DESIGN REPORT
FOR
SERRA MESA STORM DRAIN AND GREEN INFRASTRUCTURE PROJECT

(100% Submittal)

Job Number 17588-G

November 18, 2016
Revised: March 6, 2017
Revised: May 31, 2017
Revised: July 21, 2017
Revised: September 26, 2017
Revised: December 19, 2019

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December 19, 2019

This design report presents a revision to the September 26, 2017 report. Per direction from the City of San Diego during a meeting in May 2019, the BMP for Site 3 (Shawn Avenue) will be changed from a biofiltration basin to a proprietary compact biofiltration unit that captures low flows through trench drains and a curb opening to insure treatment on both sides of the existing sump inlet. The associated water quality calculations and exhibits have been updated to reflect this change.

Additionally, minor updates to water quality calculations for Sites 4 and 5 to reflect changes in grading and GI footprints have been included.

DESIGN REPORT
FOR
SERRA MESA STORM DRAIN AND
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REVISION PAGE

September 26, 2017

This design report presents a revision to the July 21, 2017 report to address 60% design plan check comments from the City of San Diego Public Works Department and comments provided during a design team site meeting that on August 15, 2017. The main revision is reducing the biofiltration basin footprint for Site 3 (Shawn Avenue) by pulling the basin back to the centerline of the Shawn Avenue to address traffic related concerns. The associated water quality calculations and exhibits have been updated to reflect this change.

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July 21, 2017

This design report presents a revision to the May 31, 2017 report to address 60% design 2nd plan check comments from the City of San Diego Public Works Department, Transportation and Stormwater Department, Access Law Review, and the Stormwater Compliance review. The comments are paraphrased below with a response to address each comment in bold.

Design Report Comments

Registered Civil Engineer needs to sign/stamp

The report will be signed and stamped by a licensed civil engineer after the remaining comments have been cleared.

For rainfall intensity, reference and use the new Drainage Design Manual (it's the same chart and calculation).

This project has been designed to the latest Drainage Design Manual, dated January 2017, and it uses the same rainfall time-intensity as in the previous Drainage Design Manual, dated April 1984. A copy of the rainfall intensity curves are provided for reference in Appendix B.

The City of San Diego does not use the County of San Diego's Hydrology Manual. Our method of calculating pipe size or Q is not the same as the County's.

Acknowledged. The hydrology runs have been prepared using the City of San Diego hydrology criteria pursuant to the Draft Drainage Design Manual, August 2016. The AES Modified Rational Method runs have been reviewed for consistency and it was determined that the results are correct.

Hydrology Process 140 to 140 Code 1- Tc=8.6, Q=17.4, A=7.6 AC per drainage map.

The total area modeled at this node has been checked for correctness. At this hydrology process, only drainage tributary to the curb inlet on the east side of Monarch Street is included (5.1 acres). No changes are necessary to the analysis.

Hydrology Process 422 to 410 Code 6- input information is different from the drainage map

Drainage basin delineations are based on a combination of survey information provided by the City of San Diego, SanGIS 1999 2-ft topography, and SanGIS 2014 2-ft topography. The Code 6 street flow calculation at this hydrology process is based on the SanGIS 2014 2-ft topography since it seemed to be more reflect of the drainage at this location. It should be noted that the drainage exhibits in Map Pocket 1 are plotted with the SanGIS 1999 2-ft topography since that topography was better overall.

Hydrology Process 410 to 430 Code 4- Q=13.3?

This hydrology process has been checked for correctness and no changes are necessary. Drainage from only the west side of Palace Drive has been included up to this process.

Hydrology Process 520 to 520 Code 1- Tc=13.5, A=8.6 AC?

This hydrology process has been checked for correctness and no changes are necessary. Drainage from only the north side of Larrabee Avenue has been included up to this process.

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REVISION PAGE

May 31, 2017

This design report presents a revision to the March 6, 2017 report to address 60% design plan check comments from the Public Works Department. The comments are paraphrased below with a response to address each comment in bold.

Comment on Sheet 1 (G-1)

How is construction site priority determined? Explain how medium was selected as the option.

Since the total disturbed area is greater than 1 acre, a Storm Water Pollution Prevention Plan (SWPPP) will be required. This will be prepared separately by the contractor in the future. At this time, it is anticipated that the construction site priority will be "medium"; however, this will be confirmed by the contractor once the SWPPP has been prepared.

Comment on Sheet 6 (C-1)

For every pipe list Qpipe and Q50(or 100) (TYP.) per DDM 1-103.4(H)

Pursuant to a meeting with City staff on March 27, 2017, it was agreed that every pipe segment will call-out the Q_{100} and Q_{system}. A single Q_{system} will be calculated for each storm drain system based on a normal depth calculation for the most limiting segment within that particular storm drain system. This is based on the pipe diameter, pipe material, and flattest pipe slope and is found at the top of the slope for each storm drain system.

Comments on Sheet 16 (C-11)

Show curb cuts are sized to handle 50/or 100 year storm (TYP.) if GI is inline and the full storm is going through it

Curb cut locations are identified on the green infrastructure plan sheets. The curb cuts for the proposed biofiltration basin at Site 3 (Shawn Avenue) will be sized for the next submittal and will be designed to convey the 100-year design storm event, since the overflow structure (Type B inlet) is located within the proposed biofiltration basin. A placeholder for this detail has been added to the green infrastructure detail sheet at this time.

Provide dimensions for ENERGY DISSIPATOR both horizontally and vertically

Once the curb cuts have been sized during a future submittal, a detail specifying the rock size and dimensions will be provided for the energy dissipater. A placeholder for this detail has been added to the green infrastructure detail sheet at this time.

Comment on Sheet 17 (C-12)

Overall area is still taking too much parking in one area. Shift GI basins to allow some street parking. We cannot take this to the CPG and show that we are taking every street parking spot on both sides of the street

The proposed green infrastructure bulbouts located at Site 4 (Palace Drive) have been reduced to allow for two parking spots on the west side of the Palace Drive.

DESIGN REPORT
FOR
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REVISION PAGE

March 6, 2017

This design report presents a revision to the November 18, 2016 report to address 30% design plan check comments from the Public Works Department and Transportation and Storm Water Division. The comments are paraphrased below with a response to address each comment in bold.

Comments on Sheet 3 (C-1) through 9 (C-7)

The current angle between pipe 1 and 2 on Sheet 3,4,5,6,7,8,9 indicates "possible jump in or upstream of the cleanout structure" per pipe flow hydraulic analysis. The cleanout structure will act as an energy dissipater. Redesign will require aligning storm drain pipes in a straight line position along a steep slope. The energy dissipater should be placed at a well-defined low point. Use SDD-105 standard drawing instead of SDD-104.

The storm drains have been designed consistent with recommendations shown on Figures 1-103.22C and 22D in the 1984 City of San Diego Drainage Design Manual for a "Typical Profile in Easement (Steep Grades)." A cleanout is located near the bottom of the slope to transition from a steep pipe to a flat pipe in order to reduce the velocity. Furthermore, the pipes are aligned such that they are perpendicular down the steep slope towards the toe of slope, and an approximately 60 degree angle is then provided between the steep and flat pipes to reduce velocities prior to the outfall. This last cleanout and flat pipe segment will include thickened joints at the cleanout and for each pipe joint. The riprap pad for each outfall will also include additional width, length, and thickness to provide added flexibility for the pad to self-adjust over time with minimal maintenance required. We do not recommend use of an SDD-105 for applications such as these.

Comments on Sheet C-9

For the proposed biofiltration bulbout cross section detail, the slopes are not required because there will a curb.

The side slopes in the biofiltration bulbout cross-section detail have been removed and the new edge condition shows vertical cutoff walls on both the sidewalk and street sides. Refer to the revised details on the plans, and Appendix I of the report for the updated detail.

For the proposed biofiltration bulbout cross section detail, a curb is needed on the left hand side next to the existing sidewalk.

In the biofiltration bulb-out detail, a 4-inch tall curb has been added adjacent to the existing sidewalk. Refer to the revised details on the plans, and Appendix I of the report for the updated detail.

Based on the depth of the storm drain it is attached to, it looks like the open graded stone layer for the proposed biofiltration bulbout can be deeper.

Since there are no low-flow restrictors proposed on the perforated underdrain, flows will be restricted by the percolation rate of the biofiltration soil media, approximately a maximum of 5 in/hr. Therefore, increasing the thickness of the open graded stone layer will not provide higher level water quality treatment.

Is the detail for the proposed biofiltration basin really a cross-section?

The detail for the proposed biofiltration basin is associated with Site 3 at the end of Shawn Avenue and represents a cross-section through the basin. The preliminary details from the 30% design have been revised to provide additional information as part of this 60% design submittal.

Let's talk about the post construction BMP operation and maintenance procedure details. Since this is not a PDP, there are no mandatory inspections and/or maintenance times.

Agreed. However, since Green Infrastructure BMPs are similar to permanent structural BMPs, they will still require maintenance to ensure long-term performance. An OMP section is provided in Section 5.0 of the design report and an OMP table is provided on the plans.

For the proposed biofiltration bulbout cross section detail, is this is a popout and there is no parking, you do not need the 1 ft area

The 1-ft of compacted soil along the proposed curb and gutter was intended to provide structural support for the curb and gutter rather than serve as a landing for pedestrians. In the biofiltration bulbout detail, the curb and gutter concrete section has now been deepened to provide more stability, allowing the removal of the 1-ft compacted bench.

Comments on Sheet C-10

Does the SQWMP checklist go on the plans?

The Storm Water Requirements Applicability Checklist (SWRAC), DS-560, has been requested on plans for other City of San Diego submittals; therefore, it has been included on the plans.

Comments on Sheet C-11

Since the region is not conducive to infiltration indicate what type of bottom is proposed for the biofiltration bulb-outs? (Geotextile fabric/liner or biofiltration basin concrete walls)

Based on the geotechnical engineer's recommendations for the Green Infrastructure BMPs, a liner will not be required if the bottom is in formational materials and a liner will be required if the bottom is in fill materials. Once the Green Infrastructure BMPs locations are confirmed, the geotechnical engineer will perform field investigations to verify whether a liner along the bottom will be required. Vertical liners are proposed to minimize the lateral migration of stormwater into the roadway section beyond the limits of the vertical concrete walls. If the bottom is in the formational materials, incidental infiltration is encouraged based on guidance provided in the 2016 Storm Water Standards Manual pursuant to 2013 MS4 permit requirements.

Comments on Sheets C-14

This is taking away too much parking in one area.

The updated biofiltration bulbout cross-section now contains no side slopes, thereby provided additional volume storage in a smaller footprint. As a result, the footprint for BMP 5-2 has been reduced to what would typically be required for a structural BMP subject to Priority Development Project (PDP) requirements (i.e., minimum of 0.75*DCV). Refer to updated biofiltration bulbout footprints in the plans and updated calculations in Appendix I of the design report.

Comments on Sheets 16 (C-14) and 17 (C-15)

Proposed bulb-outs will remove parking spaces in front of these properties. Is there a possibility of spreading out the bulb-out locations?

Based on the updated biofiltration bulbout cross-section, additional storage volume is provided within a smaller footprint; however, the provided volumes are still a fraction of what would typically be required for a Priority Development Project (PDP). It is potentially feasible to spread out the bulb-out locations to provide more parking, but this would require additional storm drain and would likely increase costs.

Comments on Design Report

Section 4.2 - Edit text to read "proposed Green Infrastructure BMPs are sited in locations which are feasible, practical, and with consideration of costs with the approval of the stormwater division."

This text has been added to the Green Infrastructure BMP Results section.

For the proposed biofiltration bulbout cross section detail, a curb is needed on the left hand side next to the existing sidewalk and the slopes are not required because there will a curb.

A curb has been added along the existing sidewalk and the side slopes have been removed in the biofiltration bulbout detail. Refer to Appendix I for the updated detail.

1.0 INTRODUCTION

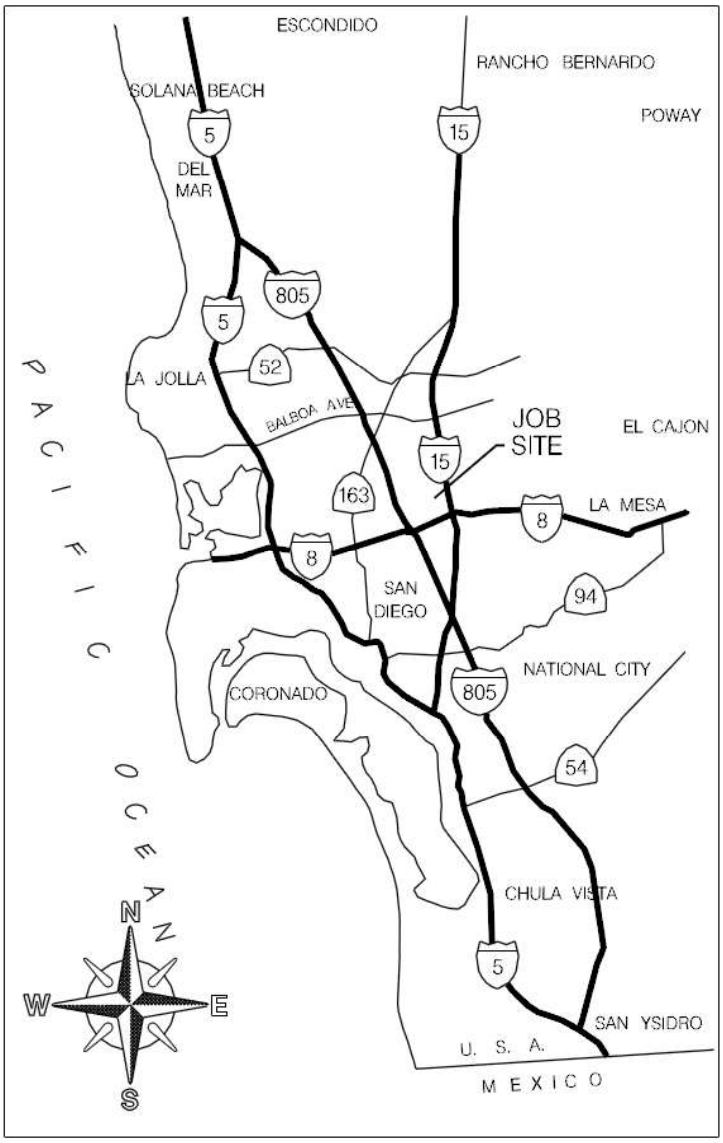
1.1 Project Description

This design report summarizes hydrologic and hydraulic analysis and storm water quality treatment (green infrastructure) for the proposed Serra Mesa Storm Drain and Green Infrastructure Project (herein referred to as the "project"). The project is located within the Serra Mesa community in the City of San Diego and includes seven (7) storm drain outfalls. The storm drains are located on or near the following streets: Monarch Street, Shawn Avenue, Palace Drive, Larrabee Avenue, Walker Drive, and Mobley Street. See Figure 1, Vicinity Map, located at the end of Section 1.0. The project includes the replacement of seven (7) existing storm drain outfalls in a developed single-family residential community and proposes to voluntarily incorporate Green Infrastructure at the top of the ridge for three (3) of the storm drain outfalls.

The project is not categorized as a "Priority Development Project" according to Chapter 1.4 of the City of San Diego Storm Water Standards (SWS) (October 2018). Its purpose is to replace the storm drain system and voluntarily implement green infrastructure. There are no proposed impervious surfaces and it only includes the removal and replacement of impervious area associated with the trenching and resurfacing necessary to install the replacement storm drain and sub-drains. Therefore, the project is considered a Standard Development Project (SDP) and thus a Standard Development Project Storm Water Quality Management Plan (SDP SWQMP) is required. Refer to the Storm Water Requirements Applicability Checklist in Appendix G.

The City is voluntarily incorporating Green Infrastructure at three (3) storm drain outfalls located along Shawn Avenue, Palace Drive, and Larrabee Avenue. The proposed water quality treatment BMPs will be sited and sized where practical as directed by City staff. The water quality BMPs will be a proprietary compact biofiltration unit or a basin that will have a bioretention soil media layer, gravel layer, underdrain and an outlet sized for overflow (i.e. – for runoff greater than the water quality volume provided within the basin, up to and including a 100-year storm event). Since the project is located within an older community developed prior to storm water regulations, it is anticipated that there is currently no storm water treatment for these drainage areas; thus, the proposed project will significantly improve water quality for the downstream channels and water bodies. The project will reference the guidelines set forth in the City of San Diego's "Storm Water Standards," dated October 2018 (herein "Storm Water Standards") and the "City of San Diego Low Impact Development (LID) Design Manual," dated July 2011.

Figure 1: Vicinity Map



VICINITY MAP
NOT TO SCALE

2.0 HYDROLOGY

The hydrologic condition for the drainage areas tributary to each of the seven (7) storm drain outfalls has been analyzed for the post-project condition. The pre-project condition hydrology is anticipated to be the same since only small impervious areas will be removed and replaced with green infrastructure; therefore the overall imperviousness remains similar.

2.1 Methodology

The 100-year, 6-hour post-project condition flow rates have been computed using the Modified Rational Method. The hydrologic methodology utilized for the project has been taken from the City of San Diego Draft Drainage Design Manual, dated August 2016. The Rational Method computer program developed by Advanced Engineering Software (AES 2003) was used for this study because it satisfies the City of San Diego's design criteria.

2.2 AES Rational Method Computer Model

The AES hydrologic model is developed by creating independent node-link models of each interior drainage basin and linking these sub-models together at confluence points. The AES program has the capability to perform calculations for 15 hydrologic processes. These processes are assigned code numbers that appear in the results. The code numbers and their significance are as follows:

Subarea Hydrologic Processes (Codes)

Code 1: Confluence analysis at node
Code 2: Initial subarea analysis
Code 3: Pipe flow travel time (computer-estimate pipe sizes)
Code 4: Pipe flow travel time (user-specified pipe size)
Code 5: Trapezoidal channel travel time
Code 6: Street flow analysis through a subarea

Code 7: User-specified information at a node

Code 8: Addition of the subarea runoff to mainline

Code 9: V-Gutter flow through subarea

Code 10: Copy mainstream data onto memory bank

Code 11: Confluence a memory bank with the mainstream memory

Code 12: Clear a memory bank

Code 13: Clear the mainstream memory

Code 14: Copy a memory bank onto the mainstream memory

Code 15: Hydrologic data bank storage functions

In order to perform the hydrologic analysis; base information for the study area is required. This information includes the existing drainage facility locations and sizes, existing land uses, flow patterns, drainage basin boundaries, and topographic elevations. Drainage basin boundaries, flow patterns, and topographic elevations are shown on the drainage exhibits located in the map pockets.

2.3 Design Criteria

The hydrologic conditions were analyzed in accordance with the City of San Diego's design criteria as follows:

Design Storm: 100-year, 6-hour

Runoff Coefficients:

Medium Density Residential (7.3 DU/AC. or less)	C = 0.57
High Density Residential (24 DU/AC. or less)	C = 0.71
Commercial (Neighborhood)	C = 0.79
Asphalt/Concrete	C = 0.95

Rainfall Intensity: Based on time-intensity criteria per City of San Diego Drainage Design Manual, dated April 1984, as directed by the City staff.

2.4 Results

For the purposes of hydrologic analyses for this project, the pre-project and post-project conditions were analyzed through one set of analyses since the removal of impervious surfaces for the proposed green infrastructure will have an insignificant impact on the hydrology of each drainage area. The Modified Rational Method results for each of the seven (7) storm drain outfalls analyzed can be found in Appendix A and the supporting weighted runoff coefficients can be found in Appendix B. Refer to the drainage study exhibit for post-project conditions in Map Pocket 1 for the location of the drainage node numbers.

A summary of the hydrologic results is provided below in Table 1.

Table 1: Summary of Hydrologic Results

		100-year Storm Event	
Drainage Node ID	**Tributary Area (ac.)**	**Time of Concentration (min.)**	**Peak Flow Rate, Q_{100} (cfs)**
195	7.6	8.8	17.4
295	5.2	13.0	11.1
395	12.1	15.8	25.2
495	5.7	10.4	13.3
595	8.6	13.8	16.9
695	6.4	11.1	14.1
795	28.5	31.7	38.9

3.0 HYDRAULICS

3.1 Hydraulic Methodology and Criteria

The 100-year post-project peak flow rates determined using the Modified Rational Method were used for inlet sizing, dry lane calculations, storm drain sizing, and energy dissipater design. The AES Pipe Flow Hydraulics computer program was used to analyze hydraulic losses that occur within the proposed storm drain system to determine the hydraulic grade lines (HGLs) within the mainline systems.

3.2 Inlet Sizing

Inlet design calculations were completed using a computer program based on the following equation for inlets on a grade and inlets in sump:

Type B Inlets on Grade

$$Q = 0.7\ L\ (a + y)^{3/2}$$

Where: y = depth of flow approaching the curb inlet, in feet (ft)
a = depth of depression of curb at inlet, in feet (ft)
L = length of clear opening of inlet for total interception, in feet (ft)
Q = interception capacity of the curb inlet, in cubic feet per second (cfs)

Type B Inlets in a Sump

$$Q/L = 1.5\ cfs/ft$$

Where: Q = inlet capacity, in cubic feet per second (cfs)
L = length of clear opening of inlet for total interception, in feet (ft)

Inlet Results

Per the request of the City of San Diego, existing curb inlets that have insufficient capacity to convey the 100-year peak flow rate will be replaced and will be upsized to provide full capture, where feasible. The inlet design calculations along with back-up information are provided in Appendix C. Inlets were sized for the 100-year storm event for the governing (maximum) condition. Inlets are located throughout the development to provide enough inlets to maintain the depth of flow in the street for the 100-year storm according to the following criteria:

a) a minimum of 0.1 foot below the top of curb, or
b) at a depth equal to or less than the depth that results in the City of San Diego "Dry Lane" requirements being met.

Each inlet was sized to provide 100% capture of the flow draining to the inlet (no bypass flow at any inlet, where feasible. For Storm Drain 7, located at Mobley Street, the curb inlets are on-grade during existing conditions and do not currently intercept the full peak flows. In the post-project condition, the replaced curb inlets on the northeast side of the street will be maximized to a 21-ft Type 'B-1' inlet (Drainage Node 720 Downstream) and an additional 21-ft Type 'B-1' inlet (Drainage Node 720 Upstream) along Keir Street to provide additional capture and improve drainage along both Keir Street and Mobley Street. Although both inlets will be maximized based on a standard Type 'B' inlet, a small amount of flow will bypass and continue downstream along Mobley Street to the next inlet (a sump inlet) which will collect the bypassed flows into a storm drain that discharges downstream along the same canyon; therefore, there are no adverse impacts. Refer to the drainage study map provided in Map Pocket 1 for the location of each node.

At Site 3 (Shawn Avenue), the trench drain and the curb inlet of the proprietary compact biofiltration unit were sized to collect the water quality flow rate and high flows are designed to bypass and be collected by the adjacent sump inlet downstream. Inlet calculations are provided in Appendix C.

3.3 Dry Lane Calculations

Per the request of the City of San Diego, a "dry lane" will be provided for all public streets throughout the project site. The "dry lane" is defined as the width of street that remains dry during the design storm. In other words, the combined width of roadway that does not fall within the computed spread width from either side of the street regardless of travel direction if no median is provided, or width of dry lane in each direction if a median is provided (as in this case for all the streets). A dry lane of 12-feet or greater is desirable during the 100-year peak storm event, however, a minimum dry lane width of 9-feet must be provided in all instances. In order to determine if an appropriate dry lane is provided, an allowable street gutter depth is calculated for each of the typical street widths proposed throughout the project site. Refer to Appendix D of this report for a visual graphic of how each allowable gutter depth was determined.

Dry Lane Results

The allowable street gutter depth calculations are provided in Appendix D. The actual street gutter depth calculations are included as part of the inlet design calculations that are included in Appendix C. The actual street gutter depth is equal to or less than the allowable street gutter depth for each public roadway located within the proposed project. It should be noted that smaller half-widths due to the water quality BMP bulb-outs have been considered in the inlet sizing and verification of sufficient dry lane for Palace Drive and Larrabee Avenue.

3.4 Storm Drain Design

The mainline storm drains conveying the 100-year storm event were analyzed using AES Pipe Flow based on 100-year peak flow rates estimated by the Modified Rational Method.

AES Pipe Flow

The AES Pipe Flow Hydraulics computer program was used to calculate the hydraulic and energy grade lines for the proposed storm drain systems. The program performs gradually varied flow and pressure flow profile computations. The results are provided in an incremental and summarized form, and indicate reaches of open channel and pressure flow within a given reach of pipe. The program also accounts for losses that may occur due to friction, junction structures, pipe bends, etc. The codes and an explanation of their function are as follows:

Pipe Flow Hydraulic Processes (Codes)

Code 1:	Friction Losses
Code 2:	Manhole Losses
Code 3:	Pipe-bend Losses
Code 4:	Sudden Pipe-enlargement
Code 5:	Junction Losses
Code 6:	Angle-point Losses
Code 7:	Sudden Pipe-reduction
Code 8:	Catch Basin Entrance Losses
Code 9:	Transition Losses

The storm drain system will be constructed of Reinforced Concrete (RCP) or equivalent. The Manning's roughness coefficient “n” used for the hydraulic calculations for RCP is 0.013.

Pipe Flow Results

The AES Pipe Flow computer outputs for the post-project condition are provided in Appendix E of this report. Node numbering used in the AES Pipe Flow computer analyses corresponds to the rational method node numbering used on the drainage study map, located in Map Pocket 1.

3.5 Energy Dissipater Design

Energy dissipaters (i.e. riprap) at the storm drain outfalls will be specified using the 2016 City of San Diego – Standard Drawing Supplemental to Regional Standard Drawing ("D" Series) drawing number SDD-104, which provides rock classifications for design velocities entering riprap outfalls.

The design velocity was determined from both the AES Pipe Flow hydraulic analyses for flow in the final reach of storm drain pipe leading to the outfall and HEC-RAS hydraulic analyses for flow across the riprap pad immediately downstream of the outfall. The AES Pipe Flow hydraulic analyses were used to determine the velocities of flow exiting the pipes at the outfall locations and the HEC-RAS hydraulic analyses were used to determine the velocity of flow across the riprap pad and exiting the downstream end of the riprap pad.

HEC-RAS cross sections were taken at 1-foot intervals across the riprap pad in order to determine the location of the hydraulic jump that is expected to occur on the riprap pad. The flow regime after the hydraulic jump is subcritical flow at normal depth, and the flow velocity after the hydraulic jump is expected to be less than 6 feet per second. The riprap pad length was then specified based on the location of the hydraulic jump, in order to provide 5 feet (or twice the pipe diameter, whichever is greater) of length beyond the hydraulic jump. The riprap pad width is based on 2016 City of San Diego Regional Standard Drawing Riprap Energy Dissipation, drawing number SDD-104.

Energy Dissipater Results

The system includes cutoff walls down the slope, watertight joints, a cleanout near the toe of slope with an approximate 60-degree angle, and a last pipe reach at a flat slope (i.e. approximately 0.5% to 1.0%) to further reduce velocities prior to the riprap pad at the outfall. The riprap pad for each outfall will also include additional length and thickness to provide added flexibility for the pad to self-adjust over time with minimal maintenance required. For example, the length will be significantly longer than 4 times diameter of pipe (standard length per SDRSD D-104) as it will be extended 5 to 7 feet beyond the hydraulic jump. In certain locations where the downstream channel is steep, the typical thickness will be doubled for the last 5 feet of the riprap pad. The dimensions and size of riprap specified meet or exceed the requirements indicated on SDD-104. Refer to the calculations prepared in Appendix F.

4.0 GREEN INFRASTRUCTURE

This project is subject to the Municipal Permit (Order No. R9-2013-0001 as amended by Order Nos. R9-2015-0001 and R9-2015-0010) as adopted by the San Diego Regional Water Quality Control Board (SDRWQCB) (herein referred to as "2013 MS4 Permit"). The requirements of the 2013 MS4 Permit went into effect on February 16, 2016 in the San Diego Region. Requirements for permanent BMPs are determined based on criteria set forth in the City of San Diego's Storm Water Requirements Applicability Checklist. Projects are identified by three categories:

- Priority Development Project
- Standard Development Project
- Exempted Project

The project is categorized as a "Standard Development Project" according to Chapter 1.4 of the City of San Diego Storm Water Standards Manual (October 2018). Refer to the Storm Water Requirements Applicability Checklist in Appendix G.

It should be noted that the City identified three (3) storm drain outfalls to propose Green Infrastructure along Shawn Avenue, Palace Drive, and Larrabee Avenue (e.g., Storm Drains 3, 4, and 5, respectively).

Additional information is provided below to summarize the receiving water impairments and TMDLs, and the project's most significant pollutants of concern. Based on SWS Chapter 2.2.2.6, the project's *most significant pollutant of* concern is based on the highest priority water quality condition identified in the watershed WQIP and pollutants expected to be presented onsite/from land use.

Land Uses within Tributary Areas (existing development)

- Detached Residential Development
- Attached Residential Development
- Streets, Highways, & Freeways

Anticipated and Potential Pollutants by Land Use Type (SWS Table B.6-1)

- Anticipated Pollutants: sediment, nutrients, heavy metals, organic compounds, trash & debris, oxygen demanding substances, oil & grease, bacteria & viruses, and pesticides
- Potential Pollutants: none in addition to the anticipated pollutants

Receiving Waters

- San Diego River (Lower)

Pollutant	Expected TMDL Completion Date
Enterococcus	2021
Fecal Coliform	2009
Low Dissolved Oxygen	2019
Manganese	2021
Nitrogen	2021
Phosphorus	2019
Total Dissolved Solids	2019
Toxicity	2021

San Diego River Water Quality Improvement Plan (WQIP) (September 2015) Highest Priority Water Quality Condition (HPWQC)

- Bacteria in the Lower San Diego River Watershed

Therefore, the project's *most significant pollutant of concern* is bacteria.

4.1 Standard Development Project Requirements

The 2013 MS4 Permit establishes performance standards for the various types of development projects. For this Standard Development Project, the project is neither subject to the storm water pollutant control BMP requirements nor the hydromodification management BMP requirements; however, it is subject to three (3) other performance standards which include: General Requirements, Source Control requirements, and Site Design requirements, as discussed below.

4.1.1 General Requirements

Excerpts from the Storm Water Standards Manual (October 2018) are duplicated below from Chapter 2.1.1.1.

All projects must meet the following general requirements:

a) *Onsite BMPs must be located so as to remove pollutants from runoff prior to its discharge to any receiving waters, and as close to the source as possible;*
b) *Structural BMPs must not be constructed within waters of the United States (U.S.); and*
c) *Onsite BMPs must be designed and implemented with measures to avoid the creation of nuisance or pollution associated with vectors (e.g. mosquitos, rodents, or flies).*

The proposed Green Infrastructure BMPs (biofiltration basins) are located at the top of the ridgeline upstream of the proposed curb inlets to provide treatment close to the source prior to discharging into the receiving waters which means they will remain outside of the waters of the United States. The Green Infrastructure BMPs will be designed to drawdown in less than 96 hours to minimize vector concerns.

4.1.2 Source Control BMPs

Excerpts from the Storm Water Standards Manual (October 2018) are duplicated below from Chapter 2.1.1.2.

Pollutant source control BMPs are features that must be implemented to address specific sources of pollutants.

The following source control BMPs must be implemented at all development projects where applicable and technically feasible:

a) *Prevention of illicit discharges into the MS4;*
b) *Storm drain system stenciling or signage;*
c) *Protection of outdoor material storage areas from rainfall, run-on, runoff, and wind dispersal;*
d) *Protection of materials stored in outdoor work areas from rainfall, run-on, runoff, and wind dispersal;*
e) *Protection of trash storage areas from rainfall, run-on, runoff, and wind dispersal; and*
f) *Use of any additional BMPs determined to be necessary by the City to minimize pollutant generation at each project.*

Further guidance is provided in Section 2.1.2 and Chapter 4.

Given the scope of this project, most of the source control BMP requirements are not applicable to this project; however, storm drain stenciling and signage is proposed for this project.

4.1.3 Site Design BMPs

Excerpts from the Storm Water Standards Manual (October 2018) are duplicated below from Chapter 2.1.1.3.

Site design requirements are qualitative requirements that apply to the layout and design of ALL development project sites (Standard Projects and PDPs).

Site design performance standards define minimum requirements for how a site must incorporate LID BMPs, including the location of BMPs and the use of integrated site design practices. The following site design practices must be implemented at all development projects, where applicable and technically feasible:

a) *Maintenance or restoration of natural storage reservoirs and drainage corridors (including topographic depressions, areas of permeable soils, natural swales, and ephemeral and intermittent streams);*
b) *Buffer zones for natural water bodies (where buffer zones are technically infeasible, require project applicant to include other buffers such as trees, access restrictions, etc.);*
c) *Conservation of natural areas within the project footprint including existing trees, other vegetation, and soils;*
d) *Construction of streets, sidewalks, or parking lot aisles to the minimum widths necessary, provided public safety is not compromised;*
e) *Minimization of the impervious footprint of the project;*
f) *Minimization of soil compaction to landscaped areas;*
g) *Disconnection of impervious surfaces through distributed pervious areas;*
h) *Landscaped or other pervious areas designed and constructed to effectively receive and infiltrate, retain and/or treat runoff from impervious areas, prior to discharging to the MS4;*
i) *Small collection strategies located at, or as close as possible to, the source (i.e. the point where storm water initially meets the ground) to minimize the transport of runoff and pollutants to the MS4 and receiving waters;*
j) *Use of permeable materials for projects with low traffic areas and appropriate soil conditions;*
k) *Landscaping with native or drought tolerant species; and*
l) *Harvesting and using precipitation.*

A key aspect of this performance standard is that these design features must be used where applicable and feasible. Responsible implementation of this performance standard depends on

evaluating applicability and feasibility. Further guidance is provided in Section 2.1.2 and Chapter 4.

Given the scope of this project, most of the site design BMP requirements are not applicable to this project. The project will maintain the natural drainage pathways and hydrologic features by pulling the proposed rip rap pads outside of the channel (where feasible), reducing the amount of impervious surfaces by voluntarily proposing Green Infrastructure BMPs, increasing impervious area dispersion through the use of curb cuts directing impervious surfaces into the Green Infrastructure BMPs, and implementing native or drought tolerant species where landscaping is proposed (if necessary).

4.2 Green Infrastructure BMP Design

As previously mentioned, this project is classified as a Standard Development Project and is therefore not required to meet either pollutant control or hydromodification management flow control requirements; however, this project is voluntarily implementing volume-based Green Infrastructure BMPs to significantly improve water quality tributary to the receiving waters. Currently, there are no numeric sizing standards for projects which elect to implement Green Infrastructure BMPs, but a 0.5-inch storm event has been used as a general "rule-of-thumb." In comparison, pollutant control sizing requirements for PDPs require designing to the project-specific 85th percentile design storm event.

The rational method equation was used to determine the Design Capture Volume (DCV):

- Rational method equation: V = RF * P *A
- 'V' is the treatment volume in acre-feet (ac-ft),
- 'RF' is the weighted runoff factor for the drainage area,
- 'P' is the 85th percentile precipitation in inches (in) [85th percentile storm event per volume-based numeric sizing criteria], and
- 'A' is the drainage area is acres (ac).

The 85th percentile storm event precipitation for the project is 0.58-inches, according to the City of San Diego Storm Water Standards Manual (October 2018), 85th Percentile Isopluvials Exhibit (Figure B.1-1).

Green Infrastructure BMP Results

Incorporating Green Infrastructure in an existing development poses inherent challenges, thus the proposed Green Infrastructure BMPs are sited in locations which are feasible, practical, and with consideration of costs within the approval of Storm Water Division (i.e., between existing residential driveways, at sump locations directly adjacent to curb inlets, minimizing conflicts with existing utilities, and avoiding bigger impacts to street parking).

Based on the project geotechnical engineer's initial assessment of infiltration feasibility (prior to conducting subsurface explorations), it is anticipated that the geologic formations in the region combined with the potential for filled areas within the region are not conducive to infiltration; therefore, it is anticipated that the Green Infrastructure will be selected based off the no infiltration condition and will be fully lined. Refer to email from the geotechnical engineer provided in Appendix J.

According to the project's most significant pollutants of concern previously identified above, Biofiltration BMPs are the most appropriate water quality treatment BMP type for this project because it provides a high level of treatment for bacteria.

Pursuant to discussions with the City, it was determined that proposed Green Infrastructure BMPs would be sited adjacent to the developed areas at the top of the slopes rather than the bottom of the slope; therefore, the most practical and cost efficient location for Green Infrastructure was at the sump locations.

For Storm Drain 3 (Shawn Avenue), the drainage is conveyed into a single sump location at the northeast end of Shawn Avenue. The largest, standard proprietary compact biofiltration unit was placed at the end of the street adjacent to the proposed inlet. Low flows will be collected on the north side of Shawn Avenue by a trench drain sized to capture water quality flows, and on the south side it will be collected by the curb opening of the proprietary compact biofiltration unit. High flows will bypass the trench train and the curb opening to be collected by the proposed inlet.

For Storm Drains 4 and 5 (Palace Drive and Larrabee Avenue, respectively), the sump locations are in the middle the single-family residential homes, therefore, Green Infrastructure would need to be incorporated into the parkway within the public right-of-way. Based on the survey information provided by the City, the approximate existing parkway width is 10-feet. It would be impractical to implement linear biofiltration within the existing parkway due to the high construction costs and minimal storage volume; therefore, it was determined that biofiltration bulb-outs would be a more practical solution. The proposed biofiltration bulb-outs would extend out into the street approximately 8-feet, or the width of a parked car, and be similar aesthetically to bulb-outs used for traffic calming. In order to treat the full 85th percentile storm event, biofiltration bulb-outs would be required for nearly the full length of the roadway on both sides of each street which could be a very costly approach; therefore, a reduced design was discussed with the City for concurrence. The biofiltration bulb-outs will have a bioretention soil media layer, gravel layer, underdrain and a curb cut at the downstream end sized for overflow (i.e. – for runoff greater than the water quality volume provided within the basin, up to and including a 100-year storm event).

Water quality calculations for the 85th percentile storm event and 0.5-inch storm event have been calculated along with the provided volumes. The provided volumes within the proposed Green Infrastructure BMPs are presented as a fraction of the full 85th-percentile storm event requirement and results are variable between approximately 3% to 100% depending on site constraints. Although the provided treatment is a fraction of what would be required if this project is subject to the full pollutant control volume requirements, the addition of Green Infrastructure would significantly improve the water quality for the drainage from these communities since no water quality treatment is currently present. Refer to the water quality calculations and biofiltration BMP details in Appendix I. The locations of the proposed proprietary compact biofiltration unit and bulb-outs is provided on the Green Infrastructure Exhibits in Map Pocket 2.

5.0 OPERATION AND MAINTENANCE PLAN (OMP)

5.1 Maintenance Responsibility

The City of San Diego Transportation and Storm Water Department will be the responsible party for operation and maintenance of the Green Infrastructure BMPs.

5.2 Inspection and Maintenance Activities

The landscaped areas for the project require permanent maintenance. The discussions below provide inspection criteria, maintenance indicators, and maintenance activities for the project BMPs that require permanent maintenance.

Landscaped Areas

The inspection and maintenance activities described herein are for landscaped areas provided for the project.

During inspection, the inspector shall check for the maintenance indicators given below:

- Erosion in the form of rills or gullies
- Ponding water
- Bare areas or less than 70% vegetation cover
- Animal burrows, holes, or mounds
- Trash
- Sediment or debris accumulation

Routine maintenance of vegetated areas shall include mowing and trimming vegetation, and removal and proper disposal of trash.

If erosion, ponding water, bare areas, poor vegetation establishment, or disturbance by animals are identified during the inspection, additional (non-routine) maintenance will be required to correct the problem.

As applicable, Integrated Pest Management (IPM) procedures must be incorporated in any corrective measures that are implemented in response to damage by pests. This may include using physical barriers to keep pests out of landscaping; physical pest elimination techniques, such as, weeding, squashing, trapping, washing, or pruning out pests; relying on natural enemies to eat pests; or proper use of pesticides as a last line of defense. More information can be obtained at the UC Davis website (http://www.ipm.ucdavis.edu/WATER/U/index.html).

Outlet Protection

Routine maintenance of outlet protection shall include removing trash, debris, and leaves. This would specifically include areas of riprap and/or landscape cobble rock for locations of concentrated flows entering landscape or bioretention areas. If soil erosion is found, reposition or increase limits of riprap or landscape rock to fully cover eroded area.

Concrete Stamping

Inspection/maintenance of the concrete stamping shall be performed. During inspection, the inspector(s) shall check for the maintenance indicators given below:

- Faded, vandalized, or otherwise unreadable concrete stamping.

There are no routine maintenance activities for the concrete stamping. If inspection indicates the concrete stamping is intact, no action is required. If inspection indicates the concrete stamping is not legible, the concrete stamping shall be repaired or replaced as applicable.

5.2.1 Inspection and Maintenance Activities for the Green Infrastructure BMP

Biofiltration Basin

During inspection, the inspector shall check for the maintenance indicators given below:

- Accumulation of sediment, litter and/or debris at the inlets/outlets
- Standing water in the storage and draining layer indicating clogging in the underdrains
- Dislodged energy dissipaters or erosion
- Overgrown vegetation

Routine maintenance of the Biofiltration Basins shall include removal and proper disposal of accumulated materials (e.g., sediment, litter), trimming vegetation, and replenishing mulch every one (1) to two (2) years. After installation inspection should occur once a month for 4-6 months. After this time period inspection should occur annually, particularly after there has been heavy rain or storms.

If inspection indicates that the underdrains for the Biofiltration Basins are clogged, the additional non-routine maintenance will be required to backwash and clear the underdrains.

Modular Wetland System

The maintenance procedure for servicing Modular Wetland System typically includes contracting the maintenance cleaning/waste removal through a provider of those services. Manufacturer/Supplier often offers maintenance services for their own facilities; however, maintenance services can also be provided by Supplier approved contractor.

The treatment contains four treatment stages, each with its own maintenance procedure. This "treatment train" concept minimizes maintenance cost because each treatment stage protects the next stage from clogging. The system can be cleaned by hand or with a use of vacuum truck.

The maintenance procedure for each stage is as follows:

1. Stage 1 – Screening

   Trash and debris that are captured in a screening filter just below the grate or curb opening can be serviced by simply removing the grate or manhole, and vacuuming the debris. To service the next stage, the screen filter should be removed.

   Sediments and TSS that have been captured in the separation chamber in the bottom of the catch basin can be simply removed by using vacuum truck.

2. Stage 3 – Primary Media Filtration

   The fine TSS, associated pollutants, hydrocarbons, dissolved metals, and a portion of the nutrients and bacteria captured by the perimeter filter containing BioMediaGREEN, can be maintained by simply removal of the spent media blocks and replacing them with new media.

3. Stage 4 – Wetland/Biofiltration Filter

   Nutrients, metals, and bacteria that are captured in the wetland/biofiltration filter (the portion of the media that is vegetated) can go 5 to 20 years before requiring media replacement. The plants shall be trimmed annually. The previous three stages shall be serviced on an annual basis.

5.3 Inspection and Maintenance Frequency

The table below lists the BMPs to be inspected and maintained and the minimum frequency of inspection and maintenance activities.

Table 2: Summary Table of Inspection and Maintenance Frequency

BMP	Inspection Frequency	Maintenance Frequency
Landscaped Areas	Monthly	Routine mowing and trimming and trash removal: monthly Non-routine maintenance as-needed based on maintenance indicators in Section 4.2.1
Outlet Protection	Monthly	Routine maintenance to remove trash, debris, and leaves. Repair any damage to roof drains. Immediately reposition all displaced energy dissipaters. If soil erosion is found, reposition or increase limits of energy dissipater to fully cover eroded area. Non-routine maintenance as-needed
Concrete Stamping (or equivalent)	Annual	As-needed based on maintenance indicators in Section 5.2
Biofiltration Basin (Green Infrastructure)	Annual, and after major storm events	Routine maintenance to remove accumulated materials at the inlets and outlets: annually, on or before September 30th. As-needed maintenance based on maintenance indicators in Section 5.2.1
Proprietary Compact Biofiltration Unit	Twice a year And after major storm events	1. As determined by inspection; and 2. The screening filter, separation chamber and the perimeter filter (BioMediaGREEN) shall be maintained annually.

The frequencies given in the Summary Table of Inspection and Maintenance Frequency are minimum recommended frequencies for inspection and maintenance activities for the project. Typically, the frequency of maintenance required for permanent BMPs is site and drainage area specific. If it is determined during the regularly scheduled inspection and/or routine maintenance that a BMP requires more frequent maintenance (e.g., to remove accumulated trash) it may be necessary to increase the frequency of inspection and/or routine maintenance.

6.0 CONCLUSION

This design report summarizes the design approach and criteria utilized to address drainage and Green Infrastructure components of this storm drain replacement project.

Since this is a storm drain replacement and green infrastructure project, the pre-project and post-project condition hydrology is the approximately the same since the removed of impervious surfaces for the proposed Green Infrastructure is relative small and will not impact the overall hydrology for each of the seven (7) storm drain outfalls. As a result, since there is no increase in peak flow rate, there are no adverse impacts to the downstream natural channel.

The proposed storm drain alignments down the steep slopes were designed with consideration of the high velocities coming out of the storm drain at the outfall and the potential for scour and erosion. To stabilize the proposed pipe and reduce the pipe exit velocities, the system includes cutoff walls down the slope, watertight joints, a cleanout near the toe of slope with an approximate 60-degree angle, and a last pipe reach at a flat slope (i.e. approximately 0.5% to 1.0%) to further reduce velocities prior to the riprap pad at the outfall. The dimensions and size of riprap specified meet or exceed the requirements indicated on SDD-104.

The project is not categorized as a "Priority Development Project" according to Chapter 1.4 of the City of San Diego Storm Water Standards Manual Part I (October 2018). Its purpose is to replace the storm drain system and voluntarily implement green infrastructure. There are no proposed impervious surfaces and only includes the removal and replacement of impervious area associated with the trenching and resurfacing necessary to install the replacement storm drain and sub-drains. Therefore, the project is considered a Standard Development Project (SDP) and thus a Standard Development Project Storm Water Quality Management Plan (SDP SWQMP) is required.

The Green Infrastructure BMPs proposed for the project include a proprietary compact biofiltration unit and biofiltration bulb-outs which extend into the street approximately 8-feet located at the sumps. These biofiltration bulb-outs are not subject to the full pollutant control BMP volume requirements; however, they have been sized in a reasonable manner with consideration for the costs with the approval of the stormwater division. Provided water quality volume calculations have been prepared and are shown as a fraction of the full pollutant control BMP required Design Capture Volume. The provided volumes are variable between each drainage area depending on the site constraints; however, the proposed BMPs will provide a significant improvement to water quality for drainage areas tributary to these three (3) storm drain outfalls.

The following BMPs for the project require permanent maintenance: landscaped areas, outlet protection, concrete stamping, and the biofiltration basins. The operation and maintenance information provided in Section 5.0 of this report provides inspection criteria, maintenance indicators, and maintenance activities for the above-listed BMPs that require permanent maintenance.

APPENDIX A

Modified Rational Method Analyses (100-year, 6-hour)
[Post-project Condition]

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          RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
          Reference: SAN DIEGO COUNTY FLOOD CONTROL DISTRICT
                       2003,1985,1981 HYDROLOGY MANUAL
        (c) Copyright 1982-2003 Advanced Engineering Software (aes)
            Ver. 1.5A Release Date: 01/01/2003  License ID 1261

                          Analysis prepared by:

                        RICK ENGINEERING COMPANY
                            5620 Friars Road
                         San Diego, California 92110
                      619-291-0707   Fax 619-291-4165

 ************************** DESCRIPTION OF STUDY **************************
* SERRA MESA STORM DRAIN AND GREEN INFRASTRUCTURE IMPROVEMENTS             *
* J-17588-G, 100-YEAR POST-PROJECT CONDITION                               *
* BASIN 100; STORM DRAIN #1                                                *
 **************************************************************************

  FILE NAME: SM_1HP00.RAT
  TIME/DATE OF STUDY: 09:33 11/04/2016
--------------------------------------------------------------------------
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
--------------------------------------------------------------------------
  USER SPECIFIED STORM EVENT(YEAR) = 100.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =  18.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.90
  RAINFALL-INTENSITY ADJUSTMENT FACTOR = 1.000
  *USER SPECIFIED:
  NUMBER OF [TIME,INTENSITY] DATA PAIRS =  9
   1)   5.000;  4.400
   2)  10.000;  3.450
   3)  15.000;  2.900
   4)  20.000;  2.500
   5)  25.000;  2.200
   6)  30.000;  2.000
   7)  40.000;  1.700
   8)  50.000;  1.500
   9)  60.000;  1.300
  SAN DIEGO HYDROLOGY MANUAL "C"-VALUES USED FOR RATIONAL METHOD
  NOTE: ONLY PEAK CONFLUENCE VALUES CONSIDERED
  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  =================  ======  ===== ====== ===== =======
  1   18.0     13.0    0.020/0.020/0.020   0.50    1.50 0.0100 0.125 0.0180
  2   35.0     30.0    0.020/0.020/0.020   0.50    1.50 0.0100 0.125 0.0180

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth = -0.10 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*

**************************************************************************
  FLOW PROCESS FROM NODE    100.00 TO NODE    102.00 IS CODE =  21
--------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
==========================================================================
```

```
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .7600
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    65.00
  UPSTREAM ELEVATION(FEET) =    367.90
  DOWNSTREAM ELEVATION(FEET) =    367.20
  ELEVATION DIFFERENCE(FEET) =      0.70
  URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    4.814
  TIME OF CONCENTRATION ASSUMED AS 6-MIN.
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.210
  SUBAREA RUNOFF(CFS) =      0.64
  TOTAL AREA(ACRES) =      0.20   TOTAL RUNOFF(CFS) =      0.64

****************************************************************************
  FLOW PROCESS FROM NODE    102.00 TO NODE    110.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  1 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  367.20  DOWNSTREAM ELEVATION(FEET) =  256.00
  STREET LENGTH(FEET) =   740.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 18.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  13.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  2
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0180
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       2.47
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.19
    HALFSTREET FLOOD WIDTH(FEET) =    4.10
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    4.85
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.91
  STREET FLOW TRAVEL TIME(MIN.) =   2.54   Tc(MIN.) =   8.54
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.727
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  SUBAREA AREA(ACRES) =    1.50      SUBAREA RUNOFF(CFS) =    3.63
  TOTAL AREA(ACRES) =      1.70        PEAK FLOW RATE(CFS) =       4.27

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.22   HALFSTREET FLOOD WIDTH(FEET) =   5.58
  FLOW VELOCITY(FEET/SEC.) =  5.37   DEPTH*VELOCITY(FT*FT/SEC.) =   1.16
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    110.00 =   805.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    120.00 TO NODE    110.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.727
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  SUBAREA AREA(ACRES) =    2.10   SUBAREA RUNOFF(CFS) =    5.09
  TOTAL AREA(ACRES) =      3.80   TOTAL RUNOFF(CFS) =    9.36
  TC(MIN.) =   8.54
```

```
****************************************************************************
  FLOW PROCESS FROM NODE    130.00 TO NODE    110.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.727
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  SUBAREA AREA(ACRES) =     1.30   SUBAREA RUNOFF(CFS) =     3.15
  TOTAL AREA(ACRES) =       5.10   TOTAL RUNOFF(CFS) =    12.51
  TC(MIN.) =   8.54

****************************************************************************
  FLOW PROCESS FROM NODE    110.00 TO NODE     14.00 IS CODE =  41
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   351.00  DOWNSTREAM(FEET) =   350.50
  FLOW LENGTH(FEET) =    40.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  24.0 INCH PIPE IS  12.3 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   7.72
  GIVEN PIPE DIAMETER(INCH) =  24.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =     12.51
  PIPE TRAVEL TIME(MIN.) =   0.09    Tc(MIN.) =   8.63
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE     14.00 =   845.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    140.00 TO NODE    140.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =   8.63
  RAINFALL INTENSITY(INCH/HR) =   3.71
  TOTAL STREAM AREA(ACRES) =     5.10
  PEAK FLOW RATE(CFS) AT CONFLUENCE =     12.51

****************************************************************************
  FLOW PROCESS FROM NODE    150.00 TO NODE    152.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    65.00
  UPSTREAM ELEVATION(FEET) =    360.80
  DOWNSTREAM ELEVATION(FEET) =    360.10
  ELEVATION DIFFERENCE(FEET) =      0.70
  URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    6.371
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.139
  SUBAREA RUNOFF(CFS) =      0.27
  TOTAL AREA(ACRES) =      0.10   TOTAL RUNOFF(CFS) =      0.27

****************************************************************************
  FLOW PROCESS FROM NODE    152.00 TO NODE    140.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  1 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  360.10  DOWNSTREAM ELEVATION(FEET) =  356.00
```

```
  STREET LENGTH(FEET) =   425.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 18.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  13.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  2
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0180
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       1.46
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.23
    HALFSTREET FLOOD WIDTH(FEET) =    6.50
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    1.43
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.34
  STREET FLOW TRAVEL TIME(MIN.) =   4.94   Tc(MIN.) =  11.31
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.306
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  SUBAREA AREA(ACRES) =    1.10      SUBAREA RUNOFF(CFS) =    2.36
  TOTAL AREA(ACRES) =      1.20        PEAK FLOW RATE(CFS) =       2.63

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.27   HALFSTREET FLOOD WIDTH(FEET) =   8.43
  FLOW VELOCITY(FEET/SEC.) =  1.65   DEPTH*VELOCITY(FT*FT/SEC.) =   0.45
  LONGEST FLOWPATH FROM NODE    150.00 TO NODE    140.00 =   490.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    160.00 TO NODE    140.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.306
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  SUBAREA AREA(ACRES) =    1.30   SUBAREA RUNOFF(CFS) =    2.79
  TOTAL AREA(ACRES) =      2.50   TOTAL RUNOFF(CFS) =    5.43
  TC(MIN.) =  11.31

****************************************************************************
  FLOW PROCESS FROM NODE    140.00 TO NODE    140.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =  11.31
  RAINFALL INTENSITY(INCH/HR) =   3.31
  TOTAL STREAM AREA(ACRES) =     2.50
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      5.43

  ** CONFLUENCE DATA **
  STREAM     RUNOFF      Tc      INTENSITY      AREA
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)    (ACRE)
      1       12.51     8.63        3.710          5.10
      2        5.43    11.31        3.306          2.50

  RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
```

```
  CONFLUENCE FORMULA USED FOR  2 STREAMS.

