0.000 | 0.728 |
| 1.708 | 6.833 | 1.000 | 0.307 | 3.073 | 0.307 | 0.657 | 0.617 | 0.617 | 0.000 | 0.000 | 0.925 |
| 1.750 | 7.000 | 1.200 | 0.311 | 3.113 | 0.311 | 0.777 | 0.819 | 0.777 | 0.000 | 0.000 | 1.089 |
| 1.792 | 7.167 | 1.400 | 0.315 | 3.153 | 0.315 | 0.881 | 1.017 | 0.881 | 0.000 | 0.000 | 1.197 |
| 1.833 | 7.333 | 1.600 | 0.319 | 3.192 | 0.319 | 0.974 | 1.201 | 0.974 | 0.000 | 0.000 | 1.294 |
| 1.875 | 7.500 | 1.800 | 0.323 | 3.231 | 0.323 | 1.059 | 1.359 | 1.059 | 0.000 | 0.000 | 1.382 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.917 | 7.667 | 2.000 | 0.327 | 3.269 | 0.327 | 1.138 | 1.487 | 1.138 | 0.000 | 0.000 | 1.465 |
| 1.958 | 7.833 | 2.200 | 0.331 | 3.307 | 0.331 | 1.211 | 1.579 | 1.211 | 0.000 | 0.000 | 1.542 |
| 2.000 | 8.000 | 2.400 | 0.334 | 3.344 | 0.334 | 1.280 | 1.636 | 1.280 | 0.000 | 0.000 | 1.615 |
| 2.042 | 8.167 | 2.600 | 0.338 | 3.381 | 0.338 | 1.346 | 1.663 | 1.346 | 0.026 | 0.000 | 1.711 |
| 2.083 | 8.333 | 2.800 | 0.342 | 3.418 | 0.342 | 1.409 | 1.672 | 1.409 | 0.075 | 0.000 | 1.825 |
| 2.125 | 8.500 | 3.000 | 0.345 | 3.454 | 0.345 | 1.469 | 1.678 | 1.469 | 0.137 | 0.000 | 1.951 |
| 2.167 | 8.667 | 3.200 | 0.349 | 3.490 | 0.349 | 1.526 | 1.707 | 1.526 | 0.211 | 0.000 | 2.086 |
| 2.208 | 8.833 | 3.400 | 0.353 | 3.525 | 0.353 | 1.582 | 1.789 | 1.582 | 0.295 | 0.000 | 2.229 |
| 2.250 | 9.000 | 3.600 | 0.356 | 3.560 | 0.356 | 1.636 | 1.965 | 1.636 | 0.388 | 0.000 | 2.379 |
| 2.292 | 9.167 | 3.800 | 0.360 | 3.595 | 0.360 | 1.688 | 2.285 | 1.688 | 0.488 | 0.000 | 2.535 |
| 2.333 | 9.333 | 4.000 | 0.363 | 3.629 | 0.363 | 1.738 | 2.807 | 1.738 | 0.597 | 0.000 | 2.697 |
| 2.375 | 9.500 | 4.200 | 0.366 | 3.663 | 0.366 | 1.787 | 3.601 | 1.787 | 0.712 | 0.000 | 2.865 |
| 2.417 | 9.667 | 4.400 | 0.370 | 3.697 | 0.370 | 1.835 | 4.750 | 1.835 | 0.834 | 0.000 | 3.038 |
| 2.458 | 9.833 | 4.600 | 0.373 | 3.731 | 0.373 | 1.881 | 6.345 | 1.881 | 0.962 | 0.000 | 3.216 |
| 2.500 | 10.000 | 4.800 | 0.376 | 3.764 | 0.376 | 1.926 | 8.494 | 1.926 | 1.096 | 0.000 | 3.399 |
| 2.542 | 10.167 | 5.000 | 0.380 | 3.797 | 0.380 | 1.971 | 11.317 | 1.971 | 1.236 | 0.290 | 3.876 |
| 2.583 | 10.333 | 5.200 | 0.383 | 3.829 | 0.383 | 2.014 | 14.947 | 2.014 | 1.381 | 0.820 | 4.598 |
| 2.625 | 10.500 | 5.400 | 0.386 | 3.862 | 0.386 | 2.056 | 19.533 | 2.056 | 1.532 | 1.507 | 5.481 |
| 2.667 | 10.667 | 5.600 | 0.389 | 3.894 | 0.389 | 2.098 | 25.241 | 2.098 | 1.687 | 2.320 | 6.495 |
| 2.708 | 10.833 | 5.800 | 0.3925 | 3.925 | 0.393 | 2.139 | 32.252 | 2.139 | 1.848 | 3.242 | 7.622 |
| 2.750 | 11.000 | 6.000 | 0.396 | 3.957 | 0.396 | 2.179 | 40.765 | 2.179 | 2.014 | 4.262 | 8.850 |
| 2.792 | 11.167 | 6.200 | 0.399 | 3.988 | 0.399 | 2.218 | 50.996 | 2.218 | 2.184 | 5.371 | 10.171 |
| 2.833 | 11.333 | 6.400 | 0.402 | 4.019 | 0.402 | 2.256 | 63.180 | 2.256 | 2.358 | 6.562 | 11.579 |
| 2.875 | 11.500 | 6.600 | 0.405 | 4.050 | 0.405 | 2.294 | 77.573 | 2.294 | 2.537 | 7.830 | 13.067 |
| 2.917 | 11.667 | 6.800 | 0.408 | 4.081 | 0.408 | 2.332 | 94.450 | 2.332 | 2.721 | 9.171 | 14.632 |
| 2.958 | 11.833 | 7.000 | 0.411 | 4.111 | 0.411 | 2.368 | 114.105 | 2.368 | 2.908 | 10.581 | 16.268 |
| 3.000 | 12.000 | 7.200 | 0.414 | 4.141 | 0.414 | 2.405 | 136.856 | 2.405 | 3.100 | 12.056 | 17.975 |

# ATTACHMENT 5

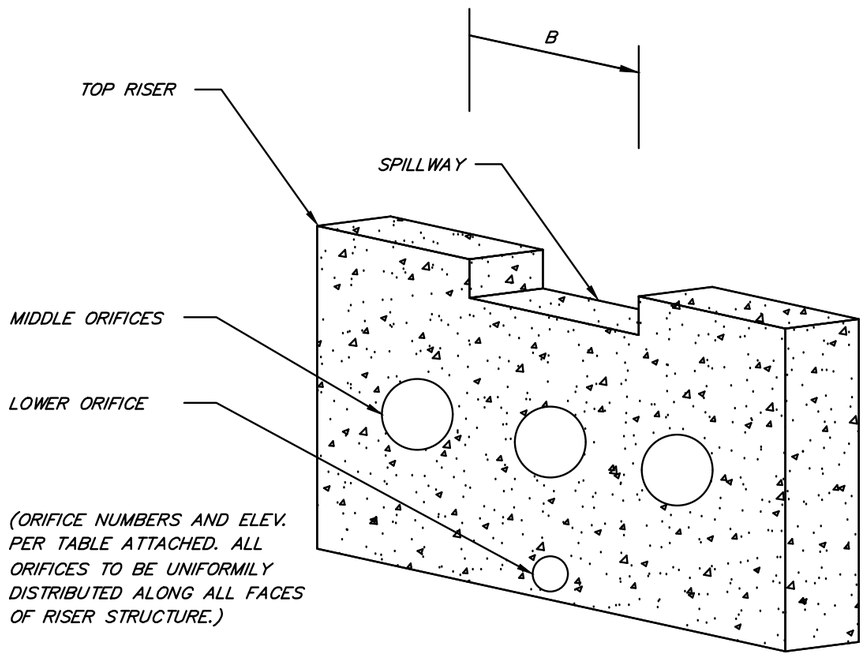
## Pre & Post-Developed Maps, Project Plan and Detention Section Sketches




# BIORETENTION AREA CROSS SECTION (TYP)

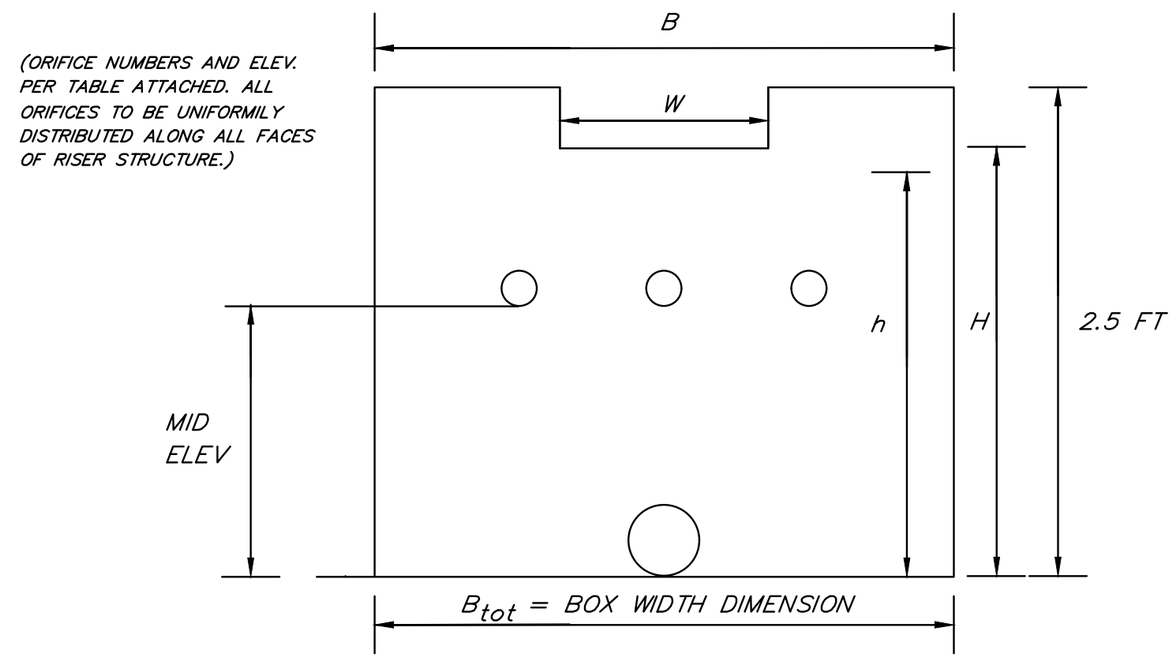
NOT TO SCALE

| BMP | H(FT) | Hmax (FT) | Hg (FT) | LID (INCHES) | Ag (FT^2) | Abot (FT^2) |
|---|---|---|---|---|---|---|
| A | 2.00 | 2.50 | 0.5 | 1.50 | 698 | 698 |
| B | 0.75 | 1.00 | 1.5 | 1.00 | 630 | 630 |
| C | 3.17 | 3.50 | 0.5 | 1.75 | 1133 | 627 |
| D | 1.00 | 2.00 | 0.5 | 1.00 | 536 | 370 |




OUTLET STRUCTURE DETAIL (TYP)

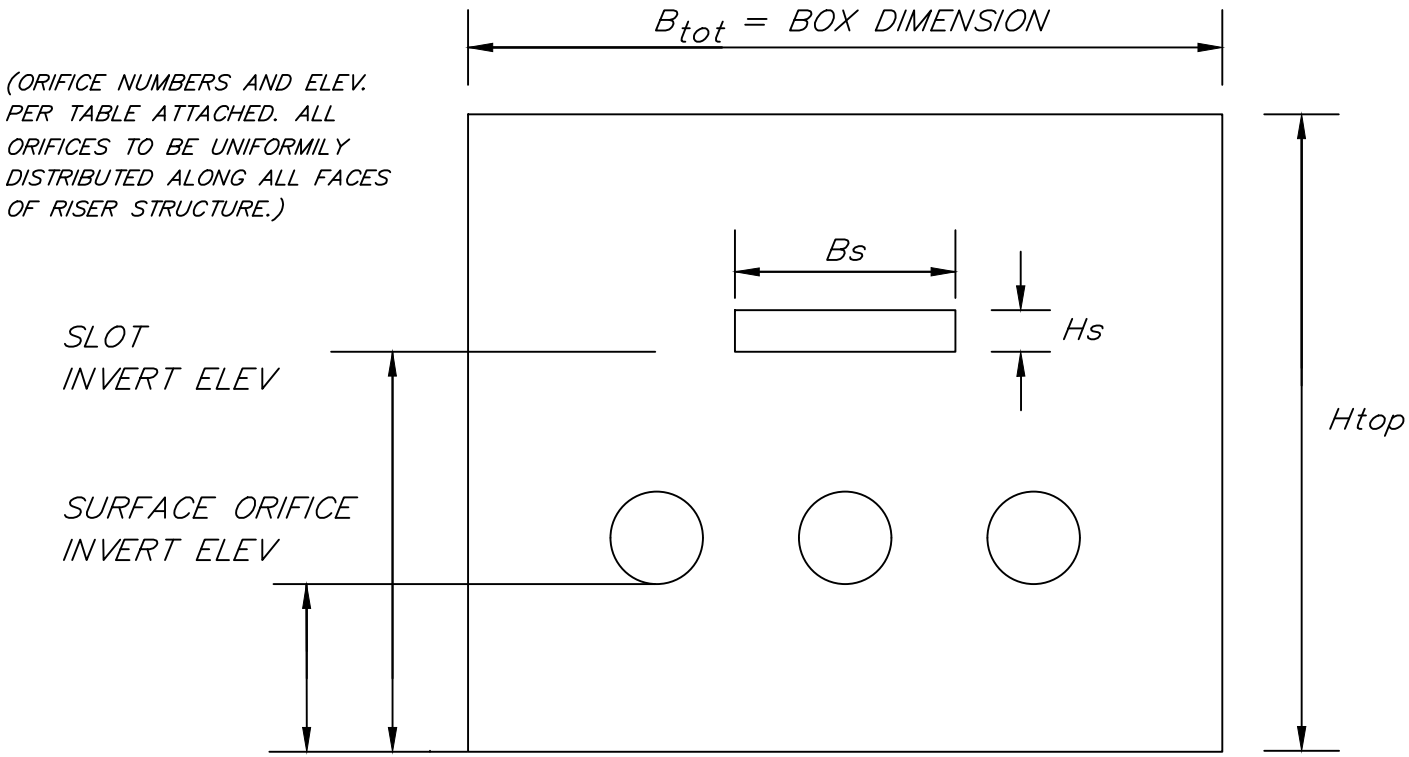
NOT TO SCALE




OUTLET STRUCTURE DETAIL - SECTION (TYP)

NOT TO SCALE

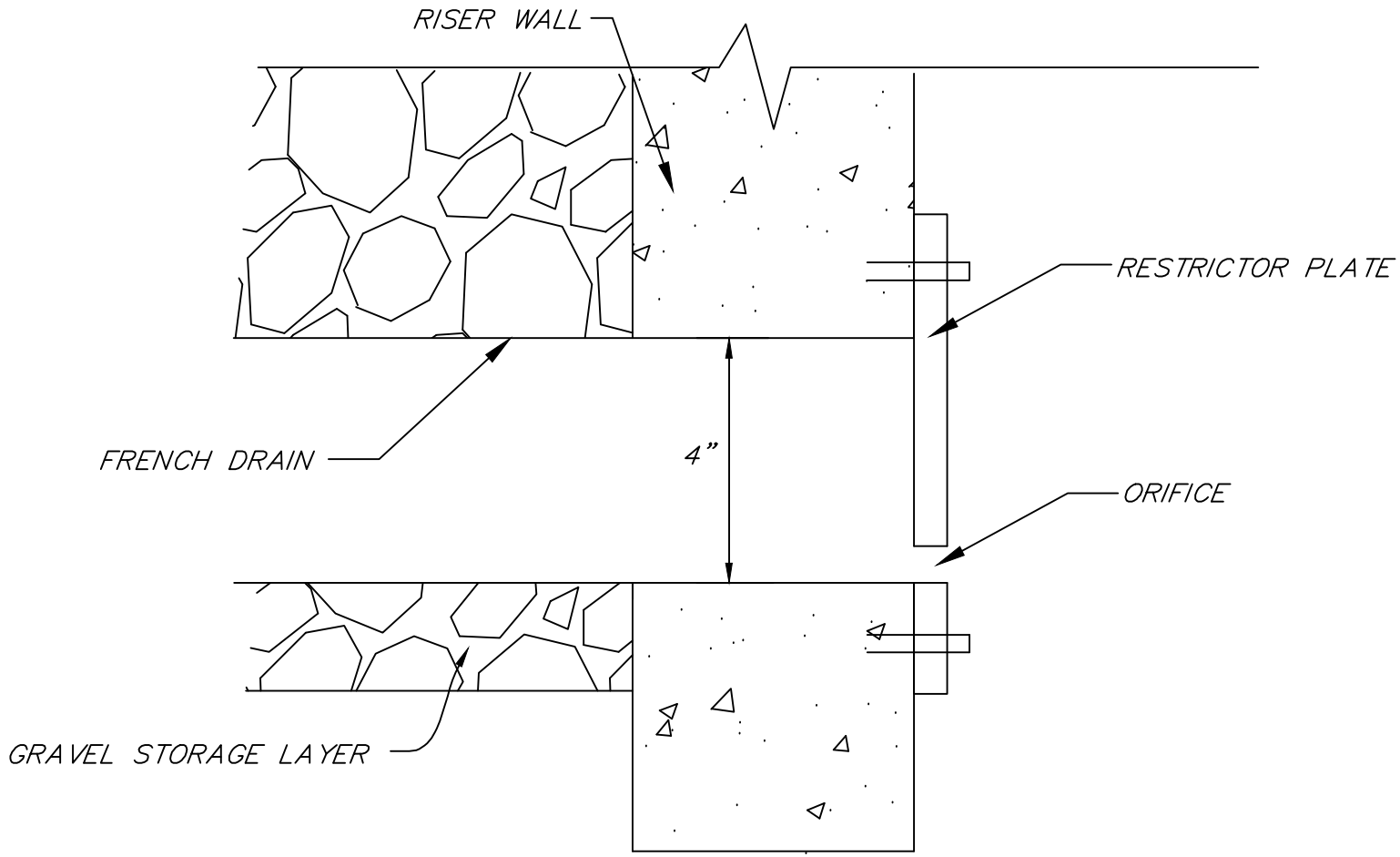
| | LOW ORIFICE | | MID ORIFICE | | LOWER WEIR | | SPILLWAY | |
|---|---|---|---|---|---|---|---|---|
| BASIN ID | #/DIAM | ELEV (FT) | #/DIAM | ELEV (FT) | W (FT) | h (FT) | B (FT) | H (FT) |
| BASIN E | 1 X 3" | 0.0 | 12 X 2.5" | 1.50 | 1.0 | 2.00 | 11.0 | 2.50 |




## BIO-RETENTION OUTLET STRUCTURE DETAIL - SECTION (TYP)

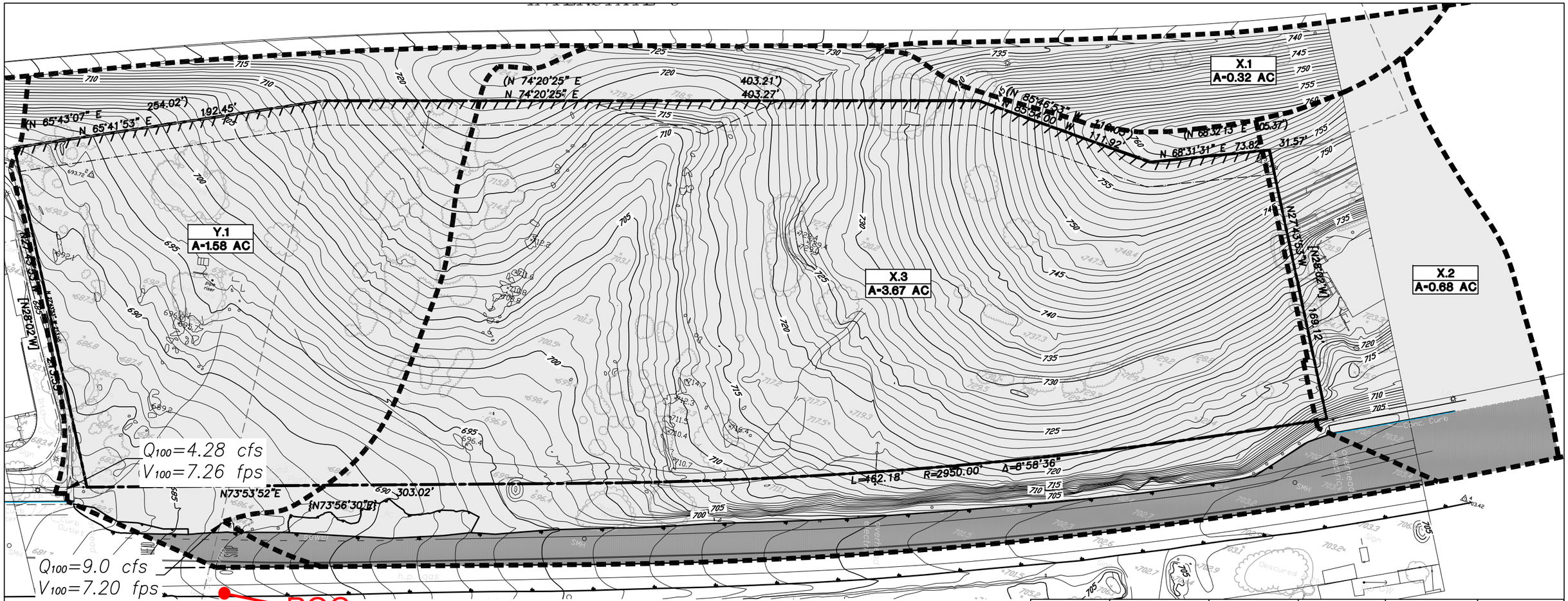
NOT TO SCALE

| BASIN | SURFACE ORIFICE #/DIAM | SURFACE ORIFICE ELEV (FT) | SLOT Bs (FT) | SLOT Hs (FT) | SLOT ELEV (FT) | SPILLWAY Btot (FT) | SPILLWAY Htop (FT) |
|---|---|---|---|---|---|---|---|
| A | N/A | N/A | 1.50 | 0.167 | 0.75 | 12.0 | 2.00 |
| C | 3 X 3" | 1.50 | 2.25 | 0.25 | 2.25 | 8.0 | 3.170 |




# LID ORIFICE DETAIL

NOT TO SCALE




## LEGEND

| DESCRIPTION | SYMBOL |
|---|---|
| PROPERTY LINE | |
| EXISTING CONTOUR | 90 |
| PROPOSED CONTOUR | 90 |
| PVC DRAIN LINE | |
| DRAINAGE SWALE OR DIRECTION OF FLOW | |
| BASIN LIMITS | |
| IMPERVIOUS AREA | |
| PERVIOUS AREA | |

BASIN ID — A.1

BASIN SIZE — A-1.00 AC

| Basin | Impervious Area | Pervious Area | Permeable Paving | Total (SF) | Total (AC) |
|---|---|---|---|---|---|
| X.1 | | 14,121.00 | | 14,121.00 | 0.32 |
| X.2 | 4,244.00 | 25,546.00 | | 29,790.00 | 0.68 |
| X.3 | 15,805.00 | 143,907.00 | | 159,712.00 | 3.67 |
| Y.1 | 1,294.00 | 67,617.00 | | 68,911.00 | 1.58 |

N

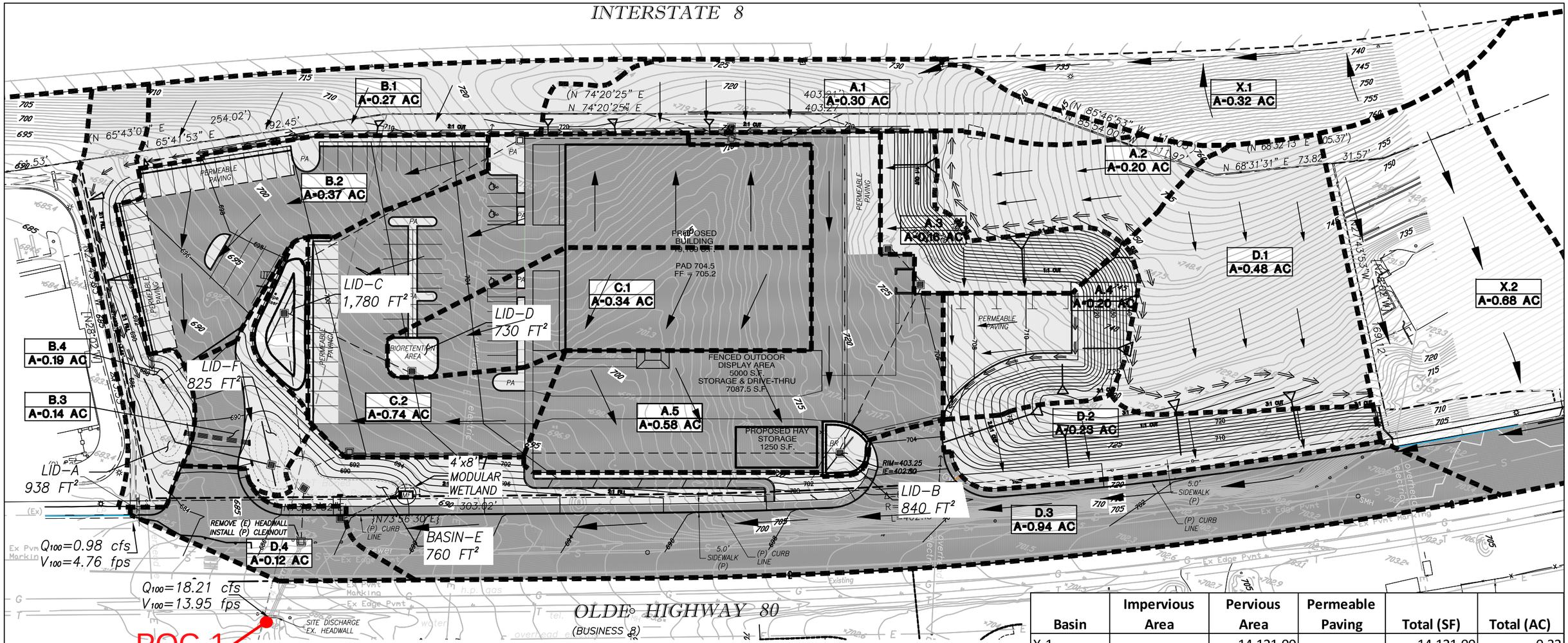
60 0 60 120 180

SCALE: 1"=60'

# DRAINAGE MAP 'A.1'
# EXISTING DRAINAGE CONDITIONS

COFFEY ENGINEERING, INC.

OFF-SITE AREA INCLUDED IN THE ANALYSIS OF POC-2




## LEGEND

| DESCRIPTION | SYMBOL | DESCRIPTION | SYMBOL |
|---|---|---|---|
| PROPERTY LINE | | PVC DRAIN LINE | |
| EXISTING CONTOUR | 90 | PERFORATED UNDERDRAIN | |
| PROPOSED CONTOUR | 90 | BROOKS BOX (OR SIM) W/GRATE | |
| DRAINAGE SWALE OR DIRECTION OF FLOW | | CLEANOUT | |
| BASIN LIMITS | | P.C.C. RIBBON GUTTER | |
| IMPERVIOUS AREA | | | |
| PERVIOUS AREA | | | |

BASIN ID — A.1
BASIN SIZE — A-1.00 AC

N

60 0 60 120 180

SCALE: 1"=60'

| Basin | Impervious Area | Pervious Area | Permeable Paving | Total (SF) | Total (AC) |
|---|---|---|---|---|---|
| X.1 | | 14,121.00 | | 14,121.00 | 0.32 |
| X.2 | 4,244.00 | 25,546.00 | | 29,790.00 | 0.68 |
| A.1 | 0.00 | 13,089.00 | | 13,089.00 | 0.30 |
| A.2 | 0.00 | 8,540.00 | | 8,540.00 | 0.20 |
| A.3 | 0.00 | 6,821.00 | | 6,821.00 | 0.16 |
| A.4 | | 4,958.00 | 3,634.00 | 8,592.00 | 0.20 |
| A.5 | 23,064.00 | 840.00 | 1,506.00 | 25,410.00 | 0.58 |
| B.1 | 0.00 | 11,743.00 | | 11,743.00 | 0.27 |
| B.2 | 11,412.00 | 1,806.00 | 2,833.00 | 16,051.00 | 0.37 |
| B.3 | 3,202.00 | 2,856.00 | | 6,058.00 | 0.14 |
| B.4 | 0.00 | 8,261.00 | | 8,261.00 | 0.19 |
| C.1 | 13,749.00 | 1,003.00 | | 14,752.00 | 0.34 |
| C.2 | 26,954.00 | 3,803.00 | 1,680.00 | 32,437.00 | 0.74 |
| D.1 | 0.00 | 20,751.00 | | 20,751.00 | 0.48 |
| D.2 | 0.00 | 9,882.00 | | 9,882.00 | 0.23 |
| D.3 | 33,014.00 | 7,684.00 | | 40,698.00 | 0.93 |
| D.4 | 5,037.00 | 0.00 | | 5,037.00 | 0.12 |

# DRAINAGE MAP 'B.1'
# PROPOSED DRAINAGE CONDITIONS

COFFEY ENGINEERING, INC.

# DMA SUMMARY TABLE

| DMA | BASIN ID's |
|---|---|
| DMA-A1 | B2, B3, B4 |
| DMA-A2 | B1 |
| DMA-B1 | A5 |
| DMA-B2 | A4 |
| DMA-C1 | C2 |
| DMA-C2 | A1, A2, X1 |
| DMA-D1 | C1 |
| DMA-E1 | A3, D1, D2 |
| DMA-E2 | D3 |
| DMA-X2 | X2 |
| DMA-D4 | D4 |
| DMA-OFF | OFFSITE |

# ATTACHMENT 6

# SWMM Input Data in Input Format (Existing & Proposed Models)

# POST_DEV

```
[TITLE]

[OPTIONS]
FLOW_UNITS           CFS
INFILTRATION         GREEN_AMPT
FLOW_ROUTING         KINWAVE
START_DATE           08/09/1963
START_TIME           00:00:00
REPORT_START_DATE    08/09/1963
REPORT_START_TIME    00:00:00
END_DATE             08/09/2008
END_TIME             00:00:00
SWEEP_START          01/01
SWEEP_END            12/31
DRY_DAYS             0
REPORT_STEP          01:00:00
WET_STEP             00:15:00
DRY_STEP             04:00:00
ROUTING_STEP         0:01:00
ALLOW_PONDING        NO
INERTIAL_DAMPING     PARTIAL
VARIABLE_STEP        0.75
LENGTHENING_STEP     0
MIN_SURFAREA         0
NORMAL_FLOW_LIMITED  BOTH
SKIP_STEADY_STATE    NO
FORCE_MAIN_EQUATION  H-W
LINK_OFFSETS         DEPTH
MIN_SLOPE            0

[EVAPORATION]
;;Type       Parameters
;;---------- ----------
MONTHLY      .041   .076   .118   .192   .237   .318   .308   .286   .217   .14    .067   .041
DRY_ONLY     NO

[RAINGAGES]
;;               Rain      Time   Snow   Data
;;Name           Type      Intrvl Catch  Source
;;-------------- --------- ------ ------ ----------
FLINN            INTENSITY 1:00   1.0    TIMESERIES FLIN

[SUBCATCHMENTS]
;;                                                   Total    Pcnt.             Pcnt.    Curb     Snow
;;Name           Raingage         Outlet           Area     Imperv   Width    Slope    Length   Pack
;;-------------- ---------------- ---------------- -------- -------- -------- -------- -------- --------
;DMA-21 w/o LID
DMA-D4           FLINN            POC-2            0.11563  100      12.9     2.4      0
;Offsite Area
DMA-OFF          FLINN            POC-2            1.720    90       299.7    3.0      0
;DMA-B2, DMA-B3, DMA-B4
DMA-A1           FLINN            LID-A            0.68118  49.3     72.3     3.5      0
;DMA-B1
DMA-A2           FLINN            LID-A            0.26958  0        22.5     11.3     0
;LID-A (Bioretention Basin)
LID-A            FLINN            DIV_A            0.016024 0        10       0        0
;LID-B (Bioretention Basin)
LID-B            FLINN            BASIN-E          0.014463 0        10       0        0
;LID-C (Bioretention Basin)
LID-C            FLINN            DIV-C            0.026    0        10       0        0
;LID-D (Bioretention Basin)
LID-D            FLINN            BASIN-E          0.012305 0        10       0        0
;DMA-A5
DMA-B1           FLINN            LID-B            0.56887  93.1     124      3        0
;DMA C-2
DMA-C1           FLINN            LID-C            0.71820  86.2     78.7     2        0
;DMA-C1
DMA-D1           FLINN            LID-D            0.32635  96.7     49       2        0
;DMA-D3
DMA-E2           FLINN            BASIN-E          0.93430  81.1     48.2     4.3      0
;DMA-A4
```

```
DMA-B2           FLINN            LID-B            0.19725  0.0      31.8     10       0
;DMA-A3,DMA-D1,DMA-D2
DMA-E1           FLINN            BASIN-E          0.85983  0        43.5     35       0
;DMA A-1, DMA A-2, DMA X-1
DMA-C2           FLINN            LID-C            0.82071  0        61.6     12.5     0
DMA-X2           FLINN            BASIN-E          0.68388  14.2     76.8     14.9     0

[SUBAREAS]
;;Subcatchment   N-Imperv   N-Perv     S-Imperv   S-Perv     PctZero    RouteTo    PctRouted
;;-------------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
DMA-D4           0.012      0.05       0.02       0.1        25         OUTLET
DMA-OFF          0.012      0.05       0.02       0.1        25         OUTLET
DMA-A1           0.012      0.05       0.02       0.1        25         OUTLET
DMA-A2           0.012      0.05       0.02       0.1        25         OUTLET
LID-A            0.012      0.05       0.02       0.1        25         OUTLET
LID-B            0.012      0.05       0.02       0.1        25         OUTLET
LID-C            0.012      0.05       0.02       0.1        25         OUTLET
LID-D            0.012      0.05       0.02       0.1        25         OUTLET
DMA-B1           0.010      0.05       0.02       0.1        25         OUTLET
DMA-C1           0.012      0.05       0.02       0.1        25         OUTLET
DMA-D1           0.012      0.05       0.02       0.1        25         OUTLET
DMA-E2           0.012      0.05       0.02       0.1        25         OUTLET
DMA-B2           0.012      0.05       0.02       0.1        25         OUTLET
DMA-E1           0.012      0.05       0.02       0.1        25         OUTLET
DMA-C2           0.012      0.05       0.02       0.1        25         OUTLET
DMA-X2           0.012      0.05       0.02       0.1        25         OUTLET

[INFILTRATION]
;;Subcatchment   Suction    HydCon     IMDmax
;;-------------- ---------- ---------- ----------
DMA-D4           6          0.075      0.31
DMA-OFF          6          0.075      0.31
DMA-A1           6          0.075      0.31
DMA-A2           6          0.1        0.31
LID-A            6          0.075      0.31
LID-B            6          0.075      0.31
LID-C            6          0.075      0.31
LID-D            6          0.075      0.31
DMA-B1           6          0.075      0.31
DMA-C1           6          0.075      0.31
DMA-D1           6          0.075      0.31
DMA-E2           6          0.075      0.31
DMA-B2           6          0.1        0.31
DMA-E1           6          0.1        0.31
DMA-C2           6          0.1        0.31
DMA-X2           6          0.075      0.31

[LID_CONTROLS]
;;               Type/Layer Parameters
;;-------------- ---------- ----------
LID-A            BC
LID-A            SURFACE    10.8045    0.05       0          0          5
LID-A            SOIL       18         0.4        0.2        0.1        5          5          1.5
LID-A            STORAGE    6          0.67       0          0
LID-A            DRAIN      1.0733     0.5        0          6

LID-B            BC
LID-B            SURFACE    14.2222    0.05       0          0          5
LID-B            SOIL       18         0.4        0.2        0.1        5          5          1.5
LID-B            STORAGE    18         0.67       0          0
LID-B            DRAIN      0.5285     0.5        0          6

LID-C            BC
LID-C            SURFACE    13.9954    0.05       0          0          5
LID-C            SOIL       18         0.4        0.2        0.1        5          5          1.5
LID-C            STORAGE    6          0.67       0          0
LID-C            DRAIN      0.9000     0.5        0          6

LID-D            BC
LID-D            SURFACE    16.6651    0.05       0          0          5
LID-D            SOIL       18         0.4        0.2        0.1        5          5          1.5
```

```
LID-D            STORAGE    6          0.67       0          0
LID-D            DRAIN      0.6212     0.5        0          6

[LID_USAGE]
;;Subcatchment   LID Process      Number  Area       Width      InitSatur  FromImprv  ToPerv     Report File
;;-------------- ---------------- ------- ---------- ---------- ---------- ---------- ---------- -----------
LID-A            LID-A            1       698        0          0          100        0
LID-B            LID-B            1       630        0          0          100        0
LID-C            LID-C            1       1133       0          0          100        0
LID-D            LID-D            1       536        0          0          100        0

[OUTFALLS]
;;               Invert     Outfall    Stage/Table      Tide
;;Name           Elev.      Type       Time Series      Gate
;;-------------- ---------- ---------- ---------------- ----
POC-2            0          FREE                        NO
POC-1            0          FREE                        NO

[DIVIDERS]
;;               Invert     Diverted         Divider
;;Name           Elev.      Link             Type       Parameters
;;-------------- ---------- ---------------- ---------- ----------
DIV-C            0          BYPASS-C         CUTOFF     0.04915    0          0          0          0
DIV_A            0          BYPASS_a         CUTOFF     0.03716    0          0          0          0

[STORAGE]
;;               Invert   Max.     Init.    Storage    Curve                      Ponded   Evap.
;;Name           Elev.    Depth    Depth    Curve      Params                     Area     Frac.    Infiltration
Parameters
;;-------------- -------- -------- -------- ---------- -------- -------- -------- -------- -------- -----------------
------
BASIN-E          0        3        0        TABULAR    BASIN-E                    760      1        6        0.1
0.31
BASIN-C          0        2        0        TABULAR    BASIN_C                    1780     1
BASIN_A_F        0        1.75     0        TABULAR    BASIN_A                    1764     1

[CONDUITS]
;;               Inlet            Outlet                      Manning    Inlet      Outlet     Init.      Max.
;;Name           Node             Node             Length     N          Offset     Offset     Flow       Flow
;;-------------- ---------------- ---------------- ---------- ---------- ---------- ---------- ---------- ----------
BYPASS-C         DIV-C            BASIN-C          10         0.01       0          0          0          0
UDRAIN-C         DIV-C            BASIN-E          10         0.01       0          0          0          0
BYPASS_A         DIV_A            BASIN_A_F        10         0.01       0          0          0          0
UDRAIN_A         DIV_A            BASIN-E          10         0.01       0          0          0          0

[OUTLETS]
;;               Inlet            Outlet           Outflow    Outlet          Qcoeff/                     Flap
;;Name           Node             Node             Height     Type            QTable           Qexpon     Gate
;;-------------- ---------------- ---------------- ---------- --------------- ---------------- ---------- ----
ORIFICE          BASIN-E          POC-1            0          TABULAR/HEAD    OUTLET-E                    NO
OUT-C            BASIN-C          BASIN-E          0          TABULAR/HEAD    OUT-C                       NO
OUT_A            BASIN_A_F        BASIN-E          0          TABULAR/HEAD    OUT_A                       NO

[XSECTIONS]
;;Link           Shape        Geom1            Geom2      Geom3      Geom4      Barrels
;;-------------- ------------ ---------------- ---------- ---------- ---------- ----------
BYPASS-C         DUMMY        0                0          0          0          1
UDRAIN-C         DUMMY        0                0          0          0          1
BYPASS_A         DUMMY        0                0          0          0          1
UDRAIN_A         DUMMY        0                0          0          0          1

[LOSSES]
;;Link           Inlet      Outlet     Average    Flap Gate
;;-------------- ---------- ---------- ---------- ----------

[CURVES]
;;Name           Type       X-Value    Y-Value
;;-------------- ---------- ---------- ----------
OUTLET-E         Rating     0.000      0.000
OUTLET-E                    0.042      0.003
OUTLET-E                    0.083      0.011
```

