# PRELIMINARY
# HYDROLOGY AND HYDRAULICS REPORT

**For:**

## PUBLIC STORAGE SPRING VALLEY

**1247 Sweetwater Road**
**Spring Valley, CA 91977**

***Prepared for:***

**Public Storage, Inc.**
**701 Western Avenue**
**Glendale, CA 91201**

***Lead Agency:***

**County of San Diego**
**Department of Public Works**
**5201 Ruffin Road, Suite D**
**San Diego, CA 92123**

***Prepared by:***


**DRC Engineering, Inc.**
**160 South Old Springs Road, Suite 210**
**Anaheim Hills, CA 92808**
**(714) 685-6860**
**Chris Mckee, P.E.**


## DECLARATION OF RESPONSIBLE CHARGE

I HERBY DECLARE THAT I AM THE ENGINEER OF WORK FOR THIS PROJECT. THAT I HAVE EXERCISED RESPONSIBLE CHARGE OVER THE DESIGN OF THE PROJECT AS DEFINED IN SECTION 6703 OF THE BUSINESS AND PROFESSIONS CODE, AND THAT THE DESIGN IS CONSISTENT WITH CURRENT STANDARDS.

I UNDERSTAND THAT THE CHECK OF PROJECT DRAWINGS AND SPECIFICATIONS BY THE CITY OF SAN DIEGO IS CONFINED TO A REVIEW ONLY AND DOES NOT RELIEVE ME, AS ENGINEER OF WORK, OF MY RESPONSIBILITIES FOR PROJECT DESIGN.

2/2/15

CHRIS MCKEE R.C.E. 74414 DATE

REGISTERED PROFESSIONAL ENGINEER
CHRISTOPHER McKEE
No. 74414
Exp. 9-30-15
CIVIL
STATE OF CALIFORNIA

**November 3, 2014**

**DRC Project No. 14-545**


**SDC PDS RCVD 05-12-15**
**MUP82-066W2**

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- Cultec Recharger 280 Storage Volumes
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## SECTION I

### *Introduction*

The proposed project is located on approximately 3.93 acres of partially developed land at the northeast corner of Sweetwater Road and Jamacha Road in the City of Spring Valley, County of San Diego, California. The project will include the demolition of existing residential building and shed and existing driveway as well as the grading and construction of a new commercial development and associated parking lot expansion. This report has been prepared to calculate the pre-construction and post-construction hydrologic conditions for peak storm water runoff rates and time of concentration.

## SECTION II

### *Project Description*

**Existing Site Conditions:** The existing site consists of 3.93 acres of partially developed land that generally drains from the northeast towards the southwest direction. Approximately, 1.81 acres of the project site will be disturbed area. Of the disturbed area, the site is 20% impervious/80% pervious and is developed as existing residential with associated driveway and shed. Site runoff travels by overland surface flow south into a series of lined dirt swales that drain into public catch basins located in Sweetwater Road and Jamacha Road. See Existing Hydrology Map in Appendix B for illustration of existing site conditions.

**Proposed Site Development:** The proposed site consists of the removal of existing residential buildings, removal of driveway, and the construction of commercial development with associated parking lot and landscaping. The proposed improvements will cover 1.81 acres or 46% of the total site. In the proposed condition, the pervious area decreases to 17% of the site. Runoff from the proposed building and parking lot areas will be directed to a series of on-site catch basins or grated inlets. Drainage from the catch basins will flow to an underground infiltration system (Cultec Arch Pipe Chamber System). The underground infiltration system will also be used as storage to detain flows down to the allowable 100-year pre-construction levels. Overflow from the underground infiltration system will drain to the existing catch basin located on Sweetwater Road. See Proposed Hydrology Map in Appendix B for illustration of proposed site conditions. The public storm drain discharges into Sweetwater River which eventually drains into San Diego Bay and then the Pacific Ocean.

## SECTION III

### *Hydrologic Analysis*

For the existing and proposed condition, the peak storm discharges for the drainage sub-areas (see Hydrology Maps in Appendix B of this report) were calculated using the San Diego County Hydrology Manual. A soil type of D was used for the project site based on the San Diego County Soils Map (see Appendix B). Soils group D is defined as having high runoff potential. Soils having very slow infiltration rates when thoroughly wetted and consisting of chiefly clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission. The rational method equation, using AES Software (Ratscx), was used to calculate the existing and proposed 100-year storm event (see calculations in Appendix C). Hydrographs were

modeled using Rick Engineering Rational Hydrograph Program (RickRatHydro). A detention analysis was calculated using Hydraflow Hydrographs Extension version 6.066 for the proposed 100-year storm event (see calculations in Appendix C). The 100-Year 6-hour rainfall was determined to be 2.8" and the 100-Year 24 hour rainfall was determined to be 5.2" per San Diego County Hydrology Manual Isopluvial Maps.

**Existing Conditions:** The hydrologic analysis for the existing site was performed by analyzing a total of eight drainage areas. The longest existing flow path for each of the drainage areas was selected and an average slope of the path calculated. See the Existing Hydrology Map in Appendix B. The results of the drainage area calculations are located in Appendix B and are summarized in Table A below.

**Proposed Conditions:** The hydrologic analysis for the proposed site was performed by analyzing four drainage areas. The longest existing flow path for the drainage area was selected and an average slope of the path calculated. See the Proposed Hydrology Map in Appendix B. The results of the drainage area calculations are located in Appendix B and are summarized in Table A below.

**TABLE A: 100-YEAR STORM SUMMARY TABLE**

| | EXISTING | PROPOSED |
|---|---|---|
| **Flowrate** | 3.33 cfs | 7.36 cfs |
| **Tc** | 10.86 mins. | 8.48 mins. |
| **Volume Required for Hydromod.** | ___ | 7,378 cf |
| **Volume Required for Pre vs. Post Detention** | ___ | 6,224 cf |
| **Flowrate after Detention** | ___ | 3.101 cfs |

## SECTION IV

### *Detention Analysis*

The proposed site meets all of the requirements to be considered for design to urban flood protection standards. A detention analysis was therefore conducted for the 100 year storm event to ensure that discharge does not exceed the pre-construction 100-year peak flow rate of 3.33 cfs. RickRatHydro was utilized to generate 100-year hydrographs for the proposed drainage areas. Hydroflow Hydrographs used this hydrograph information to generate a peak discharge rate for the proposed storm drain system. A proposed underground infiltration/detention system will be provided with Cultec Arch Pipe Infiltration System located on the south side of the parking lot. The bottom 12" of rock section (40% voids) will be used for infiltration, the bottom 14" of the underground system will be used for detention for hydromodification, while the top 12.5" of pipe plus top 6" of rock section will be used for detention for the difference in 100-year pre versus post construction volumes. The

underground system will include 245 chambers with a 6" thick rock section (40% voids) above, 12" thick rock section (40% voids) below, and 26.5" high arch pipes. A one foot wide band of rock will also surround the underground system. With the proposed detention system, the peak discharge rate for the disturbed area (1.81 acres) will be reduced from 7.36 cfs to 3.10 cfs < 3.33 cfs allowable. The required storage volume for hydromodification is 7,378 cf. The required storage volume for the difference in 100-year pre versus post construction is 6,224 cf. The total storage volume provided is 7,681.86 cf and 6,624.40 cf for a total of 14,306.26 cf. A summary of the detention calculations has been prepared and included in Appendix C.

## SECTION V

### *Conclusions*

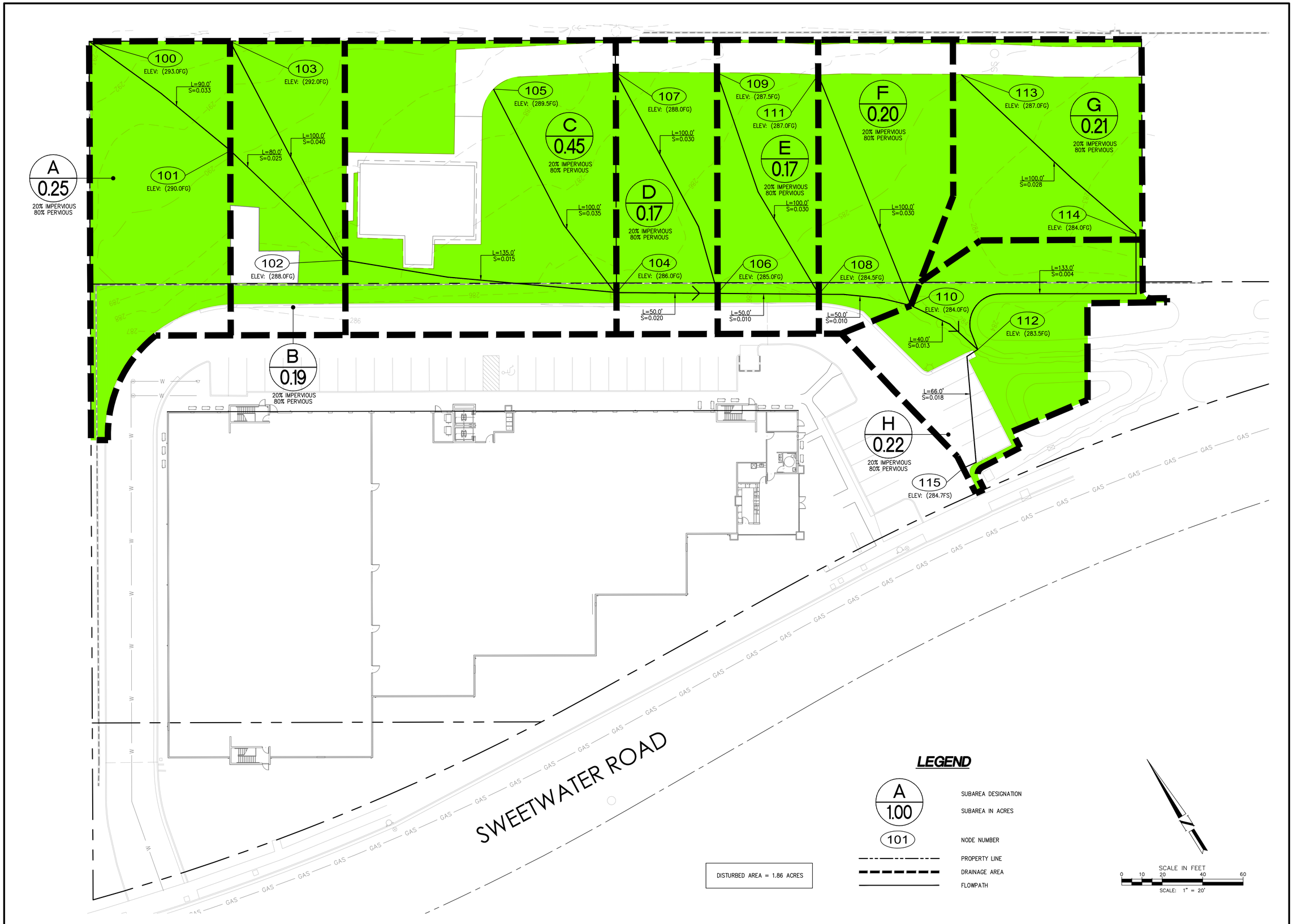
The proposed site is designed to convey the 100-year peak runoff from the site into the public infrastructure without damaging the proposed site or the downstream public facilities. The existing project site discharges stormwater into the public right of way on Sweetwater Road and Jamacha Road. The proposed site will be designed to discharge storm water to the public storm drain on Sweetwater Road. The project will discharge runoff from the site at a rate below the allowable 100-year storm in the existing condition. The site will contain several design systems to ensure that the stormwater is discharge into the public facilities prior to flooding/damaging the proposed buildings or risk damage to any of the adjacent structures.

# *APPENDIX A*

LOCATION MAP

## *APPENDIX B*

Existing Hydrology Map
Proposed Hydrology Map
San Diego County Soils Map
San Diego County Rainfall Maps
San Diego County Isopluvial Maps





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DRC Engineering, Inc.
Civil Engineering/Land Surveying/Land Planning


NOT FOR CONSTRUCTION

| NO.: | REVISION: | DATE: |
|---|---|---|
| | | |

PROJECT: **PUBLIC STORAGE**
**1247 SWEETWATER ROAD**
**SPRING VALLEY, CALIFORNIA**

DRAWING NAME: **EXISTING HYDROLOGY MAP**

| | |
|---|---|
| ISSUE: | PRELIM |
| DATE: | 10/20/14 |
| CHECKED: CM | DRAWN: LS |
| DRAWING FILE: | 14404HMEX |
| PROJECT NO.: | 14-545 |
| SHEET NUMBER: | 1 |
| OF 1 | SHEETS |
| SCALE: | AS SHOWN |

EXTERNAL REFERENCES: 14-545 BT 14-545 Brady 15-545 CT
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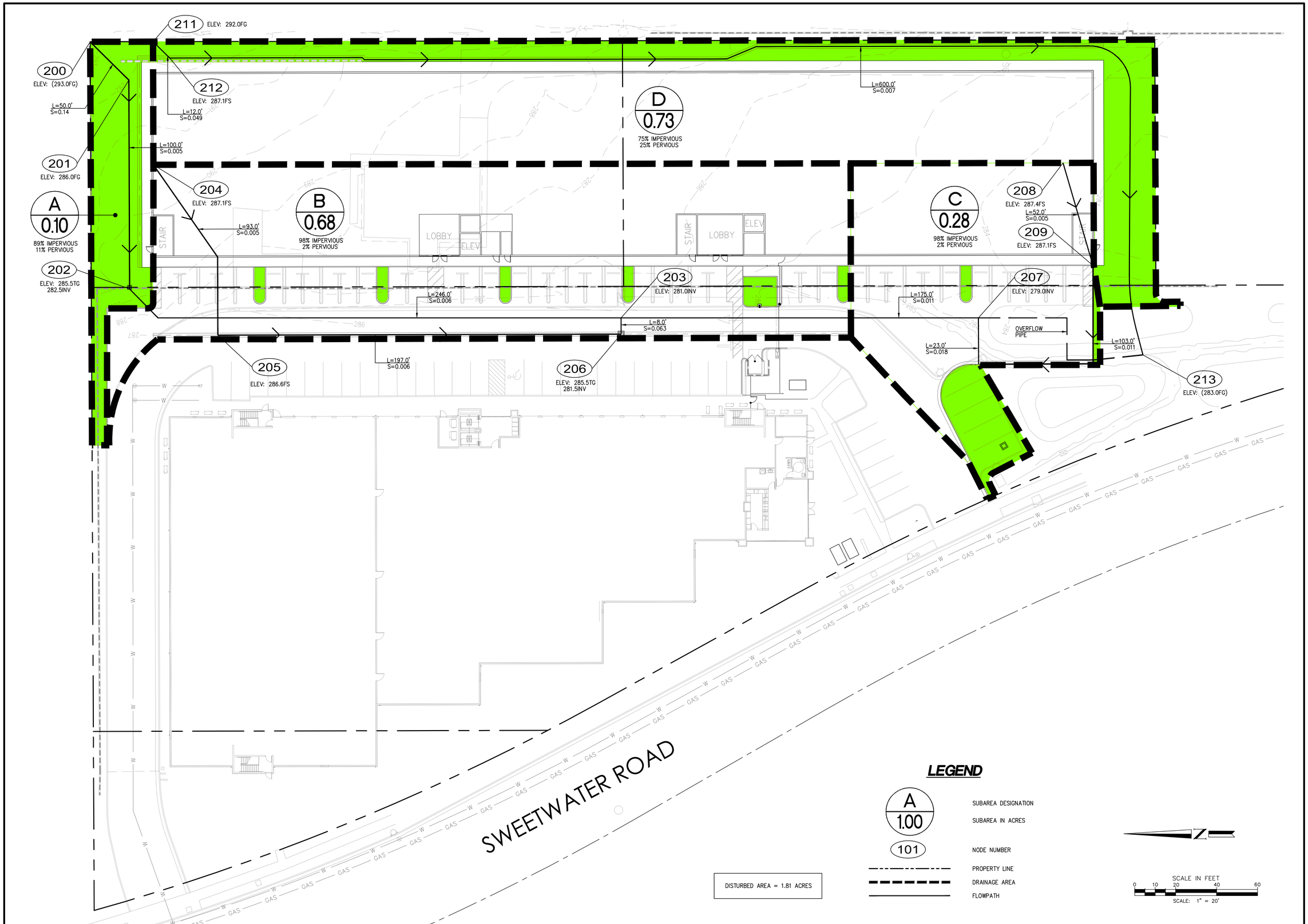