  ** PEAK FLOW RATE TABLE **
  STREAM     RUNOFF      Tc       INTENSITY
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)
      1       17.35     8.63       3.710
      2       16.57    11.31       3.306

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =     17.35   Tc(MIN.) =    8.63
  TOTAL AREA(ACRES) =      7.60
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    140.00 =   845.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    140.00 TO NODE    195.00 IS CODE =  41
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   350.50  DOWNSTREAM(FEET) =   297.00
  FLOW LENGTH(FEET) =   240.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  24.0 INCH PIPE IS   6.7 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =  24.11
  GIVEN PIPE DIAMETER(INCH) =  24.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =     17.35
  PIPE TRAVEL TIME(MIN.) =   0.17    Tc(MIN.) =   8.80
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    195.00 =  1085.00 FEET.
============================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =      7.60  TC(MIN.) =      8.80
  PEAK FLOW RATE(CFS)   =     17.35
============================================================================
============================================================================
  END OF RATIONAL METHOD ANALYSIS

♀
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****************************************************************************

          RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
          Reference: SAN DIEGO COUNTY FLOOD CONTROL DISTRICT
                       2003,1985,1981 HYDROLOGY MANUAL
        (c) Copyright 1982-2003 Advanced Engineering Software (aes)
            Ver. 1.5A Release Date: 01/01/2003  License ID 1261

                          Analysis prepared by:

                        RICK ENGINEERING COMPANY
                            5620 Friars Road
                         San Diego, California 92110
                      619-291-0707   Fax 619-291-4165

 ************************** DESCRIPTION OF STUDY **************************
* SERRA MESA STORM DRAIN AND GREEN INFRASTRUCTURE IMPROVEMENTS             *
* J-17588-G, 100-YEAR POST-PROJECT CONDITION                               *
* BASIN 200; STORM DRAIN #2                                                *
 ****************************************************************************

  FILE NAME: SM_2HP00.RAT
  TIME/DATE OF STUDY: 09:35 11/04/2016
----------------------------------------------------------------------------
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
----------------------------------------------------------------------------
  USER SPECIFIED STORM EVENT(YEAR) = 100.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =  18.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.90
  RAINFALL-INTENSITY ADJUSTMENT FACTOR = 1.000
  *USER SPECIFIED:
  NUMBER OF [TIME,INTENSITY] DATA PAIRS =  9
   1)   5.000;  4.400
   2)  10.000;  3.450
   3)  15.000;  2.900
   4)  20.000;  2.500
   5)  25.000;  2.200
   6)  30.000;  2.000
   7)  40.000;  1.700
   8)  50.000;  1.500
   9)  60.000;  1.300
  SAN DIEGO HYDROLOGY MANUAL "C"-VALUES USED FOR RATIONAL METHOD
  NOTE: ONLY PEAK CONFLUENCE VALUES CONSIDERED
  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  =================  ======  ===== ====== ===== =======
  1   18.0     13.0    0.020/0.020/0.020   0.50    1.50 0.0100 0.125 0.0180
  2   35.0     30.0    0.020/0.020/0.020   0.50    1.50 0.0100 0.125 0.0180

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth = -0.10 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*

****************************************************************************
  FLOW PROCESS FROM NODE    200.00 TO NODE    202.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
```

```
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    65.00
  UPSTREAM ELEVATION(FEET) =    366.50
  DOWNSTREAM ELEVATION(FEET) =    365.80
  ELEVATION DIFFERENCE(FEET) =      0.70
  URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    6.371
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.139
  SUBAREA RUNOFF(CFS) =      0.54
  TOTAL AREA(ACRES) =      0.20   TOTAL RUNOFF(CFS) =      0.54

****************************************************************************
  FLOW PROCESS FROM NODE    202.00 TO NODE    205.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  1 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  365.80  DOWNSTREAM ELEVATION(FEET) =  359.90
  STREET LENGTH(FEET) =   575.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 18.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  13.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0180
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       2.60
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.33
    HALFSTREET FLOOD WIDTH(FEET) =   11.07
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    1.98
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.65
  STREET FLOW TRAVEL TIME(MIN.) =   4.83   Tc(MIN.) =  11.20
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.317
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  SUBAREA AREA(ACRES) =    1.90      SUBAREA RUNOFF(CFS) =    4.10
  TOTAL AREA(ACRES) =      2.10        PEAK FLOW RATE(CFS) =       4.64

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.38   HALFSTREET FLOOD WIDTH(FEET) =  13.96
  FLOW VELOCITY(FEET/SEC.) =  2.28   DEPTH*VELOCITY(FT*FT/SEC.) =   0.87
  LONGEST FLOWPATH FROM NODE    200.00 TO NODE    205.00 =   640.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    210.00 TO NODE    205.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.317
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  SUBAREA AREA(ACRES) =    1.40   SUBAREA RUNOFF(CFS) =    3.02
  TOTAL AREA(ACRES) =      3.50   TOTAL RUNOFF(CFS) =    7.65
  TC(MIN.) =  11.20

****************************************************************************
```

```
  FLOW PROCESS FROM NODE    205.00 TO NODE    215.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  1 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  359.90  DOWNSTREAM ELEVATION(FEET) =  357.00
  STREET LENGTH(FEET) =   225.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 18.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  13.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  2
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0180
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       8.37
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.36
    HALFSTREET FLOOD WIDTH(FEET) =   12.85
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    2.41
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.87
  STREET FLOW TRAVEL TIME(MIN.) =   1.56   Tc(MIN.) =  12.76
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.146
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  SUBAREA AREA(ACRES) =    0.70      SUBAREA RUNOFF(CFS) =    1.43
  TOTAL AREA(ACRES) =      4.20        PEAK FLOW RATE(CFS) =       9.09

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.37   HALFSTREET FLOOD WIDTH(FEET) =  13.25
  FLOW VELOCITY(FEET/SEC.) =  2.47   DEPTH*VELOCITY(FT*FT/SEC.) =   0.91
  LONGEST FLOWPATH FROM NODE    200.00 TO NODE    215.00 =   865.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    220.00 TO NODE    215.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.146
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  SUBAREA AREA(ACRES) =    1.00   SUBAREA RUNOFF(CFS) =    2.05
  TOTAL AREA(ACRES) =      5.20   TOTAL RUNOFF(CFS) =   11.13
  TC(MIN.) =  12.76

****************************************************************************
  FLOW PROCESS FROM NODE    215.00 TO NODE    295.00 IS CODE =  41
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   352.00  DOWNSTREAM(FEET) =   196.00
  FLOW LENGTH(FEET) =   400.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  24.0 INCH PIPE IS   4.7 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =  25.83
  GIVEN PIPE DIAMETER(INCH) =  24.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =     11.13
  PIPE TRAVEL TIME(MIN.) =   0.26    Tc(MIN.) =  13.02
  LONGEST FLOWPATH FROM NODE    200.00 TO NODE    295.00 =  1265.00 FEET.
```

```
================================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =      5.20  TC(MIN.) =     13.02
  PEAK FLOW RATE(CFS)   =     11.13
================================================================================
================================================================================
  END OF RATIONAL METHOD ANALYSIS

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**************************************************************************

          RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
          Reference: SAN DIEGO COUNTY FLOOD CONTROL DISTRICT
                       2003,1985,1981 HYDROLOGY MANUAL
        (c) Copyright 1982-2003 Advanced Engineering Software (aes)
            Ver. 1.5A Release Date: 01/01/2003  License ID 1261

                          Analysis prepared by:

                        RICK ENGINEERING COMPANY
                            5620 Friars Road
                       San Diego, California 92110
                     619-291-0707   Fax 619-291-4165

 ************************** DESCRIPTION OF STUDY **************************
* SERRA MESA STORM DRAIN AND GREEN INFRASTRUCTURE IMPROVEMENTS             *
* J-17588-G, 100-YEAR POST-PROJECT CONDITION                               *
* BASIN 300; STORM DRAIN #3                                                *
 **************************************************************************

  FILE NAME: SM_3HP00.RAT
  TIME/DATE OF STUDY: 09:37 11/04/2016
--------------------------------------------------------------------------
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
--------------------------------------------------------------------------
  USER SPECIFIED STORM EVENT(YEAR) = 100.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =  18.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.90
  RAINFALL-INTENSITY ADJUSTMENT FACTOR = 1.000
  *USER SPECIFIED:
  NUMBER OF [TIME,INTENSITY] DATA PAIRS =  9
   1)   5.000;  4.400
   2)  10.000;  3.450
   3)  15.000;  2.900
   4)  20.000;  2.500
   5)  25.000;  2.200
   6)  30.000;  2.000
   7)  40.000;  1.700
   8)  50.000;  1.500
   9)  60.000;  1.300
  SAN DIEGO HYDROLOGY MANUAL "C"-VALUES USED FOR RATIONAL METHOD
  NOTE: ONLY PEAK CONFLUENCE VALUES CONSIDERED
  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  =================  ======  ===== ====== ===== =======
  1   18.0     13.0    0.020/0.020/0.020   0.50    1.50 0.0100 0.125 0.0180
  2   35.0     30.0    0.020/0.020/0.020   0.50    1.50 0.0100 0.125 0.0180

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth = -0.10 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*

**************************************************************************
  FLOW PROCESS FROM NODE    300.00 TO NODE    302.00 IS CODE =  21
--------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
==========================================================================
```

```
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    65.00
  UPSTREAM ELEVATION(FEET) =    371.70
  DOWNSTREAM ELEVATION(FEET) =    371.00
  ELEVATION DIFFERENCE(FEET) =      0.70
  URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    6.371
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.139
  SUBAREA RUNOFF(CFS) =      0.54
  TOTAL AREA(ACRES) =      0.20   TOTAL RUNOFF(CFS) =      0.54

****************************************************************************
  FLOW PROCESS FROM NODE    302.00 TO NODE    305.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  1 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  371.00  DOWNSTREAM ELEVATION(FEET) =  357.90
  STREET LENGTH(FEET) =   700.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 18.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  13.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  2
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0180
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       2.68
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.25
    HALFSTREET FLOOD WIDTH(FEET) =    7.36
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    2.14
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.54
  STREET FLOW TRAVEL TIME(MIN.) =   5.46   Tc(MIN.) =  11.83
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.248
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .7300
  S.C.S. CURVE NUMBER (AMC II) =   0
  SUBAREA AREA(ACRES) =    1.80      SUBAREA RUNOFF(CFS) =    4.27
  TOTAL AREA(ACRES) =      2.00        PEAK FLOW RATE(CFS) =       4.81

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.29   HALFSTREET FLOOD WIDTH(FEET) =   9.49
  FLOW VELOCITY(FEET/SEC.) =  2.43   DEPTH*VELOCITY(FT*FT/SEC.) =   0.72
  LONGEST FLOWPATH FROM NODE    300.00 TO NODE    305.00 =   765.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    308.00 TO NODE    305.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.248
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  SUBAREA AREA(ACRES) =    1.00   SUBAREA RUNOFF(CFS) =    2.11
  TOTAL AREA(ACRES) =      3.00   TOTAL RUNOFF(CFS) =    6.92
  TC(MIN.) =  11.83

****************************************************************************
```

```
  FLOW PROCESS FROM NODE    305.00 TO NODE    310.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  1 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  357.90  DOWNSTREAM ELEVATION(FEET) =  345.90
  STREET LENGTH(FEET) =   550.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 18.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  13.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  2
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0180
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       8.83
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.34
    HALFSTREET FLOOD WIDTH(FEET) =   11.78
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    3.00
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.02
  STREET FLOW TRAVEL TIME(MIN.) =   3.06   Tc(MIN.) =  14.89
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  2.912
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .7300
  S.C.S. CURVE NUMBER (AMC II) =   0
  SUBAREA AREA(ACRES) =    1.80      SUBAREA RUNOFF(CFS) =    3.83
  TOTAL AREA(ACRES) =      4.80        PEAK FLOW RATE(CFS) =      10.74

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.36   HALFSTREET FLOOD WIDTH(FEET) =  12.74
  FLOW VELOCITY(FEET/SEC.) =  3.14   DEPTH*VELOCITY(FT*FT/SEC.) =   1.13
  LONGEST FLOWPATH FROM NODE    300.00 TO NODE    310.00 =  1315.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    320.00 TO NODE    310.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  2.912
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .7700
  S.C.S. CURVE NUMBER (AMC II) =   0
  SUBAREA AREA(ACRES) =    1.80   SUBAREA RUNOFF(CFS) =    4.04
  TOTAL AREA(ACRES) =      6.60   TOTAL RUNOFF(CFS) =   14.78
  TC(MIN.) =  14.89

****************************************************************************
  FLOW PROCESS FROM NODE    310.00 TO NODE    330.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  1 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  345.90  DOWNSTREAM ELEVATION(FEET) =  338.00
  STREET LENGTH(FEET) =   180.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 18.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  13.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020
```

```
  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  2
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0180
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      15.05
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.36
    HALFSTREET FLOOD WIDTH(FEET) =   12.69
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    4.43
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.59
  STREET FLOW TRAVEL TIME(MIN.) =   0.68   Tc(MIN.) =  15.57
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  2.854
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .9500
  S.C.S. CURVE NUMBER (AMC II) =   0
  SUBAREA AREA(ACRES) =    0.20      SUBAREA RUNOFF(CFS) =    0.54
  TOTAL AREA(ACRES) =      6.80        PEAK FLOW RATE(CFS) =      15.32

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.36   HALFSTREET FLOOD WIDTH(FEET) =  12.79
  FLOW VELOCITY(FEET/SEC.) =  4.45   DEPTH*VELOCITY(FT*FT/SEC.) =   1.60
  LONGEST FLOWPATH FROM NODE    300.00 TO NODE    330.00 =  1495.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    340.00 TO NODE    330.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  2.854
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  SUBAREA AREA(ACRES) =    2.70   SUBAREA RUNOFF(CFS) =    5.01
  TOTAL AREA(ACRES) =      9.50   TOTAL RUNOFF(CFS) =   20.33
  TC(MIN.) =  15.57

****************************************************************************
  FLOW PROCESS FROM NODE    350.00 TO NODE    330.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  2.854
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  SUBAREA AREA(ACRES) =    2.60   SUBAREA RUNOFF(CFS) =    4.82
  TOTAL AREA(ACRES) =     12.10   TOTAL RUNOFF(CFS) =   25.16
  TC(MIN.) =  15.57

****************************************************************************
  FLOW PROCESS FROM NODE    330.00 TO NODE    395.00 IS CODE =  41
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   333.00  DOWNSTREAM(FEET) =   223.00
  FLOW LENGTH(FEET) =   405.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  24.0 INCH PIPE IS   7.7 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =  28.75
  GIVEN PIPE DIAMETER(INCH) =  24.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =     25.16
  PIPE TRAVEL TIME(MIN.) =   0.23    Tc(MIN.) =  15.80
  LONGEST FLOWPATH FROM NODE    300.00 TO NODE    395.00 =  1900.00 FEET.
```

```
==========================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =     12.10  TC(MIN.) =     15.80
  PEAK FLOW RATE(CFS)   =     25.16
==========================================================================
==========================================================================
  END OF RATIONAL METHOD ANALYSIS

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****************************************************************************

          RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
          Reference: SAN DIEGO COUNTY FLOOD CONTROL DISTRICT
                       2003,1985,1981 HYDROLOGY MANUAL
        (c) Copyright 1982-2003 Advanced Engineering Software (aes)
            Ver. 1.5A Release Date: 01/01/2003  License ID 1261

                          Analysis prepared by:

                        RICK ENGINEERING COMPANY
                            5620 Friars Road
                         San Diego, California 92110
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 ************************** DESCRIPTION OF STUDY **************************
* SERRA MESA STORM DRAIN AND GREEN INFRASTRUCTURE IMPROVEMENTS             *
* J-17588-G, 100-YEAR POST-PROJECT CONDITION                               *
* BASIN 400; STORM DRAIN #4                                                *
 ****************************************************************************

  FILE NAME: SM_4HP00.RAT
  TIME/DATE OF STUDY: 09:38 11/04/2016
----------------------------------------------------------------------------
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
----------------------------------------------------------------------------
  USER SPECIFIED STORM EVENT(YEAR) = 100.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =  18.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.90
  RAINFALL-INTENSITY ADJUSTMENT FACTOR = 1.000
  *USER SPECIFIED:
  NUMBER OF [TIME,INTENSITY] DATA PAIRS =  9
   1)   5.000;  4.400
   2)  10.000;  3.450
   3)  15.000;  2.900
   4)  20.000;  2.500
   5)  25.000;  2.200
   6)  30.000;  2.000
   7)  40.000;  1.700
   8)  50.000;  1.500
   9)  60.000;  1.300
  SAN DIEGO HYDROLOGY MANUAL "C"-VALUES USED FOR RATIONAL METHOD
  NOTE: ONLY PEAK CONFLUENCE VALUES CONSIDERED
  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  =================  ======  ===== ====== ===== =======
  1   18.0     13.0    0.020/0.020/0.020   0.50    1.50 0.0100 0.125 0.0180
  2   35.0     30.0    0.020/0.020/0.020   0.50    1.50 0.0100 0.125 0.0180

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth = -0.10 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*

****************************************************************************
  FLOW PROCESS FROM NODE    400.00 TO NODE    402.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
```

```
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    65.00
  UPSTREAM ELEVATION(FEET) =    357.90
  DOWNSTREAM ELEVATION(FEET) =    357.20
  ELEVATION DIFFERENCE(FEET) =      0.70
  URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    6.371
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.139
  SUBAREA RUNOFF(CFS) =      0.54
  TOTAL AREA(ACRES) =      0.20   TOTAL RUNOFF(CFS) =      0.54

****************************************************************************
  FLOW PROCESS FROM NODE    402.00 TO NODE    405.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  1 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  357.20  DOWNSTREAM ELEVATION(FEET) =  349.00
  STREET LENGTH(FEET) =   290.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 18.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  13.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  2
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0180
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       1.51
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.21
    HALFSTREET FLOOD WIDTH(FEET) =    5.03
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    2.23
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.46
  STREET FLOW TRAVEL TIME(MIN.) =   2.17   Tc(MIN.) =   8.54
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.727
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  SUBAREA AREA(ACRES) =    0.80      SUBAREA RUNOFF(CFS) =    1.94
  TOTAL AREA(ACRES) =      1.00        PEAK FLOW RATE(CFS) =       2.48

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.23   HALFSTREET FLOOD WIDTH(FEET) =   6.45
  FLOW VELOCITY(FEET/SEC.) =  2.47   DEPTH*VELOCITY(FT*FT/SEC.) =   0.58
  LONGEST FLOWPATH FROM NODE    400.00 TO NODE    405.00 =   355.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    405.00 TO NODE    410.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  1 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  349.00  DOWNSTREAM ELEVATION(FEET) =  343.10
  STREET LENGTH(FEET) =   285.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 18.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  13.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020
```

```
  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  2
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0180
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       2.99
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.26
    HALFSTREET FLOOD WIDTH(FEET) =    7.56
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    2.27
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.58
  STREET FLOW TRAVEL TIME(MIN.) =   2.09   Tc(MIN.) =  10.63
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.380
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .7600
  S.C.S. CURVE NUMBER (AMC II) =   0
  SUBAREA AREA(ACRES) =    0.40      SUBAREA RUNOFF(CFS) =    1.03
  TOTAL AREA(ACRES) =      1.40        PEAK FLOW RATE(CFS) =       3.50

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.27   HALFSTREET FLOOD WIDTH(FEET) =   8.12
  FLOW VELOCITY(FEET/SEC.) =  2.35   DEPTH*VELOCITY(FT*FT/SEC.) =   0.63
  LONGEST FLOWPATH FROM NODE    400.00 TO NODE    410.00 =   640.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    410.00 TO NODE    410.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =  10.63
  RAINFALL INTENSITY(INCH/HR) =   3.38
  TOTAL STREAM AREA(ACRES) =     1.40
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      3.50

****************************************************************************
  FLOW PROCESS FROM NODE    420.00 TO NODE    422.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    65.00
  UPSTREAM ELEVATION(FEET) =    353.20
  DOWNSTREAM ELEVATION(FEET) =    352.50
  ELEVATION DIFFERENCE(FEET) =      0.70
  URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    6.371
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.139
  SUBAREA RUNOFF(CFS) =      0.81
  TOTAL AREA(ACRES) =      0.30   TOTAL RUNOFF(CFS) =      0.81

****************************************************************************
  FLOW PROCESS FROM NODE    422.00 TO NODE    410.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  1 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  352.50  DOWNSTREAM ELEVATION(FEET) =  343.10
  STREET LENGTH(FEET) =   475.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 18.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  13.00
```

```
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  2
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0180
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       2.38
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.24
    HALFSTREET FLOOD WIDTH(FEET) =    6.85
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    2.14
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.52
  STREET FLOW TRAVEL TIME(MIN.) =   3.70   Tc(MIN.) =  10.07
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.442
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  SUBAREA AREA(ACRES) =    1.40      SUBAREA RUNOFF(CFS) =    3.13
  TOTAL AREA(ACRES) =      1.70        PEAK FLOW RATE(CFS) =       3.94

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.28   HALFSTREET FLOOD WIDTH(FEET) =   8.63
  FLOW VELOCITY(FEET/SEC.) =  2.37   DEPTH*VELOCITY(FT*FT/SEC.) =   0.66
  LONGEST FLOWPATH FROM NODE    420.00 TO NODE    410.00 =   540.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    410.00 TO NODE    410.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =  10.07
  RAINFALL INTENSITY(INCH/HR) =   3.44
  TOTAL STREAM AREA(ACRES) =     1.70
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      3.94

  ** CONFLUENCE DATA **
  STREAM     RUNOFF      Tc      INTENSITY      AREA
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)    (ACRE)
      1        3.50    10.63        3.380          1.40
      2        3.94    10.07        3.442          1.70

  RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
  CONFLUENCE FORMULA USED FOR  2 STREAMS.

  ** PEAK FLOW RATE TABLE **
  STREAM     RUNOFF      Tc      INTENSITY
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)
      1        7.38    10.07       3.442
      2        7.37    10.63       3.380

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      7.38   Tc(MIN.) =   10.07
  TOTAL AREA(ACRES) =      3.10
  LONGEST FLOWPATH FROM NODE    400.00 TO NODE    410.00 =   640.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    410.00 TO NODE    430.00 IS CODE =  41
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
```

```
  >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<
================================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   338.10  DOWNSTREAM(FEET) =   337.50
  FLOW LENGTH(FEET) =    40.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  24.0 INCH PIPE IS   8.7 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   7.19
  GIVEN PIPE DIAMETER(INCH) =  24.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      7.38
  PIPE TRAVEL TIME(MIN.) =   0.09    Tc(MIN.) =  10.16
  LONGEST FLOWPATH FROM NODE    400.00 TO NODE    430.00 =   680.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    430.00 TO NODE    430.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =  10.16
  RAINFALL INTENSITY(INCH/HR) =   3.43
  TOTAL STREAM AREA(ACRES) =     3.10
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      7.38

****************************************************************************
  FLOW PROCESS FROM NODE    440.00 TO NODE    442.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .7100
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    65.00
  UPSTREAM ELEVATION(FEET) =    354.00
  DOWNSTREAM ELEVATION(FEET) =    353.30
  ELEVATION DIFFERENCE(FEET) =      0.70
  URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    5.522
  TIME OF CONCENTRATION ASSUMED AS 6-MIN.
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.210
  SUBAREA RUNOFF(CFS) =      0.60
  TOTAL AREA(ACRES) =      0.20   TOTAL RUNOFF(CFS) =      0.60

****************************************************************************
  FLOW PROCESS FROM NODE    442.00 TO NODE    430.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  1 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  353.50  DOWNSTREAM ELEVATION(FEET) =  343.10
  STREET LENGTH(FEET) =   535.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 18.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  13.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  2
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0180
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       2.16
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.24
    HALFSTREET FLOOD WIDTH(FEET) =    6.60
```

```
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    2.07
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.49
  STREET FLOW TRAVEL TIME(MIN.) =   4.30   Tc(MIN.) =  10.30
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.417
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  SUBAREA AREA(ACRES) =    1.40      SUBAREA RUNOFF(CFS) =    3.11
  TOTAL AREA(ACRES) =      1.60        PEAK FLOW RATE(CFS) =       3.71

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.27   HALFSTREET FLOOD WIDTH(FEET) =   8.43
  FLOW VELOCITY(FEET/SEC.) =  2.33   DEPTH*VELOCITY(FT*FT/SEC.) =   0.64
  LONGEST FLOWPATH FROM NODE    440.00 TO NODE    430.00 =   600.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    450.00 TO NODE    430.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.417
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  SUBAREA AREA(ACRES) =    1.00   SUBAREA RUNOFF(CFS) =    2.22
  TOTAL AREA(ACRES) =      2.60   TOTAL RUNOFF(CFS) =    5.93
  TC(MIN.) =  10.30

****************************************************************************
  FLOW PROCESS FROM NODE    430.00 TO NODE    430.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =  10.30
  RAINFALL INTENSITY(INCH/HR) =   3.42
  TOTAL STREAM AREA(ACRES) =     2.60
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      5.93

  ** CONFLUENCE DATA **
  STREAM     RUNOFF      Tc      INTENSITY      AREA
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)    (ACRE)
      1        7.38    10.16        3.432          3.10
      2        5.93    10.30        3.417          2.60

  RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
  CONFLUENCE FORMULA USED FOR  2 STREAMS.

  ** PEAK FLOW RATE TABLE **
  STREAM     RUNOFF      Tc      INTENSITY
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)
      1       13.28    10.16       3.432
      2       13.27    10.30       3.417

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =     13.28   Tc(MIN.) =   10.16
  TOTAL AREA(ACRES) =      5.70
  LONGEST FLOWPATH FROM NODE    400.00 TO NODE    430.00 =   680.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    430.00 TO NODE    495.00 IS CODE =  41
----------------------------------------------------------------------------
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```
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   337.50  DOWNSTREAM(FEET) =   187.00
  FLOW LENGTH(FEET) =   420.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  24.0 INCH PIPE IS   5.2 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =  26.43
  GIVEN PIPE DIAMETER(INCH) =  24.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =     13.28
  PIPE TRAVEL TIME(MIN.) =   0.26    Tc(MIN.) =  10.43
  LONGEST FLOWPATH FROM NODE    400.00 TO NODE    495.00 =  1100.00 FEET.
============================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =      5.70  TC(MIN.) =     10.43
  PEAK FLOW RATE(CFS)   =     13.28
============================================================================
============================================================================
  END OF RATIONAL METHOD ANALYSIS

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          RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
          Reference: SAN DIEGO COUNTY FLOOD CONTROL DISTRICT
                       2003,1985,1981 HYDROLOGY MANUAL
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            Ver. 1.5A Release Date: 01/01/2003  License ID 1261

                          Analysis prepared by:

                        RICK ENGINEERING COMPANY
                            5620 Friars Road
                         San Diego, California 92110
                      619-291-0707   Fax 619-291-4165

 ************************** DESCRIPTION OF STUDY **************************
* SERRA MESA STORM DRAIN AND GREEN INFRASTRUCTURE IMPROVEMENTS             *
* J-17588-G, 100-YEAR POST-PROJECT CONDITION                               *
* BASIN 500; STORM DRAIN #5                                                *
 ****************************************************************************

  FILE NAME: SM_5HP00.RAT
  TIME/DATE OF STUDY: 09:39 11/04/2016
----------------------------------------------------------------------------
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
----------------------------------------------------------------------------
  USER SPECIFIED STORM EVENT(YEAR) = 100.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =  18.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.90
  RAINFALL-INTENSITY ADJUSTMENT FACTOR = 1.000
  *USER SPECIFIED:
  NUMBER OF [TIME,INTENSITY] DATA PAIRS =  9
   1)   5.000;  4.400
   2)  10.000;  3.450
   3)  15.000;  2.900
   4)  20.000;  2.500
   5)  25.000;  2.200
   6)  30.000;  2.000
   7)  40.000;  1.700
   8)  50.000;  1.500
   9)  60.000;  1.300
  SAN DIEGO HYDROLOGY MANUAL "C"-VALUES USED FOR RATIONAL METHOD
  NOTE: ONLY PEAK CONFLUENCE VALUES CONSIDERED
  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  =================  ======  ===== ====== ===== =======
  1   18.0     13.0    0.020/0.020/0.020   0.50    1.50 0.0100 0.125 0.0180
  2   35.0     30.0    0.020/0.020/0.020   0.50    1.50 0.0100 0.125 0.0180

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth = -0.10 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*

****************************************************************************
  FLOW PROCESS FROM NODE    500.00 TO NODE    502.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
                                    Page 1
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```
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    65.00
  UPSTREAM ELEVATION(FEET) =    356.40
  DOWNSTREAM ELEVATION(FEET) =    355.70
  ELEVATION DIFFERENCE(FEET) =      0.70
  URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    6.371
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.139
  SUBAREA RUNOFF(CFS) =      0.27
  TOTAL AREA(ACRES) =      0.10   TOTAL RUNOFF(CFS) =      0.27

****************************************************************************
  FLOW PROCESS FROM NODE    502.00 TO NODE    510.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  1 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  355.70  DOWNSTREAM ELEVATION(FEET) =  344.00
  STREET LENGTH(FEET) =   905.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 18.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  13.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  2
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0180
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       2.51
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.26
    HALFSTREET FLOOD WIDTH(FEET) =    7.77
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    1.82
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.47
  STREET FLOW TRAVEL TIME(MIN.) =   8.30   Tc(MIN.) =  14.67
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  2.936
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  SUBAREA AREA(ACRES) =    2.30      SUBAREA RUNOFF(CFS) =    4.39
  TOTAL AREA(ACRES) =      2.40        PEAK FLOW RATE(CFS) =       4.66

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.31   HALFSTREET FLOOD WIDTH(FEET) =  10.10
  FLOW VELOCITY(FEET/SEC.) =  2.10   DEPTH*VELOCITY(FT*FT/SEC.) =   0.65
  LONGEST FLOWPATH FROM NODE    500.00 TO NODE    510.00 =   970.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    515.00 TO NODE    510.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  2.936
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  SUBAREA AREA(ACRES) =    0.90   SUBAREA RUNOFF(CFS) =    1.72
  TOTAL AREA(ACRES) =      3.30   TOTAL RUNOFF(CFS) =    6.38
  TC(MIN.) =  14.67

****************************************************************************
```

```
 FLOW PROCESS FROM NODE    510.00 TO NODE    520.00 IS CODE =  41
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   339.00  DOWNSTREAM(FEET) =   244.00
 FLOW LENGTH(FEET) =   338.40   MANNING'S N =  0.013
 DEPTH OF FLOW IN  24.0 INCH PIPE IS   3.9 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =  19.54
 GIVEN PIPE DIAMETER(INCH) =  24.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =      6.38
 PIPE TRAVEL TIME(MIN.) =   0.29    Tc(MIN.) =  14.96
 LONGEST FLOWPATH FROM NODE    500.00 TO NODE    520.00 =  1308.40 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    520.00 TO NODE    520.00 IS CODE =   1
----------------------------------------------------------------------------
 >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
 TOTAL NUMBER OF STREAMS =  2
 CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
 TIME OF CONCENTRATION(MIN.) =  14.96
 RAINFALL INTENSITY(INCH/HR) =   2.90
 TOTAL STREAM AREA(ACRES) =     3.30
 PEAK FLOW RATE(CFS) AT CONFLUENCE =      6.38

****************************************************************************
 FLOW PROCESS FROM NODE    530.00 TO NODE    532.00 IS CODE =  21
----------------------------------------------------------------------------
 >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
 *USER SPECIFIED(SUBAREA):
 USER-SPECIFIED RUNOFF COEFFICIENT = .7300
 S.C.S. CURVE NUMBER (AMC II) =   0
 INITIAL SUBAREA FLOW-LENGTH(FEET) =    65.00
 UPSTREAM ELEVATION(FEET) =    353.00
 DOWNSTREAM ELEVATION(FEET) =    352.30
 ELEVATION DIFFERENCE(FEET) =      0.70
 URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    5.238
 TIME OF CONCENTRATION ASSUMED AS 6-MIN.
  100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.210
 SUBAREA RUNOFF(CFS) =      0.92
 TOTAL AREA(ACRES) =      0.30   TOTAL RUNOFF(CFS) =      0.92

****************************************************************************
 FLOW PROCESS FROM NODE    532.00 TO NODE    520.00 IS CODE =  62
----------------------------------------------------------------------------
 >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>(STREET TABLE SECTION #  1 USED)<<<<<
============================================================================
 UPSTREAM ELEVATION(FEET) =  352.30  DOWNSTREAM ELEVATION(FEET) =  344.00
 STREET LENGTH(FEET) =   835.00   CURB HEIGHT(INCHES) =  6.0
 STREET HALFWIDTH(FEET) = 18.00

 DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  13.00
 INSIDE STREET CROSSFALL(DECIMAL) =  0.020
 OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

 SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  2
 STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
 Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0180
 Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

   **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       4.18
```

```
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.31
    HALFSTREET FLOOD WIDTH(FEET) =   10.21
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    1.85
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.57
  STREET FLOW TRAVEL TIME(MIN.) =   7.51   Tc(MIN.) =  13.51
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.063
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  SUBAREA AREA(ACRES) =    3.20      SUBAREA RUNOFF(CFS) =    6.37
  TOTAL AREA(ACRES) =      3.50        PEAK FLOW RATE(CFS) =       7.29

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.36   HALFSTREET FLOOD WIDTH(FEET) =  12.79
  FLOW VELOCITY(FEET/SEC.) =  2.12   DEPTH*VELOCITY(FT*FT/SEC.) =   0.76
  LONGEST FLOWPATH FROM NODE    530.00 TO NODE    520.00 =   900.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    540.00 TO NODE    520.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.063
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  SUBAREA AREA(ACRES) =    1.80   SUBAREA RUNOFF(CFS) =    3.58
  TOTAL AREA(ACRES) =      5.30   TOTAL RUNOFF(CFS) =   10.88
  TC(MIN.) =  13.51

****************************************************************************
  FLOW PROCESS FROM NODE    520.00 TO NODE    520.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =  13.51
  RAINFALL INTENSITY(INCH/HR) =   3.06
  TOTAL STREAM AREA(ACRES) =     5.30
  PEAK FLOW RATE(CFS) AT CONFLUENCE =     10.88

  ** CONFLUENCE DATA **
  STREAM     RUNOFF      Tc      INTENSITY      AREA
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)    (ACRE)
      1        6.38    14.96        2.905          3.30
      2       10.88    13.51        3.063          5.30

  RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
  CONFLUENCE FORMULA USED FOR  2 STREAMS.

  ** PEAK FLOW RATE TABLE **
  STREAM     RUNOFF      Tc      INTENSITY
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)
      1       16.92    13.51       3.063
      2       16.69    14.96       2.905

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =     16.92   Tc(MIN.) =   13.51
  TOTAL AREA(ACRES) =      8.60
  LONGEST FLOWPATH FROM NODE    500.00 TO NODE    520.00 =  1308.40 FEET.
```

```
****************************************************************************
  FLOW PROCESS FROM NODE    520.00 TO NODE    595.00 IS CODE =  41
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   339.00  DOWNSTREAM(FEET) =   225.00
  FLOW LENGTH(FEET) =   392.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  25.0 INCH PIPE IS   6.1 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =  26.21
  GIVEN PIPE DIAMETER(INCH) =  25.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =     16.92
  PIPE TRAVEL TIME(MIN.) =   0.25    Tc(MIN.) =  13.76
  LONGEST FLOWPATH FROM NODE    500.00 TO NODE    595.00 =  1700.40 FEET.
============================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =      8.60  TC(MIN.) =     13.76
  PEAK FLOW RATE(CFS)   =     16.92
============================================================================
============================================================================
  END OF RATIONAL METHOD ANALYSIS

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          RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
          Reference: SAN DIEGO COUNTY FLOOD CONTROL DISTRICT
                       2003,1985,1981 HYDROLOGY MANUAL
        (c) Copyright 1982-2003 Advanced Engineering Software (aes)
            Ver. 1.5A Release Date: 01/01/2003  License ID 1261

                          Analysis prepared by:

                        RICK ENGINEERING COMPANY
                            5620 Friars Road
                         San Diego, California 92110
                      619-291-0707   Fax 619-291-4165

 ************************** DESCRIPTION OF STUDY **************************
* SERRA MESA STORM DRAIN AND GREEN INFRASTRUCTURE IMPROVEMENTS             *
* J-17588-G, 100-YEAR POST-PROJECT CONDITION                               *
* BASIN 600; STORM DRAIN #6                                                *
 ****************************************************************************

  FILE NAME: SM_6HP00.RAT
  TIME/DATE OF STUDY: 09:40 11/04/2016
----------------------------------------------------------------------------
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
----------------------------------------------------------------------------
  USER SPECIFIED STORM EVENT(YEAR) = 100.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =  18.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.90
  RAINFALL-INTENSITY ADJUSTMENT FACTOR = 1.000
  *USER SPECIFIED:
  NUMBER OF [TIME,INTENSITY] DATA PAIRS =  9
   1)   5.000;  4.400
   2)  10.000;  3.450
   3)  15.000;  2.900
   4)  20.000;  2.500
   5)  25.000;  2.200
   6)  30.000;  2.000
   7)  40.000;  1.700
   8)  50.000;  1.500
   9)  60.000;  1.300
  SAN DIEGO HYDROLOGY MANUAL "C"-VALUES USED FOR RATIONAL METHOD
  NOTE: ONLY PEAK CONFLUENCE VALUES CONSIDERED
  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  =================  ======  ===== ====== ===== =======
  1   18.0     13.0    0.020/0.020/0.020   0.50    1.50 0.0100 0.125 0.0180
  2   35.0     30.0    0.020/0.020/0.020   0.50    1.50 0.0100 0.125 0.0180

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth = -0.10 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*

****************************************************************************
  FLOW PROCESS FROM NODE    600.00 TO NODE    602.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
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```
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .9500
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    65.00
  UPSTREAM ELEVATION(FEET) =    371.70
  DOWNSTREAM ELEVATION(FEET) =    371.00
  ELEVATION DIFFERENCE(FEET) =      0.70
  URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    2.124
  TIME OF CONCENTRATION ASSUMED AS 6-MIN.
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.210
  SUBAREA RUNOFF(CFS) =      0.40
  TOTAL AREA(ACRES) =      0.10   TOTAL RUNOFF(CFS) =      0.40

****************************************************************************
  FLOW PROCESS FROM NODE    602.00 TO NODE    605.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  1 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  371.00  DOWNSTREAM ELEVATION(FEET) =  364.00
  STREET LENGTH(FEET) =   625.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 18.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  13.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0180
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       3.52
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.35
    HALFSTREET FLOOD WIDTH(FEET) =   12.34
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    2.19
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.77
  STREET FLOW TRAVEL TIME(MIN.) =   4.75   Tc(MIN.) =  10.75
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.367
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  SUBAREA AREA(ACRES) =    2.80      SUBAREA RUNOFF(CFS) =    6.13
  TOTAL AREA(ACRES) =      2.90        PEAK FLOW RATE(CFS) =       6.53

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.42   HALFSTREET FLOOD WIDTH(FEET) =  15.69
  FLOW VELOCITY(FEET/SEC.) =  2.56   DEPTH*VELOCITY(FT*FT/SEC.) =   1.07
  LONGEST FLOWPATH FROM NODE    600.00 TO NODE    605.00 =   690.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    610.00 TO NODE    605.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.367
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  SUBAREA AREA(ACRES) =    1.20   SUBAREA RUNOFF(CFS) =    2.63
  TOTAL AREA(ACRES) =      4.10   TOTAL RUNOFF(CFS) =    9.15
  TC(MIN.) =  10.75
```

```
****************************************************************************
  FLOW PROCESS FROM NODE    605.00 TO NODE    625.00 IS CODE =  41
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   359.00  DOWNSTREAM(FEET) =   358.40
  FLOW LENGTH(FEET) =    40.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  24.0 INCH PIPE IS   9.8 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   7.62
  GIVEN PIPE DIAMETER(INCH) =  24.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      9.15
  PIPE TRAVEL TIME(MIN.) =   0.09    Tc(MIN.) =  10.84
  LONGEST FLOWPATH FROM NODE    600.00 TO NODE    625.00 =   730.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    625.00 TO NODE    625.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =  10.84
  RAINFALL INTENSITY(INCH/HR) =   3.36
  TOTAL STREAM AREA(ACRES) =     4.10
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      9.15

****************************************************************************
  FLOW PROCESS FROM NODE    620.00 TO NODE    622.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    65.00
  UPSTREAM ELEVATION(FEET) =    370.30
  DOWNSTREAM ELEVATION(FEET) =    369.40
  ELEVATION DIFFERENCE(FEET) =      0.90
  URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    5.859
  TIME OF CONCENTRATION ASSUMED AS 6-MIN.
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.210
  SUBAREA RUNOFF(CFS) =      0.55
  TOTAL AREA(ACRES) =      0.20   TOTAL RUNOFF(CFS) =      0.55

****************************************************************************
  FLOW PROCESS FROM NODE    622.00 TO NODE    625.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  1 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  369.40  DOWNSTREAM ELEVATION(FEET) =  364.00
  STREET LENGTH(FEET) =   525.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 18.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  13.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  2
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0180
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200
```

```
    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       1.94
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.25
    HALFSTREET FLOOD WIDTH(FEET) =    7.26
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    1.58
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.40
  STREET FLOW TRAVEL TIME(MIN.) =   5.52   Tc(MIN.) =  11.52
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.283
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  SUBAREA AREA(ACRES) =    1.30      SUBAREA RUNOFF(CFS) =    2.77
  TOTAL AREA(ACRES) =      1.50        PEAK FLOW RATE(CFS) =       3.32

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.29   HALFSTREET FLOOD WIDTH(FEET) =   9.19
  FLOW VELOCITY(FEET/SEC.) =  1.78   DEPTH*VELOCITY(FT*FT/SEC.) =   0.52
  LONGEST FLOWPATH FROM NODE    620.00 TO NODE    625.00 =   590.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    630.00 TO NODE    625.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.283
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  SUBAREA AREA(ACRES) =    0.80   SUBAREA RUNOFF(CFS) =    1.71
  TOTAL AREA(ACRES) =      2.30   TOTAL RUNOFF(CFS) =    5.03
  TC(MIN.) =  11.52

****************************************************************************
  FLOW PROCESS FROM NODE    625.00 TO NODE    625.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =  11.52
  RAINFALL INTENSITY(INCH/HR) =   3.28
  TOTAL STREAM AREA(ACRES) =     2.30
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      5.03

  ** CONFLUENCE DATA **
  STREAM     RUNOFF      Tc      INTENSITY      AREA
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)    (ACRE)
      1        9.15    10.84        3.357          4.10
      2        5.03    11.52        3.283          2.30

  RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
  CONFLUENCE FORMULA USED FOR  2 STREAMS.

  ** PEAK FLOW RATE TABLE **
  STREAM     RUNOFF      Tc      INTENSITY
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)
      1       14.07    10.84       3.357
      2       13.98    11.52       3.283

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =     14.07   Tc(MIN.) =   10.84
  TOTAL AREA(ACRES) =      6.40
  LONGEST FLOWPATH FROM NODE    600.00 TO NODE    625.00 =   730.00 FEET.
```

```
****************************************************************************
  FLOW PROCESS FROM NODE    625.00 TO NODE    695.00 IS CODE =  41
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   358.40  DOWNSTREAM(FEET) =   214.00
  FLOW LENGTH(FEET) =   375.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  24.0 INCH PIPE IS   5.3 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =  27.57
  GIVEN PIPE DIAMETER(INCH) =  24.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =     14.07
  PIPE TRAVEL TIME(MIN.) =   0.23    Tc(MIN.) =  11.07
  LONGEST FLOWPATH FROM NODE    600.00 TO NODE    695.00 =  1105.00 FEET.
============================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =      6.40  TC(MIN.) =     11.07
  PEAK FLOW RATE(CFS)   =     14.07
============================================================================
============================================================================
  END OF RATIONAL METHOD ANALYSIS

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          RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
          Reference: SAN DIEGO COUNTY FLOOD CONTROL DISTRICT
                       2003,1985,1981 HYDROLOGY MANUAL
        (c) Copyright 1982-2003 Advanced Engineering Software (aes)
            Ver. 1.5A Release Date: 01/01/2003  License ID 1261

                          Analysis prepared by:

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 ************************** DESCRIPTION OF STUDY **************************
* SERRA MESA STORM DRAIN AND GREEN INFRASTRUCTURE IMPROVEMENTS             *
* J-17588-G, 100-YEAR POST-PROJECT CONDITION                               *
* BASIN 700; STORM DRAIN #7                                                *
 ****************************************************************************

  FILE NAME: SM_7HP00.RAT
  TIME/DATE OF STUDY: 09:41 11/04/2016
----------------------------------------------------------------------------
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
----------------------------------------------------------------------------
  USER SPECIFIED STORM EVENT(YEAR) = 100.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =  18.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.90
  RAINFALL-INTENSITY ADJUSTMENT FACTOR = 1.000
  *USER SPECIFIED:
  NUMBER OF [TIME,INTENSITY] DATA PAIRS =  9
   1)   5.000;  4.400
   2)  10.000;  3.450
   3)  15.000;  2.900
   4)  20.000;  2.500
   5)  25.000;  2.200
   6)  30.000;  2.000
   7)  40.000;  1.700
   8)  50.000;  1.500
   9)  60.000;  1.300
  SAN DIEGO HYDROLOGY MANUAL "C"-VALUES USED FOR RATIONAL METHOD
  NOTE: ONLY PEAK CONFLUENCE VALUES CONSIDERED
  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  =================  ======  ===== ====== ===== =======
  1   18.0     13.0    0.020/0.020/0.020   0.50    1.50 0.0100 0.125 0.0180
  2   35.0     30.0    0.020/0.020/0.020   0.50    1.50 0.0100 0.125 0.0180

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth = -0.10 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*

****************************************************************************
  FLOW PROCESS FROM NODE    700.00 TO NODE    702.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
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```
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .7500
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    65.00
  UPSTREAM ELEVATION(FEET) =    401.70
  DOWNSTREAM ELEVATION(FEET) =    401.00
  ELEVATION DIFFERENCE(FEET) =      0.70
  URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    4.955
  TIME OF CONCENTRATION ASSUMED AS 6-MIN.
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.210
  SUBAREA RUNOFF(CFS) =      0.63
  TOTAL AREA(ACRES) =      0.20   TOTAL RUNOFF(CFS) =      0.63

****************************************************************************
  FLOW PROCESS FROM NODE    702.00 TO NODE    705.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  1 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  401.00  DOWNSTREAM ELEVATION(FEET) =  394.00
  STREET LENGTH(FEET) =  1080.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 18.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  13.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  2
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0180
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       3.22
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.31
    HALFSTREET FLOOD WIDTH(FEET) =   10.00
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    1.48
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.45
  STREET FLOW TRAVEL TIME(MIN.) =  12.13   Tc(MIN.) =  18.13
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  2.650
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  SUBAREA AREA(ACRES) =    2.90      SUBAREA RUNOFF(CFS) =    4.99
  TOTAL AREA(ACRES) =      3.10        PEAK FLOW RATE(CFS) =       5.63

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.36   HALFSTREET FLOOD WIDTH(FEET) =  12.54
  FLOW VELOCITY(FEET/SEC.) =  1.70   DEPTH*VELOCITY(FT*FT/SEC.) =   0.60
  LONGEST FLOWPATH FROM NODE    700.00 TO NODE    705.00 =  1145.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    705.00 TO NODE    710.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  1 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  394.00  DOWNSTREAM ELEVATION(FEET) =  390.30
  STREET LENGTH(FEET) =   590.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 18.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  13.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020
```

```
  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  2
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0180
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       7.86
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.39
    HALFSTREET FLOOD WIDTH(FEET) =   14.42
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    1.81
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.71
  STREET FLOW TRAVEL TIME(MIN.) =   5.42   Tc(MIN.) =  23.55
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  2.287
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  SUBAREA AREA(ACRES) =    3.00      SUBAREA RUNOFF(CFS) =    4.46
  TOTAL AREA(ACRES) =      6.10        PEAK FLOW RATE(CFS) =      10.09

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.42   HALFSTREET FLOOD WIDTH(FEET) =  15.89
  FLOW VELOCITY(FEET/SEC.) =  1.93   DEPTH*VELOCITY(FT*FT/SEC.) =   0.82
  LONGEST FLOWPATH FROM NODE    700.00 TO NODE    710.00 =  1735.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    710.00 TO NODE    715.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  1 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  390.30  DOWNSTREAM ELEVATION(FEET) =  362.00
  STREET LENGTH(FEET) =  1340.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 18.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  13.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  2
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0180
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      12.54
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.38
    HALFSTREET FLOOD WIDTH(FEET) =   13.66
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    3.21
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.21
  STREET FLOW TRAVEL TIME(MIN.) =   6.95   Tc(MIN.) =  30.50
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  1.985
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  SUBAREA AREA(ACRES) =    3.80      SUBAREA RUNOFF(CFS) =    4.90
  TOTAL AREA(ACRES) =      9.90        PEAK FLOW RATE(CFS) =      14.99

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.40   HALFSTREET FLOOD WIDTH(FEET) =  14.62
  FLOW VELOCITY(FEET/SEC.) =  3.37   DEPTH*VELOCITY(FT*FT/SEC.) =   1.34
  LONGEST FLOWPATH FROM NODE    700.00 TO NODE    715.00 =  3075.00 FEET.

****************************************************************************
```

```
 FLOW PROCESS FROM NODE    718.00 TO NODE    715.00 IS CODE =  81
----------------------------------------------------------------------------
 >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
  100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  1.985
 *USER SPECIFIED(SUBAREA):
 USER-SPECIFIED RUNOFF COEFFICIENT = .6500
 S.C.S. CURVE NUMBER (AMC II) =   0
 SUBAREA AREA(ACRES) =    4.80   SUBAREA RUNOFF(CFS) =    6.19
 TOTAL AREA(ACRES) =     14.70   TOTAL RUNOFF(CFS) =   21.18
 TC(MIN.) =  30.50

****************************************************************************
 FLOW PROCESS FROM NODE    715.00 TO NODE    720.00 IS CODE =  62
----------------------------------------------------------------------------
 >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>(STREET TABLE SECTION #  1 USED)<<<<<
============================================================================
 UPSTREAM ELEVATION(FEET) =  362.00  DOWNSTREAM ELEVATION(FEET) =  350.50
 STREET LENGTH(FEET) =   280.00   CURB HEIGHT(INCHES) =  6.0
 STREET HALFWIDTH(FEET) = 18.00

 DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  13.00
 INSIDE STREET CROSSFALL(DECIMAL) =  0.020
 OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

 SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  2
 STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
 Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0180
 Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

   **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      21.27
   STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
   STREET FLOW DEPTH(FEET) =  0.40
   HALFSTREET FLOOD WIDTH(FEET) =   14.72
   AVERAGE FLOW VELOCITY(FEET/SEC.) =    4.72
   PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.88
 STREET FLOW TRAVEL TIME(MIN.) =   0.99   Tc(MIN.) =  31.49
  100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  1.955
 *USER SPECIFIED(SUBAREA):
 USER-SPECIFIED RUNOFF COEFFICIENT = .9500
 S.C.S. CURVE NUMBER (AMC II) =   0
 SUBAREA AREA(ACRES) =    0.10      SUBAREA RUNOFF(CFS) =    0.19
 TOTAL AREA(ACRES) =     14.80        PEAK FLOW RATE(CFS) =      21.37

 END OF SUBAREA STREET FLOW HYDRAULICS:
 DEPTH(FEET) = 0.40   HALFSTREET FLOOD WIDTH(FEET) =  14.78
 FLOW VELOCITY(FEET/SEC.) =  4.71   DEPTH*VELOCITY(FT*FT/SEC.) =   1.89
 LONGEST FLOWPATH FROM NODE    700.00 TO NODE    720.00 =  3355.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    725.00 TO NODE    720.00 IS CODE =  81
----------------------------------------------------------------------------
 >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
  100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  1.955
 *USER SPECIFIED(SUBAREA):
 USER-SPECIFIED RUNOFF COEFFICIENT = .6500
 S.C.S. CURVE NUMBER (AMC II) =   0
 SUBAREA AREA(ACRES) =    3.80   SUBAREA RUNOFF(CFS) =    4.83
 TOTAL AREA(ACRES) =     18.60   TOTAL RUNOFF(CFS) =   26.20
 TC(MIN.) =  31.49

****************************************************************************
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```
 FLOW PROCESS FROM NODE    730.00 TO NODE    720.00 IS CODE =  81
----------------------------------------------------------------------------
 >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
  100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  1.955
 *USER SPECIFIED(SUBAREA):
 USER-SPECIFIED RUNOFF COEFFICIENT = .6500
 S.C.S. CURVE NUMBER (AMC II) =   0
 SUBAREA AREA(ACRES) =    3.70   SUBAREA RUNOFF(CFS) =    4.70
 TOTAL AREA(ACRES) =     22.30   TOTAL RUNOFF(CFS) =   30.90
 TC(MIN.) =  31.49

****************************************************************************
 FLOW PROCESS FROM NODE    735.00 TO NODE    720.00 IS CODE =  81
----------------------------------------------------------------------------
 >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
  100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  1.955
 *USER SPECIFIED(SUBAREA):
 USER-SPECIFIED RUNOFF COEFFICIENT = .6500
 S.C.S. CURVE NUMBER (AMC II) =   0
 SUBAREA AREA(ACRES) =    3.80   SUBAREA RUNOFF(CFS) =    4.83
 TOTAL AREA(ACRES) =     26.10   TOTAL RUNOFF(CFS) =   35.73
 TC(MIN.) =  31.49

****************************************************************************
 FLOW PROCESS FROM NODE    720.00 TO NODE    740.00 IS CODE =  41
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   345.50  DOWNSTREAM(FEET) =   345.00
 FLOW LENGTH(FEET) =    36.00   MANNING'S N =  0.013
 ASSUME FULL-FLOWING PIPELINE
 PIPE-FLOW VELOCITY(FEET/SEC.) =   9.19
 (PIPE FLOW VELOCITY CORRESPONDING TO NORMAL-DEPTH FLOW
  AT DEPTH = 0.82 * DIAMETER)
 GIVEN PIPE DIAMETER(INCH) =  24.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =     35.73
 PIPE TRAVEL TIME(MIN.) =   0.07    Tc(MIN.) =  31.56
 LONGEST FLOWPATH FROM NODE    700.00 TO NODE    740.00 =  3391.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    740.00 TO NODE    740.00 IS CODE =   1
----------------------------------------------------------------------------
 >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
 TOTAL NUMBER OF STREAMS =  2
 CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
 TIME OF CONCENTRATION(MIN.) =  31.56
 RAINFALL INTENSITY(INCH/HR) =   1.95
 TOTAL STREAM AREA(ACRES) =    26.10
 PEAK FLOW RATE(CFS) AT CONFLUENCE =     35.73

****************************************************************************
 FLOW PROCESS FROM NODE    750.00 TO NODE    752.00 IS CODE =  21
----------------------------------------------------------------------------
 >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
 *USER SPECIFIED(SUBAREA):
 USER-SPECIFIED RUNOFF COEFFICIENT = .7600
 S.C.S. CURVE NUMBER (AMC II) =   0
 INITIAL SUBAREA FLOW-LENGTH(FEET) =    65.00
 UPSTREAM ELEVATION(FEET) =    385.50
```

```
  DOWNSTREAM ELEVATION(FEET) =    384.80
  ELEVATION DIFFERENCE(FEET) =      0.70
  URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    4.814
  TIME OF CONCENTRATION ASSUMED AS 6-MIN.
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.210
  SUBAREA RUNOFF(CFS) =      0.96
  TOTAL AREA(ACRES) =      0.30   TOTAL RUNOFF(CFS) =      0.96

****************************************************************************
  FLOW PROCESS FROM NODE    752.00 TO NODE    740.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  1 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  384.80  DOWNSTREAM ELEVATION(FEET) =  350.50
  STREET LENGTH(FEET) =   800.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 18.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  13.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  2
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0180
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       3.31
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.24
    HALFSTREET FLOOD WIDTH(FEET) =    6.70
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    3.09
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.74
  STREET FLOW TRAVEL TIME(MIN.) =   4.31   Tc(MIN.) =  10.31
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.416
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  SUBAREA AREA(ACRES) =    2.10      SUBAREA RUNOFF(CFS) =    4.66
  TOTAL AREA(ACRES) =      2.40        PEAK FLOW RATE(CFS) =       5.62

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.27   HALFSTREET FLOOD WIDTH(FEET) =   8.48
  FLOW VELOCITY(FEET/SEC.) =  3.49   DEPTH*VELOCITY(FT*FT/SEC.) =   0.96
  LONGEST FLOWPATH FROM NODE    750.00 TO NODE    740.00 =   865.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    740.00 TO NODE    740.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =  10.31
  RAINFALL INTENSITY(INCH/HR) =   3.42
  TOTAL STREAM AREA(ACRES) =     2.40
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      5.62

  ** CONFLUENCE DATA **
  STREAM     RUNOFF      Tc      INTENSITY      AREA
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)    (ACRE)
      1       35.73    31.56        1.953         26.10
      2        5.62    10.31        3.416          2.40
```

```
  RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
  CONFLUENCE FORMULA USED FOR  2 STREAMS.