| | | |
|---|---|---|
| OUTLET-E | 0.125 | 0.024 |
| OUTLET-E | 0.167 | 0.041 |
| OUTLET-E | 0.208 | 0.060 |
| OUTLET-E | 0.250 | 0.081 |
| OUTLET-E | 0.292 | 0.100 |
| OUTLET-E | 0.333 | 0.111 |
| OUTLET-E | 0.375 | 0.122 |
| OUTLET-E | 0.417 | 0.132 |
| OUTLET-E | 0.458 | 0.141 |
| OUTLET-E | 0.500 | 0.150 |
| OUTLET-E | 0.542 | 0.158 |
| OUTLET-E | 0.583 | 0.165 |
| OUTLET-E | 0.625 | 0.173 |
| OUTLET-E | 0.667 | 0.180 |
| OUTLET-E | 0.708 | 0.187 |
| OUTLET-E | 0.750 | 0.193 |
| OUTLET-E | 0.792 | 0.199 |
| OUTLET-E | 0.833 | 0.206 |
| OUTLET-E | 0.875 | 0.212 |
| OUTLET-E | 0.917 | 0.217 |
| OUTLET-E | 0.958 | 0.223 |
| OUTLET-E | 1.000 | 0.228 |
| OUTLET-E | 1.042 | 0.234 |
| OUTLET-E | 1.083 | 0.239 |
| OUTLET-E | 1.125 | 0.244 |
| OUTLET-E | 1.167 | 0.249 |
| OUTLET-E | 1.208 | 0.254 |
| OUTLET-E | 1.250 | 0.259 |
| OUTLET-E | 1.292 | 0.264 |
| OUTLET-E | 1.333 | 0.268 |
| OUTLET-E | 1.375 | 0.273 |
| OUTLET-E | 1.417 | 0.278 |
| OUTLET-E | 1.458 | 0.282 |
| OUTLET-E | 1.500 | 0.286 |
| OUTLET-E | 1.542 | 0.322 |
| OUTLET-E | 1.583 | 0.415 |
| OUTLET-E | 1.625 | 0.554 |
| OUTLET-E | 1.667 | 0.728 |
| OUTLET-E | 1.708 | 0.925 |
| OUTLET-E | 1.750 | 1.089 |
| OUTLET-E | 1.792 | 1.197 |
| OUTLET-E | 1.833 | 1.294 |
| OUTLET-E | 1.875 | 1.382 |
| OUTLET-E | 1.917 | 1.465 |
| OUTLET-E | 1.958 | 1.542 |
| OUTLET-E | 2.000 | 1.615 |
| OUTLET-E | 2.042 | 1.711 |
| OUTLET-E | 2.083 | 1.825 |
| OUTLET-E | 2.125 | 1.951 |
| OUTLET-E | 2.167 | 2.086 |
| OUTLET-E | 2.208 | 2.229 |
| OUTLET-E | 2.250 | 2.379 |
| OUTLET-E | 2.292 | 2.535 |
| OUTLET-E | 2.333 | 2.697 |
| OUTLET-E | 2.375 | 2.865 |
| OUTLET-E | 2.417 | 3.038 |
| OUTLET-E | 2.458 | 3.216 |
| OUTLET-E | 2.500 | 3.399 |
| OUTLET-E | 2.542 | 3.876 |
| OUTLET-E | 2.583 | 4.598 |
| OUTLET-E | 2.625 | 5.481 |
| OUTLET-E | 2.667 | 6.495 |
| OUTLET-E | 2.708 | 7.622 |
| OUTLET-E | 2.750 | 8.850 |
| OUTLET-E | 2.792 | 10.171 |
| OUTLET-E | 2.833 | 11.579 |
| OUTLET-E | 2.875 | 13.067 |
| OUTLET-E | 2.917 | 14.632 |
| OUTLET-E | 2.958 | 16.268 |
| OUTLET-E | 3.000 | 17.975 |

# POST_DEV

| | | | |
|---|---|---|---|
| OUT-C | Rating | 0.000 | 0.000 |
| OUT-C | | 0.042 | 0.009 |
| OUT-C | | 0.083 | 0.033 |
| OUT-C | | 0.125 | 0.072 |
| OUT-C | | 0.167 | 0.122 |
| OUT-C | | 0.208 | 0.180 |
| OUT-C | | 0.250 | 0.244 |
| OUT-C | | 0.292 | 0.299 |
| OUT-C | | 0.333 | 0.334 |
| OUT-C | | 0.375 | 0.366 |
| OUT-C | | 0.417 | 0.396 |
| OUT-C | | 0.458 | 0.423 |
| OUT-C | | 0.500 | 0.449 |
| OUT-C | | 0.542 | 0.473 |
| OUT-C | | 0.583 | 0.496 |
| OUT-C | | 0.625 | 0.518 |
| OUT-C | | 0.667 | 0.539 |
| OUT-C | | 0.708 | 0.560 |
| OUT-C | | 0.750 | 0.579 |
| OUT-C | | 0.792 | 0.658 |
| OUT-C | | 0.833 | 0.784 |
| OUT-C | | 0.875 | 0.943 |
| OUT-C | | 0.917 | 1.127 |
| OUT-C | | 0.958 | 1.332 |
| OUT-C | | 1.000 | 1.557 |
| OUT-C | | 1.042 | 1.800 |
| OUT-C | | 1.083 | 1.974 |
| OUT-C | | 1.125 | 2.109 |
| OUT-C | | 1.167 | 2.235 |
| OUT-C | | 1.208 | 2.352 |
| OUT-C | | 1.250 | 2.463 |
| OUT-C | | 1.292 | 2.569 |
| OUT-C | | 1.333 | 2.670 |
| OUT-C | | 1.375 | 2.766 |
| OUT-C | | 1.417 | 2.859 |
| OUT-C | | 1.458 | 2.949 |
| OUT-C | | 1.500 | 3.036 |
| OUT-C | | 1.542 | 3.120 |
| OUT-C | | 1.583 | 3.202 |
| OUT-C | | 1.625 | 3.282 |
| OUT-C | | 1.667 | 3.360 |
| OUT-C | | 1.708 | 3.647 |
| OUT-C | | 1.750 | 4.106 |
| OUT-C | | 1.792 | 4.678 |
| OUT-C | | 1.833 | 5.341 |
| OUT-C | | 1.875 | 6.081 |
| OUT-C | | 1.917 | 6.891 |
| OUT-C | | 1.958 | 7.765 |
| OUT-C | | 2.000 | 8.697 |
| | | | |
| OUT_A | Rating | 0.000 | 0.000 |
| OUT_A | | 0.042 | 0.039 |
| OUT_A | | 0.083 | 0.112 |
| OUT_A | | 0.125 | 0.205 |
| OUT_A | | 0.167 | 0.316 |
| OUT_A | | 0.208 | 0.433 |
| OUT_A | | 0.250 | 0.499 |
| OUT_A | | 0.292 | 0.558 |
| OUT_A | | 0.333 | 0.612 |
| OUT_A | | 0.375 | 0.661 |
| OUT_A | | 0.417 | 0.706 |
| OUT_A | | 0.458 | 0.749 |
| OUT_A | | 0.500 | 0.790 |
| OUT_A | | 0.542 | 0.828 |
| OUT_A | | 0.583 | 0.865 |
| OUT_A | | 0.625 | 0.901 |
| OUT_A | | 0.667 | 0.935 |
| OUT_A | | 0.708 | 0.967 |
| OUT_A | | 0.750 | 0.999 |
| OUT_A | | 0.792 | 1.030 |
| OUT_A | | 0.833 | 1.060 |

```
OUT_A                       0.875      1.089
OUT_A                       0.917      1.117
OUT_A                       0.958      1.145
OUT_A                       1.000      1.172
OUT_A                       1.042      1.198
OUT_A                       1.083      1.224
OUT_A                       1.125      1.249
OUT_A                       1.167      1.274
OUT_A                       1.208      1.298
OUT_A                       1.250      1.322
OUT_A                       1.292      1.662
OUT_A                       1.333      2.263
OUT_A                       1.375      3.035
OUT_A                       1.417      3.944
OUT_A                       1.458      4.972
OUT_A                       1.500      6.107
OUT_A                       1.542      7.337
OUT_A                       1.583      8.658
OUT_A                       1.625      10.062
OUT_A                       1.667      11.545
OUT_A                       1.708      13.103
OUT_A                       1.750      14.732

BASIN-E          Storage    0          760
BASIN-E                     1          760.1
BASIN-E                     2          760.2
BASIN-E                     2.5        760.3
BASIN-E                     3          760.4

BASIN_C          Storage    0.00       1133.3
BASIN_C                     0.50       1298.0
BASIN_C                     1.50       1621.4
BASIN_C                     2.00       1780.0

BASIN_A          Storage    0          977.9
BASIN_A                     0.25       1078.8
BASIN_A                     0.75       1292.0
BASIN_A                     1.75       1764.0

[TIMESERIES]
;;Name           Date       Time       Value
;;-------------- ---------- ---------- ----------
FLIN             FILE "Flinn.txt"

[REPORT]
INPUT      NO
CONTROLS   NO
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL

[TAGS]

[MAP]
DIMENSIONS -9052.344 4827.344 6192.969 12407.031
Units      None

[COORDINATES]
;;Node           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
POC-2            3500.000           6000.000
POC-1            -3006.478          5013.095
DIV-C            -3001.277          9693.487
DIV_A            -6214.121          6193.435
BASIN-E          -3000.000          6546.875
BASIN-C          -4583.269          8914.525
BASIN_A_F        -6214.121          4941.013

[VERTICES]
;;Link           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
```

```
UDRAIN-C         -2975.734          6475.096

[Polygons]
;;Subcatchment   X-Coord            Y-Coord
;;-------------- ------------------ ------------------
DMA-D4           3500.000           9500.000
DMA-OFF          5500.000           9500.000
DMA-A1           -8359.375          8281.250
DMA-A2           -6703.125          8343.750
LID-A            -6687.500          6546.875
LID-B            -6376.305          9410.088
LID-C            -3000.000          10500.000
LID-D            -1593.750          8437.500
DMA-B1           -7160.195          10239.029
DMA-C1           -3690.120          11511.976
DMA-D1           -1504.491          9670.659
DMA-E2           812.500            7609.375
DMA-B2           -5817.671          10257.050
DMA-E1           -484.375           8062.500
DMA-C2           -2447.605          11511.976
DMA-X2           812.500            6562.500

[SYMBOLS]
;;Gage           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
FLINN            -1500.000          12000.000
```

# PRE_DEV

```
[TITLE]

[OPTIONS]
FLOW_UNITS           CFS
INFILTRATION         GREEN_AMPT
FLOW_ROUTING         KINWAVE
START_DATE           08/09/1963
START_TIME           00:00:00
REPORT_START_DATE    08/09/1963
REPORT_START_TIME    00:00:00
END_DATE             08/08/2008
END_TIME             23:00:00
SWEEP_START          01/01
SWEEP_END            12/31
DRY_DAYS             0
REPORT_STEP          01:00:00
WET_STEP             00:15:00
DRY_STEP             04:00:00
ROUTING_STEP         0:01:00
ALLOW_PONDING        NO
INERTIAL_DAMPING     PARTIAL
VARIABLE_STEP        0.75
LENGTHENING_STEP     0
MIN_SURFAREA         0
NORMAL_FLOW_LIMITED  BOTH
SKIP_STEADY_STATE    NO
FORCE_MAIN_EQUATION  H-W
LINK_OFFSETS         DEPTH
MIN_SLOPE            0

[EVAPORATION]
;;Type       Parameters
;;---------- ----------
MONTHLY      .041   .076   .118   .192   .237   .318   .308   .286   .217   .14    .067   .041
DRY_ONLY     NO

[RAINGAGES]
;;               Rain      Time   Snow   Data
;;Name           Type      Intrvl Catch  Source
;;-------------- --------- ------ ------ ----------
Flinn            INTENSITY 1:00   1.0    TIMESERIES Flinn

[SUBCATCHMENTS]
;;                                                   Total    Pcnt.             Pcnt.    Curb     Snow
;;Name           Raingage         Outlet           Area     Imperv   Width    Slope    Length   Pack
;;-------------- ---------------- ---------------- -------- -------- -------- -------- -------- --------
;DMA-11 SLOPE
DMA-11           Flinn            POC-1            2.53     0.0      506      26.6     0
;DMA-2
DMA-2            Flinn            POC-2            1.438    5.5      167      11.4     0
DMA-OFF          Flinn            POC-2            1.720    90       300      3.0      0
;DMA-12 ROAD
DMA-12           Flinn            POC-1            1.221    0        168      9        0
DMA-13           Flinn            POC-1            0.41     100      483      1.5      0
DMA-X2           Flinn            POC-1            0.68388  14.2     76.8     14.9     0

[SUBAREAS]
;;Subcatchment   N-Imperv   N-Perv     S-Imperv   S-Perv     PctZero    RouteTo    PctRouted
;;-------------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
DMA-11           0.012      0.05       0.02       0.1        25         OUTLET
DMA-2            0.012      0.05       0.02       0.1        25         OUTLET
DMA-OFF          0.012      0.05       0.02       0.1        25         OUTLET
DMA-12           0.012      0.05       0.02       0.1        25         OUTLET
DMA-13           0.012      0.05       0.02       0.1        25         OUTLET
DMA-X2           0.012      0.05       0.02       0.1        25         OUTLET

[INFILTRATION]
;;Subcatchment   Suction    HydCon     IMDmax
;;-------------- ---------- ---------- ----------
DMA-11           6          0.1        0.31
DMA-2            6          0.075      0.31
```

```
DMA-OFF          6          0.075      0.31
DMA-12           6          0.1        0.31
DMA-13           6          0.075      0.31
DMA-X2           6          0.075      0.31

[OUTFALLS]
;;               Invert     Outfall    Stage/Table      Tide
;;Name           Elev.      Type       Time Series      Gate
;;-------------- ---------- ---------- ---------------- ----
POC-1            0          FREE                        NO
POC-2            0          FREE                        NO

[TIMESERIES]
;;Name           Date       Time       Value
;;-------------- ---------- ---------- ----------
Flinn            FILE "Flinn.txt"

[REPORT]
INPUT      NO
CONTROLS   NO
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL

[TAGS]

[MAP]
DIMENSIONS 0.000 0.000 10000.000 10000.000
Units      None

[COORDINATES]
;;Node           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
POC-1            750.000            6000.000
POC-2            2000.000           6000.000

[VERTICES]
;;Link           X-Coord            Y-Coord
;;-------------- ------------------ ------------------

[Polygons]
;;Subcatchment   X-Coord            Y-Coord
;;-------------- ------------------ ------------------
DMA-11           750.000            9500.000
DMA-2            2000.000           9500.000
DMA-OFF          3000.000           9500.000
DMA-12           -100.000           9500.000
DMA-13           -950.000           9500.000
DMA-X2           -2078.125          9437.500

[SYMBOLS]
;;Gage           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
Flinn            1800.000           12000.000
```

# ATTACHMENT 7

## EPA SWMM FIGURES AND EXPLANATIONS

Per the attached, the reader can see the screens associated with the EPA-SWMM Model in both pre-development and post-development conditions. Each portion, i.e., sub-catchments, outfalls, storage units, weir as a discharge, and outfalls (point of compliance), are also shown.

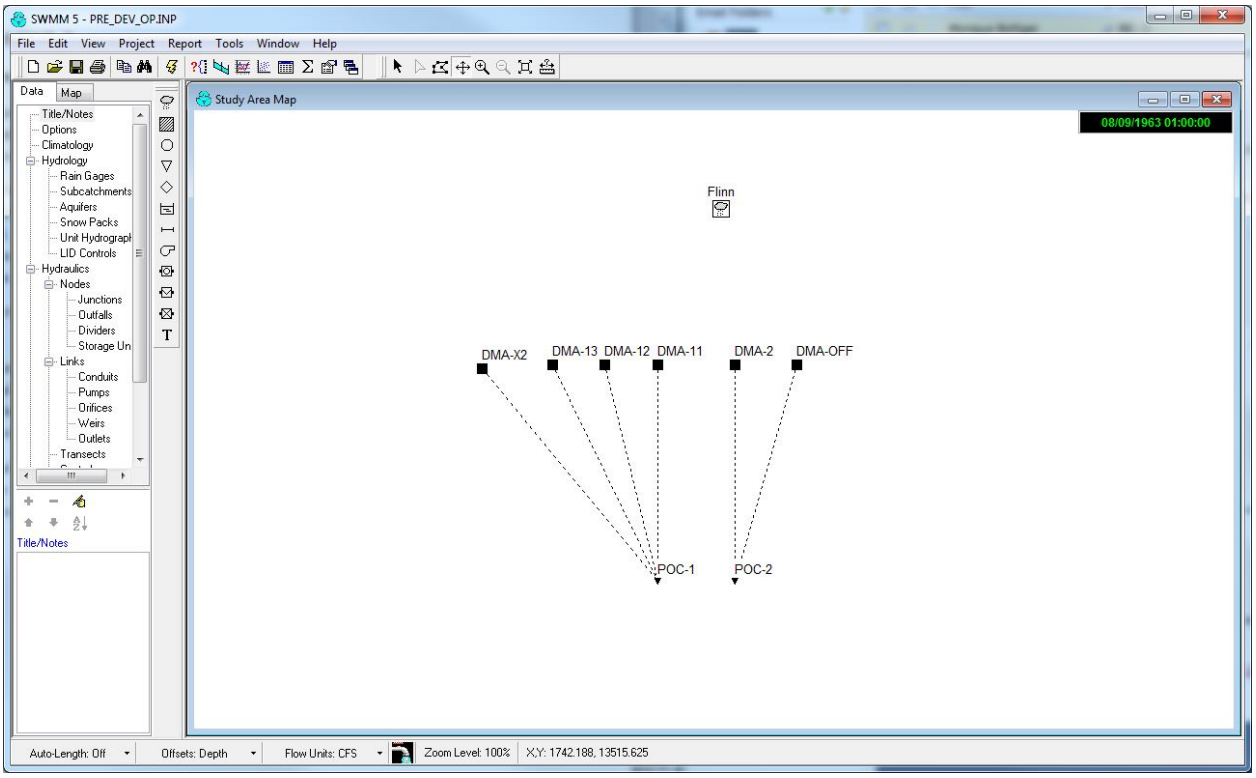
Variables for modeling are associated with typical recommended values by the EPA-SWMM model, typical values found in technical literature (such as Maidment's Handbook of Hydrology). Recommended values for the SWMM model have been attained from the interim Orange County criteria established for their SWMM calibration. Currently, no recommended values have been established by the San Diego County HMP Permit for the SWMM Model.

Soil characteristics of the existing soils were determined from the San Diego County Hydrology Manual Soils Exhibit (located in Attachment 8 of this report).

Some values incorporated within the SWMM model have been determined from the professional experience of TRWE using conservative assumptions that have a tendency to increase the size of the needed BMP and also generate a long-term runoff as a percentage of rainfall similar to those measured in gage stations in Southern California by the USGS.

A Technical document prepared by TRWE for the Cities of San Marcos, Oceanside and Vista (Reference [1]) can also be consulted for additional information regarding typical values for SWMM parameters.

# PRE-DEVELOPED CONDITION




**Outfall POC-1**

| Property | Value |
|---|---|
| Name | POC-1 |
| X-Coordinate | 750.000 |
| Y-Coordinate | 6000.000 |
| Description | |
| Tag | |
| Inflows | NO |
| Treatment | NO |
| Invert El. | 0 |
| Tide Gate | NO |
| Type | FREE |
| Fixed Outfall | |
| Fixed Stage | 0 |
| Tidal Outfall | |
| Curve Name | * |
| Time Series Outfall | |
| Series Name | * |

**Outfall POC-2**

| Property | Value |
|---|---|
| Name | POC-2 |
| X-Coordinate | 2000.000 |
| Y-Coordinate | 6000.000 |
| Description | |
| Tag | |
| Inflows | NO |
| Treatment | NO |
| Invert El. | 0 |
| Tide Gate | NO |
| Type | FREE |
| Fixed Outfall | |
| Fixed Stage | 0 |
| Tidal Outfall | |
| Curve Name | * |
| Time Series Outfall | |
| Series Name | * |

Subcatchment DMA-X2

| Property | Value |
|---|---|
| Name | DMA-X2 |
| X-Coordinate | -2078.125 |
| Y-Coordinate | 9437.500 |
| Description | |
| Tag | |
| Rain Gage | Flinn |
| Outlet | POC-1 |
| Area | 0.68388 |
| Width | 76.8 |
| % Slope | 14.9 |
| % Imperv | 14.2 |
| N-Imperv | 0.012 |
| N-Perv | 0.05 |
| Dstore-Imperv | 0.02 |
| Dstore-Perv | 0.1 |
| %Zero-Imperv | 25 |
| Subarea Routing | OUTLET |
| Percent Routed | 100 |
| Infiltration | GREEN_AMPT |
| Groundwater | NO |
| Snow Pack | |
| LID Controls | 0 |
| Land Uses | 0 |
| Initial Buildup | NONE |
| Curb Length | 0 |

User-assigned name of subcatchment

Subcatchment DMA-13

| Property | Value |
|---|---|
| Name | DMA-13 |
| X-Coordinate | -950.000 |
| Y-Coordinate | 9500.000 |
| Description | |
| Tag | |
| Rain Gage | Flinn |
| Outlet | POC-1 |
| Area | 0.41 |
| Width | 483 |
| % Slope | 1.5 |
| % Imperv | 100 |
| N-Imperv | 0.012 |
| N-Perv | 0.05 |
| Dstore-Imperv | 0.02 |
| Dstore-Perv | 0.1 |
| %Zero-Imperv | 25 |
| Subarea Routing | OUTLET |
| Percent Routed | 100 |
| Infiltration | GREEN_AMPT |
| Groundwater | NO |
| Snow Pack | |
| LID Controls | 0 |
| Land Uses | 0 |
| Initial Buildup | NONE |
| Curb Length | 0 |

User-assigned name of subcatchment

Subcatchment DMA-12

| Property | Value |
|---|---|
| Name | DMA-12 |
| X-Coordinate | -100.000 |
| Y-Coordinate | 9500.000 |
| Description | DMA-12 ROAD |
| Tag | |
| Rain Gage | Flinn |
| Outlet | POC-1 |
| Area | 1.221 |
| Width | 168 |
| % Slope | 9 |
| % Imperv | 0 |
| N-Imperv | 0.012 |
| N-Perv | 0.05 |
| Dstore-Imperv | 0.02 |
| Dstore-Perv | 0.1 |
| %Zero-Imperv | 25 |
| Subarea Routing | OUTLET |
| Percent Routed | 100 |
| Infiltration | GREEN_AMPT |
| Groundwater | NO |
| Snow Pack | |
| LID Controls | 0 |
| Land Uses | 0 |
| Initial Buildup | NONE |
| Curb Length | 0 |

User-assigned name of subcatchment

Subcatchment DMA-11

| Property | Value |
|---|---|
| Name | DMA-11 |
| X-Coordinate | 750.000 |
| Y-Coordinate | 9500.000 |
| Description | DMA-11 SLOPE |
| Tag | |
| Rain Gage | Flinn |
| Outlet | POC-1 |
| Area | 2.53 |
| Width | 506 |
| % Slope | 26.6 |
| % Imperv | 0.0 |
| N-Imperv | 0.012 |
| N-Perv | 0.05 |
| Dstore-Imperv | 0.02 |
| Dstore-Perv | 0.1 |
| %Zero-Imperv | 25 |
| Subarea Routing | OUTLET |
| Percent Routed | 100 |
| Infiltration | GREEN_AMPT |
| Groundwater | NO |
| Snow Pack | |
| LID Controls | 0 |
| Land Uses | 0 |
| Initial Buildup | NONE |
| Curb Length | 0 |

User-assigned name of subcatchment

Subcatchment DMA-2

| Property | Value |
|---|---|
| Name | DMA-2 |
| X-Coordinate | 2000.000 |
| Y-Coordinate | 9500.000 |
| Description | DMA-2 |
| Tag | |
| Rain Gage | Flinn |
| Outlet | POC-2 |
| Area | 1.438 |
| Width | 167 |
| % Slope | 11.4 |
| % Imperv | 5.5 |
| N-Imperv | 0.012 |
| N-Perv | 0.05 |
| Dstore-Imperv | 0.02 |
| Dstore-Perv | 0.1 |
| %Zero-Imperv | 25 |
| Subarea Routing | OUTLET |
| Percent Routed | 100 |
| Infiltration | GREEN_AMPT |
| Groundwater | NO |
| Snow Pack | |
| LID Controls | 0 |
| Land Uses | 0 |
| Initial Buildup | NONE |
| Curb Length | 0 |

User-assigned name of subcatchment

Subcatchment DMA-OFF

| Property | Value |
|---|---|
| Name | DMA-OFF |
| X-Coordinate | 3000.000 |
| Y-Coordinate | 9500.000 |
| Description | |
| Tag | |
| Rain Gage | Flinn |
| Outlet | POC-2 |
| Area | 1.720 |
| Width | 300 |
| % Slope | 3.0 |
| % Imperv | 90 |
| N-Imperv | 0.012 |
| N-Perv | 0.05 |
| Dstore-Imperv | 0.02 |
| Dstore-Perv | 0.1 |
| %Zero-Imperv | 25 |
| Subarea Routing | OUTLET |
| Percent Routed | 100 |
| Infiltration | GREEN_AMPT |
| Groundwater | NO |
| Snow Pack | |
| LID Controls | 0 |
| Land Uses | 0 |
| Initial Buildup | NONE |
| Curb Length | 0 |

User-assigned name of subcatchment

Infiltration Editor

Infiltration Method: GREEN_AMPT

| Property | Value |
|---|---|
| Suction Head | 6 |
| Conductivity | 0.075 |
| Initial Deficit | 0.31 |

Infiltration Editor

Infiltration Method: GREEN_AMPT

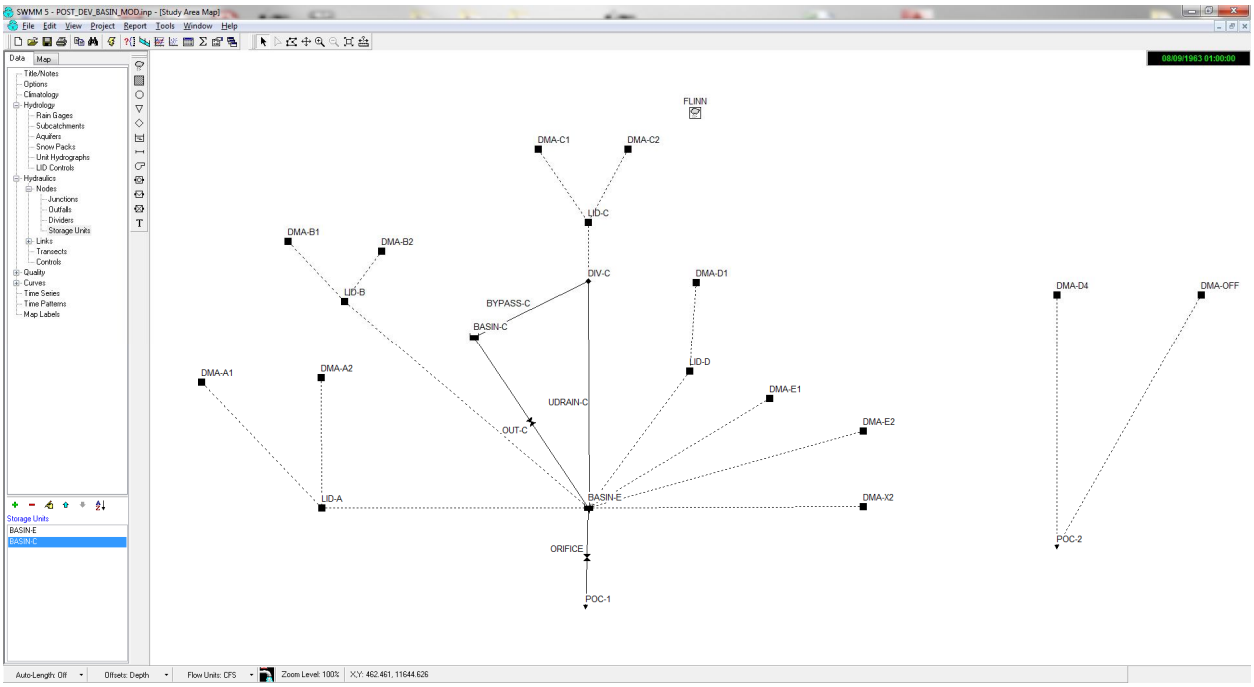
| Property | Value |
|---|---|
| Suction Head | 6 |
| Conductivity | 0.1 |
| Initial Deficit | 0.31 |

Rain Gage Flinn

| Property | Value |
|---|---|
| Name | Flinn |
| X-Coordinate | 1800.000 |
| Y-Coordinate | 12000.000 |
| Description | |
| Tag | |
| Rain Format | INTENSITY |
| Time Interval | 1:00 |
| Snow Catch Factor | 1.0 |
| Data Source | TIMESERIES |
| TIME SERIES: | |
| - Series Name | Flinn |
| DATA FILE: | |
| - File Name | * |
| - Station ID | * |
| - Rain Units | IN |

User-assigned name of rain gage

# POST-DEVELOPED CONDITION




**Outfall POC-1**

| Property | Value |
|---|---|
| Name | POC-1 |
| X-Coordinate | -3031.250 |
| Y-Coordinate | 5171.875 |
| Description | |
| Tag | |
| Inflows | NO |
| Treatment | NO |
| Invert El. | 0 |
| Tide Gate | NO |
| Type | FREE |
| Fixed Outfall | |
| Fixed Stage | 0 |
| Tidal Outfall | |
| Curve Name | * |
| Time Series Outfa | |
| Series Name | * |

User-assigned name of outfall

**Outfall POC-2**

| Property | Value |
|---|---|
| Name | POC-2 |
| X-Coordinate | 3500.000 |
| Y-Coordinate | 6000.000 |
| Description | |
| Tag | |
| Inflows | NO |
| Treatment | NO |
| Invert El. | 0 |
| Tide Gate | NO |
| Type | FREE |
| Fixed Outfall | |
| Fixed Stage | 0 |
| Tidal Outfall | |
| Curve Name | * |
| Time Series Outfa | |
| Series Name | * |

User-assigned name of outfall

Subcatchment DMA-A1

| Property | Value |
|---|---|
| Name | DMA-A1 |
| X-Coordinate | -8359.375 |
| Y-Coordinate | 8281.250 |
| Description | DMA-B2, DMA-B3, DM |
| Tag | |
| Rain Gage | FLINN |
| Outlet | LID-A |
| Area | 0.68118 |
| Width | 72.3 |
| % Slope | 3.5 |
| % Imperv | 49.3 |
| N-Imperv | 0.012 |
| N-Perv | 0.05 |
| Dstore-Imperv | 0.02 |
| Dstore-Perv | 0.1 |
| %Zero-Imperv | 25 |
| Subarea Routing | OUTLET |
| Percent Routed | 100 |
| Infiltration | GREEN_AMPT |
| Groundwater | NO |
| Snow Pack | |
| LID Controls | 0 |
| Land Uses | 0 |
| Initial Buildup | NONE |
| Curb Length | 0 |

User-assigned name of subcatchment

Subcatchment DMA-A2

| Property | Value |
|---|---|
| Name | DMA-A2 |
| X-Coordinate | -6703.125 |
| Y-Coordinate | 8343.750 |
| Description | DMA-B1 |
| Tag | |
| Rain Gage | FLINN |
| Outlet | LID-A |
| Area | 0.26958 |
| Width | 22.5 |
| % Slope | 11.3 |
| % Imperv | 0 |
| N-Imperv | 0.012 |
| N-Perv | 0.05 |
| Dstore-Imperv | 0.02 |
| Dstore-Perv | 0.1 |
| %Zero-Imperv | 25 |
| Subarea Routing | OUTLET |
| Percent Routed | 100 |
| Infiltration | GREEN_AMPT |
| Groundwater | NO |
| Snow Pack | |
| LID Controls | 0 |
| Land Uses | 0 |
| Initial Buildup | NONE |
| Curb Length | 0 |

User-assigned name of subcatchment

Subcatchment DMA-B1

| Property | Value |
|---|---|
| Name | DMA-B1 |
| X-Coordinate | -7160.195 |
| Y-Coordinate | 10239.029 |
| Description | DMA-A5 |
| Tag | |
| Rain Gage | FLINN |
| Outlet | LID-B |
| Area | 0.56887 |
| Width | 124 |
| % Slope | 3 |
| % Imperv | 93.1 |
| N-Imperv | 0.010 |
| N-Perv | 0.05 |
| Dstore-Imperv | 0.02 |
| Dstore-Perv | 0.1 |
| %Zero-Imperv | 25 |
| Subarea Routing | OUTLET |
| Percent Routed | 100 |
| Infiltration | GREEN_AMPT |
| Groundwater | NO |
| Snow Pack | |
| LID Controls | 0 |
| Land Uses | 0 |
| Initial Buildup | NONE |
| Curb Length | 0 |

User-assigned name of subcatchment

Subcatchment DMA-B2

| Property | Value |
|---|---|
| Name | DMA-B2 |
| X-Coordinate | -5817.671 |
| Y-Coordinate | 10257.050 |
| Description | DMA-A4 |
| Tag | |
| Rain Gage | FLINN |
| Outlet | LID-B |
| Area | 0.19725 |
| Width | 31.8 |
| % Slope | 10 |
| % Imperv | 0.0 |
| N-Imperv | 0.012 |
| N-Perv | 0.05 |
| Dstore-Imperv | 0.02 |
| Dstore-Perv | 0.1 |
| %Zero-Imperv | 25 |
| Subarea Routing | OUTLET |
| Percent Routed | 100 |
| Infiltration | GREEN_AMPT |
| Groundwater | NO |
| Snow Pack | |
| LID Controls | 0 |
| Land Uses | 0 |
| Initial Buildup | NONE |
| Curb Length | 0 |

User-assigned name of subcatchment

Subcatchment DMA-C1

| Property | Value |
|---|---|
| Name | DMA-C1 |
| X-Coordinate | -3690.120 |
| Y-Coordinate | 11511.976 |
| Description | DMA C-2 |
| Tag | |
| Rain Gage | FLINN |
| Outlet | LID-C |
| Area | 0.71820 |
| Width | 78.7 |
| % Slope | 2 |
| % Imperv | 86.2 |
| N-Imperv | 0.012 |
| N-Perv | 0.05 |
| Dstore-Imperv | 0.02 |
| Dstore-Perv | 0.1 |
| %Zero-Imperv | 25 |
| Subarea Routing | OUTLET |
| Percent Routed | 100 |
| Infiltration | GREEN_AMPT |
| Groundwater | NO |
| Snow Pack | |
| LID Controls | 0 |
| Land Uses | 0 |
| Initial Buildup | NONE |
| Curb Length | 0 |