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Civil Engineering/Land Surveying/Land Planning


| NO.: | REVISION: | DATE: |
|---|---|---|
| | | |

PROJECT: **PUBLIC STORAGE**
**1247 SWEETWATER ROAD**
**SPRING VALLEY, CALIFORNIA**

DRAWING NAME: **PROPOSED HYDROLOGY MAP**

| | |
|---|---|
| ISSUE: | PRELIM |
| DATE: | 03/31/15 |
| CHECKED: CM | DRAWN: LS |
| DRAWING FILE: | 14404HMEX |
| PROJECT NO.: | 14-545 |
| SHEET NUMBER: | 1 |
| OF 1 | SHEETS |
| SCALE: | AS SHOWN |

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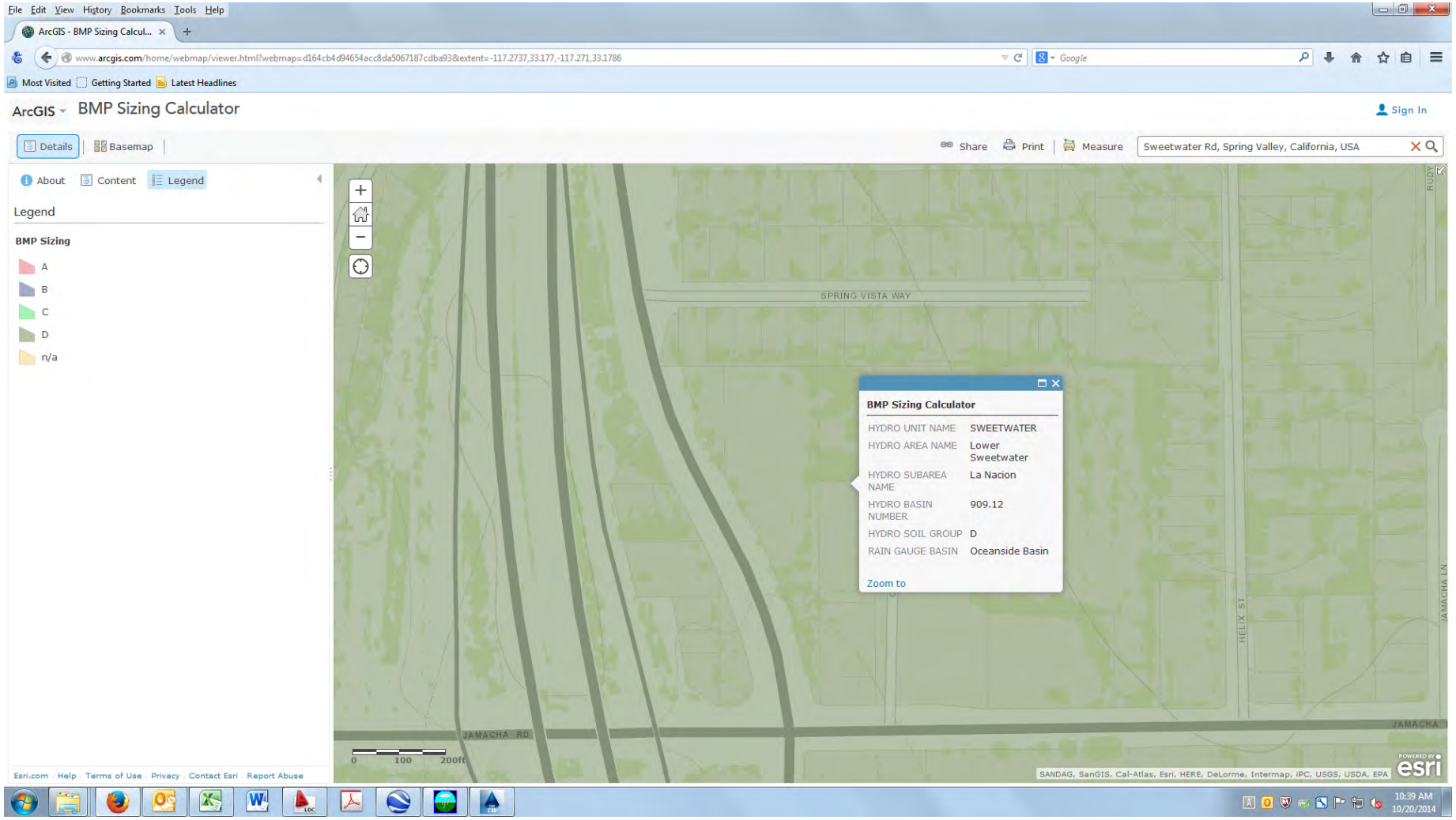
File Edit View History Bookmarks Tools Help
ArcGIS - BMP Sizing Calcul...
www.arcgis.com/home/webmap/viewer.html?webmap=d164cb4d94654acc8da5067187cdba93&extent=-117.2737,33.177,-117.271,33.1786
Most Visited Getting Started Latest Headlines
ArcGIS BMP Sizing Calculator
Sign In
Details Basemap
Share Print Measure
Sweetwater Rd, Spring Valley, California, USA
About Content Legend
Legend
BMP Sizing
A
B
C
D
n/a
SPRING VISTA WAY
JAMACHA RD
HELIX ST
JAMACHA LN
BMP Sizing Calculator
HYDRO UNIT NAME SWEETWATER
HYDRO AREA NAME Lower Sweetwater
HYDRO SUBAREA NAME La Nacion
HYDRO BASIN NUMBER 909.12
HYDRO SOIL GROUP D
RAIN GAUGE BASIN Oceanside Basin
Zoom to
0 100 200ft
SANDAG, SanGIS, Cal-Atlas, Esri, HERE, DeLorme, Intermap, iPC, USGS, USDA, EPA
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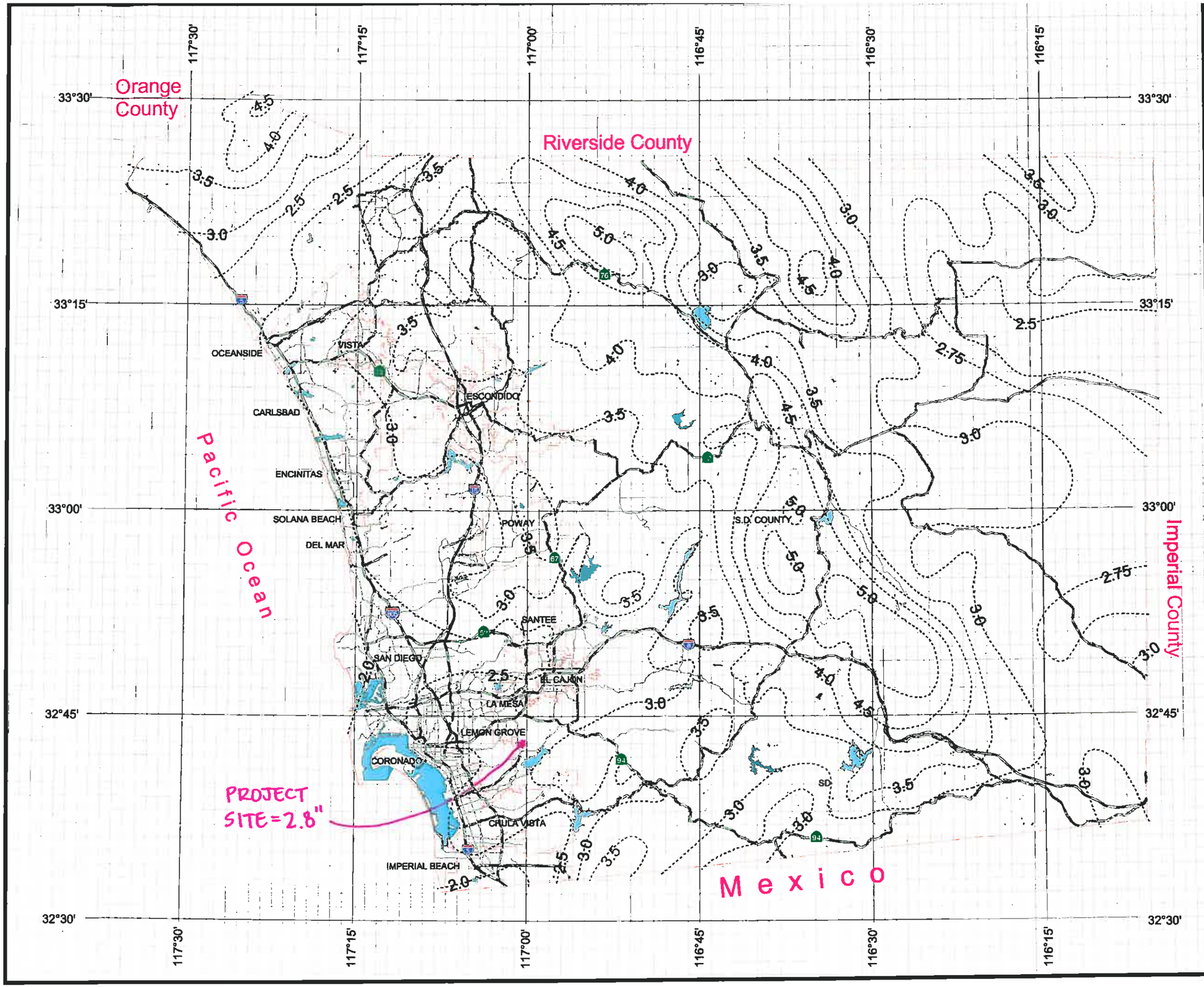
10:39 AM
10/20/2014

# County of San Diego Hydrology Manual

*Rainfall Isopluvials*

**100 Year Rainfall Event - 6 Hours**

Isopluvial (inches)




DPW GIS
Department of Public Works Geographic Information Services

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N
W E
S

3 0 3 Miles

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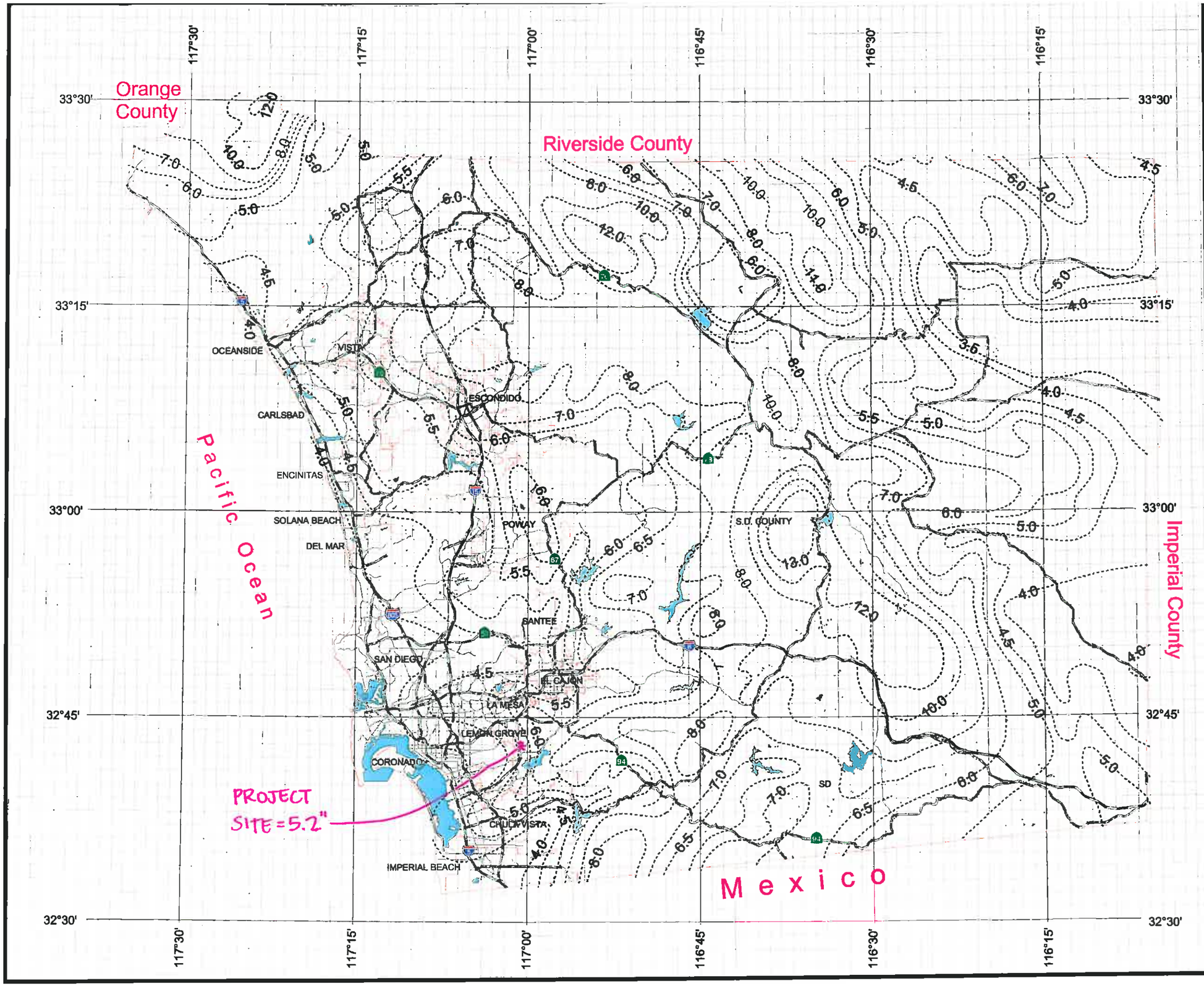
# County of San Diego Hydrology Manual

*Rainfall Isopluvials*

**100 Year Rainfall Event - 24 Hours**

Isopluvial (inches)