  ** PEAK FLOW RATE TABLE **
  STREAM     RUNOFF      Tc      INTENSITY
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)
      1       26.06    10.31       3.416
      2       38.94    31.56       1.953

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =     38.94   Tc(MIN.) =   31.56
  TOTAL AREA(ACRES) =     28.50
  LONGEST FLOWPATH FROM NODE    700.00 TO NODE    740.00 =  3391.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    740.00 TO NODE    795.00 IS CODE =  41
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   345.00  DOWNSTREAM(FEET) =   268.00
  FLOW LENGTH(FEET) =   335.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  24.0 INCH PIPE IS  10.2 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =  30.50
  GIVEN PIPE DIAMETER(INCH) =  24.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =     38.94
  PIPE TRAVEL TIME(MIN.) =   0.18    Tc(MIN.) =  31.74
  LONGEST FLOWPATH FROM NODE    700.00 TO NODE    795.00 =  3726.00 FEET.
============================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =     28.50  TC(MIN.) =     31.74
  PEAK FLOW RATE(CFS)   =     38.94
============================================================================
============================================================================
  END OF RATIONAL METHOD ANALYSIS

♀
```

APPENDIX B

Back-up Calculations for Weighted Runoff Coefficient
and
Copy of Rainfall-Intensity-Duration Curves from Drainage Design Manual (January 2017)

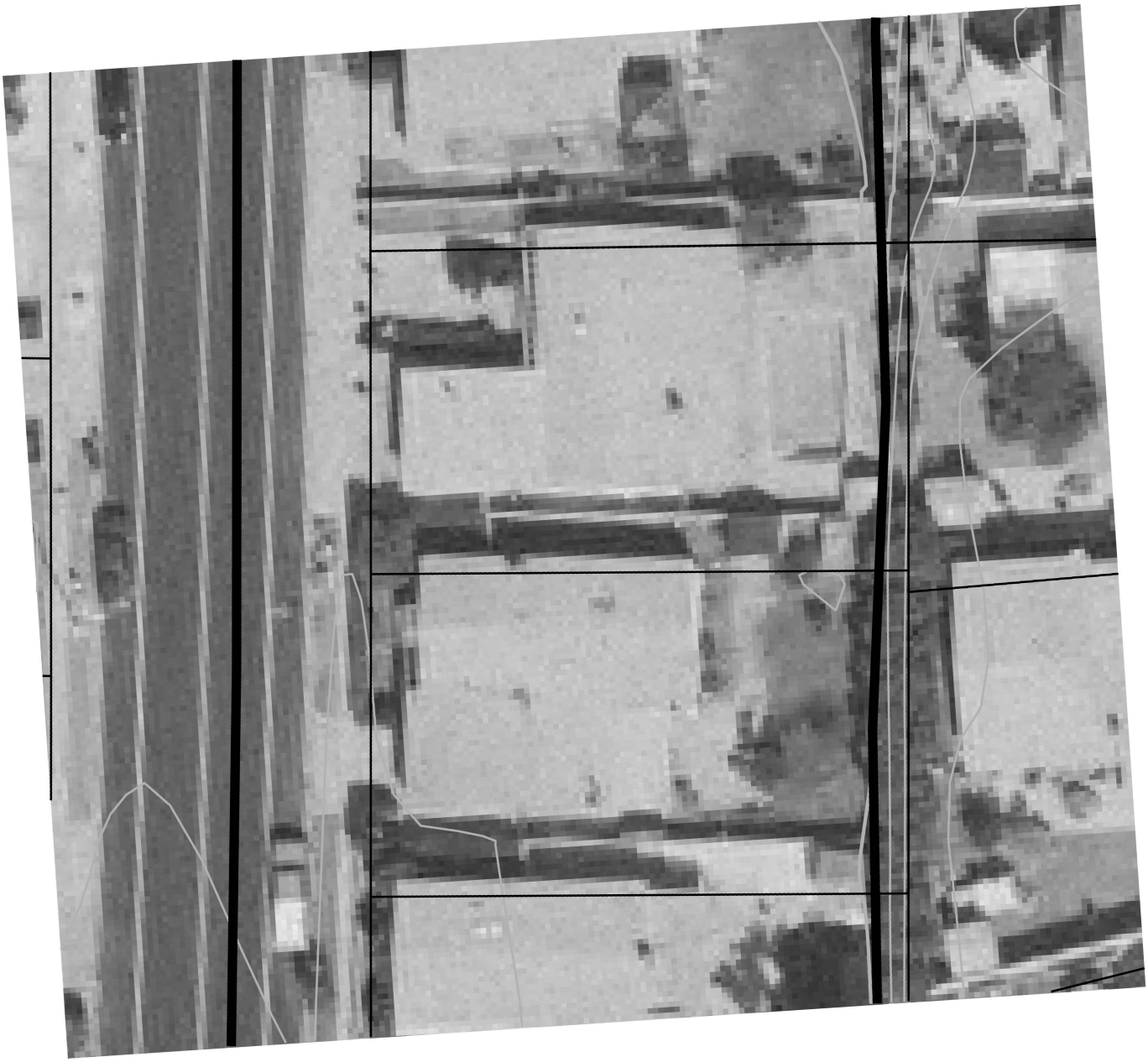
Weighted Runoff Coefficient Back-up

	Land Use			
	Medium Density Residential (7.3 DU/AC. or less)	**High Density Residential (24 DU/AC. or less)**	**Commercial (Neighborhood)**	**Asphalt/Concrete**
Runoff Coefficient for 'D' Soils[1]	0.57	0.71	0.79	0.95

U/S Node	**D/S Node**	**% Area by Land Use**				**Weighted Runoff Coefficient**
		Medium Density Residential (7.3 DU/AC. or less)	**High Density Residential (24 DU/AC. or less)**	**Commercial (Neighborhood)**	**Asphalt/Concrete**	
Typical[2]	Typical[2]	79%	0%	0%	21%	0.65
100	102	50%	0%	0%	50%	0.76
302	305	60%	0%	0%	40%	0.73
305	310	40%	30%	0%	30%	0.73
320	310	40%	15%	0%	45%	0.77
310	330	0%	0%	0%	100%	0.95
340	330	60%	15%	0%	25%	0.69
350	330	8%	25%	25%	42%	0.82
405	410	50%	0%	0%	50%	0.76
440	442	65%	0%	0%	35%	0.71
530	532	60%	0%	0%	40%	0.73
600	602	0%	0%	0%	100%	0.95
700	702	55%	0%	0%	45%	0.75
715	720	0%	0%	0%	100%	0.95
750	752	50%	0%	0%	50%	0.76

Notes:

1. The runoff coefficients for each land use are based on guidance provided in the Draft City of San Diego Drainage Design Manual (August 2016) and are modeled based on type 'D' soils.
2. A typical calculation has been prepared to address the majority of the drainage areas throughout this project. Refer to supporting exhibit in this appendix.



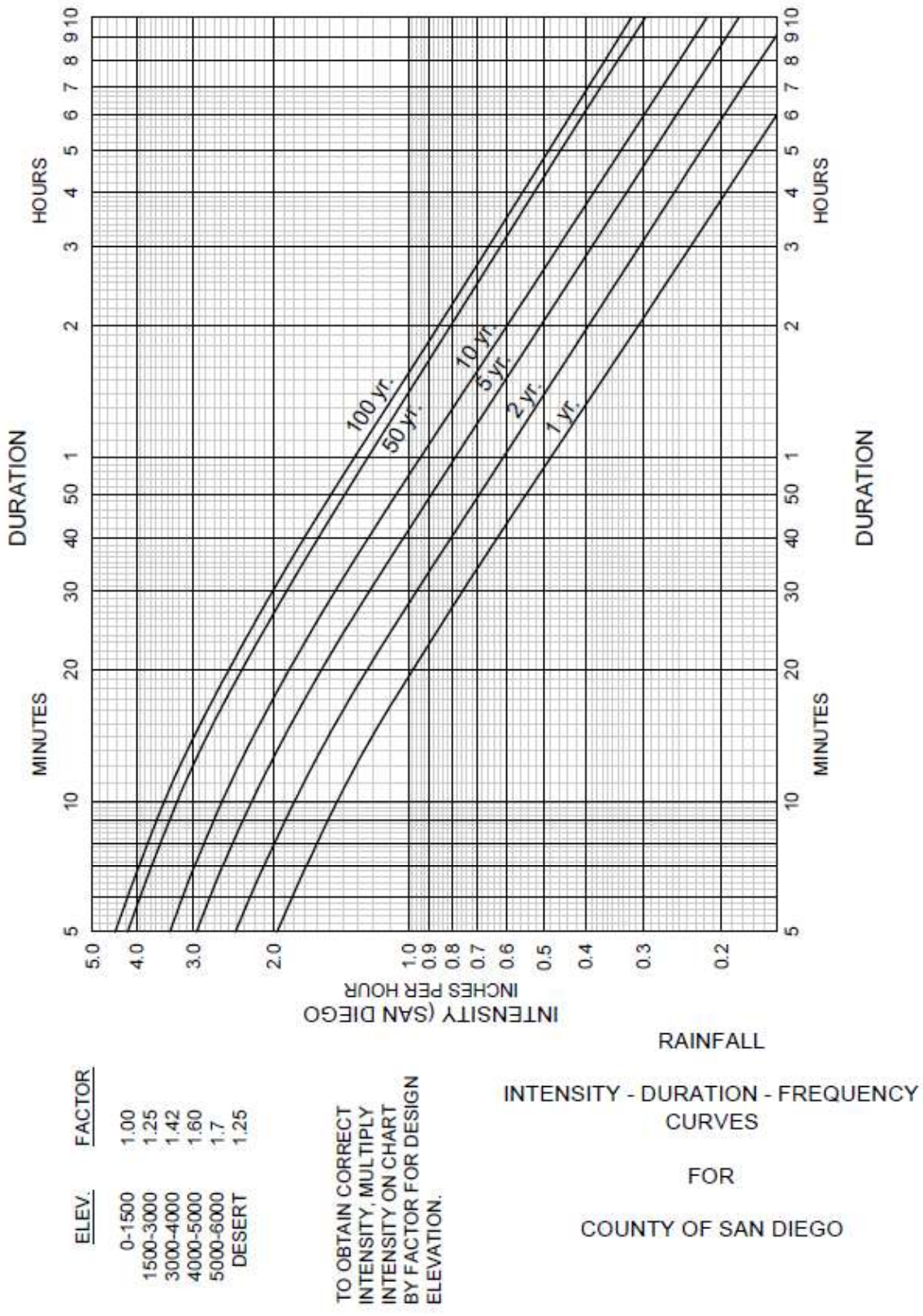


Figure A-1. Intensity-Duration-Frequency Design Chart

APPENDIX C

Inlet Sizing Calculations

Curb Inlet Sizing - Type 'B'

Drainage Basin	Drainage Node ID	Inlet Location[1]	Q_{100} Tributary to Inlet[2] (cfs)	Street Slope (%)	Minimum Inlet Opening Length (ft)	Minimum Inlet Structure Length (ft)
100	110	Sump	12.5	--	9	10
	140	Sump	5.4	--	4	5
200	215	Sump	11.1	--	8	9
300	330	Sump	25.2	--	17	18
400	410	Sump	7.4	--	5	6
	430	Sump	5.9	--	5	6
500	510	Sump	6.4	--	5	6
	520	Sump	10.9	--	9	10
600	605	Sump	9.2	--	7	8
	625	Sump	5.0	--	4	5
700	720 U/S	On-grade	6.7	3.6%	20	21
	720 D/S	On-grade	29.0	1.0%	20	21
	740	On-grade	5.6	1.0%	14	15

Legend:
Indicates existing inlets which have sufficient capacity and do not need to be replaced.

Notes:
1. Curb inlets in sump are designed to City of San Diego Drainage Design Manual (Draft August 2016) criteria for inlets in sump discussed in Chapter 3.
2. Since all curb inlets are being replaced, all proposed curb inlets are sized for full interception. The only exception is at Drainage Node 720 where the 100-year peak flow rate tributary to the inlet is approximately 35.7 cfs and cannot be intercepted by one curb inlet on-grade. As an improvement, an additional 21-ft Type 'B-1' inlet is proposed upstream to help intercept flows and the downstream inlet is maximized as a 21-ft Type 'B-1' inlet as well. With the combination of the two Type 'B' inlets, there will still be a relatively small amount of bypass in comparison to the pre-project condition where there is only one 15-fot Type 'B-2' inlet (per DWG: 7530).

Hydraulic Analysis Report

Project Data

Project Title: Serra Mesa Storm Drain and Green Infrastructure

Designer: SSL

Project Date: Wednesday, July 19, 2017

Project Units: U.S. Customary Units

Notes: Curb Inlet Sizing Calculations

Curb and Gutter Analysis: Curb and Gutter Analysis - Sump - Node 110

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0100 ft/ft

Cross-Slope of Pavement: 0.0200 ft/ft

Depressed Gutter Geometry

Cross-Slope of Gutter: 0.0833 ft/ft

Manning's n: 0.0150

Gutter Width: 1.5000 ft

Width of Spread: 17.7997 ft

Gutter Result Parameters

Design Flow: 12.5000 cfs

Gutter Depression: 1.1400 in

Area of Flow: 3.2395 ft^2

Eo (Gutter Flow to Total Flow): 0.2486

Gutter Depth at Curb: 5.4119 in

Inlet Input Parameters

Inlet Location: Inlet in Sag

Percent Clogging: 0.0000 %

Inlet Type: Curb Opening

Length of Inlet: 9.0000 ft

Curb opening height: 6.0000 in

Local Depression: 4.0000 in

Inlet Result Parameters

Perimeter: 11.7000 ft

Effective Perimeter: 11.7000 ft

Area: 7.5000 ft^2

Effective Area: 7.5000 ft^2

Depth at curb face (upstream of local depression): 0.5998 ft

Computed Width of Spread at Sag: 25.2394 ft

Flow type: Weir Flow

Efficiency: 1.0000

Curb and Gutter Analysis: Curb and Gutter Analysis - Sump - Node 140

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0150 ft/ft

Cross-Slope of Pavement: 0.0200 ft/ft

Depressed Gutter Geometry

Cross-Slope of Gutter: 0.0833 ft/ft

Manning's n: 0.0150

Gutter Width: 1.5000 ft

Design Flow: 4.8000 cfs

Gutter Result Parameters

Width of Spread: 11.2017 ft

Gutter Depression: 1.1400 in

Area of Flow: 1.3260 ft^2

Eo (Gutter Flow to Total Flow): 0.3995

Gutter Depth at Curb: 3.8284 in

Inlet Input Parameters

Inlet Location: Inlet in Sag

Percent Clogging: 0.0000 %

Inlet Type: Curb Opening

Length of Inlet: 4.0000 ft

Curb opening height: 6.0000 in

Local Depression: 4.0000 in

Inlet Result Parameters

Perimeter: 6.7000 ft

Effective Perimeter: 6.7000 ft

Area: 3.3333 ft^2

Effective Area: 3.3333 ft^2

Depth at curb face (upstream of local depression): 0.4595 ft

Computed Width of Spread at Sag: 18.2254 ft

Flow type: Weir Flow

Efficiency: 1.0000

Curb and Gutter Analysis: Curb and Gutter Analysis - Sump - Node 215

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0200 ft/ft

Cross-Slope of Pavement: 0.0200 ft/ft

Depressed Gutter Geometry

Cross-Slope of Gutter: 0.0833 ft/ft

Manning's n: 0.0150

Gutter Width: 1.5000 ft

Design Flow: 9.8000 cfs

Gutter Result Parameters

Width of Spread: 14.1101 ft

Gutter Depression: 1.1400 in

Area of Flow: 2.0622 ft^2

Eo (Gutter Flow to Total Flow): 0.3165

Gutter Depth at Curb: 4.5264 in

Inlet Input Parameters

Inlet Location: Inlet in Sag

Percent Clogging: 0.0000 %

Inlet Type: Curb Opening

Length of Inlet: 14.0000 ft

Curb opening height: 6.0000 in

Local Depression: 4.0000 in

Inlet Result Parameters

Perimeter: 14.0000 ft

Effective Perimeter: 14.0000 ft

Area: 11.6667 ft^2

Effective Area: 11.6667 ft^2

Depth at curb face (upstream of local depression): 0.3790 ft

Computed Width of Spread at Sag: 14.2005 ft

Flow type: Weir Flow

Efficiency: 1.0000

Curb and Gutter Analysis: Curb and Gutter Analysis - Sump - Node 410

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0170 ft/ft

Cross-Slope of Pavement: 0.0200 ft/ft

Depressed Gutter Geometry

Cross-Slope of Gutter: 0.0833 ft/ft

Manning's n: 0.0150

Gutter Width: 1.5000 ft

Design Flow: 7.4000 cfs

Gutter Result Parameters

Width of Spread: 13.0256 ft

Gutter Depression: 1.1400 in

Area of Flow: 1.7679 ft^2

Eo (Gutter Flow to Total Flow): 0.3435

Gutter Depth at Curb: 4.2661 in

Inlet Input Parameters

Inlet Location: Inlet in Sag

Percent Clogging: 0.0000 %

Inlet Type: Curb Opening

Length of Inlet: 5.0000 ft

Curb opening height: 6.0000 in

Local Depression: 4.0000 in

Inlet Result Parameters

Perimeter: 7.7000 ft

Effective Perimeter: 7.7000 ft

Area: 4.1667 ft^2

Effective Area: 4.1667 ft^2

Depth at curb face (upstream of local depression): 0.5589 ft

Computed Width of Spread at Sag: 23.1955 ft

Flow type: Weir Flow

Efficiency: 1.0000

Curb and Gutter Analysis: Curb and Gutter Analysis - Sump - Node 430

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0170 ft/ft

Cross-Slope of Pavement: 0.0200 ft/ft

Depressed Gutter Geometry

Cross-Slope of Gutter: 0.0833 ft/ft

Manning's n: 0.0150

Gutter Width: 1.5000 ft

Design Flow: 5.9000 cfs

Gutter Result Parameters

Width of Spread: 11.8826 ft

Gutter Depression: 1.1400 in

Area of Flow: 1.4832 ft^2

Eo (Gutter Flow to Total Flow): 0.3768

Gutter Depth at Curb: 3.9918 in

Inlet Input Parameters

Inlet Location: Inlet in Sag

Percent Clogging: 0.0000 %

Inlet Type: Curb Opening

Length of Inlet: 5.0000 ft

Curb opening height: 6.0000 in

Local Depression: 4.0000 in

Inlet Result Parameters

Perimeter: 7.7000 ft

Effective Perimeter: 7.7000 ft

Area: 4.1667 ft^2

Effective Area: 4.1667 ft^2

Depth at curb face (upstream of local depression): 0.4806 ft

Computed Width of Spread at Sag: 19.2785 ft

Flow type: Weir Flow

Efficiency: 1.0000

Curb and Gutter Analysis: Curb and Gutter Analysis - Sump - Node 510

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0200 ft/ft

Cross-Slope of Pavement: 0.0200 ft/ft

Depressed Gutter Geometry

Cross-Slope of Gutter: 0.0833 ft/ft

Manning's n: 0.0150

Gutter Width: 1.5000 ft

Design Flow: 6.4000 cfs

Gutter Result Parameters

Width of Spread: 11.8830 ft

Gutter Depression: 1.1400 in

Area of Flow: 1.4833 ft^2

Eo (Gutter Flow to Total Flow): 0.3768

Gutter Depth at Curb: 3.9919 in

Inlet Input Parameters

Inlet Location: Inlet in Sag

Percent Clogging: 0.0000 %

Inlet Type: Curb Opening

Length of Inlet: 5.0000 ft

Curb opening height: 6.0000 in

Local Depression: 4.0000 in

Inlet Result Parameters

Perimeter: 7.7000 ft

Effective Perimeter: 7.7000 ft

Area: 4.1667 ft^2

Effective Area: 4.1667 ft^2

Depth at curb face (upstream of local depression): 0.5073 ft

Computed Width of Spread at Sag: 20.6175 ft

Flow type: Weir Flow

Efficiency: 1.0000

Curb and Gutter Analysis: Curb and Gutter Analysis - Sump - Node 520

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0200 ft/ft

Cross-Slope of Pavement: 0.0200 ft/ft

Depressed Gutter Geometry

Cross-Slope of Gutter: 0.0833 ft/ft

Manning's n: 0.0150

Gutter Width: 1.5000 ft

Design Flow: 10.9000 cfs

Gutter Result Parameters

Width of Spread: 14.7197 ft

Gutter Depression: 1.1400 in

Area of Flow: 2.2379 ft^2

Eo (Gutter Flow to Total Flow): 0.3030

Gutter Depth at Curb: 4.6727 in

Inlet Input Parameters

Inlet Location: Inlet in Sag

Percent Clogging: 0.0000 %

Inlet Type: Curb Opening

Length of Inlet: 9.0000 ft

Curb opening height: 6.0000 in

Local Depression: 4.0000 in

Inlet Result Parameters

Perimeter: 11.7000 ft

Effective Perimeter: 11.7000 ft

Area: 7.5000 ft^2

Effective Area: 7.5000 ft^2

Depth at curb face (upstream of local depression): 0.5474 ft

Computed Width of Spread at Sag: 22.6224 ft

Flow type: Weir Flow

Efficiency: 1.0000

Curb and Gutter Analysis: Curb and Gutter Analysis - Sump - Node 605

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0200 ft/ft

Cross-Slope of Pavement: 0.0200 ft/ft

Depressed Gutter Geometry

Cross-Slope of Gutter: 0.0833 ft/ft

Manning's n: 0.0150

Gutter Width: 1.5000 ft

Design Flow: 9.2000 cfs

Gutter Result Parameters

Width of Spread: 13.7587 ft

Gutter Depression: 1.1400 in

Area of Flow: 1.9643 ft^2

Eo (Gutter Flow to Total Flow): 0.3248

Gutter Depth at Curb: 4.4421 in

Inlet Input Parameters

Inlet Location: Inlet in Sag

Percent Clogging: 0.0000 %

Inlet Type: Curb Opening

Length of Inlet: 7.0000 ft

Curb opening height: 6.0000 in

Local Depression: 4.0000 in

Inlet Result Parameters

Perimeter: 9.7000 ft

Effective Perimeter: 9.7000 ft

Area: 5.8333 ft^2

Effective Area: 5.8333 ft^2

Depth at curb face (upstream of local depression): 0.5540 ft

Computed Width of Spread at Sag: 22.9510 ft

Flow type: Weir Flow

Efficiency: 1.0000

Curb and Gutter Analysis: Curb and Gutter Analysis - Sump - Node 625

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0200 ft/ft

Cross-Slope of Pavement: 0.0200 ft/ft

Depressed Gutter Geometry

Cross-Slope of Gutter: 0.0833 ft/ft

Manning's n: 0.0150

Gutter Width: 1.5000 ft

Width of Spread: 10.7337 ft

Gutter Result Parameters

Design Flow: 5.0000 cfs

Gutter Depression: 1.1400 in

Area of Flow: 1.2234 ft^2

Eo (Gutter Flow to Total Flow): 0.4166

Gutter Depth at Curb: 3.7161 in

Inlet Input Parameters

Inlet Location: Inlet in Sag

Percent Clogging: 0.0000 %

Inlet Type: Curb Opening

Length of Inlet: 4.0000 ft

Curb opening height: 6.0000 in

Local Depression: 4.0000 in

Inlet Result Parameters

Perimeter: 6.7000 ft

Effective Perimeter: 6.7000 ft

Area: 3.3333 ft^2

Effective Area: 3.3333 ft^2

Depth at curb face (upstream of local depression): 0.4722 ft

Computed Width of Spread at Sag: 18.8592 ft

Flow type: Weir Flow

Efficiency: 1.0000

Curb and Gutter Analysis: Curb and Gutter Analysis - On-grade - Node 720 U/S

Notes: Based on the Rational Method results, Q100 to Node 720 is 35.7 cfs which is too much flow to be intercepted by one curb inlet; therefore, an extra Type 'B' inlet is proposed to collect flow upstream to improve the potential flooding situation in the pre-project condition (Node 720 Upstream). This inlet size has been maximized to the 20-ft opening length per City of San Diego Standard Drawing SDD-116 and is able to intercept 6.7 cfs.

Gutter Input Parameters

Longitudinal Slope of Road: 0.0360 ft/ft

Cross-Slope of Pavement: 0.0200 ft/ft

Depressed Gutter Geometry

Cross-Slope of Gutter: 0.0833 ft/ft

Manning's n: 0.0150

Gutter Width: 1.5000 ft

Design Flow: 6.7000 cfs

Gutter Result Parameters

Width of Spread: 10.7283 ft

Gutter Depression: 1.1400 in

Area of Flow: 1.2222 ft^2

Eo (Gutter Flow to Total Flow): 0.4168

Gutter Depth at Curb: 3.7148 in

Inlet Input Parameters

Inlet Location: Inlet on Grade

Inlet Type: Curb Opening

Length of Inlet: 20.0000 ft

Local Depression: 4.0000 in

Inlet Result Parameters

Intercepted Flow: 6.7000 cfs

Bypass Flow: 0.0000 cfs

Efficiency: 1.0000

Curb and Gutter Analysis: Curb and Gutter Analysis - On-grade - Node 720 D/S

Notes: Based on the Rational Method results, Q100 to Node 720 is 35.7 cfs which is too much flow to be intercepted by one curb inlet; therefore, an extra Type 'B' inlet is proposed to collect flow upstream to improve the potential flooding situation in the pre-project condition (Node 720 Upstream). This inlet size has been maximized to the 20-ft opening length per City of San Diego Standard Drawing SDD-116 and is modeled based off the remaining flow rate (35.7 cfs - 6.7 cfs) = 29.0 cfs; however, some flows will continue to bypass to the sump inlet approximately 650-ft downstream. The combination of these two proposed Type 'B' inlets will still provide a significant improvement to the pre-project condition.

Gutter Input Parameters

Longitudinal Slope of Road: 0.0100 ft/ft

Cross-Slope of Pavement: 0.0200 ft/ft

Depressed Gutter Geometry

Cross-Slope of Gutter: 0.0833 ft/ft

Manning's n: 0.0150

Gutter Width: 1.5000 ft

Design Flow: 29.0000 cfs

Gutter Result Parameters

Width of Spread: 24.6265 ft

Gutter Depression: 1.1400 in

Area of Flow: 6.1359 ft^2

Eo (Gutter Flow to Total Flow): 0.1767

Gutter Depth at Curb: 7.0504 in

Inlet Input Parameters

Inlet Location: Inlet on Grade

Inlet Type: Curb Opening

Length of Inlet: 20.0000 ft

Local Depression: 4.0000 in

Inlet Result Parameters

Intercepted Flow: 21.5067 cfs

Bypass Flow: 7.4933 cfs

Efficiency: 0.7416

Curb and Gutter Analysis: Curb and Gutter Analysis - On-grade - Node 740

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0100 ft/ft

Cross-Slope of Pavement: 0.0200 ft/ft

Depressed Gutter Geometry

Cross-Slope of Gutter: 0.0833 ft/ft

Manning's n: 0.0150

Gutter Width: 1.5000 ft

Width of Spread: 12.9555 ft

Gutter Result Parameters

Design Flow: 5.6000 cfs

Gutter Depression: 1.1400 in

Area of Flow: 1.7497 ft^2

Eo (Gutter Flow to Total Flow): 0.3453

Gutter Depth at Curb: 4.2493 in

Inlet Input Parameters

Inlet Location: Inlet on Grade

Inlet Type: Curb Opening

Length of Inlet: 14.0000 ft

Local Depression: 4.0000 in

Inlet Result Parameters

Intercepted Flow: 5.6000 cfs

Bypass Flow: 0.0000 cfs

Efficiency: 1.0000

Trench Drain Sizing Summary

		Water Quality Treatment Flow Rate Calculations						Trench Drain Sizing			
Drainage Management Area (DMA)	**Trench ID**	**Sub-Area Acreage (ac.)**	**% Impervious**	**Runoff Factor (Impervious)**	**Runoff Factor (Pervious)**	**Weighted Runoff Factor**	**Water Quality Treatment Flow Rate (cfs)**	**Approximate Longitudinal Gutter Approach Slope (%)**	**Length of Trench Required (ft)[2]**	**# of precast trenches**	**Total Provided Trench Length (ft)**
Site 3	1	9.5	70%	0.9	0.3	0.72	1.37	5.3%	18.44	6	19.5
	Total	**9.5**	**70%**				**1.37**				

Notes:
1. 85th percentile water quality storm event is based on a 0.2 in/hr storm pursuant to guidance in the City of San Diego Storm Water Standards Manual, October 2018.
2. Trench drain sizing performed using Bentley Flowmaster. See attached back-up.
3. A ACO K300 trench length is typically 1 meter, or approximately 39-inches in length.

Worksheet for Slotted Drain Inlet On Grade - Trench 1

Project Description

Solve For	Slot Length

Input Data

Discharge	1.40	ft³/s
Slope	0.05300	ft/ft
Gutter Width	1.50	ft
Gutter Cross Slope	0.08	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.015	
Efficiency	100.00	%
Local Depression	0.00	in
Local Depression Width	0.00	ft

Results

Slot Length	18.44	ft
Intercepted Flow	1.40	ft³/s
Bypass Flow	0.00	ft³/s
Spread	5.60	ft
Depth	0.18	ft
Flow Area	0.31	ft²
Gutter Depression	0.10	ft
Total Depression	0.10	ft
Velocity	4.54	ft/s
Equivalent Cross Slope	0.06442	ft/ft
Length Factor	1.00	
Total Interception Length	18.44	ft

Hydraulic Analysis Report

Project Data

Project Title: 17588G: Serra Mesa GI

Designer:

Project Date: Tuesday, December 03, 2019

Project Units: U.S. Customary Units

Notes: Inlet sizing for the proprietary compact biofiltration basin at Site 3

Curb and Gutter Analysis: MWSCurb_ShawnAveSouth

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0220 ft/ft

Cross-Slope of Pavement: 0.0510 ft/ft

Uniform Gutter Geometry

Manning's n: 0.0150

Gutter Width: 1.5000 ft

Design Flow: 0.4000 cfs

Gutter Result Parameters

Width of Spread: 2.3977 ft

Gutter Depression: 0.0000 in

Area of Flow: 0.1466 ft^2

Eo (Gutter Flow to Total Flow): 0.9274

Gutter Depth at Curb: 1.4674 in

Inlet Input Parameters

Inlet Location: Inlet on Grade

Inlet Type: Curb Opening

Length of Inlet: 4.0000 ft

Local Depression: 4.0000 in

Inlet Result Parameters

Intercepted Flow: 0.4000 cfs

Bypass Flow: 0.0000 cfs

Efficiency: 1.0000

Hydraulic Analysis Report

Project Data

Project Title: Serra Mesa SD/GI - Curb Cuts

Designer: SSL

Project Date: Thursday, July 13, 2017

Project Units: U.S. Customary Units

Notes: Curb cut sizing and street flow calculations for Green Infrastructure sites.

Curb and Gutter Analysis: Curb Cut Capacity (DMA 4-1B) - 2-ft BW, 1:1 SS @ 1.7% 1st Opening

Notes: Since the location of the curb cut is inline with the gutter, the flow into the biofiltration basin is governed by the spread width. A 2-ft spread width flowing to a 2-ft curb cut means that all the water would reach the biofiltration bulbout. Therefore, based on this curb cut configuration, it is feasible to intercept the full water quality flow rate with the first curb cut in the series.

Gutter Input Parameters

Longitudinal Slope of Road: 0.0170 ft/ft

Cross-Slope of Pavement: 0.0200 ft/ft

Depressed Gutter Geometry

Cross-Slope of Gutter: 0.0833 ft/ft

Manning's n: 0.0150

Gutter Width: 1.5000 ft

Width of Spread: 1.6895 ft

Gutter Result Parameters

Design Flow: 0.2470 cfs

Gutter Depression: 1.1394 in

Area of Flow: 0.0998 ft^2

Eo (Gutter Flow to Total Flow): 0.9997

Gutter Depth at Curb: 1.5449 in

Inlet Input Parameters

Inlet Location: Inlet on Grade

Inlet Type: Curb Opening

Length of Inlet: 2.0000 ft

Local Depression: 2.0000 in

Inlet Result Parameters

Intercepted Flow: 0.2023 cfs

Bypass Flow: 0.0447 cfs

Efficiency: 0.8191

Curb and Gutter Analysis: Curb Cut Capacity (DMA 5-1A) - 2-ft BW, 1:1 SS @ 2% 1st Opening

Notes: Since the location of the curb cut is inline with the gutter, the flow into the biofiltration basin is governed by the spread width. A 2-ft spread width flowing to a 2-ft curb cut means that all the water would reach the biofiltration bulbout. Therefore, based on this curb cut configuration, it is feasible to intercept a portion of the water quality flow rate with the first curb cut in the series.

Gutter Input Parameters

Longitudinal Slope of Road: 0.0200 ft/ft

Cross-Slope of Pavement: 0.0200 ft/ft

Depressed Gutter Geometry

Cross-Slope of Gutter: 0.0830 ft/ft

Manning's n: 0.0150

Gutter Width: 1.5000 ft

Width of Spread: 1.9757 ft

Gutter Result Parameters

Design Flow: 0.3000 cfs

Gutter Depression: 1.1340 in

Area of Flow: 0.1099 ft^2

Eo (Gutter Flow to Total Flow): 0.9965

Gutter Depth at Curb: 1.6082 in

Inlet Input Parameters

Inlet Location: Inlet on Grade

Inlet Type: Curb Opening

Length of Inlet: 2.0000 ft

Local Depression: 2.0000 in

Inlet Result Parameters

Intercepted Flow: 0.2249 cfs

Bypass Flow: 0.0751 cfs

Efficiency: 0.7498

Curb and Gutter Analysis: Curb Cut Capacity (DMA 5-1A) - 2-ft BW, 1:1 SS @ 2% 2nd Opening

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0200 ft/ft

Cross-Slope of Pavement: 0.0200 ft/ft

Depressed Gutter Geometry

Cross-Slope of Gutter: 0.0833 ft/ft

Manning's n: 0.0150

Gutter Width: 1.5000 ft

Width of Spread: 1.3668 ft

Gutter Result Parameters

Design Flow: 0.1930 cfs

Gutter Depression: 1.1394 in

Area of Flow: 0.0899 ft^2

Eo (Gutter Flow to Total Flow): 1.0000

Gutter Depth at Curb: 1.4674 in

Inlet Input Parameters

Inlet Location: Inlet on Grade

Inlet Type: Curb Opening

Length of Inlet: 2.0000 ft

Local Depression: 2.0000 in

Inlet Result Parameters

Intercepted Flow: 0.1635 cfs

Bypass Flow: 0.0295 cfs

Efficiency: 0.8473

Curb and Gutter Analysis: Curb Cut Capacity (DMA 5-1A) - 2-ft BW, 1:1 SS @ 2% 3rd Opening

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0200 ft/ft

Cross-Slope of Pavement: 0.0200 ft/ft

Depressed Gutter Geometry

Cross-Slope of Gutter: 0.0830 ft/ft

Manning's n: 0.0150

Gutter Width: 1.5000 ft

Width of Spread: 0.6730 ft

Gutter Result Parameters

Design Flow: 0.0290 cfs

Gutter Depression: 1.1340 in

Area of Flow: 0.0754 ft^2

Eo (Gutter Flow to Total Flow): 1.0000

Gutter Depth at Curb: 1.2955 in

Inlet Input Parameters

Inlet Location: Inlet on Grade

Inlet Type: Curb Opening

Length of Inlet: 2.0000 ft

Local Depression: 2.0000 in

Inlet Result Parameters

Intercepted Flow: 0.0290 cfs

Bypass Flow: 0.0000 cfs

Efficiency: 1.0000

APPENDIX D

Dry Lane Calculations

Serra Mesa SD/GI Improvements
J-17588-G
11/17/16

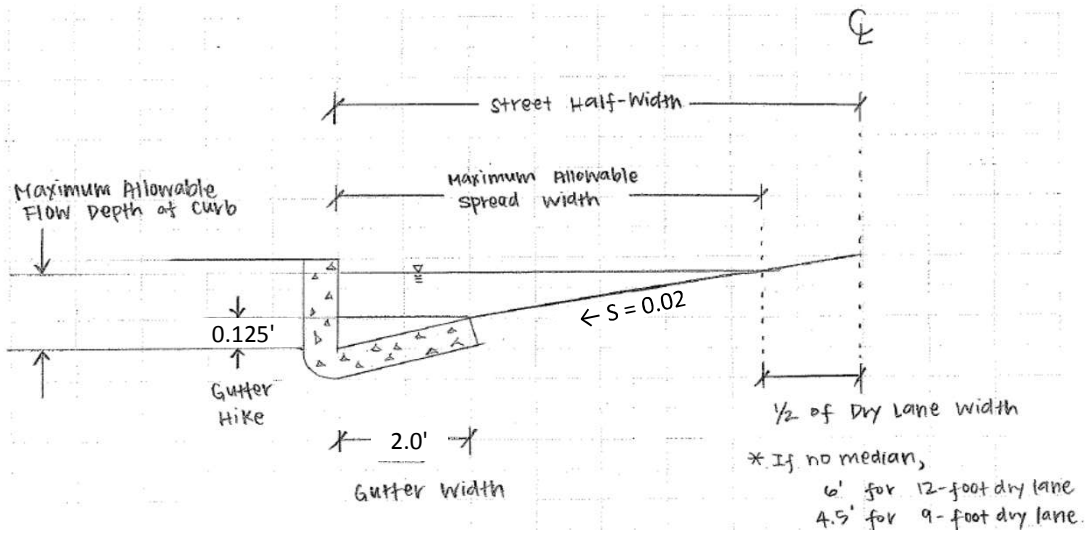
Calculation for Public Streets Maximum Allowable Spread Width and Flow Depth at Curb

Maximum Allowable Spread Width (for streets without medians) = Street Half-Width - 0.5*(Dry Lane Width)
Maximum Allowable Spread Width (for streets with medians) = Curb to Curb width - Dry Lane Width
Maximum Allowable Flow Depth at Curb = 0.125 + 0.02*(Maximum Allowable Spread Width - 2.0)

Drainage Basin ID	Street Name	Street Half Width (feet)	Maximum Allowable			
			Spread Width (feet)		Flow Depth at Curb (feet) [1]	
			12-Foot Dry Lane	9-Foot Dry Lane	12-Foot Dry Lane	9-Foot Dry Lane
100	**Monarch Street**	18	12	13.5	0.33	0.36
200	**Monarch Street**	15	9	10.5	0.27	0.30
300	**Shawn Avenue**	35	29	30.5	0.67	0.70
400	**Palace Drive**	12	6	7.5	0.21	0.24
500	**Larrabee Avenue**	12	6	7.5	0.21	0.24
600	**Walker Drive**	18	12	13.5	0.33	0.36
700	**Mobley Street**	18	12	13.5	0.33	0.36

Note- 1: For instances where the maximum allowable flow depth at curb exceeds 0.4' per Dry Lane calculations, the actual depth shall not exceed 0.4-feet per City of San Diego criteria (i.e. "-0.1-feet " below top of curb.

Serra Mesa SD/GI Improvements
J-17588-G
11/17/16



APPENDIX E

AES Pipe Flow Hydraulic Analyses

```
**************************************************************************
              PIPE-FLOW HYDRAULICS COMPUTER PROGRAM PACKAGE
          (Reference: LACFCD,LACRD, AND OCEMA HYDRAULICS CRITERION)
        (c) Copyright 1982-2014 Advanced Engineering Software (aes)
            Ver. 21.0  Release Date: 06/01/2014  License ID 1261

                          Analysis prepared by:

                        RICK ENGINEERING COMPANY
                            5620 Friars Road
                         San Diego, California 92110
                       619-291-0707   Fax 619-291-4165

  ************************* DESCRIPTION OF STUDY *************************
 * SERRA MESA STORM DRAIN AND GREEN INFRASTRUCTURE IMPROVEMENTS           *
 * J-17588-G                                                              *
 * POST-PROJECT CONDITION - CAPACITY RUN; BASIN 100 OUTFALL               *
  ************************************************************************

   FILE NAME: 195.PIP
   TIME/DATE OF STUDY: 17:04 05/31/2017
```

```
**************************************************************************
               GRADUALLY VARIED FLOW ANALYSIS FOR PIPE SYSTEM
                        NODAL POINT STATUS TABLE
                (Note: "*" indicates nodal point data used.)
                      UPSTREAM RUN                    DOWNSTREAM RUN
    NODE     MODEL    PRESSURE      PRESSURE+          FLOW         PRESSURE+
   NUMBER  PROCESS  HEAD(FT)   MOMENTUM(POUNDS)   DEPTH(FT)   MOMENTUM(POUNDS)
   195.00-              2.00             382.79        0.74*             578.11
         } FRICTION
   190.00-              1.95             373.67        0.70*             620.23
         } JUNCTION
   190.00-              1.99             380.95        0.48*            1014.04
         } FRICTION
   185.00-              1.50 Dc          338.01        0.73*             581.39
         } JUNCTION
   185.00-              1.44 Dc          412.64        0.85*             590.99
         } FRICTION
   140.00-              1.44*Dc          412.64        1.44*Dc           412.64
         } CATCH BASIN
   140.00-              3.29*            280.64        1.44 Dc            76.61
--------------------------------------------------------------------------
  MAXIMUM NUMBER OF ENERGY BALANCES USED IN EACH PROFILE =  25
--------------------------------------------------------------------------
  NOTE: STEADY FLOW HYDRAULIC HEAD-LOSS COMPUTATIONS BASED ON THE MOST
  CONSERVATIVE FORMULAE FROM THE CURRENT LACRD,LACFCD, AND OCEMA
  DESIGN MANUALS.
**************************************************************************
  DOWNSTREAM PIPE FLOW CONTROL DATA:
  NODE NUMBER =   195.00            FLOWLINE ELEVATION =   290.62
  PIPE FLOW =      17.40 CFS        PIPE DIAMETER =  24.00 INCHES
  ASSUMED DOWNSTREAM CONTROL HGL =   292.620 FEET
--------------------------------------------------------------------------
  NODE   195.00 : HGL = <  291.357>;EGL= <  295.609>;FLOWLINE= <  290.620>

**************************************************************************
  FLOW PROCESS FROM NODE   195.00 TO NODE   190.00 IS CODE =  1
  UPSTREAM NODE   190.00     ELEVATION =   290.72  (FLOW IS SUPERCRITICAL)
--------------------------------------------------------------------------
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW   =      17.40 CFS     PIPE DIAMETER =  24.00 INCHES
```

```
 PIPE LENGTH =       9.80 FEET          MANNING'S N  =  0.01300
-------------------------------------------------------------------------------
 NORMAL DEPTH(FT) =      1.31           CRITICAL DEPTH(FT) =      1.50
===============================================================================
 UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) =     0.70
===============================================================================
 GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:
-------------------------------------------------------------------------------
 DISTANCE FROM      FLOW DEPTH  VELOCITY      SPECIFIC        PRESSURE+
  CONTROL(FT)          (FT)    (FT/SEC)     ENERGY(FT)    MOMENTUM(POUNDS)
        0.000          0.697     17.867          5.657           620.23
        5.858          0.721     17.051          5.238           594.20
        9.800          0.737     16.543          4.989           578.11
-------------------------------------------------------------------------------
 NODE   190.00 : HGL = <  291.417>;EGL= <  296.377>;FLOWLINE= <  290.720>

*******************************************************************************
 FLOW PROCESS FROM NODE   190.00 TO NODE   190.00 IS CODE =  5
 UPSTREAM NODE   190.00     ELEVATION =   291.05  (FLOW IS SUPERCRITICAL)
-------------------------------------------------------------------------------
 CALCULATE JUNCTION LOSSES:
      PIPE        FLOW    DIAMETER   ANGLE    FLOWLINE   CRITICAL   VELOCITY
                  (CFS)   (INCHES) (DEGREES) ELEVATION  DEPTH(FT.)  (FT/SEC)
    UPSTREAM      17.40    24.00     49.50    291.05      1.50       29.860
   DOWNSTREAM     17.40    24.00       -      290.72      1.50       17.873
   LATERAL #1      0.00     0.00      0.00      0.00      0.00        0.000
   LATERAL #2      0.00     0.00      0.00      0.00      0.00        0.000
      Q5           0.00===Q5 EQUALS BASIN INPUT===

 LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
 DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
     Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
 UPSTREAM:    MANNING'S N = 0.01300;  FRICTION SLOPE = 0.36560
 DOWNSTREAM:  MANNING'S N = 0.01300;  FRICTION SLOPE = 0.08714
 AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.22637
 JUNCTION LENGTH =   4.00 FEET
 FRICTION LOSSES =  0.905 FEET         ENTRANCE LOSSES =  0.000 FEET
 JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
 JUNCTION LOSSES = ( 9.000)+( 0.000) =   9.000
-------------------------------------------------------------------------------
 NODE   190.00 : HGL = <  291.532>;EGL= <  305.377>;FLOWLINE= <  291.050>

*******************************************************************************
 FLOW PROCESS FROM NODE   190.00 TO NODE   185.00 IS CODE =  1
 UPSTREAM NODE   185.00     ELEVATION =   340.83  (FLOW IS SUPERCRITICAL)
-------------------------------------------------------------------------------
 CALCULATE FRICTION LOSSES(LACFCD):
 PIPE FLOW   =      17.40 CFS     PIPE DIAMETER =  24.00 INCHES
 PIPE LENGTH =     125.40 FEET          MANNING'S N  =  0.01300
-------------------------------------------------------------------------------
 NORMAL DEPTH(FT) =      0.47           CRITICAL DEPTH(FT) =      1.50
===============================================================================
 UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) =     0.73
===============================================================================
 GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:
-------------------------------------------------------------------------------
 DISTANCE FROM      FLOW DEPTH  VELOCITY      SPECIFIC        PRESSURE+
  CONTROL(FT)          (FT)    (FT/SEC)     ENERGY(FT)    MOMENTUM(POUNDS)
        0.000          0.734     16.647          5.039           581.39
        0.497          0.723     16.974          5.200           591.77
        1.031          0.713     17.314          5.371           602.57
        1.607          0.702     17.667          5.552           613.81
        2.228          0.692     18.033          5.744           625.52
```

2.899	0.681	18.413	5.949	637.71
3.627	0.671	18.807	6.167	650.42
4.417	0.661	19.218	6.399	663.66
5.280	0.650	19.645	6.646	677.48
6.222	0.640	20.090	6.910	691.91
7.258	0.629	20.553	7.192	706.97
8.399	0.619	21.036	7.494	722.71
9.663	0.608	21.539	7.817	739.16
11.072	0.598	22.065	8.162	756.37
12.651	0.587	22.614	8.533	774.38
14.435	0.577	23.188	8.931	793.24
16.470	0.566	23.789	9.359	813.02
18.816	0.556	24.418	9.820	833.76
21.561	0.545	25.077	10.316	855.53
24.829	0.535	25.768	10.852	878.41
28.818	0.524	26.494	11.431	902.46
33.854	0.514	27.257	12.058	927.78
40.554	0.503	28.060	12.737	954.44
50.301	0.493	28.905	13.475	982.56
67.534	0.482	29.797	14.277	1012.23
125.400	0.482	29.851	14.327	1014.04

NODE 185.00 : HGL = < 341.564>;EGL= < 345.869>;FLOWLINE= < 340.830>

****

FLOW PROCESS FROM NODE 185.00 TO NODE 185.00 IS CODE = 5
UPSTREAM NODE 185.00 ELEVATION = 341.16 (FLOW IS SUPERCRITICAL)

CALCULATE JUNCTION LOSSES:

PIPE	FLOW (CFS)	DIAMETER (INCHES)	ANGLE (DEGREES)	FLOWLINE ELEVATION	CRITICAL DEPTH(FT.)	VELOCITY (FT/SEC)
UPSTREAM	17.40	18.00	4.90	341.16	1.44	16.828
DOWNSTREAM	17.40	24.00	-	340.83	1.50	16.652
LATERAL #1	0.00	0.00	0.00	0.00	0.00	0.000
LATERAL #2	0.00	0.00	0.00	0.00	0.00	0.000
Q5	0.00===Q5 EQUALS BASIN INPUT===					

LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
UPSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.07251
DOWNSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.07166
AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.07209
JUNCTION LENGTH = 4.00 FEET
FRICTION LOSSES = 0.288 FEET ENTRANCE LOSSES = 0.000 FEET
JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
JUNCTION LOSSES = (0.538)+(0.000) = 0.538

NODE 185.00 : HGL = < 342.011>;EGL= < 346.408>;FLOWLINE= < 341.160>

****

FLOW PROCESS FROM NODE 185.00 TO NODE 140.00 IS CODE = 1
UPSTREAM NODE 140.00 ELEVATION = 348.00 (FLOW IS SUPERCRITICAL)

CALCULATE FRICTION LOSSES(LACFCD):
PIPE FLOW = 17.40 CFS PIPE DIAMETER = 18.00 INCHES
PIPE LENGTH = 83.00 FEET MANNING'S N = 0.01300

NORMAL DEPTH(FT) = 0.82 CRITICAL DEPTH(FT) = 1.44

==========

UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) = 1.44

==========

GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:

DISTANCE FROM CONTROL(FT)	FLOW DEPTH (FT)	VELOCITY (FT/SEC)	SPECIFIC ENERGY(FT)	PRESSURE+ MOMENTUM(POUNDS)
0.000	1.445	9.962	2.987	412.64
0.050	1.419	10.052	2.989	412.95
0.192	1.394	10.159	2.998	413.85
0.423	1.369	10.280	3.011	415.29
0.744	1.344	10.417	3.030	417.25
1.156	1.319	10.567	3.054	419.72
1.667	1.294	10.731	3.083	422.71
2.283	1.269	10.910	3.118	426.22
3.016	1.244	11.103	3.159	430.26
3.879	1.219	11.311	3.207	434.86
4.887	1.194	11.535	3.261	440.03
6.063	1.169	11.776	3.323	445.80
7.431	1.144	12.033	3.393	452.21
9.023	1.118	12.309	3.473	459.28
10.882	1.093	12.605	3.562	467.06
13.062	1.068	12.921	3.662	475.58
15.633	1.043	13.259	3.775	484.92
18.694	1.018	13.622	3.901	495.11
22.382	0.993	14.010	4.043	506.23
26.899	0.968	14.426	4.201	518.34
32.559	0.943	14.872	4.379	531.54
39.889	0.918	15.351	4.579	545.90
49.880	0.893	15.867	4.804	561.54
64.757	0.868	16.422	5.058	578.58
83.000	0.851	16.822	5.248	590.99

NODE 140.00 : HGL = < 349.445>;EGL= < 350.987>;FLOWLINE= < 348.000>

****

FLOW PROCESS FROM NODE 140.00 TO NODE 140.00 IS CODE = 8
UPSTREAM NODE 140.00 ELEVATION = 348.00 (FLOW UNSEALS IN REACH)

CALCULATE CATCH BASIN ENTRANCE LOSSES(LACFCD):
PIPE FLOW = 17.40 CFS PIPE DIAMETER = 18.00 INCHES
FLOW VELOCITY = 9.97 FEET/SEC. VELOCITY HEAD = 1.542 FEET
CATCH BASIN ENERGY LOSS = .2*(VELOCITY HEAD) = .2*(1.542) = 0.308

NODE 140.00 : HGL = < 351.295>;EGL= < 351.295>;FLOWLINE= < 348.000>

****

UPSTREAM PIPE FLOW CONTROL DATA:
NODE NUMBER = 140.00 FLOWLINE ELEVATION = 348.00
ASSUMED UPSTREAM CONTROL HGL = 349.44 FOR DOWNSTREAM RUN ANALYSIS

==========

END OF GRADUALLY VARIED FLOW ANALYSIS

♀

```
******************************************************************************
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            Ver. 21.0  Release Date: 06/01/2014  License ID 1261

                             Analysis prepared by:

                           RICK ENGINEERING COMPANY
                               5620 Friars Road
                            San Diego, California 92110
                          619-291-0707   Fax 619-291-4165

  ************************* DESCRIPTION OF STUDY *************************
 * SERRA MESA STORM DRAIN AND GREEN INFRASTRUCTURE IMPROVEMENTS            *
 * J-17588-G                                                               *
 * POST-PROJECT CONDITION - CAPACITY RUN; BASIN 200 OUTFALL                *
  ************************************************************************

   FILE NAME: 295.PIP
   TIME/DATE OF STUDY: 14:27 05/24/2017
```

```
******************************************************************************
                GRADUALLY VARIED FLOW ANALYSIS FOR PIPE SYSTEM
                        NODAL POINT STATUS TABLE
                 (Note: "*" indicates nodal point data used.)
                      UPSTREAM RUN                    DOWNSTREAM RUN
    NODE     MODEL    PRESSURE      PRESSURE+          FLOW         PRESSURE+
   NUMBER  PROCESS  HEAD(FT)   MOMENTUM(POUNDS)   DEPTH(FT)   MOMENTUM(POUNDS)
   295.00-              2.00*            272.04        0.85             215.08
         } FRICTION
   290.00-              1.91*            256.45        0.83             219.85
         } JUNCTION
   290.00-              1.79             236.95        0.46*            448.35
         } FRICTION
   285.00-              1.19 Dc          185.00        0.65*            282.42
         } JUNCTION
   285.00-              1.43             194.42        0.36*            633.21
         } FRICTION
   280.00-              1.19 Dc          185.00        0.76*            238.30
         } JUNCTION
   280.00-              1.19 Dc          185.00        0.79*            231.48
         } FRICTION
   215.00-              1.19*Dc          185.00        1.19*Dc          185.00
         } CATCH BASIN
   215.00-              1.79*            103.14        1.19 Dc           63.06
------------------------------------------------------------------------------
  MAXIMUM NUMBER OF ENERGY BALANCES USED IN EACH PROFILE =  25
------------------------------------------------------------------------------
  NOTE: STEADY FLOW HYDRAULIC HEAD-LOSS COMPUTATIONS BASED ON THE MOST
  CONSERVATIVE FORMULAE FROM THE CURRENT LACRD,LACFCD, AND OCEMA
  DESIGN MANUALS.
******************************************************************************
  DOWNSTREAM PIPE FLOW CONTROL DATA:
  NODE NUMBER =   295.00            FLOWLINE ELEVATION =   202.44
  PIPE FLOW =      11.10 CFS        PIPE DIAMETER =  24.00 INCHES
  ASSUMED DOWNSTREAM CONTROL HGL =   204.440 FEET
------------------------------------------------------------------------------
  NODE   295.00 : HGL = <  204.440>;EGL= <  204.634>;FLOWLINE= <  202.440>

******************************************************************************
  FLOW PROCESS FROM NODE   295.00 TO NODE   290.00 IS CODE =  1
```

```
  UPSTREAM NODE   290.00     ELEVATION =   202.54  (FLOW SEALS IN REACH)
--------------------------------------------------------------------------------
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW    =      11.10 CFS     PIPE DIAMETER =  24.00 INCHES
  PIPE LENGTH =       9.20 FEET          MANNING'S N  =  0.01300
--------------------------------------------------------------------------------
  NORMAL DEPTH(FT) =      0.97          CRITICAL DEPTH(FT) =      1.19
================================================================================
  DOWNSTREAM CONTROL ASSUMED PRESSURE HEAD(FT) =     2.00
================================================================================
  GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:
--------------------------------------------------------------------------------
  DISTANCE FROM      FLOW DEPTH  VELOCITY      SPECIFIC        PRESSURE+
   CONTROL(FT)           (FT)    (FT/SEC)     ENERGY(FT)    MOMENTUM(POUNDS)
         0.000          2.000      3.532          2.194           272.04
         3.590          1.968      3.544          2.163           266.00
         6.996          1.936      3.567          2.133           260.20
         9.200          1.914      3.586          2.114           256.45
--------------------------------------------------------------------------------
  NODE   290.00 : HGL = <  204.454>;EGL= <  204.654>;FLOWLINE= <  202.540>

********************************************************************************
  FLOW PROCESS FROM NODE   290.00 TO NODE   290.00 IS CODE =  5
  UPSTREAM NODE   290.00     ELEVATION =   202.87  (FLOW IS SUBCRITICAL)
  (NOTE: POSSIBLE JUMP IN OR UPSTREAM OF STRUCTURE)
--------------------------------------------------------------------------------
  CALCULATE JUNCTION LOSSES:
       PIPE        FLOW    DIAMETER   ANGLE    FLOWLINE   CRITICAL   VELOCITY
                   (CFS)   (INCHES) (DEGREES) ELEVATION  DEPTH(FT.)  (FT/SEC)
     UPSTREAM      11.10    24.00     60.00    202.87      1.19       20.551
    DOWNSTREAM     11.10    24.00       -      202.54      1.19        3.587
    LATERAL #1      0.00     0.00      0.00      0.00      0.00        0.000
    LATERAL #2      0.00     0.00      0.00      0.00      0.00        0.000
       Q5           0.00===Q5 EQUALS BASIN INPUT===

  LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
  DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
      Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
  UPSTREAM:    MANNING'S N = 0.01300;  FRICTION SLOPE = 0.18426
  DOWNSTREAM:  MANNING'S N = 0.01300;  FRICTION SLOPE = 0.00209
  AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.09318
  JUNCTION LENGTH =   4.00 FEET
  FRICTION LOSSES =  0.373 FEET         ENTRANCE LOSSES =  0.000 FEET
  JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
  JUNCTION LOSSES = ( 5.231)+( 0.000) =   5.231
--------------------------------------------------------------------------------
  NODE   290.00 : HGL = <  203.327>;EGL= <  209.885>;FLOWLINE= <  202.870>

********************************************************************************
  FLOW PROCESS FROM NODE   290.00 TO NODE   285.00 IS CODE =  1
  UPSTREAM NODE   285.00     ELEVATION =   210.53  (FLOW IS SUPERCRITICAL)
--------------------------------------------------------------------------------
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW    =      11.10 CFS     PIPE DIAMETER =  24.00 INCHES
  PIPE LENGTH =      29.90 FEET          MANNING'S N  =  0.01300
--------------------------------------------------------------------------------
  NORMAL DEPTH(FT) =      0.42          CRITICAL DEPTH(FT) =      1.19
================================================================================
  UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) =     0.65
================================================================================
  GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:
--------------------------------------------------------------------------------
  DISTANCE FROM      FLOW DEPTH  VELOCITY      SPECIFIC        PRESSURE+
```

CONTROL(FT)	(FT)	(FT/SEC)	ENERGY(FT)	MOMENTUM(POUNDS)
0.000	0.654	12.424	3.053	282.42
0.417	0.645	12.672	3.140	287.25
0.866	0.635	12.930	3.233	292.28
1.350	0.626	13.197	3.332	297.53
1.874	0.617	13.474	3.438	303.01
2.442	0.607	13.762	3.550	308.72
3.058	0.598	14.061	3.670	314.69
3.729	0.589	14.371	3.798	320.92
4.462	0.579	14.695	3.935	327.44
5.265	0.570	15.031	4.081	334.24
6.148	0.561	15.382	4.237	341.36
7.123	0.551	15.747	4.404	348.81
8.204	0.542	16.128	4.584	356.60
9.411	0.533	16.526	4.776	364.77
10.765	0.523	16.942	4.983	373.32
12.297	0.514	17.376	5.205	382.29
14.045	0.505	17.831	5.445	391.71
16.064	0.495	18.307	5.702	401.59
18.427	0.486	18.805	5.981	411.97
21.244	0.477	19.329	6.281	422.89
24.684	0.467	19.878	6.607	434.38
29.032	0.458	20.455	6.959	446.48
29.900	0.457	20.544	7.015	448.35

NODE 285.00 : HGL = < 211.184>;EGL= < 213.583>;FLOWLINE= < 210.530>

****

FLOW PROCESS FROM NODE 285.00 TO NODE 285.00 IS CODE = 5
UPSTREAM NODE 285.00 ELEVATION = 210.86 (FLOW IS SUPERCRITICAL)

CALCULATE JUNCTION LOSSES:

PIPE	FLOW (CFS)	DIAMETER (INCHES)	ANGLE (DEGREES)	FLOWLINE ELEVATION	CRITICAL DEPTH(FT.)	VELOCITY (FT/SEC)
UPSTREAM	11.10	24.00	60.00	210.86	1.19	29.278
DOWNSTREAM	11.10	24.00	-	210.53	1.19	12.428
LATERAL #1	0.00	0.00	0.00	0.00	0.00	0.000
LATERAL #2	0.00	0.00	0.00	0.00	0.00	0.000
Q5	0.00===Q5 EQUALS BASIN INPUT===					

LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
UPSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.50171
DOWNSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.04503
AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.27337
JUNCTION LENGTH = 4.00 FEET
FRICTION LOSSES = 1.093 FEET ENTRANCE LOSSES = 0.000 FEET
JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
JUNCTION LOSSES = (10.944)+(0.000) = 10.944

NODE 285.00 : HGL = < 211.216>;EGL= < 224.527>;FLOWLINE= < 210.860>

****

FLOW PROCESS FROM NODE 285.00 TO NODE 280.00 IS CODE = 1
UPSTREAM NODE 280.00 ELEVATION = 349.95 (FLOW IS SUPERCRITICAL)

CALCULATE FRICTION LOSSES(LACFCD):
PIPE FLOW = 11.10 CFS PIPE DIAMETER = 24.00 INCHES
PIPE LENGTH = 243.10 FEET MANNING'S N = 0.01300

NORMAL DEPTH(FT) = 0.35 CRITICAL DEPTH(FT) = 1.19

==========

UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) = 0.76

GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:

DISTANCE FROM CONTROL(FT)	FLOW DEPTH (FT)	VELOCITY (FT/SEC)	SPECIFIC ENERGY(FT)	PRESSURE+ MOMENTUM(POUNDS)
0.000	0.764	10.055	2.335	238.30
0.147	0.747	10.360	2.415	243.72
0.310	0.731	10.683	2.504	249.57
0.492	0.714	11.025	2.602	255.85
0.695	0.697	11.387	2.712	262.61
0.923	0.680	11.772	2.834	269.89
1.178	0.664	12.181	2.969	277.72
1.464	0.647	12.617	3.120	286.17
1.787	0.630	13.082	3.289	295.26
2.153	0.613	13.578	3.478	305.08
2.567	0.597	14.110	3.690	315.68
3.040	0.580	14.680	3.928	327.15
3.581	0.563	15.293	4.197	339.55
4.205	0.546	15.953	4.501	353.01
4.928	0.530	16.665	4.845	367.62
5.774	0.513	17.436	5.236	383.52
6.772	0.496	18.271	5.683	400.86
7.963	0.479	19.180	6.195	419.80
9.406	0.463	20.172	6.785	440.55
11.185	0.446	21.258	7.467	463.34
13.435	0.429	22.449	8.259	488.45
16.380	0.412	23.763	9.186	516.21
20.441	0.395	25.216	10.275	547.00
26.567	0.379	26.831	11.564	581.30
37.806	0.362	28.633	13.101	619.67
243.100	0.356	29.269	13.667	633.21

NODE 280.00 : HGL = < 350.714>;EGL= < 352.285>;FLOWLINE= < 349.950>

FLOW PROCESS FROM NODE 280.00 TO NODE 280.00 IS CODE = 5
UPSTREAM NODE 280.00 ELEVATION = 350.28 (FLOW IS SUPERCRITICAL)

CALCULATE JUNCTION LOSSES:

PIPE	FLOW (CFS)	DIAMETER (INCHES)	ANGLE (DEGREES)	FLOWLINE ELEVATION	CRITICAL DEPTH(FT.)	VELOCITY (FT/SEC)
UPSTREAM	11.10	24.00	11.70	350.28	1.19	9.666
DOWNSTREAM	11.10	24.00	-	349.95	1.19	10.058
LATERAL #1	0.00	0.00	0.00	0.00	0.00	0.000
LATERAL #2	0.00	0.00	0.00	0.00	0.00	0.000
Q5	0.00===Q5 EQUALS BASIN INPUT===					

LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
UPSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.02250
DOWNSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.02509
AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.02379
JUNCTION LENGTH = 4.00 FEET
FRICTION LOSSES = 0.095 FEET ENTRANCE LOSSES = 0.000 FEET
JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
JUNCTION LOSSES = (0.233)+(0.000) = 0.233

NODE 280.00 : HGL = < 351.067>;EGL= < 352.518>;FLOWLINE= < 350.280>

FLOW PROCESS FROM NODE 280.00 TO NODE 215.00 IS CODE = 1