User-assigned name of subcatchment

Subcatchment DMA-C2

| Property | Value |
|---|---|
| Name | DMA-C2 |
| X-Coordinate | -2447.605 |
| Y-Coordinate | 11511.976 |
| Description | DMA A-1, DMA A-2, D |
| Tag | |
| Rain Gage | FLINN |
| Outlet | LID-C |
| Area | 0.82071 |
| Width | 61.6 |
| % Slope | 12.5 |
| % Imperv | 0 |
| N-Imperv | 0.012 |
| N-Perv | 0.05 |
| Dstore-Imperv | 0.02 |
| Dstore-Perv | 0.1 |
| %Zero-Imperv | 25 |
| Subarea Routing | OUTLET |
| Percent Routed | 100 |
| Infiltration | GREEN_AMPT |
| Groundwater | NO |
| Snow Pack | |
| LID Controls | 0 |
| Land Uses | 0 |
| Initial Buildup | NONE |
| Curb Length | 0 |

User-assigned name of subcatchment

Subcatchment DMA-D1

| Property | Value |
|---|---|
| Name | DMA-D1 |
| X-Coordinate | -1504.491 |
| Y-Coordinate | 9670.659 |
| Description | DMA-C1 |
| Tag | |
| Rain Gage | FLINN |
| Outlet | LID-D |
| Area | 0.32635 |
| Width | 49 |
| % Slope | 2 |
| % Imperv | 96.7 |
| N-Imperv | 0.012 |
| N-Perv | 0.05 |
| Dstore-Imperv | 0.02 |
| Dstore-Perv | 0.1 |
| %Zero-Imperv | 25 |
| Subarea Routing | OUTLET |
| Percent Routed | 100 |
| Infiltration | GREEN_AMPT |
| Groundwater | NO |
| Snow Pack | |
| LID Controls | 0 |
| Land Uses | 0 |
| Initial Buildup | NONE |
| Curb Length | 0 |

User-assigned name of subcatchment

Subcatchment DMA-E1

| Property | Value |
|---|---|
| Name | DMA-E1 |
| X-Coordinate | -484.375 |
| Y-Coordinate | 8062.500 |
| Description | DMA-A3,DMA-D1,DM |
| Tag | |
| Rain Gage | FLINN |
| Outlet | BASIN-E |
| Area | 0.85983 |
| Width | 43.5 |
| % Slope | 35 |
| % Imperv | 0 |
| N-Imperv | 0.012 |
| N-Perv | 0.05 |
| Dstore-Imperv | 0.02 |
| Dstore-Perv | 0.1 |
| %Zero-Imperv | 25 |
| Subarea Routing | OUTLET |
| Percent Routed | 100 |
| Infiltration | GREEN_AMPT |
| Groundwater | NO |
| Snow Pack | |
| LID Controls | 0 |
| Land Uses | 0 |
| Initial Buildup | NONE |
| Curb Length | 0 |

User-assigned name of subcatchment

Subcatchment DMA-E2

| Property | Value |
|---|---|
| Name | DMA-E2 |
| X-Coordinate | 812.500 |
| Y-Coordinate | 7609.375 |
| Description | DMA-D3 |
| Tag | |
| Rain Gage | FLINN |
| Outlet | BASIN-E |
| Area | 0.93430 |
| Width | 48.2 |
| % Slope | 4.3 |
| % Imperv | 81.1 |
| N-Imperv | 0.012 |
| N-Perv | 0.05 |
| Dstore-Imperv | 0.02 |
| Dstore-Perv | 0.1 |
| %Zero-Imperv | 25 |
| Subarea Routing | OUTLET |
| Percent Routed | 100 |
| Infiltration | GREEN_AMPT |
| Groundwater | NO |
| Snow Pack | |
| LID Controls | 0 |
| Land Uses | 0 |
| Initial Buildup | NONE |
| Curb Length | 0 |

User-assigned name of subcatchment

Subcatchment DMA-X2

| Property | Value |
|---|---|
| Name | DMA-X2 |
| X-Coordinate | 812.500 |
| Y-Coordinate | 6562.500 |
| Description | |
| Tag | |
| Rain Gage | FLINN |
| Outlet | BASIN-E |
| Area | 0.68388 |
| Width | 76.8 |
| % Slope | 14.9 |
| % Imperv | 14.2 |
| N-Imperv | 0.012 |
| N-Perv | 0.05 |
| Dstore-Imperv | 0.02 |
| Dstore-Perv | 0.1 |
| %Zero-Imperv | 25 |
| Subarea Routing | OUTLET |
| Percent Routed | 100 |
| Infiltration | GREEN_AMPT |
| Groundwater | NO |
| Snow Pack | |
| LID Controls | 0 |
| Land Uses | 0 |
| Initial Buildup | NONE |
| Curb Length | 0 |

User-assigned name of subcatchment

Subcatchment LID-A

| Property | Value |
|---|---|
| Name | LID-A |
| X-Coordinate | -6687.500 |
| Y-Coordinate | 6546.875 |
| Description | LID-A (Bioretention Ba |
| Tag | |
| Rain Gage | FLINN |
| Outlet | DIV_A |
| Area | 0.016024 |
| Width | 10 |
| % Slope | 0 |
| % Imperv | 0 |
| N-Imperv | 0.012 |
| N-Perv | 0.05 |
| Dstore-Imperv | 0.02 |
| Dstore-Perv | 0.1 |
| %Zero-Imperv | 25 |
| Subarea Routing | OUTLET |
| Percent Routed | 100 |
| Infiltration | GREEN_AMPT |
| Groundwater | NO |
| Snow Pack | |
| LID Controls | 1 |
| Land Uses | 0 |
| Initial Buildup | NONE |
| Curb Length | 0 |

User-assigned name of subcatchment

Subcatchment LID-B

| Property | Value |
|---|---|
| Name | LID-B |
| X-Coordinate | -6376.305 |
| Y-Coordinate | 9410.088 |
| Description | LID-B (Bioretention Ba |
| Tag | |
| Rain Gage | FLINN |
| Outlet | BASIN-E |
| Area | 0.014463 |
| Width | 10 |
| % Slope | 0 |
| % Imperv | 0 |
| N-Imperv | 0.012 |
| N-Perv | 0.05 |
| Dstore-Imperv | 0.02 |
| Dstore-Perv | 0.1 |
| %Zero-Imperv | 25 |
| Subarea Routing | OUTLET |
| Percent Routed | 100 |
| Infiltration | GREEN_AMPT |
| Groundwater | NO |
| Snow Pack | |
| LID Controls | 1 |
| Land Uses | 0 |
| Initial Buildup | NONE |
| Curb Length | 0 |

User-assigned name of subcatchment

Subcatchment LID-C

| Property | Value |
|---|---|
| Name | LID-C |
| X-Coordinate | -3000.000 |
| Y-Coordinate | 10500.000 |
| Description | LID-C (Bioretention Ba |
| Tag | |
| Rain Gage | FLINN |
| Outlet | DIV-C |
| Area | 0.026 |
| Width | 10 |
| % Slope | 0 |
| % Imperv | 0 |
| N-Imperv | 0.012 |
| N-Perv | 0.05 |
| Dstore-Imperv | 0.02 |
| Dstore-Perv | 0.1 |
| %Zero-Imperv | 25 |
| Subarea Routing | OUTLET |
| Percent Routed | 100 |
| Infiltration | GREEN_AMPT |
| Groundwater | NO |
| Snow Pack | |
| LID Controls | 1 |
| Land Uses | 0 |
| Initial Buildup | NONE |
| Curb Length | 0 |

User-assigned name of subcatchment

Subcatchment LID-D

| Property | Value |
|---|---|
| Name | LID-D |
| X-Coordinate | -1593.750 |
| Y-Coordinate | 8437.500 |
| Description | LID-D (Bioretention Ba |
| Tag | |
| Rain Gage | FLINN |
| Outlet | BASIN-E |
| Area | 0.012305 |
| Width | 10 |
| % Slope | 0 |
| % Imperv | 0 |
| N-Imperv | 0.012 |
| N-Perv | 0.05 |
| Dstore-Imperv | 0.02 |
| Dstore-Perv | 0.1 |
| %Zero-Imperv | 25 |
| Subarea Routing | OUTLET |
| Percent Routed | 100 |
| Infiltration | GREEN_AMPT |
| Groundwater | NO |
| Snow Pack | |
| LID Controls | 1 |
| Land Uses | 0 |
| Initial Buildup | NONE |
| Curb Length | 0 |

User-assigned name of subcatchment

Subcatchment DMA-D4

| Property | Value |
|---|---|
| Name | DMA-D4 |
| X-Coordinate | 3500.000 |
| Y-Coordinate | 9500.000 |
| Description | DMA-21 w/o LID |
| Tag | |
| Rain Gage | FLINN |
| Outlet | POC-2 |
| Area | 0.11563 |
| Width | 12.9 |
| % Slope | 2.4 |
| % Imperv | 100 |
| N-Imperv | 0.012 |
| N-Perv | 0.05 |
| Dstore-Imperv | 0.02 |
| Dstore-Perv | 0.1 |
| %Zero-Imperv | 25 |
| Subarea Routing | OUTLET |
| Percent Routed | 100 |
| Infiltration | GREEN_AMPT |
| Groundwater | NO |
| Snow Pack | |
| LID Controls | 0 |
| Land Uses | 0 |
| Initial Buildup | NONE |
| Curb Length | 0 |

Optional comment or description

Subcatchment DMA-OFF

| Property | Value |
|---|---|
| Name | DMA-OFF |
| X-Coordinate | 5500.000 |
| Y-Coordinate | 9500.000 |
| Description | Offsite Area |
| Tag | |
| Rain Gage | FLINN |
| Outlet | POC-2 |
| Area | 1.720 |
| Width | 299.7 |
| % Slope | 3.0 |
| % Imperv | 90 |
| N-Imperv | 0.012 |
| N-Perv | 0.05 |
| Dstore-Imperv | 0.02 |
| Dstore-Perv | 0.1 |
| %Zero-Imperv | 25 |
| Subarea Routing | OUTLET |
| Percent Routed | 100 |
| Infiltration | GREEN_AMPT |
| Groundwater | NO |
| Snow Pack | |
| LID Controls | 0 |
| Land Uses | 0 |
| Initial Buildup | NONE |
| Curb Length | 0 |

Optional comment or description

Infiltration Editor

Infiltration Method: GREEN_AMPT

| Property | Value |
|---|---|
| Suction Head | 6 |
| Conductivity | 0.075 |
| Initial Deficit | 0.31 |

Infiltration Editor

Infiltration Method: GREEN_AMPT

| Property | Value |
|---|---|
| Suction Head | 6 |
| Conductivity | 0.1 |
| Initial Deficit | 0.31 |

Divider DIV_A

| Property | Value |
|---|---|
| Name | DIV_A |
| X-Coordinate | -6214.121 |
| Y-Coordinate | 6193.435 |
| Description | |
| Tag | |
| Inflows | NO |
| Treatment | NO |
| Invert El. | 0 |
| Max. Depth | 0 |
| Initial Depth | 0 |
| Surcharge Depth | 0 |
| Ponded Area | 0 |
| Diverted Link | BYPASS_a |
| Type | CUTOFF |
| Cutoff Divider | |
| Cutoff Flow | 0.03716 |
| Tabular Divider | |
| Curve Name | * |
| Weir Divider | |
| Min. Flow | 0 |
| Max. Depth | 0 |
| Coefficient | 0 |

User-assigned name of divider

Divider DIV-C

| Property | Value |
|---|---|
| Name | DIV-C |
| X-Coordinate | -3001.277 |
| Y-Coordinate | 9693.487 |
| Description | |
| Tag | |
| Inflows | NO |
| Treatment | NO |
| Invert El. | 0 |
| Max. Depth | 0 |
| Initial Depth | 0 |
| Surcharge Depth | 0 |
| Ponded Area | 0 |
| Diverted Link | BYPASS-C |
| Type | CUTOFF |
| Cutoff Divider | |
| Cutoff Flow | 0.04915 |
| Tabular Divider | |
| Curve Name | * |
| Weir Divider | |
| Min. Flow | 0 |
| Max. Depth | 0 |
| Coefficient | 0 |

User-assigned name of divider

**EXPLANATION OF SELECTED VARIABLES**

Sub Catchment Areas:

Please refer to the attached diagrams that indicate the DMA and Bio-Retention BMPs (BMP) sub areas modeled within the project site at both the pre and post developed conditions draining to the POC.

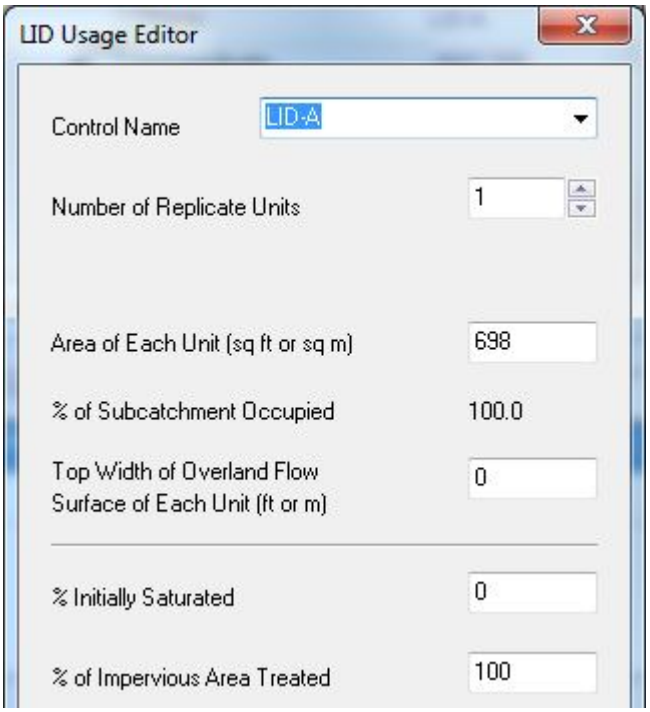
Parameters for the pre- and post-developed models include soil type C as determined from the site specific Natural Resources Conservation Service (NRCS) geologic review (attached at the end of this appendix). Suction head, conductivity and initial deficit corresponds to average values expected for these soils types, according to sources consulted, professional experience, and approximate values obtained by the interim Orange County modeling approach.

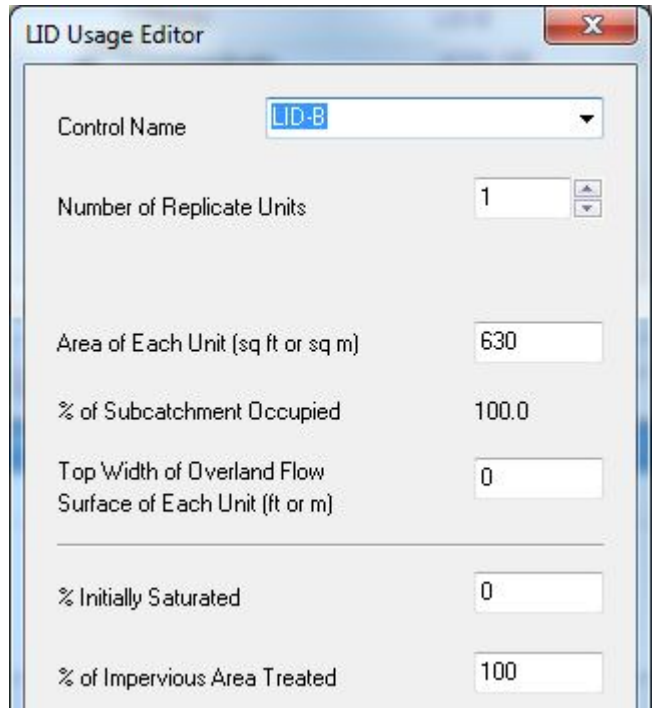
TRWE selected infiltration values, such that the percentage of total precipitation that becomes runoff, is realistic for the soil types and slightly smaller than measured values for Southern California watersheds.

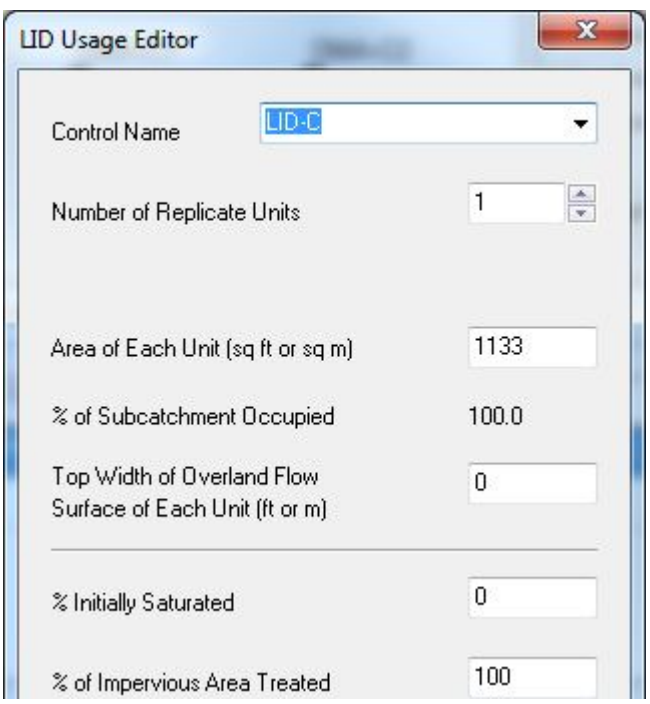
Selection of a Kinematic Approach: As the continuous model is based on hourly rainfall, and the time of concentration for the pre-development and post-development conditions is significantly smaller than 60 minutes, precise routing of the flows through the impervious surfaces, the underdrain pipe system, and the discharge pipe was considered unnecessary. The truncation error of the precipitation into hourly steps is much more significant than the precise routing in a system where the time of concentration is much smaller than 1 hour.

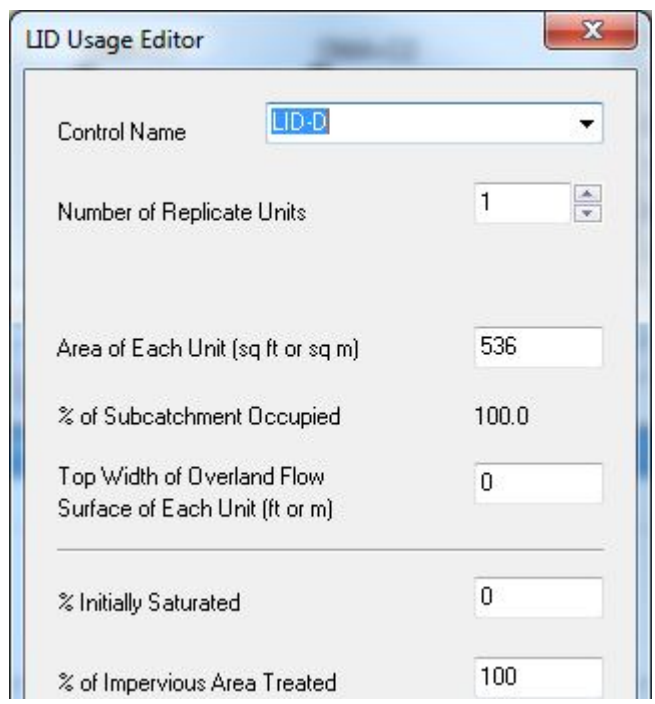
Sub-catchment BMP:

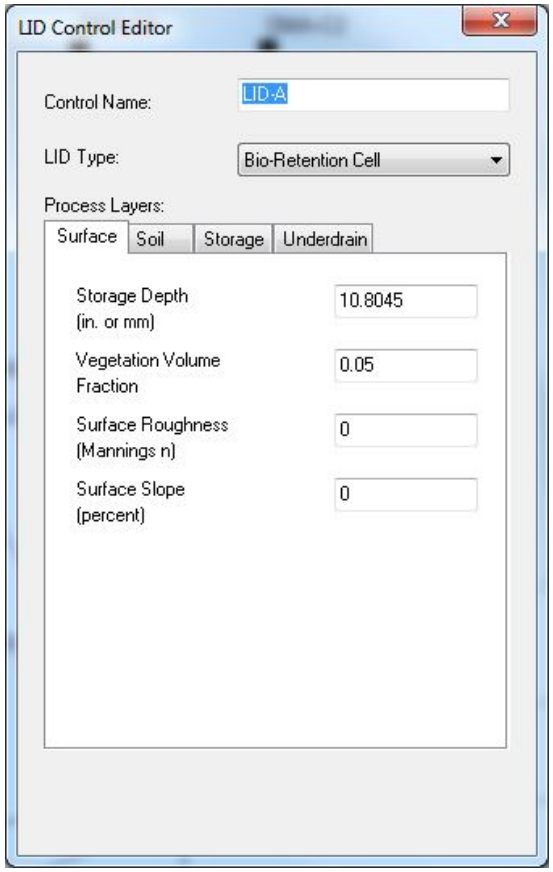
The area of bio-retention must be equal to the area of the development tributary to the bioretention facility (area that drains into the bioretention, equal external area plus bio-retention itself). Five (5) decimal places were given regarding the areas of the bio-retention to insure that the area used by the program for the LID subroutine corresponds exactly with this tributary.

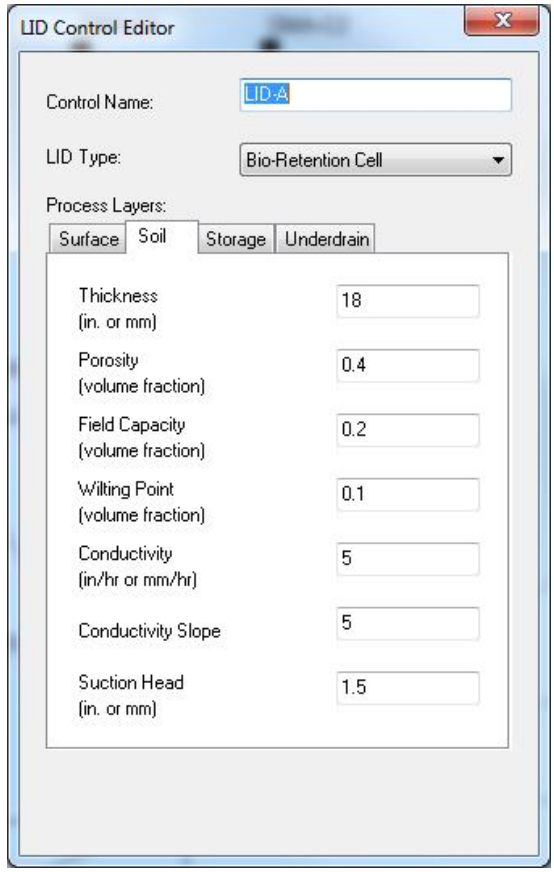

LID Usage Editor
Control Name
LID-A
Number of Replicate Units
1
Area of Each Unit (sq ft or sq m)
698
% of Subcatchment Occupied
100.0
Top Width of Overland Flow Surface of Each Unit (ft or m)
0
% Initially Saturated
0
% of Impervious Area Treated
100

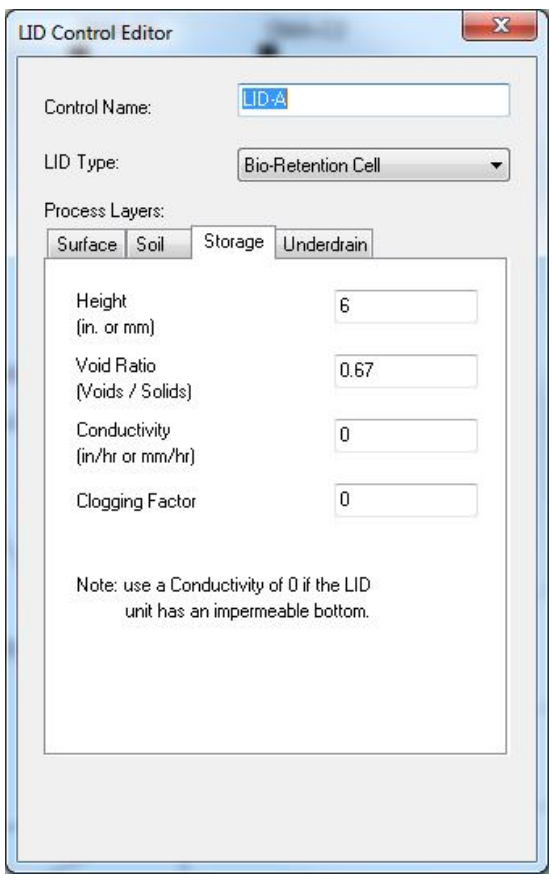

LID Usage Editor
Control Name
LID-B
Number of Replicate Units
1
Area of Each Unit (sq ft or sq m)
630
% of Subcatchment Occupied
100.0
Top Width of Overland Flow Surface of Each Unit (ft or m)
0
% Initially Saturated
0
% of Impervious Area Treated
100

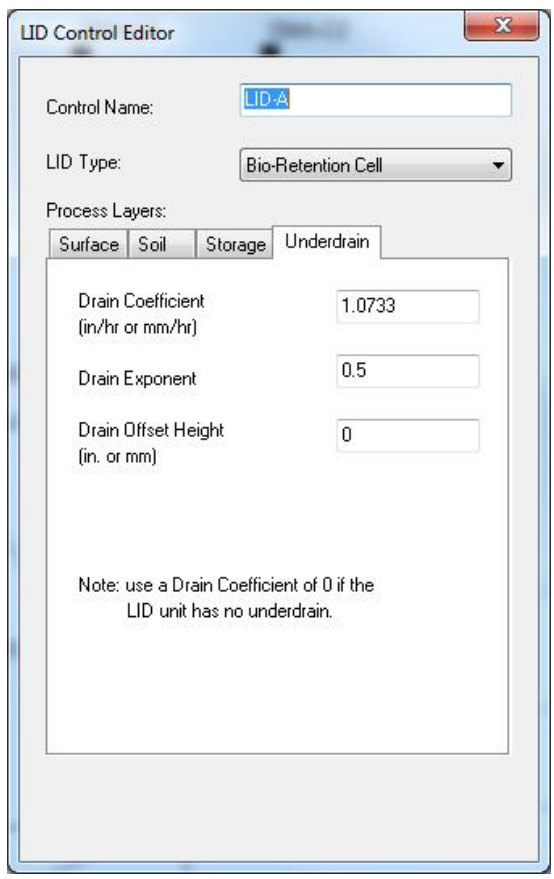

LID Usage Editor
Control Name
LID-C
Number of Replicate Units
1
Area of Each Unit (sq ft or sq m)
1133
% of Subcatchment Occupied
100.0
Top Width of Overland Flow Surface of Each Unit (ft or m)
0
% Initially Saturated
0
% of Impervious Area Treated
100

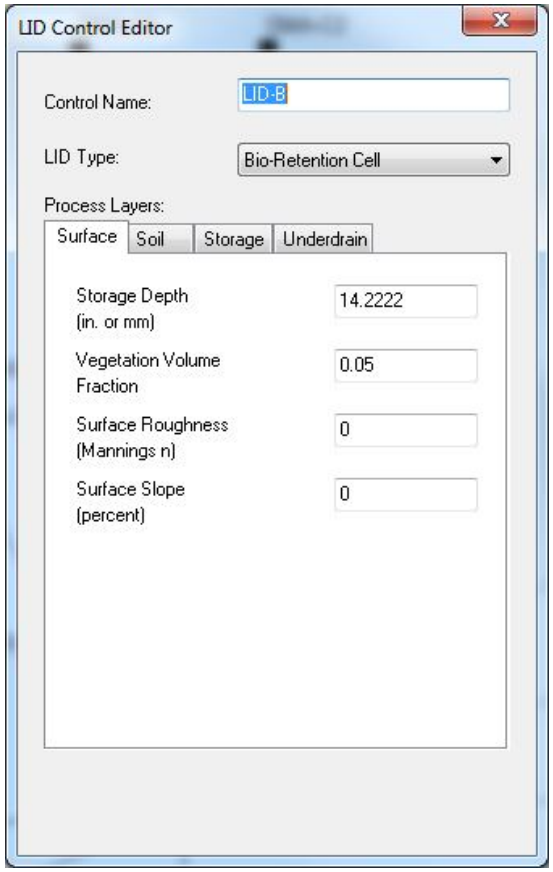

LID Usage Editor
Control Name
LID-D
Number of Replicate Units
1
Area of Each Unit (sq ft or sq m)
536
% of Subcatchment Occupied
100.0
Top Width of Overland Flow Surface of Each Unit (ft or m)
0
% Initially Saturated
0
% of Impervious Area Treated
100


LID Control Editor
Control Name:
LID-A
LID Type:
Bio-Retention Cell
Process Layers:
Surface
Soil
Storage
Underdrain
Storage Depth (in. or mm)
10.8045
Vegetation Volume Fraction
0.05
Surface Roughness (Mannings n)
0
Surface Slope (percent)
0


LID Control Editor
Control Name:
LID-A
LID Type:
Bio-Retention Cell
Process Layers:
Surface
Soil
Storage
Underdrain
Thickness (in. or mm)
18
Porosity (volume fraction)
0.4
Field Capacity (volume fraction)
0.2
Wilting Point (volume fraction)
0.1
Conductivity (in/hr or mm/hr)
5
Conductivity Slope
5
Suction Head (in. or mm)
1.5


LID Control Editor
Control Name:
LID-A
LID Type:
Bio-Retention Cell
Process Layers:
Surface
Soil
Storage
Underdrain
Height (in. or mm)
6
Void Ratio (Voids / Solids)
0.67
Conductivity (in/hr or mm/hr)
0
Clogging Factor
0
Note: use a Conductivity of 0 if the LID unit has an impermeable bottom.


LID Control Editor
Control Name:
LID-A
LID Type:
Bio-Retention Cell
Process Layers:
Surface
Soil
Storage
Underdrain
Drain Coefficient (in/hr or mm/hr)
1.0733
Drain Exponent
0.5
Drain Offset Height (in. or mm)
0
Note: use a Drain Coefficient of 0 if the LID unit has no underdrain.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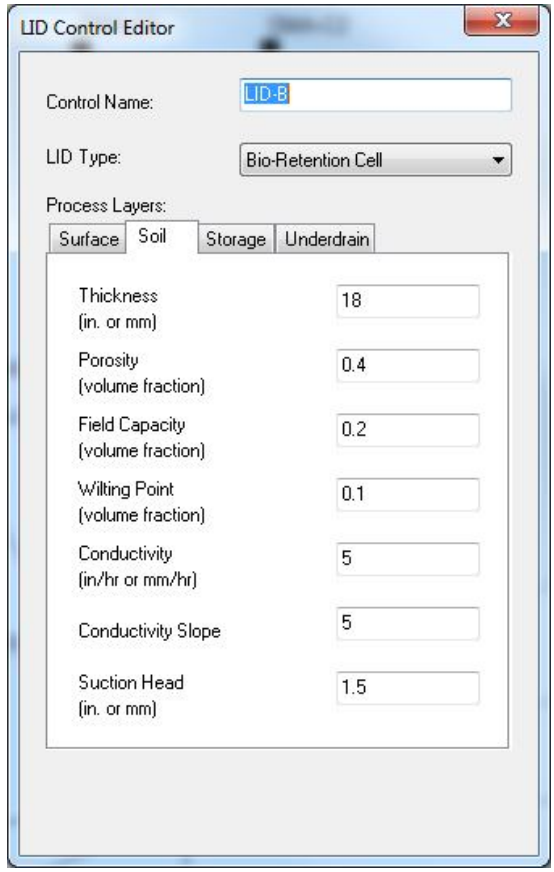
Control Name:
LID-B
LID Type:
Bio-Retention Cell
Process Layers:
Surface
Soil
Storage
Underdrain
Storage Depth (in. or mm)
14.2222
Vegetation Volume Fraction
0.05
Surface Roughness (Mannings n)
0
Surface Slope (percent)
0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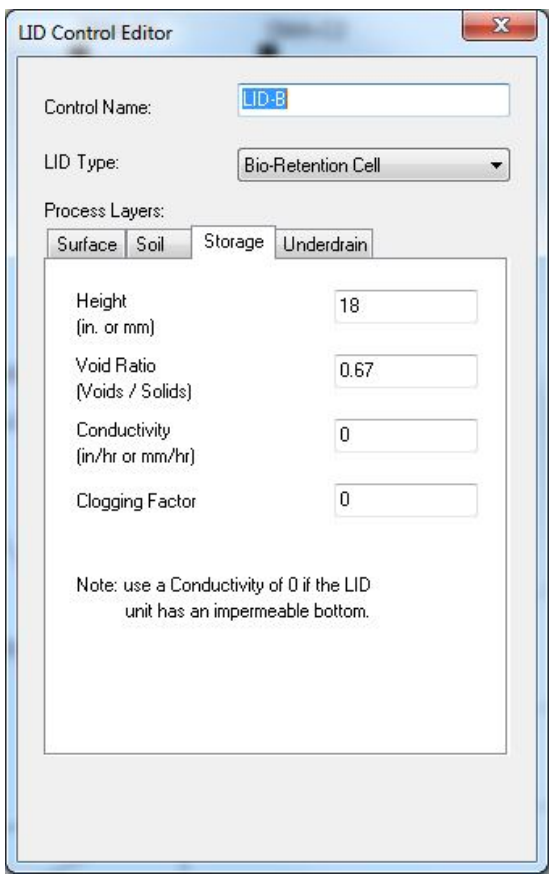
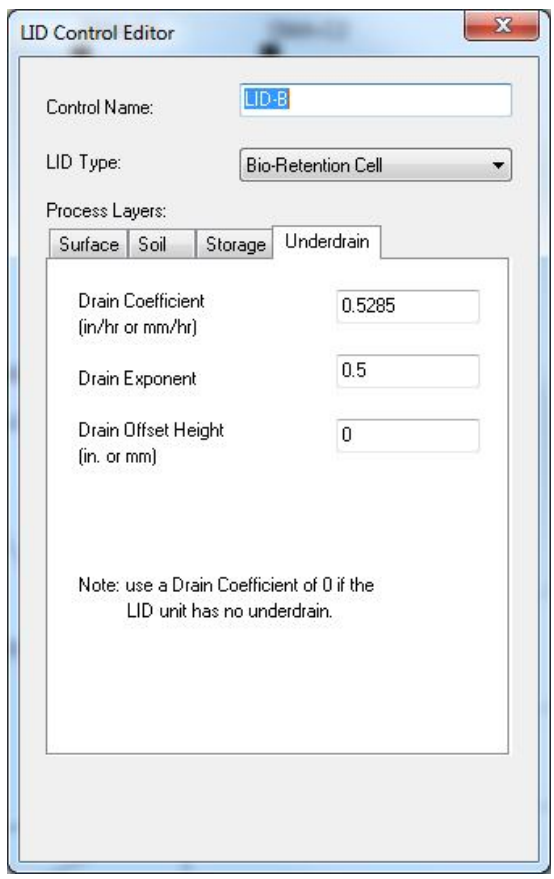
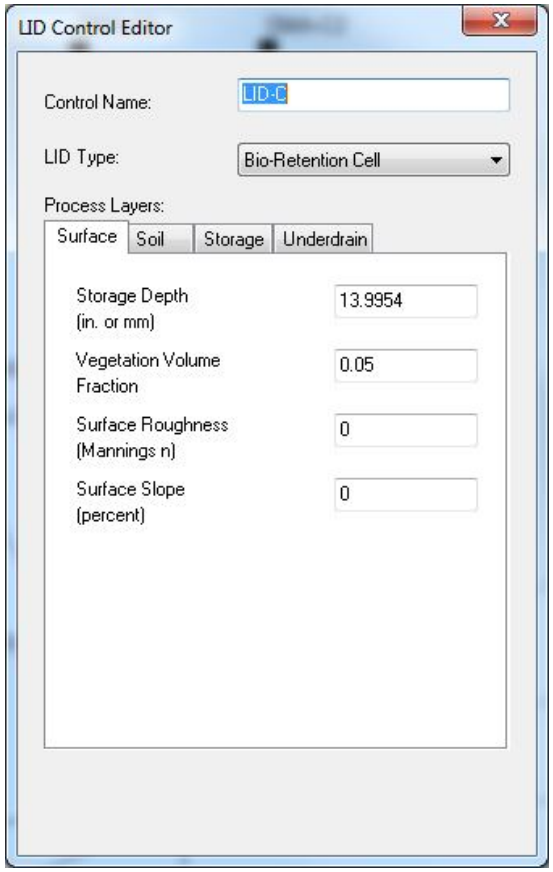
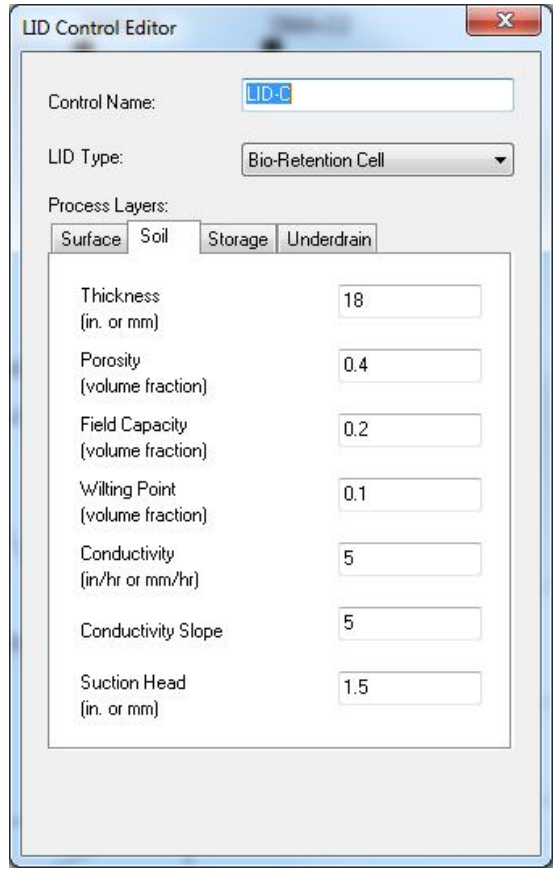
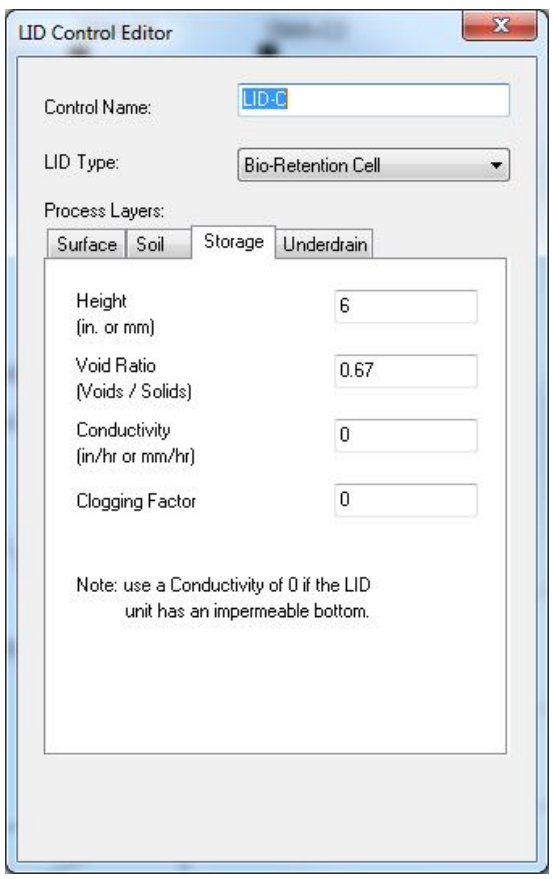
Control Name:
LID-B
LID Type:
Bio-Retention Cell
Process Layers:
Surface
Soil
Storage
Underdrain
Thickness (in. or mm)
18
Porosity (volume fraction)
0.4
Field Capacity (volume fraction)
0.2
Wilting Point (volume fraction)
0.1
Conductivity (in/hr or mm/hr)
5
Conductivity Slope
5
Suction Head (in. or mm)
1.5


LID Control Editor
Control Name:
LID-B
LID Type:
Bio-Retention Cell
Process Layers:
Surface
Soil
Storage
Underdrain
Height (in. or mm)
18
Void Ratio (Voids / Solids)
0.67
Conductivity (in/hr or mm/hr)
0
Clogging Factor
0
Note: use a Conductivity of 0 if the LID unit has an impermeable bottom.