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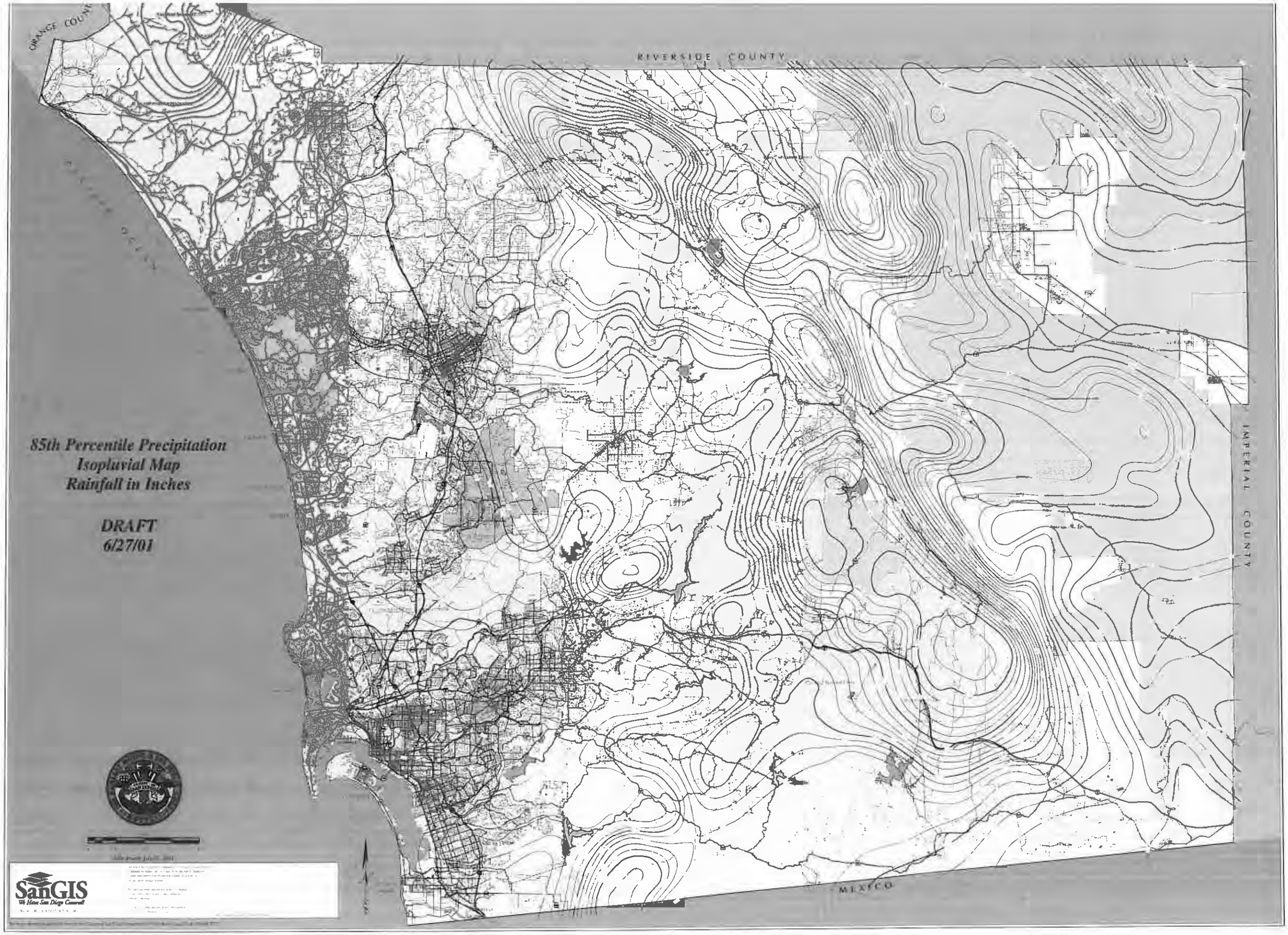
3 0 3 Miles


ORANGE COUNTY
RIVERSIDE COUNTY
IMPERIAL COUNTY
MEXICO
85th Percentile Precipitation
Isopluvial Map
Rainfall in Inches
DRAFT
6/27/01
SanGIS
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PROJECT SITE = 0.65"

# *APPENDIX C*

San Diego County BMP Sizing Spreadsheets
Cultec Recharger 280 Storage Volumes
Detention Analysis Summary

| BMP Sizing Spreadsheet V1.04 | | | |
|---|---|---|---|
| Project Name: | Public Storage Spring Valley | Hydrologic Unit: | Sweetwater |
| Project Applicant: | DRC Engineering | Rain Gauge: | Oceanside |
| Jurisdiction: | San Diego County | Total Project Area: | 78990 |
| Parcel (APN): | | Low Flow Threshold: | 0.3Q2 |
| BMP Name: | IMP 1 | BMP Type: | Bioretention Plus Vault |
| BMP Native Soil Type: | D | BMP Infiltration Rate (in/hr): | 0.024 |

| Areas Draining to BMP | | | | | | HMP Sizing Factors | | | Minimum BMP Size | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DMA Name | Area (sf) | Soil Type | Slope | Post Project Surface Type | Runoff Factor (Table 4-2) | Bioretention Surface Area | Vault Volume | N/A | Bioretention Surface Area (sf) | Vault Volume (cf) | N/A |
| DA 1 | 2820 | D | Flat | Landscape | 0.1 | 0.04 | 0.14 | N/A | 11 | 39 | N/A |
| DA 2 | 3070 | D | Flat | Landscape | 0.1 | 0.04 | 0.14 | N/A | 12 | 43 | N/A |
| DA 3 | 2240 | D | Flat | Landscape | 0.1 | 0.04 | 0.14 | N/A | 9 | 31 | N/A |
| DA 4A | 1740 | D | Flat | Landscape | 0.1 | 0.04 | 0.14 | N/A | 7 | 24 | N/A |
| DA 4B | 6230 | D | Flat | Asphalt | 1.0 | 0.04 | 0.14 | N/A | 249 | 872 | N/A |
| DA 5A | 1250 | D | Flat | Landscape | 0.1 | 0.04 | 0.14 | N/A | 5 | 18 | N/A |
| DA 5B | 4400 | D | Flat | Asphalt | 1.0 | 0.04 | 0.14 | N/A | 176 | 616 | N/A |
| DA 6 | 5840 | D | Flat | Roof | 1.0 | 0.04 | 0.14 | N/A | 234 | 818 | N/A |
| DA 7 | 4560 | D | Flat | Roof | 1.0 | 0.04 | 0.14 | N/A | 182 | 638 | N/A |
| DA 8 | 5190 | D | Flat | Roof | 1.0 | 0.04 | 0.14 | N/A | 208 | 727 | N/A |
| DA 9 | 5015 | D | Flat | Roof | 1.0 | 0.04 | 0.14 | N/A | 201 | 702 | N/A |
| DA 10 | 4730 | D | Flat | Roof | 1.0 | 0.04 | 0.14 | N/A | 189 | 662 | N/A |
| DA 11 | 3795 | D | Flat | Roof | 1.0 | 0.04 | 0.14 | N/A | 152 | 531 | N/A |
| DA 12 | 5915 | D | Flat | Roof | 1.0 | 0.04 | 0.14 | N/A | 237 | 828 | N/A |
| DA 13 | 5915 | D | Flat | Roof | 1.0 | 0.04 | 0.14 | N/A | 237 | 828 | N/A |
| Total BMP Area | 62710 | | | | | | | Minimum BMP Size | 2108.08 | 7378 | |
| | | | | | | | | Proposed BMP Size* | | N/A | N/A |
| | | | | | | | | | | 18.00 | in |
| | | | | | | | | Minimum Vault Depth | | N/A | in |
| | | | | | | | | Maximum Vault Depth | | N/A | in |
| | | | | | | | | Selected Vault Depth | | 6.00 | in |
| | | | | | | | | Selected Vault Volume | | | cubic feet |

STORMWATER TREATMENT
VOLUME REQUIRED = 3,616 CF FROM SEPARATE
CALCULATION PER COUNTY SUSMP CHAPTER 4

HYDROMODIFICATION
VOLUME REQUIRED (CF)

Describe the BMP's in sufficient detail in your SWMP to demonstrate the area, volume, and other criteria can be met within the constraints of the site.

BMP's must be adapted and applied to the conditions specific to the development project such as unstable slopes or the lack of available head.
Designated Staff have final review and approval authority over the project design.

This Sizing Calculator has been developed in compliance with the Countywide Model SUSMP. For questions or concerns please contact the jurisdiction in which your project is located.

| BMP Sizing Spreadsheet V1.04 | | | |
|---|---|---|---|
| Project Name: | ublic Storage Spring Vall | Hydrologic Unit: | Sweetwater |
| Project Applicant: | DRC Engineering | Rain Gauge: | Oceanside |
| Jurisdiction: | San Diego County | Total Project Area: | 78990 |
| Parcel (APN): | | Low Flow Threshold: | 0.3Q2 |
| BMP Name | IMP 1 | BMP Type: | Bioretention Plus Vault |

| DMA Name | Rain Gauge | Existing Condition | | | Q2 Sizing Factor (cfs/ac) | DMA Area (ac) | Orifice Flow - $\%Q_2$ (cfs) | **Orifice Area (in2)** |
|---|---|---|---|---|---|---|---|---|
| | | Soil Type | Cover | Slope | | | | |
| DA 1 | Oceanside | D | Scrub | Flat | 0.175 | 0.065 | 0.003 | **0.16** |
| DA 2 | Oceanside | D | Scrub | Flat | 0.175 | 0.070 | 0.004 | **0.17** |
| DA 3 | Oceanside | D | Scrub | Flat | 0.175 | 0.051 | 0.003 | **0.13** |
| DA 4A | Oceanside | D | Scrub | Flat | 0.175 | 0.040 | 0.002 | **0.10** |
| DA 4B | Oceanside | D | Urban | Flat | | 0.143 | | |
| DA 5A | Oceanside | D | Scrub | Flat | 0.175 | 0.029 | 0.002 | **0.07** |
| DA 5B | Oceanside | D | Urban | Flat | | 0.101 | | |
| DA 6 | Oceanside | D | Urban | Flat | | 0.134 | | |
| DA 7 | Oceanside | D | Urban | Flat | | 0.105 | | |
| DA 8 | Oceanside | D | Urban | Flat | | 0.119 | | |
| DA 9 | Oceanside | D | Urban | Flat | | 0.115 | | |
| DA 10 | Oceanside | D | Urban | Flat | | 0.109 | | |
| DA 11 | Oceanside | D | Urban | Flat | | 0.087 | | |
| DA 12 | Oceanside | D | Urban | Flat | | 0.136 | | |
| DA 13 | Oceanside | D | Urban | Flat | | 0.136 | | |

| **0.013** | **0.63** | **0.90** |
|---|---|---|
| **Tot. Allowable Orifice Flow (cfs)** | **Tot. Allowable Orifice Area (in2)** | **Max Orifice Diameter (in)** |

| **0.010** | **0.44** | **0.75** |
|---|---|---|
| Actual Orifice Flow (cfs) | Actual Orifice Area (in2) | Selected Orifice Diameter (in) |

| Drawdown (Hrs) | |
|---|---|

CULTEC, Inc.
P.O. Box 280
Brookfield, CT 06804

Phone: 203-775-4416
Fax: 203-775-1462
www.cultec.com
custservice@cultec.com

CULTEC

| | |
|---|---|
| Number of chambers - | 245 |
| Stone Void - | 0.40 |
| Base of Stone Elevation - | 279.00 |

Given: 12" stone base
6" stone above units
52" center to center

# CULTEC Recharger 280 Incremental Storage Volumes

| Height of System (in) | Chamber Ht (in) | Incremental Chamber ($ft^3$) | Incremental Stone ($ft^3$) | Incremental Chamber & Stone ($ft^3$) | Cumulative Storage per Chamber ($ft^3$) | Cumulative Storage for System ($ft^3$) | Elevation |
|---|---|---|---|---|---|---|---|
| 44.5 | | 0.00 | 1.01 | 1.01 | 70.53 | 17278.93 | 282.71 |
| 43.5 | | 0.00 | 1.01 | 1.01 | 69.52 | 17031.21 | 282.63 |
| 42.5 | | 0.00 | 1.01 | 1.01 | 68.50 | 16783.49 | 282.54 |
| 41.5 | | 0.00 | 1.01 | 1.01 | 67.49 | 16535.76 | 282.46 |
| 40.5 | | 0.00 | 1.01 | 1.01 | 66.48 | 16288.04 | 282.38 |
| 39.5 | | 0.00 | 1.01 | 1.01 | 65.47 | 16040.32 | 282.29 |
| 38.5 | 26.5 | 0.00 | 0.51 | 0.51 | 64.46 | 15792.60 | 282.21 |
| 38 | 26 | 0.13 | 0.96 | 1.09 | 63.95 | 15668.74 | 282.17 |
| 37 | 25 | 0.33 | 0.88 | 1.21 | 62.87 | 15402.49 | 282.08 |
| 36 | 24 | 0.70 | 0.73 | 1.43 | 61.66 | 15106.41 | 282.00 |
| 35 | 23 | 0.94 | 0.64 | 1.57 | 60.23 | 14755.78 | 281.92 |
| 34 | 22 | 1.11 | 0.57 | 1.68 | 58.65 | 14370.18 | 281.83 |
| 33 | 21 | 1.25 | 0.51 | 1.76 | 56.97 | 13958.84 | 281.75 |
| 32 | 20 | 1.37 | 0.47 | 1.83 | 55.21 | 13526.93 | 281.67 |
| 31 | 19 | 1.46 | 0.43 | 1.89 | 53.38 | 13078.55 | 281.58 |
| 30 | 18 | 1.55 | 0.39 | 1.94 | 51.49 | 12615.77 | 281.50 |
| 29 | 17 | 1.62 | 0.36 | 1.99 | 49.55 | 12140.64 | 281.42 |
| 28 | 16 | 1.69 | 0.34 | 2.02 | 47.57 | 11654.19 | 281.33 |
| 27 | 15 | 1.74 | 0.31 | 2.06 | 45.54 | 11158.48 | 281.25 |
| 26 | 14 | 1.84 | 0.27 | 2.12 | 43.49 | 10654.53 | 281.17 |
| 25 | 13 | 1.87 | 0.26 | 2.13 | 41.37 | 10136.18 | 281.08 |
| 24 | 12 | 1.90 | 0.25 | 2.15 | 39.24 | 9613.72 | 281.00 |
| 23 | 11 | 1.93 | 0.24 | 2.17 | 37.09 | 9087.14 | 280.92 |
| 22 | 10 | 1.95 | 0.23 | 2.18 | 34.92 | 8556.44 | 280.83 |
| 21 | 9 | 2.01 | 0.21 | 2.22 | 32.74 | 8021.63 | 280.75 |
| 20 | 8 | 2.04 | 0.19 | 2.24 | 30.52 | 7478.58 | 280.67 |
| 19 | 7 | 2.06 | 0.19 | 2.25 | 28.29 | 6930.39 | 280.58 |
| 18 | 6 | 2.14 | 0.16 | 2.29 | 26.04 | 6380.14 | 280.50 |
| 17 | 5 | 2.14 | 0.15 | 2.30 | 23.75 | 5818.58 | 280.42 |
| 16 | 4 | 2.16 | 0.15 | 2.30 | 21.45 | 5255.98 | 280.33 |
| 15 | 3 | 2.17 | 0.14 | 2.31 | 19.15 | 4691.33 | 280.25 |
| 14 | 2 | 2.18 | 0.14 | 2.32 | 16.84 | 4124.61 | 280.17 |
| 13 | 1 | 2.28 | 0.10 | 2.38 | 14.51 | 3555.84 | 280.08 |
| 12 | | 0.00 | 1.01 | 1.01 | 12.13 | 2972.67 | 280.00 |
| 11 | | 0.00 | 1.01 | 1.01 | 11.12 | 2724.94 | 279.92 |
| 10 | | 0.00 | 1.01 | 1.01 | 10.11 | 2477.22 | 279.83 |
| 9 | | 0.00 | 1.01 | 1.01 | 9.10 | 2229.50 | 279.75 |
| 8 | | 0.00 | 1.01 | 1.01 | 8.09 | 1981.78 | 279.67 |
| 7 | | 0.00 | 1.01 | 1.01 | 7.08 | 1734.06 | 279.58 |
| 6 | | 0.00 | 1.01 | 1.01 | 6.07 | 1486.33 | 279.50 |
| 5 | | 0.00 | 1.01 | 1.01 | 5.06 | 1238.61 | 279.42 |
| 4 | | 0.00 | 1.01 | 1.01 | 4.04 | 990.89 | 279.33 |
| 3 | | 0.00 | 1.01 | 1.01 | 3.03 | 743.17 | 279.25 |
| 2 | | 0.00 | 1.01 | 1.01 | 2.02 | 495.44 | 279.17 |
| 1 | | 0.00 | 1.01 | 1.01 | 1.01 | 247.72 | 279.08 |
| ***TOTALS*** | | **42.55** | **27.97** | **70.53** | **70.53** | **17278.93** | |