```
  UPSTREAM NODE   215.00     ELEVATION =   352.10  (FLOW IS SUPERCRITICAL)
---------------------------------------------------------------------------
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW    =      11.10 CFS     PIPE DIAMETER =  24.00 INCHES
  PIPE LENGTH =      72.60 FEET          MANNING'S N  =  0.01300
---------------------------------------------------------------------------
  NORMAL DEPTH(FT) =      0.76          CRITICAL DEPTH(FT) =      1.19
===========================================================================
  UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) =     1.19
===========================================================================
  GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:
---------------------------------------------------------------------------
  DISTANCE FROM      FLOW DEPTH  VELOCITY      SPECIFIC        PRESSURE+
   CONTROL(FT)           (FT)    (FT/SEC)     ENERGY(FT)    MOMENTUM(POUNDS)
         0.000          1.195       5.667          1.694           185.00
         0.025          1.178       5.767          1.694           185.06
         0.103          1.160       5.871          1.696           185.24
         0.240          1.143       5.978          1.698           185.55
         0.442          1.126       6.090          1.702           185.98
         0.716          1.109       6.207          1.707           186.55
         1.071          1.092       6.328          1.714           187.25
         1.516          1.074       6.454          1.722           188.11
         2.063          1.057       6.586          1.731           189.11
         2.726          1.040       6.723          1.742           190.27
         3.520          1.023       6.866          1.755           191.60
         4.467          1.005       7.016          1.770           193.10
         5.589          0.988       7.172          1.787           194.77
         6.919          0.971       7.335          1.807           196.64
         8.493          0.954       7.506          1.829           198.71
        10.360          0.937       7.685          1.854           200.99
        12.587          0.919       7.872          1.882           203.48
        15.262          0.902       8.068          1.914           206.21
        18.507          0.885       8.274          1.949           209.18
        22.505          0.868       8.491          1.988           212.42
        27.537          0.850       8.718          2.031           215.92
        34.075          0.833       8.957          2.080           219.72
        43.004          0.816       9.209          2.134           223.83
        56.314          0.799       9.475          2.194           228.27
        72.600          0.787       9.663          2.238           231.48
---------------------------------------------------------------------------
  NODE   215.00 : HGL = <  353.295>;EGL= <  353.794>;FLOWLINE= <  352.100>

****************************************************************************
  FLOW PROCESS FROM NODE   215.00 TO NODE   215.00 IS CODE =  8
  UPSTREAM NODE   215.00     ELEVATION =   352.10  (FLOW IS SUBCRITICAL)
---------------------------------------------------------------------------
  CALCULATE CATCH BASIN ENTRANCE LOSSES(LACFCD):
  PIPE FLOW =      11.10 CFS          PIPE DIAMETER =  24.00 INCHES
  FLOW VELOCITY =   5.67 FEET/SEC.    VELOCITY HEAD =  0.499 FEET
  CATCH BASIN ENERGY LOSS = .2*(VELOCITY HEAD) = .2*(  0.499) =  0.100
---------------------------------------------------------------------------
  NODE   215.00 : HGL = <  353.894>;EGL= <  353.894>;FLOWLINE= <  352.100>

****************************************************************************
  UPSTREAM PIPE FLOW CONTROL DATA:
  NODE NUMBER =   215.00           FLOWLINE ELEVATION =   352.10
  ASSUMED UPSTREAM CONTROL HGL =    353.29 FOR DOWNSTREAM RUN ANALYSIS

===========================================================================
  END OF GRADUALLY VARIED FLOW ANALYSIS
 ♀
```

```
******************************************************************************
                PIPE-FLOW HYDRAULICS COMPUTER PROGRAM PACKAGE
          (Reference: LACFCD,LACRD, AND OCEMA HYDRAULICS CRITERION)
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                              Analysis prepared by:

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  ************************* DESCRIPTION OF STUDY *************************
 * SERRA MESA STORM DRAIN AND GREEN INFRASTRUCTURE IMPROVEMENTS            *
 * J-17588-G                                                               *
 * POST-PROJECT CONDITION - CAPACITY RUN; BASIN 300 OUTFALL                *
  ************************************************************************

   FILE NAME: 395.PIP
   TIME/DATE OF STUDY: 14:37 05/25/2017
```

```
******************************************************************************
                GRADUALLY VARIED FLOW ANALYSIS FOR PIPE SYSTEM
                          NODAL POINT STATUS TABLE
                 (Note: "*" indicates nodal point data used.)
                        UPSTREAM RUN                    DOWNSTREAM RUN
    NODE     MODEL    PRESSURE      PRESSURE+          FLOW         PRESSURE+
   NUMBER  PROCESS  HEAD(FT)   MOMENTUM(POUNDS)   DEPTH(FT)   MOMENTUM(POUNDS)
   395.00-              2.00             587.76        1.07*             771.69
         } FRICTION
   390.00-              2.03             592.74        1.02*             803.64
         } JUNCTION
   390.00-              2.74             733.64        0.56*            1703.31
         } FRICTION
   385.00-              1.77 Dc          570.56        0.82*            1045.48
         } JUNCTION
   385.00-              1.77 Dc          570.56        0.80*            1075.15
         } FRICTION
   380.00-              1.77 Dc          570.56        1.16*             709.95
         } JUNCTION
   380.00-              2.23             633.41        0.85*             991.79
         } FRICTION
   330.00-              1.77*Dc          570.56        1.77*Dc           570.56
         } CATCH BASIN
   330.00-              3.14*            419.28        1.77 Dc           151.50
------------------------------------------------------------------------------
  MAXIMUM NUMBER OF ENERGY BALANCES USED IN EACH PROFILE =  25
------------------------------------------------------------------------------
  NOTE: STEADY FLOW HYDRAULIC HEAD-LOSS COMPUTATIONS BASED ON THE MOST
  CONSERVATIVE FORMULAE FROM THE CURRENT LACRD,LACFCD, AND OCEMA
  DESIGN MANUALS.
******************************************************************************
  DOWNSTREAM PIPE FLOW CONTROL DATA:
  NODE NUMBER =   395.00            FLOWLINE ELEVATION =   225.82
  PIPE FLOW =      25.20 CFS        PIPE DIAMETER =  24.00 INCHES
  ASSUMED DOWNSTREAM CONTROL HGL =   227.820 FEET
------------------------------------------------------------------------------
  NODE   395.00 : HGL = <  226.885>;EGL= <  230.293>;FLOWLINE= <  225.820>

******************************************************************************
  FLOW PROCESS FROM NODE   395.00 TO NODE   390.00 IS CODE =  1
```

```
  UPSTREAM NODE   390.00     ELEVATION =   225.91  (FLOW IS SUPERCRITICAL)
---------------------------------------------------------------------------
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW    =      25.20 CFS     PIPE DIAMETER =  24.00 INCHES
  PIPE LENGTH =       9.30 FEET          MANNING'S N  =  0.01300
  ===> NORMAL PIPEFLOW IS PRESSURE FLOW
---------------------------------------------------------------------------
  NORMAL DEPTH(FT) =      2.00           CRITICAL DEPTH(FT) =      1.77
===========================================================================
  UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) =     1.02
===========================================================================
  GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:
---------------------------------------------------------------------------
  DISTANCE FROM      FLOW DEPTH  VELOCITY      SPECIFIC        PRESSURE+
   CONTROL(FT)           (FT)    (FT/SEC)     ENERGY(FT)    MOMENTUM(POUNDS)
         0.000          1.025     15.549          4.781           803.64
         6.811          1.054     15.000          4.550           779.87
         9.300          1.065     14.809          4.473           771.69
---------------------------------------------------------------------------
  NODE   390.00 : HGL = <  226.935>;EGL= <  230.691>;FLOWLINE= <  225.910>

***************************************************************************
  FLOW PROCESS FROM NODE   390.00 TO NODE   390.00 IS CODE =  5
  UPSTREAM NODE   390.00     ELEVATION =   226.24  (FLOW IS SUPERCRITICAL)
---------------------------------------------------------------------------
  CALCULATE JUNCTION LOSSES:
      PIPE       FLOW    DIAMETER   ANGLE    FLOWLINE   CRITICAL   VELOCITY
                 (CFS)   (INCHES) (DEGREES) ELEVATION  DEPTH(FT.)  (FT/SEC)
    UPSTREAM      25.20    24.00     60.00    226.24       1.77       34.663
   DOWNSTREAM     25.20    24.00       -      225.91       1.77       15.554
   LATERAL #1      0.00     0.00      0.00      0.00       0.00        0.000
   LATERAL #2      0.00     0.00      0.00      0.00       0.00        0.000
      Q5           0.00===Q5 EQUALS BASIN INPUT===

  LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
  DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
      Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
  UPSTREAM:    MANNING'S N = 0.01300;  FRICTION SLOPE = 0.41208
  DOWNSTREAM:  MANNING'S N = 0.01300;  FRICTION SLOPE = 0.04571
  AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.22890
  JUNCTION LENGTH =   4.00 FEET
  FRICTION LOSSES =  0.916 FEET         ENTRANCE LOSSES =  0.000 FEET
  JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
  JUNCTION LOSSES = (14.770)+( 0.000) =  14.770
---------------------------------------------------------------------------
  NODE   390.00 : HGL = <  226.804>;EGL= <  245.462>;FLOWLINE= <  226.240>

***************************************************************************
  FLOW PROCESS FROM NODE   390.00 TO NODE   385.00 IS CODE =  1
  UPSTREAM NODE   385.00     ELEVATION =   312.84  (FLOW IS SUPERCRITICAL)
---------------------------------------------------------------------------
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW    =      25.20 CFS     PIPE DIAMETER =  24.00 INCHES
  PIPE LENGTH =     196.70 FEET          MANNING'S N  =  0.01300
---------------------------------------------------------------------------
  NORMAL DEPTH(FT) =      0.55           CRITICAL DEPTH(FT) =      1.77
===========================================================================
  UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) =     0.82
===========================================================================
  GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:
---------------------------------------------------------------------------
  DISTANCE FROM      FLOW DEPTH  VELOCITY      SPECIFIC        PRESSURE+
   CONTROL(FT)           (FT)    (FT/SEC)     ENERGY(FT)    MOMENTUM(POUNDS)
```

0.000	0.817	20.875	7.588	1045.48
0.675	0.806	21.238	7.815	1062.44
1.396	0.796	21.613	8.054	1079.99
2.170	0.785	22.001	8.306	1098.18
3.000	0.775	22.402	8.572	1117.02
3.894	0.764	22.817	8.853	1136.55
4.859	0.754	23.246	9.150	1156.81
5.902	0.743	23.691	9.464	1177.82
7.034	0.733	24.151	9.796	1199.63
8.266	0.722	24.628	10.147	1222.26
9.612	0.712	25.123	10.519	1245.78
11.090	0.701	25.637	10.913	1270.21
12.719	0.691	26.170	11.332	1295.61
14.525	0.680	26.723	11.777	1322.04
16.541	0.670	27.299	12.249	1349.53
18.809	0.659	27.897	12.752	1378.16
21.382	0.649	28.520	13.287	1407.99
24.335	0.638	29.168	13.857	1439.08
27.774	0.628	29.843	14.466	1471.51
31.850	0.617	30.547	15.116	1505.36
36.800	0.607	31.282	15.811	1540.70
43.023	0.596	32.049	16.555	1577.64
51.262	0.586	32.850	17.353	1616.27
63.193	0.575	33.688	18.208	1656.70
84.186	0.565	34.565	19.128	1699.05
196.700	0.564	34.653	19.221	1703.31

NODE 385.00 : HGL = < 313.657>;EGL= < 320.428>;FLOWLINE= < 312.840>

****

FLOW PROCESS FROM NODE 385.00 TO NODE 385.00 IS CODE = 5
UPSTREAM NODE 385.00 ELEVATION = 313.17 (FLOW IS SUPERCRITICAL)

CALCULATE JUNCTION LOSSES:

PIPE	FLOW (CFS)	DIAMETER (INCHES)	ANGLE (DEGREES)	FLOWLINE ELEVATION	CRITICAL DEPTH(FT.)	VELOCITY (FT/SEC)
UPSTREAM	25.20	24.00	0.00	313.17	1.77	21.516
DOWNSTREAM	25.20	24.00	-	312.84	1.77	20.881
LATERAL #1	0.00	0.00	0.00	0.00	0.00	0.000
LATERAL #2	0.00	0.00	0.00	0.00	0.00	0.000
Q5	0.00===Q5 EQUALS BASIN INPUT===					

LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
UPSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.10986
DOWNSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.10121
AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.10554
JUNCTION LENGTH = 4.00 FEET
FRICTION LOSSES = 0.422 FEET ENTRANCE LOSSES = 0.000 FEET
JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
JUNCTION LOSSES = (0.730)+(0.000) = 0.730

NODE 385.00 : HGL = < 313.969>;EGL= < 321.158>;FLOWLINE= < 313.170>

****

FLOW PROCESS FROM NODE 385.00 TO NODE 380.00 IS CODE = 1
UPSTREAM NODE 380.00 ELEVATION = 321.67 (FLOW IS SUPERCRITICAL)

CALCULATE FRICTION LOSSES(LACFCD):
PIPE FLOW = 25.20 CFS PIPE DIAMETER = 24.00 INCHES
PIPE LENGTH = 57.90 FEET MANNING'S N = 0.01300

NORMAL DEPTH(FT) = 0.74 CRITICAL DEPTH(FT) = 1.77

UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) = 1.16

GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:

DISTANCE FROM CONTROL(FT)	FLOW DEPTH (FT)	VELOCITY (FT/SEC)	SPECIFIC ENERGY(FT)	PRESSURE+ MOMENTUM(POUNDS)
0.000	1.160	13.327	3.920	709.95
0.720	1.144	13.566	4.003	719.67
1.499	1.127	13.815	4.092	729.89
2.346	1.110	14.074	4.187	740.62
3.266	1.093	14.343	4.289	751.90
4.268	1.076	14.623	4.398	763.75
5.362	1.059	14.914	4.515	776.19
6.558	1.042	15.218	4.641	789.27
7.870	1.025	15.535	4.775	803.00
9.314	1.009	15.865	4.919	817.44
10.908	0.992	16.209	5.074	832.62
12.674	0.975	16.569	5.240	848.58
14.641	0.958	16.945	5.419	865.36
16.842	0.941	17.338	5.612	883.02
19.322	0.924	17.750	5.819	901.60
22.136	0.907	18.181	6.043	921.17
25.360	0.890	18.632	6.284	941.79
29.092	0.874	19.106	6.545	963.52
33.475	0.857	19.603	6.827	986.43
38.715	0.840	20.125	7.133	1010.62
45.132	0.823	20.675	7.465	1036.16
53.266	0.806	21.253	7.825	1063.16
57.900	0.799	21.510	7.988	1075.15

NODE 380.00 : HGL = < 322.830>;EGL= < 325.590>;FLOWLINE= < 321.670>

FLOW PROCESS FROM NODE 380.00 TO NODE 380.00 IS CODE = 5
UPSTREAM NODE 380.00 ELEVATION = 322.00 (FLOW IS SUPERCRITICAL)

CALCULATE JUNCTION LOSSES:

PIPE	FLOW (CFS)	DIAMETER (INCHES)	ANGLE (DEGREES)	FLOWLINE ELEVATION	CRITICAL DEPTH(FT.)	VELOCITY (FT/SEC)
UPSTREAM	25.20	24.00	45.00	322.00	1.77	19.725
DOWNSTREAM	25.20	24.00	-	321.67	1.77	13.331
LATERAL #1	0.00	0.00	0.00	0.00	0.00	0.000
LATERAL #2	0.00	0.00	0.00	0.00	0.00	0.000
Q5	0.00===Q5 EQUALS BASIN INPUT===					

LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
UPSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.08665
DOWNSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.03050
AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.05857
JUNCTION LENGTH = 4.00 FEET
FRICTION LOSSES = 0.234 FEET ENTRANCE LOSSES = 0.000 FEET
JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
JUNCTION LOSSES = (3.304)+(0.000) = 3.304

NODE 380.00 : HGL = < 322.853>;EGL= < 328.894>;FLOWLINE= < 322.000>

FLOW PROCESS FROM NODE 380.00 TO NODE 330.00 IS CODE = 1
UPSTREAM NODE 330.00 ELEVATION = 332.20 (FLOW IS SUPERCRITICAL)

```
------------------------------------------------------------------------------
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW    =      25.20 CFS     PIPE DIAMETER =  24.00 INCHES
  PIPE LENGTH =      99.80 FEET          MANNING'S N  =  0.01300
------------------------------------------------------------------------------
  NORMAL DEPTH(FT) =      0.81          CRITICAL DEPTH(FT) =      1.77
==============================================================================
  UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) =     1.77
==============================================================================
  GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:
------------------------------------------------------------------------------
  DISTANCE FROM      FLOW DEPTH  VELOCITY      SPECIFIC        PRESSURE+
   CONTROL(FT)           (FT)    (FT/SEC)     ENERGY(FT)    MOMENTUM(POUNDS)
         0.000          1.767       8.579          2.910           570.56
         0.026          1.729       8.729          2.912           570.98
         0.105          1.691       8.894          2.920           572.27
         0.243          1.652       9.075          2.932           574.43
         0.443          1.614       9.272          2.950           577.52
         0.715          1.576       9.485          2.974           581.57
         1.064          1.538       9.717          3.005           586.63
         1.503          1.500       9.967          3.044           592.77
         2.042          1.462      10.237          3.090           600.05
         2.696          1.424      10.529          3.147           608.55
         3.485          1.386      10.845          3.213           618.36
         4.429          1.348      11.186          3.292           629.59
         5.557          1.310      11.555          3.384           642.35
         6.905          1.272      11.954          3.492           656.77
         8.516          1.234      12.387          3.618           673.00
        10.451          1.196      12.857          3.764           691.23
        12.787          1.157      13.369          3.934           711.64
        15.630          1.119      13.926          4.133           734.48
        19.134          1.081      14.535          4.364           760.01
        23.520          1.043      15.201          4.634           788.54
        29.137          1.005      15.933          4.950           820.45
        36.571          0.967      16.739          5.321           856.16
        46.924          0.929      17.630          5.758           896.19
        62.678          0.891      18.618          6.277           941.15
        91.802          0.853      19.719          6.894           991.79
        99.800          0.853      19.719          6.894           991.79
------------------------------------------------------------------------------
  NODE   330.00 : HGL = <  333.967>;EGL= <  335.110>;FLOWLINE= <  332.200>

******************************************************************************
  FLOW PROCESS FROM NODE   330.00 TO NODE   330.00 IS CODE =  8
  UPSTREAM NODE   330.00     ELEVATION =   332.20  (FLOW UNSEALS IN REACH)
------------------------------------------------------------------------------
  CALCULATE CATCH BASIN ENTRANCE LOSSES(LACFCD):
  PIPE FLOW =      25.20 CFS          PIPE DIAMETER =  24.00 INCHES
  FLOW VELOCITY =   8.58 FEET/SEC.    VELOCITY HEAD =  1.143 FEET
  CATCH BASIN ENERGY LOSS = .2*(VELOCITY HEAD) = .2*(  1.143) =  0.229
------------------------------------------------------------------------------
  NODE   330.00 : HGL = <  335.339>;EGL= <  335.339>;FLOWLINE= <  332.200>

******************************************************************************
  UPSTREAM PIPE FLOW CONTROL DATA:
  NODE NUMBER =   330.00           FLOWLINE ELEVATION =   332.20
  ASSUMED UPSTREAM CONTROL HGL =    333.97 FOR DOWNSTREAM RUN ANALYSIS

==============================================================================
  END OF GRADUALLY VARIED FLOW ANALYSIS
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******************************************************************************
              PIPE-FLOW HYDRAULICS COMPUTER PROGRAM PACKAGE
          (Reference: LACFCD,LACRD, AND OCEMA HYDRAULICS CRITERION)
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                          Analysis prepared by:

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                          San Diego, California 92110
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  ************************* DESCRIPTION OF STUDY *************************
 * SERRA MESA STORM DRAIN AND GREEN INFRASTRUCTURE IMPROVEMENTS           *
 * J-17588-G                                                              *
 * POST-PROJECT CONDITION - CAPACITY RUN; BASIN 400 OUTFALL               *
  ************************************************************************

   FILE NAME: 495.PIP
   TIME/DATE OF STUDY: 18:56 05/31/2017
```

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******************************************************************************
               GRADUALLY VARIED FLOW ANALYSIS FOR PIPE SYSTEM
                        NODAL POINT STATUS TABLE
                 (Note: "*" indicates nodal point data used.)
                      UPSTREAM RUN                    DOWNSTREAM RUN
    NODE     MODEL    PRESSURE      PRESSURE+          FLOW         PRESSURE+
   NUMBER  PROCESS  HEAD(FT)   MOMENTUM(POUNDS)   DEPTH(FT)   MOMENTUM(POUNDS)
   495.00-              2.00             305.15        0.81*             311.33
         } FRICTION
   490.00-              1.88             285.21        0.76*             336.31
         } JUNCTION
   490.00-              1.85             280.27        0.43*             686.85
         } FRICTION
   485.00-              1.31 Dc          235.13        0.42*             724.27
         } JUNCTION
   485.00-              1.31 Dc          235.13        0.39*             796.88
         } FRICTION
   480.00-              1.31 Dc          235.13        0.90*             281.78
         } JUNCTION
   480.00-              1.36 Dc          271.11        1.12*             286.40
         } FRICTION
   430.00-              1.36*Dc          271.11        1.36*Dc           271.11
         } CATCH BASIN
   430.00-              2.52*            195.41        1.36 Dc            67.64
------------------------------------------------------------------------------
  MAXIMUM NUMBER OF ENERGY BALANCES USED IN EACH PROFILE =  25
------------------------------------------------------------------------------
  NOTE: STEADY FLOW HYDRAULIC HEAD-LOSS COMPUTATIONS BASED ON THE MOST
  CONSERVATIVE FORMULAE FROM THE CURRENT LACRD,LACFCD, AND OCEMA
  DESIGN MANUALS.
******************************************************************************
  DOWNSTREAM PIPE FLOW CONTROL DATA:
  NODE NUMBER =   495.00           FLOWLINE ELEVATION =   185.64
  PIPE FLOW =      13.30 CFS       PIPE DIAMETER =  24.00 INCHES
  ASSUMED DOWNSTREAM CONTROL HGL =   187.640 FEET
------------------------------------------------------------------------------
  NODE   495.00 : HGL = <  186.453>;EGL= <  188.363>;FLOWLINE= <  185.640>

******************************************************************************
  FLOW PROCESS FROM NODE   495.00 TO NODE   490.00 IS CODE =  1
```

```
  UPSTREAM NODE   490.00     ELEVATION =   185.79  (FLOW IS SUPERCRITICAL)
---------------------------------------------------------------------------
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW    =      13.30 CFS     PIPE DIAMETER =  24.00 INCHES
  PIPE LENGTH =      15.30 FEET          MANNING'S N  =  0.01300
---------------------------------------------------------------------------
  NORMAL DEPTH(FT) =      1.11          CRITICAL DEPTH(FT) =      1.31
===========================================================================
  UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) =     0.76
===========================================================================
  GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:
---------------------------------------------------------------------------
  DISTANCE FROM      FLOW DEPTH  VELOCITY      SPECIFIC        PRESSURE+
   CONTROL(FT)           (FT)    (FT/SEC)     ENERGY(FT)    MOMENTUM(POUNDS)
         0.000          0.756     12.214          3.074           336.31
         3.737          0.771     11.914          2.976           329.54
         7.522          0.785     11.627          2.885           323.15
        11.362          0.799     11.353          2.801           317.10
        15.261          0.813     11.091          2.724           311.38
        15.300          0.813     11.088          2.723           311.33
---------------------------------------------------------------------------
  NODE   490.00 : HGL = <  186.546>;EGL= <  188.864>;FLOWLINE= <  185.790>

***************************************************************************
  FLOW PROCESS FROM NODE   490.00 TO NODE   490.00 IS CODE =  5
  UPSTREAM NODE   490.00     ELEVATION =   186.12  (FLOW IS SUPERCRITICAL)
---------------------------------------------------------------------------
  CALCULATE JUNCTION LOSSES:
      PIPE        FLOW    DIAMETER   ANGLE    FLOWLINE   CRITICAL   VELOCITY
                  (CFS)   (INCHES) (DEGREES) ELEVATION  DEPTH(FT.)  (FT/SEC)
    UPSTREAM      13.30     24.00     58.50    186.12       1.31       26.433
   DOWNSTREAM     13.30     24.00       -      185.79       1.31       12.218
   LATERAL #1      0.00      0.00      0.00      0.00       0.00        0.000
   LATERAL #2      0.00      0.00      0.00      0.00       0.00        0.000
      Q5           0.00===Q5 EQUALS BASIN INPUT===

  LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
  DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
      Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
  UPSTREAM:    MANNING'S N = 0.01300;  FRICTION SLOPE = 0.32315
  DOWNSTREAM:  MANNING'S N = 0.01300;  FRICTION SLOPE = 0.03741
  AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.18028
  JUNCTION LENGTH =   4.00 FEET
  FRICTION LOSSES =  0.721 FEET         ENTRANCE LOSSES =  0.000 FEET
  JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
  JUNCTION LOSSES = ( 8.539)+( 0.000) =   8.539
---------------------------------------------------------------------------
  NODE   490.00 : HGL = <  186.554>;EGL= <  197.404>;FLOWLINE= <  186.120>

***************************************************************************
  FLOW PROCESS FROM NODE   490.00 TO NODE   485.00 IS CODE =  1
  UPSTREAM NODE   485.00     ELEVATION =   191.81  (FLOW IS SUPERCRITICAL)
---------------------------------------------------------------------------
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW    =      13.30 CFS     PIPE DIAMETER =  24.00 INCHES
  PIPE LENGTH =      20.00 FEET          MANNING'S N  =  0.01300
---------------------------------------------------------------------------
  NORMAL DEPTH(FT) =      0.45          CRITICAL DEPTH(FT) =      1.31
===========================================================================
  UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) =     0.42
===========================================================================
  GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:
---------------------------------------------------------------------------
```

DISTANCE FROM CONTROL(FT)	FLOW DEPTH (FT)	VELOCITY (FT/SEC)	SPECIFIC ENERGY(FT)	PRESSURE+ MOMENTUM(POUNDS)
0.000	0.418	27.895	12.509	724.27
1.089	0.419	27.781	12.411	721.36
2.220	0.421	27.667	12.314	718.46
3.397	0.422	27.554	12.219	715.59
4.624	0.423	27.442	12.124	712.73
5.906	0.424	27.331	12.030	709.90
7.249	0.425	27.220	11.938	707.09
8.659	0.427	27.111	11.847	704.30
10.143	0.428	27.002	11.756	701.52
11.712	0.429	26.893	11.667	698.77
13.376	0.430	26.786	11.578	696.04
15.148	0.431	26.679	11.491	693.33
17.044	0.433	26.573	11.404	690.63
19.085	0.434	26.468	11.319	687.96
20.000	0.434	26.425	11.284	686.85

NODE 485.00 : HGL = < 192.228>;EGL= < 204.319>;FLOWLINE= < 191.810>

****

FLOW PROCESS FROM NODE 485.00 TO NODE 485.00 IS CODE = 5
UPSTREAM NODE 485.00 ELEVATION = 192.14 (FLOW IS SUPERCRITICAL)

CALCULATE JUNCTION LOSSES:

PIPE	FLOW (CFS)	DIAMETER (INCHES)	ANGLE (DEGREES)	FLOWLINE ELEVATION	CRITICAL DEPTH(FT.)	VELOCITY (FT/SEC)
UPSTREAM	13.30	24.00	0.00	192.14	1.31	30.751
DOWNSTREAM	13.30	24.00	-	191.81	1.31	27.904
LATERAL #1	0.00	0.00	0.00	0.00	0.00	0.000
LATERAL #2	0.00	0.00	0.00	0.00	0.00	0.000
Q5	0.00===Q5 EQUALS BASIN INPUT===					

LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
UPSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.49579
DOWNSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.37660
AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.43620
JUNCTION LENGTH = 4.00 FEET
FRICTION LOSSES = 1.745 FEET ENTRANCE LOSSES = 0.000 FEET
JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
JUNCTION LOSSES = (2.896)+(0.000) = 2.896

NODE 485.00 : HGL = < 192.531>;EGL= < 207.214>;FLOWLINE= < 192.140>

****

FLOW PROCESS FROM NODE 485.00 TO NODE 480.00 IS CODE = 1
UPSTREAM NODE 480.00 ELEVATION = 331.65 (FLOW IS SUPERCRITICAL)

CALCULATE FRICTION LOSSES(LACFCD):
PIPE FLOW = 13.30 CFS PIPE DIAMETER = 24.00 INCHES
PIPE LENGTH = 239.90 FEET MANNING'S N = 0.01300

NORMAL DEPTH(FT) = 0.38 CRITICAL DEPTH(FT) = 1.31

==========

UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) = 0.90

==========

GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:

DISTANCE FROM CONTROL(FT)	FLOW DEPTH (FT)	VELOCITY (FT/SEC)	SPECIFIC ENERGY(FT)	PRESSURE+ MOMENTUM(POUNDS)
0.000	0.902	9.664	2.353	281.78

0.127	0.881	9.967	2.425	287.82
0.271	0.860	10.290	2.505	294.41
0.433	0.839	10.633	2.596	301.57
0.617	0.818	10.998	2.697	309.37
0.824	0.797	11.387	2.812	317.85
1.058	0.776	11.803	2.941	327.07
1.325	0.755	12.248	3.086	337.09
1.628	0.734	12.726	3.250	348.01
1.974	0.713	13.239	3.436	359.89
2.371	0.692	13.791	3.647	372.83
2.827	0.671	14.387	3.887	386.96
3.354	0.650	15.032	4.160	402.39
3.967	0.628	15.731	4.473	419.27
4.684	0.607	16.491	4.833	437.77
5.530	0.586	17.319	5.247	458.09
6.538	0.565	18.225	5.726	480.46
7.752	0.544	19.218	6.283	505.14
9.237	0.523	20.313	6.934	532.47
11.086	0.502	21.522	7.699	562.82
13.446	0.481	22.865	8.604	596.66
16.567	0.460	24.363	9.682	634.52
20.914	0.439	26.041	10.975	677.10
27.540	0.418	27.932	12.540	725.21
39.826	0.397	30.076	14.452	779.88
239.900	0.391	30.742	15.074	796.88

NODE 480.00 : HGL = < 332.552>;EGL= < 334.003>;FLOWLINE= < 331.650>

****

FLOW PROCESS FROM NODE 480.00 TO NODE 480.00 IS CODE = 5
UPSTREAM NODE 480.00 ELEVATION = 331.73 (FLOW IS SUPERCRITICAL)

CALCULATE JUNCTION LOSSES:

PIPE	FLOW (CFS)	DIAMETER (INCHES)	ANGLE (DEGREES)	FLOWLINE ELEVATION	CRITICAL DEPTH(FT.)	VELOCITY (FT/SEC)
UPSTREAM	13.30	18.00	13.70	331.73	1.36	9.395
DOWNSTREAM	13.30	24.00	-	331.65	1.31	9.667
LATERAL #1	0.00	0.00	0.00	0.00	0.00	0.000
LATERAL #2	0.00	0.00	0.00	0.00	0.00	0.000
Q5	0.00===Q5 EQUALS BASIN INPUT===					

LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
UPSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.01947
DOWNSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.01974
AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.01960
JUNCTION LENGTH = 4.00 FEET
FRICTION LOSSES = 0.078 FEET ENTRANCE LOSSES = 0.000 FEET
JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
JUNCTION LOSSES = (0.218)+(0.000) = 0.218

NODE 480.00 : HGL = < 332.850>;EGL= < 334.221>;FLOWLINE= < 331.730>

****

FLOW PROCESS FROM NODE 480.00 TO NODE 430.00 IS CODE = 1
UPSTREAM NODE 430.00 ELEVATION = 333.38 (FLOW IS SUPERCRITICAL)

CALCULATE FRICTION LOSSES(LACFCD):
PIPE FLOW = 13.30 CFS PIPE DIAMETER = 18.00 INCHES
PIPE LENGTH = 82.50 FEET MANNING'S N = 0.01300

NORMAL DEPTH(FT) = 1.11 CRITICAL DEPTH(FT) = 1.36

```
==============================================================================
  UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) =     1.36
==============================================================================
  GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:
------------------------------------------------------------------------------
  DISTANCE FROM      FLOW DEPTH  VELOCITY      SPECIFIC        PRESSURE+
   CONTROL(FT)          (FT)    (FT/SEC)     ENERGY(FT)    MOMENTUM(POUNDS)
          0.000         1.361      7.892          2.329           271.11
          0.041         1.351      7.934          2.329           271.14
          0.168         1.341      7.978          2.330           271.21
          0.383         1.330      8.024          2.331           271.34
          0.692         1.320      8.071          2.332           271.52
          1.101         1.310      8.120          2.335           271.75
          1.618         1.300      8.171          2.338           272.04
          2.251         1.290      8.224          2.341           272.37
          3.012         1.280      8.279          2.345           272.76
          3.913         1.270      8.335          2.349           273.20
          4.972         1.260      8.393          2.354           273.69
          6.207         1.249      8.453          2.360           274.24
          7.644         1.239      8.515          2.366           274.85
          9.312         1.229      8.579          2.373           275.51
         11.251         1.219      8.644          2.380           276.22
         13.510         1.209      8.712          2.388           277.00
         16.155         1.199      8.782          2.397           277.83
         19.276         1.189      8.853          2.406           278.72
         23.000         1.179      8.927          2.417           279.68
         27.511         1.168      9.003          2.428           280.70
         33.095         1.158      9.081          2.439           281.78
         40.235         1.148      9.161          2.452           282.92
         49.830         1.138      9.243          2.465           284.13
         63.910         1.128      9.328          2.480           285.41
         82.500         1.120      9.392          2.491           286.40
------------------------------------------------------------------------------
  NODE   430.00 : HGL = <  334.741>;EGL= <  335.709>;FLOWLINE= <  333.380>

******************************************************************************
  FLOW PROCESS FROM NODE   430.00 TO NODE   430.00 IS CODE =  8
  UPSTREAM NODE   430.00     ELEVATION =   333.38  (FLOW UNSEALS IN REACH)
------------------------------------------------------------------------------
  CALCULATE CATCH BASIN ENTRANCE LOSSES(LACFCD):
  PIPE FLOW =      13.30 CFS          PIPE DIAMETER =  18.00 INCHES
  FLOW VELOCITY =   7.89 FEET/SEC.    VELOCITY HEAD =  0.968 FEET
  CATCH BASIN ENERGY LOSS = .2*(VELOCITY HEAD) = .2*(  0.968) =  0.194
------------------------------------------------------------------------------
  NODE   430.00 : HGL = <  335.902>;EGL= <  335.902>;FLOWLINE= <  333.380>

******************************************************************************
  UPSTREAM PIPE FLOW CONTROL DATA:
  NODE NUMBER =   430.00            FLOWLINE ELEVATION =   333.38
  ASSUMED UPSTREAM CONTROL HGL =    334.74 FOR DOWNSTREAM RUN ANALYSIS

==============================================================================
  END OF GRADUALLY VARIED FLOW ANALYSIS
 ♀
```

```
**************************************************************************
              PIPE-FLOW HYDRAULICS COMPUTER PROGRAM PACKAGE
        (Reference: LACFCD,LACRD, AND OCEMA HYDRAULICS CRITERION)
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                          Analysis prepared by:

                        RICK ENGINEERING COMPANY
                            5620 Friars Road
                         San Diego, California 92110
                       619-291-0707   Fax 619-291-4165

 ************************* DESCRIPTION OF STUDY *************************
* SERRA MESA STORM DRAIN AND GREEN INFRASTRUCTURE IMPROVEMENTS           *
* J-17588-G                                                              *
* POST-PROJECT CONDITION - CAPACITY RUN; BASIN 500 OUTFALL               *
 ************************************************************************

  FILE NAME: 595.PIP
  TIME/DATE OF STUDY: 09:57 09/13/2017
--------------------------------------------------------------------------
**************************************************************************
               GRADUALLY VARIED FLOW ANALYSIS FOR PIPE SYSTEM
                        NODAL POINT STATUS TABLE
                 (Note: "*" indicates nodal point data used.)
                      UPSTREAM RUN                  DOWNSTREAM RUN
   NODE     MODEL    PRESSURE      PRESSURE+         FLOW         PRESSURE+
  NUMBER  PROCESS  HEAD(FT)    MOMENTUM(POUNDS)   DEPTH(FT)   MOMENTUM(POUNDS)
  595.00-             2.00*          372.21        1.39             326.67
        } FRICTION
  590.00-             1.96*          364.74        1.48 Dc          324.80
        } JUNCTION
  590.00-             2.40           450.15        0.73*            552.46
        } FRICTION
  585.00-             1.48 Dc        324.80        0.68*            605.81
        } JUNCTION
  585.00-             1.81           344.82        0.46*           1031.04
        } FRICTION
  580.00-             1.48 Dc        324.80        1.04*            382.19
        } JUNCTION
  580.00-             1.48 Dc        324.80        1.05*            377.62
        } FRICTION
  520.00-             1.48*Dc        324.80        1.48*Dc          324.80
        } CATCH BASIN
  520.00-             2.34*          261.95        1.48 Dc          103.02
--------------------------------------------------------------------------
  MAXIMUM NUMBER OF ENERGY BALANCES USED IN EACH PROFILE =  25
--------------------------------------------------------------------------
  NOTE: STEADY FLOW HYDRAULIC HEAD-LOSS COMPUTATIONS BASED ON THE MOST
  CONSERVATIVE FORMULAE FROM THE CURRENT LACRD,LACFCD, AND OCEMA
  DESIGN MANUALS.
**************************************************************************
  DOWNSTREAM PIPE FLOW CONTROL DATA:
  NODE NUMBER =   595.00           FLOWLINE ELEVATION =   214.18
  PIPE FLOW =      16.90 CFS       PIPE DIAMETER =  24.00 INCHES
  ASSUMED DOWNSTREAM CONTROL HGL =   216.180 FEET
--------------------------------------------------------------------------
  NODE   595.00 : HGL = <  216.180>;EGL= <  216.629>;FLOWLINE= <  214.180>

**************************************************************************
  FLOW PROCESS FROM NODE   595.00 TO NODE   590.00 IS CODE =  1
  UPSTREAM NODE   590.00     ELEVATION =   214.27  (FLOW SEALS IN REACH)
```

```
------------------------------------------------------------------------------
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW   =      16.90 CFS     PIPE DIAMETER =  24.00 INCHES
  PIPE LENGTH =      10.00 FEET          MANNING'S N  =  0.01300
------------------------------------------------------------------------------
  NORMAL DEPTH(FT) =      1.34          CRITICAL DEPTH(FT) =      1.48
==============================================================================
  DOWNSTREAM CONTROL ASSUMED PRESSURE HEAD(FT) =     2.00
==============================================================================
  GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:
------------------------------------------------------------------------------
  DISTANCE FROM      FLOW DEPTH  VELOCITY      SPECIFIC        PRESSURE+
   CONTROL(FT)           (FT)    (FT/SEC)     ENERGY(FT)    MOMENTUM(POUNDS)
         0.000          2.000      5.378          2.449           372.21
         5.182          1.979      5.387          2.430           368.47
         9.689          1.959      5.405          2.412           364.99
        10.000          1.957      5.407          2.411           364.74
------------------------------------------------------------------------------
  NODE   590.00 : HGL = <  216.227>;EGL= <  216.681>;FLOWLINE= <  214.270>

******************************************************************************
  FLOW PROCESS FROM NODE   590.00 TO NODE   590.00 IS CODE =  5
  UPSTREAM NODE   590.00     ELEVATION =   214.60  (FLOW UNSEALS IN REACH)
  (NOTE: POSSIBLE JUMP IN OR UPSTREAM OF STRUCTURE)
------------------------------------------------------------------------------
  CALCULATE JUNCTION LOSSES:
       PIPE       FLOW    DIAMETER   ANGLE    FLOWLINE   CRITICAL   VELOCITY
                  (CFS)   (INCHES) (DEGREES) ELEVATION  DEPTH(FT.)  (FT/SEC)
     UPSTREAM      16.90    24.00     80.00    214.60      1.48       16.267
    DOWNSTREAM     16.90    24.00       -      214.27      1.48        5.408
    LATERAL #1      0.00     0.00      0.00      0.00      0.00        0.000
    LATERAL #2      0.00     0.00      0.00      0.00      0.00        0.000
       Q5           0.00===Q5 EQUALS BASIN INPUT===

  LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
  DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
      Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
  UPSTREAM:    MANNING'S N = 0.01300;  FRICTION SLOPE = 0.06869
  DOWNSTREAM:  MANNING'S N = 0.01300;  FRICTION SLOPE = 0.00498
  AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.03684
  JUNCTION LENGTH =   4.00 FEET
  FRICTION LOSSES =  0.147 FEET         ENTRANCE LOSSES =  0.000 FEET
  JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
  JUNCTION LOSSES = ( 2.759)+( 0.000) =   2.759
------------------------------------------------------------------------------
  NODE   590.00 : HGL = <  215.331>;EGL= <  219.440>;FLOWLINE= <  214.600>

******************************************************************************
  FLOW PROCESS FROM NODE   590.00 TO NODE   585.00 IS CODE =  1
  UPSTREAM NODE   585.00     ELEVATION =   217.08  (FLOW IS SUPERCRITICAL)
------------------------------------------------------------------------------
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW   =      16.90 CFS     PIPE DIAMETER =  24.00 INCHES
  PIPE LENGTH =      43.11 FEET          MANNING'S N  =  0.01300
------------------------------------------------------------------------------
  NORMAL DEPTH(FT) =      0.77          CRITICAL DEPTH(FT) =      1.48
==============================================================================
  UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) =     0.68
==============================================================================
  GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:
------------------------------------------------------------------------------
  DISTANCE FROM      FLOW DEPTH  VELOCITY      SPECIFIC        PRESSURE+
   CONTROL(FT)           (FT)    (FT/SEC)     ENERGY(FT)    MOMENTUM(POUNDS)
         0.000          0.679     17.989          5.707           605.81
```

```
         2.072          0.682     17.862          5.640          601.87
         4.215          0.686     17.737          5.574          597.98
         6.438          0.689     17.614          5.510          594.14
         8.746          0.693     17.492          5.447          590.36
        11.150          0.696     17.371          5.385          586.63
        13.657          0.700     17.252          5.324          582.95
        16.281          0.703     17.135          5.265          579.31
        19.033          0.707     17.019          5.207          575.73
        21.931          0.710     16.905          5.150          572.20
        24.992          0.714     16.791          5.095          568.71
        28.240          0.717     16.680          5.040          565.27
        31.703          0.721     16.569          4.986          561.88
        35.414          0.724     16.460          4.934          558.53
        39.418          0.728     16.352          4.883          555.23
        43.110          0.731     16.262          4.840          552.46
--------------------------------------------------------------------------------
  NODE   585.00 : HGL = <  217.759>;EGL= <  222.787>;FLOWLINE= <  217.080>

********************************************************************************
  FLOW PROCESS FROM NODE   585.00 TO NODE   585.00 IS CODE =  5
  UPSTREAM NODE   585.00     ELEVATION =   217.41  (FLOW IS SUPERCRITICAL)
--------------------------------------------------------------------------------
  CALCULATE JUNCTION LOSSES:
       PIPE        FLOW    DIAMETER   ANGLE    FLOWLINE   CRITICAL   VELOCITY
                   (CFS)   (INCHES) (DEGREES) ELEVATION  DEPTH(FT.)  (FT/SEC)
     UPSTREAM      16.90    24.00     51.00    217.41      1.48       31.290
    DOWNSTREAM     16.90    24.00       -      217.08      1.48       17.995
    LATERAL #1      0.00     0.00      0.00      0.00      0.00        0.000
    LATERAL #2      0.00     0.00      0.00      0.00      0.00        0.000
       Q5           0.00===Q5 EQUALS BASIN INPUT===

  LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
  DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
      Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
  UPSTREAM:    MANNING'S N = 0.01300;  FRICTION SLOPE = 0.42717
  DOWNSTREAM:  MANNING'S N = 0.01300;  FRICTION SLOPE = 0.09080
  AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.25899
  JUNCTION LENGTH =   4.00 FEET
  FRICTION LOSSES =  1.036 FEET         ENTRANCE LOSSES =  0.000 FEET
  JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
  JUNCTION LOSSES = (10.283)+( 0.000) =  10.283
--------------------------------------------------------------------------------
  NODE   585.00 : HGL = <  217.867>;EGL= <  233.069>;FLOWLINE= <  217.410>

********************************************************************************
  FLOW PROCESS FROM NODE   585.00 TO NODE   580.00 IS CODE =  1
  UPSTREAM NODE   580.00     ELEVATION =   333.10  (FLOW IS SUPERCRITICAL)
--------------------------------------------------------------------------------
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW   =      16.90 CFS     PIPE DIAMETER =  24.00 INCHES
  PIPE LENGTH =     228.79 FEET          MANNING'S N  =  0.01300
--------------------------------------------------------------------------------
  NORMAL DEPTH(FT) =      0.44          CRITICAL DEPTH(FT) =      1.48
================================================================================
  UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) =     1.04
================================================================================
  GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:
--------------------------------------------------------------------------------
  DISTANCE FROM      FLOW DEPTH  VELOCITY      SPECIFIC        PRESSURE+
   CONTROL(FT)          (FT)    (FT/SEC)     ENERGY(FT)    MOMENTUM(POUNDS)
         0.000          1.036     10.287          2.680          382.19
         0.157          1.012     10.595          2.756          389.89
         0.334          0.988     10.923          2.842          398.28
         0.534          0.964     11.272          2.938          407.42
```

```
         0.760          0.940     11.643          3.046          417.38
         1.016          0.916     12.039          3.168          428.22
         1.305          0.892     12.462          3.305          440.02
         1.633          0.868     12.914          3.460          452.85
         2.006          0.844     13.399          3.634          466.82
         2.432          0.820     13.920          3.831          482.03
         2.919          0.797     14.480          4.054          498.60
         3.479          0.773     15.084          4.308          516.68
         4.125          0.749     15.736          4.596          536.43
         4.876          0.725     16.443          4.926          558.01
         5.754          0.701     17.211          5.303          581.66
         6.788          0.677     18.047          5.737          607.62
         8.018          0.653     18.960          6.238          636.16
         9.498          0.629     19.960          6.819          667.63
        11.304          0.605     21.060          7.496          702.42
        13.551          0.581     22.273          8.289          741.01
        16.415          0.557     23.617          9.224          783.95
        20.195          0.533     25.113         10.333          831.92
        25.452          0.510     26.786         11.657          885.74
        33.451          0.486     28.666         13.253          946.42
        48.259          0.462     30.791         15.192         1015.18
       228.790          0.457     31.280         15.659         1031.04
--------------------------------------------------------------------------------
  NODE   580.00 : HGL = <  334.136>;EGL= <  335.780>;FLOWLINE= <  333.100>

********************************************************************************
  FLOW PROCESS FROM NODE   580.00 TO NODE   580.00 IS CODE =  5
  UPSTREAM NODE   580.00     ELEVATION =   333.43  (FLOW IS SUPERCRITICAL)
--------------------------------------------------------------------------------
  CALCULATE JUNCTION LOSSES:
       PIPE        FLOW    DIAMETER   ANGLE    FLOWLINE   CRITICAL   VELOCITY
                   (CFS)   (INCHES) (DEGREES) ELEVATION  DEPTH(FT.)  (FT/SEC)
     UPSTREAM      16.90    24.00     17.50    333.43      1.48       10.102
    DOWNSTREAM     16.90    24.00       -      333.10      1.48       10.290
    LATERAL #1      0.00     0.00      0.00      0.00      0.00        0.000
    LATERAL #2      0.00     0.00      0.00      0.00      0.00        0.000
       Q5           0.00===Q5 EQUALS BASIN INPUT===

  LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
  DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
      Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
  UPSTREAM:    MANNING'S N = 0.01300;  FRICTION SLOPE = 0.01889
  DOWNSTREAM:  MANNING'S N = 0.01300;  FRICTION SLOPE = 0.01983
  AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.01936
  JUNCTION LENGTH =   4.00 FEET
  FRICTION LOSSES =  0.077 FEET         ENTRANCE LOSSES =  0.000 FEET
  JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
  JUNCTION LOSSES = ( 0.286)+( 0.000) =   0.286
--------------------------------------------------------------------------------
  NODE   580.00 : HGL = <  334.481>;EGL= <  336.066>;FLOWLINE= <  333.430>

********************************************************************************
  FLOW PROCESS FROM NODE   580.00 TO NODE   520.00 IS CODE =  1
  UPSTREAM NODE   520.00     ELEVATION =   335.49  (FLOW IS SUPERCRITICAL)
--------------------------------------------------------------------------------
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW   =      16.90 CFS     PIPE DIAMETER =  24.00 INCHES
  PIPE LENGTH =     102.97 FEET          MANNING'S N  =  0.01300
--------------------------------------------------------------------------------
  NORMAL DEPTH(FT) =      1.03          CRITICAL DEPTH(FT) =      1.48
================================================================================
  UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) =     1.48
================================================================================
  GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:
```

DISTANCE FROM CONTROL(FT)	FLOW DEPTH (FT)	VELOCITY (FT/SEC)	SPECIFIC ENERGY(FT)	PRESSURE+ MOMENTUM(POUNDS)
0.000	1.482	6.769	2.194	324.80
0.035	1.464	6.856	2.194	324.87
0.143	1.446	6.947	2.196	325.08
0.331	1.428	7.040	2.198	325.43
0.607	1.410	7.137	2.201	325.94
0.981	1.392	7.237	2.206	326.60
1.463	1.374	7.342	2.212	327.42
2.065	1.356	7.450	2.219	328.41
2.803	1.338	7.562	2.227	329.56
3.692	1.320	7.679	2.236	330.90
4.755	1.302	7.800	2.248	332.41
6.015	1.284	7.925	2.260	334.12
7.504	1.266	8.056	2.275	336.02
9.260	1.248	8.191	2.291	338.13
11.332	1.231	8.332	2.309	340.46
13.781	1.213	8.478	2.329	343.00
16.688	1.195	8.631	2.352	345.77
20.167	1.177	8.789	2.377	348.79
24.371	1.159	8.954	2.404	352.06
29.531	1.141	9.126	2.435	355.59
35.999	1.123	9.304	2.468	359.39
44.370	1.105	9.491	2.504	363.49
55.758	1.087	9.685	2.544	367.88
72.666	1.069	9.888	2.588	372.60
102.970	1.051	10.099	2.636	377.62

NODE 520.00 : HGL = < 336.972>;EGL= < 337.684>;FLOWLINE= < 335.490>

****

FLOW PROCESS FROM NODE 520.00 TO NODE 520.00 IS CODE = 8
UPSTREAM NODE 520.00 ELEVATION = 335.49 (FLOW UNSEALS IN REACH)

CALCULATE CATCH BASIN ENTRANCE LOSSES(LACFCD):
PIPE FLOW = 16.90 CFS PIPE DIAMETER = 24.00 INCHES
FLOW VELOCITY = 6.77 FEET/SEC. VELOCITY HEAD = 0.712 FEET
CATCH BASIN ENERGY LOSS = .2*(VELOCITY HEAD) = .2*(0.712) = 0.142

NODE 520.00 : HGL = < 337.826>;EGL= < 337.826>;FLOWLINE= < 335.490>

****

UPSTREAM PIPE FLOW CONTROL DATA:
NODE NUMBER = 520.00 FLOWLINE ELEVATION = 335.49
ASSUMED UPSTREAM CONTROL HGL = 336.97 FOR DOWNSTREAM RUN ANALYSIS

==========

END OF GRADUALLY VARIED FLOW ANALYSIS

```
**************************************************************************
              PIPE-FLOW HYDRAULICS COMPUTER PROGRAM PACKAGE
          (Reference: LACFCD,LACRD, AND OCEMA HYDRAULICS CRITERION)
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            Ver. 21.0  Release Date: 06/01/2014  License ID 1261

                          Analysis prepared by:

                        RICK ENGINEERING COMPANY
                            5620 Friars Road
                         San Diego, California 92110
                       619-291-0707   Fax 619-291-4165

 ************************* DESCRIPTION OF STUDY *************************
* SERRA MESA STORM DRAIN AND GREEN INFRASTRUCTURE IMPROVEMENTS           *
* J-17588-G                                                              *
* POST-PROJECT CONDITION - CAPACITY RUN; BASIN 600 OUTFALL               *
 ************************************************************************

  FILE NAME: 695.PIP
  TIME/DATE OF STUDY: 13:03 05/24/2017
```

```
**************************************************************************
              GRADUALLY VARIED FLOW ANALYSIS FOR PIPE SYSTEM
                      NODAL POINT STATUS TABLE
               (Note: "*" indicates nodal point data used.)
```

NODE NUMBER	MODEL PROCESS	UPSTREAM RUN PRESSURE HEAD(FT)	UPSTREAM RUN PRESSURE+ MOMENTUM(POUNDS)	DOWNSTREAM RUN FLOW DEPTH(FT)	DOWNSTREAM RUN PRESSURE+ MOMENTUM(POUNDS)
695.00-		2.00	318.67	0.72*	398.22
	} FRICTION				
690.00-		1.62	266.75	0.54*	572.22
	} JUNCTION				
690.00-		1.57	262.65	0.38*	920.40
	} FRICTION				
685.00-		1.35 Dc	254.23	0.77*	366.71
	} JUNCTION				
685.00-		1.35 Dc	254.23	0.78*	362.58
	} FRICTION				
625.00-		1.35*Dc	254.23	1.35*Dc	254.23
	} CATCH BASIN				
625.00-		2.08*	211.17	1.35 Dc	83.82

```
--------------------------------------------------------------------------
  MAXIMUM NUMBER OF ENERGY BALANCES USED IN EACH PROFILE =  25
--------------------------------------------------------------------------
  NOTE: STEADY FLOW HYDRAULIC HEAD-LOSS COMPUTATIONS BASED ON THE MOST
  CONSERVATIVE FORMULAE FROM THE CURRENT LACRD,LACFCD, AND OCEMA
  DESIGN MANUALS.
**************************************************************************
  DOWNSTREAM PIPE FLOW CONTROL DATA:
  NODE NUMBER =   695.00            FLOWLINE ELEVATION =   215.12
  PIPE FLOW =      14.10 CFS        PIPE DIAMETER =  24.00 INCHES
  ASSUMED DOWNSTREAM CONTROL HGL =   217.120 FEET
--------------------------------------------------------------------------
  NODE   695.00 : HGL = <  215.839>;EGL= <  218.831>;FLOWLINE= <  215.120>

**************************************************************************
  FLOW PROCESS FROM NODE   695.00 TO NODE   690.00 IS CODE =  1
  UPSTREAM NODE   690.00     ELEVATION =   215.55  (FLOW IS SUPERCRITICAL)
--------------------------------------------------------------------------
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW   =      14.10 CFS     PIPE DIAMETER =  24.00 INCHES
```

```
  PIPE LENGTH =      43.10 FEET          MANNING'S N  =  0.01300
-------------------------------------------------------------------------------
  NORMAL DEPTH(FT) =      1.14           CRITICAL DEPTH(FT) =      1.35
===============================================================================
  UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) =     0.54
===============================================================================
  GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:
-------------------------------------------------------------------------------
  DISTANCE FROM      FLOW DEPTH  VELOCITY      SPECIFIC        PRESSURE+
   CONTROL(FT)          (FT)    (FT/SEC)     ENERGY(FT)    MOMENTUM(POUNDS)
         0.000          0.540     20.588          7.126           572.22
         5.645          0.564     19.366          6.391           539.87
        11.342          0.588     18.267          5.773           510.96
        17.093          0.613     17.275          5.249           485.05
        22.902          0.637     16.376          4.803           461.73
        28.773          0.661     15.558          4.422           440.71
        34.712          0.685     14.811          4.094           421.70
        40.728          0.709     14.127          3.810           404.48
        43.100          0.719     13.877          3.711           398.22
-------------------------------------------------------------------------------
  NODE   690.00 : HGL = <  216.090>;EGL= <  222.676>;FLOWLINE= <  215.550>

*******************************************************************************
  FLOW PROCESS FROM NODE   690.00 TO NODE   690.00 IS CODE =  5
  UPSTREAM NODE   690.00     ELEVATION =   215.88  (FLOW IS SUPERCRITICAL)
-------------------------------------------------------------------------------
  CALCULATE JUNCTION LOSSES:
       PIPE        FLOW    DIAMETER   ANGLE    FLOWLINE   CRITICAL   VELOCITY
                   (CFS)   (INCHES) (DEGREES) ELEVATION  DEPTH(FT.)  (FT/SEC)
     UPSTREAM      14.10     24.00     47.00    215.88       1.35       33.534
    DOWNSTREAM     14.10     24.00       -      215.55       1.35       20.595
    LATERAL #1      0.00      0.00      0.00      0.00       0.00        0.000
    LATERAL #2      0.00      0.00      0.00      0.00       0.00        0.000
       Q5           0.00===Q5 EQUALS BASIN INPUT===

  LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
  DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
      Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
  UPSTREAM:    MANNING'S N = 0.01300;  FRICTION SLOPE = 0.60364
  DOWNSTREAM:  MANNING'S N = 0.01300;  FRICTION SLOPE = 0.15263
  AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.37813
  JUNCTION LENGTH =   4.00 FEET
  FRICTION LOSSES =  1.513 FEET         ENTRANCE LOSSES =  0.000 FEET
  JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
  JUNCTION LOSSES = (11.049)+( 0.000) =  11.049
-------------------------------------------------------------------------------
  NODE   690.00 : HGL = <  216.263>;EGL= <  233.725>;FLOWLINE= <  215.880>

*******************************************************************************
  FLOW PROCESS FROM NODE   690.00 TO NODE   685.00 IS CODE =  1
  UPSTREAM NODE   685.00     ELEVATION =   350.53  (FLOW IS SUPERCRITICAL)
-------------------------------------------------------------------------------
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW   =      14.10 CFS     PIPE DIAMETER =  24.00 INCHES
  PIPE LENGTH =     194.80 FEET          MANNING'S N  =  0.01300
-------------------------------------------------------------------------------
  NORMAL DEPTH(FT) =      0.37           CRITICAL DEPTH(FT) =      1.35
===============================================================================
  UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) =     0.77
===============================================================================
  GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:
-------------------------------------------------------------------------------
  DISTANCE FROM      FLOW DEPTH  VELOCITY      SPECIFIC        PRESSURE+
```

CONTROL(FT)	(FT)	(FT/SEC)	ENERGY(FT)	MOMENTUM(POUNDS)
0.000	0.772	12.593	3.236	366.71
0.196	0.756	12.955	3.364	375.48
0.412	0.740	13.336	3.503	384.82
0.650	0.724	13.738	3.657	394.78
0.913	0.708	14.164	3.825	405.39
1.205	0.692	14.614	4.010	416.72
1.529	0.676	15.091	4.214	428.80
1.890	0.660	15.597	4.440	441.72
2.293	0.644	16.135	4.689	455.53
2.746	0.628	16.707	4.965	470.31
3.255	0.612	17.318	5.271	486.16
3.831	0.596	17.969	5.612	503.16
4.486	0.579	18.666	5.993	521.43
5.234	0.563	19.412	6.418	541.09
6.096	0.547	20.213	6.896	562.27
7.095	0.531	21.075	7.433	585.15
8.266	0.515	22.005	8.039	609.90
9.653	0.499	23.009	8.725	636.72
11.320	0.483	24.097	9.505	665.87
13.360	0.467	25.279	10.396	697.60
15.921	0.451	26.567	11.418	732.26
19.248	0.435	27.974	12.594	770.20
23.801	0.419	29.517	13.956	811.87
30.618	0.403	31.214	15.541	857.79
43.028	0.387	33.088	17.398	908.58
194.800	0.383	33.524	17.845	920.40