LID Control Editor
Control Name:
LID-B
LID Type:
Bio-Retention Cell
Process Layers:
Surface
Soil
Storage
Underdrain
Drain Coefficient (in/hr or mm/hr)
0.5285
Drain Exponent
0.5
Drain Offset Height (in. or mm)
0
Note: use a Drain Coefficient of 0 if the LID unit has no underdrain.


LID Control Editor
Control Name:
LID-C
LID Type:
Bio-Retention Cell
Process Layers:
Surface
Soil
Storage
Underdrain
Storage Depth (in. or mm)
13.9954
Vegetation Volume Fraction
0.05
Surface Roughness (Mannings n)
0
Surface Slope (percent)
0


LID Control Editor
Control Name:
LID-C
LID Type:
Bio-Retention Cell
Process Layers:
Surface
Soil
Storage
Underdrain
Thickness (in. or mm)
18
Porosity (volume fraction)
0.4
Field Capacity (volume fraction)
0.2
Wilting Point (volume fraction)
0.1
Conductivity (in/hr or mm/hr)
5
Conductivity Slope
5
Suction Head (in. or mm)
1.5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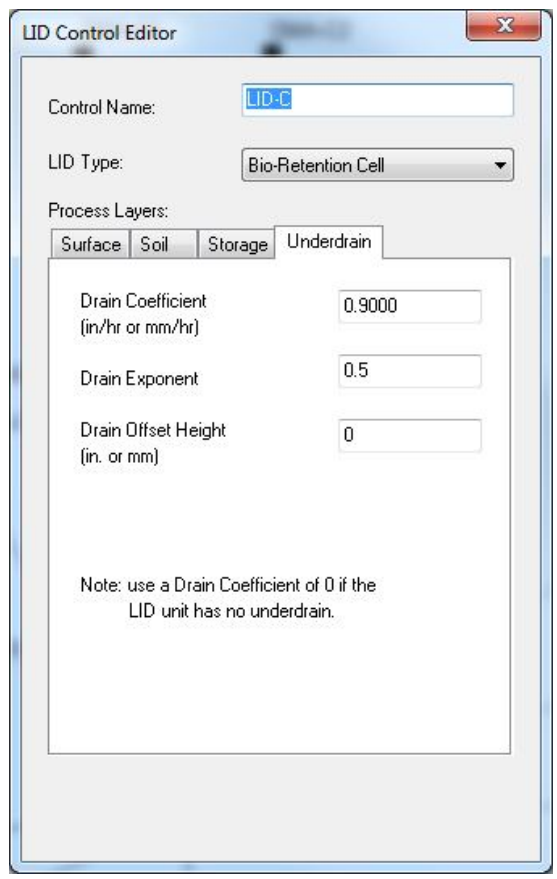
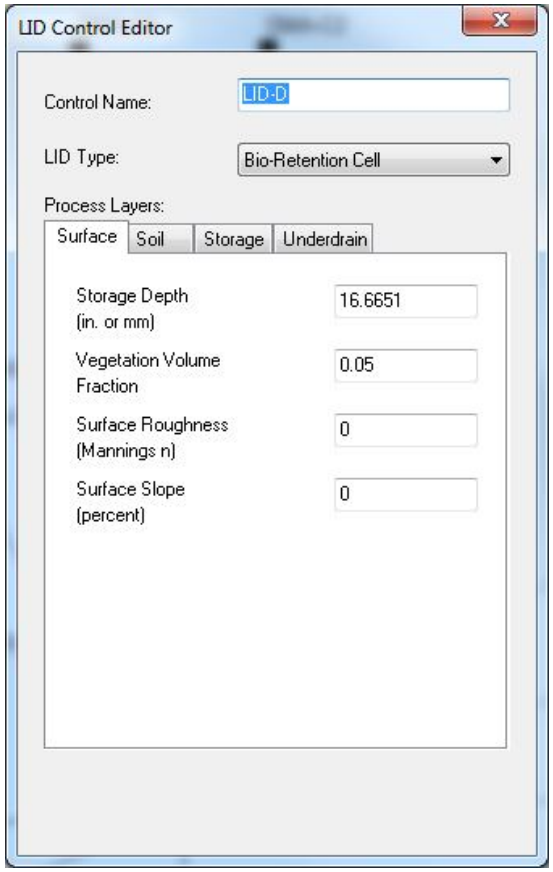
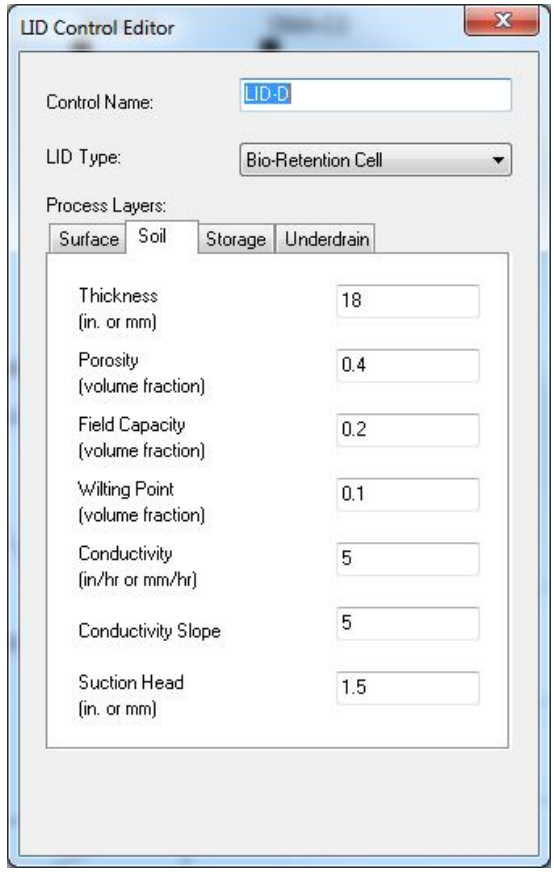
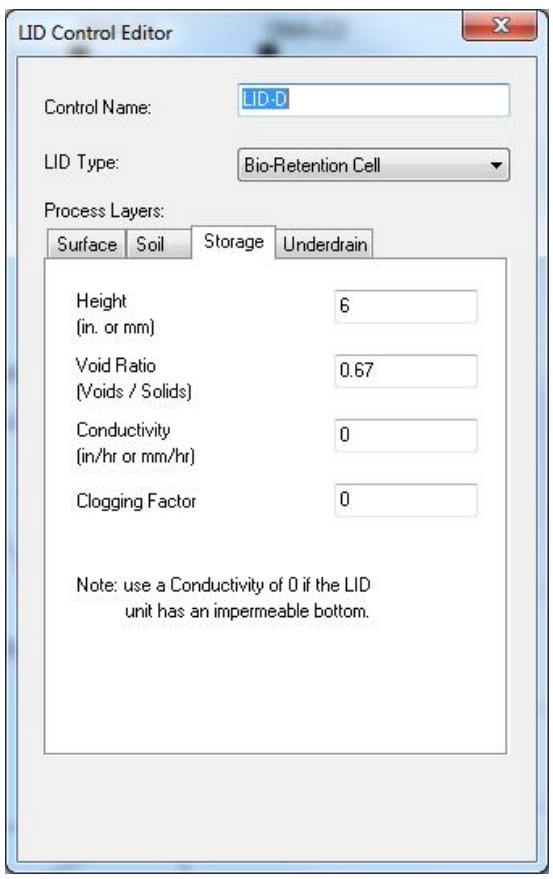
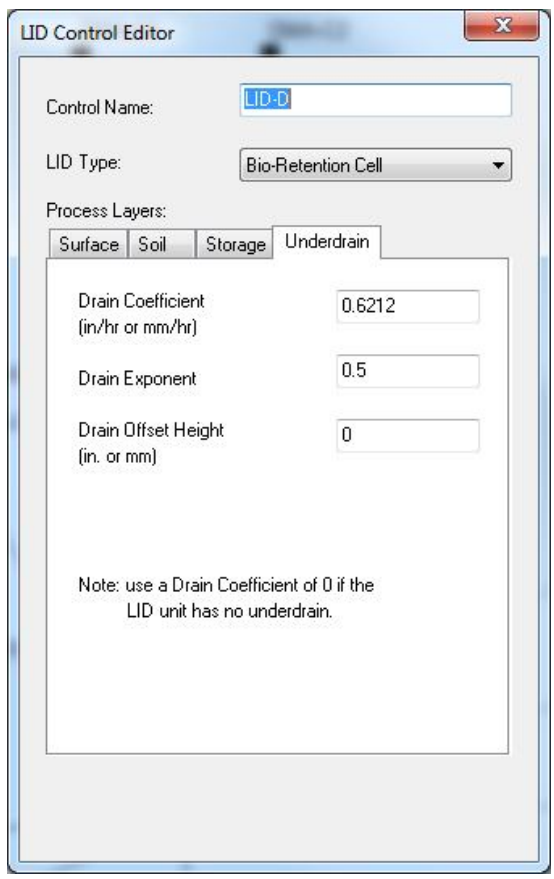
Control Name:
LID-C
LID Type:
Bio-Retention Cell
Process Layers:
Surface
Soil
Storage
Underdrain
Height (in. or mm)
6
Void Ratio (Voids / Solids)
0.67
Conductivity (in/hr or mm/hr)
0
Clogging Factor
0
Note: use a Conductivity of 0 if the LID unit has an impermeable bottom.


LID Control Editor
Control Name:
LID-C
LID Type:
Bio-Retention Cell
Process Layers:
Surface
Soil
Storage
Underdrain
Drain Coefficient (in/hr or mm/hr)
0.9000
Drain Exponent
0.5
Drain Offset Height (in. or mm)
0
Note: use a Drain Coefficient of 0 if the LID unit has no underdrain.


LID Control Editor
Control Name:
LID-D
LID Type:
Bio-Retention Cell
Process Layers:
Surface
Soil
Storage
Underdrain
Storage Depth (in. or mm)
16.6651
Vegetation Volume Fraction
0.05
Surface Roughness (Mannings n)
0
Surface Slope (percent)
0


LID Control Editor
Control Name:
LID-D
LID Type:
Bio-Retention Cell
Process Layers:
Surface
Soil
Storage
Underdrain
Thickness (in. or mm)
18
Porosity (volume fraction)
0.4
Field Capacity (volume fraction)
0.2
Wilting Point (volume fraction)
0.1
Conductivity (in/hr or mm/hr)
5
Conductivity Slope
5
Suction Head (in. or mm)
1.5


LID Control Editor
Control Name:
LID-D
LID Type:
Bio-Retention Cell
Process Layers:
Surface
Soil
Storage
Underdrain
Height (in. or mm)
6
Void Ratio (Voids / Solids)
0.67
Conductivity (in/hr or mm/hr)
0
Clogging Factor
0
Note: use a Conductivity of 0 if the LID unit has an impermeable bottom.


LID Control Editor
Control Name:
LID-D
LID Type:
Bio-Retention Cell
Process Layers:
Surface
Soil
Storage
Underdrain
Drain Coefficient (in/hr or mm/hr)
0.6212
Drain Exponent
0.5
Drain Offset Height (in. or mm)
0
Note: use a Drain Coefficient of 0 if the LID unit has no underdrain.

**LID Control Editor: Explanation of Significant Variables**

*Storage Depth*:

The storage depth variable within the SWMM model is representative of the storage volume provided beneath the engineered soil and mulch components of the bioretention facility.

In those cases where the surface storage has a variable area that is also different to the area of the gravel and amended soil, the SWMM model needs to be calibrated as the LID module will use the storage depth multiplied by the BMP area as the amount of volume stored at the surface.

Let $A_{BMP}$ be the area of the BMP (area of amended soil and area of gravel). The proper value of the storage depth $S_D$ to be included in the LID module can be calculated by using geometric properties of the surface volume. Let $A_0$ be the surface area at the bottom of the surface pond, and let $A_i$ be the surface area at the elevation of the invert of the first row of orifices (or at the invert of the riser if not surface orifices are included). Finally, let $h_i$ be the difference in elevation between $A_0$ and $A_i$. By volumetric definition:

$$A_{BMP} \cdot S_D = \frac{(A_0 + A_i)}{2} h_i \qquad (1)$$

Equation (1) allows the determination of $S_D$ to be included as Storage Depth in the LID module.

*Porosity*: A porosity value of 0.4 has been selected for the model. The amended soil is to be highly sandy in content in order to have a saturated hydraulic conductivity of approximately 5 in/hr.

TRWE considers such a value to be slightly high; however, in order to comply with the HMP Permit, the value recommended by the Copermittees for the porosity of amended soil is 0.4, per Appendix A of the Final Hydromodification Management Plan by Brown & Caldwell, dated March 2011. Such porosity is equal to the porosity of the gravel per the same document.

*Void Ratio*: The ratio of the void volume divided by the soil volume is directly related to porosity as n/(1-n). As the underdrain layer is composed of gravel, a porosity value of 0.4 has been selected (also per Appendix A of the Final HMP document), which results in a void ratio of 0.4/(1-0.4) = 0.67 for the gravel detention layer.

*Conductivity:* Per the geotechnical study performed for the project site (see Attachment 8), no infiltration was possible on the project site. As such, the LID's have been modeled with zero infiltration.

*Clogging factor*: A clogging factor was not used (0 indicates that there is no clogging assumed within the model). The reason for this is related to the fairness of a comparison with the SDHM model and the HMP sizing tables: a clogging factor was not considered, and instead, a conservative value of infiltration was recommended.

*Drain (Flow) coefficient*: The flow coefficient C in the SWMM Model is the coefficient needed to transform the orifice equation into a general power law equation of the form:

$$q = C(H - H_D)^n \tag{2}$$

where q is the peak flow in in/hr, n is the exponent (typically 0.5 for orifice equation), $H_D$ is the elevation of the centroid of the orifice in inches (assumed equal to the invert of the orifice for small orifices and in our design equal to 0) and H is the depth of the water in inches.

The general orifice equation can be expressed as:

$$Q = \frac{\pi}{4} c_g \frac{D^2}{144} \sqrt{2g \frac{(H - H_D)}{12}} \tag{3}$$

where Q is the peak flow in cfs, D is the diameter in inches, $c_g$ is the typical discharge coefficient for orifices (0.61-0.63 for thin walls and around 0.75-0.8 for thick walls), g is the acceleration of gravity in $ft/s^2$, and H and $H_D$ are defined above and are also used in inches in Equation (3).

It is clear that:

$$q \left(\frac{in}{hr}\right) X \frac{A_{BMP}}{12 \; X \; 3600} = Q \; (cfs) \tag{4}$$

*Cut-Off Flow:* Q (cfs) and q (in/hr) are also the cutoff flow. For numerical reasons to insure the LID is full, the model uses cut-off = 1.01 Q.

## Detention Basins

Storage Unit BASIN-E

| Property | Value |
|---|---|
| Name | BASIN-E |
| X-Coordinate | -3000.000 |
| Y-Coordinate | 6546.875 |
| Description | |
| Tag | |
| Inflows | NO |
| Treatment | NO |
| Invert El. | 0 |
| Max. Depth | 3 |
| Initial Depth | 0 |
| Ponded Area | 760 |
| Evap. Factor | 1 |
| Infiltration | YES |
| Storage Curve | TABULAR |
| Functional Curve | |
| Coefficient | 1000 |
| Exponent | 0 |
| Constant | 0 |
| Tabular Curve | |
| Curve Name | BASIN-E |

User-assigned name of storage unit

Storage Curve Editor

Curve Name: BASIN-E

Description:

| | Depth (ft) | Area (ft2) |
|---|---|---|
| 1 | 0 | 760 |
| 2 | 1 | 760.1 |
| 3 | 2 | 760.2 |
| 4 | 2.5 | 760.3 |
| 5 | 3 | 760.4 |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |

Outlet ORIFICE

| Property | Value |
|---|---|
| Name | ORIFICE |
| Inlet Node | BASIN-E |
| Outlet Node | POC-1 |
| Description | |
| Tag | |
| Inlet Offset | 0 |
| Flap Gate | NO |
| Rating Curve | TABULAR/HEAD |
| Functional Curve | |
| Coefficient | 10.0 |
| Exponent | 0.5 |
| Tabular Curve | |
| Curve Name | OUTLET-E |

Rating Curve Editor

Curve Name: OUTLET-E

Description:

| | Head (ft) | Outflow (CFS) |
|---|---|---|
| 1 | 0.000 | 0.000 |
| 2 | 0.042 | 0.003 |
| 3 | 0.083 | 0.011 |
| 4 | 0.125 | 0.024 |
| 5 | 0.167 | 0.041 |
| 6 | 0.208 | 0.060 |
| 7 | 0.250 | 0.081 |
| 8 | 0.292 | 0.100 |
| 9 | 0.333 | 0.111 |

Storage Unit BASIN-C

| Property | Value |
|---|---|
| Name | BASIN-C |
| X-Coordinate | -4583.269 |
| Y-Coordinate | 8914.525 |
| Description | |
| Tag | |
| Inflows | NO |
| Treatment | NO |
| Invert El. | 0 |
| Max. Depth | 2 |
| Initial Depth | 0 |
| Ponded Area | 1780 |
| Evap. Factor | 1 |
| Infiltration | NO |
| Storage Curve | TABULAR |
| Functional Curve | |
| Coefficient | 1000 |
| Exponent | 0 |
| Constant | 0 |
| Tabular Curve | |
| Curve Name | BASIN_C |

Name of storage curve to use (after specifing a curve, you can double-click to edit it)

Storage Curve Editor

Curve Name: BASIN_C

Description:

| | Depth (ft) | Area (ft2) |
|---|---|---|
| 1 | 0.00 | 1133.3 |
| 2 | 0.50 | 1298.0 |
| 3 | 1.50 | 1621.4 |
| 4 | 2.00 | 1780.0 |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |

Outlet OUT-C

| Property | Value |
|---|---|
| Name | OUT-C |
| Inlet Node | BASIN-C |
| Outlet Node | BASIN-E |
| Description | |
| Tag | |
| Inlet Offset | 0 |
| Flap Gate | NO |
| Rating Curve | TABULAR/HEAD |
| Functional Curve | |
| Coefficient | 10.0 |
| Exponent | 0.5 |
| Tabular Curve | |
| Curve Name | OUT-C |

Rating Curve Editor

Curve Name: OUT-C

Description:

| | Head (ft) | Outflow (CFS) |
|---|---|---|
| 1 | 0.000 | 0.000 |
| 2 | 0.042 | 0.009 |
| 3 | 0.083 | 0.033 |
| 4 | 0.125 | 0.072 |
| 5 | 0.167 | 0.122 |
| 6 | 0.208 | 0.180 |
| 7 | 0.250 | 0.244 |
| 8 | 0.292 | 0.299 |
| 9 | 0.333 | 0.334 |

Storage Unit BASIN_A_F

| Property | Value |
|---|---|
| Name | BASIN_A_F |
| X-Coordinate | -6214.121 |
| Y-Coordinate | 4941.013 |
| Description | |
| Tag | |
| Inflows | NO |
| Treatment | NO |
| Invert El. | 0 |
| Max. Depth | 1.75 |
| Initial Depth | 0 |
| Ponded Area | 1764 |
| Evap. Factor | 1 |
| Infiltration | NO ... |
| Storage Curve | TABULAR |
| Functional Curve | |
| Coefficient | 1000 |
| Exponent | 0 |
| Constant | 0 |
| Tabular Curve | |
| Curve Name | BASIN_A |

Click to specify infiltration through the bottom of the storage unit

Storage Curve Editor

Curve Name: BASIN_A

Description:

| | Depth (ft) | Area (ft2) |
|---|---|---|
| 1 | 0 | 977.9 |
| 2 | 0.25 | 1078.8 |
| 3 | 0.75 | 1292.0 |
| 4 | 1.75 | 1764.0 |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |

Outlet OUT_A

| Property | Value |
|---|---|
| Name | OUT_A |
| Inlet Node | BASIN_A_F |
| Outlet Node | BASIN-E |
| Description | |
| Tag | |
| Inlet Offset | 0 |
| Flap Gate | NO |
| Rating Curve | TABULAR/HEAD |
| Functional Curve | |
| Coefficient | 10.0 |
| Exponent | 0.5 |
| Tabular Curve | |
| Curve Name | OUT_A |

User-assigned name of outlet

Rating Curve Editor

Curve Name: OUT_A

Description:

| | Head (ft) | Outflow (CFS) |
|---|---|---|
| 1 | 0.000 | 0.000 |
| 2 | 0.042 | 0.039 |
| 3 | 0.083 | 0.112 |
| 4 | 0.125 | 0.205 |
| 5 | 0.167 | 0.316 |
| 6 | 0.208 | 0.433 |
| 7 | 0.250 | 0.499 |
| 8 | 0.292 | 0.558 |
| 9 | 0.333 | 0.612 |

# ATTACHMENT 8

## Geotechnical Study & Soils Maps

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# GEOTECHNICAL INVESTIGATION
# COMMERCIAL DEVELOPMENT
# APN 395-250-2100
# LAKESIDE, CALIFORNIA

**PREPARED FOR:**

**MR. STEVE POWELL**
**WOODCREST HOMES, INC.**
**POST OFFICE BOX 823**
**RAMONA, CALIFORNIA 92065**

**PREPARED BY:**

**SOUTHERN CALIFORNIA SOIL & TESTING, INC.**
**6280 RIVERDALE STREET**
**SAN DIEGO, CALIFORNIA 92120**

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July 16, 2013

**SCS&T No. 1311105**
**Report No. 1**

**Mr. Steve Powell**
**Woodcrest Homes, Inc.**
**Post Office Box 823**
**Ramona, California 92065**

Subject: GEOTECHNICAL INVESTIGATION
COMMERCIAL DEVELOPMENT
APN 395-250-2100
LAKESIDE, CALIFORNIA

Dear Mr. Powell:

This letter transmits Southern California Soil & Testing, Inc.'s (SCS&T) geotechnical report for the subject project. This investigation was performed in general conformance with the scope of work presented in SCS&T's proposal, June 21, 2013.

If you have questions concerning this report, please call us at (619) 280-4321.

Respectfully Submitted,
**SOUTHERN CALIFORNIA SOIL & TESTING, INC.**

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Senior Engineer

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Staff Geologist

RNB:GBF:aw

(4) Addressee
(1) Addressee via e-mail steve@woodcresthomesinc.com

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Table 1 ..... Flexible Pavement Section Recommendations

## EXECUTIVE SUMMARY

This report presents the results of the geotechnical investigation performed by Southern California Soil and Testing, Inc. (SCS&T) for the proposed commercial development to be located on APN 395-250-2100 in the Lakeside area of San Diego County, California. We understand the proposed project could consist of a commercial building, outdoor display areas and a drive-through storage area. Additionally, exterior improvements could consist of paved driveways and parking lots, typical hardscape improvements, a storm-water detention area and landscaping. The purpose of our work is to provide conclusions and recommendations regarding the geotechnical aspects of the project.

An SCS&T geologist observed the excavation of 10 exploratory test trenches to depths of between 2½ feet and 4½ feet below the existing grade. The exploratory test trenches were excavated with a backhoe equipped with an 18-inch bucket. Selected samples from the trenches were tested to evaluate pertinent soil classification and engineering properties and enable development of geotechnical conclusions and recommendations. Additionally, 2 infiltration rate tests were performed at the subject site along with 2 seismic traverses to determine the excavation characteristics of the underlying rock.

SCS&T's geologist observed slopewash underlain by metasedimentary rock in all the test trenches. The slopewash consists of loose clayey sand and soft sandy clay. The metasedimentary rock is very hard, slightly weathered and moderately fractured. Groundwater was not encountered in any of the test trenches.

The main geotechnical considerations affecting the planned development are:

- The presence of compressible slopewash soils;
- Difficult excavation conditions;
- Cut/fill transitions below the building pads.

The existing slopewash is not suitable for the support of settlement sensitive structures or improvements. To reduce the potential for differential settlement, the existing slopewash should be excavated in its entirety. This material will need to be excavated and replaced as compacted fill. The seismic traverses indicate that the very hard rock will require blasting and specialized rock breaking equipment to reach the over-excavation elevations. The on-site soil tested has a low expansion potential. Shallow spread footings with bottom levels in compacted fill or rock can be used for the support of the proposed structures. The grading and foundation recommendations herein may need to be updated once final grading and foundation plans are developed.

# 1. INTRODUCTION

## 1.1 GENERAL

This report presents the results of the geotechnical investigation performed by Southern California Soil and Testing, Inc. (SCS&T) for the proposed commercial development to be located on APN 395-250-2100 in the Lakeside area of San Diego County, California. We understand the proposed project could consist of a commercial building, outdoor display areas and a drive-through storage area. Additionally, exterior improvements could consist of paved driveways and parking lots, typical hardscape improvements, a storm-water detention area and landscaping. The purpose of our work is to provide conclusions and recommendations regarding the geotechnical aspects of the project. Figure 1 presents a site vicinity map.

## 1.2 SCOPE OF WORK

### 1.2.1 Field Exploration

Subsurface conditions were explored by excavating 10 exploratory test trenches to depths of between 5 feet and 9 feet below the existing ground surface. Additionally, 2 infiltration rate tests along with 4 seismic traverses were performed at the subject site. Figure 2 shows the test trench, infiltration rate test and seismic traverse locations. An SCS&T geologist logged the test trenches and obtained samples for examination and laboratory testing. The logs of the test trenches are in Appendix I. Soils are classified according to the Unified Soil Classification System illustrated on Figure I-1.

### 1.2.2 Laboratory Testing

The laboratory program consisted of tests for:

- Grain Size Distribution
- Maximum Density and Optimum Moisture
- Expansion Index
- Corrosivity
- Direct Shear
- R-Value

The results of the laboratory tests, and brief explanations of test procedures, are in Appendix II.

### 1.2.3 Analysis and Report

The results of the field and laboratory tests were evaluated to develop conclusions and recommendations regarding:

- Subsurface conditions;
- Site preparation and grading;
- Excavation characteristics;
- Potential geologic hazards;
- Criteria for seismic design in accordance with the current California Building Code;
- Appropriate alternatives for foundation support along with geotechnical engineering criteria for design;
- Resistance to lateral loads;
- Estimated foundation settlements;
- Infiltration rates for the design of storm water detention systems;
- Support for slab-on-grade floors;
- Lateral pressure recommendations for the design of retaining walls;
- Flexible pavement sections.

## 2. FINDINGS

### 2.1 SURFACE CONDITIONS

The subject site is a rectangular parcel located along the north side of Olde Highway 80 east of the intersection with Lake Jennings Park Road in the Lakeside area of San Diego County, California. The site is bounded by Interstate 8 on the north, Olde Highway 80 on the south, a commercial property on the west, and a residential property on the east. The existing site consists of a vacant lot. Topographically, the site descends to the southwest with a total elevation difference of about 70 feet over a span of about 700 feet. A 10 foot road cut with a slope inclination of 1:1 (horizontal: vertical) in very hard rock bounds 400 horizontal feet along the southern boundary of the site. Vegetation consists of scattered weeds and trees.

### 2.2 SUBSURFACE CONDITIONS

Materials encountered in the test trenches consisted of slopewash and metasedimentary rock. The slopewash is comprised of loose clayey sand and soft sandy clay. The metasedimentary rock is very hard, slightly weathered and moderately fractured. Backhoe refusal was encountered in all test trenches on very hard metasedimentary rock.

Groundwater was not encountered in the test trenches. The permanent groundwater level is expected to be below a depth that will influence planned construction. However, groundwater levels can fluctuate seasonally, and can rise significantly following periods of precipitation. In addition, groundwater can be perched on top of the metasedimentary rock as a result of rainfall and irrigation.

### 2.3 LIQUEFACTION

The materials underlying the site are not considered susceptible to liquefaction due to the metasedimentary rock at relatively shallow depths.

### 2.4 POTENTIAL GEOLOGIC HAZARDS

No known geologic hazards are mapped at the site. A geologic hazard likely to affect the project is ground shaking as a result of movement along an active fault zone in the vicinity of the subject site.

### 2.5 SEISMIC DESIGN CRITERIA

A likely geologic hazard to affect the project is groundshaking as a result of movement along an active fault zone in the vicinity of the subject site. The site coefficients and adjusted maximum considered earthquake spectral response acceleration parameters determined in accordance with the 2010 California Building Code are presented below:

Site Coordinates: Latitude = 32.844°
Longitude = -116.878°
Site Class: C
Site Coefficient $F_a$ = 1.0
Site Coefficient $F_v$ = 1.455
Spectral Response Acceleration at Short Periods $S_s$ = 1.015
Spectral Response Acceleration at 1-Second Period $S_1$ = 0.345
$S_{MS}=F_aS_s$ = 1.015
$S_{M1}=F_vS_1$ = 0.502
$S_{DS}$=2/3* $S_{MS}$= 0.677
$S_{D1}$=2/3* $S_{M1}$= 0.335

## 3. CONCLUSIONS

The main geotechnical considerations affecting the planned development are:

- The presence of compressible slopewash soils;
- Difficult excavation conditions;
- Cut/fill transitions below the building pads.

The existing slopewash is not suitable for the support of settlement sensitive structures or improvements. To reduce the potential for differential settlement, the existing slopewash should be excavated in its entirety. This material will need to be excavated and replaced as compacted fill. The seismic traverses indicate that the very hard rock will require blasting and specialized rock breaking equipment to reach the over-excavation elevations. The on-site soil tested has a low expansion potential. Shallow spread footings with bottom levels in compacted fill or rock can be

used for the support of the proposed structures. The grading and foundation recommendations herein may need to be updated once final grading and foundation plans are developed.

# 4. RECOMMENDATIONS

## 4.1 SITE PREPARATION AND GRADING

### 4.1.1 Site Preparation

Site preparation should begin with the removal of existing improvements, debris, vegetation and deleterious matter. The existing slopewash and fill, if any, should be excavated in their entirety.

An SCS&T representative should observe conditions exposed in the bottom of the excavation to determine if additional removal is required.

### 4.1.2 Cut/Fill and Transitions

Where structures span a cut/fill transition the exposed rock should be excavated to a depth that is at least 2 feet below the planned bottom elevation of the deepest footing. The bottom of the excavation should be sloped toward the fill portion of the pad and away from the center of the pad.

### 4.1.3 Earthwork

Excavated materials, except for soil containing roots and organic debris, can be used as compacted fill. Fill should be placed in 6- to 8-inch thick loose lifts, moisture conditioned to near optimum moisture content, and compacted to at least 90% relative compaction. The maximum dry density and optimum moisture content for the evaluation of relative compaction should be determined in accordance with ASTM D 1557.

Utility trench backfill should be compacted to a minimum of 90% relative compaction. The upper 12 inches of subgrade beneath slabs and paved areas should be compacted to at least 95% relative compaction.

### 4.1.4 Rock Fill Placement

The quantity of rock generated during grading operations will depend on the grading scheme. The rock will most likely consist of cobbles and boulders of varying size. The rock should be mixed with sufficient quantities of soil such that nesting does not occur during placement and the rock is completely surrounded by a soil matrix material with no voids. The rock/soil mixture should be placed in lifts of approximately 12 inches in thickness and compacted with heavy rubber-tire or smooth drum vibratory compaction equipment. Oversized rock greater than 6 inches may be placed in structural fills in accordance with the detail presented on attached

Figure 4. Rocks greater than 3 inches in diameter should not be used within 18 inches of final grade or where foundation or utility trenches will be located.

#### 4.1.5 Site Excavation Characteristics

Conventional heavy equipment in good working order is expected to be able to excavate the slopewash and some of the upper portions of the metasedimentary rock on site. However, non-ripple rock exists on-site, and these areas will require blasting and specialized rock breaking equipment to reach the over-excavation elevations. Additionally, rocks up to 3 feet in diameter are exposed near the surface. Contract documents should specify that the contractor mobilize equipment capable of excavating and breaking the bedrock and removing rock. Appendix III presents the results of the excavation characteristics study performed for the project.

#### 4.1.6 Permanent Fill Slopes

Fill slopes can be constructed at an inclination of 2:1 (horizontal: vertical). Compaction of slopes should be performed by back-rolling with a sheep foot compactor at vertical intervals of 2 feet or less as the fill is being placed, and by track-walking the face of the slope when the fill is completed. Alternatively, slopes can be overfilled and cut back to expose dense material at the design line and grade. Fills should be benched into temporary slopes and into the rock when the natural slope is steeper than 5:1 (horizontal: vertical).

#### 4.1.7 Permanent Cut Slopes

It is our opinion that cut slopes, constructed at an inclination of 2:1 (horizontal: vertical) or flatter, ratio will possess an adequate factor of safety. The engineering geologist should observe all cut slopes during grading to ascertain that no unforeseen adverse conditions requiring revised recommendations are encountered.

#### 4.1.8 Temporary Excavation Slopes

Temporary slopes in slopewash and fill should not be steeper than 1:1 (horizontal:vertical). Temporary slopes slopes in rock should not be steeper than ½:1 (horizontal: vertical). Excavations less than or equal to 4 feet in height can be excavated vertically. Temporary cut slopes should be observed by an SCS&T Engineering Geologist during grading to ascertain that no unforeseen adverse conditions are observed. The temporary slopes should be inspected daily by the contractor's Competent Person before personnel are allowed to enter the excavation. Zones of potential instability, sloughing or raveling should be brought to the attention of the Engineer and corrective action implemented before personnel begin working in the trench. No surcharge loads should be placed within a distance from the top of temporary cut slopes equal to half the slope height.

#### 4.1.9 Expansive Material

The existing slopewash soils on-site that were tested have a very low expansion potential. The recommendations contained in this report assume a very low expansion potential.

#### 4.1.10 Imported Soil

Imported fill should consist of predominately granular soils free of organic material and rocks greater than 3 inches in maximum dimension. Imported soils should have an Expansion Index of 20 or less. Imported soils should be inspected and, if appropriate, tested by SCS&T prior to transport to the site.

#### 4.1.11 Surface Drainage

Final surface grades around the buildings should be designed to collect and direct surface water away from the structure and toward appropriate drainage facilities. The ground around the structures should be graded so that surface water flows rapidly away from the structure without ponding. In general, we recommend that the ground adjacent to the structure slope away at a gradient of at least 2%. Densely vegetated areas where runoff can be impaired should have a minimum gradient of at least 5% within the first 5 feet from the structure. Roof gutters with downspouts that discharge directly into a closed drainage system are recommended on structures.