VOLUME PROVIDED FOR HYDROMOD = 7681.86 CF

VOLUME REQUIRED = 7,378 CF

7,681.86 CF > 7,378 CF ✓

Created on: 3/30/2015

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# *APPENDIX D*

San Diego County 100-Year Storm Calculations
San Diego County 100-Year Storm Hydrograph
Runoff Coefficient Calculations
Hydroflow Hydrograph Calculations
Cultec Recharger 280 Storage Volumes
Pre-Construction vs. Post-Construction 100-year Summary

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

            RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
            Reference: SAN DIEGO COUNTY FLOOD CONTROL DISTRICT
                         2003,1985,1981 HYDROLOGY MANUAL
         (c) Copyright 1982-2008 Advanced Engineering Software (aes)
             Ver. 15.0 Release Date: 04/01/2008  License ID 1510

                           Analysis prepared by:

                           DRC Engineering, Inc.
                    160 South Old Springs Road, Suite 210
                           Anaheim Hills, CA 92808
                                714-685-6860

 ************************** DESCRIPTION OF STUDY **************************
* 14-545 SPRING VALLEY                                                     *
* EXISTING CONDITION                                                       *
* 100 YEAR                                                                 *
 ***************************************************************************

  FILE NAME: 4545E100.DAT
  TIME/DATE OF STUDY: 14:58 10/30/2014
----------------------------------------------------------------------------
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
----------------------------------------------------------------------------
  2003 SAN DIEGO MANUAL CRITERIA

  USER SPECIFIED STORM EVENT(YEAR) = 100.00
  6-HOUR DURATION PRECIPITATION (INCHES) =   2.800
  SPECIFIED MINIMUM PIPE SIZE(INCH) =  12.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.90
  SAN DIEGO HYDROLOGY MANUAL "C"-VALUES USED FOR RATIONAL METHOD
  NOTE: USE MODIFIED RATIONAL METHOD PROCEDURES FOR CONFLUENCE ANALYSIS
  *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   30.0     20.0    0.018/0.018/0.020   0.67    2.00 0.0313 0.167 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  0.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*

+--------------------------------------------------------------------------+
| AREA A                                                                   |
|                                                                          |
|                                                                          |
+--------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE    100.00 TO NODE    101.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
```

```
  RESIDENTIAL (2. DU/AC OR LESS) RUNOFF COEFFICIENT = .3800
  SOIL CLASSIFICATION IS "B"
  S.C.S. CURVE NUMBER (AMC II) =  68
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    90.00
  UPSTREAM ELEVATION(FEET) =    293.00
  DOWNSTREAM ELEVATION(FEET) =    290.00
  ELEVATION DIFFERENCE(FEET) =      3.00
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    8.231
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.349
  SUBAREA RUNOFF(CFS) =      0.51
  TOTAL AREA(ACRES) =      0.25   TOTAL RUNOFF(CFS) =      0.51

+----------------------------------------------------------------------+
| AREA B                                                               |
|                                                                      |
|                                                                      |
+----------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE    101.00 TO NODE    102.00 IS CODE =  51
----------------------------------------------------------------------------
  >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    290.00  DOWNSTREAM(FEET) =    288.00
  CHANNEL LENGTH THRU SUBAREA(FEET) =    80.00   CHANNEL SLOPE =  0.0250
  CHANNEL BASE(FEET) =    6.00   "Z" FACTOR =  50.000
  MANNING'S FACTOR = 0.020   MAXIMUM DEPTH(FEET) =   1.00
  CHANNEL FLOW THRU SUBAREA(CFS) =       0.51
  FLOW VELOCITY(FEET/SEC.) =   1.24   FLOW DEPTH(FEET) =   0.05
  TRAVEL TIME(MIN.) =   1.08   Tc(MIN.) =    9.31
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    102.00 =     170.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    102.00 TO NODE    102.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =    9.31
  RAINFALL INTENSITY(INCH/HR) =   4.94
  TOTAL STREAM AREA(ACRES) =     0.25
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      0.51

****************************************************************************
  FLOW PROCESS FROM NODE    103.00 TO NODE    102.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  RESIDENTIAL (2. DU/AC OR LESS) RUNOFF COEFFICIENT = .3800
  SOIL CLASSIFICATION IS "B"
  S.C.S. CURVE NUMBER (AMC II) =  68
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
  UPSTREAM ELEVATION(FEET) =    292.00
  DOWNSTREAM ELEVATION(FEET) =    288.00
  ELEVATION DIFFERENCE(FEET) =      4.00
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    8.165
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.377
  SUBAREA RUNOFF(CFS) =      0.39
```

```
  TOTAL AREA(ACRES) =      0.19   TOTAL RUNOFF(CFS) =      0.39

****************************************************************************
  FLOW PROCESS FROM NODE    102.00 TO NODE    102.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =    8.16
  RAINFALL INTENSITY(INCH/HR) =   5.38
  TOTAL STREAM AREA(ACRES) =     0.19
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      0.39

  ** CONFLUENCE DATA **
  STREAM     RUNOFF       Tc      INTENSITY      AREA
  NUMBER      (CFS)     (MIN.)   (INCH/HOUR)    (ACRE)
      1        0.51     9.31        4.941          0.25
      2        0.39     8.16        5.377          0.19

  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        0.83     8.16       5.377
      2        0.86     9.31       4.941

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =       0.86   Tc(MIN.) =    9.31
  TOTAL AREA(ACRES) =        0.4
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    102.00 =     170.00 FEET.

+---------------------------------------------------------------------------+
| AREA C                                                                    |
|                                                                           |
|                                                                           |
+---------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE    102.00 TO NODE    104.00 IS CODE =  51
----------------------------------------------------------------------------
  >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    288.00  DOWNSTREAM(FEET) =    286.00
  CHANNEL LENGTH THRU SUBAREA(FEET) =   135.00   CHANNEL SLOPE =  0.0148
  CHANNEL BASE(FEET) =    6.00   "Z" FACTOR =  50.000
  MANNING'S FACTOR = 0.020   MAXIMUM DEPTH(FEET) =   1.00
  CHANNEL FLOW THRU SUBAREA(CFS) =       0.86
  FLOW VELOCITY(FEET/SEC.) =   1.26   FLOW DEPTH(FEET) =   0.07
  TRAVEL TIME(MIN.) =   1.78   Tc(MIN.) =   11.09
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    104.00 =     305.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    104.00 TO NODE    104.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
```

```
==============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =   11.09
  RAINFALL INTENSITY(INCH/HR) =   4.41
  TOTAL STREAM AREA(ACRES) =     0.44
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      0.86

******************************************************************************
  FLOW PROCESS FROM NODE    105.00 TO NODE    104.00 IS CODE =  21
------------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
==============================================================================
  RESIDENTIAL (2. DU/AC OR LESS) RUNOFF COEFFICIENT = .3800
  SOIL CLASSIFICATION IS "B"
  S.C.S. CURVE NUMBER (AMC II) =  68
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
  UPSTREAM ELEVATION(FEET) =    289.50
  DOWNSTREAM ELEVATION(FEET) =    286.00
  ELEVATION DIFFERENCE(FEET) =      3.50
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    8.536
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.225
  SUBAREA RUNOFF(CFS) =      0.89
  TOTAL AREA(ACRES) =      0.45   TOTAL RUNOFF(CFS) =      0.89

******************************************************************************
  FLOW PROCESS FROM NODE    104.00 TO NODE    104.00 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.) =    8.54
  RAINFALL INTENSITY(INCH/HR) =   5.22
  TOTAL STREAM AREA(ACRES) =     0.45
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      0.89

  ** CONFLUENCE DATA **
  STREAM     RUNOFF       Tc      INTENSITY      AREA
  NUMBER      (CFS)     (MIN.)   (INCH/HOUR)    (ACRE)
      1        0.86    11.09        4.413          0.44
      2        0.89     8.54        5.225          0.45

  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        1.62     8.54       5.225
      2        1.62    11.09       4.413

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =       1.62   Tc(MIN.) =    8.54
  TOTAL AREA(ACRES) =        0.9
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    104.00 =     305.00 FEET.

+----------------------------------------------------------------------------+
| AREA D                                                                     |
```

```
|                                                                          |
|                                                                          |
+--------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE    104.00 TO NODE    106.00 IS CODE =  51
----------------------------------------------------------------------------
  >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    286.00  DOWNSTREAM(FEET) =    285.00
  CHANNEL LENGTH THRU SUBAREA(FEET) =    50.00   CHANNEL SLOPE =  0.0200
  CHANNEL BASE(FEET) =    6.00   "Z" FACTOR =  50.000
  MANNING'S FACTOR = 0.020   MAXIMUM DEPTH(FEET) =   1.00
  CHANNEL FLOW THRU SUBAREA(CFS) =       1.62
  FLOW VELOCITY(FEET/SEC.) =   1.75   FLOW DEPTH(FEET) =   0.09
  TRAVEL TIME(MIN.) =   0.47   Tc(MIN.) =    9.01
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    106.00 =     355.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    106.00 TO NODE    106.00 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.) =    9.01
  RAINFALL INTENSITY(INCH/HR) =   5.05
  TOTAL STREAM AREA(ACRES) =     0.89
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      1.62

****************************************************************************
  FLOW PROCESS FROM NODE    107.00 TO NODE    106.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  RESIDENTIAL (2. DU/AC OR LESS) RUNOFF COEFFICIENT = .3800
  SOIL CLASSIFICATION IS "B"
  S.C.S. CURVE NUMBER (AMC II) =  68
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
  UPSTREAM ELEVATION(FEET) =    288.00
  DOWNSTREAM ELEVATION(FEET) =    285.00
  ELEVATION DIFFERENCE(FEET) =      3.00
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    8.986
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.054
  SUBAREA RUNOFF(CFS) =      0.33
  TOTAL AREA(ACRES) =      0.17   TOTAL RUNOFF(CFS) =      0.33

****************************************************************************
  FLOW PROCESS FROM NODE    106.00 TO NODE    106.00 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.) =    8.99
  RAINFALL INTENSITY(INCH/HR) =   5.05
  TOTAL STREAM AREA(ACRES) =     0.17
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      0.33
```

```
  ** CONFLUENCE DATA **
  STREAM     RUNOFF       Tc      INTENSITY      AREA
  NUMBER      (CFS)     (MIN.)   (INCH/HOUR)    (ACRE)
      1        1.62     9.01        5.045          0.89
      2        0.33     8.99        5.054          0.17

  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        1.95     8.99       5.054
      2        1.95     9.01       5.045

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =       1.95   Tc(MIN.) =    9.01
  TOTAL AREA(ACRES) =        1.1
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    106.00 =     355.00 FEET.

+----------------------------------------------------------------------------+
| AREA E                                                                     |
|                                                                            |
|                                                                            |
+----------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE    106.00 TO NODE    108.00 IS CODE =  51
----------------------------------------------------------------------------
  >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    285.00  DOWNSTREAM(FEET) =    284.75
  CHANNEL LENGTH THRU SUBAREA(FEET) =    50.00   CHANNEL SLOPE =  0.0050
  CHANNEL BASE(FEET) =    6.00   "Z" FACTOR =  50.000
  MANNING'S FACTOR = 0.020   MAXIMUM DEPTH(FEET) =   1.00
  CHANNEL FLOW THRU SUBAREA(CFS) =       1.95
  FLOW VELOCITY(FEET/SEC.) =   1.07   FLOW DEPTH(FEET) =   0.14
  TRAVEL TIME(MIN.) =   0.78   Tc(MIN.) =    9.79
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    108.00 =     405.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    108.00 TO NODE    108.00 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.) =    9.79
  RAINFALL INTENSITY(INCH/HR) =   4.78
  TOTAL STREAM AREA(ACRES) =     1.06
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      1.95

****************************************************************************
  FLOW PROCESS FROM NODE    109.00 TO NODE    108.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  RESIDENTIAL (2. DU/AC OR LESS) RUNOFF COEFFICIENT = .3800
```

```
  SOIL CLASSIFICATION IS "B"
  S.C.S. CURVE NUMBER (AMC II) =  68
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
  UPSTREAM ELEVATION(FEET) =    287.50
  DOWNSTREAM ELEVATION(FEET) =    284.50
  ELEVATION DIFFERENCE(FEET) =      3.00
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    8.986
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.054
  SUBAREA RUNOFF(CFS) =      0.33
  TOTAL AREA(ACRES) =      0.17   TOTAL RUNOFF(CFS) =      0.33

****************************************************************************
  FLOW PROCESS FROM NODE    108.00 TO NODE    108.00 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.) =    8.99
  RAINFALL INTENSITY(INCH/HR) =   5.05
  TOTAL STREAM AREA(ACRES) =     0.17
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      0.33

  ** CONFLUENCE DATA **
  STREAM     RUNOFF       Tc      INTENSITY      AREA
  NUMBER      (CFS)     (MIN.)   (INCH/HOUR)    (ACRE)
      1        1.95     9.79        4.783          1.06
      2        0.33     8.99        5.054          0.17

  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        2.17     8.99       5.054
      2        2.26     9.79       4.783

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =       2.26   Tc(MIN.) =    9.79
  TOTAL AREA(ACRES) =        1.2
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    108.00 =     405.00 FEET.