NODE 685.00 : HGL = < 351.302>;EGL= < 353.766>;FLOWLINE= < 350.530>

****

FLOW PROCESS FROM NODE 685.00 TO NODE 685.00 IS CODE = 5
UPSTREAM NODE 685.00 ELEVATION = 350.86 (FLOW IS SUPERCRITICAL)

CALCULATE JUNCTION LOSSES:

PIPE	FLOW (CFS)	DIAMETER (INCHES)	ANGLE (DEGREES)	FLOWLINE ELEVATION	CRITICAL DEPTH(FT.)	VELOCITY (FT/SEC)
UPSTREAM	14.10	24.00	0.00	350.86	1.35	12.426
DOWNSTREAM	14.10	24.00	-	350.53	1.35	12.597
LATERAL #1	0.00	0.00	0.00	0.00	0.00	0.000
LATERAL #2	0.00	0.00	0.00	0.00	0.00	0.000
Q5	0.00===Q5 EQUALS BASIN INPUT===					

LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
UPSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.03751
DOWNSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.03895
AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.03823
JUNCTION LENGTH = 4.00 FEET
FRICTION LOSSES = 0.153 FEET ENTRANCE LOSSES = 0.000 FEET
JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
JUNCTION LOSSES = (0.271)+(0.000) = 0.271

NODE 685.00 : HGL = < 351.640>;EGL= < 354.038>;FLOWLINE= < 350.860>

****

FLOW PROCESS FROM NODE 685.00 TO NODE 625.00 IS CODE = 1
UPSTREAM NODE 625.00 ELEVATION = 354.70 (FLOW IS SUPERCRITICAL)

CALCULATE FRICTION LOSSES(LACFCD):
PIPE FLOW = 14.10 CFS PIPE DIAMETER = 24.00 INCHES
PIPE LENGTH = 91.30 FEET MANNING'S N = 0.01300

NORMAL DEPTH(FT) = 0.76 CRITICAL DEPTH(FT) = 1.35

UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) = 1.35

GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:

DISTANCE FROM CONTROL(FT)	FLOW DEPTH (FT)	VELOCITY (FT/SEC)	SPECIFIC ENERGY(FT)	PRESSURE+ MOMENTUM(POUNDS)
0.000	1.352	6.235	1.956	254.23
0.024	1.329	6.361	1.957	254.35
0.098	1.305	6.493	1.960	254.71
0.228	1.281	6.633	1.964	255.32
0.420	1.257	6.779	1.971	256.19
0.682	1.233	6.933	1.980	257.35
1.022	1.209	7.096	1.992	258.79
1.451	1.186	7.267	2.006	260.55
1.980	1.162	7.447	2.023	262.62
2.624	1.138	7.637	2.044	265.04
3.400	1.114	7.838	2.069	267.82
4.328	1.090	8.050	2.097	270.99
5.435	1.066	8.275	2.130	274.56
6.752	1.042	8.513	2.169	278.56
8.320	1.019	8.765	2.212	283.03
10.191	0.995	9.033	2.263	288.00
12.435	0.971	9.318	2.320	293.49
15.147	0.947	9.621	2.385	299.56
18.458	0.923	9.944	2.460	306.25
22.564	0.899	10.289	2.544	313.60
27.768	0.876	10.658	2.640	321.67
34.577	0.852	11.052	2.750	330.53
43.943	0.828	11.476	2.874	340.24
58.009	0.804	11.931	3.016	350.89
83.648	0.780	12.422	3.178	362.57
91.300	0.780	12.422	3.178	362.58

NODE 625.00 : HGL = < 356.052>;EGL= < 356.656>;FLOWLINE= < 354.700>

****

FLOW PROCESS FROM NODE 625.00 TO NODE 625.00 IS CODE = 8
UPSTREAM NODE 625.00 ELEVATION = 354.70 (FLOW UNSEALS IN REACH)

CALCULATE CATCH BASIN ENTRANCE LOSSES(LACFCD):
PIPE FLOW = 14.10 CFS PIPE DIAMETER = 24.00 INCHES
FLOW VELOCITY = 6.24 FEET/SEC. VELOCITY HEAD = 0.604 FEET
CATCH BASIN ENERGY LOSS = .2*(VELOCITY HEAD) = .2*(0.604) = 0.121

NODE 625.00 : HGL = < 356.777>;EGL= < 356.777>;FLOWLINE= < 354.700>

****

UPSTREAM PIPE FLOW CONTROL DATA:
NODE NUMBER = 625.00 FLOWLINE ELEVATION = 354.70
ASSUMED UPSTREAM CONTROL HGL = 356.05 FOR DOWNSTREAM RUN ANALYSIS

END OF GRADUALLY VARIED FLOW ANALYSIS

```
******************************************************************************
              PIPE-FLOW HYDRAULICS COMPUTER PROGRAM PACKAGE
          (Reference: LACFCD,LACRD, AND OCEMA HYDRAULICS CRITERION)
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                          Analysis prepared by:

                        RICK ENGINEERING COMPANY
                            5620 Friars Road
                         San Diego, California 92110
                       619-291-0707   Fax 619-291-4165

  ************************* DESCRIPTION OF STUDY *************************
 * SERRA MESA STORM DRAIN AND GREEN INFRASTRUCTURE IMPROVEMENTS           *
 * J-17588-G                                                              *
 * POST-PROJECT CONDITION - CAPACITY RUN; BASIN 700 OUTFALL               *
  ************************************************************************

   FILE NAME: 795.PIP
   TIME/DATE OF STUDY: 20:24 05/31/2017
```

```
******************************************************************************
               GRADUALLY VARIED FLOW ANALYSIS FOR PIPE SYSTEM
                        NODAL POINT STATUS TABLE
                 (Note: "*" indicates nodal point data used.)
                      UPSTREAM RUN                    DOWNSTREAM RUN
    NODE     MODEL    PRESSURE      PRESSURE+          FLOW         PRESSURE+
   NUMBER  PROCESS  HEAD(FT)   MOMENTUM(POUNDS)   DEPTH(FT)   MOMENTUM(POUNDS)
   795.00-              2.00            1129.46        1.54*            1243.85
         } FRICTION
   790.00-              3.04            1332.54        1.24*            1507.71
         } JUNCTION
   790.00-              3.56            1435.47        1.05*            1798.73
         } FRICTION
   785.00-              3.31            1386.10        0.95*            2032.24
         } JUNCTION
   785.00-              4.49            1617.99        0.70*            2999.72
         } FRICTION
   780.00-              1.95 Dc         1125.93        1.90*            1128.16
         } JUNCTION
   780.00-              2.10            1148.27        1.69*            1173.41
         } FRICTION
   740.00-              1.95*Dc         1125.93        1.95*Dc          1125.93
         } JUNCTION
   740.00-              3.69*           1045.27        1.43              772.65
         } FRICTION
   720.00-              3.17*            943.85        1.85 Dc           704.10
         } CATCH BASIN
   720.00-              4.76*            736.34        1.85 Dc           166.32
------------------------------------------------------------------------------
  MAXIMUM NUMBER OF ENERGY BALANCES USED IN EACH PROFILE =  25
------------------------------------------------------------------------------
  NOTE: STEADY FLOW HYDRAULIC HEAD-LOSS COMPUTATIONS BASED ON THE MOST
  CONSERVATIVE FORMULAE FROM THE CURRENT LACRD,LACFCD, AND OCEMA
  DESIGN MANUALS.
******************************************************************************
  DOWNSTREAM PIPE FLOW CONTROL DATA:
  NODE NUMBER =   795.00            FLOWLINE ELEVATION =   265.36
  PIPE FLOW =      38.90 CFS        PIPE DIAMETER =  24.00 INCHES
  ASSUMED DOWNSTREAM CONTROL HGL =   267.360 FEET
------------------------------------------------------------------------------
```

NODE 795.00 : HGL = < 266.897>;EGL= < 270.399>;FLOWLINE= < 265.360>

****

FLOW PROCESS FROM NODE 795.00 TO NODE 790.00 IS CODE = 1
UPSTREAM NODE 790.00 ELEVATION = 265.90 (FLOW IS SUPERCRITICAL)

CALCULATE FRICTION LOSSES(LACFCD):
PIPE FLOW = 38.90 CFS PIPE DIAMETER = 24.00 INCHES
PIPE LENGTH = 53.30 FEET MANNING'S N = 0.01300
===> NORMAL PIPEFLOW IS PRESSURE FLOW

NORMAL DEPTH(FT) = 2.00 CRITICAL DEPTH(FT) = 1.95

==========

UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) = 1.24

==========

GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:

DISTANCE FROM CONTROL(FT)	FLOW DEPTH (FT)	VELOCITY (FT/SEC)	SPECIFIC ENERGY(FT)	PRESSURE+ MOMENTUM(POUNDS)
0.000	1.235	19.091	6.898	1507.71
5.553	1.264	18.588	6.632	1473.46
11.018	1.292	18.115	6.391	1441.54
16.390	1.321	17.669	6.172	1411.78
21.661	1.349	17.249	5.972	1384.05
26.824	1.378	16.853	5.790	1358.22
31.871	1.406	16.479	5.625	1334.17
36.794	1.434	16.126	5.475	1311.80
41.583	1.463	15.793	5.338	1291.01
46.229	1.491	15.479	5.214	1271.73
50.719	1.520	15.182	5.101	1253.86
53.300	1.537	15.013	5.039	1243.85

NODE 790.00 : HGL = < 267.135>;EGL= < 272.798>;FLOWLINE= < 265.900>

****

FLOW PROCESS FROM NODE 790.00 TO NODE 790.00 IS CODE = 5
UPSTREAM NODE 790.00 ELEVATION = 266.23 (FLOW IS SUPERCRITICAL)

CALCULATE JUNCTION LOSSES:

PIPE	FLOW (CFS)	DIAMETER (INCHES)	ANGLE (DEGREES)	FLOWLINE ELEVATION	CRITICAL DEPTH(FT.)	VELOCITY (FT/SEC)
UPSTREAM	38.90	24.00	32.30	266.23	1.95	23.240
DOWNSTREAM	38.90	24.00	-	265.90	1.95	19.097
LATERAL #1	0.00	0.00	0.00	0.00	0.00	0.000
LATERAL #2	0.00	0.00	0.00	0.00	0.00	0.000
Q5	0.00===Q5 EQUALS BASIN INPUT===					

LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
UPSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.09991
DOWNSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.06001
AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.07996
JUNCTION LENGTH = 4.00 FEET
FRICTION LOSSES = 0.320 FEET ENTRANCE LOSSES = 0.000 FEET
JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
JUNCTION LOSSES = (2.870)+(0.000) = 2.870

NODE 790.00 : HGL = < 267.282>;EGL= < 275.668>;FLOWLINE= < 266.230>

****

FLOW PROCESS FROM NODE 790.00 TO NODE 785.00 IS CODE = 1
UPSTREAM NODE 785.00 ELEVATION = 267.36 (FLOW IS SUPERCRITICAL)

```
------------------------------------------------------------------------------
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW   =      38.90 CFS     PIPE DIAMETER =  24.00 INCHES
  PIPE LENGTH =      29.70 FEET          MANNING'S N  =  0.01300
------------------------------------------------------------------------------
  NORMAL DEPTH(FT) =      1.46          CRITICAL DEPTH(FT) =      1.95
==============================================================================
  UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) =     0.95
==============================================================================
  GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:
------------------------------------------------------------------------------
  DISTANCE FROM      FLOW DEPTH  VELOCITY      SPECIFIC        PRESSURE+
   CONTROL(FT)          (FT)    (FT/SEC)     ENERGY(FT)    MOMENTUM(POUNDS)
         0.000          0.949     26.462         11.830          2032.24
         5.678          0.970     25.750         11.272          1980.40
        11.462          0.990     25.074         10.759          1931.39
        17.362          1.010     24.433         10.286          1885.04
        23.392          1.031     23.824          9.849          1841.16
        29.566          1.051     23.245          9.446          1799.58
        29.700          1.052     23.233          9.438          1798.73
------------------------------------------------------------------------------
  NODE   785.00 : HGL = <  268.309>;EGL= <  279.190>;FLOWLINE= <  267.360>

******************************************************************************
  FLOW PROCESS FROM NODE   785.00 TO NODE   785.00 IS CODE =  5
  UPSTREAM NODE   785.00     ELEVATION =   267.69  (FLOW IS SUPERCRITICAL)
------------------------------------------------------------------------------
  CALCULATE JUNCTION LOSSES:
       PIPE        FLOW    DIAMETER   ANGLE    FLOWLINE   CRITICAL   VELOCITY
                   (CFS)   (INCHES) (DEGREES) ELEVATION  DEPTH(FT.)  (FT/SEC)
     UPSTREAM      38.90     24.00     45.00     267.69      1.95       39.555
    DOWNSTREAM     38.90     24.00       -       267.36      1.95       26.470
    LATERAL #1      0.00      0.00      0.00       0.00      0.00        0.000
    LATERAL #2      0.00      0.00      0.00       0.00      0.00        0.000
       Q5           0.00===Q5 EQUALS BASIN INPUT===

  LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
  DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
      Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
  UPSTREAM:    MANNING'S N = 0.01300;  FRICTION SLOPE = 0.42349
  DOWNSTREAM:  MANNING'S N = 0.01300;  FRICTION SLOPE = 0.14137
  AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.28243
  JUNCTION LENGTH =   4.00 FEET
  FRICTION LOSSES =  1.130 FEET         ENTRANCE LOSSES =  0.000 FEET
  JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
  JUNCTION LOSSES = (13.498)+( 0.000) =  13.498
------------------------------------------------------------------------------
  NODE   785.00 : HGL = <  268.392>;EGL= <  292.687>;FLOWLINE= <  267.690>

******************************************************************************
  FLOW PROCESS FROM NODE   785.00 TO NODE   780.00 IS CODE =  1
  UPSTREAM NODE   780.00     ELEVATION =   337.39  (FLOW IS SUPERCRITICAL)
------------------------------------------------------------------------------
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW   =      38.90 CFS     PIPE DIAMETER =  24.00 INCHES
  PIPE LENGTH =     164.60 FEET          MANNING'S N  =  0.01300
------------------------------------------------------------------------------
  NORMAL DEPTH(FT) =      0.70          CRITICAL DEPTH(FT) =      1.95
==============================================================================
  UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) =     1.90
==============================================================================
  GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:
------------------------------------------------------------------------------
```

DISTANCE FROM CONTROL(FT)	FLOW DEPTH (FT)	VELOCITY (FT/SEC)	SPECIFIC ENERGY(FT)	PRESSURE+ MOMENTUM(POUNDS)
0.000	1.895	12.631	4.374	1128.16
0.074	1.848	12.826	4.404	1133.74
0.189	1.800	13.059	4.450	1142.36
0.347	1.752	13.328	4.512	1153.89
0.550	1.704	13.634	4.593	1168.34
0.801	1.657	13.977	4.692	1185.79
1.106	1.609	14.358	4.812	1206.37
1.473	1.561	14.781	4.956	1230.28
1.909	1.513	15.247	5.125	1257.74
2.425	1.466	15.762	5.326	1289.06
3.037	1.418	16.328	5.560	1324.57
3.760	1.370	16.953	5.836	1364.70
4.616	1.322	17.642	6.158	1409.94
5.634	1.275	18.402	6.536	1460.87
6.851	1.227	19.244	6.981	1518.17
8.313	1.179	20.177	7.505	1582.67
10.087	1.131	21.215	8.125	1655.35
12.261	1.084	22.374	8.862	1737.39
14.965	1.036	23.672	9.742	1830.23
18.391	0.988	25.132	10.802	1935.60
22.838	0.941	26.784	12.087	2055.67
28.817	0.893	28.662	13.657	2193.10
37.292	0.845	30.811	15.595	2351.27
50.441	0.797	33.288	18.015	2534.46
75.274	0.750	36.167	21.073	2748.19
164.600	0.702	39.543	24.997	2999.72

NODE 780.00 : HGL = < 339.285>;EGL= < 341.764>;FLOWLINE= < 337.390>

****

FLOW PROCESS FROM NODE 780.00 TO NODE 780.00 IS CODE = 5
UPSTREAM NODE 780.00 ELEVATION = 337.72 (FLOW IS SUPERCRITICAL)

CALCULATE JUNCTION LOSSES:

PIPE	FLOW (CFS)	DIAMETER (INCHES)	ANGLE (DEGREES)	FLOWLINE ELEVATION	CRITICAL DEPTH(FT.)	VELOCITY (FT/SEC)
UPSTREAM	38.90	24.00	21.50	337.72	1.95	13.740
DOWNSTREAM	38.90	24.00	-	337.39	1.95	12.635
LATERAL #1	0.00	0.00	0.00	0.00	0.00	0.000
LATERAL #2	0.00	0.00	0.00	0.00	0.00	0.000
Q5	0.00===Q5 EQUALS BASIN INPUT===					

LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
UPSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.02811
DOWNSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.02559
AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.02685
JUNCTION LENGTH = 4.00 FEET
FRICTION LOSSES = 0.107 FEET ENTRANCE LOSSES = 0.000 FEET
JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
JUNCTION LOSSES = (0.577)+(0.000) = 0.577

NODE 780.00 : HGL = < 339.410>;EGL= < 342.341>;FLOWLINE= < 337.720>

****

FLOW PROCESS FROM NODE 780.00 TO NODE 740.00 IS CODE = 1
UPSTREAM NODE 740.00 ELEVATION = 340.12 (FLOW IS SUPERCRITICAL)

CALCULATE FRICTION LOSSES(LACFCD):
PIPE FLOW = 38.90 CFS PIPE DIAMETER = 24.00 INCHES

PIPE LENGTH = 79.90 FEET MANNING'S N = 0.01300

NORMAL DEPTH(FT) = 1.63 CRITICAL DEPTH(FT) = 1.95

==========

UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) = 1.95

==========

GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:

DISTANCE FROM CONTROL(FT)	FLOW DEPTH (FT)	VELOCITY (FT/SEC)	SPECIFIC ENERGY(FT)	PRESSURE+ MOMENTUM(POUNDS)
0.000	1.947	12.470	4.363	1125.93
0.193	1.934	12.505	4.363	1126.08
0.730	1.921	12.544	4.366	1126.52
1.570	1.908	12.586	4.369	1127.22
2.693	1.895	12.632	4.374	1128.18
4.089	1.882	12.680	4.381	1129.37
5.758	1.869	12.732	4.388	1130.80
7.706	1.857	12.786	4.397	1132.46
9.948	1.844	12.844	4.407	1134.33
12.502	1.831	12.903	4.418	1136.43
15.395	1.818	12.966	4.430	1138.74
18.663	1.805	13.031	4.444	1141.26
22.351	1.792	13.099	4.458	1143.99
26.516	1.779	13.170	4.474	1146.93
31.233	1.767	13.243	4.491	1150.09
36.600	1.754	13.319	4.510	1153.45
42.745	1.741	13.397	4.530	1157.03
49.847	1.728	13.478	4.550	1160.81
58.153	1.715	13.562	4.573	1164.82
68.029	1.702	13.648	4.596	1169.03
79.900	1.690	13.736	4.621	1173.41

NODE 740.00 : HGL = < 342.066>;EGL= < 344.483>;FLOWLINE= < 340.120>

****

FLOW PROCESS FROM NODE 740.00 TO NODE 740.00 IS CODE = 5

UPSTREAM NODE 740.00 ELEVATION = 340.45 (FLOW UNSEALS IN REACH)

CALCULATE JUNCTION LOSSES:

PIPE	FLOW (CFS)	DIAMETER (INCHES)	ANGLE (DEGREES)	FLOWLINE ELEVATION	CRITICAL DEPTH(FT.)	VELOCITY (FT/SEC)
UPSTREAM	29.00	24.00	1.50	340.45	1.85	9.231
DOWNSTREAM	38.90	24.00	-	340.12	1.95	12.474
LATERAL #1	9.90	24.00	55.50	340.95	1.13	3.151
LATERAL #2	0.00	0.00	0.00	0.00	0.00	0.000
Q5	0.00===Q5 EQUALS BASIN INPUT===					

LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:

DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES

UPSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.01643

DOWNSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.02616

AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.02129

JUNCTION LENGTH = 4.00 FEET

FRICTION LOSSES = 0.085 FEET ENTRANCE LOSSES = 0.000 FEET

JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)

JUNCTION LOSSES = (0.976)+(0.000) = 0.976

NODE 740.00 : HGL = < 344.136>;EGL= < 345.459>;FLOWLINE= < 340.450>

****

FLOW PROCESS FROM NODE 740.00 TO NODE 720.00 IS CODE = 1

UPSTREAM NODE 720.00 ELEVATION = 341.60 (FLOW IS UNDER PRESSURE)

```
------------------------------------------------------------------------------
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW    =      29.00 CFS     PIPE DIAMETER =  24.00 INCHES
  PIPE LENGTH =       38.50 FEET          MANNING'S N  =  0.01300
  SF=(Q/K)**2 = ((     29.00)/(   226.226))**2 = 0.01643
  HF=L*SF = (     38.50)*(0.01643) =      0.633
------------------------------------------------------------------------------
  NODE   720.00 : HGL = <  344.768>;EGL= <  346.092>;FLOWLINE= <  341.600>

******************************************************************************
  FLOW PROCESS FROM NODE   720.00 TO NODE   720.00 IS CODE =  8
  UPSTREAM NODE   720.00     ELEVATION =   341.60  (FLOW IS UNDER PRESSURE)
------------------------------------------------------------------------------
  CALCULATE CATCH BASIN ENTRANCE LOSSES(LACFCD):
  PIPE FLOW =      29.00 CFS          PIPE DIAMETER =  24.00 INCHES
  FLOW VELOCITY =   9.23 FEET/SEC.    VELOCITY HEAD =  1.323 FEET
  CATCH BASIN ENERGY LOSS = .2*(VELOCITY HEAD) = .2*(  1.323) =  0.265
------------------------------------------------------------------------------
  NODE   720.00 : HGL = <  346.356>;EGL= <  346.356>;FLOWLINE= <  341.600>

******************************************************************************
  UPSTREAM PIPE FLOW CONTROL DATA:
  NODE NUMBER =   720.00            FLOWLINE ELEVATION =   341.60
  ASSUMED UPSTREAM CONTROL HGL =    343.45 FOR DOWNSTREAM RUN ANALYSIS

==============================================================================
  END OF GRADUALLY VARIED FLOW ANALYSIS
 ♀
```

```
**************************************************************************
              PIPE-FLOW HYDRAULICS COMPUTER PROGRAM PACKAGE
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                          Analysis prepared by:

                        RICK ENGINEERING COMPANY
                            5620 Friars Road
                         San Diego, California 92110
                        619-291-0707   Fax 619-291-4165

 ************************* DESCRIPTION OF STUDY *************************
* SERRA MESA STORM DRAIN AND GREEN INFRASTRUCTURE IMPROVEMENTS           *
* J-17588-G                                                              *
* POST-PROJECT CONDITION - CAPACITY RUN; BASIN 700 LATERAL               *
 ************************************************************************

  FILE NAME: 740.LAT
  TIME/DATE OF STUDY: 20:44 05/31/2017
--------------------------------------------------------------------------
**************************************************************************
               GRADUALLY VARIED FLOW ANALYSIS FOR PIPE SYSTEM
                        NODAL POINT STATUS TABLE
                (Note: "*" indicates nodal point data used.)
                     UPSTREAM RUN                    DOWNSTREAM RUN
   NODE     MODEL    PRESSURE      PRESSURE+          FLOW         PRESSURE+
  NUMBER  PROCESS  HEAD(FT)   MOMENTUM(POUNDS)   DEPTH(FT)   MOMENTUM(POUNDS)
  740.00-              4.44*            701.66        0.63              115.83
        } FRICTION
  741.00-              3.22*            463.61        0.92 Dc            95.81
        } JUNCTION
  741.00-              2.97*            413.46        0.64              114.62
        } FRICTION
  742.00-              2.01*            226.02        0.92 Dc            95.81
        } CATCH BASIN
  742.00-              2.10*            214.94        0.92 Dc            33.93
--------------------------------------------------------------------------
  MAXIMUM NUMBER OF ENERGY BALANCES USED IN EACH PROFILE =  25
--------------------------------------------------------------------------
  NOTE: STEADY FLOW HYDRAULIC HEAD-LOSS COMPUTATIONS BASED ON THE MOST
  CONSERVATIVE FORMULAE FROM THE CURRENT LACRD,LACFCD, AND OCEMA
  DESIGN MANUALS.
**************************************************************************
  DOWNSTREAM PIPE FLOW CONTROL DATA:
  NODE NUMBER =   740.00            FLOWLINE ELEVATION =   340.95
  PIPE FLOW =       6.70 CFS        PIPE DIAMETER =  24.00 INCHES
  ASSUMED DOWNSTREAM CONTROL HGL =   345.388 FEET
--------------------------------------------------------------------------
  NODE   740.00 : HGL = <  345.388>;EGL= <  345.459>;FLOWLINE= <  340.950>

**************************************************************************
  FLOW PROCESS FROM NODE   740.00 TO NODE   741.00 IS CODE =  1
  UPSTREAM NODE   741.00     ELEVATION =   342.22  (FLOW IS UNDER PRESSURE)
--------------------------------------------------------------------------
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW   =       6.70 CFS     PIPE DIAMETER =  24.00 INCHES
  PIPE LENGTH =      63.50 FEET          MANNING'S N  =  0.01300
  SF=(Q/K)**2 = ((      6.70)/(   226.233))**2 = 0.00088
  HF=L*SF = (     63.50)*(0.00088) =      0.056
--------------------------------------------------------------------------
```

```
  NODE   741.00 : HGL = <  345.444>;EGL= <  345.514>;FLOWLINE= <  342.220>

****************************************************************************
  FLOW PROCESS FROM NODE   741.00 TO NODE   741.00 IS CODE =  5
  UPSTREAM NODE   741.00     ELEVATION =   342.55  (FLOW IS UNDER PRESSURE)
----------------------------------------------------------------------------
  CALCULATE JUNCTION LOSSES:
       PIPE       FLOW    DIAMETER   ANGLE    FLOWLINE   CRITICAL   VELOCITY
                  (CFS)   (INCHES) (DEGREES) ELEVATION  DEPTH(FT.)  (FT/SEC)
     UPSTREAM       6.70    24.00     60.00    342.55      0.92        2.133
    DOWNSTREAM      6.70    24.00       -      342.22      0.92        2.133
    LATERAL #1      0.00     0.00      0.00      0.00      0.00        0.000
    LATERAL #2      0.00     0.00      0.00      0.00      0.00        0.000
       Q5           0.00===Q5 EQUALS BASIN INPUT===

  LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
  DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
      Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
  UPSTREAM:    MANNING'S N = 0.01300;  FRICTION SLOPE = 0.00088
  DOWNSTREAM:  MANNING'S N = 0.01300;  FRICTION SLOPE = 0.00088
  AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.00088
  JUNCTION LENGTH =   4.00 FEET
  FRICTION LOSSES =  0.004 FEET         ENTRANCE LOSSES =  0.000 FEET
  JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
  JUNCTION LOSSES = ( 0.074)+( 0.000) =   0.074
----------------------------------------------------------------------------
  NODE   741.00 : HGL = <  345.518>;EGL= <  345.588>;FLOWLINE= <  342.550>

****************************************************************************
  FLOW PROCESS FROM NODE   741.00 TO NODE   742.00 IS CODE =  1
  UPSTREAM NODE   742.00     ELEVATION =   343.55  (FLOW IS UNDER PRESSURE)
----------------------------------------------------------------------------
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW   =       6.70 CFS     PIPE DIAMETER =  24.00 INCHES
  PIPE LENGTH =      50.00 FEET          MANNING'S N  =  0.01300
  SF=(Q/K)**2 = ((      6.70)/(   226.233))**2 = 0.00088
  HF=L*SF = (     50.00)*(0.00088) =      0.044
----------------------------------------------------------------------------
  NODE   742.00 : HGL = <  345.562>;EGL= <  345.632>;FLOWLINE= <  343.550>

****************************************************************************
  FLOW PROCESS FROM NODE   742.00 TO NODE   742.00 IS CODE =  8
  UPSTREAM NODE   742.00     ELEVATION =   343.55  (FLOW IS UNDER PRESSURE)
----------------------------------------------------------------------------
  CALCULATE CATCH BASIN ENTRANCE LOSSES(LACFCD):
  PIPE FLOW =       6.70 CFS          PIPE DIAMETER =  24.00 INCHES
  FLOW VELOCITY =   2.13 FEET/SEC.    VELOCITY HEAD =  0.071 FEET
  CATCH BASIN ENERGY LOSS = .2*(VELOCITY HEAD) = .2*(  0.071) =  0.014
----------------------------------------------------------------------------
  NODE   742.00 : HGL = <  345.646>;EGL= <  345.646>;FLOWLINE= <  343.550>

****************************************************************************
  UPSTREAM PIPE FLOW CONTROL DATA:
  NODE NUMBER =   742.00            FLOWLINE ELEVATION =   343.55
  ASSUMED UPSTREAM CONTROL HGL =    344.47 FOR DOWNSTREAM RUN ANALYSIS

============================================================================
  END OF GRADUALLY VARIED FLOW ANALYSIS
 ♀
```

APPENDIX F

Energy Dissipater Design

Serra Mesa Storm Drain and Green Infrastructure Improvements
J-17588-G
9/26/17

Rip Rap Sizing for Storm Drain Outfalls

							Tractive Force Calculation Inputs[2]							
Site #	Drainage Basin	Drainage Node ID	Storm Drain Outfall Pipe Diameter (inches)	Q_{100} (cfs)	$V_{100,\ pipe\ exit}$ (ft/s)	$V_{100,\ rip\ rap\ exit}$ (ft/s)	Flow Depth (y) (ft)	Rip Rap Pad Bottom Width (b) (ft)	b/y	Rip Rap Size Slopes (z)	Angle of Side Slope (ϕ) (degrees)	Angle of Repose of Rock (θ) (degrees)	Slope of the Energy Grade Line (S_{EGL})	
													from PIPEFLOW	from HEC-RAS
1	100	195	24	**17.4**	**16.5**	2.1	0.33	6	18	2	26.6	40.0	0.078	0.580
2	200	295	24	**11.1**	**13.4**	1.8	0.30	6	20	2	26.6	40.0	0.018	0.250
3	300	395	24	**25.2**	**14.8**	2.5	0.49	6	12	2	26.6	40.0	0.043	0.400
4	400	495	24	**13.3**	**11.1**	1.9	0.30	6	20	2	26.6	40.0	0.033	0.360
5	500	595	24	**16.9**	**7.2**	2.3	0.50	6	12	2	26.6	40.0	0.008	0.140
6	600	695	24	**14.1**	**13.9**	1.9	0.31	6	19	2	26.6	40.0	0.089	0.430
7	700	795	24	**38.9**	**15.0**	2.8	0.54	6	11	2	26.6	40.0	0.045	0.350

Notes:

1. The minimum rock gradation provided will be 1/4 Ton rock.
2. Refer to separate hand-calculation for equations used in the tractive force calculation
3. Due the the steep downstream channel slopes, the downstreammost 5-feet of the rip rap pad for Drainage Basins 100, 300, and 500 will be doubled in thickness to allow the rip rap pad to self-adjust over time. This double thickness is reflected in the table.
4. Site 1 (Drainage Basin 100) rip rap pad has been designed with two rock gradations based on the decreased velocities as water slows down through the initial portion of the pad. For this outfall, the minimum proposed rip rap pad requires 1 Ton Rip Rap 14-ft (W) x 6-ft (L) x 4.4-ft (T) transitioning to 1/4 Ton Rip Rap 14-ft (W) x 4-ft (L) x 5.4-ft (T).
5. Site 3 (Drainage Basin 300) rip rap pad has been designed with two rock gradations based on the decreased velocities as water slows down through the initial portion of the pad. For this outfall, the minimum proposed rip rap pad requires 1 Ton Rip Rap 14-ft (W) x 6-ft (L) x 4.4-ft (T) transitioning to 1/4 Ton Rip Rap 14-ft (W) x 6-ft (L) x 5.4-ft (T).
6. Site 7 (Drainage Basin 700) rip rap pad has been designed with two rock gradations based on the decreased velocities as water slows down through the initial portion of the pad. For this outfall, the minimum proposed rip rap pad requires 1 Ton Rip Rap 14-ft (W) x 6-ft (L) x 4.4-ft (T) transitioning to 1/4 Ton Rip Rap 14-ft (W) x 6-ft (L) x 5.4-ft (T).

Serra Mesa Storm Drain and Green Infrastructure Improvements
J-17588-G
9/26/17

Tractive Force Calculation[2]									Rip Rap Design Results Based on HEC-RAS Analysis						
Channel Bottom			Channel Sides				Governing D_{50} (ft)	Governing Rock Gradation	Rock Gradation			Length (ft)		Width (ft)	Thickness[3] (ft)
X_{bottom} (ft)	τ_{bottom} (lb/ft^3)	D_{50} (ft)	X_{side} (ft)	τ_{side} (lb/ft^3)	Tractive-force Ratio (K)	D_{50} (ft)			Minimum Required Per DDM	Minimum Required Per Tractive Force Calculations	Provided[1]	Minimum Required	Provided		
1.00	11.943	2.91	0.78	9.316	0.997	2.28	2.91	1 Ton	1 Ton	1 Ton	**1 Ton to 1/4 Ton**	10	**15**	**14**	***varies***[4]
1.00	4.680	1.14	0.78	3.650	0.997	0.89	1.14	Light	No. 1 Backing	Light	**1/4 Ton**	10	**15**	**14**	**2.7**
1.00	12.230	2.98	0.78	9.540	0.997	2.33	2.98	1 Ton	1/2 Ton	1 Ton	**1 Ton to 1/4 Ton**	12	**16**	**14**	***varies***[5]
1.00	6.739	1.64	0.78	5.257	0.997	1.29	1.64	1/4 Ton	1/4 Ton	1/4 Ton	**1/4 Ton**	10	**15**	**14**	**2.7**
1.00	4.368	1.07	0.78	3.407	0.997	0.83	1.07	Light	No. 2 Backing	Light	**1/4 Ton**	10	**15**	**14**	***5.4***
1.00	8.318	2.03	0.78	6.488	0.997	1.59	2.03	1/2 Ton	1/2 Ton	1/2 Ton	**1/2 Ton**	10	**18**	**14**	**3.5**
1.00	11.794	2.88	0.78	9.199	0.997	2.25	2.88	1 Ton	1 Ton	1 Ton	**1 Ton to 1/4 Ton**	11	**18**	**14**	***varies***[6]

```
**************************************************************************
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                          Analysis prepared by:

                        RICK ENGINEERING COMPANY
                            5620 Friars Road
                       San Diego, California 92110
                      619-291-0707   Fax 619-291-4165

  ************************* DESCRIPTION OF STUDY *************************
 * SERRA MESA STORM DRAIN AND GREEN INFRASTRUCTURE IMPROVEMENTS           *
 * J-17588-G                                                              *
 * POST-PROJECT CONDITION - VELOCITY RUN; BASIN 100 OUTFALL               *
  ************************************************************************

   FILE NAME: 195_V.PIP
   TIME/DATE OF STUDY: 17:09 05/31/2017
--------------------------------------------------------------------------
**************************************************************************
               GRADUALLY VARIED FLOW ANALYSIS FOR PIPE SYSTEM
                        NODAL POINT STATUS TABLE
                (Note: "*" indicates nodal point data used.)
                      UPSTREAM RUN                    DOWNSTREAM RUN
    NODE     MODEL    PRESSURE      PRESSURE+          FLOW         PRESSURE+
   NUMBER  PROCESS  HEAD(FT)   MOMENTUM(POUNDS)   DEPTH(FT)   MOMENTUM(POUNDS)
   195.00-             1.50 Dc          338.01        0.74*             578.11
         } FRICTION
   190.00-             1.50 Dc          338.01        0.70*             620.23
         } JUNCTION
   190.00-             1.83             357.59        0.48*            1014.04
         } FRICTION
   185.00-             1.50 Dc          338.01        0.73*             581.39
         } JUNCTION
   185.00-             1.44 Dc          412.64        0.85*             590.99
         } FRICTION
   140.00-             1.44*Dc          412.64        1.44*Dc           412.64
         } CATCH BASIN
   140.00-             3.29*            280.64        1.44 Dc            76.61
--------------------------------------------------------------------------
  MAXIMUM NUMBER OF ENERGY BALANCES USED IN EACH PROFILE =  25
--------------------------------------------------------------------------
  NOTE: STEADY FLOW HYDRAULIC HEAD-LOSS COMPUTATIONS BASED ON THE MOST
  CONSERVATIVE FORMULAE FROM THE CURRENT LACRD,LACFCD, AND OCEMA
  DESIGN MANUALS.
**************************************************************************
  DOWNSTREAM PIPE FLOW CONTROL DATA:
  NODE NUMBER =   195.00            FLOWLINE ELEVATION =   290.62
  PIPE FLOW =      17.40 CFS        PIPE DIAMETER =  24.00 INCHES
  ASSUMED DOWNSTREAM CONTROL HGL =   290.620 FEET
  *NOTE: ASSUMED DOWNSTREAM CONTROL DEPTH(  0.00 FT.)
         IS LESS THAN CRITICAL DEPTH(  1.50 FT.)
  ===> CRITICAL DEPTH IS ASSUMED AS DOWNSTREAM CONTROL DEPTH
       FOR UPSTREAM RUN ANALYSIS
--------------------------------------------------------------------------
  NODE   195.00 : HGL = <  291.357>;EGL= <  295.609>;FLOWLINE= <  290.620>

**************************************************************************
  FLOW PROCESS FROM NODE   195.00 TO NODE   190.00 IS CODE =  1
```

```
  UPSTREAM NODE   190.00     ELEVATION =   290.72  (FLOW IS SUPERCRITICAL)
---------------------------------------------------------------------------
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW    =      17.40 CFS     PIPE DIAMETER =  24.00 INCHES
  PIPE LENGTH =       9.80 FEET          MANNING'S N  =  0.01300
---------------------------------------------------------------------------
  NORMAL DEPTH(FT) =      1.31          CRITICAL DEPTH(FT) =      1.50
===========================================================================
  UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) =     0.70
===========================================================================
  GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:
---------------------------------------------------------------------------
  DISTANCE FROM      FLOW DEPTH  VELOCITY      SPECIFIC        PRESSURE+
   CONTROL(FT)           (FT)    (FT/SEC)     ENERGY(FT)    MOMENTUM(POUNDS)
         0.000          0.697     17.867          5.657           620.23
         5.858          0.721     17.051          5.238           594.20
         9.800          0.737     16.543          4.989           578.11
---------------------------------------------------------------------------
  NODE   190.00 : HGL = <  291.417>;EGL= <  296.377>;FLOWLINE= <  290.720>

***************************************************************************
  FLOW PROCESS FROM NODE   190.00 TO NODE   190.00 IS CODE =  5
  UPSTREAM NODE   190.00     ELEVATION =   291.05  (FLOW IS SUPERCRITICAL)
---------------------------------------------------------------------------
  CALCULATE JUNCTION LOSSES:
       PIPE       FLOW    DIAMETER   ANGLE    FLOWLINE   CRITICAL   VELOCITY
                  (CFS)   (INCHES) (DEGREES) ELEVATION  DEPTH(FT.)  (FT/SEC)
     UPSTREAM      17.40    24.00     49.50    291.05      1.50       29.860
    DOWNSTREAM     17.40    24.00       -      290.72      1.50       17.873
    LATERAL #1      0.00     0.00      0.00      0.00      0.00        0.000
    LATERAL #2      0.00     0.00      0.00      0.00      0.00        0.000
       Q5           0.00===Q5 EQUALS BASIN INPUT===

  LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
  DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
      Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
  UPSTREAM:    MANNING'S N = 0.01300;  FRICTION SLOPE = 0.36560
  DOWNSTREAM:  MANNING'S N = 0.01300;  FRICTION SLOPE = 0.08714
  AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.22637
  JUNCTION LENGTH =   4.00 FEET
  FRICTION LOSSES =  0.905 FEET         ENTRANCE LOSSES =  0.000 FEET
  JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
  JUNCTION LOSSES = ( 9.000)+( 0.000) =   9.000
---------------------------------------------------------------------------
  NODE   190.00 : HGL = <  291.532>;EGL= <  305.377>;FLOWLINE= <  291.050>

***************************************************************************
  FLOW PROCESS FROM NODE   190.00 TO NODE   185.00 IS CODE =  1
  UPSTREAM NODE   185.00     ELEVATION =   340.83  (FLOW IS SUPERCRITICAL)
---------------------------------------------------------------------------
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW    =      17.40 CFS     PIPE DIAMETER =  24.00 INCHES
  PIPE LENGTH =     125.40 FEET          MANNING'S N  =  0.01300
---------------------------------------------------------------------------
  NORMAL DEPTH(FT) =      0.47          CRITICAL DEPTH(FT) =      1.50
===========================================================================
  UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) =     0.73
===========================================================================
  GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:
---------------------------------------------------------------------------
  DISTANCE FROM      FLOW DEPTH  VELOCITY      SPECIFIC        PRESSURE+
   CONTROL(FT)           (FT)    (FT/SEC)     ENERGY(FT)    MOMENTUM(POUNDS)
         0.000          0.734     16.647          5.039           581.39
```

0.497	0.723	16.974	5.200	591.77
1.031	0.713	17.314	5.371	602.57
1.607	0.702	17.667	5.552	613.81
2.228	0.692	18.033	5.744	625.52
2.899	0.681	18.413	5.949	637.71
3.627	0.671	18.807	6.167	650.42
4.417	0.661	19.218	6.399	663.66
5.280	0.650	19.645	6.646	677.48
6.222	0.640	20.090	6.910	691.91
7.258	0.629	20.553	7.192	706.97
8.399	0.619	21.036	7.494	722.71
9.663	0.608	21.539	7.817	739.16
11.072	0.598	22.065	8.162	756.37
12.651	0.587	22.614	8.533	774.38
14.435	0.577	23.188	8.931	793.24
16.470	0.566	23.789	9.359	813.02
18.816	0.556	24.418	9.820	833.76
21.561	0.545	25.077	10.316	855.53
24.829	0.535	25.768	10.852	878.41
28.818	0.524	26.494	11.431	902.46
33.854	0.514	27.257	12.058	927.78
40.554	0.503	28.060	12.737	954.44
50.301	0.493	28.905	13.475	982.56
67.534	0.482	29.797	14.277	1012.23
125.400	0.482	29.851	14.327	1014.04

NODE 185.00 : HGL = < 341.564>;EGL= < 345.869>;FLOWLINE= < 340.830>

****

FLOW PROCESS FROM NODE 185.00 TO NODE 185.00 IS CODE = 5
UPSTREAM NODE 185.00 ELEVATION = 341.16 (FLOW IS SUPERCRITICAL)

CALCULATE JUNCTION LOSSES:

PIPE	FLOW (CFS)	DIAMETER (INCHES)	ANGLE (DEGREES)	FLOWLINE ELEVATION	CRITICAL DEPTH(FT.)	VELOCITY (FT/SEC)
UPSTREAM	17.40	18.00	4.90	341.16	1.44	16.828
DOWNSTREAM	17.40	24.00	-	340.83	1.50	16.652
LATERAL #1	0.00	0.00	0.00	0.00	0.00	0.000
LATERAL #2	0.00	0.00	0.00	0.00	0.00	0.000
Q5	0.00===Q5 EQUALS BASIN INPUT===					

LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
UPSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.07251
DOWNSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.07166
AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.07209
JUNCTION LENGTH = 4.00 FEET
FRICTION LOSSES = 0.288 FEET ENTRANCE LOSSES = 0.000 FEET
JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
JUNCTION LOSSES = (0.538)+(0.000) = 0.538

NODE 185.00 : HGL = < 342.011>;EGL= < 346.408>;FLOWLINE= < 341.160>

****

FLOW PROCESS FROM NODE 185.00 TO NODE 140.00 IS CODE = 1
UPSTREAM NODE 140.00 ELEVATION = 348.00 (FLOW IS SUPERCRITICAL)

CALCULATE FRICTION LOSSES(LACFCD):
PIPE FLOW = 17.40 CFS PIPE DIAMETER = 18.00 INCHES
PIPE LENGTH = 83.00 FEET MANNING'S N = 0.01300

NORMAL DEPTH(FT) = 0.82 CRITICAL DEPTH(FT) = 1.44

```
================================================================================
  UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) =     1.44
================================================================================
  GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:
--------------------------------------------------------------------------------
  DISTANCE FROM      FLOW DEPTH  VELOCITY      SPECIFIC        PRESSURE+
   CONTROL(FT)          (FT)    (FT/SEC)     ENERGY(FT)    MOMENTUM(POUNDS)
          0.000         1.445       9.962         2.987           412.64
          0.050         1.419      10.052         2.989           412.95
          0.192         1.394      10.159         2.998           413.85
          0.423         1.369      10.280         3.011           415.29
          0.744         1.344      10.417         3.030           417.25
          1.156         1.319      10.567         3.054           419.72
          1.667         1.294      10.731         3.083           422.71
          2.283         1.269      10.910         3.118           426.22
          3.016         1.244      11.103         3.159           430.26
          3.879         1.219      11.311         3.207           434.86
          4.887         1.194      11.535         3.261           440.03
          6.063         1.169      11.776         3.323           445.80
          7.431         1.144      12.033         3.393           452.21
          9.023         1.118      12.309         3.473           459.28
         10.882         1.093      12.605         3.562           467.06
         13.062         1.068      12.921         3.662           475.58
         15.633         1.043      13.259         3.775           484.92
         18.694         1.018      13.622         3.901           495.11
         22.382         0.993      14.010         4.043           506.23
         26.899         0.968      14.426         4.201           518.34
         32.559         0.943      14.872         4.379           531.54
         39.889         0.918      15.351         4.579           545.90
         49.880         0.893      15.867         4.804           561.54
         64.757         0.868      16.422         5.058           578.58
         83.000         0.851      16.822         5.248           590.99
--------------------------------------------------------------------------------
  NODE   140.00 : HGL = <  349.445>;EGL= <  350.987>;FLOWLINE= <  348.000>

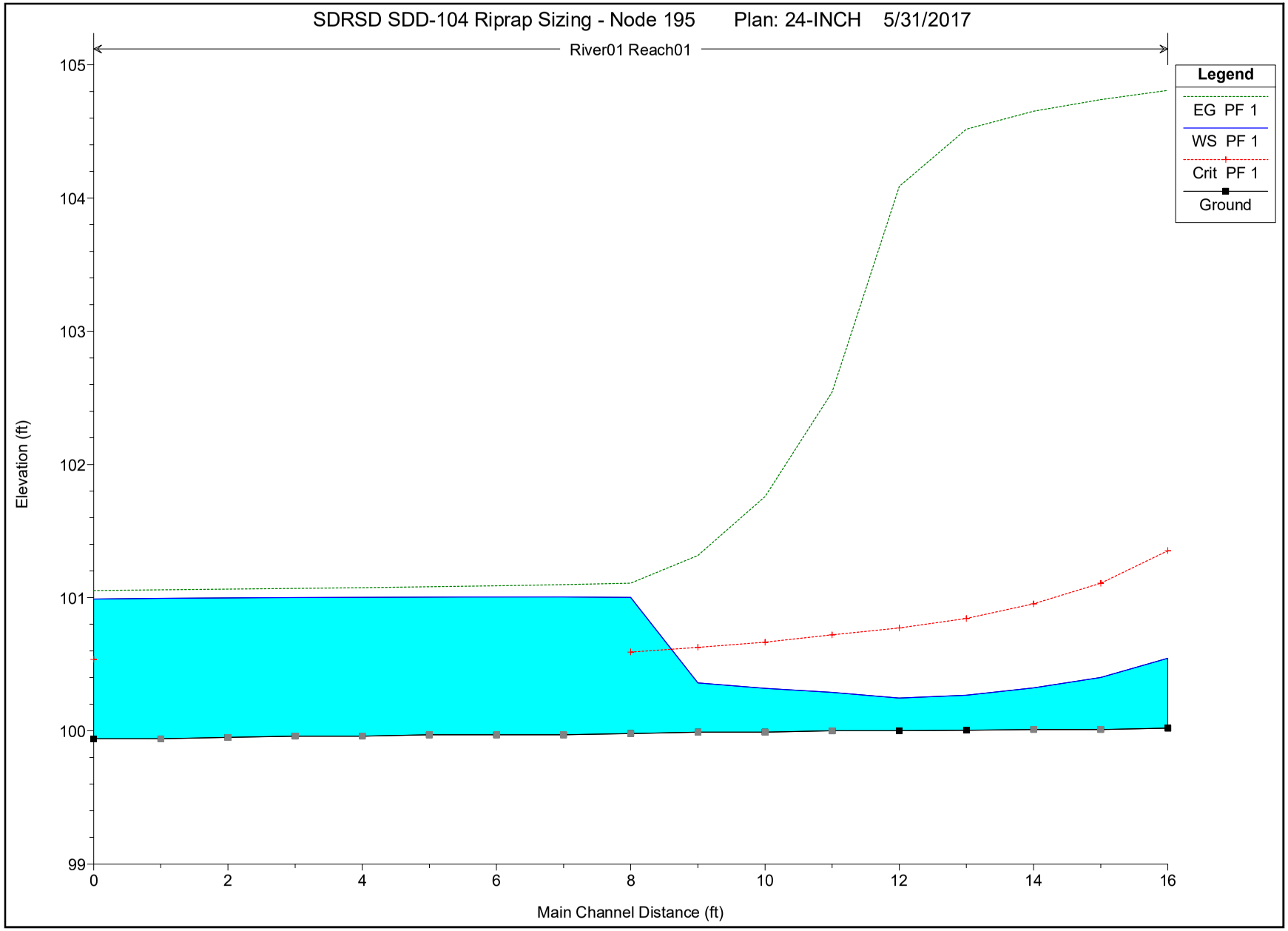
********************************************************************************
  FLOW PROCESS FROM NODE   140.00 TO NODE   140.00 IS CODE =  8
  UPSTREAM NODE   140.00     ELEVATION =   348.00  (FLOW UNSEALS IN REACH)
--------------------------------------------------------------------------------
  CALCULATE CATCH BASIN ENTRANCE LOSSES(LACFCD):
  PIPE FLOW =      17.40 CFS          PIPE DIAMETER =  18.00 INCHES
  FLOW VELOCITY =   9.97 FEET/SEC.    VELOCITY HEAD =  1.542 FEET
  CATCH BASIN ENERGY LOSS = .2*(VELOCITY HEAD) = .2*(  1.542) =  0.308
--------------------------------------------------------------------------------
  NODE   140.00 : HGL = <  351.295>;EGL= <  351.295>;FLOWLINE= <  348.000>

********************************************************************************
  UPSTREAM PIPE FLOW CONTROL DATA:
  NODE NUMBER =   140.00            FLOWLINE ELEVATION =   348.00
  ASSUMED UPSTREAM CONTROL HGL =    349.44 FOR DOWNSTREAM RUN ANALYSIS

================================================================================
  END OF GRADUALLY VARIED FLOW ANALYSIS
 ♀
```

HEC-RAS Plan: 24-inch River: River01 Reach: Reach01 Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach01	104	PF 1	17.40	100.02	100.55	101.35	104.81	0.049629	16.57	1.05	4.00	4.03
Reach01	103.*	PF 1	17.40	100.01	100.40	101.11	104.74	0.074968	16.72	1.04	4.66	4.71
Reach01	102.*	PF 1	17.40	100.01	100.32	100.95	104.65	0.100615	16.70	1.04	5.34	5.26
Reach01	101	PF 1	17.40	100.01	100.27	100.84	104.52	0.124314	16.54	1.05	6.00	5.68
Reach01	100	PF 1	17.40	100.00	100.25	100.77	104.09	1.608366	15.73	1.11	6.98	5.59
Reach01	99.*	PF 1	17.40	100.00	100.29	100.72	102.54	0.761355	12.05	1.44	7.16	3.95
Reach01	98.*	PF 1	17.40	99.99	100.32	100.67	101.76	0.409893	9.63	1.81	7.31	2.96
Reach01	97.*	PF 1	17.40	99.99	100.36	100.63	101.32	0.232221	7.85	2.22	7.48	2.27
Reach01	96.*	PF 1	17.40	99.98	101.00	100.59	101.11	0.006871	2.63	6.61	10.09	0.46
Reach01	95.*	PF 1	17.40	99.97	101.00		101.10	0.005979	2.44	7.12	10.14	0.43
Reach01	94.*	PF 1	17.40	99.97	101.00		101.09	0.004912	2.33	7.48	10.14	0.41
Reach01	93.*	PF 1	17.40	99.97	101.00		101.08	0.004750	2.24	7.77	10.14	0.40
Reach01	92.*	PF 1	17.40	99.96	101.00		101.08	0.004544	2.15	8.09	10.17	0.39
Reach01	91.*	PF 1	17.40	99.96	101.00		101.07	0.004637	2.11	8.24	10.16	0.39
Reach01	90.*	PF 1	17.40	99.95	101.00		101.06	0.004657	2.07	8.42	10.19	0.39
Reach01	89.*	PF 1	17.40	99.94	100.99		101.06	0.004783	2.04	8.54	10.21	0.39
Reach01	88	PF 1	17.40	99.94	100.99	100.54	101.05	0.005002	2.05	8.49	10.20	0.40


SDRSD SDD-104 Riprap Sizing - Node 195 Plan: 24-INCH 5/31/2017
River01 Reach01
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Elevation (ft)
105
104
103
102
101
100
99
0
2
4
6
8
10
12
14
16
Main Channel Distance (ft)

```
******************************************************************************
              PIPE-FLOW HYDRAULICS COMPUTER PROGRAM PACKAGE
          (Reference: LACFCD,LACRD, AND OCEMA HYDRAULICS CRITERION)
        (c) Copyright 1982-2014 Advanced Engineering Software (aes)
            Ver. 21.0  Release Date: 06/01/2014  License ID 1261

                          Analysis prepared by:

                        RICK ENGINEERING COMPANY
                            5620 Friars Road
                         San Diego, California 92110
                       619-291-0707   Fax 619-291-4165

  ************************* DESCRIPTION OF STUDY *************************
 * SERRA MESA STORM DRAIN AND GREEN INFRASTRUCTURE IMPROVEMENTS           *
 * J-17588-G                                                              *
 * POST-PROJECT CONDITION - VELOCITY RUN; BASIN 200 OUTFALL               *
  ************************************************************************

   FILE NAME: 295_V.PIP
   TIME/DATE OF STUDY: 14:29 05/24/2017
```

```
******************************************************************************
              GRADUALLY VARIED FLOW ANALYSIS FOR PIPE SYSTEM
                       NODAL POINT STATUS TABLE
                (Note: "*" indicates nodal point data used.)
                      UPSTREAM RUN                    DOWNSTREAM RUN
    NODE     MODEL    PRESSURE      PRESSURE+          FLOW         PRESSURE+
   NUMBER  PROCESS  HEAD(FT)   MOMENTUM(POUNDS)   DEPTH(FT)   MOMENTUM(POUNDS)
   295.00-              1.19 Dc          185.00        0.85*             215.08
         } FRICTION
   290.00-              1.19 Dc          185.00        0.83*             219.85
         } JUNCTION
   290.00-              1.43             194.42        0.46*             448.35
         } FRICTION
   285.00-              1.19 Dc          185.00        0.65*             282.42
         } JUNCTION
   285.00-              1.43             194.42        0.36*             633.21
         } FRICTION
   280.00-              1.19 Dc          185.00        0.76*             238.30
         } JUNCTION
   280.00-              1.19 Dc          185.00        0.79*             231.48
         } FRICTION
   215.00-              1.19*Dc          185.00        1.19*Dc           185.00
         } CATCH BASIN
   215.00-              1.79*            103.14        1.19 Dc            63.06
------------------------------------------------------------------------------
  MAXIMUM NUMBER OF ENERGY BALANCES USED IN EACH PROFILE =  25
------------------------------------------------------------------------------
  NOTE: STEADY FLOW HYDRAULIC HEAD-LOSS COMPUTATIONS BASED ON THE MOST
  CONSERVATIVE FORMULAE FROM THE CURRENT LACRD,LACFCD, AND OCEMA
  DESIGN MANUALS.
******************************************************************************
  DOWNSTREAM PIPE FLOW CONTROL DATA:
  NODE NUMBER =   295.00           FLOWLINE ELEVATION =   202.44
  PIPE FLOW =      11.10 CFS       PIPE DIAMETER =  24.00 INCHES
  ASSUMED DOWNSTREAM CONTROL HGL =   202.440 FEET
  *NOTE: ASSUMED DOWNSTREAM CONTROL DEPTH(  0.00 FT.)
         IS LESS THAN CRITICAL DEPTH(  1.19 FT.)
  ===> CRITICAL DEPTH IS ASSUMED AS DOWNSTREAM CONTROL DEPTH
       FOR UPSTREAM RUN ANALYSIS
------------------------------------------------------------------------------
```

NODE 295.00 : HGL = < 203.294>;EGL= < 204.461>;FLOWLINE= < 202.440>

****

FLOW PROCESS FROM NODE 295.00 TO NODE 290.00 IS CODE = 1
UPSTREAM NODE 290.00 ELEVATION = 202.54 (FLOW IS SUPERCRITICAL)

CALCULATE FRICTION LOSSES(LACFCD):
PIPE FLOW = 11.10 CFS PIPE DIAMETER = 24.00 INCHES
PIPE LENGTH = 9.20 FEET MANNING'S N = 0.01300

NORMAL DEPTH(FT) = 0.97 CRITICAL DEPTH(FT) = 1.19

==========

UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) = 0.83

==========

GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:

DISTANCE FROM CONTROL(FT)	FLOW DEPTH (FT)	VELOCITY (FT/SEC)	SPECIFIC ENERGY(FT)	PRESSURE+ MOMENTUM(POUNDS)
0.000	0.833	8.965	2.082	219.85
2.144	0.838	8.890	2.066	218.64
4.344	0.843	8.816	2.051	217.47
6.604	0.849	8.743	2.036	216.32
8.931	0.854	8.672	2.022	215.20
9.200	0.854	8.664	2.021	215.08

NODE 290.00 : HGL = < 203.373>;EGL= < 204.622>;FLOWLINE= < 202.540>

****

FLOW PROCESS FROM NODE 290.00 TO NODE 290.00 IS CODE = 5
UPSTREAM NODE 290.00 ELEVATION = 202.87 (FLOW IS SUPERCRITICAL)

CALCULATE JUNCTION LOSSES:

PIPE	FLOW (CFS)	DIAMETER (INCHES)	ANGLE (DEGREES)	FLOWLINE ELEVATION	CRITICAL DEPTH(FT.)	VELOCITY (FT/SEC)
UPSTREAM	11.10	24.00	60.00	202.87	1.19	20.551
DOWNSTREAM	11.10	24.00	-	202.54	1.19	8.968
LATERAL #1	0.00	0.00	0.00	0.00	0.00	0.000
LATERAL #2	0.00	0.00	0.00	0.00	0.00	0.000
Q5	0.00===Q5 EQUALS BASIN INPUT===					

LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
UPSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.18426
DOWNSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.01833
AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.10130
JUNCTION LENGTH = 4.00 FEET
FRICTION LOSSES = 0.405 FEET ENTRANCE LOSSES = 0.000 FEET
JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
JUNCTION LOSSES = (5.263)+(0.000) = 5.263

NODE 290.00 : HGL = < 203.327>;EGL= < 209.885>;FLOWLINE= < 202.870>

****

FLOW PROCESS FROM NODE 290.00 TO NODE 285.00 IS CODE = 1
UPSTREAM NODE 285.00 ELEVATION = 210.53 (FLOW IS SUPERCRITICAL)

CALCULATE FRICTION LOSSES(LACFCD):
PIPE FLOW = 11.10 CFS PIPE DIAMETER = 24.00 INCHES
PIPE LENGTH = 29.90 FEET MANNING'S N = 0.01300

NORMAL DEPTH(FT) = 0.42 CRITICAL DEPTH(FT) = 1.19

==========

UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) = 0.65

GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:

DISTANCE FROM CONTROL(FT)	FLOW DEPTH (FT)	VELOCITY (FT/SEC)	SPECIFIC ENERGY(FT)	PRESSURE+ MOMENTUM(POUNDS)
0.000	0.654	12.424	3.053	282.42
0.417	0.645	12.672	3.140	287.25
0.866	0.635	12.930	3.233	292.28
1.350	0.626	13.197	3.332	297.53
1.874	0.617	13.474	3.438	303.01
2.442	0.607	13.762	3.550	308.72
3.058	0.598	14.061	3.670	314.69
3.729	0.589	14.371	3.798	320.92
4.462	0.579	14.695	3.935	327.44
5.265	0.570	15.031	4.081	334.24
6.148	0.561	15.382	4.237	341.36
7.123	0.551	15.747	4.404	348.81
8.204	0.542	16.128	4.584	356.60
9.411	0.533	16.526	4.776	364.77
10.765	0.523	16.942	4.983	373.32
12.297	0.514	17.376	5.205	382.29
14.045	0.505	17.831	5.445	391.71
16.064	0.495	18.307	5.702	401.59
18.427	0.486	18.805	5.981	411.97
21.244	0.477	19.329	6.281	422.89
24.684	0.467	19.878	6.607	434.38
29.032	0.458	20.455	6.959	446.48
29.900	0.457	20.544	7.015	448.35

NODE 285.00 : HGL = < 211.184>;EGL= < 213.583>;FLOWLINE= < 210.530>

FLOW PROCESS FROM NODE 285.00 TO NODE 285.00 IS CODE = 5
UPSTREAM NODE 285.00 ELEVATION = 210.86 (FLOW IS SUPERCRITICAL)

CALCULATE JUNCTION LOSSES:

PIPE	FLOW (CFS)	DIAMETER (INCHES)	ANGLE (DEGREES)	FLOWLINE ELEVATION	CRITICAL DEPTH(FT.)	VELOCITY (FT/SEC)
UPSTREAM	11.10	24.00	60.00	210.86	1.19	29.278
DOWNSTREAM	11.10	24.00	-	210.53	1.19	12.428
LATERAL #1	0.00	0.00	0.00	0.00	0.00	0.000
LATERAL #2	0.00	0.00	0.00	0.00	0.00	0.000
Q5	0.00===Q5 EQUALS BASIN INPUT===					

LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
UPSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.50171
DOWNSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.04503
AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.27337
JUNCTION LENGTH = 4.00 FEET
FRICTION LOSSES = 1.093 FEET ENTRANCE LOSSES = 0.000 FEET
JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
JUNCTION LOSSES = (10.944)+(0.000) = 10.944

NODE 285.00 : HGL = < 211.216>;EGL= < 224.527>;FLOWLINE= < 210.860>

FLOW PROCESS FROM NODE 285.00 TO NODE 280.00 IS CODE = 1
UPSTREAM NODE 280.00 ELEVATION = 349.95 (FLOW IS SUPERCRITICAL)

CALCULATE FRICTION LOSSES(LACFCD):

PIPE FLOW = 11.10 CFS PIPE DIAMETER = 24.00 INCHES
PIPE LENGTH = 243.10 FEET MANNING'S N = 0.01300

NORMAL DEPTH(FT) = 0.35 CRITICAL DEPTH(FT) = 1.19

UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) = 0.76

GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:

DISTANCE FROM CONTROL(FT)	FLOW DEPTH (FT)	VELOCITY (FT/SEC)	SPECIFIC ENERGY(FT)	PRESSURE+ MOMENTUM(POUNDS)
0.000	0.764	10.055	2.335	238.30
0.147	0.747	10.360	2.415	243.72
0.310	0.731	10.683	2.504	249.57
0.492	0.714	11.025	2.602	255.85
0.695	0.697	11.387	2.712	262.61
0.923	0.680	11.772	2.834	269.89
1.178	0.664	12.181	2.969	277.72
1.464	0.647	12.617	3.120	286.17
1.787	0.630	13.082	3.289	295.26
2.153	0.613	13.578	3.478	305.08
2.567	0.597	14.110	3.690	315.68
3.040	0.580	14.680	3.928	327.15
3.581	0.563	15.293	4.197	339.55
4.205	0.546	15.953	4.501	353.01
4.928	0.530	16.665	4.845	367.62
5.774	0.513	17.436	5.236	383.52
6.772	0.496	18.271	5.683	400.86
7.963	0.479	19.180	6.195	419.80
9.406	0.463	20.172	6.785	440.55
11.185	0.446	21.258	7.467	463.34
13.435	0.429	22.449	8.259	488.45
16.380	0.412	23.763	9.186	516.21
20.441	0.395	25.216	10.275	547.00
26.567	0.379	26.831	11.564	581.30
37.806	0.362	28.633	13.101	619.67
243.100	0.356	29.269	13.667	633.21

NODE 280.00 : HGL = < 350.714>;EGL= < 352.285>;FLOWLINE= < 349.950>

****

FLOW PROCESS FROM NODE 280.00 TO NODE 280.00 IS CODE = 5
UPSTREAM NODE 280.00 ELEVATION = 350.28 (FLOW IS SUPERCRITICAL)

CALCULATE JUNCTION LOSSES:

PIPE	FLOW (CFS)	DIAMETER (INCHES)	ANGLE (DEGREES)	FLOWLINE ELEVATION	CRITICAL DEPTH(FT.)	VELOCITY (FT/SEC)
UPSTREAM	11.10	24.00	11.70	350.28	1.19	9.666
DOWNSTREAM	11.10	24.00	-	349.95	1.19	10.058
LATERAL #1	0.00	0.00	0.00	0.00	0.00	0.000
LATERAL #2	0.00	0.00	0.00	0.00	0.00	0.000
Q5	0.00===Q5 EQUALS BASIN INPUT===					

LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
UPSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.02250
DOWNSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.02509
AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.02379
JUNCTION LENGTH = 4.00 FEET
FRICTION LOSSES = 0.095 FEET ENTRANCE LOSSES = 0.000 FEET
JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
JUNCTION LOSSES = (0.233)+(0.000) = 0.233

```
------------------------------------------------------------------------------
  NODE   280.00 : HGL = <  351.067>;EGL= <  352.518>;FLOWLINE= <  350.280>

******************************************************************************
  FLOW PROCESS FROM NODE   280.00 TO NODE   215.00 IS CODE =  1
  UPSTREAM NODE   215.00     ELEVATION =   352.10  (FLOW IS SUPERCRITICAL)
------------------------------------------------------------------------------
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW   =      11.10 CFS     PIPE DIAMETER =  24.00 INCHES
  PIPE LENGTH =      72.60 FEET          MANNING'S N  =  0.01300
------------------------------------------------------------------------------
  NORMAL DEPTH(FT) =      0.76           CRITICAL DEPTH(FT) =      1.19
==============================================================================
  UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) =     1.19
==============================================================================
  GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:
------------------------------------------------------------------------------
  DISTANCE FROM      FLOW DEPTH  VELOCITY      SPECIFIC        PRESSURE+
   CONTROL(FT)           (FT)    (FT/SEC)     ENERGY(FT)    MOMENTUM(POUNDS)
         0.000          1.195       5.667          1.694           185.00
         0.025          1.178       5.767          1.694           185.06
         0.103          1.160       5.871          1.696           185.24
         0.240          1.143       5.978          1.698           185.55
         0.442          1.126       6.090          1.702           185.98
         0.716          1.109       6.207          1.707           186.55
         1.071          1.092       6.328          1.714           187.25
         1.516          1.074       6.454          1.722           188.11
         2.063          1.057       6.586          1.731           189.11
         2.726          1.040       6.723          1.742           190.27
         3.520          1.023       6.866          1.755           191.60
         4.467          1.005       7.016          1.770           193.10
         5.589          0.988       7.172          1.787           194.77
         6.919          0.971       7.335          1.807           196.64
         8.493          0.954       7.506          1.829           198.71
        10.360          0.937       7.685          1.854           200.99
        12.587          0.919       7.872          1.882           203.48
        15.262          0.902       8.068          1.914           206.21
        18.507          0.885       8.274          1.949           209.18
        22.505          0.868       8.491          1.988           212.42
        27.537          0.850       8.718          2.031           215.92
        34.075          0.833       8.957          2.080           219.72
        43.004          0.816       9.209          2.134           223.83
        56.314          0.799       9.475          2.194           228.27
        72.600          0.787       9.663          2.238           231.48
------------------------------------------------------------------------------
  NODE   215.00 : HGL = <  353.295>;EGL= <  353.794>;FLOWLINE= <  352.100>

******************************************************************************
  FLOW PROCESS FROM NODE   215.00 TO NODE   215.00 IS CODE =  8
  UPSTREAM NODE   215.00     ELEVATION =   352.10  (FLOW IS SUBCRITICAL)
------------------------------------------------------------------------------
  CALCULATE CATCH BASIN ENTRANCE LOSSES(LACFCD):
  PIPE FLOW =       11.10 CFS          PIPE DIAMETER =  24.00 INCHES
  FLOW VELOCITY =    5.67 FEET/SEC.    VELOCITY HEAD =  0.499 FEET
  CATCH BASIN ENERGY LOSS = .2*(VELOCITY HEAD) = .2*(  0.499) =  0.100
------------------------------------------------------------------------------
  NODE   215.00 : HGL = <  353.894>;EGL= <  353.894>;FLOWLINE= <  352.100>

******************************************************************************
  UPSTREAM PIPE FLOW CONTROL DATA:
  NODE NUMBER =   215.00            FLOWLINE ELEVATION =   352.10
  ASSUMED UPSTREAM CONTROL HGL =    353.29 FOR DOWNSTREAM RUN ANALYSIS
```

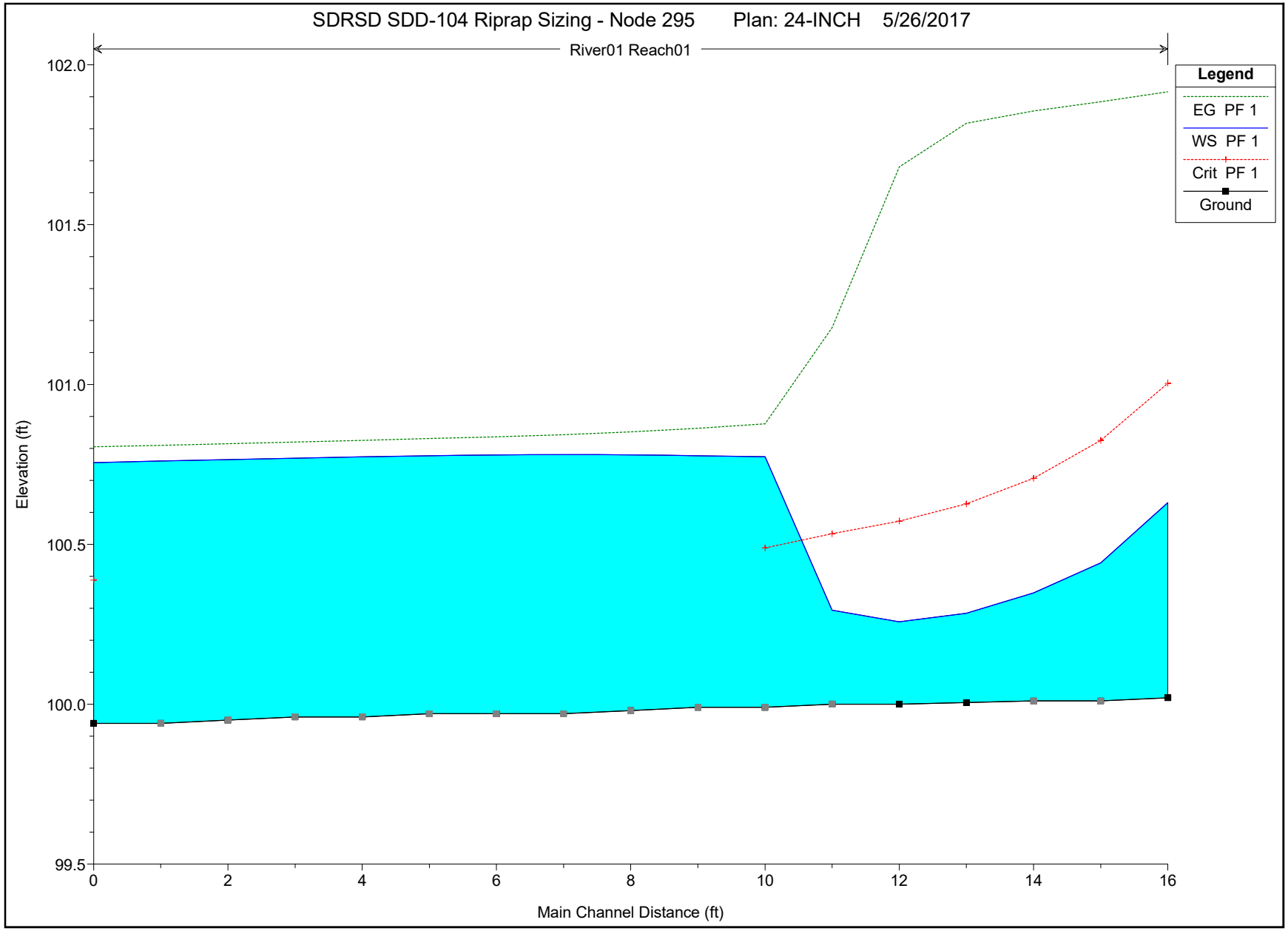
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END OF GRADUALLY VARIED FLOW ANALYSIS

♀

HEC-RAS Plan: 24-inch River: River01 Reach: Reach01 Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach01	104	PF 1	11.10	100.02	100.63	101.00	101.92	0.012248	9.10	1.22	4.00	2.05
Reach01	103.*	PF 1	11.10	100.01	100.44	100.82	101.88	0.021777	9.64	1.15	4.66	2.58
Reach01	102.*	PF 1	11.10	100.01	100.35	100.71	101.86	0.031570	9.85	1.13	5.34	2.99
Reach01	101	PF 1	11.10	100.01	100.28	100.63	101.82	0.041372	9.93	1.12	6.00	3.31
Reach01	100	PF 1	11.10	100.00	100.26	100.57	101.68	0.490229	9.57	1.16	7.03	3.32
Reach01	99.*	PF 1	11.10	100.00	100.29	100.53	101.18	0.254860	7.54	1.47	7.18	2.45
Reach01	98.*	PF 1	11.10	99.99	100.77	100.49	100.88	0.008042	2.57	4.31	9.14	0.51
Reach01	97.*	PF 1	11.10	99.99	100.78		100.86	0.006668	2.35	4.72	9.15	0.47
Reach01	96.*	PF 1	11.10	99.98	100.78		100.85	0.005550	2.15	5.17	9.20	0.42
Reach01	95.*	PF 1	11.10	99.97	100.78		100.84	0.004876	2.00	5.55	9.25	0.40
Reach01	94.*	PF 1	11.10	99.97	100.78		100.84	0.004691	1.92	5.79	9.24	0.38
Reach01	93.*	PF 1	11.10	99.97	100.78		100.83	0.004692	1.86	5.96	9.23	0.38
Reach01	92.*	PF 1	11.10	99.96	100.77		100.83	0.004626	1.81	6.14	9.26	0.37
Reach01	91.*	PF 1	11.10	99.96	100.77		100.82	0.004962	1.80	6.16	9.24	0.38
Reach01	90.*	PF 1	11.10	99.95	100.77		100.81	0.005010	1.78	6.22	9.26	0.38
Reach01	89.*	PF 1	11.10	99.94	100.76		100.81	0.004894	1.77	6.27	9.28	0.38
Reach01	88	PF 1	11.10	99.94	100.76	100.39	100.81	0.005001	1.78	6.22	9.26	0.38


SDRSD SDD-104 Riprap Sizing - Node 295 Plan: 24-INCH 5/26/2017
River01 Reach01
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Elevation (ft)
102.0
101.5
101.0
100.5
100.0
99.5
0
2
4
6
8
10
12
14
16
Main Channel Distance (ft)

```
**************************************************************************
              PIPE-FLOW HYDRAULICS COMPUTER PROGRAM PACKAGE
          (Reference: LACFCD,LACRD, AND OCEMA HYDRAULICS CRITERION)
        (c) Copyright 1982-2014 Advanced Engineering Software (aes)
            Ver. 21.0  Release Date: 06/01/2014  License ID 1261

                          Analysis prepared by:

                        RICK ENGINEERING COMPANY
                            5620 Friars Road
                         San Diego, California 92110
                       619-291-0707   Fax 619-291-4165

 ************************* DESCRIPTION OF STUDY *************************
* SERRA MESA STORM DRAIN AND GREEN INFRASTRUCTURE IMPROVEMENTS           *
* J-17588-G                                                              *
* POST-PROJECT CONDITION - VELOCITY RUN; BASIN 300 OUTFALL               *
 ************************************************************************

  FILE NAME: 395_V.PIP
  TIME/DATE OF STUDY: 14:43 05/25/2017
--------------------------------------------------------------------------
**************************************************************************
            GRADUALLY VARIED FLOW ANALYSIS FOR PIPE SYSTEM
                     NODAL POINT STATUS TABLE
              (Note: "*" indicates nodal point data used.)
                    UPSTREAM RUN                  DOWNSTREAM RUN
   NODE    MODEL   PRESSURE      PRESSURE+         FLOW         PRESSURE+
  NUMBER  PROCESS  HEAD(FT)   MOMENTUM(POUNDS)   DEPTH(FT)   MOMENTUM(POUNDS)
  395.00-             1.77 Dc          570.56        1.07*            771.69
       } FRICTION
  390.00-             1.85             572.57        1.02*            803.64
       } JUNCTION
  390.00-             2.65             716.06        0.56*           1703.31
       } FRICTION
  385.00-             1.77 Dc          570.56        0.82*           1045.48
       } JUNCTION
  385.00-             1.77 Dc          570.56        0.80*           1075.15
       } FRICTION
  380.00-             1.77 Dc          570.56        1.16*            709.95
       } JUNCTION
  380.00-             2.23             633.41        0.85*            991.79
       } FRICTION
  330.00-             1.77*Dc          570.56        1.77*Dc          570.56
       } CATCH BASIN
  330.00-             3.14*            419.28        1.77 Dc          151.50
--------------------------------------------------------------------------
  MAXIMUM NUMBER OF ENERGY BALANCES USED IN EACH PROFILE =  25
--------------------------------------------------------------------------
  NOTE: STEADY FLOW HYDRAULIC HEAD-LOSS COMPUTATIONS BASED ON THE MOST
  CONSERVATIVE FORMULAE FROM THE CURRENT LACRD,LACFCD, AND OCEMA
  DESIGN MANUALS.
**************************************************************************
  DOWNSTREAM PIPE FLOW CONTROL DATA:
  NODE NUMBER =   395.00           FLOWLINE ELEVATION =   225.82
  PIPE FLOW =      25.20 CFS       PIPE DIAMETER =  24.00 INCHES
  ASSUMED DOWNSTREAM CONTROL HGL =   225.820 FEET
  *NOTE: ASSUMED DOWNSTREAM CONTROL DEPTH(  0.00 FT.)
         IS LESS THAN CRITICAL DEPTH(  1.77 FT.)
  ===> CRITICAL DEPTH IS ASSUMED AS DOWNSTREAM CONTROL DEPTH
       FOR UPSTREAM RUN ANALYSIS
--------------------------------------------------------------------------
```

NODE 395.00 : HGL = < 226.885>;EGL= < 230.293>;FLOWLINE= < 225.820>

****

FLOW PROCESS FROM NODE 395.00 TO NODE 390.00 IS CODE = 1
UPSTREAM NODE 390.00 ELEVATION = 225.91 (FLOW IS SUPERCRITICAL)

CALCULATE FRICTION LOSSES(LACFCD):
PIPE FLOW = 25.20 CFS PIPE DIAMETER = 24.00 INCHES
PIPE LENGTH = 9.30 FEET MANNING'S N = 0.01300
===> NORMAL PIPEFLOW IS PRESSURE FLOW

NORMAL DEPTH(FT) = 2.00 CRITICAL DEPTH(FT) = 1.77

==========

UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) = 1.02

==========

GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:

DISTANCE FROM CONTROL(FT)	FLOW DEPTH (FT)	VELOCITY (FT/SEC)	SPECIFIC ENERGY(FT)	PRESSURE+ MOMENTUM(POUNDS)
0.000	1.025	15.549	4.781	803.64
6.811	1.054	15.000	4.550	779.87
9.300	1.065	14.809	4.473	771.69

NODE 390.00 : HGL = < 226.935>;EGL= < 230.691>;FLOWLINE= < 225.910>

****

FLOW PROCESS FROM NODE 390.00 TO NODE 390.00 IS CODE = 5
UPSTREAM NODE 390.00 ELEVATION = 226.24 (FLOW IS SUPERCRITICAL)

CALCULATE JUNCTION LOSSES:

PIPE	FLOW (CFS)	DIAMETER (INCHES)	ANGLE (DEGREES)	FLOWLINE ELEVATION	CRITICAL DEPTH(FT.)	VELOCITY (FT/SEC)
UPSTREAM	25.20	24.00	60.00	226.24	1.77	34.663
DOWNSTREAM	25.20	24.00	-	225.91	1.77	15.554
LATERAL #1	0.00	0.00	0.00	0.00	0.00	0.000
LATERAL #2	0.00	0.00	0.00	0.00	0.00	0.000
Q5	0.00===Q5 EQUALS BASIN INPUT===					

LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
UPSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.41208
DOWNSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.04571
AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.22890
JUNCTION LENGTH = 4.00 FEET
FRICTION LOSSES = 0.916 FEET ENTRANCE LOSSES = 0.000 FEET
JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
JUNCTION LOSSES = (14.770)+(0.000) = 14.770

NODE 390.00 : HGL = < 226.804>;EGL= < 245.462>;FLOWLINE= < 226.240>

****

FLOW PROCESS FROM NODE 390.00 TO NODE 385.00 IS CODE = 1
UPSTREAM NODE 385.00 ELEVATION = 312.84 (FLOW IS SUPERCRITICAL)

CALCULATE FRICTION LOSSES(LACFCD):
PIPE FLOW = 25.20 CFS PIPE DIAMETER = 24.00 INCHES
PIPE LENGTH = 196.70 FEET MANNING'S N = 0.01300

NORMAL DEPTH(FT) = 0.55 CRITICAL DEPTH(FT) = 1.77

==========

UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) = 0.82

==========

GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:

DISTANCE FROM CONTROL(FT)	FLOW DEPTH (FT)	VELOCITY (FT/SEC)	SPECIFIC ENERGY(FT)	PRESSURE+ MOMENTUM(POUNDS)
0.000	0.817	20.875	7.588	1045.48
0.675	0.806	21.238	7.815	1062.44
1.396	0.796	21.613	8.054	1079.99
2.170	0.785	22.001	8.306	1098.18
3.000	0.775	22.402	8.572	1117.02
3.894	0.764	22.817	8.853	1136.55
4.859	0.754	23.246	9.150	1156.81
5.902	0.743	23.691	9.464	1177.82
7.034	0.733	24.151	9.796	1199.63
8.266	0.722	24.628	10.147	1222.26
9.612	0.712	25.123	10.519	1245.78
11.090	0.701	25.637	10.913	1270.21
12.719	0.691	26.170	11.332	1295.61
14.525	0.680	26.723	11.777	1322.04
16.541	0.670	27.299	12.249	1349.53
18.809	0.659	27.897	12.752	1378.16
21.382	0.649	28.520	13.287	1407.99
24.335	0.638	29.168	13.857	1439.08
27.774	0.628	29.843	14.466	1471.51
31.850	0.617	30.547	15.116	1505.36
36.800	0.607	31.282	15.811	1540.70
43.023	0.596	32.049	16.555	1577.64
51.262	0.586	32.850	17.353	1616.27
63.193	0.575	33.688	18.208	1656.70
84.186	0.565	34.565	19.128	1699.05
196.700	0.564	34.653	19.221	1703.31

NODE 385.00 : HGL = < 313.657>;EGL= < 320.428>;FLOWLINE= < 312.840>

****

FLOW PROCESS FROM NODE 385.00 TO NODE 385.00 IS CODE = 5
UPSTREAM NODE 385.00 ELEVATION = 313.17 (FLOW IS SUPERCRITICAL)

CALCULATE JUNCTION LOSSES:

PIPE	FLOW (CFS)	DIAMETER (INCHES)	ANGLE (DEGREES)	FLOWLINE ELEVATION	CRITICAL DEPTH(FT.)	VELOCITY (FT/SEC)
UPSTREAM	25.20	24.00	0.00	313.17	1.77	21.516
DOWNSTREAM	25.20	24.00	-	312.84	1.77	20.881
LATERAL #1	0.00	0.00	0.00	0.00	0.00	0.000
LATERAL #2	0.00	0.00	0.00	0.00	0.00	0.000
Q5	0.00===Q5 EQUALS BASIN INPUT===					

LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
UPSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.10986
DOWNSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.10121
AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.10554
JUNCTION LENGTH = 4.00 FEET
FRICTION LOSSES = 0.422 FEET ENTRANCE LOSSES = 0.000 FEET
JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
JUNCTION LOSSES = (0.730)+(0.000) = 0.730

NODE 385.00 : HGL = < 313.969>;EGL= < 321.158>;FLOWLINE= < 313.170>

****

FLOW PROCESS FROM NODE 385.00 TO NODE 380.00 IS CODE = 1
UPSTREAM NODE 380.00 ELEVATION = 321.67 (FLOW IS SUPERCRITICAL)

```
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW    =      25.20 CFS     PIPE DIAMETER =  24.00 INCHES
  PIPE LENGTH =      57.90 FEET          MANNING'S N  =  0.01300
-------------------------------------------------------------------------------
  NORMAL DEPTH(FT) =      0.74           CRITICAL DEPTH(FT) =      1.77
===============================================================================
  UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) =     1.16
===============================================================================
  GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:
-------------------------------------------------------------------------------
  DISTANCE FROM      FLOW DEPTH  VELOCITY      SPECIFIC        PRESSURE+
   CONTROL(FT)           (FT)    (FT/SEC)     ENERGY(FT)    MOMENTUM(POUNDS)
         0.000          1.160     13.327          3.920           709.95
         0.720          1.144     13.566          4.003           719.67
         1.499          1.127     13.815          4.092           729.89
         2.346          1.110     14.074          4.187           740.62
         3.266          1.093     14.343          4.289           751.90
         4.268          1.076     14.623          4.398           763.75
         5.362          1.059     14.914          4.515           776.19
         6.558          1.042     15.218          4.641           789.27
         7.870          1.025     15.535          4.775           803.00
         9.314          1.009     15.865          4.919           817.44
        10.908          0.992     16.209          5.074           832.62
        12.674          0.975     16.569          5.240           848.58
        14.641          0.958     16.945          5.419           865.36
        16.842          0.941     17.338          5.612           883.02
        19.322          0.924     17.750          5.819           901.60
        22.136          0.907     18.181          6.043           921.17
        25.360          0.890     18.632          6.284           941.79
        29.092          0.874     19.106          6.545           963.52
        33.475          0.857     19.603          6.827           986.43
        38.715          0.840     20.125          7.133          1010.62
        45.132          0.823     20.675          7.465          1036.16
        53.266          0.806     21.253          7.825          1063.16
        57.900          0.799     21.510          7.988          1075.15
-------------------------------------------------------------------------------
  NODE   380.00 : HGL = <  322.830>;EGL= <  325.590>;FLOWLINE= <  321.670>

*******************************************************************************
  FLOW PROCESS FROM NODE   380.00 TO NODE   380.00 IS CODE =  5
  UPSTREAM NODE   380.00     ELEVATION =   322.00  (FLOW IS SUPERCRITICAL)
-------------------------------------------------------------------------------
  CALCULATE JUNCTION LOSSES:
       PIPE        FLOW    DIAMETER   ANGLE    FLOWLINE   CRITICAL   VELOCITY
                   (CFS)   (INCHES) (DEGREES) ELEVATION  DEPTH(FT.)  (FT/SEC)
     UPSTREAM      25.20    24.00     45.00    322.00      1.77       19.725
    DOWNSTREAM     25.20    24.00       -      321.67      1.77       13.331
    LATERAL #1      0.00     0.00      0.00      0.00      0.00        0.000
    LATERAL #2      0.00     0.00      0.00      0.00      0.00        0.000
       Q5           0.00===Q5 EQUALS BASIN INPUT===

  LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
  DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
      Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
  UPSTREAM:    MANNING'S N = 0.01300;  FRICTION SLOPE = 0.08665
  DOWNSTREAM:  MANNING'S N = 0.01300;  FRICTION SLOPE = 0.03050
  AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.05857
  JUNCTION LENGTH =   4.00 FEET
  FRICTION LOSSES =  0.234 FEET         ENTRANCE LOSSES =  0.000 FEET
  JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
  JUNCTION LOSSES = ( 3.304)+( 0.000) =   3.304
-------------------------------------------------------------------------------
  NODE   380.00 : HGL = <  322.853>;EGL= <  328.894>;FLOWLINE= <  322.000>
```

```
****************************************************************************
  FLOW PROCESS FROM NODE   380.00 TO NODE   330.00 IS CODE =  1
  UPSTREAM NODE   330.00     ELEVATION =   332.20  (FLOW IS SUPERCRITICAL)
----------------------------------------------------------------------------
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW    =      25.20 CFS     PIPE DIAMETER =  24.00 INCHES
  PIPE LENGTH =      99.80 FEET          MANNING'S N  =  0.01300
----------------------------------------------------------------------------
  NORMAL DEPTH(FT) =      0.81           CRITICAL DEPTH(FT) =      1.77
============================================================================
  UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) =     1.77
============================================================================
  GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:
----------------------------------------------------------------------------
  DISTANCE FROM      FLOW DEPTH  VELOCITY      SPECIFIC        PRESSURE+
   CONTROL(FT)           (FT)    (FT/SEC)     ENERGY(FT)    MOMENTUM(POUNDS)
         0.000          1.767       8.579          2.910           570.56
         0.026          1.729       8.729          2.912           570.98
         0.105          1.691       8.894          2.920           572.27
         0.243          1.652       9.075          2.932           574.43
         0.443          1.614       9.272          2.950           577.52
         0.715          1.576       9.485          2.974           581.57
         1.064          1.538       9.717          3.005           586.63
         1.503          1.500       9.967          3.044           592.77
         2.042          1.462      10.237          3.090           600.05
         2.696          1.424      10.529          3.147           608.55
         3.485          1.386      10.845          3.213           618.36
         4.429          1.348      11.186          3.292           629.59
         5.557          1.310      11.555          3.384           642.35
         6.905          1.272      11.954          3.492           656.77
         8.516          1.234      12.387          3.618           673.00
        10.451          1.196      12.857          3.764           691.23
        12.787          1.157      13.369          3.934           711.64
        15.630          1.119      13.926          4.133           734.48
        19.134          1.081      14.535          4.364           760.01
        23.520          1.043      15.201          4.634           788.54
        29.137          1.005      15.933          4.950           820.45
        36.571          0.967      16.739          5.321           856.16
        46.924          0.929      17.630          5.758           896.19
        62.678          0.891      18.618          6.277           941.15
        91.802          0.853      19.719          6.894           991.79
        99.800          0.853      19.719          6.894           991.79
----------------------------------------------------------------------------
  NODE   330.00 : HGL = <  333.967>;EGL= <  335.110>;FLOWLINE= <  332.200>

****************************************************************************
  FLOW PROCESS FROM NODE   330.00 TO NODE   330.00 IS CODE =  8
  UPSTREAM NODE   330.00     ELEVATION =   332.20  (FLOW UNSEALS IN REACH)
----------------------------------------------------------------------------
  CALCULATE CATCH BASIN ENTRANCE LOSSES(LACFCD):
  PIPE FLOW =      25.20 CFS          PIPE DIAMETER =  24.00 INCHES
  FLOW VELOCITY =   8.58 FEET/SEC.    VELOCITY HEAD =  1.143 FEET
  CATCH BASIN ENERGY LOSS = .2*(VELOCITY HEAD) = .2*(  1.143) =  0.229
----------------------------------------------------------------------------
  NODE   330.00 : HGL = <  335.339>;EGL= <  335.339>;FLOWLINE= <  332.200>

****************************************************************************
  UPSTREAM PIPE FLOW CONTROL DATA:
  NODE NUMBER =   330.00           FLOWLINE ELEVATION =   332.20
  ASSUMED UPSTREAM CONTROL HGL =    333.97 FOR DOWNSTREAM RUN ANALYSIS

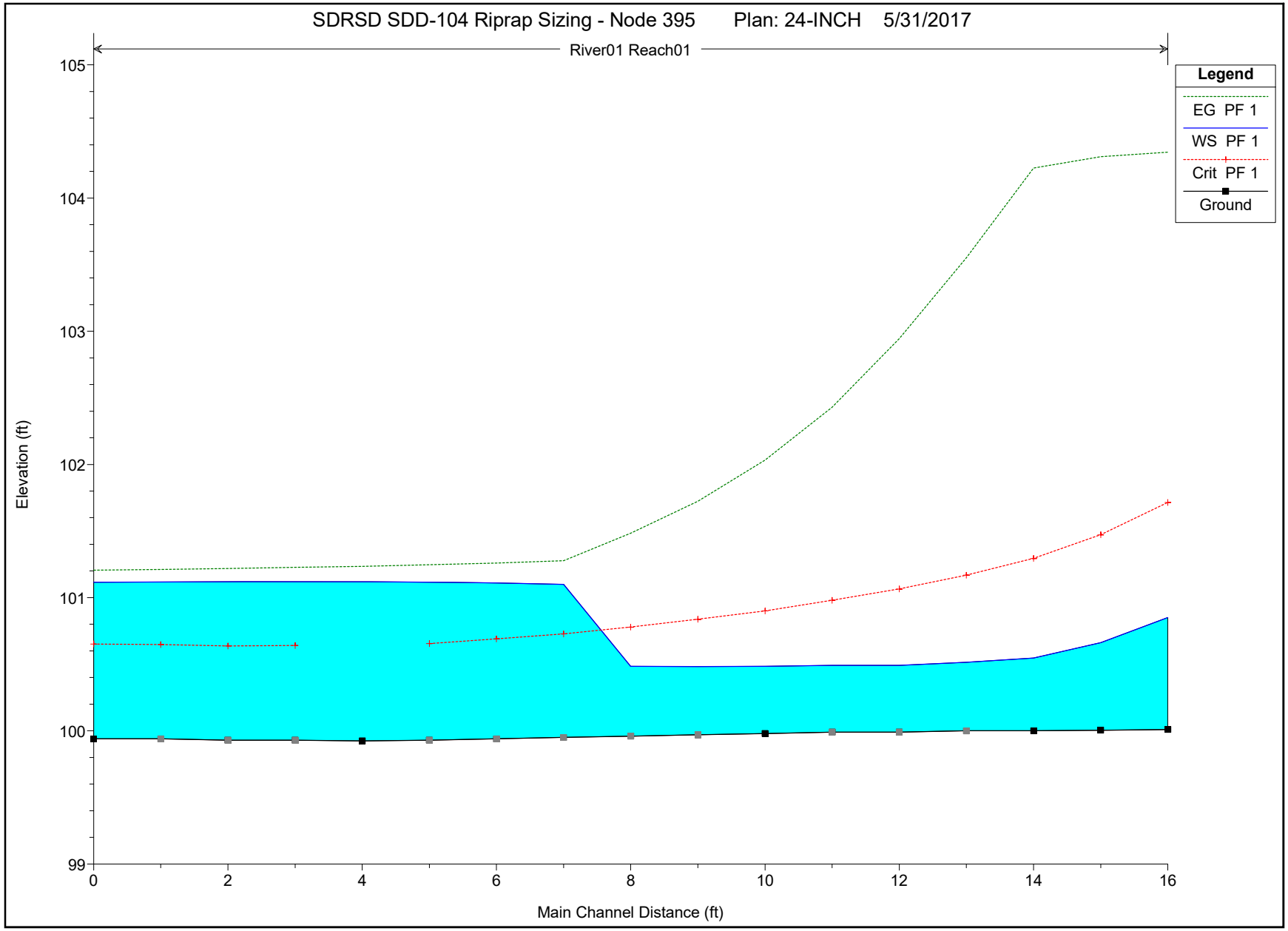
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END OF GRADUALLY VARIED FLOW ANALYSIS

♀

HEC-RAS Plan: 24-inch River: River01 Reach: Reach01 Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach01	102	PF 1	25.20	100.01	100.85	101.72	104.34	0.021729	15.00	1.68	2.50	2.88
Reach01	101	PF 1	25.20	100.01	100.66	101.47	104.31	0.031454	15.33	1.64	5.00	3.33
Reach01	100	PF 1	25.20	100.00	100.55	101.29	104.23	0.487569	15.40	1.64	7.27	3.67
Reach01	99.*	PF 1	25.20	100.00	100.51	101.17	103.55	0.473946	13.98	1.80	7.59	3.43
Reach01	98.*	PF 1	25.20	99.99	100.49	101.07	102.95	0.397161	12.57	2.00	8.01	3.13
Reach01	97.*	PF 1	25.20	99.99	100.49	100.98	102.43	0.313806	11.17	2.26	8.51	2.78
Reach01	96	PF 1	25.20	99.98	100.48	100.90	102.03	0.248238	9.99	2.52	9.03	2.48
Reach01	95.*	PF 1	25.20	99.97	100.48	100.84	101.72	0.195207	8.94	2.82	9.07	2.20
Reach01	94.*	PF 1	25.20	99.96	100.48	100.78	101.48	0.152664	8.02	3.14	9.14	1.95
Reach01	93.*	PF 1	25.20	99.95	101.10	100.73	101.28	0.008390	3.38	7.46	12.90	0.56
Reach01	92.*	PF 1	25.20	99.94	101.11	100.69	101.26	0.007036	3.11	8.11	13.02	0.51
Reach01	91.*	PF 1	25.20	99.93	101.12	100.66	101.25	0.006095	2.89	8.71	13.12	0.47
Reach01	90	PF 1	25.20	99.93	101.12		101.24	0.005515	2.73	9.22	13.17	0.45
Reach01	89.*	PF 1	25.20	99.93	101.12	100.64	101.23	0.005266	2.63	9.59	13.14	0.44
Reach01	88.*	PF 1	25.20	99.93	101.12	100.64	101.22	0.005036	2.53	9.95	13.13	0.42
Reach01	87.*	PF 1	25.20	99.94	101.12	100.65	101.21	0.005071	2.48	10.16	13.06	0.42
Reach01	86	PF 1	25.20	99.94	101.11	100.65	101.21	0.005001	2.42	10.42	13.05	0.42


SDRSD SDD-104 Riprap Sizing - Node 395 Plan: 24-INCH 5/31/2017
River01 Reach01
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Elevation (ft)
105
104
103
102
101
100
99
0
2
4
6
8
10
12
14
16
Main Channel Distance (ft)

```
**************************************************************************
              PIPE-FLOW HYDRAULICS COMPUTER PROGRAM PACKAGE
          (Reference: LACFCD,LACRD, AND OCEMA HYDRAULICS CRITERION)
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            Ver. 21.0  Release Date: 06/01/2014  License ID 1261

                          Analysis prepared by:

                        RICK ENGINEERING COMPANY
                            5620 Friars Road
                         San Diego, California 92110
                       619-291-0707   Fax 619-291-4165

 ************************* DESCRIPTION OF STUDY *************************
* SERRA MESA STORM DRAIN AND GREEN INFRASTRUCTURE IMPROVEMENTS           *
* J-17588-G                                                              *
* POST-PROJECT CONDITION - VELOCITY RUN; BASIN 400 OUTFALL               *
 ************************************************************************

  FILE NAME: 495_V.PIP
  TIME/DATE OF STUDY: 18:58 05/31/2017
```

```
**************************************************************************
            GRADUALLY VARIED FLOW ANALYSIS FOR PIPE SYSTEM
                     NODAL POINT STATUS TABLE
              (Note: "*" indicates nodal point data used.)
```

NODE NUMBER	MODEL PROCESS	UPSTREAM RUN PRESSURE HEAD(FT)	UPSTREAM RUN PRESSURE+ MOMENTUM(POUNDS)	DOWNSTREAM RUN FLOW DEPTH(FT)	DOWNSTREAM RUN PRESSURE+ MOMENTUM(POUNDS)
495.00-		1.31 Dc	235.13	0.81*	311.33
	} FRICTION				
490.00-		1.31 Dc	235.13	0.76*	336.31
	} JUNCTION				
490.00-		1.61	250.70	0.43*	686.85
	} FRICTION				
485.00-		1.31 Dc	235.13	0.42*	724.27
	} JUNCTION				
485.00-		1.31 Dc	235.13	0.39*	796.88
	} FRICTION				
480.00-		1.31 Dc	235.13	0.90*	281.78
	} JUNCTION				
480.00-		1.36 Dc	271.11	1.12*	286.40
	} FRICTION				
430.00-		1.36*Dc	271.11	1.36*Dc	271.11
	} CATCH BASIN				
430.00-		2.52*	195.41	1.36 Dc	67.64

```
--------------------------------------------------------------------------
  MAXIMUM NUMBER OF ENERGY BALANCES USED IN EACH PROFILE =  25
--------------------------------------------------------------------------
  NOTE: STEADY FLOW HYDRAULIC HEAD-LOSS COMPUTATIONS BASED ON THE MOST
  CONSERVATIVE FORMULAE FROM THE CURRENT LACRD,LACFCD, AND OCEMA
  DESIGN MANUALS.
**************************************************************************
  DOWNSTREAM PIPE FLOW CONTROL DATA:
  NODE NUMBER =   495.00           FLOWLINE ELEVATION =   185.64
  PIPE FLOW =      13.30 CFS       PIPE DIAMETER =  24.00 INCHES
  ASSUMED DOWNSTREAM CONTROL HGL =   185.640 FEET
  *NOTE: ASSUMED DOWNSTREAM CONTROL DEPTH(  0.00 FT.)
         IS LESS THAN CRITICAL DEPTH(  1.31 FT.)
  ===> CRITICAL DEPTH IS ASSUMED AS DOWNSTREAM CONTROL DEPTH
       FOR UPSTREAM RUN ANALYSIS
--------------------------------------------------------------------------
```

```
  NODE   495.00 : HGL = <  186.453>;EGL= <  188.363>;FLOWLINE= <  185.640>

****************************************************************************
  FLOW PROCESS FROM NODE   495.00 TO NODE   490.00 IS CODE =  1
  UPSTREAM NODE   490.00     ELEVATION =   185.79  (FLOW IS SUPERCRITICAL)
----------------------------------------------------------------------------
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW    =      13.30 CFS     PIPE DIAMETER =  24.00 INCHES
  PIPE LENGTH =      15.30 FEET          MANNING'S N  =  0.01300
----------------------------------------------------------------------------
  NORMAL DEPTH(FT) =      1.11           CRITICAL DEPTH(FT) =      1.31
============================================================================
  UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) =     0.76
============================================================================
  GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:
----------------------------------------------------------------------------
  DISTANCE FROM      FLOW DEPTH  VELOCITY      SPECIFIC        PRESSURE+
   CONTROL(FT)           (FT)    (FT/SEC)     ENERGY(FT)    MOMENTUM(POUNDS)
         0.000          0.756     12.214          3.074           336.31
         3.737          0.771     11.914          2.976           329.54
         7.522          0.785     11.627          2.885           323.15
        11.362          0.799     11.353          2.801           317.10
        15.261          0.813     11.091          2.724           311.38
        15.300          0.813     11.088          2.723           311.33
----------------------------------------------------------------------------
  NODE   490.00 : HGL = <  186.546>;EGL= <  188.864>;FLOWLINE= <  185.790>

****************************************************************************
  FLOW PROCESS FROM NODE   490.00 TO NODE   490.00 IS CODE =  5
  UPSTREAM NODE   490.00     ELEVATION =   186.12  (FLOW IS SUPERCRITICAL)
----------------------------------------------------------------------------
  CALCULATE JUNCTION LOSSES:
       PIPE        FLOW    DIAMETER   ANGLE    FLOWLINE   CRITICAL   VELOCITY
                   (CFS)   (INCHES) (DEGREES) ELEVATION  DEPTH(FT.)  (FT/SEC)
     UPSTREAM      13.30    24.00     58.50    186.12      1.31       26.433
    DOWNSTREAM     13.30    24.00       -      185.79      1.31       12.218
    LATERAL #1      0.00     0.00      0.00      0.00      0.00        0.000
    LATERAL #2      0.00     0.00      0.00      0.00      0.00        0.000
       Q5           0.00===Q5 EQUALS BASIN INPUT===

  LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
  DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
      Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
  UPSTREAM:    MANNING'S N = 0.01300;  FRICTION SLOPE = 0.32315
  DOWNSTREAM:  MANNING'S N = 0.01300;  FRICTION SLOPE = 0.03741
  AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.18028
  JUNCTION LENGTH =   4.00 FEET
  FRICTION LOSSES =  0.721 FEET         ENTRANCE LOSSES =  0.000 FEET
  JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
  JUNCTION LOSSES = ( 8.539)+( 0.000) =   8.539
----------------------------------------------------------------------------
  NODE   490.00 : HGL = <  186.554>;EGL= <  197.404>;FLOWLINE= <  186.120>

****************************************************************************
  FLOW PROCESS FROM NODE   490.00 TO NODE   485.00 IS CODE =  1
  UPSTREAM NODE   485.00     ELEVATION =   191.81  (FLOW IS SUPERCRITICAL)
----------------------------------------------------------------------------
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW    =      13.30 CFS     PIPE DIAMETER =  24.00 INCHES
  PIPE LENGTH =      20.00 FEET          MANNING'S N  =  0.01300
----------------------------------------------------------------------------
  NORMAL DEPTH(FT) =      0.45           CRITICAL DEPTH(FT) =      1.31
============================================================================
```

UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) = 0.42

GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:

DISTANCE FROM CONTROL(FT)	FLOW DEPTH (FT)	VELOCITY (FT/SEC)	SPECIFIC ENERGY(FT)	PRESSURE+ MOMENTUM(POUNDS)
0.000	0.418	27.895	12.509	724.27
1.089	0.419	27.781	12.411	721.36
2.220	0.421	27.667	12.314	718.46
3.397	0.422	27.554	12.219	715.59
4.624	0.423	27.442	12.124	712.73
5.906	0.424	27.331	12.030	709.90
7.249	0.425	27.220	11.938	707.09
8.659	0.427	27.111	11.847	704.30
10.143	0.428	27.002	11.756	701.52
11.712	0.429	26.893	11.667	698.77
13.376	0.430	26.786	11.578	696.04
15.148	0.431	26.679	11.491	693.33
17.044	0.433	26.573	11.404	690.63
19.085	0.434	26.468	11.319	687.96
20.000	0.434	26.425	11.284	686.85

NODE 485.00 : HGL = < 192.228>;EGL= < 204.319>;FLOWLINE= < 191.810>

FLOW PROCESS FROM NODE 485.00 TO NODE 485.00 IS CODE = 5
UPSTREAM NODE 485.00 ELEVATION = 192.14 (FLOW IS SUPERCRITICAL)

CALCULATE JUNCTION LOSSES:

PIPE	FLOW (CFS)	DIAMETER (INCHES)	ANGLE (DEGREES)	FLOWLINE ELEVATION	CRITICAL DEPTH(FT.)	VELOCITY (FT/SEC)
UPSTREAM	13.30	24.00	0.00	192.14	1.31	30.751
DOWNSTREAM	13.30	24.00	-	191.81	1.31	27.904
LATERAL #1	0.00	0.00	0.00	0.00	0.00	0.000
LATERAL #2	0.00	0.00	0.00	0.00	0.00	0.000
Q5	0.00===Q5 EQUALS BASIN INPUT===					

LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
UPSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.49579
DOWNSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.37660
AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.43620
JUNCTION LENGTH = 4.00 FEET
FRICTION LOSSES = 1.745 FEET ENTRANCE LOSSES = 0.000 FEET
JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
JUNCTION LOSSES = (2.896)+(0.000) = 2.896

NODE 485.00 : HGL = < 192.531>;EGL= < 207.214>;FLOWLINE= < 192.140>

FLOW PROCESS FROM NODE 485.00 TO NODE 480.00 IS CODE = 1
UPSTREAM NODE 480.00 ELEVATION = 331.65 (FLOW IS SUPERCRITICAL)

CALCULATE FRICTION LOSSES(LACFCD):
PIPE FLOW = 13.30 CFS PIPE DIAMETER = 24.00 INCHES
PIPE LENGTH = 239.90 FEET MANNING'S N = 0.01300

NORMAL DEPTH(FT) = 0.38 CRITICAL DEPTH(FT) = 1.31

UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) = 0.90

GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:

DISTANCE FROM CONTROL(FT)	FLOW DEPTH (FT)	VELOCITY (FT/SEC)	SPECIFIC ENERGY(FT)	PRESSURE+ MOMENTUM(POUNDS)
0.000	0.902	9.664	2.353	281.78
0.127	0.881	9.967	2.425	287.82
0.271	0.860	10.290	2.505	294.41
0.433	0.839	10.633	2.596	301.57
0.617	0.818	10.998	2.697	309.37
0.824	0.797	11.387	2.812	317.85
1.058	0.776	11.803	2.941	327.07
1.325	0.755	12.248	3.086	337.09
1.628	0.734	12.726	3.250	348.01
1.974	0.713	13.239	3.436	359.89
2.371	0.692	13.791	3.647	372.83
2.827	0.671	14.387	3.887	386.96
3.354	0.650	15.032	4.160	402.39
3.967	0.628	15.731	4.473	419.27
4.684	0.607	16.491	4.833	437.77
5.530	0.586	17.319	5.247	458.09
6.538	0.565	18.225	5.726	480.46
7.752	0.544	19.218	6.283	505.14
9.237	0.523	20.313	6.934	532.47
11.086	0.502	21.522	7.699	562.82
13.446	0.481	22.865	8.604	596.66
16.567	0.460	24.363	9.682	634.52
20.914	0.439	26.041	10.975	677.10
27.540	0.418	27.932	12.540	725.21
39.826	0.397	30.076	14.452	779.88
239.900	0.391	30.742	15.074	796.88

NODE 480.00 : HGL = < 332.552>;EGL= < 334.003>;FLOWLINE= < 331.650>

****

FLOW PROCESS FROM NODE 480.00 TO NODE 480.00 IS CODE = 5
UPSTREAM NODE 480.00 ELEVATION = 331.73 (FLOW IS SUPERCRITICAL)

CALCULATE JUNCTION LOSSES:

PIPE	FLOW (CFS)	DIAMETER (INCHES)	ANGLE (DEGREES)	FLOWLINE ELEVATION	CRITICAL DEPTH(FT.)	VELOCITY (FT/SEC)
UPSTREAM	13.30	18.00	13.70	331.73	1.36	9.395
DOWNSTREAM	13.30	24.00	-	331.65	1.31	9.667
LATERAL #1	0.00	0.00	0.00	0.00	0.00	0.000
LATERAL #2	0.00	0.00	0.00	0.00	0.00	0.000
Q5	0.00===Q5 EQUALS BASIN INPUT===					

LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
UPSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.01947
DOWNSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.01974
AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.01960
JUNCTION LENGTH = 4.00 FEET
FRICTION LOSSES = 0.078 FEET ENTRANCE LOSSES = 0.000 FEET
JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
JUNCTION LOSSES = (0.218)+(0.000) = 0.218

NODE 480.00 : HGL = < 332.850>;EGL= < 334.221>;FLOWLINE= < 331.730>

****

FLOW PROCESS FROM NODE 480.00 TO NODE 430.00 IS CODE = 1
UPSTREAM NODE 430.00 ELEVATION = 333.38 (FLOW IS SUPERCRITICAL)

CALCULATE FRICTION LOSSES(LACFCD):

```
  PIPE FLOW    =      13.30 CFS     PIPE DIAMETER =  18.00 INCHES
  PIPE LENGTH =      82.50 FEET          MANNING'S N  =  0.01300
-------------------------------------------------------------------------------
  NORMAL DEPTH(FT) =      1.11          CRITICAL DEPTH(FT) =      1.36
===============================================================================
  UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) =     1.36
===============================================================================
  GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:
-------------------------------------------------------------------------------
  DISTANCE FROM      FLOW DEPTH  VELOCITY      SPECIFIC        PRESSURE+
   CONTROL(FT)           (FT)    (FT/SEC)     ENERGY(FT)    MOMENTUM(POUNDS)
          0.000          1.361      7.892          2.329           271.11
          0.041          1.351      7.934          2.329           271.14
          0.168          1.341      7.978          2.330           271.21
          0.383          1.330      8.024          2.331           271.34
          0.692          1.320      8.071          2.332           271.52
          1.101          1.310      8.120          2.335           271.75
          1.618          1.300      8.171          2.338           272.04
          2.251          1.290      8.224          2.341           272.37
          3.012          1.280      8.279          2.345           272.76
          3.913          1.270      8.335          2.349           273.20
          4.972          1.260      8.393          2.354           273.69
          6.207          1.249      8.453          2.360           274.24
          7.644          1.239      8.515          2.366           274.85
          9.312          1.229      8.579          2.373           275.51
         11.251          1.219      8.644          2.380           276.22
         13.510          1.209      8.712          2.388           277.00
         16.155          1.199      8.782          2.397           277.83
         19.276          1.189      8.853          2.406           278.72
         23.000          1.179      8.927          2.417           279.68
         27.511          1.168      9.003          2.428           280.70
         33.095          1.158      9.081          2.439           281.78
         40.235          1.148      9.161          2.452           282.92
         49.830          1.138      9.243          2.465           284.13
         63.910          1.128      9.328          2.480           285.41
         82.500          1.120      9.392          2.491           286.40
-------------------------------------------------------------------------------
  NODE   430.00 : HGL = <  334.741>;EGL= <  335.709>;FLOWLINE= <  333.380>

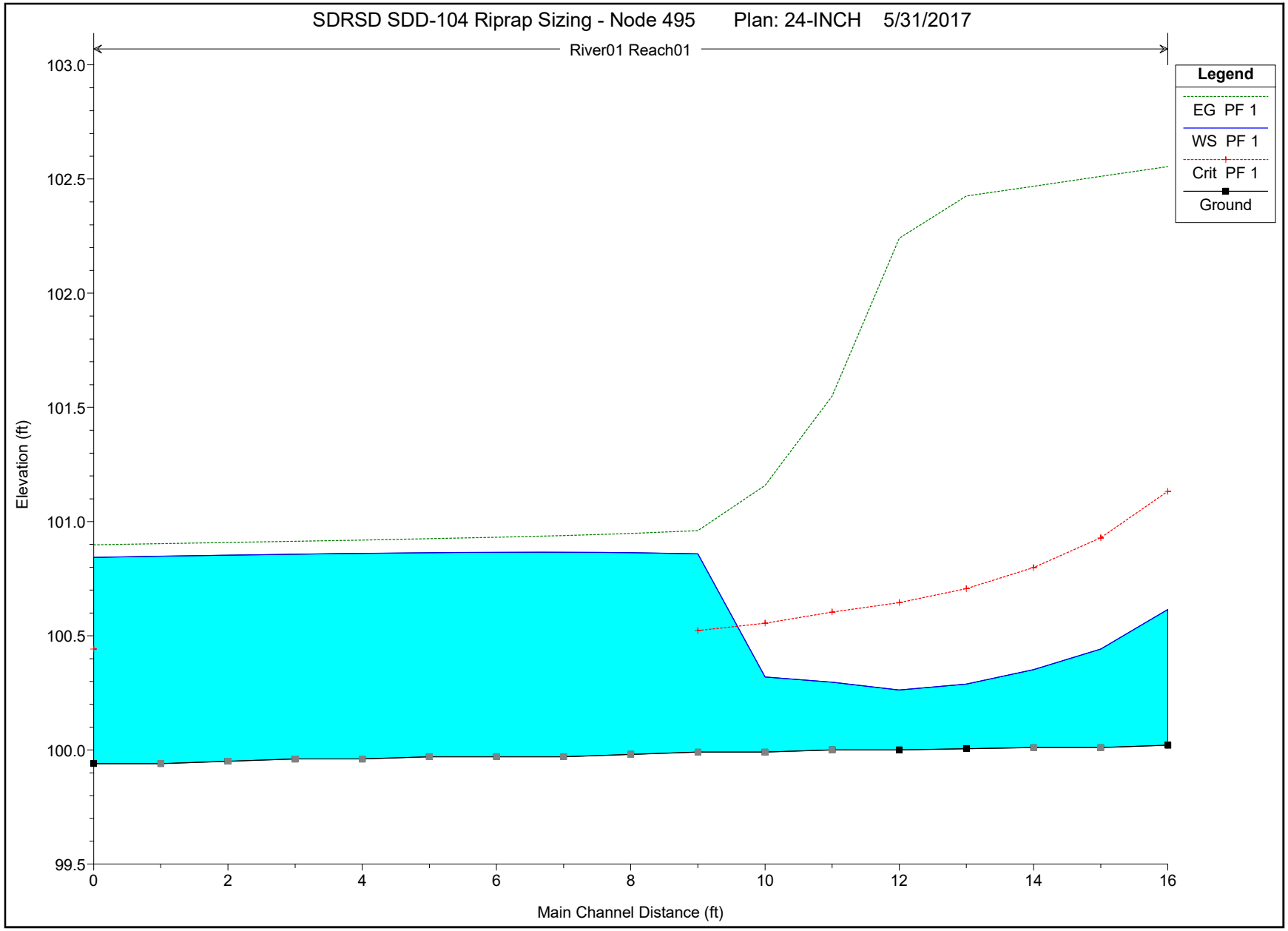
*******************************************************************************
  FLOW PROCESS FROM NODE   430.00 TO NODE   430.00 IS CODE =  8
  UPSTREAM NODE   430.00     ELEVATION =   333.38  (FLOW UNSEALS IN REACH)
-------------------------------------------------------------------------------
  CALCULATE CATCH BASIN ENTRANCE LOSSES(LACFCD):
  PIPE FLOW =      13.30 CFS          PIPE DIAMETER =  18.00 INCHES
  FLOW VELOCITY =   7.89 FEET/SEC.    VELOCITY HEAD =  0.968 FEET
  CATCH BASIN ENERGY LOSS = .2*(VELOCITY HEAD) = .2*(  0.968) =  0.194
-------------------------------------------------------------------------------
  NODE   430.00 : HGL = <  335.902>;EGL= <  335.902>;FLOWLINE= <  333.380>