Drainage patterns established at the time of fine grading should be maintained throughout the life of the proposed structures. Site irrigation should be limited to the minimum necessary to sustain landscape growth. Should excessive irrigation, impaired drainage, or unusually high rainfall occur, saturated zones of perched groundwater can develop.

#### 4.1.12 Grading Plan Review

The grading plans should be submitted to SCS&T for review to ascertain whether the intent of the recommendations contained in this report have been implemented, and that no revised recommendations are necessary due to changes in the development scheme.

### 4.2 FOUNDATIONS

Shallow spread footings with bottom levels in compacted fill or weathered granitic rock can support the planned structure. The following report sections present recommendations for each foundation alternative discussed above.

#### 4.2.1 Shallow Spread Footings (Footings Supported on Compacted Fill)

Shallow spread footings with bottom levels in compacted fill can be used to support the proposed structures. A minimum width of 12 inches is recommended for continuous footings

and 24 inches for isolated footings. All footings should extend a minimum of 18 inches below lowest adjacent grade. A bearing capacity of 2,500 pounds per square foot (psf) can be used. These values can be increased by ⅓ when considering including wind or seismic forces. Footings adjacent to slopes should be extended to a depth such that a minimum distance of 7 feet exists between the bottom of the footing and the face of the slope.

#### 4.2.2 Shallow Spread Footings (Footings Supported on Rock)

Shallow spread footings with bottom levels in rock can be used to support the proposed structures. The footings should extend at least 18 inches below lowest adjacent finish pad grade. A minimum width of 12 inches is recommended for continuous footings and 24 inches for isolated footings. A bearing capacity of 7,500 pounds per square foot (psf) can be used for footings in rock. This value can be increased by ⅓ when considering wind or seismic forces. Footings located adjacent to slopes should be extended to a depth such that a minimum distance of 7 feet exists between the outside bottom footing edge and the face of slopes.

#### 4.2.3 Resistance to Lateral Loads

Lateral loads will be resisted by friction between the bottoms of footings and passive pressure on the faces of footings and other structural elements below grade. A friction factor of 0.30 can be used. Passive pressure can be computed using a lateral pressure value of 300 psf per foot of depth below the ground surface. The upper 1 foot of soil should not be relied on for passive support unless the ground is covered with pavements or slabs. The passive pressure can be increased by ⅓ when considering the total of all loads, including wind or seismic forces.

#### 4.2.4 Settlement Characteristics

Total footing settlements are estimated to be less than 1 inch. Differential settlements between adjacent footings, are estimated to be less than ½ and between the middle and ends of continuous footings, inch. Settlements should occur rapidly, and should be completed shortly after structural loads are applied.

#### 4.2.5 Foundation Plan Review

The foundation plans should be submitted to SCS&T for review to ascertain that the intent of the recommendations in this report has been implemented and that revised recommendations are not necessary due to the layout.

## 4.3 SLABS-ON-GRADE

### 4.3.1 Interior Concrete Slabs-on-Grade

Concrete slabs-on-grade should have a thickness of at least 5 inches and be reinforced with at least No. 4 reinforcing bars placed at 18 inches on-center each way. Slab reinforcement should be placed approximately at mid-height of the slab.

Slabs-on-grade should be underlain by a 6-inch thick blanket of clean, poorly graded, coarse sand or crushed rock. A moisture vapor retarder/barrier should be placed beneath slabs where moisture-sensitive floor coverings will be installed. Typically, plastic is used as a vapor retardant. If plastic is used, a minimum 10-mil is recommended. The plastic should comply with ASTM E 1745. Plastic installation should comply with ASTM E 1643.

Current construction practice typically includes placement of a 2-inch thick sand cushion between the bottom of the concrete slab and the moisture vapor retarder/barrier. This cushion can provide some protection to the vapor retarder/barrier during construction, and may assist in reducing the potential for edge curling in the slab during curing. However, the sand layer also provides a source of moisture vapor to the underside of the slab that can increase the time required to reduce moisture vapor emissions to limits acceptable for the type of floor covering placed on top of the slab. The floor covering manufacturer should be contacted to determine the volume of moisture vapor allowable and any treatment needed to reduce moisture vapor emissions to acceptable limits for the particular type of floor covering installed.

### 4.3.2 Exterior Slabs-on-Grade

Exterior concrete slabs-on-grade should be underlain by at least 2 feet of soil having an expansion index of 20 or less. Exterior concrete slabs-on-grade should have a minimum thickness of 5 inches; reinforced with at least No. 4 bars at 18 inches on center each way. Slabs should be provided with weakened plane joints. Joints should be placed in accordance with the American Concrete Institute Guidelines. The landscape architect should be consulted in selecting the final joint patterns.

A 1-inch maximum size aggregate mix is recommended for concrete for exterior slabs. A water/cement ratio of less than 0.45 also is recommended, to decrease the potential for shrinkage cracks. The corrosion potential of on-site soils with respect to reinforced concrete will need to be taken into account in concrete mix design. Coarse and fine aggregate in concrete should conform to the “Greenbook” Standard Specifications for Public Works Construction.

## 4.4 RETAINING WALLS

### 4.4.1 Foundations

The recommendations provided in the foundation section of this report are also applicable to earth retaining structures.

### 4.4.2 Passive Pressure

The passive pressure for the retaining walls can be considered to be 350 psf per foot of depth up to a maximum of 5,000 psf. This pressure may be increased by ⅓ for wind or seismic loading. The coefficient of friction for concrete to soil may be taken as 0.35 for resistance to lateral movement. The upper 12 inches of soil in front of retaining wall footings should not be included in passive pressure calculations unless pavement extends adjacent to the footing.

### 4.4.3 Active Pressure

The active soil pressure for the design of unrestrained earth retaining structures with level backfills can be taken as equivalent to the pressure of a fluid weighing 40 pounds per cubic foot (pcf). An additional 20 pcf should be added for walls with sloping backfills of 2:1(horizontal:vertical). A granular and drained backfill condition has been assumed. Surcharge loads from vehicles can be taken into account by assuming an additional 2 feet of soil is supported by the wall. If any other surcharge loads are anticipated, SCS&T should be contacted for the necessary increase in soil pressure. The project architect should provide waterproofing specifications and details. A typical wall backdrain detail is shown on Figure 4.

### 4.4.4 At-Rest Pressure

The at-rest soil pressure for the design of restrained earth retaining structures with level backfills can be taken as equivalent to the pressure of a fluid weighing 60 pcf. An additional 20 pcf should be added for walls with sloping backfills of 2:1 (horizontal: vertical) or flatter. A granular and drained backfill condition has been assumed. If any surcharge loads are anticipated, SCS&T should be contacted for the necessary increase in soil pressure.

### 4.4.5 Seismic Earth Pressure

The seismic earth pressures can be taken as an inverted triangular distribution with a maximum pressure at the top equal to 14H pounds per square foot (with H being the height of the retained earth in feet). This pressure is in addition to the un-factored static design wall load. The resultant acts at a height of 0.6H up from the base of the wall.

#### 4.4.6 Waterproofing and Backdrain Observation

The geotechnical engineer should be requested to verify that waterproofing has been applied and that the backdrain has been properly installed. However, unless specifically asked to do so, we will not verify proper application of the waterproofing. SCS&T does have a waterproofing division that can provide this service if requested.

#### 4.4.7 Backfill

All backfill soils should be compacted to at least 90% relative compaction. Expansive or clayey soils should not be used for backfill material. The wall should not be backfilled until the grout has reached an adequate strength.

#### 4.4.8 Factor of Safety

The above values, with the exception of the allowable soil bearing pressure, do not include a factor of safety. Appropriate factors of safety should be incorporated into the design.

### 4.5 TIE BACK DESIGN RECOMMENDATIONS

We anticipate tie backs may be needed to support the wall along the north perimeter of the site. It is anticipated the tie backs for the wall will encounter material ranging from artificial fill, slopewash and metasedimentary rock. The following soil parameters can be used for the design of the tie backs.

- **Soil Unit Weight** – 120 Pounds Per Cubic Foot
- **Internal Friction Angle** – 20 Degrees
- **Ultimate Unit Bond Stress** – 1,000 Pounds Per Square Foot

Anchor pullout capacity is influenced by soil and rock condition, method of construction and grouting techniques. Anchor capacity should be verified in the field. Casing or other methods may be needed to maintain an open hole during construction.

#### 4.5.1 Tie Back Plan Review

The tie-back plans should be submitted to SCS&T for review to ascertain whether the intent of the recommendations in this report has been implemented and that revised recommendations are not necessary due to the layout.

### 4.6 PAVEMENT SECTION RECOMMENDATIONS

The materials encountered at the site have poor pavement support characteristics. An R-value of less than 6 was measured. The actual R-value of the subgrade soils should be determined after

grading. The following flexible structural sections are recommended for the Traffic Indices presented below.

**TABLE 1**
**Flexible Pavement Section Recommendations**

| Traffic Type | Traffic Index | Full Depth AC[note 1] (inches) | AC/AB Crushed Aggregate Base* (inches) |
|---|---|---|---|
| Parking Stalls | 4.5 | 7 | 3/8 |
| Drive Lanes | 6.0 | 10 | 4/12 |

**Note 1: Ac, Asphalt Concrete.**
**Note 2: AB, aggregated base shall in conform to Standard Specifications for Public Works Construction, Section 200-2 – Crushed Miscellaneous Base. Alternatively, AB shall conform to Class 2 Aggregate Base in Section 26-1.02 of the Standard Specifications of The State of California Department of Transportation.**

Areas expected to experience heavy loads from trash trucks or similar vehicles should be paved with Portland Cement Concrete Pavement (PCCP) with compressive strength of at least 3,250 pounds per square inch. The concrete should be at least 7½ inches thick and reinforced with number 4 reinforcing bars placed at 18 inches on-center each way placed at the mid-height of the slab. The PCCP should be underlain by at least 6 inches of aggregate base.

The upper 12 inches of subgrade should be scarified; moisture conditioned to above optimum moisture content, and compacted to at least 95% relative compaction. All soft or spongy areas should be removed and replaced with compacted fill. If undisturbed rock is exposed at finished pavement subgrade, scarifying and recompaction need not to be performed. The base material should be compacted to at least 95% relative compaction.

### 4.7 INFILTRATION RATE

An SCS&T geologist performed 2 infiltration rate tests at the locations are presented on Figure 2. The tests were performed using a Double-Ring Infiltrometer in accordance with ASTM D3385. The test holes were excavated 3 feet below the existing ground surface with a rubber tire backhoe. Metasedimentary rock was exposed along the bottom of each excavation. The rock is very hard and considered impermeable. An infiltration rate of 0 inch per hour was measured at both test locations. The infiltration test results reflect the condition in the ground, as they existed at the time SCS&T performed the tests. The project designer should apply an appropriate factor-of-safety to the measured infiltration rates.

### 4.8 GEOTECHNICAL ENGINEERING DURING CONSTRUCTION

The geotechnical engineer should review project plans and specifications prior to bidding and construction to check that the intent of the recommendations in this report has been incorporated. Observations and tests should be performed during construction. If the conditions encountered during construction differ from those anticipated based on the subsurface exploration program, the presence of the geotechnical engineer during construction will enable an evaluation of the exposed conditions and modifications of the recommendations in this report or development of additional recommendations in a timely manner.

## 5. CLOSURE

SCS&T should be advised of any changes in the project scope so that the recommendations contained in this report can be evaluated with respect to the revised plans. Changes in recommendations will be verified in writing. The findings in this report are valid as of the date of this report. Changes in the condition of the site can, however, occur with the passage of time, whether they are due to natural processes or work on this or adjacent areas. In addition, changes in the standards of practice and government regulations can occur. Thus, the findings in this report may be invalidated wholly or in part by changes beyond our control. This report should not be relied upon after a period of two years without a review by us verifying the suitability of the conclusions and recommendations to site conditions at that time.

In the performance of our professional services, we comply with that level of care and skill ordinarily exercised by members of our profession currently practicing under similar conditions and in the same locality. The client recognizes that subsurface conditions may vary from those encountered at the boring location, and that our data, interpretations, and recommendations are based solely on the information obtained by us. We will be responsible for those data, interpretations, and recommendations, but shall not be responsible for interpretations by others of the information developed. Our services consist of professional consultation and observation only, and no warranty of any kind whatsoever, express or implied, is made or intended in connection with the work performed or to be performed by us, or by our proposal for consulting or other services, or by our furnishing of oral or written reports or findings.

2013 Google Maps

| | | | |
|---|---|---|---|
| SOUTHERN CALIFORNIA SOIL & TESTING, INC. | SITE VICINITY MAP<br>LAKESIDE PARCEL<br>APN 395-250-2100<br>Lakeside, California | Date: July, 2013<br>By: RB<br>Job No.: 1311105-1<br>Scale: Not to Scale | Figure:<br>1 |

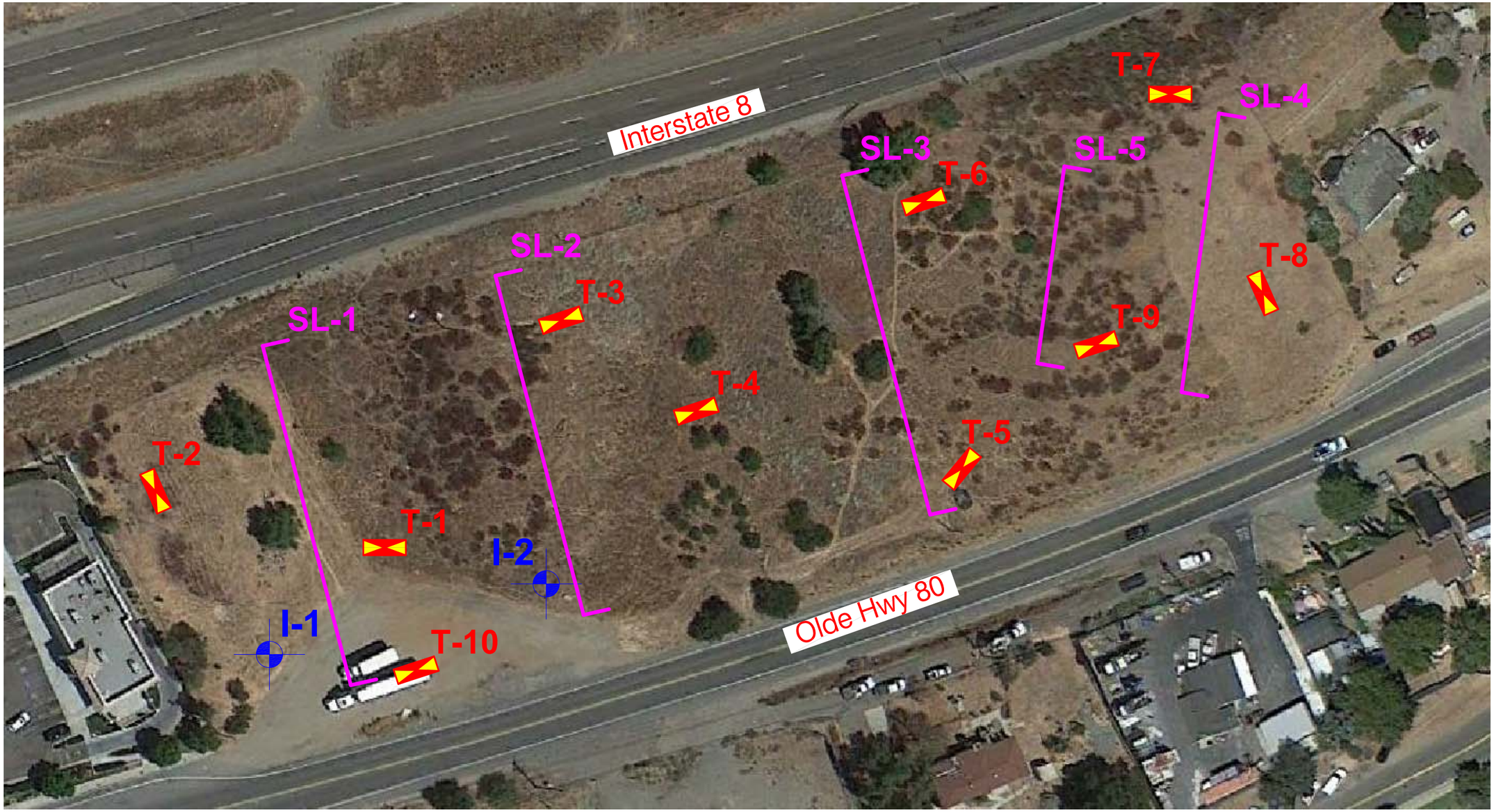
## SCS&T LEGEND

T-10 Approximate Location of Test Trench

I-2 Approximate Location of Infiltration Rate Test

SL-5 Approximate Location of Seismic Traverse

NORTH



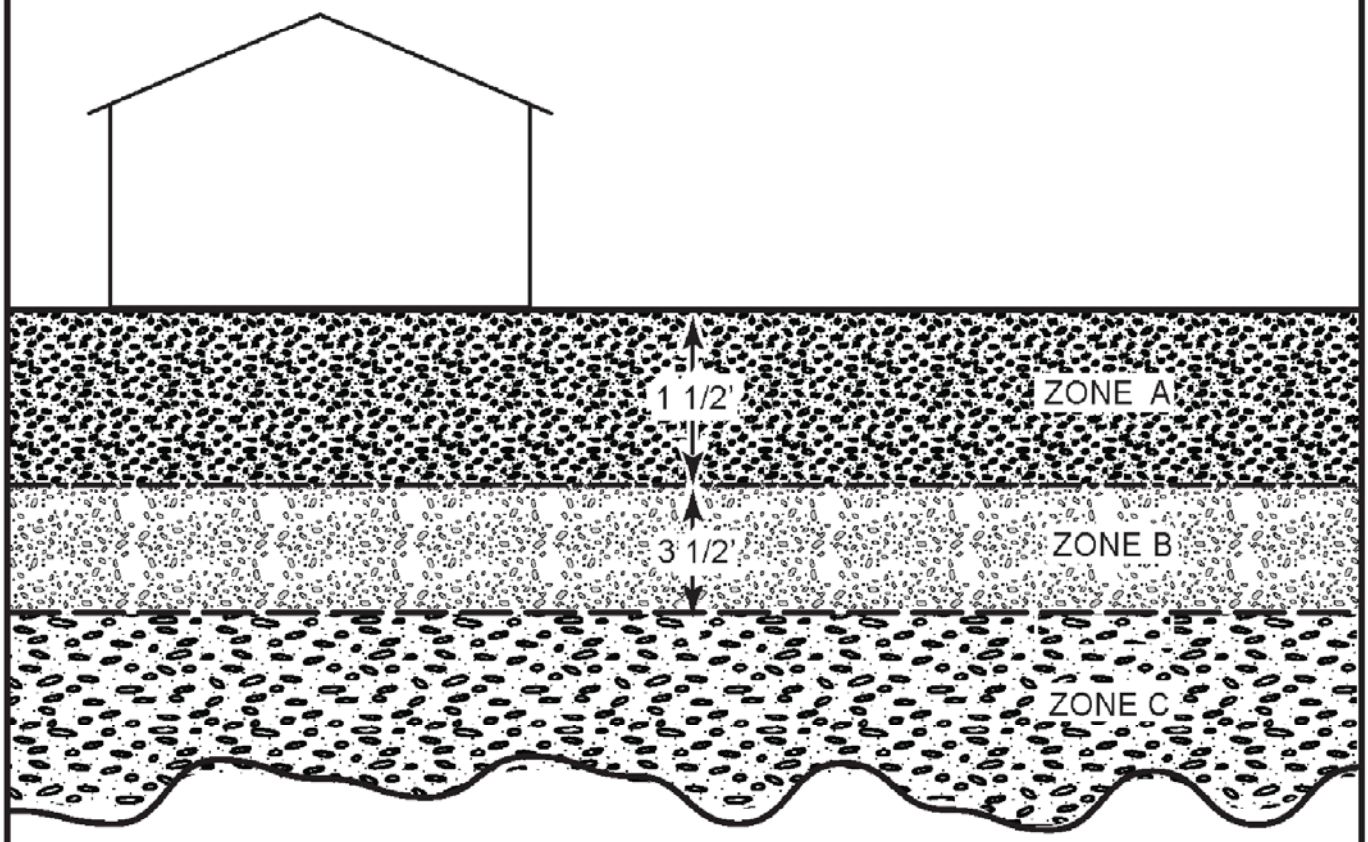

| | |
|---|---|
| Date: | July, 2013 |
| By: | RB |
| Job No.: | 1311105-1 |
| Scale: | Not To Scale |

SUBSURFACE INVESTIGATION MAP
LAKESIDE PARCEL
APN 395-250-2100
Lakeside, California

SOUTHERN CALIFORNIA
SOIL & TESTING, INC.

Figure:
2

# OVERSIZE ROCK FILL PLACEMENT




Zone A: Compacted soil fill.
No rock or soil lumps over 3" in greatest dimension.

Zone B: Compacted Soil Fill
No Rocks or Soil Lumps over 6" in Greatest Dimension

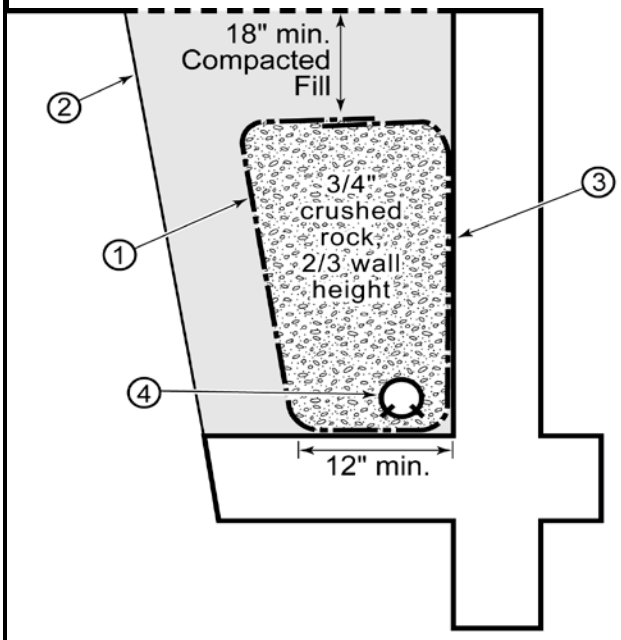
Zone C: Rocks 6"- 2' in maximum dimension.
Uniformly distributed and well spaced in compacted fill.

Note 1 Compacted soil fill should contain at least 40% soil finer than 3/4" sieve (by weight) and be compacted to at least 90% Relative Compaction.

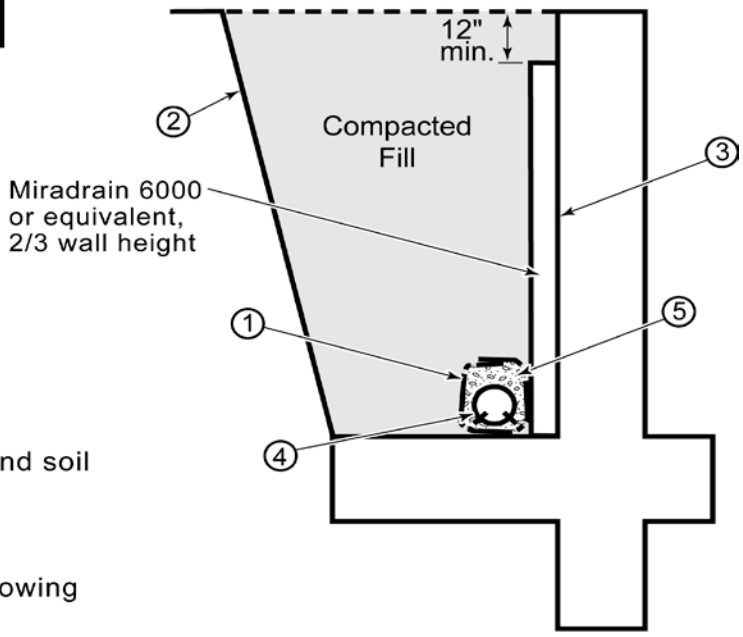
Note 2: Rocks over 2' in maximum dimension are not permitted in fill.

SOUTHERN CALIFORNIA SOIL & TESTING, INC.

| LAKESIDE PARCEL, APN 395-250-2100 | |
|---|---|
| By: RB | Date: July, 2013 |
| Job No.: 1311105-1 | Figure.: 3 |




**Typical Retaining Wall**
**Backdrain Detail**
Not to Scale




① Filter fabric between rock and soil

② Backcut

③ Waterproof back of wall following architect's specifications

④ 4" minimum perforated pipe, SDR35 or equivalent, holes down, 1% fall to outlet, encased in 3/4" crushed rock. Provide 3 cubic feet per linear foot crushed rock minimum. Crushed rock to be surrounded by filter fabric (Mirafi 140N or equivalent), with 6" minimum overlap. Provide solid outlet pipe at suitable location.

⑤ 3/4" crushed rock

| | | | |
|---|---|---|---|
| SOUTHERN CALIFORNIA SOIL & TESTING, INC. | LAKESIDE PARCEL APN 395-250-2100 | | |
| | By: RB | Date: | 7/16/2013 |
| | Job Number: 1311105-1 | Figure: | 4 |

## APPENDIX I
## FIELD INVESTIGATION

Ten exploratory test trenches were excavated at the locations shown on Figure 2 on June 27, 2013. The fieldwork was performed under the observation of our geology personnel, who also logged the trenches and obtained samples of the materials encountered.

The logs are presented on Figures I-2 through I-11. Soils are classified in accordance with the Unified Soil Classification System illustrated on Figure I-1.

# SUBSURFACE EXPLORATION LEGEND

## UNIFIED SOIL CLASSIFICATION CHART

| SOIL DESCRIPTION | | GROUP SYMBOL | TYPICAL NAMES |
|---|---|---|---|
| I. COARSE GRAINED, more than 50% of material is larger than No. 200 sieve size. | | | |
| GRAVELS<br>More than half of coarse fraction is larger than No. 4 sieve size but smaller than 3". | CLEAN GRAVELS | GW | Well graded gravels, gravel-sand mixtures, little or no fines |
| | | GP | Poorly graded gravels, gravel sand mixtures, little or no fines. |
| | GRAVELS WITH FINES (Appreciable amount of fines) | GM | Silty gravels, poorly graded gravel-sand-silt mixtures. |
| | | GC | Clayey gravels, poorly graded gravel-sand-clay mixtures. |
| SANDS<br>More than half of coarse fraction is smaller than No. 4 sieve size. | CLEAN SANDS | SW | Well graded sand, gravelly sands, little or no fines. |
| | | SP | Poorly graded sands, gravelly sands, little or no fines. |
| | SANDS WITH FINES (Appreciable amount of fines) | SM | Silty sands, poorly graded sand and silty mixtures. |
| | | SC | Clayey sands, poorly graded sand and clay mixtures. |
| II. FINE GRAINED, more than 50% of material is smaller than No. 200 sieve size. | | | |
| | SILTS AND CLAYS (Liquid Limit less than 50) | ML | Inorganic silts and very fine sands, rock flour, sandy silt or clayey-silt-sand mixtures with slight plasticity. |
| | | CL | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. |
| | | OL | Organic silts and organic silty clays of low plasticity. |
| | SILTS AND CLAYS (Liquid Limit greater than 50) | MH | Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts. |
| | | CH | Inorganic clays of high plasticity, fat clays. |
| | | OH | Organic clays of medium to high plasticity. |
| III. HIGHLY ORGANIC SOILS | | PT | Peat and other highly organic soils. |

### FIELD SAMPLE SYMBOLS

- ☒ - Bulk Sample
- CAL - Modified California penetration test sampler
- CK - Undisturbed chunk sample
- MS - Maximum Size of Particle
- ≀≀ - Water seepage at time of excavation or as indicated
- SPT - Standard penetration test sampler
- ST - Shelby Tube
- ▽ - Water level at time of excavation or as indicated

### LABORATORY TEST SYMBOLS

- AL - Atterberg Limits
- CON - Consolidation
- COR - Corrosivity Test
  - Sulfate
  - Chloride
  - pH and Resistivity
- DS - Direct Shear
- EI - Expansion Index
- MAX - Maximum Density
- RV - R Value
- SA - Sieve Analysis
- UC - Unconfined Compression

| SOUTHERN CALIFORNIA SOIL & TESTING, INC. | LAKESIDE PARCEL APN 395-250-2100 | | | |
|---|---|---|---|---|
| | By: | RB | Date: | 7/16/2013 |
| | Job Number: | 1311105-1 | Figure: | I-1 |

# LOG OF TEST TRENCH NUMBER T-1

| | | | |
|---|---|---|---|
| Date Excavated: | 06/27/13 | Logged by: | RNB |
| Equipment: | Case Backhoe | Project Manager: | GBF |
| Surface Elevation (ft): | N/A | Depth to Water (ft): | N/A |

| DEPTH (ft) | USCS | SUMMARY OF SUBSURFACE CONDITIONS | SAMPLES: UNDISTURBED | SAMPLES: BULK | MOISTURE (%) | DRY UNIT WT. (pcf) | LBAORATORY TESTS |
|---|---|---|---|---|---|---|---|
| 1, 2 | CL | **SLOPEWASH:** Dark brown to reddish brown, moist, soft, SANDY CLAY. | | X | | | SA, COR |
| 3 | | **METASEDIMENTARY ROCK:** Light reddish brown to gray, very hard, moderately fractured. | | | | | |
| 4 | | **BACKHOE REFUSAL AT 3½ FEET.** | | | | | |
| 5 | | | | | | | |
| 6 | | | | | | | |
| 7 | | | | | | | |
| 8 | | | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |

| | | | |
|---|---|---|---|
| **SOUTHERN CALIFORNIA SOIL & TESTING, INC.** | LAKESIDE PARCEL APN 395-250-2100 | | |
| | By: RB | Date: | 07/16/2013 |
| | Job No.: 1311105-1 | Figure: | I-2 |

# LOG OF TEST TRENCH NUMBER T-2

| | | | |
|---|---|---|---|
| Date Excavated: | 06/27/13 | Logged by: | RNB |
| Equipment: | Case Backhoe | Project Manager: | GBF |
| Surface Elevation (ft): | N/A | Depth to Water (ft): | N/A |

| DEPTH (ft) | USCS | SUMMARY OF SUBSURFACE CONDITIONS | SAMPLES: UNDISTURBED | SAMPLES: BULK | MOISTURE (%) | DRY UNIT WT. (pcf) | LBAORATORY TESTS |
|---|---|---|---|---|---|---|---|
| | CL | **SLOPEWASH:** Dark brown to reddish brown, moist, soft, SANDY CLAY. | | X | | | RV |
| 1 | | | | | | | |
| 2 | | | | | | | |
| 3 | | | | | | | |
| 4 | | **METASEDIMENTARY ROCK:** Light reddish brown to gray, very hard, moderately fractured. | | | | | |
| 5 | | **BACKHOE REFUSAL AT 5 FEET.** | | | | | |
| 6 | | | | | | | |
| 7 | | | | | | | |
| 8 | | | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |

| | | | |
|---|---|---|---|
| **SOUTHERN CALIFORNIA SOIL & TESTING, INC.** | LAKESIDE PARCEL APN 395-250-2100 | | |
| | By: RB | Date: | 07/16/2013 |
| | Job No.: 1311105-1 | Figure: | I-3 |

# LOG OF TEST TRENCH NUMBER T-3

| | | | |
|---|---|---|---|
| Date Excavated: | 06/27/13 | Logged by: | RNB |
| Equipment: | Case Backhoe | Project Manager: | GBF |
| Surface Elevation (ft): | N/A | Depth to Water (ft): | N/A |

| DEPTH (ft) | USCS | SUMMARY OF SUBSURFACE CONDITIONS | SAMPLES: UNDISTURBED | SAMPLES: BULK | MOISTURE (%) | DRY UNIT WT. (pcf) | LBAORATORY TESTS |
|---|---|---|---|---|---|---|---|
| 1, 2 | SC | **SLOPEWASH:** Dark brown to reddish brown, moist, loose, CLAYEY SAND. | | X | | | |
| 3 | | **METASEDIMENTARY ROCK:** Light reddish brown to gray, very hard, moderately fractured. | | | | | |
| 4 | | **BACKHOE REFUSAL AT 3½ FEET.** | | | | | |
| 5 | | | | | | | |
| 6 | | | | | | | |
| 7 | | | | | | | |
| 8 | | | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |

| | | | |
|---|---|---|---|
| **SOUTHERN CALIFORNIA SOIL & TESTING, INC.** | LAKESIDE PARCEL APN 395-250-2100 | | |
| | By: RB | Date: | 07/16/2013 |
| | Job No.: 1311105-1 | Figure: | I-4 |

# LOG OF TEST TRENCH NUMBER T-4

| | | | |
|---|---|---|---|
| Date Excavated: | 06/27/13 | Logged by: | RNB |
| Equipment: | Case Backhoe | Project Manager: | GBF |
| Surface Elevation (ft): | N/A | Depth to Water (ft): | N/A |

| DEPTH (ft) | USCS | SUMMARY OF SUBSURFACE CONDITIONS | SAMPLES: UNDISTURBED | SAMPLES: BULK | MOISTURE (%) | DRY UNIT WT. (pcf) | LBAORATORY TESTS |
|---|---|---|---|---|---|---|---|
| 1, 2 | SC | **SLOPEWASH:** Dark brown to reddish brown, moist, loose, CLAYEY SAND. | | X | | | MAX, DS |
| 3 | | **METASEDIMENTARY ROCK:** Light reddish brown to gray, very hard, moderately fractured. | | | | | |
| 4 | | **BACKHOE REFUSAL AT 3½ FEET.** | | | | | |
| 5 | | | | | | | |
| 6 | | | | | | | |
| 7 | | | | | | | |
| 8 | | | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |

| | | | |
|---|---|---|---|
| **SOUTHERN CALIFORNIA SOIL & TESTING, INC.** | LAKESIDE PARCEL APN 395-250-2100 | | |
| | By: RB | Date: | 07/16/2013 |
| | Job No.: 1311105-1 | Figure: | I-5 |

# LOG OF TEST TRENCH NUMBER T-5

| | | | |
|---|---|---|---|
| Date Excavated: | 06/27/13 | Logged by: | RNB |
| Equipment: | Case Backhoe | Project Manager: | GBF |
| Surface Elevation (ft): | N/A | Depth to Water (ft): | N/A |

| DEPTH (ft) | USCS | SUMMARY OF SUBSURFACE CONDITIONS | SAMPLES: UNDISTURBED | SAMPLES: BULK | MOISTURE (%) | DRY UNIT WT. (pcf) | LBAORATORY TESTS |
|---|---|---|---|---|---|---|---|
| | SC | **SLOPEWASH:** Dark brown to reddish brown, moist, loose, CLAYEY SAND. | | X | | | |
| 1 | | | | | | | |
| 2 | | | | | | | |
| 3 | | **METASEDIMENTARY ROCK:** Light reddish brown to gray, very hard, moderately fractured. | | | | | |
| 4 | | **BACKHOE REFUSAL AT 4 Feet.** | | | | | |
| 5 | | | | | | | |
| 6 | | | | | | | |
| 7 | | | | | | | |
| 8 | | | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |

| | | | |
|---|---|---|---|
| **SOUTHERN CALIFORNIA SOIL & TESTING, INC.** | LAKESIDE PARCEL APN 395-250-2100 | | |
| | By: RB | Date: | 07/16/2013 |
| | Job No.: 1311105-1 | Figure: | I-6 |

# LOG OF TEST TRENCH NUMBER T-6

| | | | |
|---|---|---|---|
| Date Excavated: | 06/27/13 | Logged by: | RNB |
| Equipment: | Case Backhoe | Project Manager: | GBF |
| Surface Elevation (ft): | N/A | Depth to Water (ft): | N/A |

| DEPTH (ft) | USCS | SUMMARY OF SUBSURFACE CONDITIONS | SAMPLES: UNDISTURBED | SAMPLES: BULK | MOISTURE (%) | DRY UNIT WT. (pcf) | LBAORATORY TESTS |
|---|---|---|---|---|---|---|---|
| 1 | CL | **SLOPEWASH:** Dark brown to reddish brown, moist, soft, SANDY CLAY. | | X | | | EI |
| 2 | | **METASEDIMENTARY ROCK:** Light reddish brown to gray, very hard, moderately fractured. | | | | | |
| 3 | | **BACKHOE REFUSAL AT 3 Feet.** | | | | | |
| 4 | | | | | | | |
| 5 | | | | | | | |
| 6 | | | | | | | |
| 7 | | | | | | | |
| 8 | | | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |

**SOUTHERN CALIFORNIA SOIL & TESTING, INC.**

LAKESIDE PARCEL APN 395-250-2100

| | | | |
|---|---|---|---|
| By: | RB | Date: | 07/16/2013 |
| Job No.: | 1311105-1 | Figure: | I-7 |