+--------------------------------------------------------------------------+
| AREA F                                                                   |
|                                                                          |
|                                                                          |
+--------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE    108.00 TO NODE    110.00 IS CODE =  51
----------------------------------------------------------------------------
  >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    284.75  DOWNSTREAM(FEET) =    284.50
  CHANNEL LENGTH THRU SUBAREA(FEET) =    50.00   CHANNEL SLOPE =  0.0050
  CHANNEL BASE(FEET) =    6.00   "Z" FACTOR =  50.000
  MANNING'S FACTOR = 0.020   MAXIMUM DEPTH(FEET) =   1.00
```

```
  CHANNEL FLOW THRU SUBAREA(CFS) =       2.26
  FLOW VELOCITY(FEET/SEC.) =   1.12   FLOW DEPTH(FEET) =   0.15
  TRAVEL TIME(MIN.) =   0.74   Tc(MIN.) =   10.54
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    110.00 =     455.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    110.00 TO NODE    110.00 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.) =   10.54
  RAINFALL INTENSITY(INCH/HR) =   4.56
  TOTAL STREAM AREA(ACRES) =     1.23
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      2.26

****************************************************************************
  FLOW PROCESS FROM NODE    111.00 TO NODE    110.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  RESIDENTIAL (2. DU/AC OR LESS) RUNOFF COEFFICIENT = .3800
  SOIL CLASSIFICATION IS "B"
  S.C.S. CURVE NUMBER (AMC II) =  68
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
  UPSTREAM ELEVATION(FEET) =    287.00
  DOWNSTREAM ELEVATION(FEET) =    284.00
  ELEVATION DIFFERENCE(FEET) =      3.00
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    8.986
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.054
  SUBAREA RUNOFF(CFS) =      0.38
  TOTAL AREA(ACRES) =      0.20   TOTAL RUNOFF(CFS) =      0.38

****************************************************************************
  FLOW PROCESS FROM NODE    110.00 TO NODE    110.00 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.) =    8.99
  RAINFALL INTENSITY(INCH/HR) =   5.05
  TOTAL STREAM AREA(ACRES) =     0.20
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      0.38

  ** CONFLUENCE DATA **
  STREAM     RUNOFF       Tc      INTENSITY      AREA
  NUMBER      (CFS)     (MIN.)   (INCH/HOUR)    (ACRE)
      1        2.26    10.54        4.562          1.23
      2        0.38     8.99        5.054          0.20

  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        2.42     8.99       5.054
```

```
     2        2.61    10.54       4.562

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =       2.61   Tc(MIN.) =   10.54
  TOTAL AREA(ACRES) =        1.4
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    110.00 =     455.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    110.00 TO NODE    112.00 IS CODE =  51
----------------------------------------------------------------------------
  >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    284.50  DOWNSTREAM(FEET) =    283.50
  CHANNEL LENGTH THRU SUBAREA(FEET) =    40.00   CHANNEL SLOPE =  0.0250
  CHANNEL BASE(FEET) =    6.00   "Z" FACTOR =  50.000
  MANNING'S FACTOR = 0.020   MAXIMUM DEPTH(FEET) =   1.00
  CHANNEL FLOW THRU SUBAREA(CFS) =       2.61
  FLOW VELOCITY(FEET/SEC.) =   2.07   FLOW DEPTH(FEET) =   0.11
  TRAVEL TIME(MIN.) =   0.32   Tc(MIN.) =   10.86
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    112.00 =     495.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    112.00 TO NODE    112.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  3
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =   10.86
  RAINFALL INTENSITY(INCH/HR) =   4.47
  TOTAL STREAM AREA(ACRES) =     1.43
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      2.61

+--------------------------------------------------------------------------+
| AREA G                                                                   |
|                                                                          |
|                                                                          |
+--------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE    113.00 TO NODE    114.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  RESIDENTIAL (2. DU/AC OR LESS) RUNOFF COEFFICIENT = .3800
  SOIL CLASSIFICATION IS "B"
  S.C.S. CURVE NUMBER (AMC II) =  68
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
  UPSTREAM ELEVATION(FEET) =    287.00
  DOWNSTREAM ELEVATION(FEET) =    284.00
  ELEVATION DIFFERENCE(FEET) =      3.00
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    8.986
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.054
  SUBAREA RUNOFF(CFS) =      0.40
  TOTAL AREA(ACRES) =      0.21   TOTAL RUNOFF(CFS) =      0.40

+--------------------------------------------------------------------------+
| AREA H                                                                   |
|                                                                          |
```

```
|                                                                          |
+--------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE    114.00 TO NODE    112.00 IS CODE =  51
----------------------------------------------------------------------------
  >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    284.10  DOWNSTREAM(FEET) =    283.50
  CHANNEL LENGTH THRU SUBAREA(FEET) =   133.00   CHANNEL SLOPE =  0.0045
  CHANNEL BASE(FEET) =    6.00   "Z" FACTOR =  50.000
  MANNING'S FACTOR = 0.020   MAXIMUM DEPTH(FEET) =   1.00
  CHANNEL FLOW THRU SUBAREA(CFS) =       0.40
  FLOW VELOCITY(FEET/SEC.) =   0.66   FLOW DEPTH(FEET) =   0.07
  TRAVEL TIME(MIN.) =   3.36   Tc(MIN.) =   12.35
  LONGEST FLOWPATH FROM NODE    113.00 TO NODE    112.00 =     233.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    112.00 TO NODE    112.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  3
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =   12.35
  RAINFALL INTENSITY(INCH/HR) =   4.12
  TOTAL STREAM AREA(ACRES) =     0.21
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      0.40

****************************************************************************
  FLOW PROCESS FROM NODE    115.00 TO NODE    112.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  RESIDENTIAL (2. DU/AC OR LESS) RUNOFF COEFFICIENT = .3800
  SOIL CLASSIFICATION IS "B"
  S.C.S. CURVE NUMBER (AMC II) =  68
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    66.00
  UPSTREAM ELEVATION(FEET) =    284.70
  DOWNSTREAM ELEVATION(FEET) =    283.50
  ELEVATION DIFFERENCE(FEET) =      1.20
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    8.627
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.189
  SUBAREA RUNOFF(CFS) =      0.43
  TOTAL AREA(ACRES) =      0.22   TOTAL RUNOFF(CFS) =      0.43

****************************************************************************
  FLOW PROCESS FROM NODE    112.00 TO NODE    112.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  3
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  3 ARE:
  TIME OF CONCENTRATION(MIN.) =    8.63
  RAINFALL INTENSITY(INCH/HR) =   5.19
  TOTAL STREAM AREA(ACRES) =     0.22
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      0.43
```

```
** CONFLUENCE DATA **
STREAM     RUNOFF       Tc      INTENSITY      AREA
NUMBER      (CFS)     (MIN.)   (INCH/HOUR)    (ACRE)
    1        2.61    10.86        4.474          1.43
    2        0.40    12.35        4.118          0.21
    3        0.43     8.63        5.189          0.22

RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
CONFLUENCE FORMULA USED FOR  3 STREAMS.

** PEAK FLOW RATE TABLE **
STREAM     RUNOFF      Tc      INTENSITY
NUMBER      (CFS)    (MIN.)   (INCH/HOUR)
    1        2.96     8.63       5.189
    2        3.33    10.86       4.474
    3        3.15    12.35       4.118

COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
PEAK FLOW RATE(CFS) =       3.33   Tc(MIN.) =   10.86
TOTAL AREA(ACRES) =        1.9
LONGEST FLOWPATH FROM NODE    100.00 TO NODE    112.00 =     495.00 FEET.
============================================================================
END OF STUDY SUMMARY:
TOTAL AREA(ACRES)     =        1.9  TC(MIN.) =     10.86
PEAK FLOW RATE(CFS)   =       3.33
============================================================================
============================================================================
END OF RATIONAL METHOD ANALYSIS
```

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

            RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
            Reference: SAN DIEGO COUNTY FLOOD CONTROL DISTRICT
                         2003,1985,1981 HYDROLOGY MANUAL
         (c) Copyright 1982-2008 Advanced Engineering Software (aes)
             Ver. 15.0 Release Date: 04/01/2008  License ID 1510

                           Analysis prepared by:

                           DRC Engineering, Inc.
                    160 South Old Springs Road, Suite 210
                           Anaheim Hills, CA 92808
                                714-685-6860

 ************************** DESCRIPTION OF STUDY **************************
* 14-545 SPRING VALLEY                                                     *
* PROPOSED CONDITION                                                       *
* 100 YEAR                                                                 *
 ***************************************************************************

  FILE NAME: 4545P100.DAT
  TIME/DATE OF STUDY: 15:56 10/30/2014
----------------------------------------------------------------------------
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
----------------------------------------------------------------------------
  2003 SAN DIEGO MANUAL CRITERIA

  USER SPECIFIED STORM EVENT(YEAR) = 100.00
  6-HOUR DURATION PRECIPITATION (INCHES) =   2.800
  SPECIFIED MINIMUM PIPE SIZE(INCH) =  12.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.90
  SAN DIEGO HYDROLOGY MANUAL "C"-VALUES USED FOR RATIONAL METHOD
  NOTE: USE MODIFIED RATIONAL METHOD PROCEDURES FOR CONFLUENCE ANALYSIS
  *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   30.0     20.0    0.018/0.018/0.020   0.67    2.00 0.0313 0.167 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  0.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*

+--------------------------------------------------------------------------+
| AREA A                                                                   |
|                                                                          |
|                                                                          |
+--------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE    200.00 TO NODE    201.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
```

```
  GENERAL COMMERCIAL RUNOFF COEFFICIENT = .8000
  SOIL CLASSIFICATION IS "B"
  S.C.S. CURVE NUMBER (AMC II) =  92
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    10.00
  UPSTREAM ELEVATION(FEET) =    293.00
  DOWNSTREAM ELEVATION(FEET) =    287.00
  ELEVATION DIFFERENCE(FEET) =      6.00
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    0.793
  WARNING: THE MAXIMUM OVERLAND FLOW SLOPE, 10.%, IS USED IN Tc CALCULATION!
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  7.377
  NOTE: RAINFALL INTENSITY IS BASED ON Tc = 5-MINUTE.
  SUBAREA RUNOFF(CFS) =      0.12
  TOTAL AREA(ACRES) =      0.02   TOTAL RUNOFF(CFS) =      0.12

****************************************************************************
  FLOW PROCESS FROM NODE    201.00 TO NODE    202.00 IS CODE =  91
----------------------------------------------------------------------------
  >>>>>COMPUTE "V" GUTTER FLOW TRAVEL TIME THRU SUBAREA<<<<<
============================================================================
  UPSTREAM NODE ELEVATION(FEET) =    287.00
  DOWNSTREAM NODE ELEVATION(FEET) =    285.50
  CHANNEL LENGTH THRU SUBAREA(FEET) =   150.00
  "V" GUTTER WIDTH(FEET) =   3.00   GUTTER HIKE(FEET) =  0.080
  PAVEMENT LIP(FEET) =  0.040   MANNING'S N = .0300
  PAVEMENT CROSSFALL(DECIMAL NOTATION) = 0.01000
  MAXIMUM DEPTH(FEET) =   1.00
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  7.377
  NOTE: RAINFALL INTENSITY IS BASED ON Tc = 5-MINUTE.
  GENERAL COMMERCIAL RUNOFF COEFFICIENT = .8000
  SOIL CLASSIFICATION IS "B"
  S.C.S. CURVE NUMBER (AMC II) =  92
  TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      0.35
  TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   0.94
  AVERAGE FLOW DEPTH(FEET) =   0.14   FLOOD WIDTH(FEET) =    7.98
  "V" GUTTER FLOW TRAVEL TIME(MIN.) =   2.66   Tc(MIN.) =    3.45
  SUBAREA AREA(ACRES) =    0.08       SUBAREA RUNOFF(CFS) =    0.47
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.800
  TOTAL AREA(ACRES) =        0.1         PEAK FLOW RATE(CFS) =       0.59

  END OF SUBAREA "V" GUTTER HYDRAULICS:
  DEPTH(FEET) =  0.17   FLOOD WIDTH(FEET) =   12.80
  FLOW VELOCITY(FEET/SEC.) =   0.94   DEPTH*VELOCITY(FT*FT/SEC) =   0.16
  LONGEST FLOWPATH FROM NODE    200.00 TO NODE    202.00 =     160.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    202.00 TO NODE    203.00 IS CODE =  41
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   282.50  DOWNSTREAM(FEET) =   281.00
  FLOW LENGTH(FEET) =   246.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  18.0 INCH PIPE IS   3.4 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   2.59
  GIVEN PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       0.59
  PIPE TRAVEL TIME(MIN.) =   1.58    Tc(MIN.) =    5.04
  LONGEST FLOWPATH FROM NODE    200.00 TO NODE    203.00 =     406.00 FEET.

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

```
  FLOW PROCESS FROM NODE    203.00 TO NODE    203.00 IS CODE =  10
----------------------------------------------------------------------------
  >>>>>MAIN-STREAM MEMORY COPIED ONTO MEMORY BANK # 1 <<<<<
============================================================================

+--------------------------------------------------------------------------+
| AREA B                                                                   |
|                                                                          |
|                                                                          |
+--------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE    204.00 TO NODE    205.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  GENERAL COMMERCIAL RUNOFF COEFFICIENT = .8000
  SOIL CLASSIFICATION IS "B"
  S.C.S. CURVE NUMBER (AMC II) =  92
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    59.00
  UPSTREAM ELEVATION(FEET) =    287.20
  DOWNSTREAM ELEVATION(FEET) =    286.60
  ELEVATION DIFFERENCE(FEET) =      0.60
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    4.125
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  7.377
  NOTE: RAINFALL INTENSITY IS BASED ON Tc = 5-MINUTE.
  SUBAREA RUNOFF(CFS) =      0.47
  TOTAL AREA(ACRES) =      0.08   TOTAL RUNOFF(CFS) =      0.47

****************************************************************************
  FLOW PROCESS FROM NODE    205.00 TO NODE    206.00 IS CODE =  91
----------------------------------------------------------------------------
  >>>>>COMPUTE "V" GUTTER FLOW TRAVEL TIME THRU SUBAREA<<<<<
============================================================================
  UPSTREAM NODE ELEVATION(FEET) =    286.60
  DOWNSTREAM NODE ELEVATION(FEET) =    285.50
  CHANNEL LENGTH THRU SUBAREA(FEET) =   197.00
  "V" GUTTER WIDTH(FEET) =   3.00   GUTTER HIKE(FEET) =  0.080
  PAVEMENT LIP(FEET) =  0.040   MANNING'S N = .0200
  PAVEMENT CROSSFALL(DECIMAL NOTATION) = 0.01000
  MAXIMUM DEPTH(FEET) =   1.00
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.884
  GENERAL COMMERCIAL RUNOFF COEFFICIENT = .8000
  SOIL CLASSIFICATION IS "B"
  S.C.S. CURVE NUMBER (AMC II) =  92
  TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      1.89
  TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   1.10
  AVERAGE FLOW DEPTH(FEET) =   0.23   FLOOD WIDTH(FEET) =   24.48
  "V" GUTTER FLOW TRAVEL TIME(MIN.) =   2.97   Tc(MIN.) =    7.10
  SUBAREA AREA(ACRES) =    0.60       SUBAREA RUNOFF(CFS) =    2.82
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.800
  TOTAL AREA(ACRES) =        0.7         PEAK FLOW RATE(CFS) =       3.20

  END OF SUBAREA "V" GUTTER HYDRAULICS:
  DEPTH(FEET) =  0.26   FLOOD WIDTH(FEET) =   31.02
  FLOW VELOCITY(FEET/SEC.) =   1.22   DEPTH*VELOCITY(FT*FT/SEC) =   0.32
  LONGEST FLOWPATH FROM NODE    204.00 TO NODE    206.00 =     256.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    206.00 TO NODE    203.00 IS CODE =  41
```

```
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   281.50  DOWNSTREAM(FEET) =   281.00
  FLOW LENGTH(FEET) =     8.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  18.0 INCH PIPE IS   4.4 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   9.70
  GIVEN PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       3.20
  PIPE TRAVEL TIME(MIN.) =   0.01    Tc(MIN.) =    7.11
  LONGEST FLOWPATH FROM NODE    204.00 TO NODE    203.00 =     264.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    203.00 TO NODE    203.00 IS CODE =  11
----------------------------------------------------------------------------
  >>>>>CONFLUENCE MEMORY BANK # 1 WITH THE MAIN-STREAM MEMORY<<<<<
============================================================================

  ** MAIN STREAM CONFLUENCE DATA **
  STREAM     RUNOFF      Tc      INTENSITY     AREA
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)   (ACRE)
      1        3.20     7.11       5.877        0.68
  LONGEST FLOWPATH FROM NODE    204.00 TO NODE    203.00 =     264.00 FEET.