*******************************************************************************
  UPSTREAM PIPE FLOW CONTROL DATA:
  NODE NUMBER =   430.00            FLOWLINE ELEVATION =   333.38
  ASSUMED UPSTREAM CONTROL HGL =    334.74 FOR DOWNSTREAM RUN ANALYSIS

===============================================================================
  END OF GRADUALLY VARIED FLOW ANALYSIS
 ♀
```

HEC-RAS Plan: 24-inch River: River01 Reach: Reach01 Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach01	104	PF 1	13.30	100.02	100.62	101.13	102.55	0.019105	11.18	1.19	4.00	2.55
Reach01	103.*	PF 1	13.30	100.01	100.44	100.93	102.51	0.031243	11.55	1.15	4.66	3.10
Reach01	102.*	PF 1	13.30	100.01	100.35	100.80	102.47	0.043680	11.68	1.14	5.34	3.52
Reach01	101	PF 1	13.30	100.01	100.29	100.71	102.43	0.056609	11.73	1.13	6.00	3.88
Reach01	100	PF 1	13.30	100.00	100.26	100.65	102.24	0.667172	11.29	1.18	7.05	3.89
Reach01	99.*	PF 1	13.30	100.00	100.30	100.60	101.55	0.358287	8.98	1.48	7.18	2.91
Reach01	98.*	PF 1	13.30	99.99	100.32	100.56	101.16	0.208753	7.35	1.81	7.32	2.26
Reach01	97.*	PF 1	13.30	99.99	100.86	100.52	100.96	0.006887	2.55	5.21	9.47	0.48
Reach01	96.*	PF 1	13.30	99.98	100.86		100.95	0.005718	2.33	5.71	9.53	0.44
Reach01	95.*	PF 1	13.30	99.97	100.87		100.94	0.004998	2.16	6.14	9.58	0.41
Reach01	94.*	PF 1	13.30	99.97	100.86		100.93	0.004753	2.07	6.43	9.58	0.39
Reach01	93.*	PF 1	13.30	99.97	100.86		100.93	0.004684	2.00	6.64	9.57	0.39
Reach01	92.*	PF 1	13.30	99.96	100.86		100.92	0.004557	1.93	6.88	9.60	0.38
Reach01	91.*	PF 1	13.30	99.96	100.86		100.91	0.004780	1.91	6.95	9.59	0.38
Reach01	90.*	PF 1	13.30	99.95	100.85		100.91	0.004924	1.89	7.05	9.61	0.39
Reach01	89.*	PF 1	13.30	99.94	100.85		100.90	0.004896	1.87	7.10	9.63	0.38
Reach01	88	PF 1	13.30	99.94	100.84	100.44	100.90	0.005004	1.89	7.05	9.61	0.39


SDRSD SDD-104 Riprap Sizing - Node 495 Plan: 24-INCH 5/31/2017
River01 Reach01
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Elevation (ft)
103.0
102.5
102.0
101.5
101.0
100.5
100.0
99.5
0
2
4
6
8
10
12
14
16
Main Channel Distance (ft)

```
**************************************************************************
              PIPE-FLOW HYDRAULICS COMPUTER PROGRAM PACKAGE
        (Reference: LACFCD,LACRD, AND OCEMA HYDRAULICS CRITERION)
      (c) Copyright 1982-2014 Advanced Engineering Software (aes)
          Ver. 21.0  Release Date: 06/01/2014  License ID 1261

                          Analysis prepared by:

                        RICK ENGINEERING COMPANY
                            5620 Friars Road
                         San Diego, California 92110
                       619-291-0707   Fax 619-291-4165

 ************************* DESCRIPTION OF STUDY *************************
* SERRA MESA STORM DRAIN AND GREEN INFRASTRUCTURE IMPROVEMENTS           *
* J-17588-G                                                              *
* POST-PROJECT CONDITION - VELOCITY RUN; BASIN 500 OUTFALL               *
 ************************************************************************

  FILE NAME: 595_V.PIP
  TIME/DATE OF STUDY: 10:04 09/13/2017
**************************************************************************
            GRADUALLY VARIED FLOW ANALYSIS FOR PIPE SYSTEM
                      NODAL POINT STATUS TABLE
             (Note: "*" indicates nodal point data used.)
                    UPSTREAM RUN                  DOWNSTREAM RUN
   NODE    MODEL    PRESSURE      PRESSURE+        FLOW         PRESSURE+
  NUMBER  PROCESS  HEAD(FT)    MOMENTUM(POUNDS)   DEPTH(FT)   MOMENTUM(POUNDS)
  595.00-             1.48 Dc          324.80        1.39*            326.67
        } FRICTION
  590.00-             1.48*Dc          324.80        1.48*Dc          324.80
        } JUNCTION
  590.00-             2.26             423.92        0.73*            552.46
        } FRICTION
  585.00-             1.48 Dc          324.80        0.68*            605.81
        } JUNCTION
  585.00-             1.81             344.82        0.46*           1031.04
        } FRICTION
  580.00-             1.48 Dc          324.80        1.04*            382.19
        } JUNCTION
  580.00-             1.48 Dc          324.80        1.05*            377.62
        } FRICTION
  520.00-             1.48*Dc          324.80        1.48*Dc          324.80
        } CATCH BASIN
  520.00-             2.34*            261.95        1.48 Dc          103.02
--------------------------------------------------------------------------
  MAXIMUM NUMBER OF ENERGY BALANCES USED IN EACH PROFILE =  25
--------------------------------------------------------------------------
  NOTE: STEADY FLOW HYDRAULIC HEAD-LOSS COMPUTATIONS BASED ON THE MOST
  CONSERVATIVE FORMULAE FROM THE CURRENT LACRD,LACFCD, AND OCEMA
  DESIGN MANUALS.
**************************************************************************
  DOWNSTREAM PIPE FLOW CONTROL DATA:
  NODE NUMBER =   595.00           FLOWLINE ELEVATION =   214.18
  PIPE FLOW =      16.90 CFS       PIPE DIAMETER =  24.00 INCHES
  ASSUMED DOWNSTREAM CONTROL HGL =   214.180 FEET
  *NOTE: ASSUMED DOWNSTREAM CONTROL DEPTH(  0.00 FT.)
         IS LESS THAN CRITICAL DEPTH(  1.48 FT.)
  ===> CRITICAL DEPTH IS ASSUMED AS DOWNSTREAM CONTROL DEPTH
       FOR UPSTREAM RUN ANALYSIS
--------------------------------------------------------------------------
  NODE   595.00 : HGL = <  215.570>;EGL= <  216.386>;FLOWLINE= <  214.180>
                                    Page 1
```

```
****************************************************************************
  FLOW PROCESS FROM NODE   595.00 TO NODE   590.00 IS CODE =  1
  UPSTREAM NODE   590.00     ELEVATION =   214.27  (FLOW IS SUPERCRITICAL)
----------------------------------------------------------------------------
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW   =      16.90 CFS     PIPE DIAMETER =  24.00 INCHES
  PIPE LENGTH =      10.00 FEET          MANNING'S N  =  0.01300
----------------------------------------------------------------------------
  NORMAL DEPTH(FT) =      1.34           CRITICAL DEPTH(FT) =      1.48
============================================================================
  UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) =     1.48
============================================================================
  GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:
----------------------------------------------------------------------------
  DISTANCE FROM      FLOW DEPTH  VELOCITY      SPECIFIC        PRESSURE+
   CONTROL(FT)           (FT)    (FT/SEC)     ENERGY(FT)    MOMENTUM(POUNDS)
         0.000          1.482      6.769          2.194           324.80
         0.022          1.476      6.797          2.194           324.80
         0.092          1.470      6.825          2.194           324.83
         0.212          1.465      6.853          2.194           324.86
         0.389          1.459      6.882          2.195           324.91
         0.626          1.453      6.911          2.195           324.98
         0.932          1.447      6.940          2.196           325.06
         1.312          1.441      6.969          2.196           325.15
         1.775          1.436      6.999          2.197           325.26
         2.331          1.430      7.030          2.198           325.39
         2.993          1.424      7.060          2.199           325.53
         3.774          1.418      7.091          2.200           325.68
         4.693          1.413      7.123          2.201           325.86
         5.771          1.407      7.154          2.202           326.04
         7.036          1.401      7.187          2.204           326.25
         8.523          1.395      7.219          2.205           326.47
        10.000          1.390      7.247          2.206           326.67
----------------------------------------------------------------------------
  NODE   590.00 : HGL = <  215.752>;EGL= <  216.464>;FLOWLINE= <  214.270>

****************************************************************************
  FLOW PROCESS FROM NODE   590.00 TO NODE   590.00 IS CODE =  5
  UPSTREAM NODE   590.00     ELEVATION =   214.60  (FLOW UNSEALS IN REACH)
  (NOTE: POSSIBLE JUMP IN OR UPSTREAM OF STRUCTURE)
----------------------------------------------------------------------------
  CALCULATE JUNCTION LOSSES:
       PIPE        FLOW    DIAMETER   ANGLE    FLOWLINE   CRITICAL   VELOCITY
                   (CFS)   (INCHES) (DEGREES) ELEVATION  DEPTH(FT.)  (FT/SEC)
     UPSTREAM      16.90    24.00     80.00    214.60      1.48       16.267
    DOWNSTREAM     16.90    24.00       -      214.27      1.48        6.772
    LATERAL #1      0.00     0.00      0.00      0.00      0.00        0.000
    LATERAL #2      0.00     0.00      0.00      0.00      0.00        0.000
       Q5           0.00===Q5 EQUALS BASIN INPUT===

  LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
  DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
      Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
  UPSTREAM:    MANNING'S N = 0.01300;  FRICTION SLOPE = 0.06869
  DOWNSTREAM:  MANNING'S N = 0.01300;  FRICTION SLOPE = 0.00691
  AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.03780
  JUNCTION LENGTH =   4.00 FEET
  FRICTION LOSSES =  0.151 FEET         ENTRANCE LOSSES =  0.000 FEET
  JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
  JUNCTION LOSSES = ( 2.976)+( 0.000) =   2.976
----------------------------------------------------------------------------
  NODE   590.00 : HGL = <  215.331>;EGL= <  219.440>;FLOWLINE= <  214.600>
```

```
****************************************************************************
  FLOW PROCESS FROM NODE   590.00 TO NODE   585.00 IS CODE =  1
  UPSTREAM NODE   585.00     ELEVATION =   217.08  (FLOW IS SUPERCRITICAL)
----------------------------------------------------------------------------
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW   =      16.90 CFS     PIPE DIAMETER =  24.00 INCHES
  PIPE LENGTH =      43.11 FEET          MANNING'S N  =  0.01300
----------------------------------------------------------------------------
  NORMAL DEPTH(FT) =      0.77           CRITICAL DEPTH(FT) =      1.48
============================================================================
  UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) =     0.68
============================================================================
  GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:
----------------------------------------------------------------------------
  DISTANCE FROM      FLOW DEPTH  VELOCITY      SPECIFIC        PRESSURE+
   CONTROL(FT)           (FT)    (FT/SEC)     ENERGY(FT)    MOMENTUM(POUNDS)
         0.000          0.679     17.989          5.707            605.81
         2.072          0.682     17.862          5.640            601.87
         4.215          0.686     17.737          5.574            597.98
         6.438          0.689     17.614          5.510            594.14
         8.746          0.693     17.492          5.447            590.36
        11.150          0.696     17.371          5.385            586.63
        13.657          0.700     17.252          5.324            582.95
        16.281          0.703     17.135          5.265            579.31
        19.033          0.707     17.019          5.207            575.73
        21.931          0.710     16.905          5.150            572.20
        24.992          0.714     16.791          5.095            568.71
        28.240          0.717     16.680          5.040            565.27
        31.703          0.721     16.569          4.986            561.88
        35.414          0.724     16.460          4.934            558.53
        39.418          0.728     16.352          4.883            555.23
        43.110          0.731     16.262          4.840            552.46
----------------------------------------------------------------------------
  NODE   585.00 : HGL = <  217.759>;EGL= <  222.787>;FLOWLINE= <  217.080>

****************************************************************************
  FLOW PROCESS FROM NODE   585.00 TO NODE   585.00 IS CODE =  5
  UPSTREAM NODE   585.00     ELEVATION =   217.41  (FLOW IS SUPERCRITICAL)
----------------------------------------------------------------------------
  CALCULATE JUNCTION LOSSES:
       PIPE        FLOW    DIAMETER   ANGLE    FLOWLINE   CRITICAL   VELOCITY
                   (CFS)   (INCHES) (DEGREES) ELEVATION  DEPTH(FT.)  (FT/SEC)
     UPSTREAM      16.90     24.00     51.00     217.41       1.48       31.290
    DOWNSTREAM     16.90     24.00       -       217.08       1.48       17.995
    LATERAL #1      0.00      0.00      0.00       0.00       0.00        0.000
    LATERAL #2      0.00      0.00      0.00       0.00       0.00        0.000
       Q5           0.00===Q5 EQUALS BASIN INPUT===

  LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
  DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
      Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
  UPSTREAM:    MANNING'S N = 0.01300;  FRICTION SLOPE = 0.42717
  DOWNSTREAM:  MANNING'S N = 0.01300;  FRICTION SLOPE = 0.09080
  AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.25899
  JUNCTION LENGTH =   4.00 FEET
  FRICTION LOSSES =  1.036 FEET         ENTRANCE LOSSES =  0.000 FEET
  JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
  JUNCTION LOSSES = (10.283)+( 0.000) =  10.283
----------------------------------------------------------------------------
  NODE   585.00 : HGL = <  217.867>;EGL= <  233.069>;FLOWLINE= <  217.410>

****************************************************************************
  FLOW PROCESS FROM NODE   585.00 TO NODE   580.00 IS CODE =  1
  UPSTREAM NODE   580.00     ELEVATION =   333.10  (FLOW IS SUPERCRITICAL)
```

```
------------------------------------------------------------------------------
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW    =      16.90 CFS     PIPE DIAMETER =  24.00 INCHES
  PIPE LENGTH =     228.79 FEET          MANNING'S N  =  0.01300
------------------------------------------------------------------------------
  NORMAL DEPTH(FT) =      0.44           CRITICAL DEPTH(FT) =      1.48
==============================================================================
  UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) =     1.04
==============================================================================
  GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:
------------------------------------------------------------------------------
  DISTANCE FROM      FLOW DEPTH  VELOCITY      SPECIFIC        PRESSURE+
   CONTROL(FT)           (FT)    (FT/SEC)     ENERGY(FT)    MOMENTUM(POUNDS)
          0.000          1.036     10.287          2.680           382.19
          0.157          1.012     10.595          2.756           389.89
          0.334          0.988     10.923          2.842           398.28
          0.534          0.964     11.272          2.938           407.42
          0.760          0.940     11.643          3.046           417.38
          1.016          0.916     12.039          3.168           428.22
          1.305          0.892     12.462          3.305           440.02
          1.633          0.868     12.914          3.460           452.85
          2.006          0.844     13.399          3.634           466.82
          2.432          0.820     13.920          3.831           482.03
          2.919          0.797     14.480          4.054           498.60
          3.479          0.773     15.084          4.308           516.68
          4.125          0.749     15.736          4.596           536.43
          4.876          0.725     16.443          4.926           558.01
          5.754          0.701     17.211          5.303           581.66
          6.788          0.677     18.047          5.737           607.62
          8.018          0.653     18.960          6.238           636.16
          9.498          0.629     19.960          6.819           667.63
         11.304          0.605     21.060          7.496           702.42
         13.551          0.581     22.273          8.289           741.01
         16.415          0.557     23.617          9.224           783.95
         20.195          0.533     25.113         10.333           831.92
         25.452          0.510     26.786         11.657           885.74
         33.451          0.486     28.666         13.253           946.42
         48.259          0.462     30.791         15.192          1015.18
        228.790          0.457     31.280         15.659          1031.04
------------------------------------------------------------------------------
  NODE   580.00 : HGL = <  334.136>;EGL= <  335.780>;FLOWLINE= <  333.100>

******************************************************************************
  FLOW PROCESS FROM NODE   580.00 TO NODE   580.00 IS CODE =  5
  UPSTREAM NODE   580.00     ELEVATION =   333.43  (FLOW IS SUPERCRITICAL)
------------------------------------------------------------------------------
  CALCULATE JUNCTION LOSSES:
       PIPE        FLOW    DIAMETER   ANGLE    FLOWLINE   CRITICAL   VELOCITY
                   (CFS)   (INCHES) (DEGREES) ELEVATION  DEPTH(FT.)  (FT/SEC)
     UPSTREAM      16.90    24.00     17.50    333.43      1.48       10.102
    DOWNSTREAM     16.90    24.00       -      333.10      1.48       10.290
    LATERAL #1      0.00     0.00      0.00      0.00      0.00        0.000
    LATERAL #2      0.00     0.00      0.00      0.00      0.00        0.000
       Q5           0.00===Q5 EQUALS BASIN INPUT===

  LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
  DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
      Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
  UPSTREAM:    MANNING'S N = 0.01300;  FRICTION SLOPE = 0.01889
  DOWNSTREAM:  MANNING'S N = 0.01300;  FRICTION SLOPE = 0.01983
  AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.01936
  JUNCTION LENGTH =   4.00 FEET
  FRICTION LOSSES =  0.077 FEET         ENTRANCE LOSSES =  0.000 FEET
  JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
```

```
  JUNCTION LOSSES = ( 0.286)+( 0.000) =   0.286
------------------------------------------------------------------------------
  NODE   580.00 : HGL = <  334.481>;EGL= <  336.066>;FLOWLINE= <  333.430>

******************************************************************************
  FLOW PROCESS FROM NODE   580.00 TO NODE   520.00 IS CODE =  1
  UPSTREAM NODE   520.00     ELEVATION =   335.49  (FLOW IS SUPERCRITICAL)
------------------------------------------------------------------------------
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW   =      16.90 CFS     PIPE DIAMETER =  24.00 INCHES
  PIPE LENGTH =     102.97 FEET          MANNING'S N  =  0.01300
------------------------------------------------------------------------------
  NORMAL DEPTH(FT) =      1.03           CRITICAL DEPTH(FT) =      1.48
==============================================================================
  UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) =     1.48
==============================================================================
  GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:
------------------------------------------------------------------------------
  DISTANCE FROM      FLOW DEPTH  VELOCITY      SPECIFIC        PRESSURE+
   CONTROL(FT)           (FT)    (FT/SEC)     ENERGY(FT)    MOMENTUM(POUNDS)
         0.000          1.482       6.769          2.194           324.80
         0.035          1.464       6.856          2.194           324.87
         0.143          1.446       6.947          2.196           325.08
         0.331          1.428       7.040          2.198           325.43
         0.607          1.410       7.137          2.201           325.94
         0.981          1.392       7.237          2.206           326.60
         1.463          1.374       7.342          2.212           327.42
         2.065          1.356       7.450          2.219           328.41
         2.803          1.338       7.562          2.227           329.56
         3.692          1.320       7.679          2.236           330.90
         4.755          1.302       7.800          2.248           332.41
         6.015          1.284       7.925          2.260           334.12
         7.504          1.266       8.056          2.275           336.02
         9.260          1.248       8.191          2.291           338.13
        11.332          1.231       8.332          2.309           340.46
        13.781          1.213       8.478          2.329           343.00
        16.688          1.195       8.631          2.352           345.77
        20.167          1.177       8.789          2.377           348.79
        24.371          1.159       8.954          2.404           352.06
        29.531          1.141       9.126          2.435           355.59
        35.999          1.123       9.304          2.468           359.39
        44.370          1.105       9.491          2.504           363.49
        55.758          1.087       9.685          2.544           367.88
        72.666          1.069       9.888          2.588           372.60
       102.970          1.051      10.099          2.636           377.62
------------------------------------------------------------------------------
  NODE   520.00 : HGL = <  336.972>;EGL= <  337.684>;FLOWLINE= <  335.490>

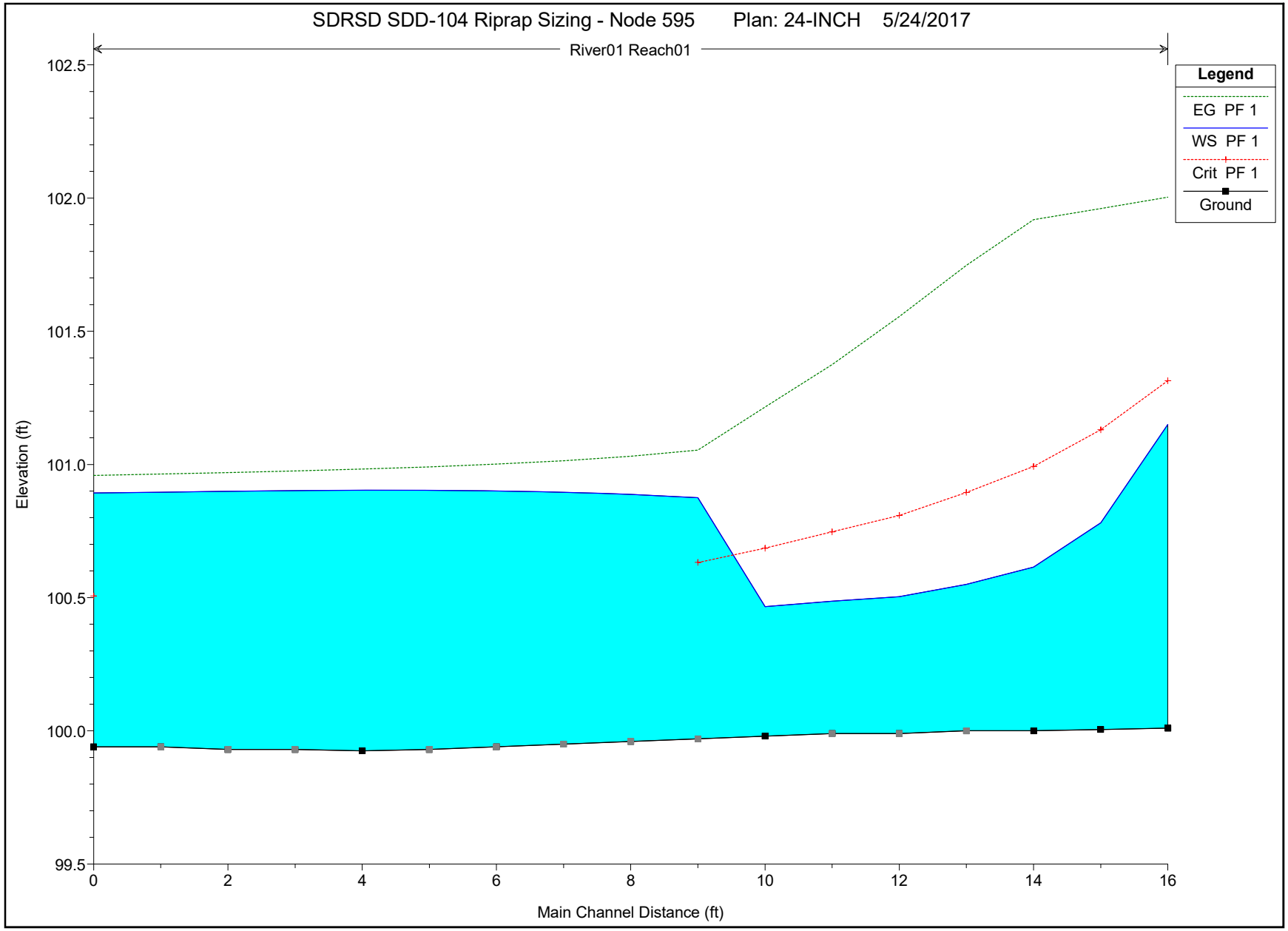
******************************************************************************
  FLOW PROCESS FROM NODE   520.00 TO NODE   520.00 IS CODE =  8
  UPSTREAM NODE   520.00     ELEVATION =   335.49  (FLOW UNSEALS IN REACH)
------------------------------------------------------------------------------
  CALCULATE CATCH BASIN ENTRANCE LOSSES(LACFCD):
  PIPE FLOW =      16.90 CFS          PIPE DIAMETER =  24.00 INCHES
  FLOW VELOCITY =   6.77 FEET/SEC.    VELOCITY HEAD =  0.712 FEET
  CATCH BASIN ENERGY LOSS = .2*(VELOCITY HEAD) = .2*(  0.712) =  0.142
------------------------------------------------------------------------------
  NODE   520.00 : HGL = <  337.826>;EGL= <  337.826>;FLOWLINE= <  335.490>

******************************************************************************
  UPSTREAM PIPE FLOW CONTROL DATA:
  NODE NUMBER =   520.00            FLOWLINE ELEVATION =   335.49
  ASSUMED UPSTREAM CONTROL HGL =    336.97 FOR DOWNSTREAM RUN ANALYSIS
```

```
================================================================================
  END OF GRADUALLY VARIED FLOW ANALYSIS
 ♀
```

HEC-RAS Plan: 24-inch River: River01 Reach: Reach01 Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach01	102	PF 1	16.90	100.01	101.15	101.31	102.00	0.003531	7.41	2.28	2.50	1.22
Reach01	101	PF 1	16.90	100.01	100.78	101.13	101.96	0.008164	8.72	1.94	5.00	1.74
Reach01	100	PF 1	16.90	100.00	100.61	100.99	101.92	0.140874	9.16	1.84	7.69	2.06
Reach01	99.*	PF 1	16.90	100.00	100.55	100.90	101.75	0.150025	8.78	1.92	7.80	2.09
Reach01	98.*	PF 1	16.90	99.99	100.50	100.81	101.56	0.144531	8.23	2.05	8.08	2.02
Reach01	97.*	PF 1	16.90	99.99	100.49	100.75	101.38	0.127639	7.56	2.23	8.48	1.89
Reach01	96	PF 1	16.90	99.98	100.47	100.69	101.22	0.110604	6.95	2.43	8.92	1.76
Reach01	95.*	PF 1	16.90	99.97	100.88	100.63	101.05	0.011545	3.40	4.98	11.43	0.63
Reach01	94.*	PF 1	16.90	99.96	100.89		101.03	0.008934	3.04	5.57	11.57	0.56
Reach01	93.*	PF 1	16.90	99.95	100.90		101.01	0.007259	2.76	6.13	11.67	0.50
Reach01	92.*	PF 1	16.90	99.94	100.90		101.00	0.006157	2.55	6.64	11.76	0.46
Reach01	91.*	PF 1	16.90	99.93	100.90		100.99	0.005394	2.38	7.11	11.84	0.43
Reach01	90	PF 1	16.90	99.93	100.90		100.98	0.004952	2.26	7.49	11.87	0.41
Reach01	89.*	PF 1	16.90	99.93	100.90		100.98	0.004840	2.18	7.74	11.83	0.40
Reach01	88.*	PF 1	16.90	99.93	100.90		100.97	0.004734	2.12	7.98	11.82	0.40
Reach01	87.*	PF 1	16.90	99.94	100.90		100.96	0.004931	2.10	8.06	11.73	0.40
Reach01	86	PF 1	16.90	99.94	100.89	100.51	100.96	0.005008	2.06	8.19	11.72	0.40


SDRSD SDD-104 Riprap Sizing - Node 595 Plan: 24-INCH 5/24/2017
River01 Reach01
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Elevation (ft)
102.5
102.0
101.5
101.0
100.5
100.0
99.5
0
2
4
6
8
10
12
14
16
Main Channel Distance (ft)

```
**************************************************************************
              PIPE-FLOW HYDRAULICS COMPUTER PROGRAM PACKAGE
          (Reference: LACFCD,LACRD, AND OCEMA HYDRAULICS CRITERION)
        (c) Copyright 1982-2014 Advanced Engineering Software (aes)
            Ver. 21.0  Release Date: 06/01/2014  License ID 1261

                          Analysis prepared by:

                        RICK ENGINEERING COMPANY
                            5620 Friars Road
                       San Diego, California 92110
                      619-291-0707   Fax 619-291-4165

  ************************* DESCRIPTION OF STUDY *************************
 * SERRA MESA STORM DRAIN AND GREEN INFRASTRUCTURE IMPROVEMENTS           *
 * J-17588-G                                                              *
 * POST-PROJECT CONDITION - VELOCITY RUN; BASIN 600 OUTFALL               *
  ************************************************************************

   FILE NAME: 695_V.PIP
   TIME/DATE OF STUDY: 13:09 05/24/2017

**************************************************************************
               GRADUALLY VARIED FLOW ANALYSIS FOR PIPE SYSTEM
                        NODAL POINT STATUS TABLE
                (Note: "*" indicates nodal point data used.)
                      UPSTREAM RUN                    DOWNSTREAM RUN
    NODE     MODEL    PRESSURE      PRESSURE+          FLOW         PRESSURE+
   NUMBER  PROCESS  HEAD(FT)   MOMENTUM(POUNDS)   DEPTH(FT)   MOMENTUM(POUNDS)
   695.00-             1.35 Dc          254.23        0.72*             398.22
         } FRICTION
   690.00-             1.35 Dc          254.23        0.54*             572.22
         } JUNCTION
   690.00-             1.51             258.88        0.38*             920.40
         } FRICTION
   685.00-             1.35 Dc          254.23        0.77*             366.71
         } JUNCTION
   685.00-             1.35 Dc          254.23        0.78*             362.58
         } FRICTION
   625.00-             1.35*Dc          254.23        1.35*Dc           254.23
         } CATCH BASIN
   625.00-             2.08*            211.17        1.35 Dc            83.82
--------------------------------------------------------------------------
  MAXIMUM NUMBER OF ENERGY BALANCES USED IN EACH PROFILE =  25
--------------------------------------------------------------------------
  NOTE: STEADY FLOW HYDRAULIC HEAD-LOSS COMPUTATIONS BASED ON THE MOST
  CONSERVATIVE FORMULAE FROM THE CURRENT LACRD,LACFCD, AND OCEMA
  DESIGN MANUALS.
**************************************************************************
  DOWNSTREAM PIPE FLOW CONTROL DATA:
  NODE NUMBER =   695.00            FLOWLINE ELEVATION =   215.12
  PIPE FLOW =      14.10 CFS        PIPE DIAMETER =  24.00 INCHES
  ASSUMED DOWNSTREAM CONTROL HGL =   215.120 FEET
  *NOTE: ASSUMED DOWNSTREAM CONTROL DEPTH(  0.00 FT.)
         IS LESS THAN CRITICAL DEPTH(  1.35 FT.)
  ===> CRITICAL DEPTH IS ASSUMED AS DOWNSTREAM CONTROL DEPTH
       FOR UPSTREAM RUN ANALYSIS
--------------------------------------------------------------------------
  NODE   695.00 : HGL = <  215.839>;EGL= <  218.831>;FLOWLINE= <  215.120>

**************************************************************************
  FLOW PROCESS FROM NODE   695.00 TO NODE   690.00 IS CODE =  1
```

UPSTREAM NODE 690.00 ELEVATION = 215.55 (FLOW IS SUPERCRITICAL)

CALCULATE FRICTION LOSSES(LACFCD):
PIPE FLOW = 14.10 CFS PIPE DIAMETER = 24.00 INCHES
PIPE LENGTH = 43.10 FEET MANNING'S N = 0.01300

NORMAL DEPTH(FT) = 1.14 CRITICAL DEPTH(FT) = 1.35

==========

UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) = 0.54

==========

GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:

DISTANCE FROM CONTROL(FT)	FLOW DEPTH (FT)	VELOCITY (FT/SEC)	SPECIFIC ENERGY(FT)	PRESSURE+ MOMENTUM(POUNDS)
0.000	0.540	20.588	7.126	572.22
5.645	0.564	19.366	6.391	539.87
11.342	0.588	18.267	5.773	510.96
17.093	0.613	17.275	5.249	485.05
22.902	0.637	16.376	4.803	461.73
28.773	0.661	15.558	4.422	440.71
34.712	0.685	14.811	4.094	421.70
40.728	0.709	14.127	3.810	404.48
43.100	0.719	13.877	3.711	398.22

NODE 690.00 : HGL = < 216.090>;EGL= < 222.676>;FLOWLINE= < 215.550>

****

FLOW PROCESS FROM NODE 690.00 TO NODE 690.00 IS CODE = 5
UPSTREAM NODE 690.00 ELEVATION = 215.88 (FLOW IS SUPERCRITICAL)

CALCULATE JUNCTION LOSSES:

PIPE	FLOW (CFS)	DIAMETER (INCHES)	ANGLE (DEGREES)	FLOWLINE ELEVATION	CRITICAL DEPTH(FT.)	VELOCITY (FT/SEC)
UPSTREAM	14.10	24.00	47.00	215.88	1.35	33.534
DOWNSTREAM	14.10	24.00	-	215.55	1.35	20.595
LATERAL #1	0.00	0.00	0.00	0.00	0.00	0.000
LATERAL #2	0.00	0.00	0.00	0.00	0.00	0.000
Q5	0.00===Q5 EQUALS BASIN INPUT===					

LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
UPSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.60364
DOWNSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.15263
AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.37813
JUNCTION LENGTH = 4.00 FEET
FRICTION LOSSES = 1.513 FEET ENTRANCE LOSSES = 0.000 FEET
JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
JUNCTION LOSSES = (11.049)+(0.000) = 11.049

NODE 690.00 : HGL = < 216.263>;EGL= < 233.725>;FLOWLINE= < 215.880>

****

FLOW PROCESS FROM NODE 690.00 TO NODE 685.00 IS CODE = 1
UPSTREAM NODE 685.00 ELEVATION = 350.53 (FLOW IS SUPERCRITICAL)

CALCULATE FRICTION LOSSES(LACFCD):
PIPE FLOW = 14.10 CFS PIPE DIAMETER = 24.00 INCHES
PIPE LENGTH = 194.80 FEET MANNING'S N = 0.01300

NORMAL DEPTH(FT) = 0.37 CRITICAL DEPTH(FT) = 1.35

==========

UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) = 0.77

GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:

DISTANCE FROM CONTROL(FT)	FLOW DEPTH (FT)	VELOCITY (FT/SEC)	SPECIFIC ENERGY(FT)	PRESSURE+ MOMENTUM(POUNDS)
0.000	0.772	12.593	3.236	366.71
0.196	0.756	12.955	3.364	375.48
0.412	0.740	13.336	3.503	384.82
0.650	0.724	13.738	3.657	394.78
0.913	0.708	14.164	3.825	405.39
1.205	0.692	14.614	4.010	416.72
1.529	0.676	15.091	4.214	428.80
1.890	0.660	15.597	4.440	441.72
2.293	0.644	16.135	4.689	455.53
2.746	0.628	16.707	4.965	470.31
3.255	0.612	17.318	5.271	486.16
3.831	0.596	17.969	5.612	503.16
4.486	0.579	18.666	5.993	521.43
5.234	0.563	19.412	6.418	541.09
6.096	0.547	20.213	6.896	562.27
7.095	0.531	21.075	7.433	585.15
8.266	0.515	22.005	8.039	609.90
9.653	0.499	23.009	8.725	636.72
11.320	0.483	24.097	9.505	665.87
13.360	0.467	25.279	10.396	697.60
15.921	0.451	26.567	11.418	732.26
19.248	0.435	27.974	12.594	770.20
23.801	0.419	29.517	13.956	811.87
30.618	0.403	31.214	15.541	857.79
43.028	0.387	33.088	17.398	908.58
194.800	0.383	33.524	17.845	920.40

NODE 685.00 : HGL = < 351.302>;EGL= < 353.766>;FLOWLINE= < 350.530>

****

FLOW PROCESS FROM NODE 685.00 TO NODE 685.00 IS CODE = 5
UPSTREAM NODE 685.00 ELEVATION = 350.86 (FLOW IS SUPERCRITICAL)

CALCULATE JUNCTION LOSSES:

PIPE	FLOW (CFS)	DIAMETER (INCHES)	ANGLE (DEGREES)	FLOWLINE ELEVATION	CRITICAL DEPTH(FT.)	VELOCITY (FT/SEC)
UPSTREAM	14.10	24.00	0.00	350.86	1.35	12.426
DOWNSTREAM	14.10	24.00	-	350.53	1.35	12.597
LATERAL #1	0.00	0.00	0.00	0.00	0.00	0.000
LATERAL #2	0.00	0.00	0.00	0.00	0.00	0.000
Q5	0.00===Q5 EQUALS BASIN INPUT===					

LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
UPSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.03751
DOWNSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.03895
AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.03823
JUNCTION LENGTH = 4.00 FEET
FRICTION LOSSES = 0.153 FEET ENTRANCE LOSSES = 0.000 FEET
JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
JUNCTION LOSSES = (0.271)+(0.000) = 0.271

NODE 685.00 : HGL = < 351.640>;EGL= < 354.038>;FLOWLINE= < 350.860>

****

FLOW PROCESS FROM NODE 685.00 TO NODE 625.00 IS CODE = 1
UPSTREAM NODE 625.00 ELEVATION = 354.70 (FLOW IS SUPERCRITICAL)

```
------------------------------------------------------------------------------
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW    =      14.10 CFS     PIPE DIAMETER =  24.00 INCHES
  PIPE LENGTH =      91.30 FEET          MANNING'S N  =  0.01300
------------------------------------------------------------------------------
  NORMAL DEPTH(FT) =      0.76          CRITICAL DEPTH(FT) =      1.35
==============================================================================
  UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) =     1.35
==============================================================================
  GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:
------------------------------------------------------------------------------
  DISTANCE FROM      FLOW DEPTH  VELOCITY      SPECIFIC        PRESSURE+
   CONTROL(FT)           (FT)    (FT/SEC)     ENERGY(FT)    MOMENTUM(POUNDS)
         0.000          1.352       6.235          1.956           254.23
         0.024          1.329       6.361          1.957           254.35
         0.098          1.305       6.493          1.960           254.71
         0.228          1.281       6.633          1.964           255.32
         0.420          1.257       6.779          1.971           256.19
         0.682          1.233       6.933          1.980           257.35
         1.022          1.209       7.096          1.992           258.79
         1.451          1.186       7.267          2.006           260.55
         1.980          1.162       7.447          2.023           262.62
         2.624          1.138       7.637          2.044           265.04
         3.400          1.114       7.838          2.069           267.82
         4.328          1.090       8.050          2.097           270.99
         5.435          1.066       8.275          2.130           274.56
         6.752          1.042       8.513          2.169           278.56
         8.320          1.019       8.765          2.212           283.03
        10.191          0.995       9.033          2.263           288.00
        12.435          0.971       9.318          2.320           293.49
        15.147          0.947       9.621          2.385           299.56
        18.458          0.923       9.944          2.460           306.25
        22.564          0.899      10.289          2.544           313.60
        27.768          0.876      10.658          2.640           321.67
        34.577          0.852      11.052          2.750           330.53
        43.943          0.828      11.476          2.874           340.24
        58.009          0.804      11.931          3.016           350.89
        83.648          0.780      12.422          3.178           362.57
        91.300          0.780      12.422          3.178           362.58
------------------------------------------------------------------------------
  NODE   625.00 : HGL = <  356.052>;EGL= <  356.656>;FLOWLINE= <  354.700>

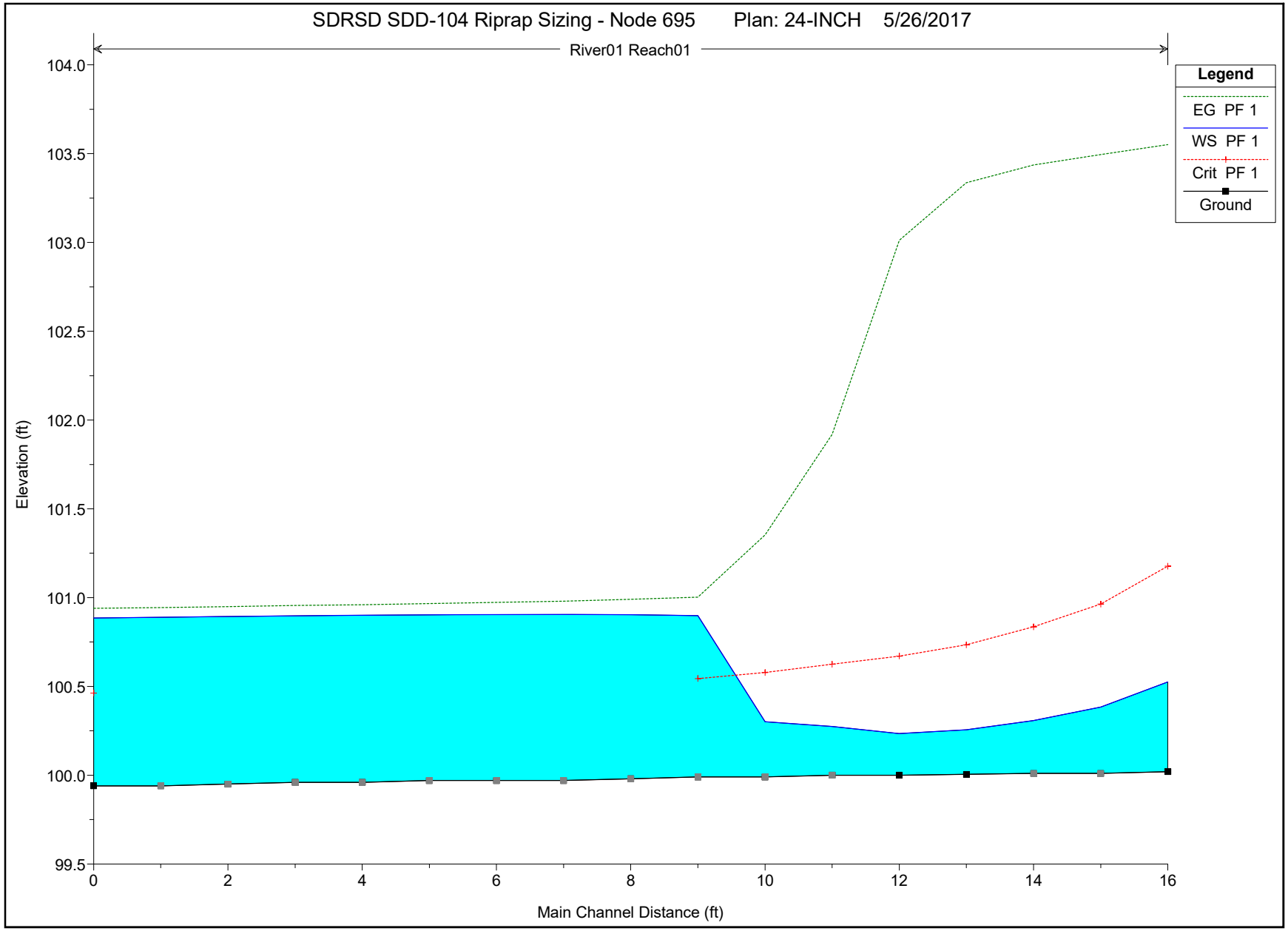
******************************************************************************
  FLOW PROCESS FROM NODE   625.00 TO NODE   625.00 IS CODE =  8
  UPSTREAM NODE   625.00     ELEVATION =   354.70  (FLOW UNSEALS IN REACH)
------------------------------------------------------------------------------
  CALCULATE CATCH BASIN ENTRANCE LOSSES(LACFCD):
  PIPE FLOW =      14.10 CFS          PIPE DIAMETER =  24.00 INCHES
  FLOW VELOCITY =   6.24 FEET/SEC.    VELOCITY HEAD =  0.604 FEET
  CATCH BASIN ENERGY LOSS = .2*(VELOCITY HEAD) = .2*(  0.604) =  0.121
------------------------------------------------------------------------------
  NODE   625.00 : HGL = <  356.777>;EGL= <  356.777>;FLOWLINE= <  354.700>

******************************************************************************
  UPSTREAM PIPE FLOW CONTROL DATA:
  NODE NUMBER =   625.00           FLOWLINE ELEVATION =   354.70
  ASSUMED UPSTREAM CONTROL HGL =    356.05 FOR DOWNSTREAM RUN ANALYSIS

==============================================================================
  END OF GRADUALLY VARIED FLOW ANALYSIS
 ♀
```

HEC-RAS Plan: 24-inch River: River01 Reach: Reach01 Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach01	104	PF 1	14.10	100.02	100.53	101.18	103.55	0.037093	13.96	1.01	4.00	3.46
Reach01	103.*	PF 1	14.10	100.01	100.38	100.96	103.50	0.057003	14.16	1.00	4.66	4.08
Reach01	102.*	PF 1	14.10	100.01	100.31	100.84	103.44	0.077467	14.19	0.99	5.34	4.58
Reach01	101	PF 1	14.10	100.01	100.26	100.73	103.34	0.096290	14.09	1.00	6.00	4.96
Reach01	100	PF 1	14.10	100.00	100.23	100.67	103.01	1.136807	13.38	1.05	6.94	4.87
Reach01	99.*	PF 1	14.10	100.00	100.27	100.63	101.92	0.545766	10.29	1.37	7.10	3.46
Reach01	98.*	PF 1	14.10	99.99	100.30	100.58	101.35	0.294304	8.23	1.71	7.25	2.60
Reach01	97.*	PF 1	14.10	99.99	100.90	100.54	101.00	0.006979	2.59	5.45	9.63	0.48
Reach01	96.*	PF 1	14.10	99.98	100.90		100.99	0.005799	2.36	5.97	9.69	0.43
Reach01	95.*	PF 1	14.10	99.97	100.91		100.98	0.005065	2.19	6.42	9.74	0.40
Reach01	94.*	PF 1	14.10	99.97	100.90		100.97	0.004797	2.09	6.73	9.74	0.39
Reach01	93.*	PF 1	14.10	99.97	100.90		100.97	0.004701	2.02	6.96	9.73	0.38
Reach01	92.*	PF 1	14.10	99.96	100.90		100.96	0.004552	1.95	7.22	9.77	0.37
Reach01	91.*	PF 1	14.10	99.96	100.90		100.96	0.004734	1.93	7.31	9.75	0.38
Reach01	90.*	PF 1	14.10	99.95	100.89		100.95	0.004838	1.90	7.44	9.78	0.38
Reach01	89.*	PF 1	14.10	99.94	100.89		100.94	0.004913	1.88	7.50	9.80	0.38
Reach01	88	PF 1	14.10	99.94	100.88	100.46	100.94	0.005007	1.89	7.45	9.78	0.38


SDRSD SDD-104 Riprap Sizing - Node 695 Plan: 24-INCH 5/26/2017
River01 Reach01
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Elevation (ft)
104.0
103.5
103.0
102.5
102.0
101.5
101.0
100.5
100.0
99.5
0
2
4
6
8
10
12
14
16
Main Channel Distance (ft)

```
**************************************************************************
              PIPE-FLOW HYDRAULICS COMPUTER PROGRAM PACKAGE
          (Reference: LACFCD,LACRD, AND OCEMA HYDRAULICS CRITERION)
        (c) Copyright 1982-2014 Advanced Engineering Software (aes)
            Ver. 21.0  Release Date: 06/01/2014  License ID 1261

                          Analysis prepared by:

                        RICK ENGINEERING COMPANY
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                       San Diego, California 92110
                      619-291-0707   Fax 619-291-4165

  ************************* DESCRIPTION OF STUDY *************************
 * SERRA MESA STORM DRAIN AND GREEN INFRASTRUCTURE IMPROVEMENTS           *
 * J-17588-G                                                              *
 * POST-PROJECT CONDITION - VELOCITY RUN; BASIN 700 OUTFALL               *
  ************************************************************************

   FILE NAME: 795_V.PIP
   TIME/DATE OF STUDY: 20:27 05/31/2017
--------------------------------------------------------------------------
**************************************************************************
               GRADUALLY VARIED FLOW ANALYSIS FOR PIPE SYSTEM
                        NODAL POINT STATUS TABLE
                (Note: "*" indicates nodal point data used.)
                      UPSTREAM RUN                    DOWNSTREAM RUN
    NODE     MODEL    PRESSURE      PRESSURE+          FLOW         PRESSURE+
   NUMBER  PROCESS  HEAD(FT)   MOMENTUM(POUNDS)   DEPTH(FT)   MOMENTUM(POUNDS)
   795.00-              1.95 Dc          1125.93        1.54*            1243.85
         } FRICTION
   790.00-              3.02             1328.61        1.24*            1507.71
         } JUNCTION
   790.00-              3.54             1431.54        1.05*            1798.73
         } FRICTION
   785.00-              3.29             1382.18        0.95*            2032.24
         } JUNCTION
   785.00-              4.47             1614.06        0.70*            2999.72
         } FRICTION
   780.00-              1.95 Dc          1125.93        1.90*            1128.16
         } JUNCTION
   780.00-              2.10             1148.27        1.69*            1173.41
         } FRICTION
   740.00-              1.95*Dc          1125.93        1.95*Dc          1125.93
         } JUNCTION
   740.00-              3.69*            1045.27        1.43              772.65
         } FRICTION
   720.00-              3.17*             943.85        1.85 Dc           704.10
         } CATCH BASIN
   720.00-              4.76*             736.34        1.85 Dc           166.32
--------------------------------------------------------------------------
  MAXIMUM NUMBER OF ENERGY BALANCES USED IN EACH PROFILE =  25
--------------------------------------------------------------------------
  NOTE: STEADY FLOW HYDRAULIC HEAD-LOSS COMPUTATIONS BASED ON THE MOST
  CONSERVATIVE FORMULAE FROM THE CURRENT LACRD,LACFCD, AND OCEMA
  DESIGN MANUALS.
**************************************************************************
  DOWNSTREAM PIPE FLOW CONTROL DATA:
  NODE NUMBER =   795.00            FLOWLINE ELEVATION =   265.36
  PIPE FLOW =      38.90 CFS        PIPE DIAMETER =  24.00 INCHES
  ASSUMED DOWNSTREAM CONTROL HGL =   265.360 FEET
  *NOTE: ASSUMED DOWNSTREAM CONTROL DEPTH(  0.00 FT.)
```

```
       IS LESS THAN CRITICAL DEPTH(  1.95 FT.)
  ===> CRITICAL DEPTH IS ASSUMED AS DOWNSTREAM CONTROL DEPTH
       FOR UPSTREAM RUN ANALYSIS
--------------------------------------------------------------------------------
  NODE   795.00 : HGL = <  266.897>;EGL= <  270.399>;FLOWLINE= <  265.360>

********************************************************************************
  FLOW PROCESS FROM NODE   795.00 TO NODE   790.00 IS CODE =  1
  UPSTREAM NODE   790.00     ELEVATION =   265.90  (FLOW IS SUPERCRITICAL)
--------------------------------------------------------------------------------
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW   =      38.90 CFS     PIPE DIAMETER =  24.00 INCHES
  PIPE LENGTH =      53.30 FEET          MANNING'S N  =  0.01300
  ===> NORMAL PIPEFLOW IS PRESSURE FLOW
--------------------------------------------------------------------------------
  NORMAL DEPTH(FT) =      2.00           CRITICAL DEPTH(FT) =      1.95
================================================================================
  UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) =     1.24
================================================================================
  GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:
--------------------------------------------------------------------------------
  DISTANCE FROM      FLOW DEPTH  VELOCITY      SPECIFIC        PRESSURE+
   CONTROL(FT)           (FT)    (FT/SEC)     ENERGY(FT)    MOMENTUM(POUNDS)
          0.000          1.235     19.091          6.898          1507.71
          5.553          1.264     18.588          6.632          1473.46
         11.018          1.292     18.115          6.391          1441.54
         16.390          1.321     17.669          6.172          1411.78
         21.661          1.349     17.249          5.972          1384.05
         26.824          1.378     16.853          5.790          1358.22
         31.871          1.406     16.479          5.625          1334.17
         36.794          1.434     16.126          5.475          1311.80
         41.583          1.463     15.793          5.338          1291.01
         46.229          1.491     15.479          5.214          1271.73
         50.719          1.520     15.182          5.101          1253.86
         53.300          1.537     15.013          5.039          1243.85
--------------------------------------------------------------------------------
  NODE   790.00 : HGL = <  267.135>;EGL= <  272.798>;FLOWLINE= <  265.900>

********************************************************************************
  FLOW PROCESS FROM NODE   790.00 TO NODE   790.00 IS CODE =  5
  UPSTREAM NODE   790.00     ELEVATION =   266.23  (FLOW IS SUPERCRITICAL)
--------------------------------------------------------------------------------
  CALCULATE JUNCTION LOSSES:
       PIPE        FLOW    DIAMETER   ANGLE    FLOWLINE   CRITICAL   VELOCITY
                   (CFS)   (INCHES) (DEGREES) ELEVATION  DEPTH(FT.)  (FT/SEC)
     UPSTREAM      38.90    24.00     32.30    266.23      1.95       23.240
    DOWNSTREAM     38.90    24.00       -      265.90      1.95       19.097
    LATERAL #1      0.00     0.00      0.00      0.00      0.00        0.000
    LATERAL #2      0.00     0.00      0.00      0.00      0.00        0.000
       Q5           0.00===Q5 EQUALS BASIN INPUT===

  LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
  DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
      Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
  UPSTREAM:    MANNING'S N = 0.01300;  FRICTION SLOPE = 0.09991
  DOWNSTREAM:  MANNING'S N = 0.01300;  FRICTION SLOPE = 0.06001
  AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.07996
  JUNCTION LENGTH =   4.00 FEET
  FRICTION LOSSES =  0.320 FEET         ENTRANCE LOSSES =  0.000 FEET
  JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
  JUNCTION LOSSES = ( 2.870)+( 0.000) =   2.870
--------------------------------------------------------------------------------
  NODE   790.00 : HGL = <  267.282>;EGL= <  275.668>;FLOWLINE= <  266.230>
```

```
****************************************************************************
  FLOW PROCESS FROM NODE   790.00 TO NODE   785.00 IS CODE =  1
  UPSTREAM NODE   785.00     ELEVATION =   267.36  (FLOW IS SUPERCRITICAL)
----------------------------------------------------------------------------
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW    =      38.90 CFS     PIPE DIAMETER =  24.00 INCHES
  PIPE LENGTH =      29.70 FEET          MANNING'S N  =  0.01300
----------------------------------------------------------------------------
  NORMAL DEPTH(FT) =      1.46           CRITICAL DEPTH(FT) =      1.95
============================================================================
  UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) =     0.95
============================================================================
  GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:
----------------------------------------------------------------------------
  DISTANCE FROM      FLOW DEPTH  VELOCITY      SPECIFIC        PRESSURE+
   CONTROL(FT)          (FT)    (FT/SEC)     ENERGY(FT)    MOMENTUM(POUNDS)
         0.000          0.949     26.462         11.830          2032.24
         5.678          0.970     25.750         11.272          1980.40
        11.462          0.990     25.074         10.759          1931.39
        17.362          1.010     24.433         10.286          1885.04
        23.392          1.031     23.824          9.849          1841.16
        29.566          1.051     23.245          9.446          1799.58
        29.700          1.052     23.233          9.438          1798.73
----------------------------------------------------------------------------
  NODE   785.00 : HGL = <  268.309>;EGL= <  279.190>;FLOWLINE= <  267.360>

****************************************************************************
  FLOW PROCESS FROM NODE   785.00 TO NODE   785.00 IS CODE =  5
  UPSTREAM NODE   785.00     ELEVATION =   267.69  (FLOW IS SUPERCRITICAL)
----------------------------------------------------------------------------
  CALCULATE JUNCTION LOSSES:
       PIPE        FLOW    DIAMETER   ANGLE    FLOWLINE   CRITICAL   VELOCITY
                   (CFS)   (INCHES) (DEGREES) ELEVATION  DEPTH(FT.)  (FT/SEC)
     UPSTREAM      38.90     24.00     45.00     267.69       1.95       39.555
    DOWNSTREAM     38.90     24.00         -     267.36       1.95       26.470
    LATERAL #1      0.00      0.00      0.00       0.00       0.00        0.000
    LATERAL #2      0.00      0.00      0.00       0.00       0.00        0.000
       Q5           0.00===Q5 EQUALS BASIN INPUT===

  LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
  DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
      Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
  UPSTREAM:    MANNING'S N = 0.01300;  FRICTION SLOPE = 0.42349
  DOWNSTREAM:  MANNING'S N = 0.01300;  FRICTION SLOPE = 0.14137
  AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.28243
  JUNCTION LENGTH =   4.00 FEET
  FRICTION LOSSES =  1.130 FEET         ENTRANCE LOSSES =  0.000 FEET
  JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
  JUNCTION LOSSES = (13.498)+( 0.000) =  13.498
----------------------------------------------------------------------------
  NODE   785.00 : HGL = <  268.392>;EGL= <  292.687>;FLOWLINE= <  267.690>