# LOG OF TEST TRENCH NUMBER T-7

| | | | |
|---|---|---|---|
| Date Excavated: | 06/27/13 | Logged by: | RNB |
| Equipment: | Case Backhoe | Project Manager: | GBF |
| Surface Elevation (ft): | N/A | Depth to Water (ft): | N/A |

| DEPTH (ft) | USCS | SUMMARY OF SUBSURFACE CONDITIONS | SAMPLES: UNDISTURBED | SAMPLES: BULK | MOISTURE (%) | DRY UNIT WT. (pcf) | LBAORATORY TESTS |
|---|---|---|---|---|---|---|---|
| 1 | CL | **SLOPEWASH:** Dark brown to reddish brown, moist, soft, SANDY CLAY. | | X | | | |
| 2 | | **METASEDIMENTARY ROCK:** Light reddish brown to gray, very hard, moderately fractured. | | | | | |
| 3 | | **BACKHOE REFUSAL AT 3 Feet.** | | | | | |
| 4 | | | | | | | |
| 5 | | | | | | | |
| 6 | | | | | | | |
| 7 | | | | | | | |
| 8 | | | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |

**SOUTHERN CALIFORNIA SOIL & TESTING, INC.**

LAKESIDE PARCEL APN 395-250-2100

| | | | |
|---|---|---|---|
| By: | RB | Date: | 07/16/2013 |
| Job No.: | 1311105-1 | Figure: | I-8 |

# LOG OF TEST TRENCH NUMBER T-8

| | | | |
|---|---|---|---|
| Date Excavated: | 06/27/13 | Logged by: | RNB |
| Equipment: | Case Backhoe | Project Manager: | GBF |
| Surface Elevation (ft): | N/A | Depth to Water (ft): | N/A |

| DEPTH (ft) | USCS | SUMMARY OF SUBSURFACE CONDITIONS | SAMPLES: UNDISTURBED | SAMPLES: BULK | MOISTURE (%) | DRY UNIT WT. (pcf) | LBAORATORY TESTS |
|---|---|---|---|---|---|---|---|
| 1, 2 | SC | **SLOPEWASH:** Dark brown to reddish brown, moist, loose, CLAYEY SAND. | | X | | | SA |
| 3 | | **METASEDIMENTARY ROCK:** Light reddish brown to gray, very hard, moderately fractured. | | | | | |
| 4 | | **BACKHOE REFUSAL AT 3½ FEET.** | | | | | |
| 5 | | | | | | | |
| 6 | | | | | | | |
| 7 | | | | | | | |
| 8 | | | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |

| | | | |
|---|---|---|---|
| **SOUTHERN CALIFORNIA SOIL & TESTING, INC.** | LAKESIDE PARCEL APN 395-250-2100 | | |
| | By: RB | Date: | 07/16/2013 |
| | Job No.: 1311105-1 | Figure: | I-9 |

# LOG OF TEST TRENCH NUMBER T-9

| | | | |
|---|---|---|---|
| Date Excavated: | 06/27/13 | Logged by: | RNB |
| Equipment: | Case Backhoe | Project Manager: | GBF |
| Surface Elevation (ft): | N/A | Depth to Water (ft): | N/A |

| DEPTH (ft) | USCS | SUMMARY OF SUBSURFACE CONDITIONS | SAMPLES: UNDISTURBED | SAMPLES: BULK | MOISTURE (%) | DRY UNIT WT. (pcf) | LBAORATORY TESTS |
|---|---|---|---|---|---|---|---|
| 1, 2 | SC | **SLOPEWASH:** Dark brown to reddish brown, moist, loose, CLAYEY SAND. | | X | | | |
| 3 | | **METASEDIMENTARY ROCK:** Light reddish brown to gray, very hard, moderately fractured. | | | | | |
| 4 | | **BACKHOE REFUSAL AT 3½ FEET.** | | | | | |
| 5 | | | | | | | |
| 6 | | | | | | | |
| 7 | | | | | | | |
| 8 | | | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |

| | | | |
|---|---|---|---|
| **SOUTHERN CALIFORNIA SOIL & TESTING, INC.** | LAKESIDE PARCEL APN 395-250-2100 | | |
| | By: RB | Date: | 07/16/2013 |
| | Job No.: 1311105-1 | Figure: | I-10 |

# LOG OF TEST TRENCH NUMBER T-10

| | | | |
|---|---|---|---|
| Date Excavated: | 06/27/13 | Logged by: | RNB |
| Equipment: | Case Backhoe | Project Manager: | GBF |
| Surface Elevation (ft): | N/A | Depth to Water (ft): | N/A |

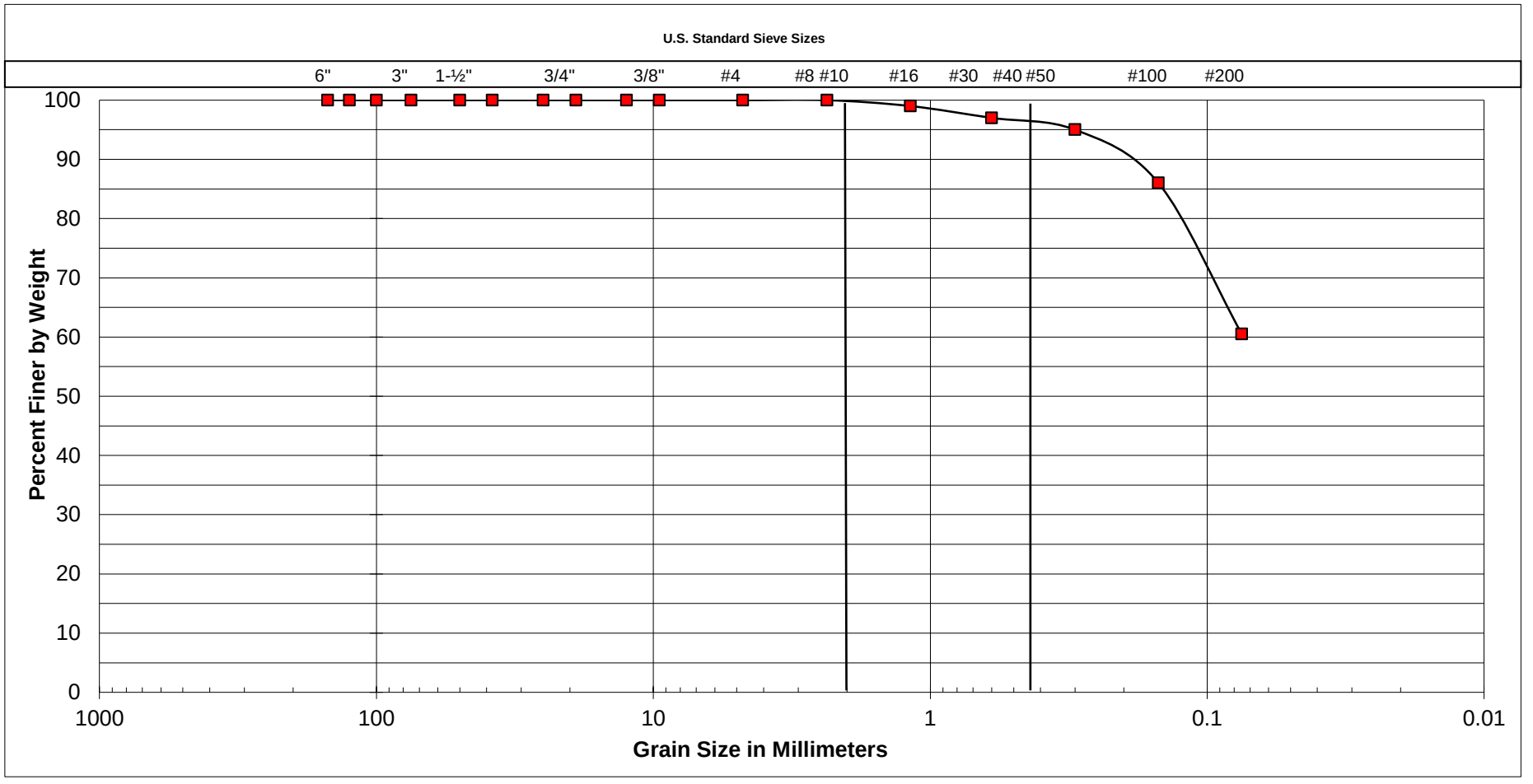
| DEPTH (ft) | USCS | SUMMARY OF SUBSURFACE CONDITIONS | SAMPLES: UNDISTURBED | SAMPLES: BULK | MOISTURE (%) | DRY UNIT WT. (pcf) | LBAORATORY TESTS |
|---|---|---|---|---|---|---|---|
| 1, 2 | CL | **SLOPEWASH:** Dark brown to reddish brown, moist, soft, SANDY CLAY. | | X | | | |
| 3 | | **METASEDIMENTARY ROCK:** Light reddish brown to gray, very hard, moderately fractured. | | | | | |
| 4 | | **BACKHOE REFUSAL AT 3½ FEET.** | | | | | |
| 5 | | | | | | | |
| 6 | | | | | | | |
| 7 | | | | | | | |
| 8 | | | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |

| | | | |
|---|---|---|---|
| **SOUTHERN CALIFORNIA SOIL & TESTING, INC.** | LAKESIDE PARCEL APN 395-250-2100 | | |
| | By: RB | Date: | 07/16/2013 |
| | Job No.: 1311105-1 | Figure: | I-11 |

## APPENDIX II
## LABORATORY TEST RESULTS
## SUMMARY

Laboratory tests were performed to provide geotechnical parameters for engineering analyses. The following tests were conducted:

- **CLASSIFICATION:** Field classifications were verified in the laboratory by visual examination. The final soil classifications are in accordance with the Unified Soil Classification System.
- **GRAIN SIZE DISTRIBUTION:** Grain size distributions were determined for 2 samples in accordance with ASTM D 422. The results of these tests are presented on Figure II-1 and Figure II-2.
- **MAXIMUM DENSITY AND OPTIMUM MOISTURE:** The maximum density and optimum moisture was determined for one sample in accordance with ASTM D 1557. The result of this test is presented on Figure II-4.
- **EXPANSION INDEX:** The expansion index for one sample was determined in accordance with ASTM D 4829. The result of this test is presented on Figure II-3.
- **CORROSIVITY:** Corrosivity tests were performed on one sample. The pH and minimum resistivity were determined in general accordance with California Test 643. The soluble sulfate content was determined in accordance with California Test 417. The total chloride ion content was determined in accordance with California Test 422. The results of these tests are presented on Figure II-3.
- **DIRECT SHEAR:** One direct shear test was performed in accordance with ASTM D 3080. The shear stress was applied at a constant rate of strain of approximately 0.003 inch per minute. The result of this test is presented on Figure II-4.
- **R-VALUE:** The R-Value was determined for one representative sample of on-site material. The result is presented on Figure II-5.




| Cobbles | Gravel | | Sand | | | Silt or Clay |
|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | |

| SAMPLE LOCATION |
|---|
| T-1 @ 0 Feet - 2½ Feet |

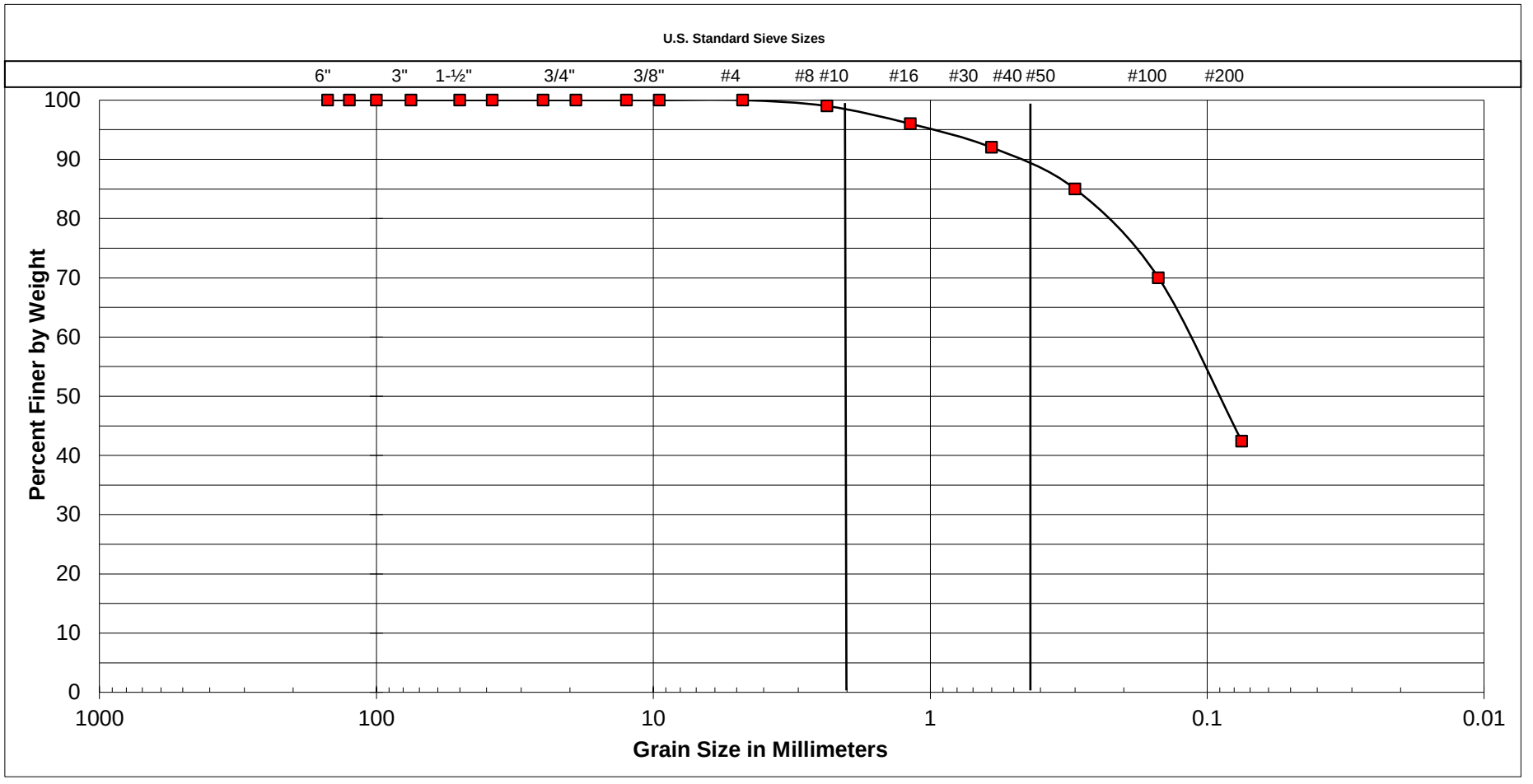
| UNIFIED SOIL CLASSIFICATION: | CL |
|---|---|
| DESCRIPTION | SANDY CLAY |

| ATTERBERG LIMITS | |
|---|---|
| LIQUID LIMIT | |
| PLASTIC LIMIT | |
| PLASTICITY INDEX | |

**SOUTHERN CALIFORNIA SOIL & TESTING, INC.**

LAKESIDE COMMERCIAL APN 395-250-2100

| | | | |
|---|---|---|---|
| By: | RB | Date: | 7/16/13 |
| Job Number: | 1311105-1 | Figure: | II-1 |




| Cobbles | Gravel | | Sand | | | Silt or Clay |
|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | |

| SAMPLE LOCATION |
|---|
| T-8 0 Feet - 3 Feet |

| UNIFIED SOIL CLASSIFICATION: | SC |
|---|---|
| DESCRIPTION | CLAYEY SAND |

| ATTERBERG LIMITS | |
|---|---|
| LIQUID LIMIT | |
| PLASTIC LIMIT | |
| PLASTICITY INDEX | |

**SOUTHERN CALIFORNIA SOIL & TESTING, INC.**

LAKESIDE COMMERCIAL APN 395-250-2100

| By: | RB | Date: | 7/16/13 |
|---|---|---|---|
| Job Number: | 1311105-1 | Figure: | II-2 |

## EXPANSION INDEX

ASTM - D4829

| SAMPLE | DESCRIPTION | EXPANSION INDEX |
|---|---|---|
| T-6 @ 0' - 2' | Dark Brown SANDY CLAY | 3 |

***CLASSIFICATION OF EXPANSIVE SOIL*** [1]

| EXPANSION INDEX | POTENTIAL EXPANSION |
|---|---|
| 1 - 20 | Very Low |
| 21 - 50 | Low |
| 51 - 90 | Medium |
| 91 - 130 | High |
| Above 130 | Very High |

1. ASTM - D4829

## RESISTIVITY, pH, SOLUBLE SULFATE, CHLORIDE

Caltrans Corrosion Guidelines, Version 1.0 (September 2003)

| SAMPLE IDENTIFICATION | RESISTIVITY (Ω-cm) | pH | SOLUBLE SULFATE (%) | CHLORIDE (%) |
|---|---|---|---|---|
| T-1 @ 0' - 2½' | 2080 | 8 | 0.004 | 0.007 |

**ACI 318-05 Building Code Requirements for Structural Concrete**

**Table 4.3.1 Requirements for Concrete Exposed to Sulfate-Containing Solutions**

| Sulfate Exposure | Water-Soluble Sulfate ($SO_4$) in Soil Percentage by Weight | Cement Type | Maximum Water-Cementitious Materials Ratio, By Weight, Normal Weight Aggregate Concrete | Minimum f'c, Normal-Weight and Lightweight Aggregate Concrete, psi |
|---|---|---|---|---|
| Negligible | 0.00-0.10 | - | - | - |
| Moderate | 0.10-0.20 | II,IP(MS),IS(MS), P(MS), I(PM)(MS), I(SM)(MS) | 0.50 | 4000 |
| Severe | 0.20-2.00 | V | 0.45 | 4500 |
| Very Severe | Over 2.00 | V plus pozzolan | 0.45 | 4500 |

**Caltrans Corrosion Criteria**

| | RESISTIVITY( Ω - cm) | pH | SOLUBLE SULFATE | CHLORIDE |
|---|---|---|---|---|
| Corrosive Environment* | <1000 | <5.5 | >0.2 | >0.05 |

* Corrosive enivronment as determined by the California Department of Transportation Division of Engineering Services, Materials Engineering and testing Services Corrosion Technology Branch, 2003;Corrosion Guidelines Version 1.0, September 2003

**SOUTHERN CALIFORNIA SOIL & TESTING, INC.**

LAKESIDE PARCEL APN 395-250-2100

| | | | |
|---|---|---|---|
| By: | RB | Date: | 7/16/2013 |
| Job No.: | 1311105-1 | Figure: | II-3 |

| SAMPLE | DESCRIPTION | INTERNAL FRICTION ANGLE(DEG.) | COHESION INTERCEPT (PSF) |
|---|---|---|---|
| T-4 @ 0 Feet - 2½ Feet | CLAYEY SAND<br>REMOLDED TO 90% RELATIVE COMPACTION | | |
| MAXIMUM DENSITY AND OPTIMUM MOSITURE CONTENT 124.7 POUNDS PER CUBIC FOOT AT 10.1% MOISTURE | | | |
| ***Shear Strength at 0.2 inches of Deformation*** | | 23 | 523 |

**SOUTHERN CALIFORNIA SOIL & TESTING**

LAKESIDE PARCEL APN 395-250-2100

| | | | |
|---|---|---|---|
| By: | RB | Date: | 7/16/2013 |
| Job Number: | 1311105-1 | Figure: | II-4 |

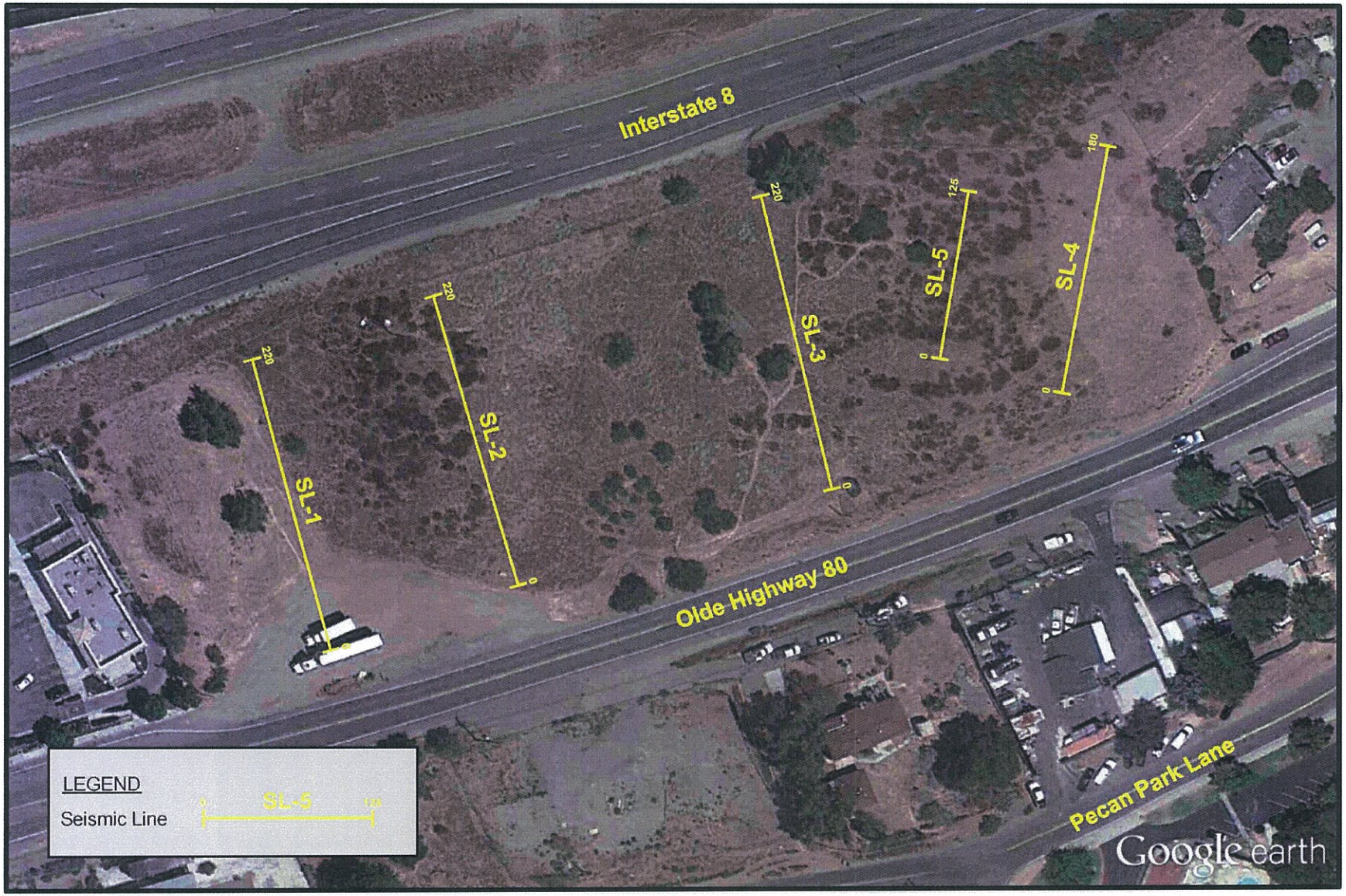
## R - Value

Caltran Test 301

| SAMPLE IDENTIFICATION | DESCRIPTION | R- Value |
|---|---|---|
| T-2 @ 0 Feet - 4 Feet | Dark Brown to Reddish Brown SANDY CLAY | 6 |

| | | | |
|---|---|---|---|
| SOUTHERN CALIFORNIA SOIL & TESTING, INC. | LAKESIDE PARCEL APN 395-250-2100 | | |
| | By: RB | Date: | 7/16/2013 |
| | Job No.: 1311105-1 | Figure: | II-5 |

# APPENDIX III
# SEISMIC TRAVERSE RESULTS




**LINE LOCATION MAP**

N

Lakeside APN 395-250-2100
San Diego County, California

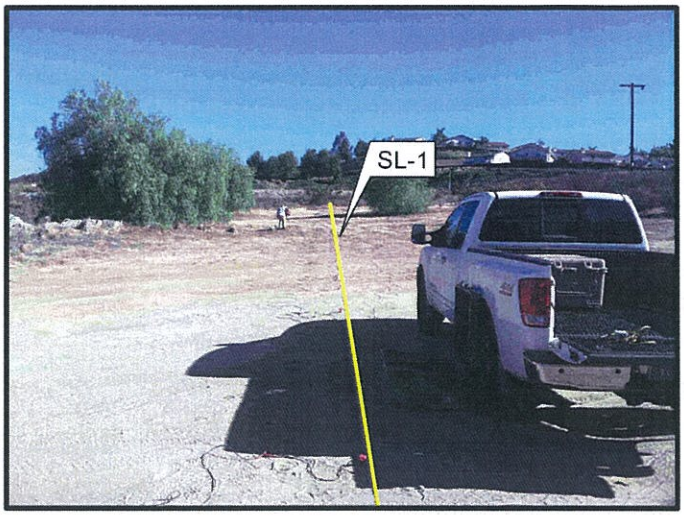
Project No.: 113249 | Date: 07/13

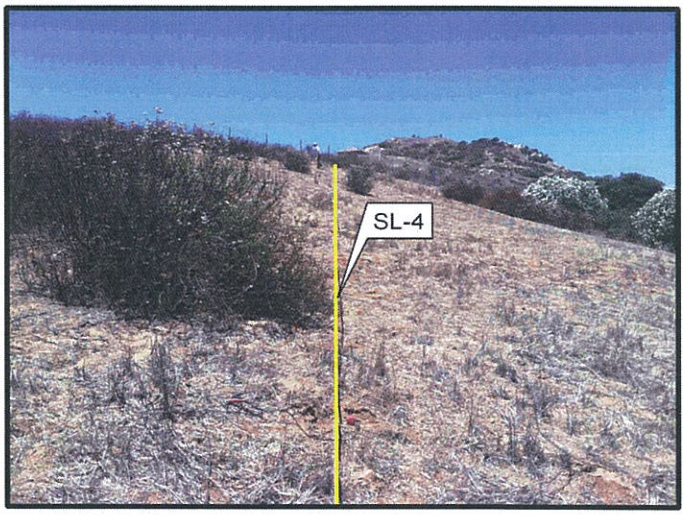
SOUTHWEST GEOPHYSICS INC.

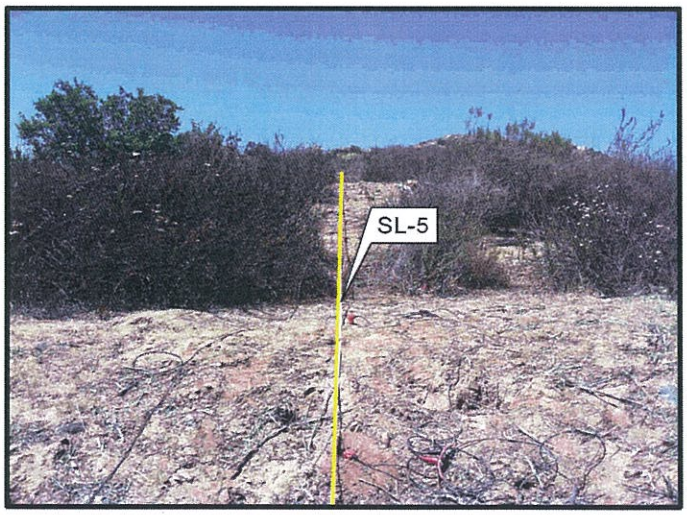
Figure 2

0 100 200

approximate scale in feet

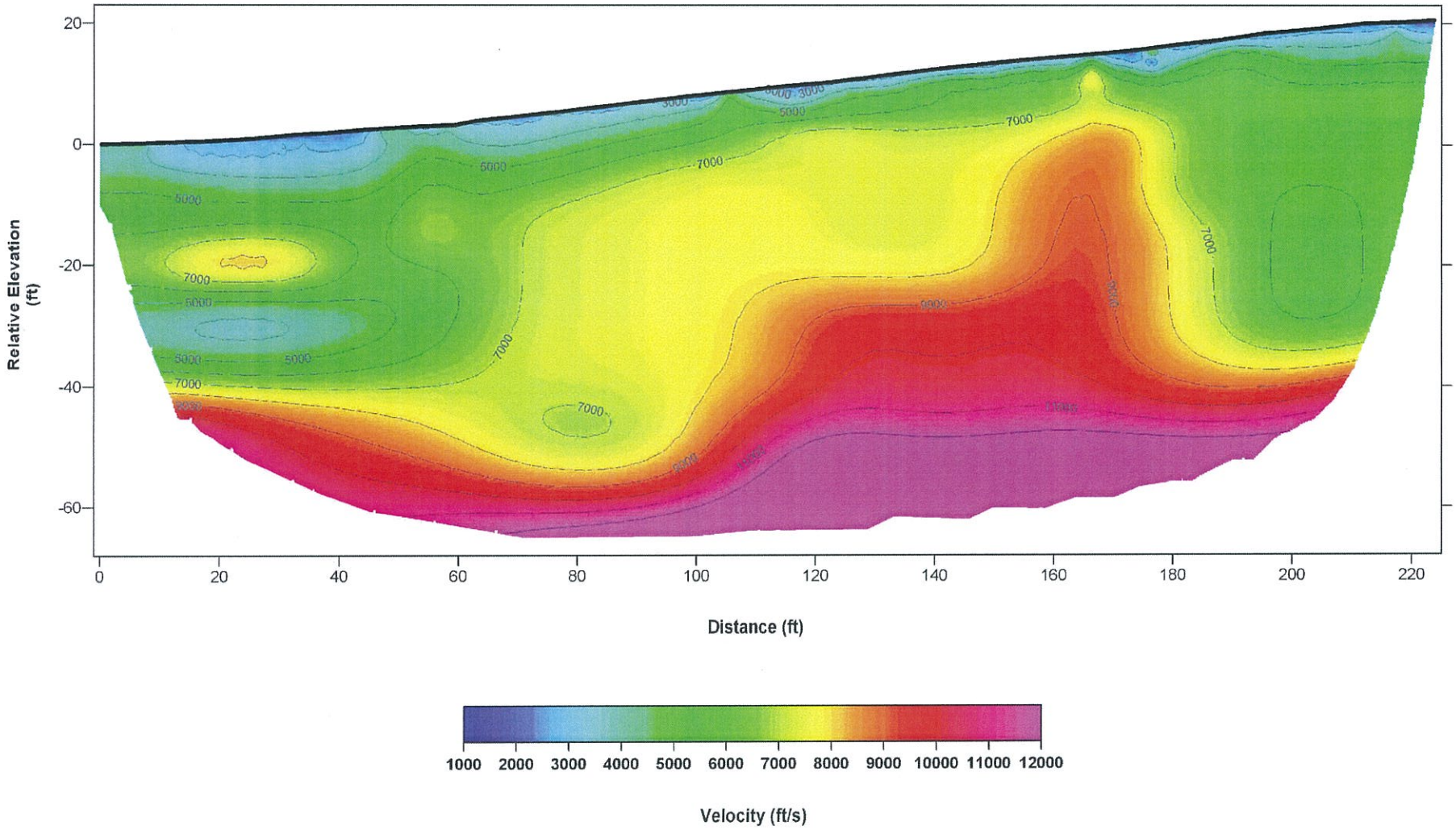




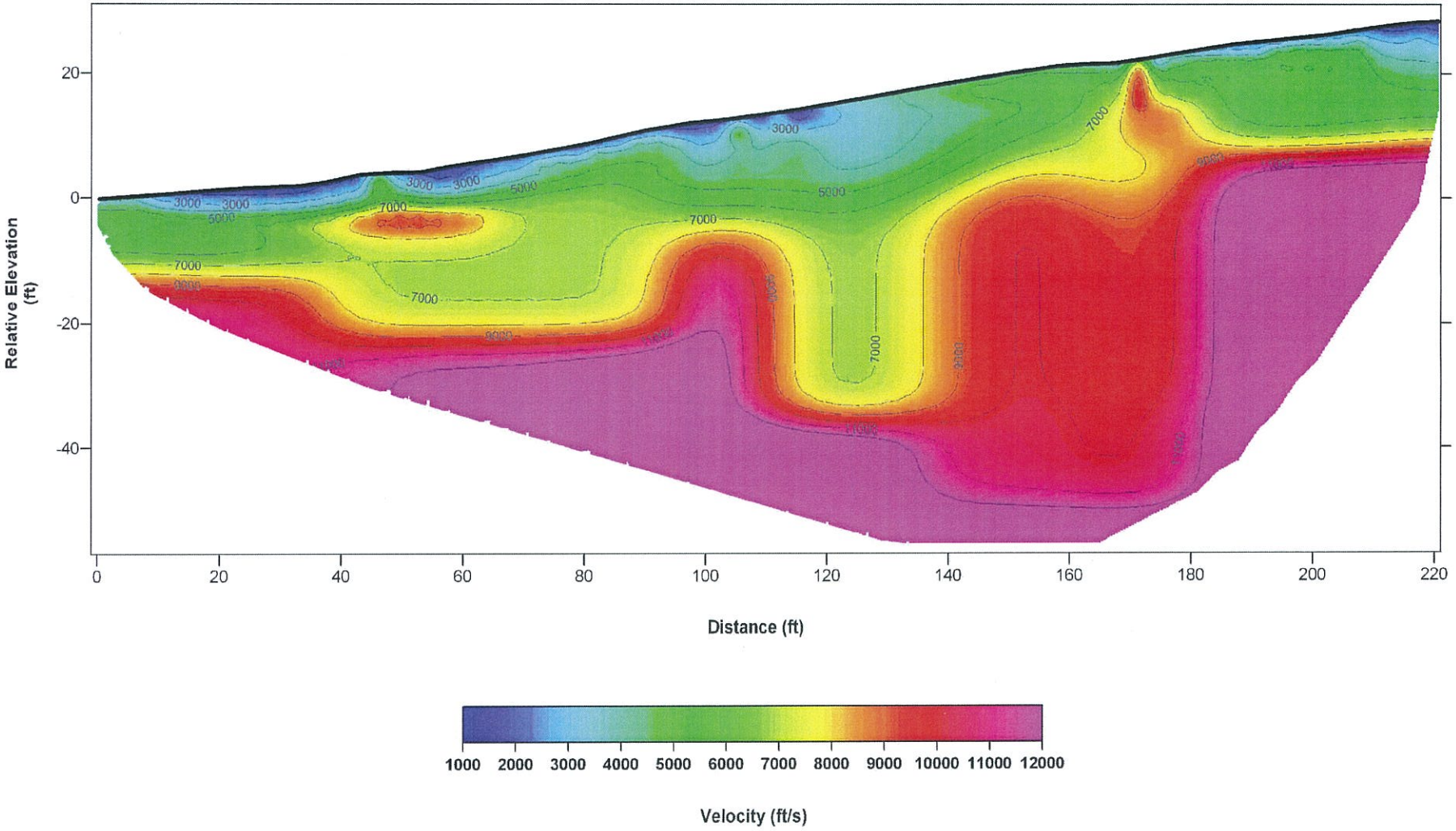

| | | |
|---|---|---|
| **SITE PHOTOGRAPHS** | Lakeside APN 395-250-2100<br>San Diego County, California | SOUTHWEST GEOPHYSICS INC. |
| | Project No.: 113249 / Date: 07/13 | Figure 3 |

# TOMOGRAPHY MODEL



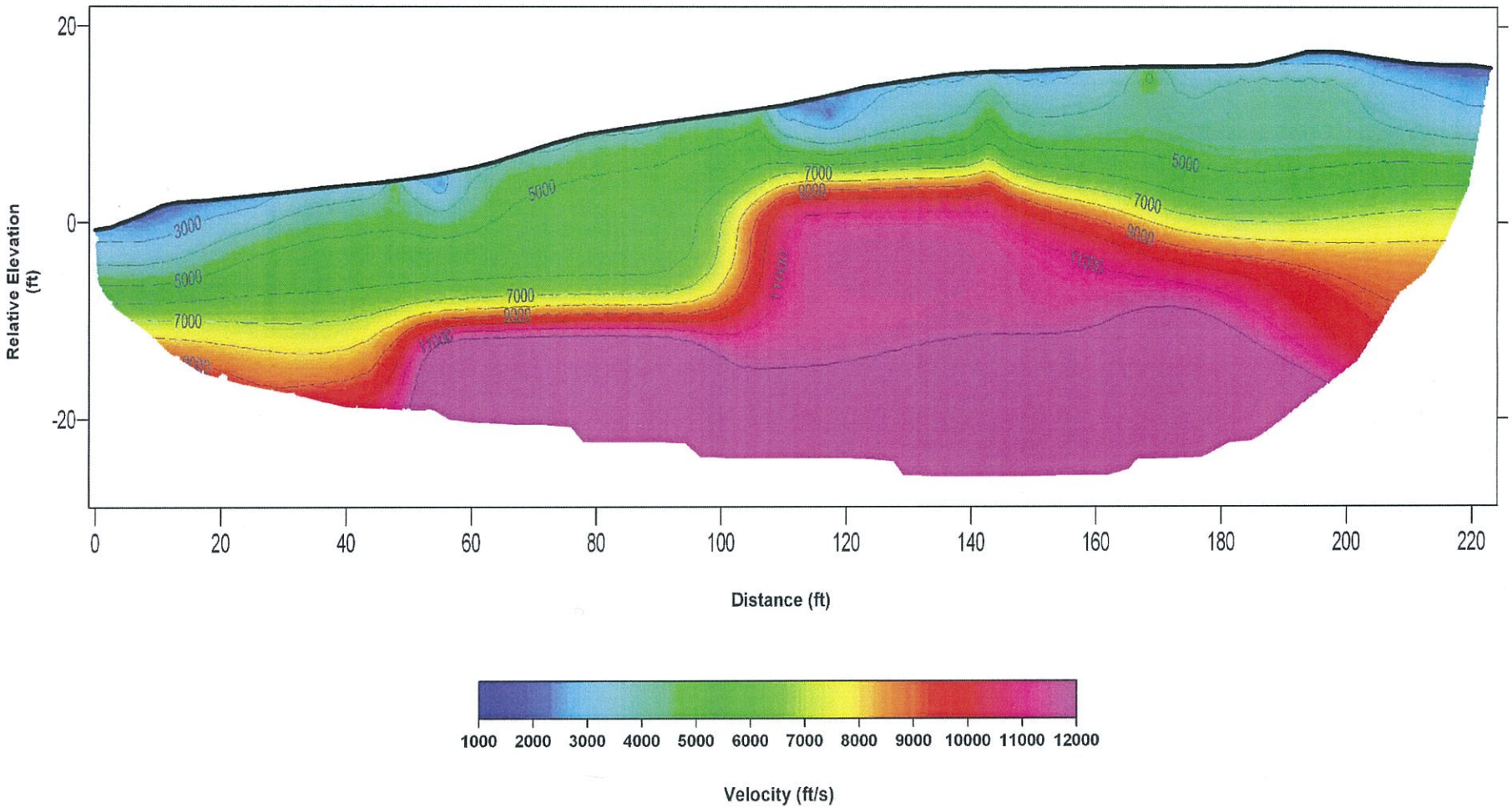

| | | | |
|---|---|---|---|
| **SEISMIC PROFILE SL-1** | Lakeside APN 395-250-2100<br>San Diego County, California | SOUTHWEST GEOPHYSICS INC.<br>Figure 4a | **Note: Contour Interval = 1,000 feet per second** |
| | Project No.: 113249 / Date: 07/13 | | |