  ** MEMORY BANK #  1 CONFLUENCE DATA **
  STREAM     RUNOFF      Tc      INTENSITY     AREA
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)   (ACRE)
      1        0.59     5.04       7.343        0.10
  LONGEST FLOWPATH FROM NODE    200.00 TO NODE    203.00 =     406.00 FEET.

  ** PEAK FLOW RATE TABLE **
  STREAM    RUNOFF       Tc      INTENSITY
  NUMBER     (CFS)     (MIN.)   (INCH/HOUR)
      1       2.86       5.04        7.343
      2       3.67       7.11        5.877

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =       3.67   Tc(MIN.) =    7.11
  TOTAL AREA(ACRES) =        0.8

****************************************************************************
  FLOW PROCESS FROM NODE    203.00 TO NODE    203.00 IS CODE =  12
----------------------------------------------------------------------------
  >>>>>CLEAR MEMORY BANK # 1 <<<<<
============================================================================

****************************************************************************
  FLOW PROCESS FROM NODE    203.00 TO NODE    207.00 IS CODE =  41
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   281.00  DOWNSTREAM(FEET) =   279.00
  FLOW LENGTH(FEET) =   175.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  18.0 INCH PIPE IS   7.3 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   5.47
  GIVEN PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       3.67
  PIPE TRAVEL TIME(MIN.) =   0.53    Tc(MIN.) =    7.65
```

```
  LONGEST FLOWPATH FROM NODE    200.00 TO NODE    207.00 =     581.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    207.00 TO NODE    207.00 IS CODE =  10
----------------------------------------------------------------------------
  >>>>>MAIN-STREAM MEMORY COPIED ONTO MEMORY BANK # 2 <<<<<
============================================================================

+--------------------------------------------------------------------------+
| AREA C                                                                   |
|                                                                          |
|                                                                          |
+--------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE    208.00 TO NODE    209.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  GENERAL COMMERCIAL RUNOFF COEFFICIENT = .8000
  SOIL CLASSIFICATION IS "B"
  S.C.S. CURVE NUMBER (AMC II) =  92
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    51.00
  UPSTREAM ELEVATION(FEET) =    287.40
  DOWNSTREAM ELEVATION(FEET) =    287.10
  ELEVATION DIFFERENCE(FEET) =      0.30
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    4.602
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  7.377
  NOTE: RAINFALL INTENSITY IS BASED ON Tc = 5-MINUTE.
  SUBAREA RUNOFF(CFS) =      0.59
  TOTAL AREA(ACRES) =      0.10   TOTAL RUNOFF(CFS) =      0.59

****************************************************************************
  FLOW PROCESS FROM NODE    209.00 TO NODE    210.00 IS CODE =  91
----------------------------------------------------------------------------
  >>>>>COMPUTE "V" GUTTER FLOW TRAVEL TIME THRU SUBAREA<<<<<
============================================================================
  UPSTREAM NODE ELEVATION(FEET) =    287.10
  DOWNSTREAM NODE ELEVATION(FEET) =    284.70
  CHANNEL LENGTH THRU SUBAREA(FEET) =   127.00
  "V" GUTTER WIDTH(FEET) =   1.50   GUTTER HIKE(FEET) =  0.120
  PAVEMENT LIP(FEET) =  0.040   MANNING'S N = .0200
  PAVEMENT CROSSFALL(DECIMAL NOTATION) = 0.01200
  MAXIMUM DEPTH(FEET) =   1.00
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  6.740
  RESIDENTIAL (1. DU/AC OR LESS) RUNOFF COEFFICIENT = .3200
  SOIL CLASSIFICATION IS "B"
  S.C.S. CURVE NUMBER (AMC II) =  65
  TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      0.86
  TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   1.84
  AVERAGE FLOW DEPTH(FEET) =   0.21   FLOOD WIDTH(FEET) =   10.39
  "V" GUTTER FLOW TRAVEL TIME(MIN.) =   1.15   Tc(MIN.) =    5.75
  SUBAREA AREA(ACRES) =    0.25       SUBAREA RUNOFF(CFS) =    0.54
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.457
  TOTAL AREA(ACRES) =        0.3         PEAK FLOW RATE(CFS) =       1.08

  END OF SUBAREA "V" GUTTER HYDRAULICS:
  DEPTH(FEET) =  0.22   FLOOD WIDTH(FEET) =   12.30
  FLOW VELOCITY(FEET/SEC.) =   1.81   DEPTH*VELOCITY(FT*FT/SEC) =   0.41
  LONGEST FLOWPATH FROM NODE    208.00 TO NODE    210.00 =     178.00 FEET.
```

```
****************************************************************************
  FLOW PROCESS FROM NODE    210.00 TO NODE    207.00 IS CODE =  41
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   280.20  DOWNSTREAM(FEET) =   279.00
  FLOW LENGTH(FEET) =    64.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  18.0 INCH PIPE IS   3.4 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   4.61
  GIVEN PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       1.08
  PIPE TRAVEL TIME(MIN.) =   0.23    Tc(MIN.) =    5.98
  LONGEST FLOWPATH FROM NODE    208.00 TO NODE    207.00 =     242.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    207.00 TO NODE    207.00 IS CODE =  11
----------------------------------------------------------------------------
  >>>>>CONFLUENCE MEMORY BANK # 2 WITH THE MAIN-STREAM MEMORY<<<<<
============================================================================

  ** MAIN STREAM CONFLUENCE DATA **
  STREAM     RUNOFF      Tc      INTENSITY     AREA
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)   (ACRE)
      1        1.08     5.98       6.570        0.35
  LONGEST FLOWPATH FROM NODE    208.00 TO NODE    207.00 =     242.00 FEET.

  ** MEMORY BANK #  2 CONFLUENCE DATA **
  STREAM     RUNOFF      Tc      INTENSITY     AREA
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)   (ACRE)
      1        3.67     7.65       5.609        0.78
  LONGEST FLOWPATH FROM NODE    200.00 TO NODE    207.00 =     581.00 FEET.

  ** PEAK FLOW RATE TABLE **
  STREAM    RUNOFF       Tc      INTENSITY
  NUMBER     (CFS)     (MIN.)   (INCH/HOUR)
      1       3.95       5.98        6.570
      2       4.59       7.65        5.609

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =       4.59   Tc(MIN.) =    7.65
  TOTAL AREA(ACRES) =        1.1

****************************************************************************
  FLOW PROCESS FROM NODE    207.00 TO NODE    207.00 IS CODE =  12
----------------------------------------------------------------------------
  >>>>>CLEAR MEMORY BANK # 2 <<<<<
============================================================================

****************************************************************************
  FLOW PROCESS FROM NODE    207.00 TO NODE    207.00 IS CODE =  10
----------------------------------------------------------------------------
  >>>>>MAIN-STREAM MEMORY COPIED ONTO MEMORY BANK # 3 <<<<<
============================================================================

+--------------------------------------------------------------------------+
| AREA D                                                                   |
|                                                                          |
|                                                                          |
```

```
+----------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE    211.00 TO NODE    212.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  GENERAL COMMERCIAL RUNOFF COEFFICIENT = .8000
  SOIL CLASSIFICATION IS "B"
  S.C.S. CURVE NUMBER (AMC II) =  92
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    85.00
  UPSTREAM ELEVATION(FEET) =    292.00
  DOWNSTREAM ELEVATION(FEET) =    287.10
  ELEVATION DIFFERENCE(FEET) =      4.90
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    2.777
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  7.377
  NOTE: RAINFALL INTENSITY IS BASED ON Tc = 5-MINUTE.
  SUBAREA RUNOFF(CFS) =      0.30
  TOTAL AREA(ACRES) =      0.05   TOTAL RUNOFF(CFS) =      0.30

****************************************************************************
  FLOW PROCESS FROM NODE    212.00 TO NODE    213.00 IS CODE =  91
----------------------------------------------------------------------------
  >>>>>COMPUTE "V" GUTTER FLOW TRAVEL TIME THRU SUBAREA<<<<<
============================================================================
  UPSTREAM NODE ELEVATION(FEET) =    287.10
  DOWNSTREAM NODE ELEVATION(FEET) =    283.00
  CHANNEL LENGTH THRU SUBAREA(FEET) =   525.00
  "V" GUTTER WIDTH(FEET) =   3.00   GUTTER HIKE(FEET) =  0.080
  PAVEMENT LIP(FEET) =  0.040   MANNING'S N = .0250
  PAVEMENT CROSSFALL(DECIMAL NOTATION) = 0.05000
  MAXIMUM DEPTH(FEET) =   1.00
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.247
  GENERAL COMMERCIAL RUNOFF COEFFICIENT = .8000
  SOIL CLASSIFICATION IS "B"
  S.C.S. CURVE NUMBER (AMC II) =  92
  TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      1.75
  TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   1.53
  AVERAGE FLOW DEPTH(FEET) =   0.27   FLOOD WIDTH(FEET) =    9.02
  "V" GUTTER FLOW TRAVEL TIME(MIN.) =   5.70   Tc(MIN.) =    8.48
  SUBAREA AREA(ACRES) =    0.68       SUBAREA RUNOFF(CFS) =    2.85
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.800
  TOTAL AREA(ACRES) =        0.7         PEAK FLOW RATE(CFS) =       3.06

  END OF SUBAREA "V" GUTTER HYDRAULICS:
  DEPTH(FEET) =  0.33   FLOOD WIDTH(FEET) =   11.49
  FLOW VELOCITY(FEET/SEC.) =   1.72   DEPTH*VELOCITY(FT*FT/SEC) =   0.57
  LONGEST FLOWPATH FROM NODE    211.00 TO NODE    213.00 =     610.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    213.00 TO NODE    213.00 IS CODE =  11
----------------------------------------------------------------------------
  >>>>>CONFLUENCE MEMORY BANK # 3 WITH THE MAIN-STREAM MEMORY<<<<<
============================================================================

  ** MAIN STREAM CONFLUENCE DATA **
  STREAM     RUNOFF      Tc      INTENSITY     AREA
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)   (ACRE)
      1        3.06     8.48       5.247        0.73
  LONGEST FLOWPATH FROM NODE    211.00 TO NODE    213.00 =     610.00 FEET.
```

```
  ** MEMORY BANK #  3 CONFLUENCE DATA **
  STREAM     RUNOFF      Tc      INTENSITY     AREA
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)   (ACRE)
      1        4.59     7.65       5.609        1.13
  LONGEST FLOWPATH FROM NODE    200.00 TO NODE    213.00 =     581.00 FEET.

  ** PEAK FLOW RATE TABLE **
  STREAM    RUNOFF       Tc      INTENSITY
  NUMBER     (CFS)     (MIN.)   (INCH/HOUR)
      1       7.36       7.65        5.609
      2       7.36       8.48        5.247