****************************************************************************
  FLOW PROCESS FROM NODE   785.00 TO NODE   780.00 IS CODE =  1
  UPSTREAM NODE   780.00     ELEVATION =   337.39  (FLOW IS SUPERCRITICAL)
----------------------------------------------------------------------------
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW    =      38.90 CFS     PIPE DIAMETER =  24.00 INCHES
  PIPE LENGTH =     164.60 FEET          MANNING'S N  =  0.01300
----------------------------------------------------------------------------
  NORMAL DEPTH(FT) =      0.70           CRITICAL DEPTH(FT) =      1.95
============================================================================
```

UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) = 1.90

GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:

DISTANCE FROM CONTROL(FT)	FLOW DEPTH (FT)	VELOCITY (FT/SEC)	SPECIFIC ENERGY(FT)	PRESSURE+ MOMENTUM(POUNDS)
0.000	1.895	12.631	4.374	1128.16
0.074	1.848	12.826	4.404	1133.74
0.189	1.800	13.059	4.450	1142.36
0.347	1.752	13.328	4.512	1153.89
0.550	1.704	13.634	4.593	1168.34
0.801	1.657	13.977	4.692	1185.79
1.106	1.609	14.358	4.812	1206.37
1.473	1.561	14.781	4.956	1230.28
1.909	1.513	15.247	5.125	1257.74
2.425	1.466	15.762	5.326	1289.06
3.037	1.418	16.328	5.560	1324.57
3.760	1.370	16.953	5.836	1364.70
4.616	1.322	17.642	6.158	1409.94
5.634	1.275	18.402	6.536	1460.87
6.851	1.227	19.244	6.981	1518.17
8.313	1.179	20.177	7.505	1582.67
10.087	1.131	21.215	8.125	1655.35
12.261	1.084	22.374	8.862	1737.39
14.965	1.036	23.672	9.742	1830.23
18.391	0.988	25.132	10.802	1935.60
22.838	0.941	26.784	12.087	2055.67
28.817	0.893	28.662	13.657	2193.10
37.292	0.845	30.811	15.595	2351.27
50.441	0.797	33.288	18.015	2534.46
75.274	0.750	36.167	21.073	2748.19
164.600	0.702	39.543	24.997	2999.72

NODE 780.00 : HGL = < 339.285>;EGL= < 341.764>;FLOWLINE= < 337.390>

FLOW PROCESS FROM NODE 780.00 TO NODE 780.00 IS CODE = 5
UPSTREAM NODE 780.00 ELEVATION = 337.72 (FLOW IS SUPERCRITICAL)

CALCULATE JUNCTION LOSSES:

PIPE	FLOW (CFS)	DIAMETER (INCHES)	ANGLE (DEGREES)	FLOWLINE ELEVATION	CRITICAL DEPTH(FT.)	VELOCITY (FT/SEC)
UPSTREAM	38.90	24.00	21.50	337.72	1.95	13.740
DOWNSTREAM	38.90	24.00	-	337.39	1.95	12.635
LATERAL #1	0.00	0.00	0.00	0.00	0.00	0.000
LATERAL #2	0.00	0.00	0.00	0.00	0.00	0.000
Q5	0.00===Q5 EQUALS BASIN INPUT===					

LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
UPSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.02811
DOWNSTREAM: MANNING'S N = 0.01300; FRICTION SLOPE = 0.02559
AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.02685
JUNCTION LENGTH = 4.00 FEET
FRICTION LOSSES = 0.107 FEET ENTRANCE LOSSES = 0.000 FEET
JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
JUNCTION LOSSES = (0.577)+(0.000) = 0.577

NODE 780.00 : HGL = < 339.410>;EGL= < 342.341>;FLOWLINE= < 337.720>

FLOW PROCESS FROM NODE 780.00 TO NODE 740.00 IS CODE = 1

```
  UPSTREAM NODE   740.00     ELEVATION =   340.12  (FLOW IS SUPERCRITICAL)
---------------------------------------------------------------------------
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW    =      38.90 CFS     PIPE DIAMETER =  24.00 INCHES
  PIPE LENGTH =      79.90 FEET          MANNING'S N  =  0.01300
---------------------------------------------------------------------------
  NORMAL DEPTH(FT) =      1.63          CRITICAL DEPTH(FT) =      1.95
===========================================================================
  UPSTREAM CONTROL ASSUMED FLOWDEPTH(FT) =     1.95
===========================================================================
  GRADUALLY VARIED FLOW PROFILE COMPUTED INFORMATION:
---------------------------------------------------------------------------
  DISTANCE FROM      FLOW DEPTH  VELOCITY      SPECIFIC        PRESSURE+
   CONTROL(FT)           (FT)    (FT/SEC)     ENERGY(FT)    MOMENTUM(POUNDS)
         0.000          1.947     12.470          4.363          1125.93
         0.193          1.934     12.505          4.363          1126.08
         0.730          1.921     12.544          4.366          1126.52
         1.570          1.908     12.586          4.369          1127.22
         2.693          1.895     12.632          4.374          1128.18
         4.089          1.882     12.680          4.381          1129.37
         5.758          1.869     12.732          4.388          1130.80
         7.706          1.857     12.786          4.397          1132.46
         9.948          1.844     12.844          4.407          1134.33
        12.502          1.831     12.903          4.418          1136.43
        15.395          1.818     12.966          4.430          1138.74
        18.663          1.805     13.031          4.444          1141.26
        22.351          1.792     13.099          4.458          1143.99
        26.516          1.779     13.170          4.474          1146.93
        31.233          1.767     13.243          4.491          1150.09
        36.600          1.754     13.319          4.510          1153.45
        42.745          1.741     13.397          4.530          1157.03
        49.847          1.728     13.478          4.550          1160.81
        58.153          1.715     13.562          4.573          1164.82
        68.029          1.702     13.648          4.596          1169.03
        79.900          1.690     13.736          4.621          1173.41
---------------------------------------------------------------------------
  NODE   740.00 : HGL = <  342.066>;EGL= <  344.483>;FLOWLINE= <  340.120>

***************************************************************************
  FLOW PROCESS FROM NODE   740.00 TO NODE   740.00 IS CODE =  5
  UPSTREAM NODE   740.00     ELEVATION =   340.45  (FLOW UNSEALS IN REACH)
---------------------------------------------------------------------------
  CALCULATE JUNCTION LOSSES:
       PIPE        FLOW    DIAMETER   ANGLE    FLOWLINE   CRITICAL   VELOCITY
                   (CFS)   (INCHES) (DEGREES) ELEVATION  DEPTH(FT.)  (FT/SEC)
     UPSTREAM      29.00    24.00      1.50    340.45      1.85        9.231
    DOWNSTREAM     38.90    24.00       -      340.12      1.95       12.474
    LATERAL #1      9.90    24.00     55.50    340.95      1.13        3.151
    LATERAL #2      0.00     0.00      0.00      0.00      0.00        0.000
       Q5           0.00===Q5 EQUALS BASIN INPUT===

  LACFCD AND OCEMA FLOW JUNCTION FORMULAE USED:
  DY=(Q2*V2-Q1*V1*COS(DELTA1)-Q3*V3*COS(DELTA3)-
      Q4*V4*COS(DELTA4))/((A1+A2)*16.1)+FRICTION LOSSES
  UPSTREAM:    MANNING'S N = 0.01300;  FRICTION SLOPE = 0.01643
  DOWNSTREAM:  MANNING'S N = 0.01300;  FRICTION SLOPE = 0.02616
  AVERAGED FRICTION SLOPE IN JUNCTION ASSUMED AS 0.02129
  JUNCTION LENGTH =   4.00 FEET
  FRICTION LOSSES =  0.085 FEET         ENTRANCE LOSSES =  0.000 FEET
  JUNCTION LOSSES = (DY+HV1-HV2)+(ENTRANCE LOSSES)
  JUNCTION LOSSES = ( 0.976)+( 0.000) =   0.976
---------------------------------------------------------------------------
  NODE   740.00 : HGL = <  344.136>;EGL= <  345.459>;FLOWLINE= <  340.450>
```

```
****************************************************************************
  FLOW PROCESS FROM NODE   740.00 TO NODE   720.00 IS CODE =  1
  UPSTREAM NODE   720.00     ELEVATION =   341.60  (FLOW IS UNDER PRESSURE)
----------------------------------------------------------------------------
  CALCULATE FRICTION LOSSES(LACFCD):
  PIPE FLOW   =      29.00 CFS     PIPE DIAMETER =  24.00 INCHES
  PIPE LENGTH =      38.50 FEET          MANNING'S N  =  0.01300
  SF=(Q/K)**2 = ((     29.00)/(   226.226))**2 = 0.01643
  HF=L*SF = (     38.50)*(0.01643) =      0.633
----------------------------------------------------------------------------
  NODE   720.00 : HGL = <  344.768>;EGL= <  346.092>;FLOWLINE= <  341.600>

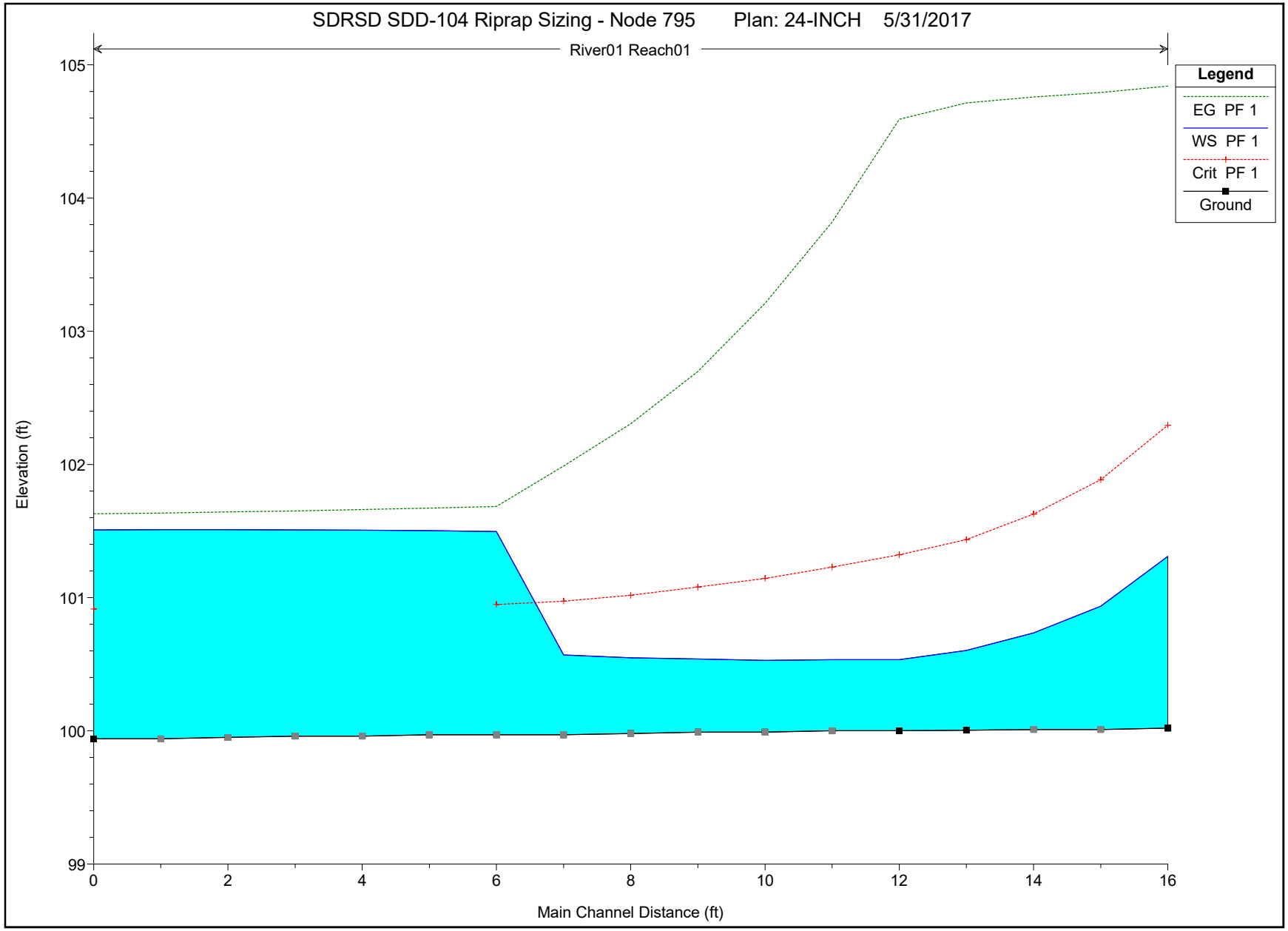
****************************************************************************
  FLOW PROCESS FROM NODE   720.00 TO NODE   720.00 IS CODE =  8
  UPSTREAM NODE   720.00     ELEVATION =   341.60  (FLOW IS UNDER PRESSURE)
----------------------------------------------------------------------------
  CALCULATE CATCH BASIN ENTRANCE LOSSES(LACFCD):
  PIPE FLOW =      29.00 CFS          PIPE DIAMETER =  24.00 INCHES
  FLOW VELOCITY =   9.23 FEET/SEC.    VELOCITY HEAD =  1.323 FEET
  CATCH BASIN ENERGY LOSS = .2*(VELOCITY HEAD) = .2*(  1.323) =  0.265
----------------------------------------------------------------------------
  NODE   720.00 : HGL = <  346.356>;EGL= <  346.356>;FLOWLINE= <  341.600>

****************************************************************************
  UPSTREAM PIPE FLOW CONTROL DATA:
  NODE NUMBER =   720.00            FLOWLINE ELEVATION =   341.60
  ASSUMED UPSTREAM CONTROL HGL =    343.45 FOR DOWNSTREAM RUN ANALYSIS

============================================================================
  END OF GRADUALLY VARIED FLOW ANALYSIS
 ♀
```

HEC-RAS Plan: 24-inch River: River01 Reach: Reach01 Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach01	104	PF 1	38.90	100.02	101.31	102.29	104.84	0.012391	15.08	2.58	4.00	2.34
Reach01	103.*	PF 1	38.90	100.01	100.94	101.88	104.79	0.021064	15.76	2.47	4.66	2.89
Reach01	102.*	PF 1	38.90	100.01	100.74	101.63	104.76	0.030450	16.10	2.42	5.34	3.33
Reach01	101	PF 1	38.90	100.01	100.60	101.44	104.71	0.040257	16.27	2.39	6.00	3.71
Reach01	100	PF 1	38.90	100.00	100.53	101.32	104.59	0.601878	16.16	2.41	8.14	3.89
Reach01	99.*	PF 1	38.90	100.00	100.53	101.23	103.82	0.487521	14.55	2.67	8.14	3.50
Reach01	98.*	PF 1	38.90	99.99	100.53	101.14	103.21	0.394762	13.14	2.96	8.15	3.16
Reach01	97.*	PF 1	38.90	99.99	100.54	101.08	102.70	0.308612	11.79	3.30	8.20	2.80
Reach01	96.*	PF 1	38.90	99.98	100.55	101.02	102.30	0.246631	10.64	3.66	8.27	2.50
Reach01	95.*	PF 1	38.90	99.97	100.57	100.97	101.99	0.192674	9.56	4.07	8.40	2.21
Reach01	94.*	PF 1	38.90	99.97	101.50	100.95	101.68	0.006457	3.48	11.17	12.11	0.50
Reach01	93.*	PF 1	38.90	99.97	101.50		101.67	0.005969	3.31	11.76	12.13	0.48
Reach01	92.*	PF 1	38.90	99.96	101.51		101.66	0.005502	3.14	12.37	12.19	0.46
Reach01	91.*	PF 1	38.90	99.96	101.51		101.65	0.005318	3.04	12.81	12.19	0.45
Reach01	90.*	PF 1	38.90	99.95	101.51		101.64	0.005089	2.93	13.28	12.24	0.44
Reach01	89.*	PF 1	38.90	99.94	101.51		101.63	0.004946	2.84	13.70	12.28	0.43
Reach01	88	PF 1	38.90	99.94	101.51	100.91	101.63	0.005009	2.79	13.93	12.27	0.43


SDRSD SDD-104 Riprap Sizing - Node 795 Plan: 24-INCH 5/31/2017
River01 Reach01
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Elevation (ft)
105
104
103
102
101
100
99
0
2
4
6
8
10
12
14
16
Main Channel Distance (ft)

APPENDIX G

Storm Water Requirements Applicability Checklist (DS-560)

City of San Diego
Development Services
1222 First Ave., MS-302
San Diego, CA 92101
(619) 446-5000

Storm Water Requirements Applicability Checklist

FORM DS-560
OCTOBER 2016

Project Address: Serra Mesa-Monarch St., Shawn Ave., Palace Dr., Larrabee Ave., Walker Dr.,& Mobley St.

Project Number *(for City Use Only):*

SECTION 1. Construction Storm Water BMP Requirements:

All construction sites are required to implement construction BMPs in accordance with the performance standards in the Storm Water Standards Manual. Some sites are additionally required to obtain coverage under the State Construction General Permit (CGP)[1] , which is administered by the State Water Resources Control Board.

For all projects complete PART A: If project is required to submit a SWPPP or WPCP, continue to PART B.

PART A: Determine Construction Phase Storm Water Requirements.

1. Is the project subject to California's statewide General NPDES permit for Storm Water Discharges Associated with Construction Activities, also known as the State Construction General Permit (CGP)? (Typically projects with land disturbance greater than or equal to 1 acre.)

   ☒ Yes; SWPPP required, skip questions 2-4 ☐ No; next question

2. Does the project propose construction or demolition activity, including but not limited to, clearing, grading, grubbing, excavation, or any other activity resulting in ground disturbance and contact with storm water runoff?

   ☐ Yes; WPCP required, skip 3-4 ☒ No; next question

3. Does the project propose routine maintenance to maintain original line and grade, hydraulic capacity, or original purpose of the facility? (Projects such as pipeline/utility replacement)

   ☐ Yes; WPCP required, skip 4 ☒ No; next question

4. Does the project only include the following Permit types listed below?

   - Electrical Permit, Fire Alarm Permit, Fire Sprinkler Permit, Plumbing Permit, Sign Permit, Mechanical Permit, Spa Permit.
   - Individual Right of Way Permits that exclusively include only ONE of the following activities: water service, sewer lateral, or utility service.
   - Right of Way Permits with a project footprint less than 150 linear feet that exclusively include only ONE of the following activities: curb ramp, sidewalk and driveway apron replacement, pot holing, curb and gutter replacement, and retaining wall encroachments.

   ☐ Yes; no document required

Check one of the boxes below, and continue to PART B:

☒ If you checked "Yes" for question 1, **a SWPPP is REQUIRED. Continue to PART B**

☐ If you checked "No" for question 1, and checked "Yes" for question 2 or 3, **a WPCP is REQUIRED.** If the project proposes less than 5,000 square feet of ground disturbance AND has less than a 5-foot elevation change over the entire project area, a Minor WPCP may be required instead. **Continue to PART B.**

☐ If you checked "No" for all questions 1-3, and checked "Yes" for question 4 PART B **does not apply and no document is required. Continue to Section 2.**

1. More information on the City's construction BMP requirements as well as CGP requirements can be found at: www.sandiego.gov/stormwater/regulations/index.shtml

PART B: Determine Construction Site Priority

This prioritization must be completed within this form, noted on the plans, and included in the SWPPP or WPCP. The city reserves the right to adjust the priority of projects both before and after construction. Construction projects are assigned an inspection frequency based on if the project has a "high threat to water quality." The City has aligned the local definition of "high threat to water quality" to the risk determination approach of the State Construction General Permit (CGP). The CGP determines risk level based on project specific sediment risk and receiving water risk. Additional inspection is required for projects within the Areas of Special Biological Significance (ASBS) watershed. **NOTE:** The construction priority does **NOT** change construction BMP requirements that apply to projects; rather, it determines the frequency of inspections that will be conducted by city staff.

Complete PART B and continued to Section 2

1. ☐ **ASBS**
   a. Projects located in the ASBS watershed.

2. ☐ **High Priority**
   a. Projects 1 acre or more determined to be Risk Level 2 or Risk Level 3 per the Construction General Permit and not located in the ASBS watershed.
   b. Projects 1 acre or more determined to be LUP Type 2 or LUP Type 3 per the Construction General Permit and not located in the ASBS watershed.

3. ☒ **Medium Priority**
   a. Projects 1 acre or more but not subject to an ASBS or high priority designation.
   b. Projects determined to be Risk Level 1 or LUP Type 1 per the Construction General Permit and not located in the ASBS watershed.

4. ☐ **Low Priority**
   a. Projects requiring a Water Pollution Control Plan but not subject to ASBS, high, or medium priority designation.

SECTION 2. Permanent Storm Water BMP Requirements.

Additional information for determining the requirements is found in the Storm Water Standards Manual.

PART C: Determine if Not Subject to Permanent Storm Water Requirements.

Projects that are considered maintenance, or otherwise not categorized as "new development projects" or "redevelopment projects" according to the Storm Water Standards Manual are not subject to Permanent Storm Water BMPs.

If "yes" is checked for any number in Part C, proceed to Part F and check "Not Subject to Permanent Storm Water BMP Requirements".

If "no" is checked for all of the numbers in Part C continue to Part D.

1.	Does the project only include interior remodels and/or is the project entirely within an existing enclosed structure and does not have the potential to contact storm water?	☐ Yes ☒ No
2.	Does the project only include the construction of overhead or underground utilities without creating new impervious surfaces?	☐ Yes ☒ No
3.	Does the project fall under routine maintenance? Examples include, but are not limited to: roof or exterior structure surface replacement, resurfacing or reconfiguring surface parking lots or existing roadways without expanding the impervious footprint, and routine replacement of damaged pavement (grinding, overlay, and pothole repair).	☐ Yes ☒ No

PART D: PDP Exempt Requirements.

PDP Exempt projects are required to implement site design and source control BMPs.

If "yes" was checked for any questions in Part D, continue to Part F and check the box labeled "PDP Exempt."

If "no" was checked for all questions in Part D, continue to Part E.

1. **Does the project ONLY include new or retrofit sidewalks, bicycle lanes, or trails that:**
   - **Are designed and constructed to direct storm water runoff to adjacent vegetated areas, or other non-erodible permeable areas? Or;**
   - **Are designed and constructed to be hydraulically disconnected from paved streets and roads? Or;**
   - **Are designed and constructed with permeable pavements or surfaces in accordance with the Green Streets guidance in the City's Storm Water Standards manual?**

   ☐ Yes; PDP exempt requirements apply ☒ No; next question

2. Does the project ONLY include retrofitting or redeveloping existing paved alleys, streets or roads designed and constructed in accordance with the Green Streets guidance in the City's Storm Water Standards Manual?

   ☐ Yes; PDP exempt requirements apply ☒ No; project not exempt.

PART E: Determine if Project is a Priority Development Project (PDP).

Projects that match one of the definitions below are subject to additional requirements including preparation of a Storm Water Quality Management Plan (SWQMP).

If "yes" is checked for any number in PART E, continue to PART F and check the box labeled "Priority Development Project".

If "no" is checked for every number in PART E, continue to PART F and check the box labeled "Standard Development Project".

1. **New Development that creates 10,000 square feet or more of impervious surfaces collectively over the project site.** This includes commercial, industrial, residential, mixed-use, and public development projects on public or private land. ☐ Yes ☒ No

2. **Redevelopment project that creates and/or replaces 5,000 square feet or more of impervious surfaces on an existing site of 10,000 square feet or more of impervious surfaces.** This includes commercial, industrial, residential, mixed-use, and public development projects on public or private land. ☐ Yes ☒ No

3. **New development or redevelopment of a restaurant.** Facilities that sell prepared foods and drinks for consumption, including stationary lunch counters and refreshment stands selling prepared foods and drinks for immediate consumption (SIC 5812), and where the land development creates and/or replace 5,000 square feet or more of impervious surface. ☐ Yes ☒ No

4. **New development or redevelopment on a hillside.** The project creates and/or replaces 5,000 square feet or more of impervious surface (collectively over the project site) and where the development will grade on any natural slope that is twenty-five percent or greater. ☐ Yes ☒ No

5. **New development or redevelopment of a parking lot that creates and/or replaces 5,000 square feet or more of impervious surface (collectively over the project site).** ☐ Yes ☒ No

6. **New development or redevelopment of streets, roads, highways, freeways, and driveways.** The project creates and/or replaces 5,000 square feet or more of impervious surface (collectively over the project site). ☐ Yes ☒ No

7. **New development or redevelopment discharging directly to an Environmentally Sensitive Area.** The project creates and/or replaces 2,500 square feet of impervious surface (collectively over project site), and discharges directly to an Environmentally Sensitive Area (ESA). "Discharging directly to" includes flow that is conveyed overland a distance of 200 feet or less from the project to the ESA, or conveyed in a pipe or open channel any distance as an isolated flow from the project to the ESA (i.e. not commingled with flows from adjacent lands). ☐ Yes ☒ No

8. **New development or redevelopment projects of a retail gasoline outlet (RGO) that create and/or replaces 5,000 square feet of impervious surface.** The development project meets the following criteria: (a) 5,000 square feet or more or (b) has a projected Average Daily Traffic (ADT) of 100 or more vehicles per day. ☐ Yes ☒ No

9. **New development or redevelopment projects of an automotive repair shops that creates and/or replaces 5,000 square feet or more of impervious surfaces.** Development projects categorized in any one of Standard Industrial Classification (SIC) codes 5013, 5014, 5541, 7532-7534, or 7536-7539. ☐ Yes ☒ No

10. **Other Pollutant Generating Project.** The project is not covered in the categories above, results in the disturbance of one or more acres of land and is expected to generate pollutants post construction, such as fertilizers and pesticides. This does not include projects creating less than 5,000 sf of impervious surface and where added landscaping does not require regular use of pesticides and fertilizers, such as slope stabilization using native plants. Calculation of the square footage of impervious surface need not include linear pathways that are for infrequent vehicle use, such as emergency maintenance access or bicycle pedestrian use, if they are built with pervious surfaces of if they sheet flow to surrounding pervious surfaces. ☐ Yes ☒ No

PART F: Select the appropriate category based on the outcomes of PART C through PART E.

1. The project is **NOT SUBJECT TO PERMANENT STORM WATER REQUIREMENTS.** ☐
2. The project is a **STANDARD DEVELOPMENT PROJECT.** Site design and source control BMP requirements apply. See the Storm Water Standards Manual for guidance. ☒
3. The project is **PDP EXEMPT.** Site design and source control BMP requirements apply. See the Storm Water Standards Manual for guidance. ☐
4. The project is a **PRIORITY DEVELOPMENT PROJECT.** Site design, source control, and structural pollutant control BMP requirements apply. See the Storm Water Standards Manual for guidance on determining if project requires a hydromodification plan management ☐

Kevin Gibson - Rick Engineering Co. — Name of Owner or Agent *(Please Print)*

Principal — Title

Signature

7/20/17 — Date

APPENDIX H

Standard Project Storm Water Quality Management Plan (SDP SWQMP)

Source Control BMP Checklist for Standard Projects			Form I-4
All development projects must implement source control BMPs SC-1 through SC-6 and. Refer to Chapter 4 and Appendix E of the BMP Design Manual for information to implement BMPs shown in this checklist. **Note: All selected BMPs must be shown on the construction plans.**			
Source Control Requirement	Applied[(1)]?		
SC-1 Prevention of Illicit Discharges into the MS4	☐ Yes	☐ No	☒ N/A
SC-2 Storm Drain Stenciling or Signage	☒ Yes	☐ No	☐ N/A
SC-3 Protect Outdoor Materials Storage Areas from Rainfall, Run-On, Runoff, and Wind Dispersal	☐ Yes	☐ No	☒ N/A
SC-4 Protect Materials Stored in Outdoor Work Areas from Rainfall, Run-On, Runoff, and Wind Dispersal	☐ Yes	☐ No	☒ N/A
SC-5 Protect Trash Storage Areas from Rainfall, Run-On, Runoff, and Wind Dispersal	☐ Yes	☐ No	☒ N/A
SC-6 BMPs based on Potential Sourcres of Runoff Pollutants			
On-site storm drain inlets	☒ Yes	☐ No	☐ N/A
Interior floor drains and elevator shaft sump pumps	☐ Yes	☐ No	☒ N/A
Interior parking garages	☐ Yes	☐ No	☒ N/A
Need for future indoor & structural pest control	☐ Yes	☐ No	☒ N/A
Landscape/Outdoor Pesticide Use	☒ Yes	☐ No	☐ N/A
Pools, spas, ponds, decorative fountains, and other water features	☐ Yes	☐ No	☒ N/A
Food service	☐ Yes	☐ No	☒ N/A
Refuse areas	☐ Yes	☐ No	☒ N/A
Industrial processes	☐ Yes	☐ No	☒ N/A
Outdoor storage of equipment or materials	☐ Yes	☐ No	☒ N/A
Vehicle/Equipment Repair and Maintenance	☐ Yes	☐ No	☒ N/A
Fuel Dispensing Areas	☐ Yes	☐ No	☒ N/A
Loading Docks	☐ Yes	☐ No	☒ N/A
Fire Sprinkler Test Water	☐ Yes	☐ No	☒ N/A
Miscellaneous Drain or Wash Water	☐ Yes	☐ No	☒ N/A
Plazas, sidewalks, and parking lots	☒ Yes	☐ No	☐ N/A
SC-6A: Large Trash Generating Facilities	☐ Yes	☐ No	☒ N/A
SC-6B: Animal Facilities	☐ Yes	☐ No	☒ N/A
SC-6C: Plant Nurseries and Garden Centers	☐ Yes	☐ No	☒ N/A
SC-6D: Automotive-related Uses	☐ Yes	☐ No	☒ N/A
Discussion / justification for **all** "No" answers shown above:			

Site Design BMP Checklist for Standard Projects				Form I-5
All development projects must implement site design BMPs SD-1 through SD-8. Refer to Chapter 4 and Appendix E of the BMP Design Manual for information to implement BMPs shown in this checklist. **Note: All selected BMPs must be shown on the construction plans.**				
Site Design Requirement	Applied[1]?			
SD-1 Maintain Natural Drainage Pathways and Hydrologic Features	☒ Yes	☐ No	☐ N/A	
SD-2 Conserve Natural Areas, Soils, and Vegetation	☐ Yes	☐ No	☒ N/A	
SD-3 Minimize Impervious Area	☒ Yes	☐ No	☐ N/A	
SD-4 Minimize Soil Compaction	☐ Yes	☐ No	☒ N/A	
SD-5 Impervious Area Dispersion	☒ Yes	☐ No	☐ N/A	
SD-6 Runoff Collection	☒ Yes	☐ No	☐ N/A	
SD-7 Landscaping with Native or Drought Tolerant Species	☒ Yes	☐ No	☐ N/A	
SD-8 Harvesting and Using Precipitation	☐ Yes	☐ No	☒ N/A	
Discussion / justification for **all** "No" answers shown above:				

[1] Answer for each source control and site design category shall be pursuant to the following:

- "Yes" means the project will implement the BMP as described in Chapter 4 and/or Appendix E of the BMP Design Manual. Discussion / justification is not required.
- "No" means the BMP is applicable to the project but it is not feasible to implement. Discussion / justification must be provided.
- "N/A" means the BMP is not applicable at the project site because the project does not include the feature that is addressed by the BMP (e.g., the project has no outdoor materials storage areas). Discussion / justification may be provided.

APPENDIX I

Green Infrastructure Calculations and Details

Water Quality Pollutant Control Sizing Calculations (2013 MS4 Permit)

Water Quality Calculations: Design Capture Volume and Treatment Flow Rate															
									85th Percentile Storm			Green Infrastructure (GI) Storm			Water Quality Event
BMP ID	DMA ID	Approximate Drainage Area (SF)	Approximate Drainage Area (ac)	Approx. % impervious	Runoff Factor Impervious (C=0.9)	Runoff Factor Pervious (C=varies)	Weighted Runoff Factor	Effective Impervious Area (ac)	P_{85} (in)	Design Capture Volume (ft^3)	*0.75 * Design Capture Volume (ft^3)*	GI Storm (in)	Design Capture Volume (ft^3)	0.75 * DCV (ft^3)	Required WQ Treatment Flow Rate, Q_T (cfs)
3	3-1	413,463	9.5	70%	0.90	0.30	0.72	6.83	0.58	18,966	*14,225*	0.50	16,350	12,263	1.802
	3-2	112,758	2.6	90%	0.90	0.30	0.84	2.17							
4-1	4-1A	41,729	1.0	70%	0.90	0.30	0.72	0.69	0.58	4,007	*3,005*	0.50	3,454	1,943	0.138
	4-1B	73,408	1.7	70%	0.90	0.30	0.72	1.21							0.243
4-2	4-2A	60,174	1.4	70%	0.90	0.30	0.72	0.99	0.58	4,697	*3,523*	0.50	4,049	3,037	0.199
	4-2B	74,808	1.7	70%	0.90	0.30	0.72	1.24							0.247
5-1	5-1A	149,030	3.4	70%	0.90	0.30	0.72	2.46	0.58	8,022	*6,016*	0.50	6,915	5,186	0.493
	5-1B	81,474	1.9	70%	0.90	0.30	0.72	1.35							0.269
5-2	5-2A	104,487	2.4	70%	0.90	0.30	0.72	1.73	0.58	5,011	*3,758*	0.50	4,319	3,240	0.345
	5-2B	39,496	0.9	70%	0.90	0.30	0.72	0.65							0.131
			26.4	**72%**							**30,527**			**25,669**	

Notes:

1. Refer to the City of San Diego Storm Water Standards Manual (October 2018) for the BF-1 Biofiltration BMP Structural BMP Fact Sheet in Appendix E.
2. A ratio of the provided volume of the proposed Green Infrastructure BMP (biofiltration basin) is compared to 75% of the required Design Capture Volume (for other projects which are subject to the Priority Development Project requirements).

BF-1: Biofiltration BMP (Bulbouts and Basin)[1]											
Provided Design											
BMP ID	Gravel (ft)	Gravel Porosity (%)	Bioretention Soil Media (BSM) + Mulch (ft)	BSM + M Porosity (%)	WQ Ponding Depth (ft)	Conveyance + Freeboard (ft)	Effective Ponding Depth (ft)	Surface Area at Basin Bottom (ft^2)	Surface Area at Ponding Depth (ft^2)	Provided Volume (ft^3)	Provided Volume / 0.75 * DCV (85th Percentile Storm)[2]
4-1	1.5	40%	1.75	30%	0.5	0.0	1.63	992	--	*1,612*	*54%*
4-2	1.5	40%	1.75	30%	0.5	0.0	1.63	1,926	--	*3,130*	*89%*
5-1	1.5	40%	1.75	30%	0.5	0.0	1.63	925	--	*1,503*	*25%*
5-2	1.5	40%	1.75	30%	0.5	0.0	1.63	1,837	--	*2,985*	*79%*
										9,230	**57%**

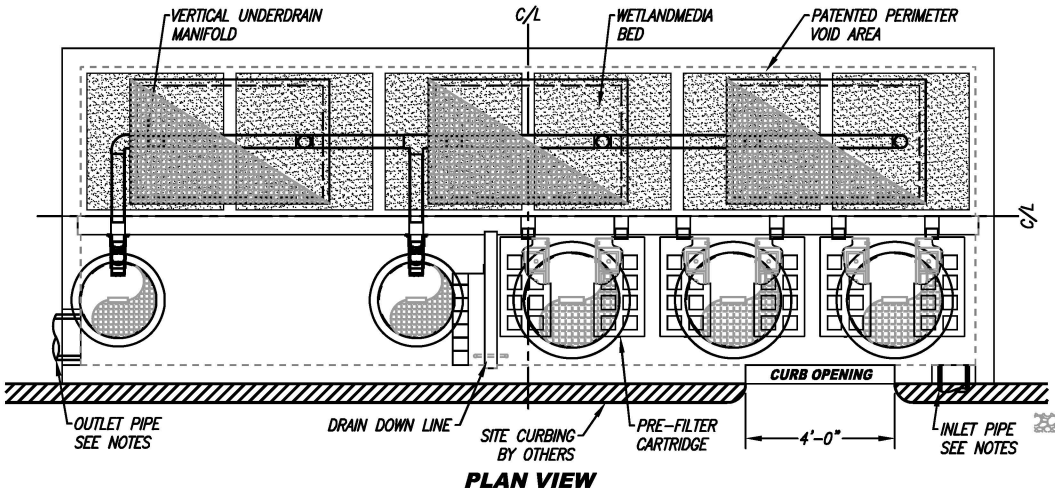
Water Quality Pollutant Control Sizing Calculations (2013 MS4 Permit)

Water Quality Calculations: Design Capture Volume and Treatment Flow Rate																Compact Biofiltration BMP [≥ Q_T (Required)]	
									85th Percentile Storm			Green Infrastructure (GI) Storm			Water Quality Event		
BMP ID	DMA ID	Approximate Drainage Area (SF)	Approximate Drainage Area (ac)	Approx. % impervious	Runoff Factor Impervious (C=0.9)	Runoff Factor Pervious (C=varies)	Weighted Runoff Factor	Effective Impervious Area (ac)	P_{85} (in)	Design Capture Volume (ft^3)	*0.75 * Design Capture Volume (ft^3)*	GI Storm (in)	Design Capture Volume (ft^3)	0.75 * DCV (ft^3)	Required WQ Treatment Flow Rate, Q_T (cfs)	Modular Wetland System (MWS) Unit No.	Provided WQ Treatment Flow Rate, Q_T (cfs)
3	3-1	413,463	9.5	70%	0.90	0.30	0.72	6.83	0.58	18,966	*14,225*	0.50	16,350	12,263	1.802	MWS-L-8-24-C-UG	0.693
	3-2	112,758	2.6	90%	0.90	0.30	0.84	2.17									
			12.1	**74%**							**14,225**			**12,263**			

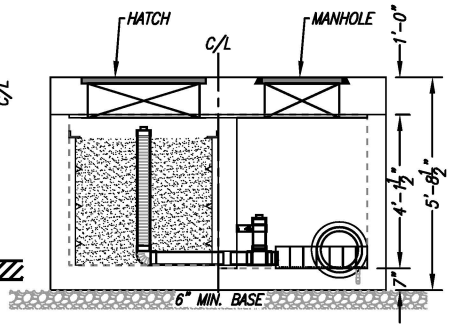
Notes:

1. Per discussion with the city of San Diego, it was decided that the largest, standard proprietary compact biofiltration unit would be selected for treatment at Site 3. This unit provides a water quality treatment flow rate of 0.639cfs.

SITE SPECIFIC DATA			
PROJECT NUMBER		10205	
PROJECT NAME		SERRA MESA GI	
PROJECT LOCATION		SAN DIEGO, CA	
STRUCTURE ID		----	
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
----		0.693	
TREATMENT HGL AVAILABLE (FT)			N/K
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			FLOW BY
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	334.00	PVC	8"
INLET PIPE 2	N/A	N/A	N/A
OUTLET PIPE	331.91	PVC	12"
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION	337.04	337.04	337.04
SURFACE LOAD	PEDESTRIAN	PEDESTRIAN	PEDESTRIAN
FRAME & COVER	3 EA ø30"	3 EA 30" X 48"	2 EA ø24"
WETLANDMEDIA VOLUME (CY)			10.24
ORIFICE SIZE (DIA. INCHES)			2 EA ø2.66"
NOTES: PRELIMINARY. NOT FOR CONSTRUCTION. ENGINEER TO VERIFY OUTLET PIPE I.E.			



PLAN VIEW



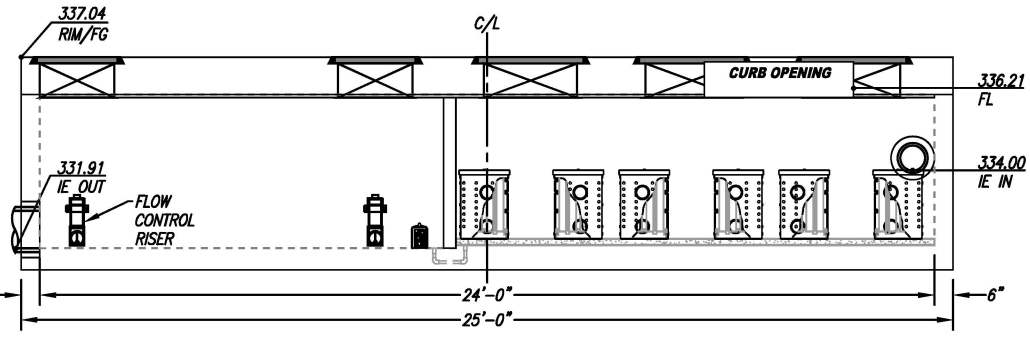
LEFT END VIEW

INSTALLATION NOTES

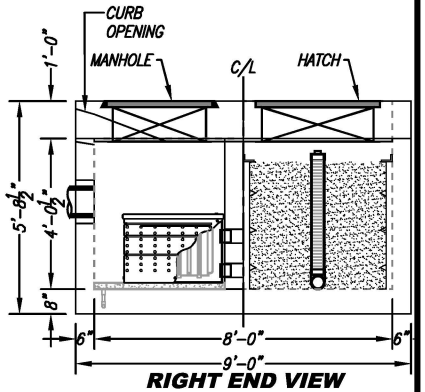
1. CONTRACTOR TO PROVIDE ALL LABOR, EQUIPMENT, MATERIALS AND INCIDENTALS REQUIRED TO OFFLOAD AND INSTALL THE SYSTEM AND APPURTENANCES IN ACCORDANCE WITH THIS DRAWING AND THE MANUFACTURERS SPECIFICATIONS, UNLESS OTHERWISE STATED IN MANUFACTURERS CONTRACT.
2. UNIT MUST BE INSTALLED ON LEVEL BASE. MANUFACTURER RECOMMENDS A MINIMUM 6" LEVEL ROCK BASE UNLESS SPECIFIED BY THE PROJECT ENGINEER. CONTRACTOR IS RESPONSIBLE TO VERIFY PROJECT ENGINEERS RECOMMENDED BASE SPECIFICATIONS.
3. ALL PIPES MUST BE FLUSH WITH INSIDE SURFACE OF CONCRETE. (PIPES CANNOT INTRUDE BEYOND FLUSH). INVERT OF OUTFLOW PIPE MUST BE FLUSH WITH DISCHARGE CHAMBER FLOOR. ALL GAPS AROUND PIPES SHALL BE SEALED WATER TIGHT WITH A NON-SHRINK GROUT PER MANUFACTURERS STANDARD CONNECTION DETAIL AND SHALL MEET OR EXCEED REGIONAL PIPE CONNECTION STANDARDS.
4. CONTRACTOR TO SUPPLY AND INSTALL ALL EXTERNAL CONNECTING PIPES.
5. CONTRACTOR RESPONSIBLE FOR INSTALLATION OF ALL RISERS, MANHOLES, AND HATCHES. CONTRACTOR TO GROUT ALL MANHOLES AND HATCHES TO MATCH FINISHED SURFACE UNLESS SPECIFIED OTHERWISE.
6. DRIP OR SPRAY IRRIGATION REQUIRED ON ALL UNITS WITH VEGETATION.
7. CONTRACTOR RESPONSIBLE FOR CONTACTING MODULAR WETLANDS FOR ACTIVATION OF UNIT. MANUFACTURES WARRANTY IS VOID WITH OUT PROPER ACTIVATION BY A MODULAR WETLANDS REPRESENTATIVE.

GENERAL NOTES

1. MANUFACTURER TO PROVIDE ALL MATERIALS UNLESS OTHERWISE NOTED.
2. ALL DIMENSIONS, ELEVATIONS, SPECIFICATIONS AND CAPACITIES ARE SUBJECT TO CHANGE. FOR PROJECT SPECIFIC DRAWINGS DETAILING EXACT DIMENSIONS, WEIGHTS AND ACCESSORIES PLEASE CONTACT MANUFACTURER.



ELEVATION VIEW



RIGHT END VIEW

TREATMENT FLOW (CFS)	0.693
OPERATING HEAD (FT)	3.4
PRETREATMENT LOADING RATE (GPM/SF)	2.0
WETLAND MEDIA LOADING RATE (GPM/SF)	1.0

MODULAR WETLANDS

THIS PRODUCT MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING US PATENTS: 7,425,262; 7,470,362; 7,674,370; 8,303,816; RELATED FOREIGN PATENTS OR OTHER PATENTS PENDING

PROPRIETARY AND CONFIDENTIAL:

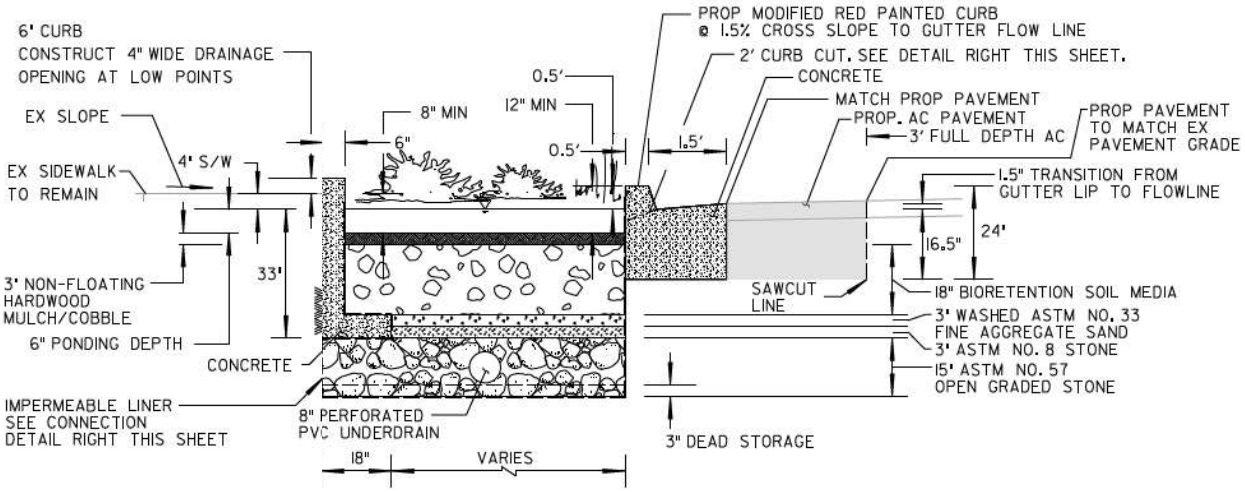
THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF MODULAR WETLANDS SYSTEMS. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF MODULAR WETLANDS SYSTEMS IS PROHIBITED.

BioClean
A Forterra Company

MWS-L-8-24-4'-0.5"-C-UG
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

12/18/19GSCHNEIDER

Biofiltration Bulb-out



BIOFILTRATION BULBOUT
CROSS-SECTION (F)
NOT TO SCALE

PLANT LEGEND			
BOTANICAL NAME	COMMON NAME	SIZE	SPACING
ANEMOPSIS CALIFORNICA	YERBA MANZA	1 GAL.	3' O.C.
LEYMUS TRITICOIDES	BEARDLESS WILD RYE	1 GAL.	2' O.C.

NOTE: SEE PLANTING DETAIL RIGHT THIS SHEET

APPENDIX J

Copy of Email from the Geotechnical Engineer Assessing Infiltration Feasibility

From: Sani Sutanto
To: Shu-wen Sharon Liu
Cc: Brendan Hastie; Kevin Gibson
Subject: RE: Serra Mesa SD/GI- Green Infrastructure Infiltration Feasibility (J-17588-G)
Date: Thursday, November 17, 2016 4:03:20 PM
Attachments: image001.png

Sharon,

At the very top of the mesa the project alignment (north of Ronda Avenue) you should be on top of Old Paralic Deposits. Depending on the age of the deposits you may be able to get partial infiltration. I doubt you would be able to get full infiltration

South of Ronda Avenue, you have a thin section of Mission Valley formation. If we are in the siltstone, we may not get any infiltration. If we are in the sandstone, we may be able to get full infiltration.

Below the Mission Valley (the southernmost of the project alignment) we will be in Stadium Conglomerate. Generally we will have close to no infiltration in this material.

I generally recommend against placing infiltration basin close to top of slope. Especially if we have filled ground which is common in this area. Without subsurface data, I would go with no infiltration design with 30-mil thick PVC geomembrane liner installed on the sides of the basin, extending up at least to the top of the underdrain layer.

Sani Sutanto
Senior Project Manager

Allied Geotechnical Engineers, Inc.
9500 Cuyamaca Street, Suite 102
Santee, CA 92071
Tel: (619) 449-5900/Fax: (619) 449-5902

From: Shu-wen Sharon Liu [mailto:SLiu@rickengineering.com]
Sent: Thursday, November 17, 2016 2:19 PM
To: Sani Sutanto (s_sutanto@alliedgeo.org)
Cc: Brendan Hastie; Kevin Gibson
Subject: Serra Mesa SD/GI- Green Infrastructure Infiltration Feasibility (J-17588-G)

Hi Sani,

I'm work with Brendan Hastie and Kevin Gibson from RICK on the Serra Mesa Storm Drain and Green Infrastructure project. Attached are two draft exhibits which illustrate the locations where we are proposing bioretention/biofiltration BMPs within the streets at the top of the slopes. We're hoping that you can help provide a brief, narrative discussion regarding full infiltration, partial infiltration, or no infiltration feasibility at these locations as well as requirements for liners on the sides or bottoms

of the BMPs. I will give you a call shortly to discuss.

Download files: https://rickengineering.sharefile.com/d-s6c4d2a73f1d41399

Thank you,
Sharon

Shu-wen (Sharon) Liu MS PE
PRINCIPAL WATER RESOURCES DESIGNER

RICK ENGINEERING COMPANY
5620 FRIARS ROAD, SAN DIEGO, CA 92110

t 619.291.0707 / d 619.688.1480
ssliu@rickengineering.com / **www.rickengineering.com**

WARNING: The information provided via electronic media is not guaranteed or warranted against any defects, including design, calculation, data translation or transmission errors or omissions.

MAP POCKET 1

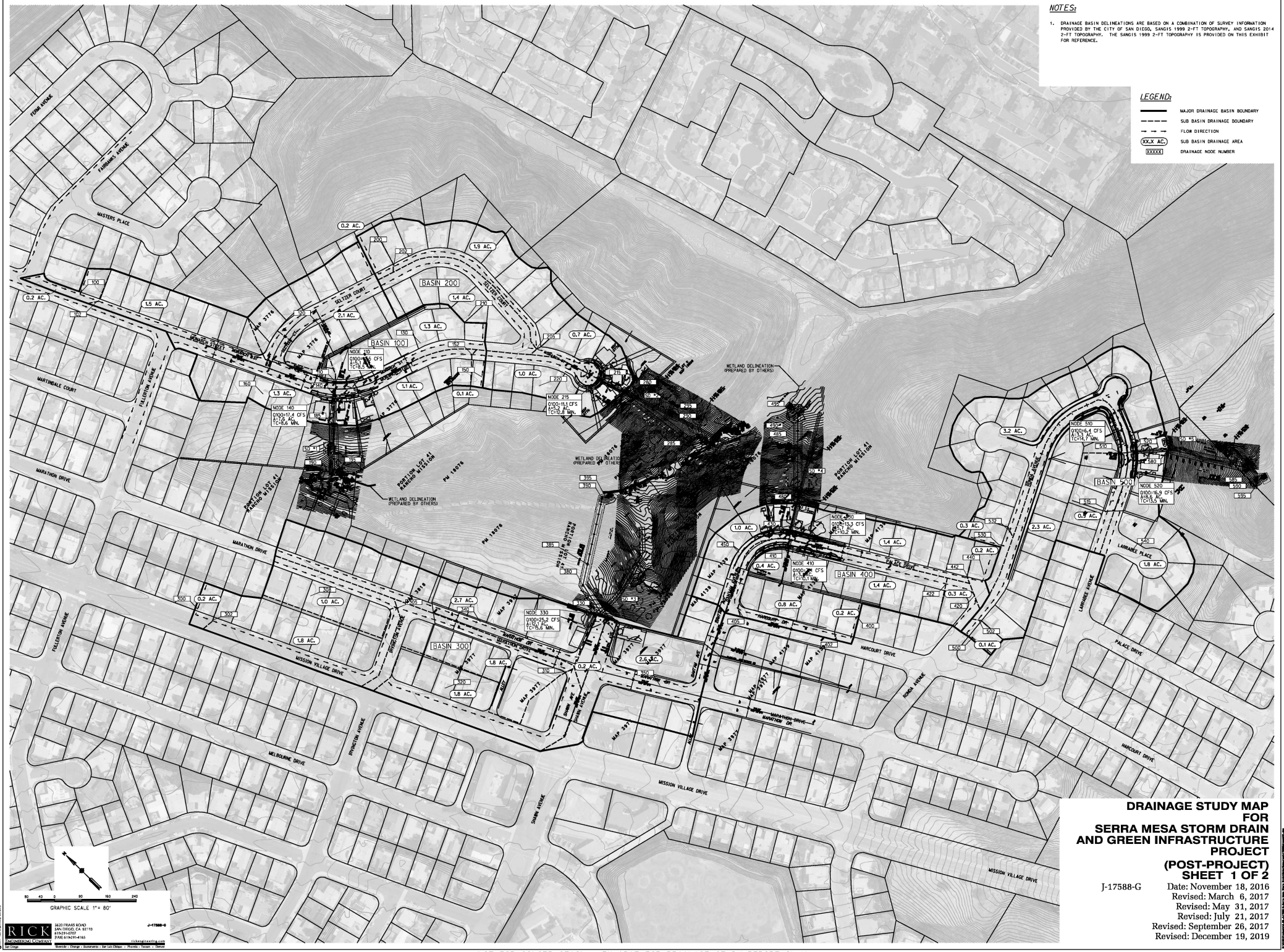
Drainage Study Map

for

Serra Mesa Storm Drain and Green Infrastructure Project

[Post-project Condition]

(2 Sheets)



DRAINAGE STUDY MAP FOR SERRA MESA STORM DRAIN AND GREEN INFRASTRUCTURE PROJECT (POST-PROJECT) SHEET 1 OF 2

J-17588-G

Date: November 18, 2016
Revised: March 6, 2017
Revised: May 31, 2017
Revised: July 21, 2017
Revised: September 26, 2017
Revised: December 19, 2019

NOT FOR CONSTRUCTION - EXHIBIT FOR DRAINAGE STUDY REPORT ONLY


NOTES:
1. DRAINAGE BASIN DELINEATIONS ARE BASED ON A COMBINATION OF SURVEY INFORMATION PROVIDED BY THE CITY OF SAN DIEGO, SANGIS 1999 2-FT TOPOGRAPHY, AND SANGIS 2014 2-FT TOPOGRAPHY. THE SANGIS 1999 2-FT TOPOGRAPHY IS PROVIDED ON THIS EXHIBIT FOR REFERENCE.
LEGEND:
MAJOR DRAINAGE BASIN BOUNDARY
SUB BASIN DRAINAGE BOUNDARY
FLOW DIRECTION
XX.X AC. SUB BASIN DRAINAGE AREA
XXXXX DRAINAGE NODE NUMBER
BASIN 700
BASIN 600
NODE 720
Q100=35.7 CFS
A=3.7 AC.
TC=31.5 MIN.
NODE 745
Q100=39.9 CFS
A=3.8 AC.
TC=31.5 MIN.
NODE 625
Q100=14.3 CFS
A=5.4 AC.
TC=10.8 MIN.
NODE 605
Q100=9.2 CFS
A=4.1 AC.
TC=10.8 MIN.
MORLEY STREET
SKIPPER STREET
EARHART STREET
ROAM PLACE
TRAVER PLACE
WALKER COURT
LARKIN PLACE
GRAPHIC SCALE 1" = 80'
RICK ENGINEERING COMPANY
5620 FRIARS ROAD
SAN DIEGO, CA 92110
619-291-0707
FAX 619-291-4165
J-17588-G
DRAINAGE STUDY MAP
FOR
SERRA MESA STORM DRAIN
AND GREEN INFRASTRUCTURE
PROJECT
(POST-PROJECT)
SHEET 2 OF 2
J-17588-G
Date: November 18, 2016
Revised: March 6, 2017
Revised: May 31, 2017
Revised: July 21, 2017
Revised: September 26, 2017
Revised: December 19, 2019
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MAP POCKET 2

Green Infrastructure Exhibit

for

Serra Mesa Storm Drain and Green Infrastructure Project

(2 Sheets)



GREEN INFRASTRUCTURE EXHIBIT FOR SERRA MESA STORM DRAIN AND GREEN INFRASTRUCTURE PROJECT

SHEET 1 OF 2

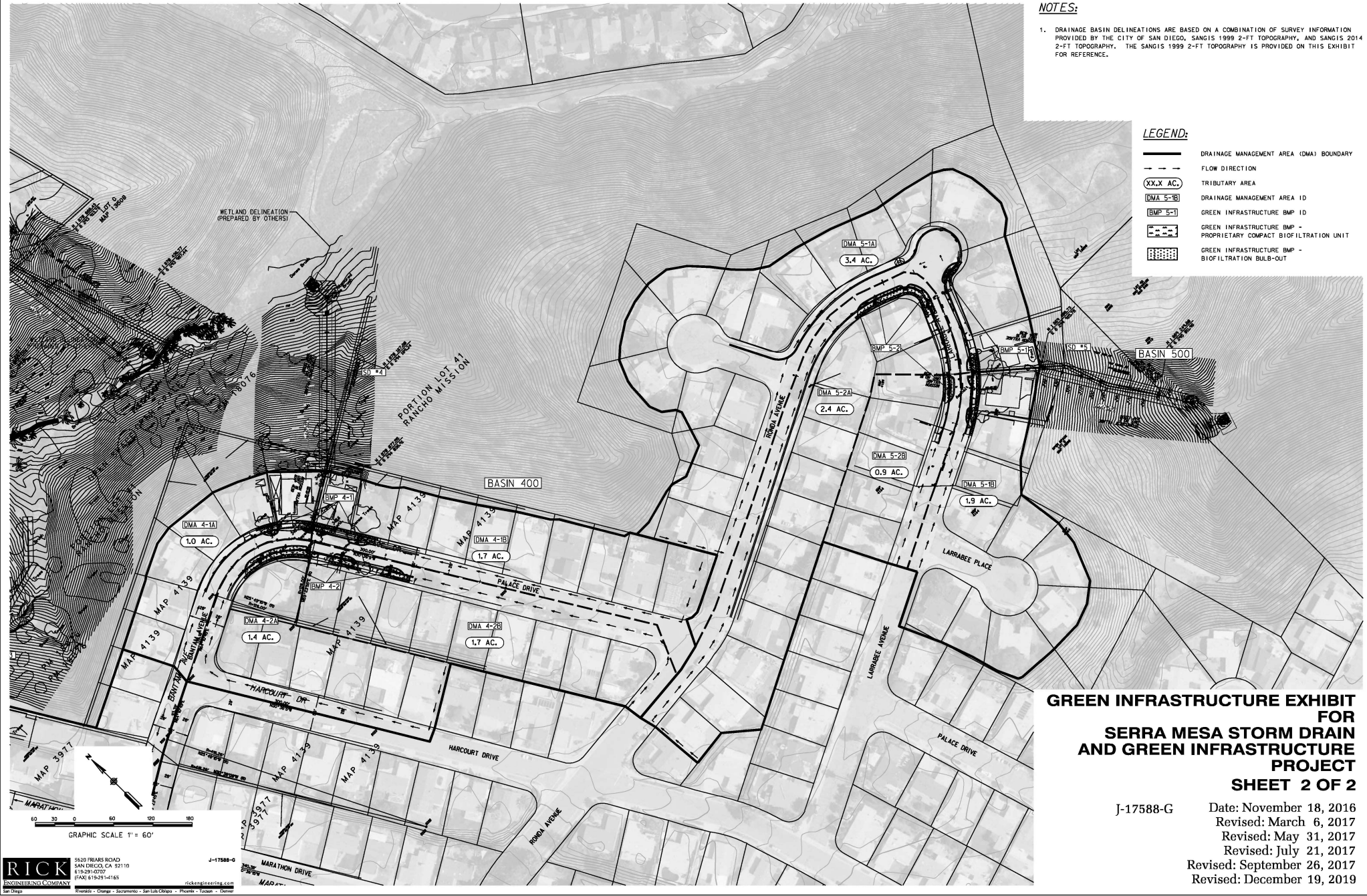
J-17588-G

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GREEN INFRASTRUCTURE EXHIBIT FOR SERRA MESA STORM DRAIN AND GREEN INFRASTRUCTURE PROJECT

SHEET 2 OF 2

J-17588-G

Date: November 18, 2016
Revised: March 6, 2017
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Revised: July 21, 2017
Revised: September 26, 2017
Revised: December 19, 2019

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