# TOMOGRAPHY MODEL



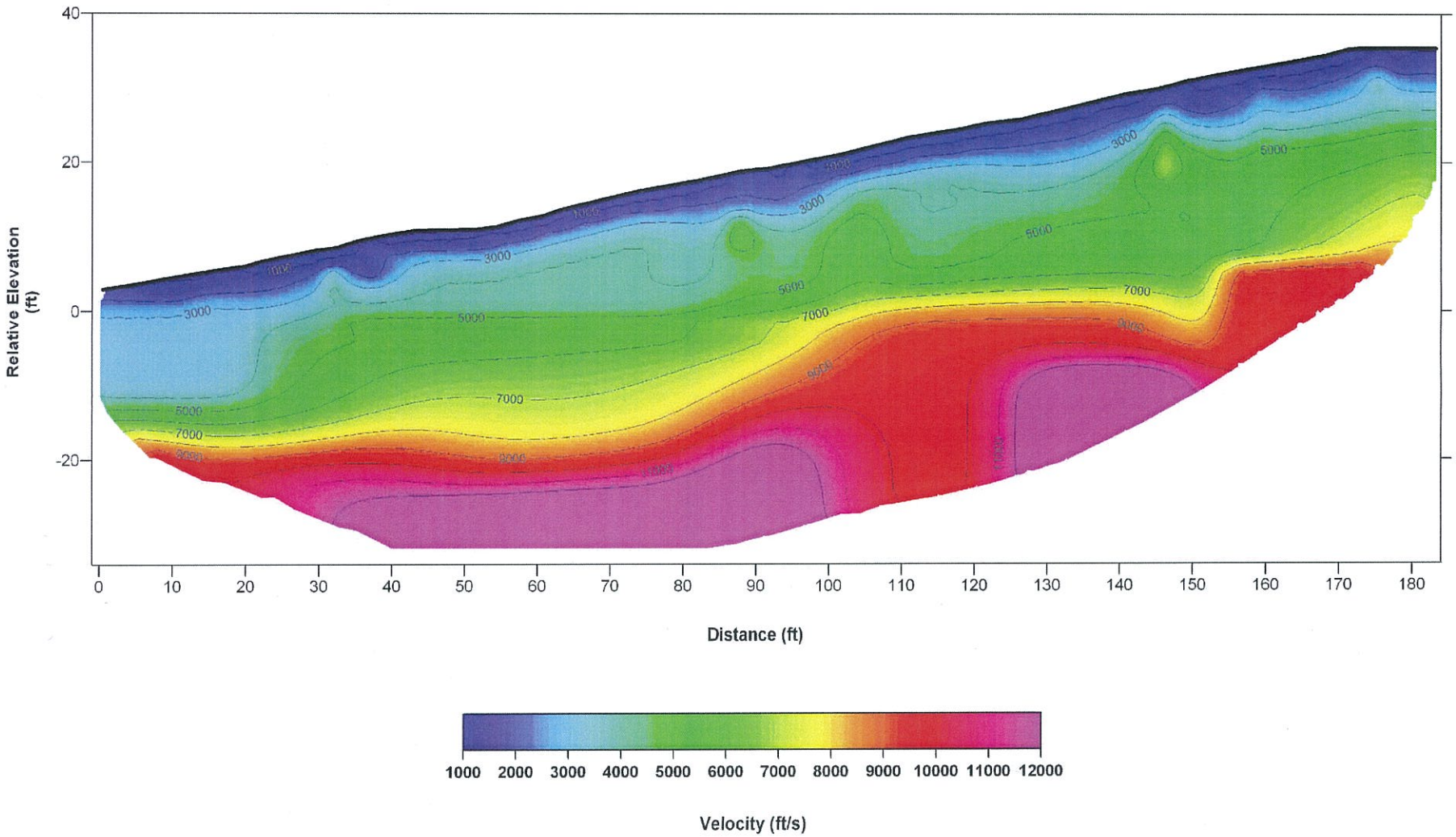

| | | | |
|---|---|---|---|
| **SEISMIC PROFILE SL-2** | Lakeside APN 395-250-2100<br>San Diego County, California | SOUTHWEST GEOPHYSICS INC.<br>Figure 4b | **Note: Contour Interval = 1,000 feet per second** |
| | Project No.: 113249 / Date: 07/13 | | |

# TOMOGRAPHY MODEL



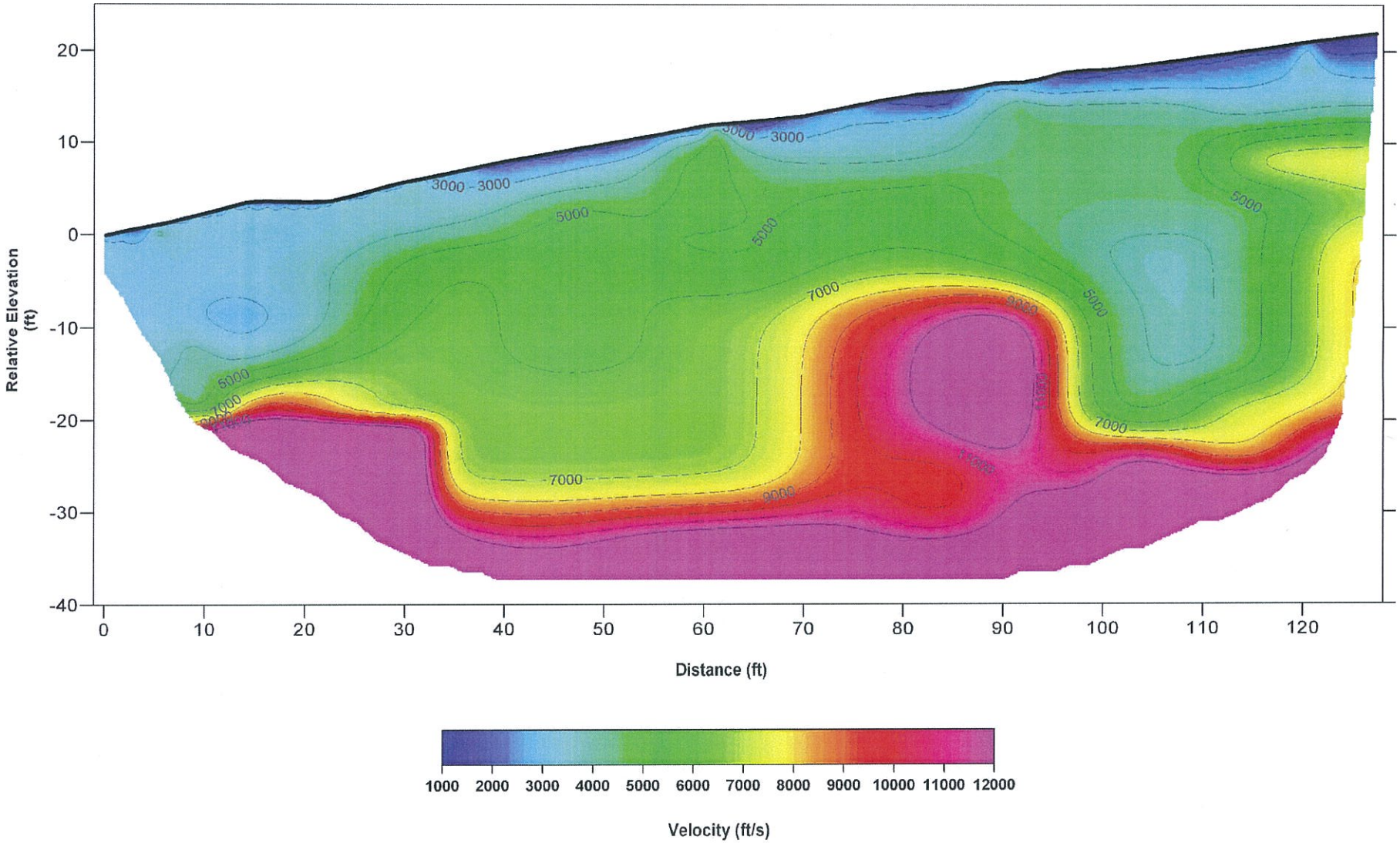

| | | | |
|---|---|---|---|
| **SEISMIC PROFILE SL-3** | Lakeside APN 395-250-2100<br>San Diego County, California<br>Project No.: 113249 Date: 07/13 | SOUTHWEST GEOPHYSICS INC.<br>Figure 4c | **Note: Contour Interval = 1,000 feet per second** |

# TOMOGRAPHY MODEL




| | | | |
|---|---|---|---|
| **SEISMIC PROFILE SL-4** | Lakeside APN 395-250-2100<br>San Diego County, California | SOUTHWEST GEOPHYSICS INC.<br>Figure 4d | **Note: Contour Interval = 1,000 feet per second** |
| | Project No.: 113249 / Date: 07/13 | | |

# TOMOGRAPHY MODEL




| | | | |
|---|---|---|---|
| **SEISMIC PROFILE SL-5** | Lakeside APN 395-250-2100<br>San Diego County, California | SOUTHWEST GEOPHYSICS INC.<br>Figure 4e | **Note: Contour Interval = 1,000 feet per second** |
| | Project No.: 113249 / Date: 07/13 | | |

# SEISMIC REFRACTION SURVEY
# LAKESIDE APN 395-250-2100
# SAN DIEGO COUNTY, CALIFORNIA

**PREPARED FOR:**
Southern California Soil & Testing, Inc.
6280 Riverdale Street
San Diego, CA 92120

**PREPARED BY:**
Southwest Geophysics, Inc.
8057 Raytheon Road, Suite 9
San Diego, CA 92111

July 11, 2013
Project No. 113249

SOUTHWEST
GEOPHYSICS, INC.
YOUR SUBSURFACE SOLUTION

July 11, 2013
Project No. 113249

Mr. Roy Butz
Southern California Soil & Testing, Inc.
6280 Riverdale Street
San Diego, CA 92120

Subject: Seismic Refraction Survey
Lakeside APN 395-250-2100
San Diego County, California

Dear Mr. Butz:

In accordance with your authorization, we have performed a seismic refraction survey pertaining to a portion of the subject property located along the north side of Olde Highway 80, just east of Lake Jennings Park Road in the Lakeside area of San Diego County, California. Specifically, our survey consisted of performing five seismic refraction traverses at the project site. The purpose of our study was to develop subsurface velocity profiles of the areas surveyed, and to assess the apparent rippability of the subsurface materials. This data report presents our survey methodology, equipment used, analysis, and results.

We appreciate the opportunity to be of service on this project. Should you have any questions related to this report, please contact the undersigned at your convenience.

Sincerely,
**SOUTHWEST GEOPHYSICS, INC.**

Aaron T. Puente
Senior Staff Geologist/Geophysicist

Hans van de Vrugt, C.E.G., P.Gp.
Principal Geologist/Geophysicist

REGISTERED GEOPHYSICIST
Hans van de Vrugt
No 1012
Exp. 2/28/14
STATE OF CALIFORNIA

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## 1. INTRODUCTION

In accordance with your authorization, we have performed a seismic refraction survey pertaining to a portion of the subject property located along the north side of Olde Highway 80, just east of Lake Jennings Park Road in the Lakeside area of San Diego County, California. Specifically, our survey consisted of performing five seismic refraction traverses at the project site. The purpose of our study was to develop subsurface velocity profiles of the areas surveyed, and to assess the apparent rippability of the subsurface materials. This data report presents our survey methodology, equipment used, analysis, and results.

## 2. SCOPE OF SERVICES

Our scope of services included:

- Performance of five seismic refraction lines at the project site.
- Compilation and analysis of the data collected.
- Preparation of this data report presenting our results, conclusions and recommendations.

## 3. SITE DESCRIPTION

The project site is a vacant lot located along the north side of Olde Highway 80, just east of Lake Jennings Park Road (Figure 1). The site is bounded to the north by Interstate 8, to the east by a residential property, and to the west by a Burger King restaurant. The study area included south facing slopes with annual grass, brush, scattered trees and outcrops of weathered granitic rock. Portions of the site contained former building foundations, excavation pits and fill. Figures 2 and 3 depict the general site conditions in the study area.

## 4. SURVEY METHODOLOGY

A seismic P-wave (compression wave) refraction survey was conducted at the site to evaluate the rippability characteristics of the subsurface materials and to develop subsurface velocity profiles of the areas surveyed. The seismic refraction method uses first-arrival times of refracted seismic waves to estimate the thicknesses and seismic velocities of subsurface layers. Seismic P-waves generated at the surface, using a hammer and plate, are refracted at boundaries separating materials of contrasting velocities. These refracted seismic waves are then detected by a series of

surface vertical component geophones and recorded with a 24-channel Geometrics Geode seismograph. The travel times of the seismic P-waves are used in conjunction with the shot-to-geophone distances to obtain thickness and velocity information on the subsurface materials.
Five seismic lines (SL-1 through SL-5) were conducted in the study area. The general locations and lengths of the lines were selected by your office. Shot points (signal generation locations) were conducted along the lines at the ends, midpoint, and intermediate points between the ends and the midpoint for a total of five shot points along each line.

The seismic refraction theory requires that subsurface velocities increase with depth. A layer having a velocity lower than that of the layer above will not generally be detectable by the seismic refraction method and, therefore, could lead to errors in the depth calculations of subsequent layers. In addition, lateral variations in velocity, such as those caused by core stones, intrusions or boulders can also result in the misinterpretation of the subsurface conditions.

In general, seismic wave velocities can be correlated to material density and/or rock hardness. The relationship between rippability and seismic velocity is empirical and assumes a homogenous mass. Localized areas of differing composition, texture, and/or structure may affect both the measured data and the actual rippability of the mass. The rippability of a mass is also dependent on the excavation equipment used and the skill and experience of the equipment operator.

The rippability values presented in Table 1 are based on our experience with similar materials and assumes that a Caterpillar D-9 dozer ripping with a single shank is used. We emphasize that the cutoffs in this classification scheme are approximate and that rock characteristics, such as fracture spacing and orientation, play a significant role in determining rock rippability. These characteristics may also vary with location and depth. For trenching operations, the rippability values should be scaled downward. For example, velocities as low as 3,500 feet/second may indicate difficult ripping during trenching operations. In addition, the presence of boulders, which can be troublesome in a narrow trench, should be anticipated.

| Table 1 – Rippability Classification | |
|---|---|
| **Seismic P-wave Velocity** | **Rippability** |
| 0 to 2,000 feet/second | Easy |
| 2,000 to 4,000 feet/second | Moderate |
| 4,000 to 5,500 feet/second | Difficult, Possible Blasting |
| 5,500 to 7,000 feet/second | Very Difficult, Probable Blasting |
| Greater than 7,000 feet/second | Blasting Generally Required |

It should be noted that the rippability cutoffs presented in Table 1 are slightly more conservative than those published in the Caterpillar Performance Handbook (Caterpillar, 2011). Accordingly, the above classification scheme should be used with discretion, and contractors should not be relieved of making their own independent evaluation of the rippability of the on-site materials prior to submitting their bids.

## 5. RESULTS

As previously indicated, five seismic traverses were conducted as part of our study. The collected data were processed using SIPwin (Rimrock Geophysics, 2003), a seismic interpretation program, and analyzed using SeisOpt Pro (Optim, 2008). SeisOpt Pro uses first arrival picks and elevation data to produce subsurface velocity models through a nonlinear optimization technique called adaptive simulated annealing. The resulting velocity model provides a tomography image of the estimated geologic conditions. Both vertical and lateral velocity information is contained in the tomography model. Changes in layer velocity are revealed as gradients rather than discrete contacts, which typically are more representative of actual conditions.

Figures 4a through 4e present the velocity models generated from our study. The approximate locations of the seismic refraction traverses are shown on the Line Location Map (Figure 2). In general, the effective depth of evaluation for a seismic refraction traverse is approximately one-third to one-fifth the length of the traverse.

## 6. CONCLUSIONS AND RECOMMENDATIONS

The results from our seismic survey revealed distinct layers/zones in the near surface that likely represent soil (topsoil, colluvium and fill) overlying granitic bedrock with varying degrees of weathering. Figures 4a through 4e provide the velocity models calculated from SeisOpt Pro.

Distinct vertical and lateral velocity variations are evident in the models. These inhomogeneities are likely related to the presence of remnant boulders, intrusions and differential weathering of the bedrock. It is also evident in the tomography models that bedrock is relatively shallow across much of the site.

Based on the refraction results, variability in the excavatability (including depth of rippability) of the subsurface materials should be expected across the project area. Furthermore, blasting may be required depending on the excavation depth, location, equipment used, and desired rate of production. In addition, oversized materials should be expected. A contractor with excavation experience in similar difficult conditions should be consulted for expert advice on excavation methodology, equipment and production rate.

## 7. LIMITATIONS

The field evaluation and geophysical analyses presented in this report have been conducted in general accordance with current practice and the standard of care exercised by consultants performing similar tasks in the project area. No warranty, expressed or implied, is made regarding the conclusions, recommendations, and opinions presented in this report. There is no evaluation detailed enough to reveal every subsurface condition. Variations may exist and conditions not observed or described in this report may be present. Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Additional subsurface surveying will be performed upon request.

This document is intended to be used only in its entirety. No portion of the document, by itself, is designed to completely represent any aspect of the project described herein. Southwest Geophysics, Inc. should be contacted if the reader requires additional information or has questions

regarding the content, interpretations presented, or completeness of this document. This report is intended exclusively for use by the client. Any use or reuse of the findings, conclusions, and/or recommendations of this report by parties other than the client is undertaken at said parties' sole risk.

## 8. SELECTED REFERENCES

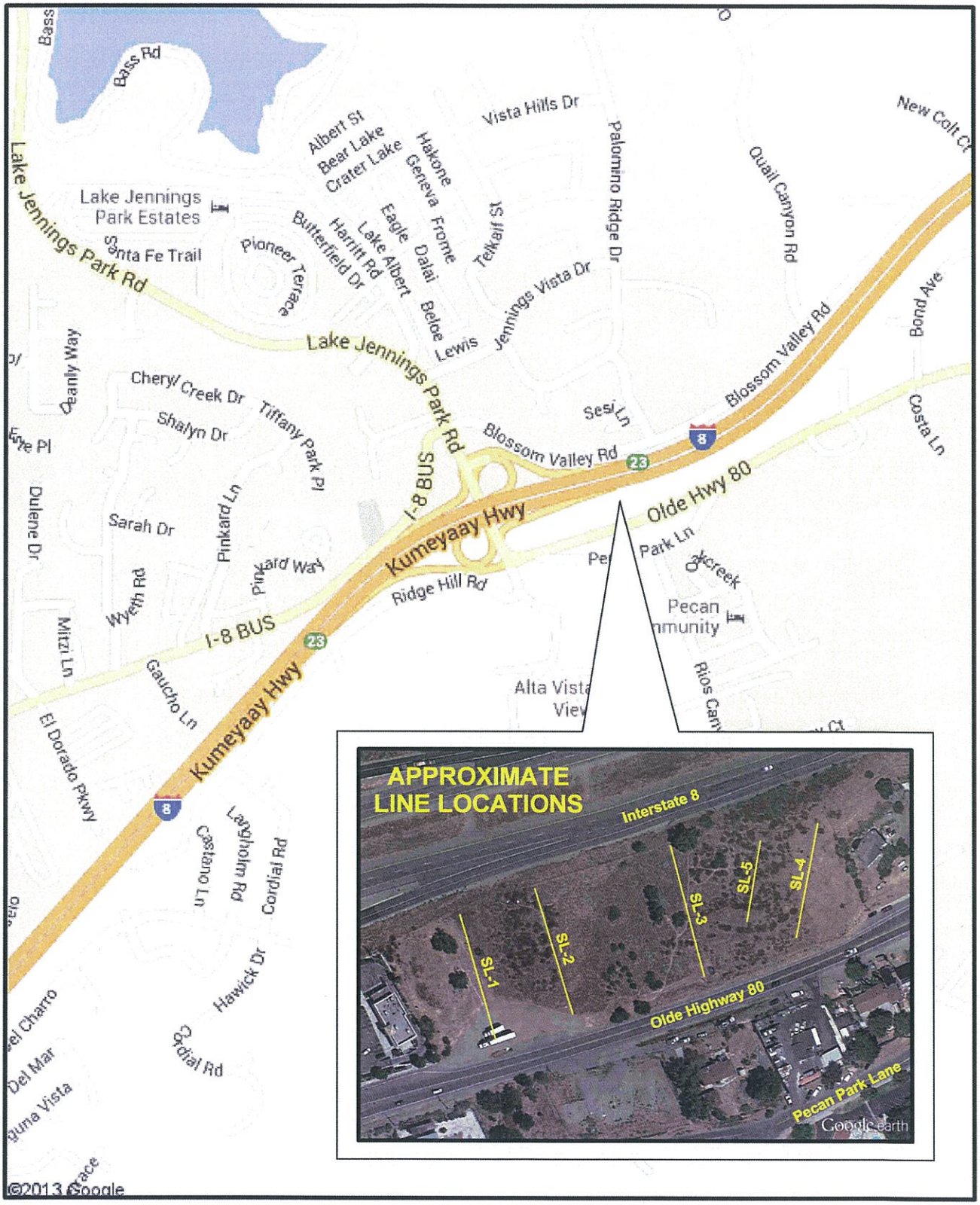
Caterpillar, Inc., 2011, Caterpillar Performance Handbook, Edition 41, Caterpillar, Inc., Peoria, Illinois.

Mooney, H.M., 1976, Handbook of Engineering Geophysics, dated February.

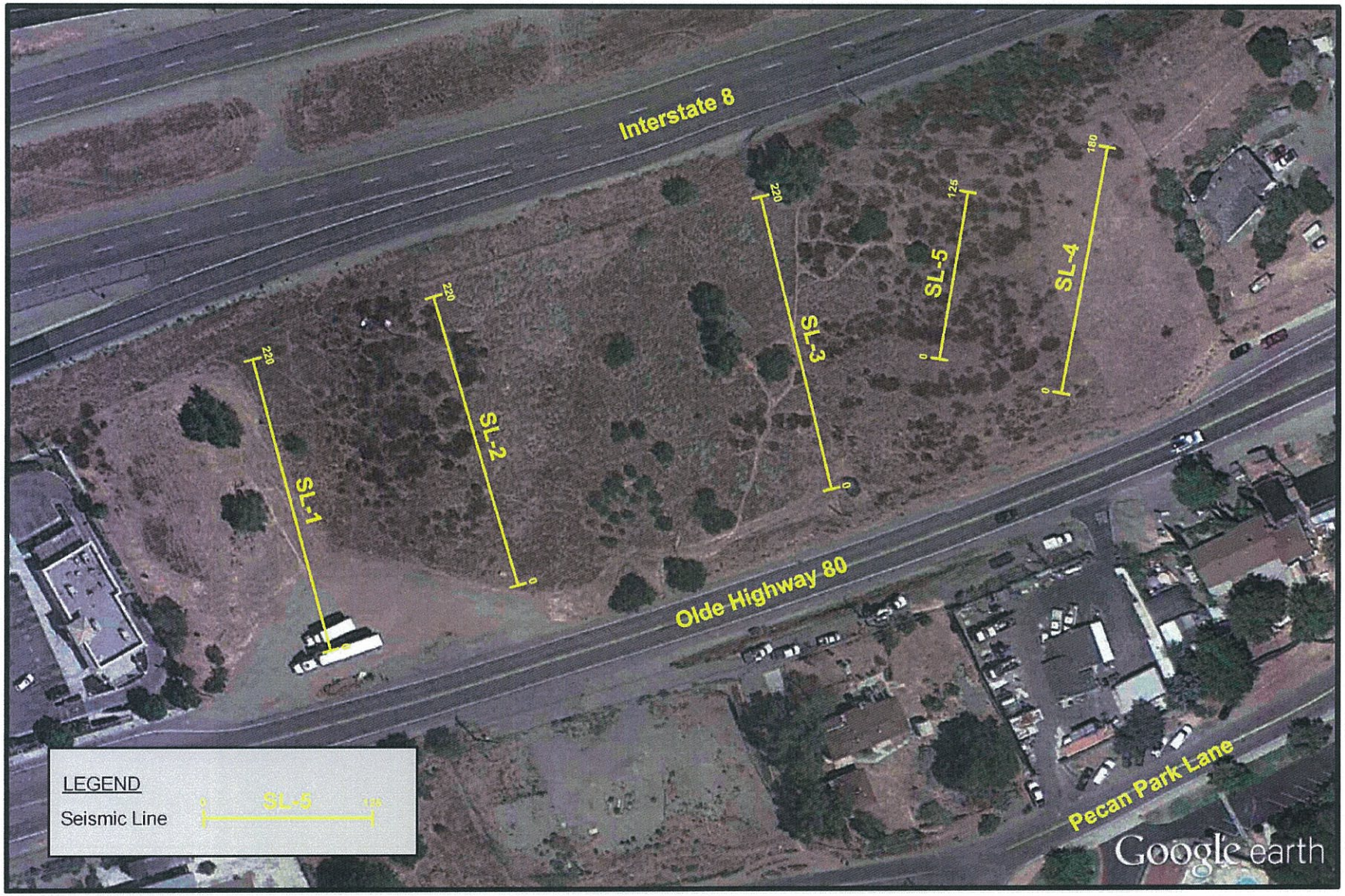
Optim, Inc., 2008, SeisOpt Pro, V-5.0.

Rimrock Geophysics, 2003, Seismic Refraction Interpretation Program (SIPwin), V-2.76.

Telford, W.M., Geldart, L.P., Sheriff, R.E., and Keys, D.A., 1976, Applied Geophysics, Cambridge University Press.




| SITE LOCATION MAP | N | Lakeside APN 395-250-2100<br>San Diego County, California | SOUTHWEST GEOPHYSICS INC. |
|---|---|---|---|
| | | Project No.: 113249 / Date: 07/13 | Figure 1 |




**LINE LOCATION MAP**

N

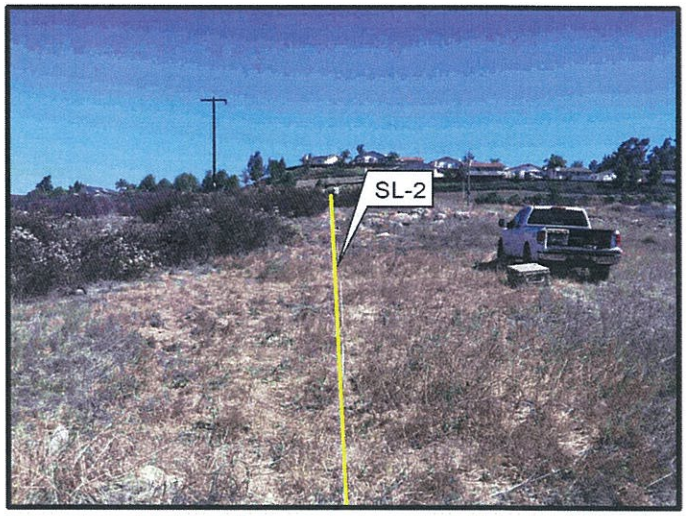
Lakeside APN 395-250-2100
San Diego County, California

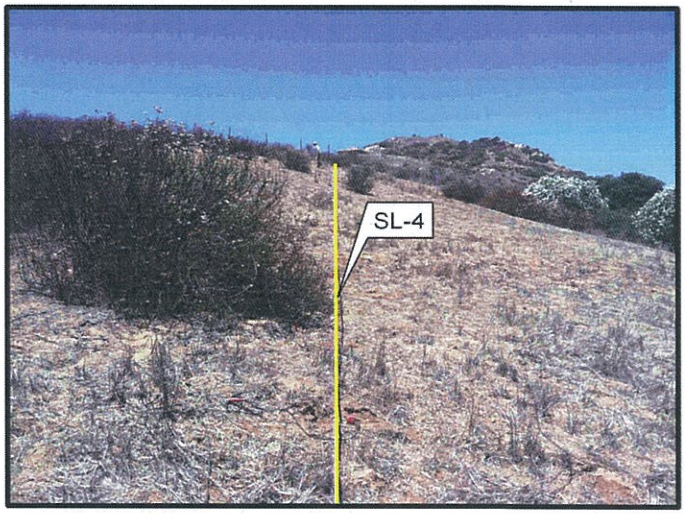
Project No.: 113249 | Date: 07/13

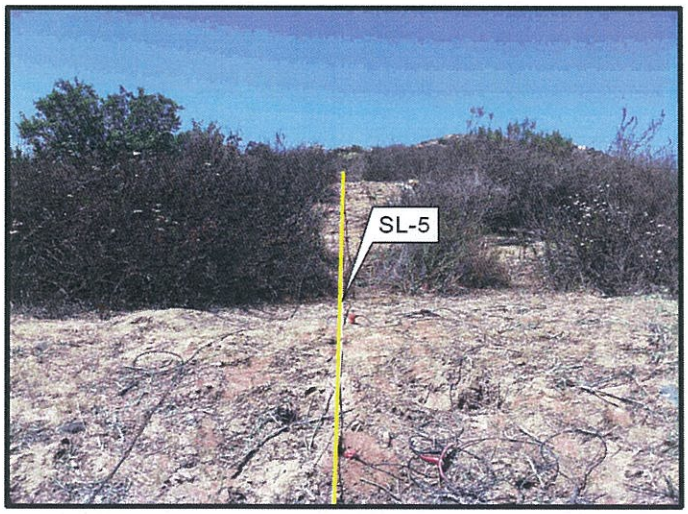
SOUTHWEST GEOPHYSICS INC.

Figure 2

0 100 200
approximate scale in feet

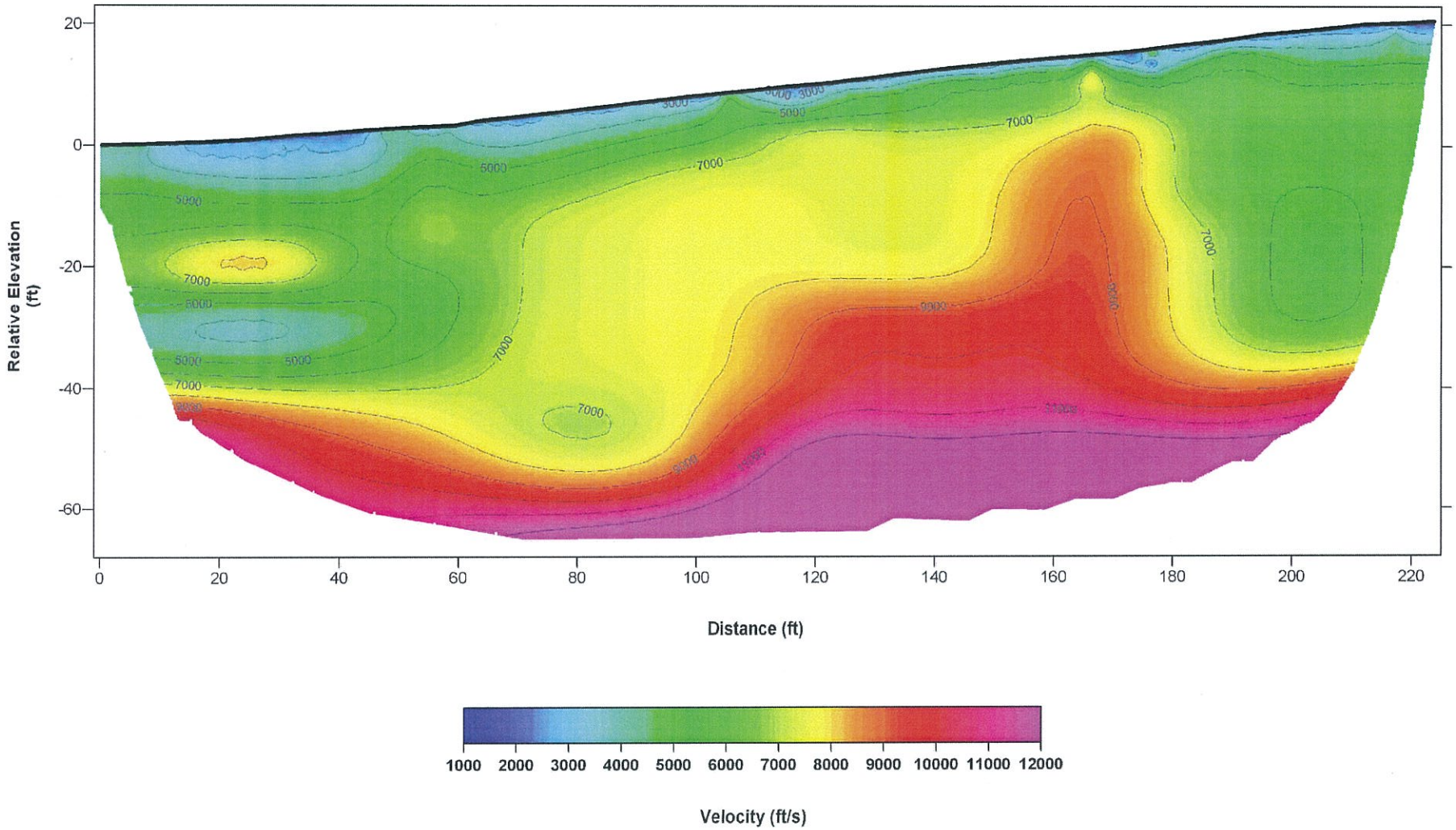




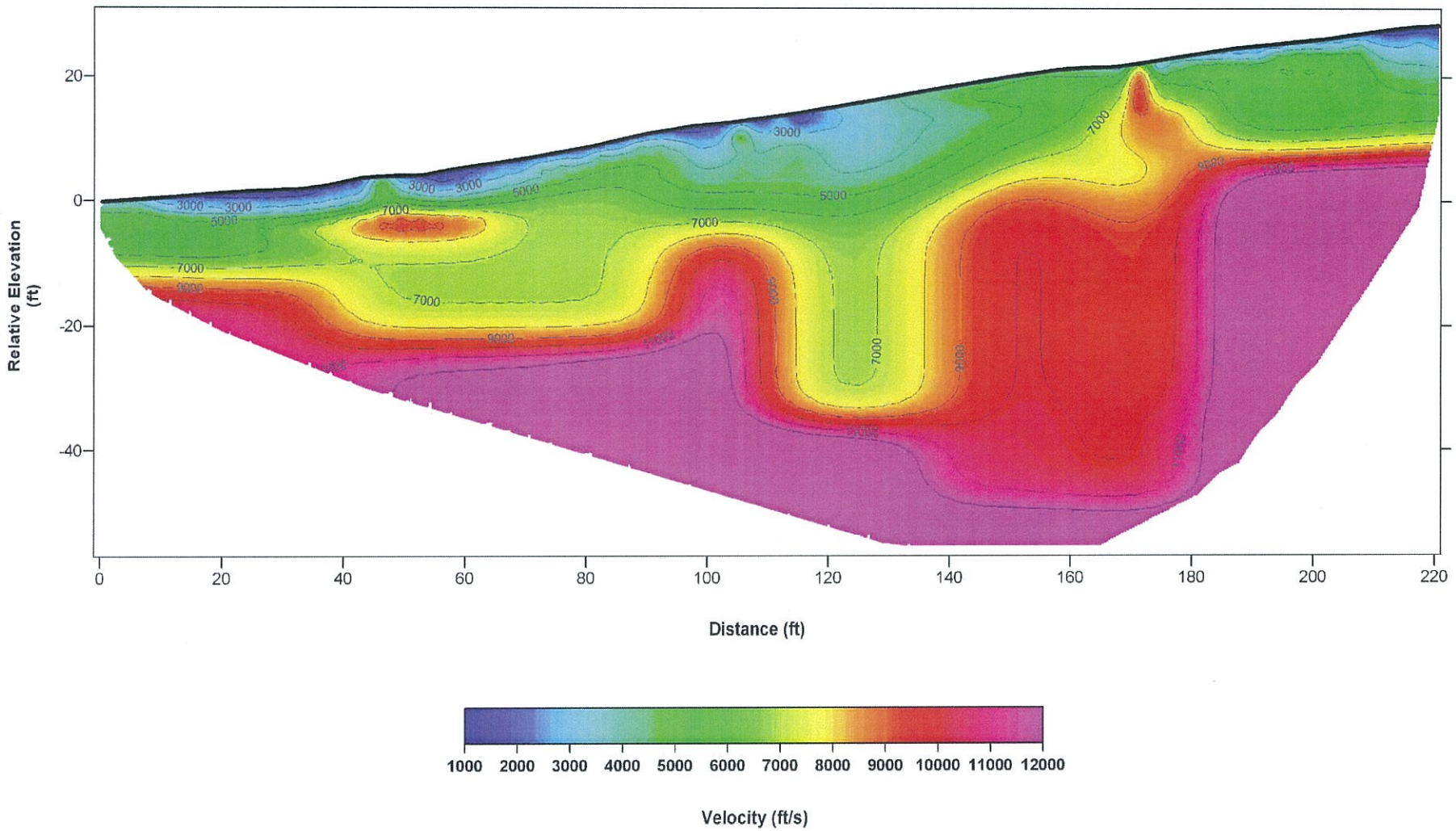

| | | |
|---|---|---|
| **SITE PHOTOGRAPHS** | Lakeside APN 395-250-2100<br>San Diego County, California | SOUTHWEST GEOPHYSICS INC. |
| | Project No.: 113249 / Date: 07/13 | Figure 3 |