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =       7.36   Tc(MIN.) =    8.48
  TOTAL AREA(ACRES) =        1.9
================================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =        1.9  TC(MIN.) =      8.48
  PEAK FLOW RATE(CFS)   =       7.36
================================================================================
================================================================================
  END OF RATIONAL METHOD ANALYSIS
```

RATIONAL METHOD HYDROGRAPH PROGRAM
COPYRIGHT 1992, 2001 RICK ENGINEERING COMPANY

RUN DATE 10/30/2014
HYDROGRAPH FILE NAME Text1
TIME OF CONCENTRATION 8 MIN.
6 HOUR RAINFALL 2.8 INCHES
BASIN AREA 1.86 ACRES
RUNOFF COEFFICIENT 0.8
PEAK DISCHARGE 7.36 CFS

| | |
|---|---|
| TIME (MIN) = 0 | DISCHARGE (CFS) = 0 |
| TIME (MIN) = 8 | DISCHARGE (CFS) = 0.2 |
| TIME (MIN) = 16 | DISCHARGE (CFS) = 0.3 |
| TIME (MIN) = 24 | DISCHARGE (CFS) = 0.3 |
| TIME (MIN) = 32 | DISCHARGE (CFS) = 0.3 |
| TIME (MIN) = 40 | DISCHARGE (CFS) = 0.3 |
| TIME (MIN) = 48 | DISCHARGE (CFS) = 0.3 |
| TIME (MIN) = 56 | DISCHARGE (CFS) = 0.3 |
| TIME (MIN) = 64 | DISCHARGE (CFS) = 0.3 |
| TIME (MIN) = 72 | DISCHARGE (CFS) = 0.3 |
| TIME (MIN) = 80 | DISCHARGE (CFS) = 0.3 |
| TIME (MIN) = 88 | DISCHARGE (CFS) = 0.3 |
| TIME (MIN) = 96 | DISCHARGE (CFS) = 0.3 |
| TIME (MIN) = 104 | DISCHARGE (CFS) = 0.3 |
| TIME (MIN) = 112 | DISCHARGE (CFS) = 0.4 |
| TIME (MIN) = 120 | DISCHARGE (CFS) = 0.4 |
| TIME (MIN) = 128 | DISCHARGE (CFS) = 0.4 |
| TIME (MIN) = 136 | DISCHARGE (CFS) = 0.4 |
| TIME (MIN) = 144 | DISCHARGE (CFS) = 0.4 |
| TIME (MIN) = 152 | DISCHARGE (CFS) = 0.5 |
| TIME (MIN) = 160 | DISCHARGE (CFS) = 0.5 |
| TIME (MIN) = 168 | DISCHARGE (CFS) = 0.5 |
| TIME (MIN) = 176 | DISCHARGE (CFS) = 0.5 |
| TIME (MIN) = 184 | DISCHARGE (CFS) = 0.6 |
| TIME (MIN) = 192 | DISCHARGE (CFS) = 0.6 |
| TIME (MIN) = 200 | DISCHARGE (CFS) = 0.7 |
| TIME (MIN) = 208 | DISCHARGE (CFS) = 0.8 |
| TIME (MIN) = 216 | DISCHARGE (CFS) = 1 |
| TIME (MIN) = 224 | DISCHARGE (CFS) = 1.1 |
| TIME (MIN) = 232 | DISCHARGE (CFS) = 1.6 |
| TIME (MIN) = 240 | DISCHARGE (CFS) = 3 |
| TIME (MIN) = 248 | DISCHARGE (CFS) = 7.36 |
| TIME (MIN) = 256 | DISCHARGE (CFS) = 1.3 |
| TIME (MIN) = 264 | DISCHARGE (CFS) = 0.9 |
| TIME (MIN) = 272 | DISCHARGE (CFS) = 0.7 |
| TIME (MIN) = 280 | DISCHARGE (CFS) = 0.6 |
| TIME (MIN) = 288 | DISCHARGE (CFS) = 0.5 |
| TIME (MIN) = 296 | DISCHARGE (CFS) = 0.4 |
| TIME (MIN) = 304 | DISCHARGE (CFS) = 0.4 |
| TIME (MIN) = 312 | DISCHARGE (CFS) = 0.4 |
| TIME (MIN) = 320 | DISCHARGE (CFS) = 0.3 |
| TIME (MIN) = 328 | DISCHARGE (CFS) = 0.3 |
| TIME (MIN) = 336 | DISCHARGE (CFS) = 0.3 |
| TIME (MIN) = 344 | DISCHARGE (CFS) = 0.3 |
| TIME (MIN) = 352 | DISCHARGE (CFS) = 0.3 |
| TIME (MIN) = 360 | DISCHARGE (CFS) = 0.3 |
| TIME (MIN) = 368 | DISCHARGE (CFS) = 0 |

- The storm frequency of peak discharges is the same as that of I for the given $T_c$.

- The fraction of rainfall that becomes runoff (or the runoff coefficient, C) is independent of I or precipitation zone number (PZN) condition (PZN Condition is discussed in Section 4.1.2.4).

- The peak rate of runoff is the only information produced by using the RM.

### 3.1.2 Runoff Coefficient

Table 3-1 lists the estimated runoff coefficients for urban areas. The concepts related to the runoff coefficient were evaluated in a report entitled *Evaluation, Rational Method "C" Values* (Hill, 2002) that was reviewed by the Hydrology Manual Committee. The Report is available at San Diego County Department of Public Works, Flood Control Section and on the San Diego County Department of Public Works web page.

The runoff coefficients are based on land use and soil type. Soil type can be determined from the soil type map provided in Appendix A. An appropriate runoff coefficient (C) for each type of land use in the subarea should be selected from this table and multiplied by the percentage of the total area (A) included in that class. The sum of the products for all land uses is the weighted runoff coefficient ($\Sigma[CA]$). Good engineering judgment should be used when applying the values presented in Table 3-1, as adjustments to these values may be appropriate based on site-specific characteristics. In any event, the impervious percentage (% Impervious) as given in the table, for any area, shall govern the selected value for C. The runoff coefficient can also be calculated for an area based on soil type and impervious percentage using the following formula:

$$C = 0.90 \times (\% \text{ Impervious}) + C_p \times (1 - \% \text{ Impervious})$$

Where: $C_p$ = Pervious Coefficient Runoff Value for the soil type (shown in Table 3-1 as Undisturbed Natural Terrain/Permanent Open Space, 0% Impervious). Soil type can be determined from the soil type map provided in Appendix A.

The values in Table 3-1 are typical for most urban areas. However, if the basin contains rural or agricultural land use, parks, golf courses, or other types of nonurban land use that are expected to be permanent, the appropriate value should be selected based upon the soil and cover and approved by the local agency.

## Table 3-1
## RUNOFF COEFFICIENTS FOR URBAN AREAS

| Land Use | | Runoff Coefficient "C" | | | | |
|---|---|---|---|---|---|---|
| | | | Soil Type | | | |
| NRCS Elements | County Elements | % IMPER. | A | B | C | D |
| Undisturbed Natural Terrain (Natural) | Permanent Open Space | 0* | 0.20 | 0.25 | 0.30 | 0.35 |
| Low Density Residential (LDR) | Residential, 1.0 DU/A or less | 10 | 0.27 | 0.32 | 0.36 | 0.41 |
| Low Density Residential (LDR) | Residential, 2.0 DU/A or less | 20 | 0.34 | 0.38 | 0.42 | 0.46 |
| Low Density Residential (LDR) | Residential, 2.9 DU/A or less | 25 | 0.38 | 0.41 | 0.45 | 0.49 |
| Medium Density Residential (MDR) | Residential, 4.3 DU/A or less | 30 | 0.41 | 0.45 | 0.48 | 0.52 |
| Medium Density Residential (MDR) | Residential, 7.3 DU/A or less | 40 | 0.48 | 0.51 | 0.54 | 0.57 |
| Medium Density Residential (MDR) | Residential, 10.9 DU/A or less | 45 | 0.52 | 0.54 | 0.57 | 0.60 |
| Medium Density Residential (MDR) | Residential, 14.5 DU/A or less | 50 | 0.55 | 0.58 | 0.60 | 0.63 |
| High Density Residential (HDR) | Residential, 24.0 DU/A or less | 65 | 0.66 | 0.67 | 0.69 | 0.71 |
| High Density Residential (HDR) | Residential, 43.0 DU/A or less | 80 | 0.76 | 0.77 | 0.78 | 0.79 |
| Commercial/Industrial (N. Com) | Neighborhood Commercial | 80 | 0.76 | 0.77 | 0.78 | 0.79 |
| Commercial/Industrial (G. Com) | General Commercial | 85 | 0.80 | **0.80** | 0.81 | 0.82 |
| Commercial/Industrial (O.P. Com) | Office Professional/Commercial | 90 | 0.83 | **0.84** | 0.84 | 0.85 |
| Commercial/Industrial (Limited I.) | Limited Industrial | 90 | 0.83 | **0.84** | 0.84 | 0.85 |
| Commercial/Industrial (General I.) | General Industrial | 95 | 0.87 | **0.87** | 0.87 | 0.87 |

*The values associated with 0% impervious may be used for direct calculation of the runoff coefficient as described in Section 3.1.2 (representing the pervious runoff coefficient, Cp, for the soil type), or for areas that will remain undisturbed in perpetuity. Justification must be given that the area will remain natural forever (e.g., the area is located in Cleveland National Forest).
DU/A = dwelling units per acre
NRCS = National Resources Conservation Service

RUNOFF COEFFICIENT PROPOSED

# Hydrograph Return Period Recap

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066

| Hyd. No. | Hydrograph type (origin) | Inflow Hyd(s) | Peak Outflow (cfs) | | | | | | | | Hydrograph description |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1-Yr | 2-Yr | 3-Yr | 5-Yr | 10-Yr | 25-Yr | 50-Yr | 100-Yr | |
| 1 | Manual | ------ | ------- | ------- | ------- | ------- | ------- | 7.360 | ------- | 7.360 | <no description> |
| 3 | Reservoir | 1 | ------- | ------- | ------- | ------- | ------- | 3.101 | ------- | 3.101 | <no description> |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066

| Hyd. No. | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to peak (min) | Hyd. volume (cuft) | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph description |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Manual | 7.360 | 10 | 250 | 16,116 | ------ | ------ | ------ | <no description> |
| 3 | Reservoir | 3.101 | 10 | 260 | 16,035 | 1 | 282.58 | 6,224 | <no description> |