# TOMOGRAPHY MODEL



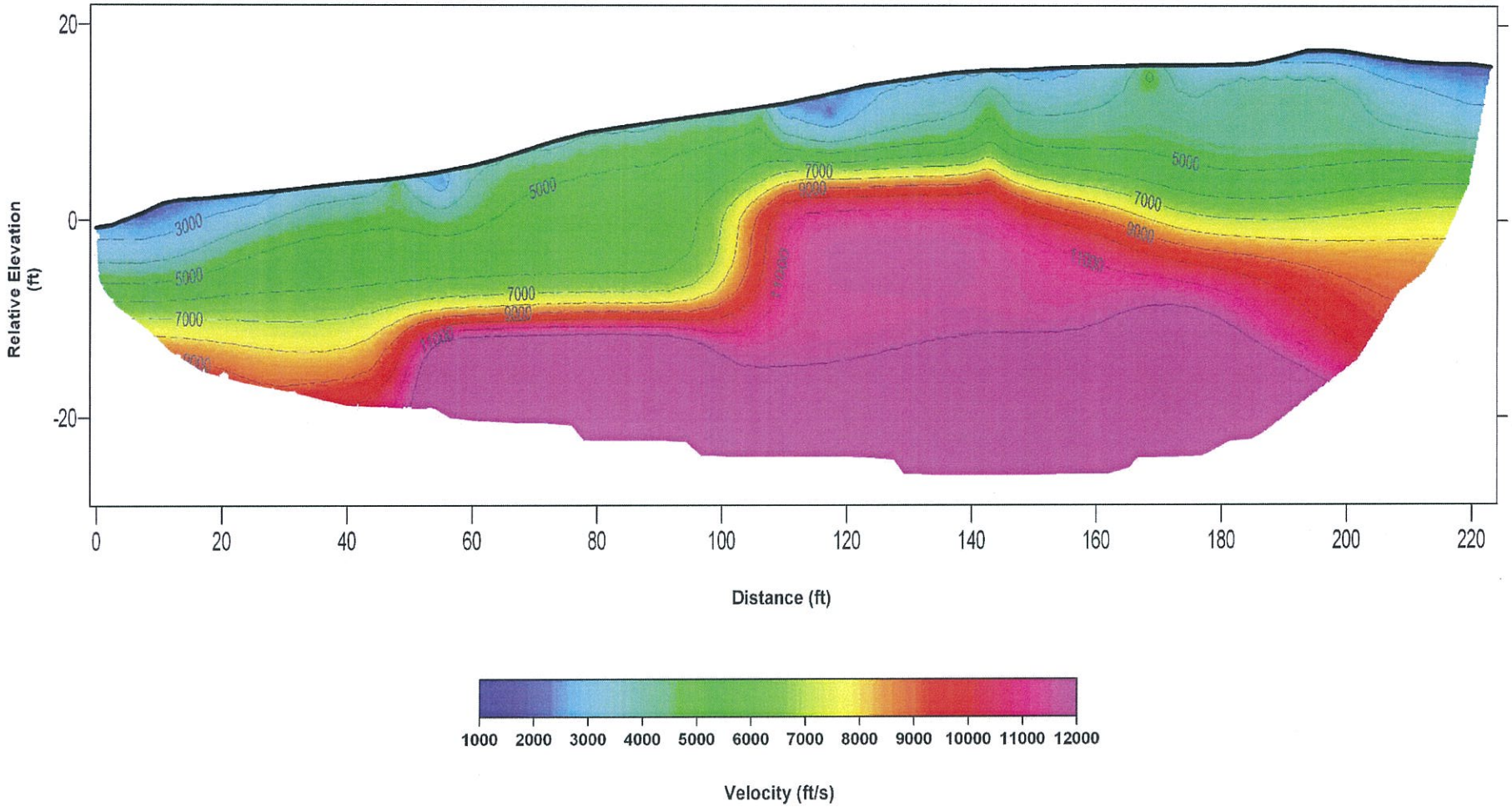

| | | | |
|---|---|---|---|
| **SEISMIC PROFILE SL-1** | Lakeside APN 395-250-2100<br>San Diego County, California | SOUTHWEST GEOPHYSICS INC.<br>Figure 4a | **Note: Contour Interval = 1,000 feet per second** |
| | Project No.: 113249 / Date: 07/13 | | |

# TOMOGRAPHY MODEL



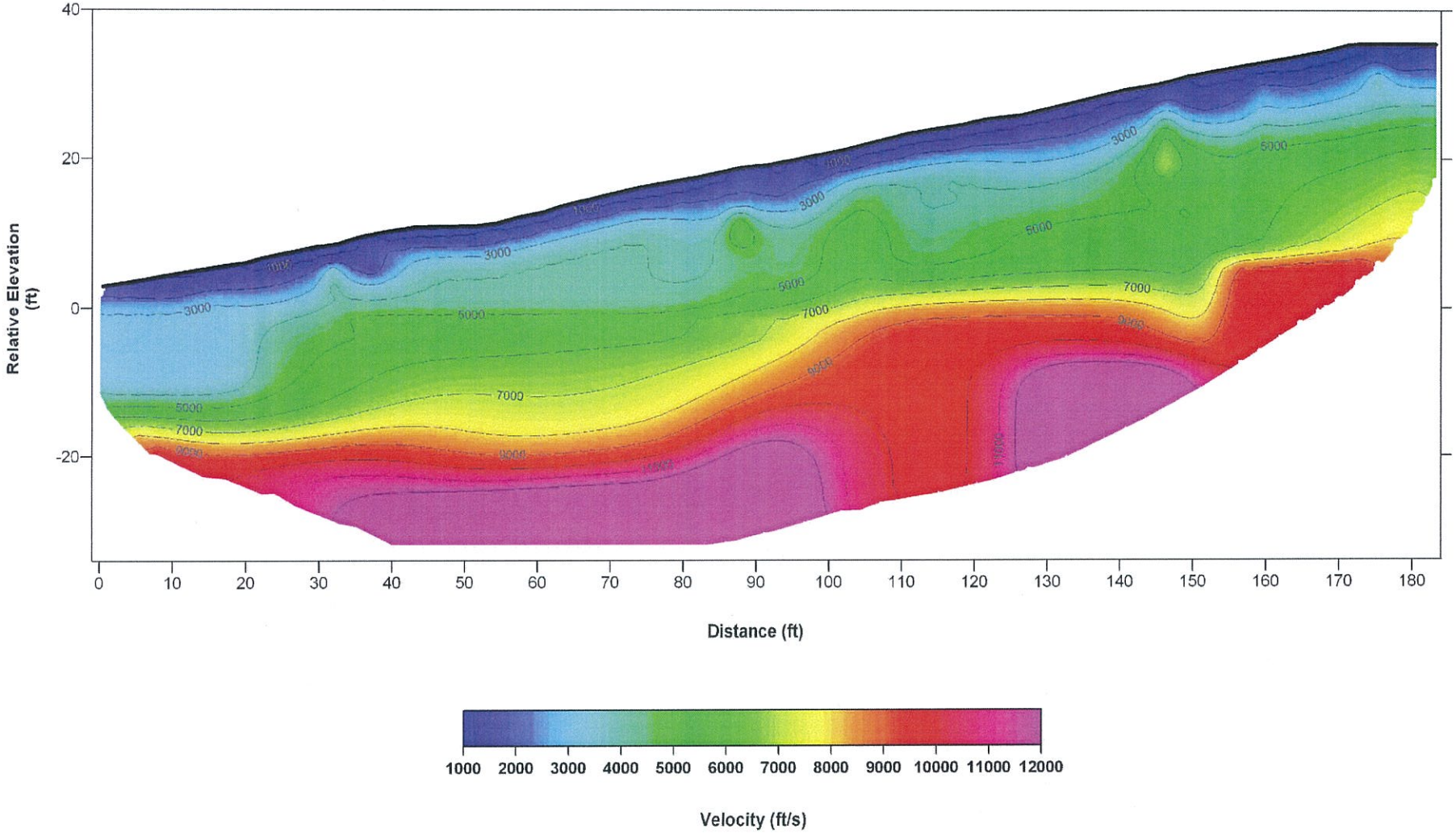

| | | | |
|---|---|---|---|
| **SEISMIC PROFILE SL-2** | Lakeside APN 395-250-2100<br>San Diego County, California<br>Project No.: 113249 Date: 07/13 | SOUTHWEST GEOPHYSICS INC.<br>Figure 4b | **Note: Contour Interval = 1,000 feet per second** |

# TOMOGRAPHY MODEL



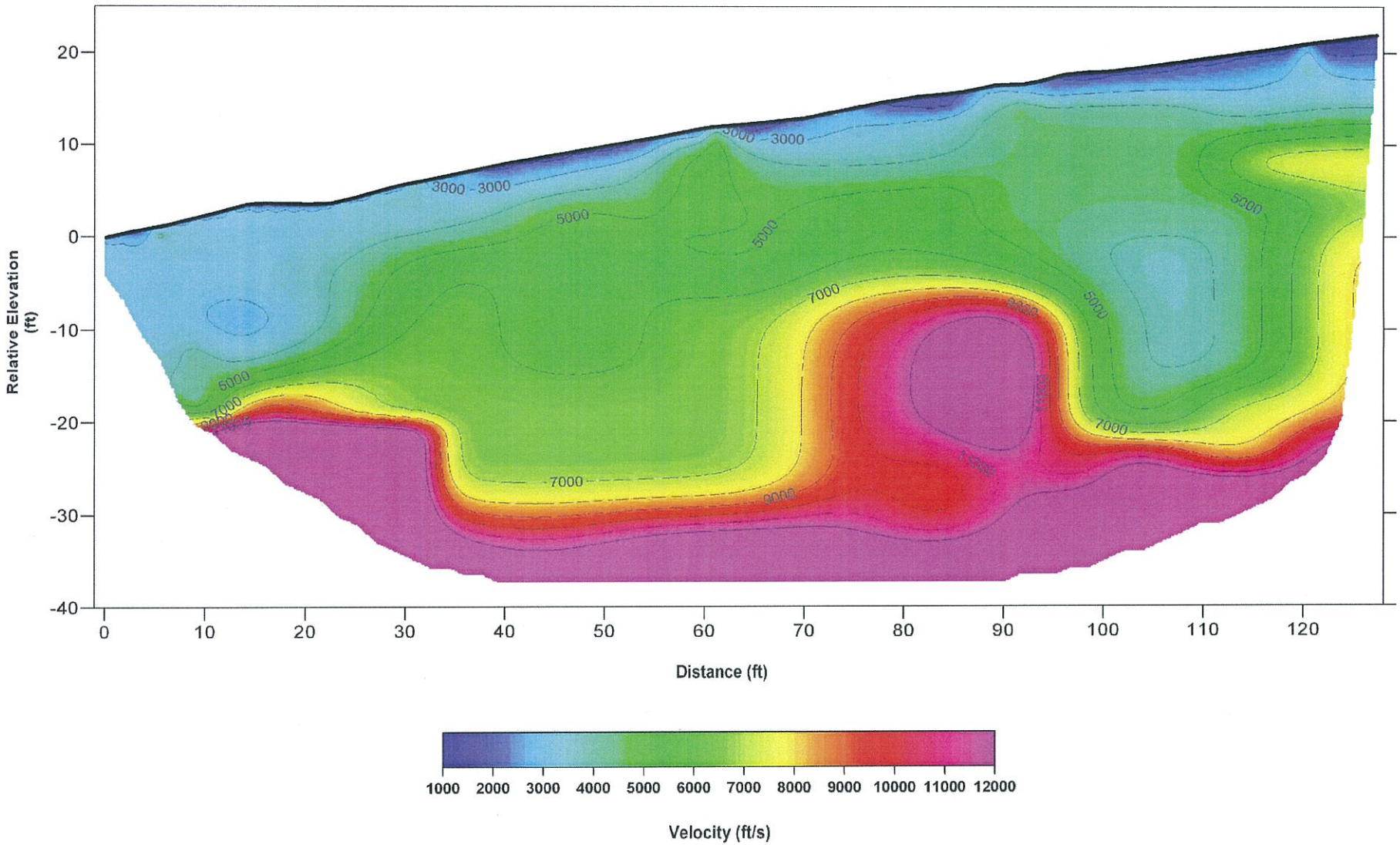

| | | | |
|---|---|---|---|
| **SEISMIC PROFILE SL-3** | Lakeside APN 395-250-2100<br>San Diego County, California<br>Project No.: 113249 Date: 07/13 | SOUTHWEST GEOPHYSICS INC.<br>Figure 4c | **Note: Contour Interval = 1,000 feet per second** |

# TOMOGRAPHY MODEL




| | | | |
|---|---|---|---|
| **SEISMIC PROFILE SL-4** | Lakeside APN 395-250-2100<br>San Diego County, California<br>Project No.: 113249 Date: 07/13 | SOUTHWEST GEOPHYSICS INC.<br>Figure 4d | **Note: Contour Interval = 1,000 feet per second** |

# TOMOGRAPHY MODEL




| | | | |
|---|---|---|---|
| **SEISMIC PROFILE SL-5** | Lakeside APN 395-250-2100<br>San Diego County, California | SOUTHWEST GEOPHYSICS INC.<br>Figure 4e | **Note: Contour Interval = 1,000 feet per second** |
| | Project No.: 113249 / Date: 07/13 | | |

# Hydrologic Soil Group—San Diego County Area, California

## MAP LEGEND

**Area of Interest (AOI)**

Area of Interest (AOI)

**Soils**

**Soil Rating Polygons**

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

**Soil Rating Lines**

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

**Soil Rating Points**

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

**Water Features**

Streams and Canals

**Transportation**

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

**Background**

Aerial Photography

## MAP INFORMATION

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

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: San Diego County Area, California
Survey Area Data: Version 7, Nov 15, 2013

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

Date(s) aerial images were photographed: May 2, 2010—May 6, 2010

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

# Hydrologic Soil Group

| Hydrologic Soil Group— Summary by Map Unit — San Diego County Area, California (CA638) | | | | |
|---|---|---|---|---|
| **Map unit symbol** | **Map unit name** | **Rating** | **Acres in AOI** | **Percent of AOI** |
| EsC | Escondido very fine sandy loam, 5 to 9 percent slopes | C | 4.2 | 82.8% |
| EsE2 | Escondido very fine sandy loam, 15 to 30 percent slopes , eroded | C | 0.9 | 17.2% |
| **Totals for Area of Interest** | | | **5.1** | **100.0%** |

## Description

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

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

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

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

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

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

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

## Rating Options

*Aggregation Method:* Dominant Condition

*Component Percent Cutoff:* *None Specified*

*Tie-break Rule:* Higher

# ATTACHMENT 9

## Summary Files from the SWMM Model

# POST_DEV

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.0 (Build 5.0.022)
--------------------------------------------------------------

*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ YES
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... GREEN_AMPT
Flow Routing Method ...... KINWAVE
Starting Date ............ AUG-09-1963 00:00:00
Ending Date .............. AUG-09-2008 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 01:00:00
Wet Time Step ............ 00:15:00
Dry Time Step ............ 04:00:00
Routing Time Step ........ 60.00 sec


WARNING 04: minimum elevation drop used for Conduit BYPASS-C

WARNING 04: minimum elevation drop used for Conduit UDRAIN-C

WARNING 04: minimum elevation drop used for Conduit BYPASS_A

WARNING 04: minimum elevation drop used for Conduit UDRAIN_A

**************************        Volume         Depth
Runoff Quantity Continuity     acre-feet        inches
**************************     ---------       -------
Total Precipitation ......       395.335       595.640
Evaporation Loss .........        35.063        52.828
Infiltration Loss ........       165.061       248.693
Surface Runoff ...........       198.711       299.392
Final Surface Storage ....         0.000         0.000
Continuity Error (%) .....        -0.885


**************************        Volume        Volume
Flow Routing Continuity        acre-feet      10^6 gal
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......       198.708        64.752
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........       193.383        63.017
Internal Outflow .........         0.000         0.000
Storage Losses ...........         5.276         1.719
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.000         0.000
Continuity Error (%) .....         0.024


*******************************
Highest Flow Instability Indexes
*******************************
```

# POST_DEV

All links are stable.

```
*************************
Routing Time Step Summary
*************************
Minimum Time Step           :    60.00 sec
Average Time Step           :    60.00 sec
Maximum Time Step           :    60.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     1.00
```

```
****************************
Subcatchment Runoff Summary
****************************
```

| Subcatchment | Total Precip in | Total Runon in | Total Evap in | Total Infil in | Total Runoff in | Total Runoff 10^6 gal | Peak Runoff CFS | Runoff Coeff |
|---|---|---|---|---|---|---|---|---|
| DMA-D4 | 595.64 | 0.00 | 82.86 | 0.00 | 518.21 | 1.63 | 0.12 | 0.870 |
| DMA-OFF | 595.64 | 0.00 | 72.39 | 54.15 | 475.87 | 22.22 | 1.80 | 0.799 |
| DMA-A1 | 595.64 | 0.00 | 42.03 | 276.14 | 282.11 | 5.22 | 0.69 | 0.474 |
| DMA-A2 | 595.64 | 0.00 | 4.25 | 560.53 | 32.14 | 0.24 | 0.26 | 0.054 |
| LID-A | 595.64 | 12532.99 | 772.69 | 0.00 | 12444.77 | 5.41 | 0.96 | 0.948 |
| LID-B | 595.64 | 19834.92 | 819.60 | 0.00 | 19797.61 | 7.77 | 0.78 | 0.969 |
| LID-C | 595.64 | 13546.29 | 771.79 | 0.00 | 13463.94 | 9.51 | 1.55 | 0.952 |
| LID-D | 595.64 | 13383.61 | 781.74 | 0.00 | 13279.52 | 4.44 | 0.36 | 0.950 |
| DMA-B1 | 595.64 | 0.00 | 73.39 | 37.33 | 492.57 | 7.61 | 0.60 | 0.827 |
| DMA-C1 | 595.64 | 0.00 | 72.06 | 74.88 | 453.87 | 8.85 | 0.75 | 0.762 |
| DMA-D1 | 595.64 | 0.00 | 79.15 | 17.85 | 504.63 | 4.47 | 0.34 | 0.847 |
| DMA-E2 | 595.64 | 0.00 | 69.55 | 102.78 | 427.58 | 10.85 | 0.97 | 0.718 |
| DMA-B2 | 595.64 | 0.00 | 4.19 | 559.27 | 33.80 | 0.18 | 0.19 | 0.057 |
| DMA-E1 | 595.64 | 0.00 | 4.24 | 560.37 | 32.34 | 0.75 | 0.82 | 0.054 |
| DMA-C2 | 595.64 | 0.00 | 4.25 | 560.66 | 31.96 | 0.71 | 0.78 | 0.054 |
| DMA-X2 | 595.64 | 0.00 | 15.62 | 466.79 | 116.40 | 2.16 | 0.68 | 0.195 |

```
***********************
LID Performance Summary
***********************
```

| Subcatchment | LID Control | Total Inflow in | Evap Loss in | Infil Loss in | Surface Outflow in | Drain Outflow in | Init. Storage in | Final Storage in | Pcnt. Error |
|---|---|---|---|---|---|---|---|---|---|
| LID-A | LID-A | 13128.63 | 772.72 | 0.00 | 1274.65 | 11170.67 | 0.00 | 0.00 | -0.68 |
| LID-B | LID-B | 20430.56 | 819.65 | 0.00 | 1870.81 | 17927.79 | 0.00 | 0.00 | -0.92 |
| LID-C | LID-C | 14141.93 | 771.52 | 0.00 | 1203.00 | 12256.21 | 0.00 | 0.00 | -0.63 |
| LID-D | LID-D | 13979.25 | 781.78 | 0.00 | 673.56 | 12606.60 | 0.00 | 0.00 | -0.59 |

```
******************
Node Depth Summary
******************
```

| Node | Type | Average Depth Feet | Maximum Depth Feet | Maximum HGL Feet | Time of Max Occurrence days hr:min |
|---|---|---|---|---|---|
| POC-2 | OUTFALL | 0.00 | 0.00 | 0.00 | 0 00:00 |
| POC-1 | OUTFALL | 0.00 | 0.00 | 0.00 | 0 00:00 |
| DIV-C | DIVIDER | 0.00 | 0.00 | 0.00 | 0 00:00 |
| DIV_A | DIVIDER | 0.00 | 0.00 | 0.00 | 0 00:00 |
| BASIN-E | STORAGE | 0.01 | 2.65 | 2.65 | 6039 20:00 |
| BASIN-C | STORAGE | 0.00 | 0.99 | 0.99 | 6039 20:15 |
| BASIN_A_F | STORAGE | 0.00 | 0.59 | 0.59 | 6039 20:19 |

# POST_DEV

**********
Node Inflow Summary
**********

| Node | Type | Maximum Lateral Inflow CFS | Maximum Total Inflow CFS | Time of Max Occurrence days hr:min | Lateral Inflow Volume 10^6 gal | Total Inflow Volume 10^6 gal |
|---|---|---|---|---|---|---|
| POC-2 | OUTFALL | 1.92 | 1.92 | 6039 20:00 | 23.852 | 23.852 |
| POC-1 | OUTFALL | 0.00 | 5.98 | 6039 20:00 | 0.000 | 39.160 |
| DIV-C | DIVIDER | 1.55 | 1.55 | 6039 20:15 | 9.505 | 9.505 |
| DIV_A | DIVIDER | 0.96 | 0.96 | 6039 20:00 | 5.415 | 5.415 |
| BASIN-E | STORAGE | 3.61 | 5.98 | 6039 20:00 | 25.975 | 40.880 |
| BASIN-C | STORAGE | 0.00 | 1.50 | 6039 20:15 | 0.000 | 1.045 |
| BASIN_A_F | STORAGE | 0.00 | 0.92 | 6039 20:00 | 0.000 | 0.553 |

**********
Node Surcharge Summary
**********

Surcharging occurs when water rises above the top of the highest conduit.

| Node | Type | Hours Surcharged | Max. Height Above Crown Feet | Min. Depth Below Rim Feet |
|---|---|---|---|---|
| DIV-C | DIVIDER | 394488.02 | 0.000 | 0.000 |
| DIV_A | DIVIDER | 394488.02 | 0.000 | 0.000 |
| BASIN-E | STORAGE | 394488.02 | 2.646 | 0.354 |
| BASIN-C | STORAGE | 394488.02 | 0.989 | 1.011 |
| BASIN_A_F | STORAGE | 394488.02 | 0.588 | 1.162 |

**********
Node Flooding Summary
**********

No nodes were flooded.

**********
Storage Volume Summary
**********

| Storage Unit | Average Volume 1000 ft3 | Avg Pcnt Full | E&I Pcnt Loss | Maximum Volume 1000 ft3 | Max Pcnt Full | Time of Max Occurrence days hr:min | Maximum Outflow CFS |
|---|---|---|---|---|---|---|---|
| BASIN-E | 0.010 | 0 | 4 | 2.011 | 88 | 6039 20:00 | 5.98 |
| BASIN-C | 0.000 | 0 | 1 | 1.281 | 44 | 6039 20:15 | 1.50 |
| BASIN_A_F | 0.000 | 0 | 0 | 0.647 | 27 | 6039 20:18 | 0.87 |

**********
Outfall Loading Summary
**********

| Outfall Node | Flow Freq. Pcnt. | Avg. Flow CFS | Max. Flow CFS | Total Volume 10^6 gal |
|---|---|---|---|---|
| POC-2 | 3.16 | 0.07 | 1.92 | 23.852 |
| POC-1 | 4.73 | 0.08 | 5.98 | 39.160 |
| System | 3.95 | 0.15 | 7.90 | 63.012 |

# POST_DEV

**********
Link Flow Summary
**********

| Link | Type | Maximum \|Flow\| CFS | Time of Max Occurrence days | hr:min | Maximum \|Veloc\| ft/sec | Max/ Full Flow | Max/ Full Depth |
|---|---|---|---|---|---|---|---|
| BYPASS-C | DUMMY | 1.50 | 6039 | 20:15 | | | |
| UDRAIN-C | DUMMY | 0.05 | 836 | 23:00 | | | |
| BYPASS_A | DUMMY | 0.92 | 6039 | 20:00 | | | |
| UDRAIN_A | DUMMY | 0.04 | 836 | 23:23 | | | |
| ORIFICE | DUMMY | 5.98 | 6039 | 20:00 | | | |
| OUT-C | DUMMY | 1.50 | 6039 | 20:15 | | | |
| OUT_A | DUMMY | 0.87 | 6039 | 20:19 | | | |

**********
Conduit Surcharge Summary
**********

| Conduit | Hours Full Both Ends | Hours Full Upstream | Hours Full Dnstream | Hours Above Full Normal Flow | Hours Capacity Limited |
|---|---|---|---|---|---|
| BYPASS-C | 0.01 | 0.01 | 0.01 | 394488.02 | 0.01 |
| UDRAIN-C | 0.01 | 0.01 | 0.01 | 394488.02 | 0.01 |
| BYPASS_A | 0.01 | 0.01 | 0.01 | 394488.02 | 0.01 |
| UDRAIN_A | 0.01 | 0.01 | 0.01 | 394488.02 | 0.01 |

Analysis begun on: Thu Oct 23 13:03:37 2014
Analysis ended on: Thu Oct 23 13:04:20 2014
Total elapsed time: 00:00:43

# PRE_DEV

```
[TITLE]

[OPTIONS]
FLOW_UNITS           CFS
INFILTRATION         GREEN_AMPT
FLOW_ROUTING         KINWAVE
START_DATE           08/09/1963
START_TIME           00:00:00
REPORT_START_DATE    08/09/1963
REPORT_START_TIME    00:00:00
END_DATE             08/08/2008
END_TIME             23:00:00
SWEEP_START          01/01
SWEEP_END            12/31
DRY_DAYS             0
REPORT_STEP          01:00:00
WET_STEP             00:15:00
DRY_STEP             04:00:00
ROUTING_STEP         0:01:00
ALLOW_PONDING        NO
INERTIAL_DAMPING     PARTIAL
VARIABLE_STEP        0.75
LENGTHENING_STEP     0
MIN_SURFAREA         0
NORMAL_FLOW_LIMITED  BOTH
SKIP_STEADY_STATE    NO
FORCE_MAIN_EQUATION  H-W
LINK_OFFSETS         DEPTH
MIN_SLOPE            0

[EVAPORATION]
;;Type       Parameters
;;---------- ----------
MONTHLY      .041   .076   .118   .192   .237   .318   .308   .286   .217   .14    .067   .041
DRY_ONLY     NO

[RAINGAGES]
;;               Rain      Time   Snow   Data
;;Name           Type      Intrvl Catch  Source
;;-------------- --------- ------ ------ ----------
Flinn            INTENSITY 1:00   1.0    TIMESERIES Flinn

[SUBCATCHMENTS]
;;                                                   Total    Pcnt.             Pcnt.    Curb     Snow
;;Name           Raingage         Outlet           Area     Imperv   Width    Slope    Length   Pack
;;-------------- ---------------- ---------------- -------- -------- -------- -------- -------- --------
;DMA-11 SLOPE
DMA-11           Flinn            POC-1            2.53     0.0      506      26.6     0
;DMA-2
DMA-2            Flinn            POC-2            1.438    5.5      167      11.4     0
DMA-OFF          Flinn            POC-2            1.720    90       300      3.0      0
;DMA-12 ROAD
DMA-12           Flinn            POC-1            1.221    0        168      9        0
DMA-13           Flinn            POC-1            0.41     100      483      1.5      0
DMA-X2           Flinn            POC-1            0.68388  14.2     76.8     14.9     0

[SUBAREAS]
;;Subcatchment   N-Imperv   N-Perv     S-Imperv   S-Perv     PctZero    RouteTo    PctRouted
;;-------------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
DMA-11           0.012      0.05       0.02       0.1        25         OUTLET
DMA-2            0.012      0.05       0.02       0.1        25         OUTLET
DMA-OFF          0.012      0.05       0.02       0.1        25         OUTLET
DMA-12           0.012      0.05       0.02       0.1        25         OUTLET
DMA-13           0.012      0.05       0.02       0.1        25         OUTLET
DMA-X2           0.012      0.05       0.02       0.1        25         OUTLET

[INFILTRATION]
;;Subcatchment   Suction    HydCon     IMDmax
;;-------------- ---------- ---------- ----------
DMA-11           6          0.1        0.31
DMA-2            6          0.075      0.31
```

```
DMA-OFF          6          0.075      0.31
DMA-12           6          0.1        0.31
DMA-13           6          0.075      0.31
DMA-X2           6          0.075      0.31

[OUTFALLS]
;;               Invert     Outfall    Stage/Table      Tide
;;Name           Elev.      Type       Time Series      Gate
;;-------------- ---------- ---------- ---------------- ----
POC-1            0          FREE                        NO
POC-2            0          FREE                        NO

[TIMESERIES]
;;Name           Date       Time       Value
;;-------------- ---------- ---------- ----------
Flinn            FILE "Flinn.txt"

[REPORT]
INPUT      NO
CONTROLS   NO
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL

[TAGS]

[MAP]
DIMENSIONS 0.000 0.000 10000.000 10000.000
Units      None

[COORDINATES]
;;Node           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
POC-1            750.000            6000.000
POC-2            2000.000           6000.000

[VERTICES]
;;Link           X-Coord            Y-Coord
;;-------------- ------------------ ------------------

[Polygons]
;;Subcatchment   X-Coord            Y-Coord
;;-------------- ------------------ ------------------
DMA-11           750.000            9500.000
DMA-2            2000.000           9500.000
DMA-OFF          3000.000           9500.000
DMA-12           -100.000           9500.000
DMA-13           -950.000           9500.000
DMA-X2           -2078.125          9437.500

[SYMBOLS]
;;Gage           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
Flinn            1800.000           12000.000
```

# ATTACHMENT 10

# Response to Comments

# ATTACHMENT 10

## RESPONSE TO COMMENTS

The comments are responded in blue in the next pages. The reader is also referred to the new pages in the HMP Memorandum, where changes were made following the comments when applicable.

**Comment 5a-2:** "Does report have a project description, hydromodification management description, vicinity map, proposed maintenance entity identified for hydromodification management features included in text?

1st Plancheck Comment:

No. Please provide a vicinity map in the report."

**Response:** A vicinity map is now included in the report.

**Comment 5a-3:** "Does report have a geotechnical investigation? (Reference checklist for the geotechnical information necessary for a Preliminary Design and Final Design phase submittal.)

1st Plancheck Comment:

No. It appears that infiltration is considered at the proposed hydromodification management BMP locations (i.e. - LID A, LID B, LID C, and LID D); therefore, it is necessary for a geotechnical assessment (prepared by an appropriately licensed professional) to be made to discuss the feasibility of infiltration and determine the groundwater depth and infiltration rates at the above referenced hydromodification management BMP locations."

**Response:** A geotechnical study was provided to TRWE after the submittal of the original HMP Memo. The geotechnical analysis concluded that infiltration was not a viable alternative for the bioretention facilities and as such all LID BMPs for the project site have been revised accordingly.

The geotechnical study is included in Attachment 8 of the revised HMP Memo.

**Comment 5a-4:** "Does report have a legible and adequate Drainage exhibit? Pre- and Post-Project?

1st Plancheck Comment:

Yes, the exhibits are included in Attachment 5; however, the pre- and post-project drainage exhibits must both include point of compliance (POC) labels (i.e. - POC-1 and POC-2). Additionally, the post-project model has off-site DMA E1 and DMA E2, but these areas are not displayed on the Proposed Drainage Condition Map in Attachment 5. Please update the exhibits to show POC locations, DMA E1 and DMA E2."

**Response:** POC's have been included in all drainage exhibits. It should be noted that due to the nature of the sites variable sloped areas, tributaries to the LID's were broken into two groups to reflect the

steep and flat tributaries, these tributaries were labeled per LID (ie. DMA E1 and DMA E2 were the "flat' and "steep" tributaries to LID E). These areas were in some cases more than one "Basin ID" as identified on the Drainage Exhibits. To assist, labels were added within the SWMM models such that the Basin IDs and corresponding DMA could be determined.

In the specific example raised by the plan checker – DMA's E-1 and E-2 – these DMAs are in actuality Basins A3, D1 & D2 (DMA E-1) and Basin D3 (DMA E-2). In order to further assist with the review, a "DMA Summary Table" has been included within Attachment 5 such that the reviewer can easily determine which Basin corresponds to which DMA accordingly.

**Comment 5a-5:** "Does report have a tabular summary of the pre- and post-project pervious and impervious land parameters along with supporting backup.

1st Plancheck Comment:

Yes, a post-project tabular summary (Table 1) is provided; however, a pre-project summary is not available. Please also provide a summary table for the pre-project condition."

**Response:** A pre-developed summary table has now been included in the revised HMP study.

**Comment 5a-7:** "Does report have drawdown calculations for proposed mitigation measures?

1st Plancheck Comment:

No. Provide drawdown calculations for the proposed bioretention basins pursuant to Section 6.4.6 of the Final HMP dated March 2011. If drawdown time exceeds 96 hours, contact County of San Diego Department of Environmental Health to determine available mitigation measures for vector control."

**Response:** A section regarding drawdown calculations is now included in the body of the report and drawdown calculations have been included in Attachment 4 of the revised HMP study.

**Comment 5a-8:** "1st Plancheck Comment:

Specify the name and date of the "current Hydromodification Management Plan (HMP)" in the Introduction section."

**Response:** The HMP study has been revised to include the full document name and date.

**Comment 5a-9:** "1st Plancheck Comment:

The "Bioretention Area Cross-section" summary table in Attachment 5 indicates that LID C has a "Hmax" of 3.0 feet. However, Table 2 (Page 3) shows that "Total Surface Depth" for LID C is 30 inches. Please revise the above reference summary tables accordingly. Please refer to additional comment #10 below."

**Response:** The exhibit and tables have been revised accordingly.

**Comment 5a-10:** "1st Plancheck Comment:

The "Surface" tab of the LID Control Editor indicates that the "Storage Depth" for LIDs A through D are 9.57 inches, 9 inches, 26.44 inches, and 10.53 inches, respectively. However, it appears that the values for LIDs A, C and D are in conflict with the "Depth Riser Invert" values in Table 2 (Page 3) and the "Bioretention Area Cross-section" summary table in Attachment 5. Please correct the model and tables accordingly."

**Response:** The storage depth used within SWMM is not total depth of the facility. The following is an explanation of the way storage depth is calculated:

SURFACE STORAGE DEPTH

For those cases where the surface storage has a variable area ($A_{BOTTOM}$ at the bottom surface, and $A_{TOP}$ at the riser elevation), the surface volume is calculated for the riser depth h as:
$V_{SURF} = 0.5 \cdot h \cdot (A_{BOTT} + A_{TOP})$

The area of the amended soil layer $A_{SOIL}$ is equal to the area of the gravel $A_{GRAVEL}$ and is usually selected such that $A_{BOTT} \leq A_{SOIL} \leq A_{TOP}$

As the SWMM model assumes the area at the surface constant, we need to determine an equivalent depth $h_{EQ}$ such that the volume that the equivalent depth produces at the surface level with the amended soil area is equal to the real volume already determined ($V_{SURF}$).

Therefore: $h_{EQ} \cdot A_{SOIL} = V_{SURF}$. Consequently, $h_{EQ} = V_{SURF}/A_{SOIL}$.

Notice that $h_{EQ}$ is not necessarily equal to the real depth of the riser h, as it depends on the values $A_{BOTT}$, $A_{TOP}$ and $A_{SOIL}$. The values $h_{EQ}$ and h are equal only when $A_{SOIL} = 0.5 \cdot (A_{BOTT} + A_{TOP})$.

Please keep in mind that a similar explanation has been provided in Attachment 7 of the hydromodification study.

**Comment 5a-11:** "1st Plancheck Comment:

There is no document in Attachment 10 ("Susceptibility Analysis of Pecan Creek"). Please make a reference to the separate (standalone) susceptibility analysis report in Attachment 10."

**Response:** TRWE was of the understanding that the Susceptibility Analysis of Pecan Creek was to be submitted as part of the HMP analysis. The revised HMP study now references the Susceptibility Analysis as a stand alone report.