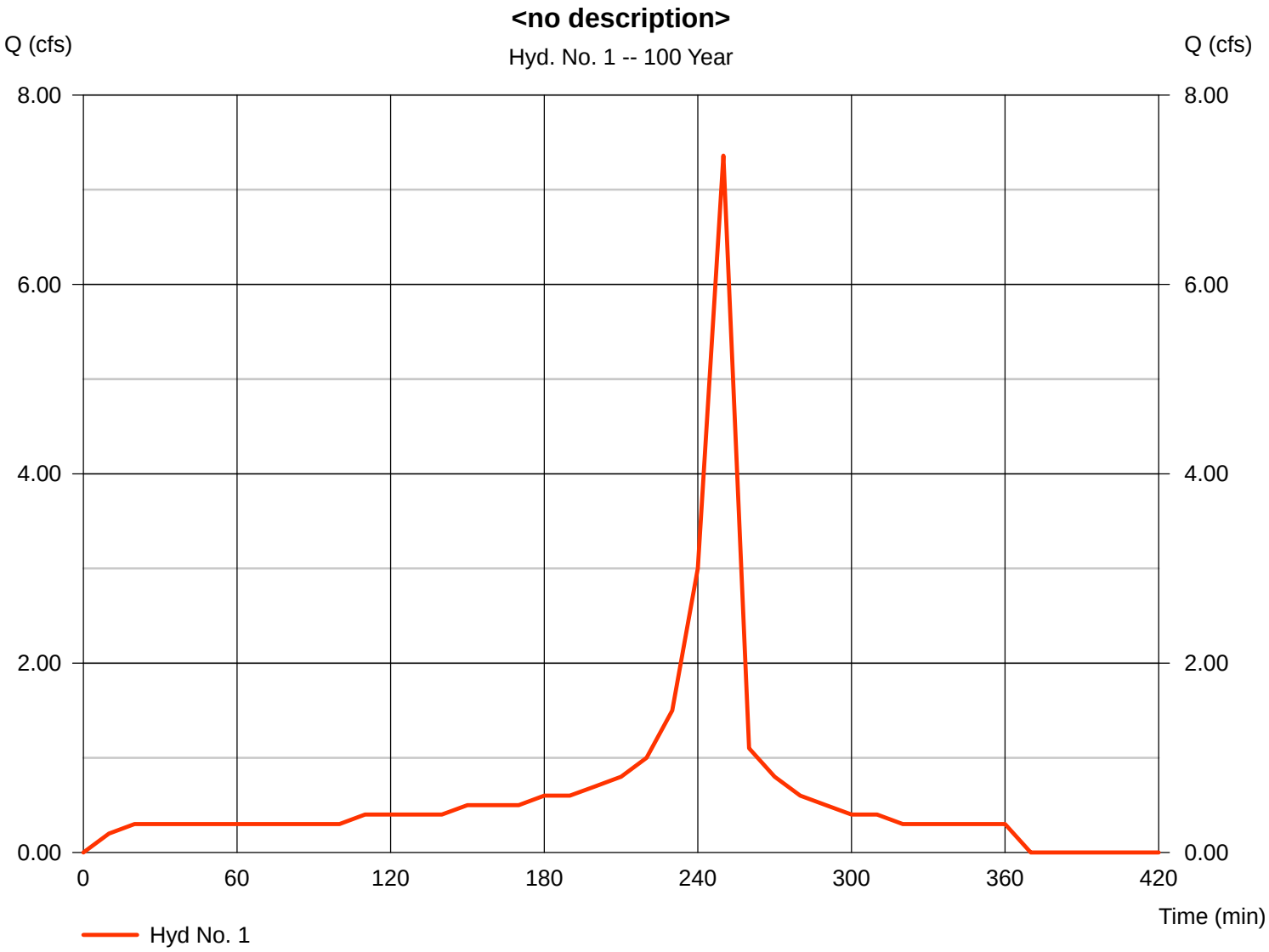
# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066 Monday, Mar 30, 2015

## Hyd. No. 1

<no description>

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Manual | Peak discharge | = | 7.360 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 250 min |
| Time interval | = | 10 min | Hyd. volume | = | 16,116 cuft |



# Hydrograph Report

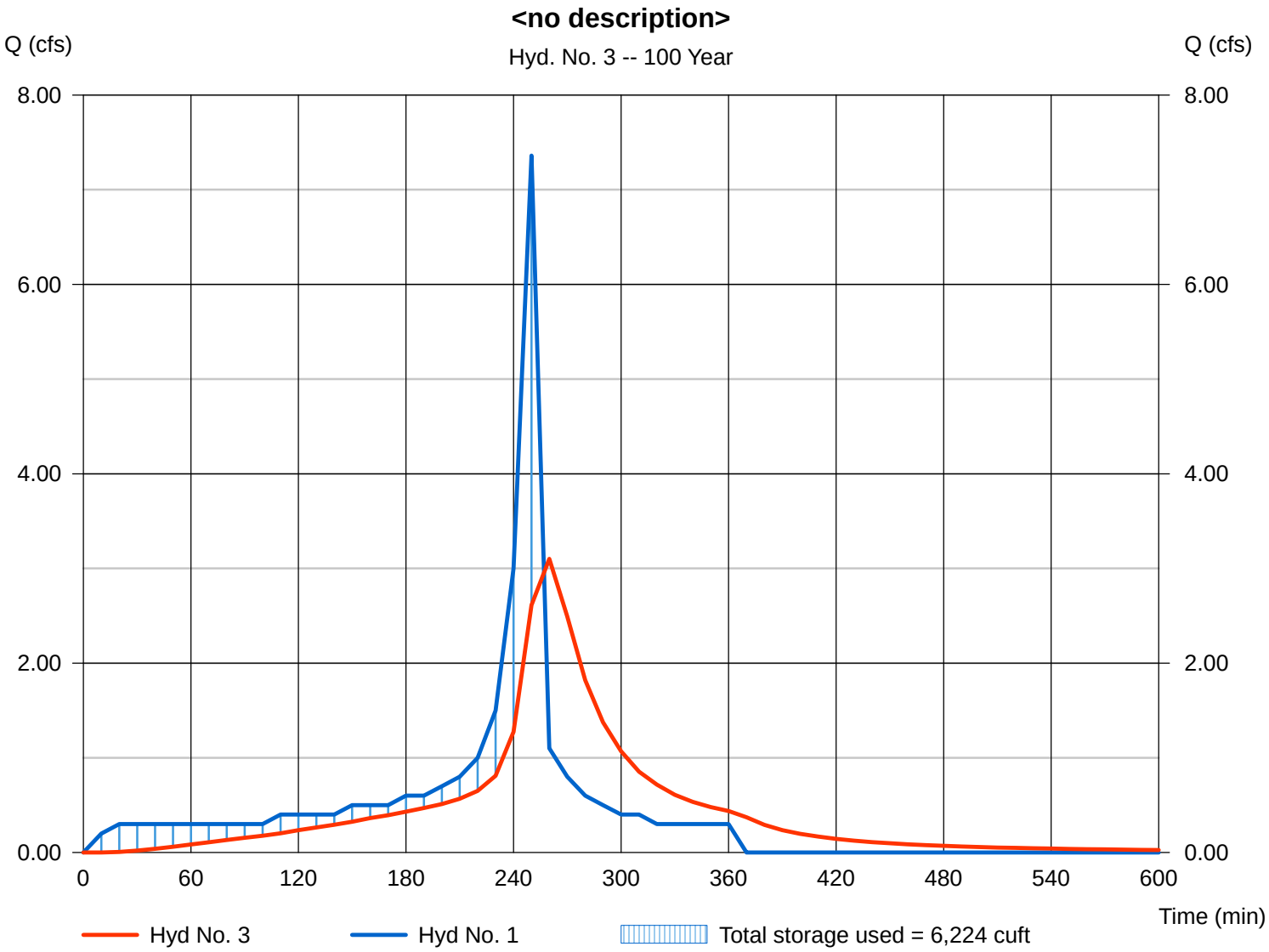
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066 Monday, Mar 30, 2015

## Hyd. No. 3

<no description>

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | Reservoir | Peak discharge | = | 3.101 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 260 min |
| Time interval | = | 10 min | Hyd. volume | = | 16,035 cuft |
| Inflow hyd. No. | = | 1 - <no description> | Max. Elevation | = | 282.58 ft |
| Reservoir name | = | Arch Pipe | Max. Storage | = | 6,224 cuft |

Storage Indication method used.



# Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066 Monday, Mar 30, 2015

## Pond No. 1 - Arch Pipe

## Pond Data

**Pond storage is based on user-defined values.**

## Stage / Storage Table

| Stage (ft) | Elevation (ft) | Contour area (sqft) | Incr. Storage (cuft) | Total storage (cuft) |
|---|---|---|---|---|
| 0.00 | 281.17 | n/a | 0 | 0 |
| 0.09 | 281.26 | n/a | 504 | 504 |
| 0.17 | 281.34 | n/a | 496 | 1,000 |
| 0.25 | 281.42 | n/a | 486 | 1,486 |
| 0.34 | 281.51 | n/a | 475 | 1,961 |
| 0.42 | 281.59 | n/a | 463 | 2,424 |
| 0.50 | 281.67 | n/a | 448 | 2,872 |
| 0.59 | 281.76 | n/a | 432 | 3,304 |
| 0.67 | 281.84 | n/a | 411 | 3,716 |
| 0.75 | 281.92 | n/a | 386 | 4,101 |
| 0.84 | 282.01 | n/a | 351 | 4,452 |
| 0.92 | 282.09 | n/a | 296 | 4,748 |
| 1.00 | 282.17 | n/a | 266 | 5,014 |
| 1.09 | 282.26 | n/a | 124 | 5,138 |
| 1.13 | 282.30 | n/a | 248 | 5,386 |
| 1.21 | 282.38 | n/a | 248 | 5,634 |
| 1.30 | 282.47 | n/a | 248 | 5,881 |
| 1.38 | 282.55 | n/a | 248 | 6,129 |
| 1.46 | 282.63 | n/a | 248 | 6,377 |
| 1.54 | 282.71 | n/a | 248 | 6,624 |

## Culvert / Orifice Structures

| | [A] | [B] | [C] | [PrfRsr] |
|---|---|---|---|---|
| **Rise (in)** | = 11.00 | 0.00 | 0.00 | 0.00 |
| **Span (in)** | = 11.00 | 0.00 | 0.00 | 0.00 |
| **No. Barrels** | = 1 | 0 | 0 | 0 |
| **Invert El. (ft)** | = 281.17 | 0.00 | 0.00 | 0.00 |
| **Length (ft)** | = 0.00 | 0.00 | 0.00 | 0.00 |
| **Slope (%)** | = 0.01 | 0.00 | 0.00 | n/a |
| **N-Value** | = .013 | .013 | .013 | n/a |
| **Orifice Coeff.** | = 0.60 | 0.60 | 0.60 | 0.60 |
| **Multi-Stage** | = n/a | No | No | No |

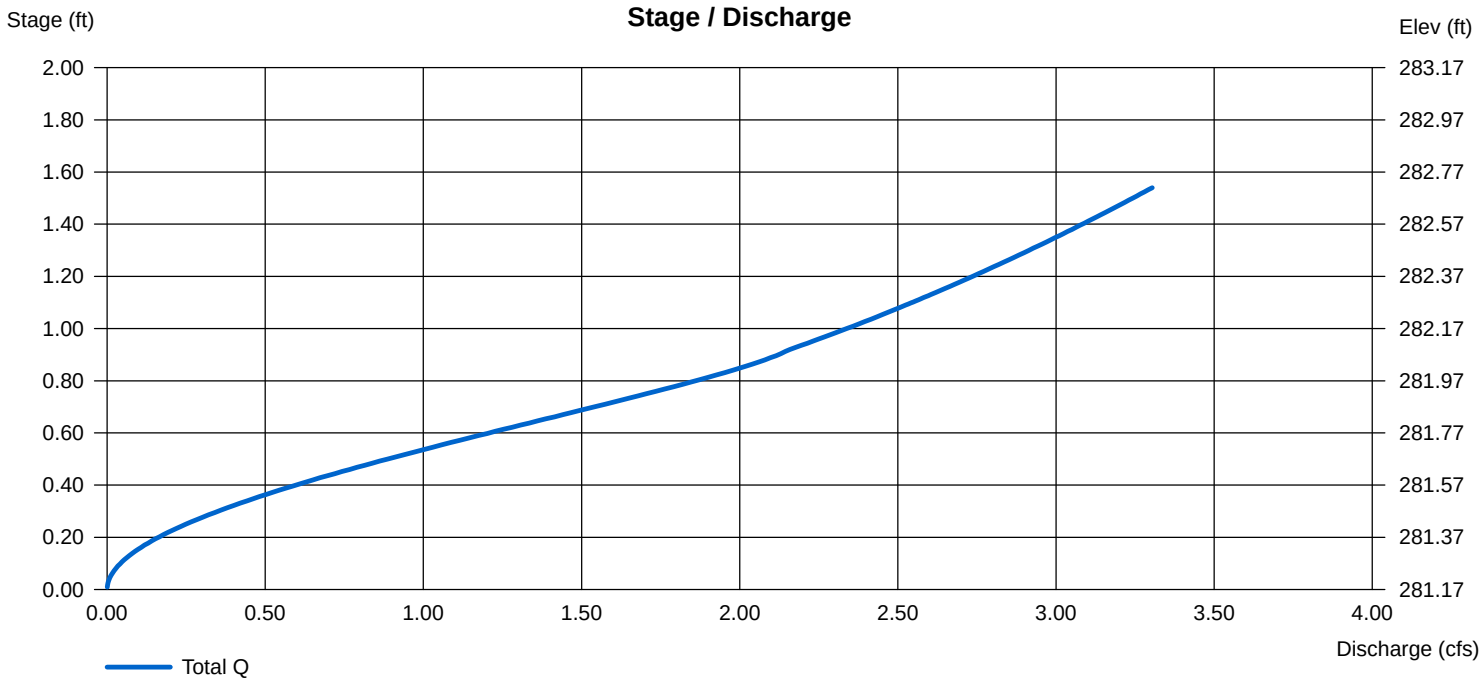
## Weir Structures

| | [A] | [B] | [C] | [D] |
|---|---|---|---|---|
| **Crest Len (ft)** | = 0.00 | 0.00 | 0.00 | 0.00 |
| **Crest El. (ft)** | = 0.00 | 0.00 | 0.00 | 0.00 |
| **Weir Coeff.** | = 3.33 | 3.33 | 3.33 | 3.33 |
| **Weir Type** | = --- | --- | --- | --- |
| **Multi-Stage** | = No | No | No | No |

**Exfil.(in/hr)** = 0.000 (by Wet area)

**TW Elev. (ft)** = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



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Brookfield, CT 06804

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Fax: 203-775-1462
www.cultec.com
custservice@cultec.com

CULTEC

| | |
|---|---|
| Number of chambers - | 245 |
| Stone Void - | 0.40 |
| Base of Stone Elevation - | 279.00 |

Given: 12" stone base
6" stone above units
52" center to center

# CULTEC Recharger 280 Incremental Storage Volumes

| Height of System (in) | Chamber Ht (in) | Incremental Chamber ($ft^3$) | Incremental Stone ($ft^3$) | Incremental Chamber & Stone ($ft^3$) | Cumulative Storage per Chamber ($ft^3$) | Cumulative Storage for System ($ft^3$) | Elevation |
|---|---|---|---|---|---|---|---|
| 44.5 | | 0.00 | 1.01 | 1.01 | 70.53 | 17278.93 | 282.71 |
| 43.5 | | 0.00 | 1.01 | 1.01 | 69.52 | 17031.21 | 282.63 |
| 42.5 | | 0.00 | 1.01 | 1.01 | 68.50 | 16783.49 | 282.54 |
| 41.5 | | 0.00 | 1.01 | 1.01 | 67.49 | 16535.76 | 282.46 |
| 40.5 | | 0.00 | 1.01 | 1.01 | 66.48 | 16288.04 | 282.38 |
| 39.5 | | 0.00 | 1.01 | 1.01 | 65.47 | 16040.32 | 282.29 |
| 38.5 | 26.5 | 0.00 | 0.51 | 0.51 | 64.46 | 15792.60 | 282.21 |
| 38 | 26 | 0.13 | 0.96 | 1.09 | 63.95 | 15668.74 | 282.17 |
| 37 | 25 | 0.33 | 0.88 | 1.21 | 62.87 | 15402.49 | 282.08 |
| 36 | 24 | 0.70 | 0.73 | 1.43 | 61.66 | 15106.41 | 282.00 |
| 35 | 23 | 0.94 | 0.64 | 1.57 | 60.23 | 14755.78 | 281.92 |
| 34 | 22 | 1.11 | 0.57 | 1.68 | 58.65 | 14370.18 | 281.83 |
| 33 | 21 | 1.25 | 0.51 | 1.76 | 56.97 | 13958.84 | 281.75 |
| 32 | 20 | 1.37 | 0.47 | 1.83 | 55.21 | 13526.93 | 281.67 |
| 31 | 19 | 1.46 | 0.43 | 1.89 | 53.38 | 13078.55 | 281.58 |
| 30 | 18 | 1.55 | 0.39 | 1.94 | 51.49 | 12615.77 | 281.50 |
| 29 | 17 | 1.62 | 0.36 | 1.99 | 49.55 | 12140.64 | 281.42 |
| 28 | 16 | 1.69 | 0.34 | 2.02 | 47.57 | 11654.19 | 281.33 |
| 27 | 15 | 1.74 | 0.31 | 2.06 | 45.54 | 11158.48 | 281.25 |
| 26 | 14 | 1.84 | 0.27 | 2.12 | 43.49 | 10654.53 | 281.17 |
| 25 | 13 | 1.87 | 0.26 | 2.13 | 41.37 | 10136.18 | 281.08 |
| 24 | 12 | 1.90 | 0.25 | 2.15 | 39.24 | 9613.72 | 281.00 |
| 23 | 11 | 1.93 | 0.24 | 2.17 | 37.09 | 9087.14 | 280.92 |
| 22 | 10 | 1.95 | 0.23 | 2.18 | 34.92 | 8556.44 | 280.83 |
| 21 | 9 | 2.01 | 0.21 | 2.22 | 32.74 | 8021.63 | 280.75 |
| 20 | 8 | 2.04 | 0.19 | 2.24 | 30.52 | 7478.58 | 280.67 |
| 19 | 7 | 2.06 | 0.19 | 2.25 | 28.29 | 6930.39 | 280.58 |
| 18 | 6 | 2.14 | 0.16 | 2.29 | 26.04 | 6380.14 | 280.50 |
| 17 | 5 | 2.14 | 0.15 | 2.30 | 23.75 | 5818.58 | 280.42 |
| 16 | 4 | 2.16 | 0.15 | 2.30 | 21.45 | 5255.98 | 280.33 |
| 15 | 3 | 2.17 | 0.14 | 2.31 | 19.15 | 4691.33 | 280.25 |
| 14 | 2 | 2.18 | 0.14 | 2.32 | 16.84 | 4124.61 | 280.17 |
| 13 | 1 | 2.28 | 0.10 | 2.38 | 14.51 | 3555.84 | 280.08 |
| 12 | | 0.00 | 1.01 | 1.01 | 12.13 | 2972.67 | 280.00 |
| 11 | | 0.00 | 1.01 | 1.01 | 11.12 | 2724.94 | 279.92 |
| 10 | | 0.00 | 1.01 | 1.01 | 10.11 | 2477.22 | 279.83 |
| 9 | | 0.00 | 1.01 | 1.01 | 9.10 | 2229.50 | 279.75 |
| 8 | | 0.00 | 1.01 | 1.01 | 8.09 | 1981.78 | 279.67 |
| 7 | | 0.00 | 1.01 | 1.01 | 7.08 | 1734.06 | 279.58 |
| 6 | | 0.00 | 1.01 | 1.01 | 6.07 | 1486.33 | 279.50 |
| 5 | | 0.00 | 1.01 | 1.01 | 5.06 | 1238.61 | 279.42 |
| 4 | | 0.00 | 1.01 | 1.01 | 4.04 | 990.89 | 279.33 |
| 3 | | 0.00 | 1.01 | 1.01 | 3.03 | 743.17 | 279.25 |
| 2 | | 0.00 | 1.01 | 1.01 | 2.02 | 495.44 | 279.17 |
| 1 | | 0.00 | 1.01 | 1.01 | 1.01 | 247.72 | 279.08 |
| ***TOTALS*** | | **42.55** | **27.97** | **70.53** | **70.53** | **17278.93** | |

VOLUME PROVIDED FOR 100-YEAR PRE V. POST = 6,624.4 CF

VOLUME REQUIRED = 6,224 CF

6,624.4 CF > 6,224 CF ✓

Created on: 3/30/2015

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# Technical Information

## CULTEC Recharger® 280HD

The Recharger® 280HD is a 26.5" (673 mm) tall, mid-size chamber and is typically used for installations with depth restrictions or when a larger infiltrative area is required. The Recharger® 280HD has the side portal internal manifold feature. HVLV™ FC-24 Feed Connectors are inserted into the side portals to create the internal manifold.

| | |
|---|---|
| Size (L x W x H) | 8' x 47" x 26.5"<br>2.44 m x 1194 mm x 673 mm |
| Installed Length | 7'<br>2.13 m |
| Length Adjustment per Run | 1'<br>0.30 m |
| Chamber Storage | 6.08 $ft^3/ft$<br>0.56 $m^3/m$<br>42.55 $ft^3/unit$<br>1.21 $m^3/unit$ |
| Min. Installed Storage | 9.21 $ft^3/ft$<br>0.86 $m^3/m$<br>64.46 $ft^3/unit$<br>1.83 $m^3/unit$ |
| Min. Area Required | 30.33 $ft^2$<br>2.82 $m^2$ |
| Min. Center to Center Spacing | 4.33'<br>1.32 m |
| Max. Allowable Cover | 12'<br>3.66 m |
| Max. Inlet Opening in Endwall | 18"<br>450 mm |
| Side Portal Dimensions (H x W) | 12" x 12"<br>305 mm x 305 mm |
| Max. Allowable Pipe Size in Side Portal | 10"<br>250 mm |
| Compatible Feed Connector | HVLV™ FC-24 Feed Connector |

| | Stone Foundation Depth | | |
|---|---|---|---|
| | 6" | 12" | 18" |
| | 152 mm | 305 mm | 457 mm |
| Chamber and Stone Storage Per Chamber | 64.46 $ft^3$<br>1.83 $m^3$ | 70.53 $ft^3$<br>2.00 $m^3$ | 76.59 $ft^3$<br>2.17 $m^3$ |
| Min. Effective Depth | 3.21'<br>0.98 m | 3.71'<br>1.13 m | 4.21'<br>1.28 m |
| Stone Required Per Chamber | 2.03 $yd^3$<br>1.55 $m^3$ | 2.59 $yd^3$<br>1.98 $m^3$ | 3.15 $yd^3$<br>2.41 $m^3$ |

Calculations are based on installed chamber length.
Includes 6" (152 mm) stone above crown of chamber and typical stone surround.
Stone void calculated at 40%.

**Recharger® 280HD Bare Chamber Storage Volumes**

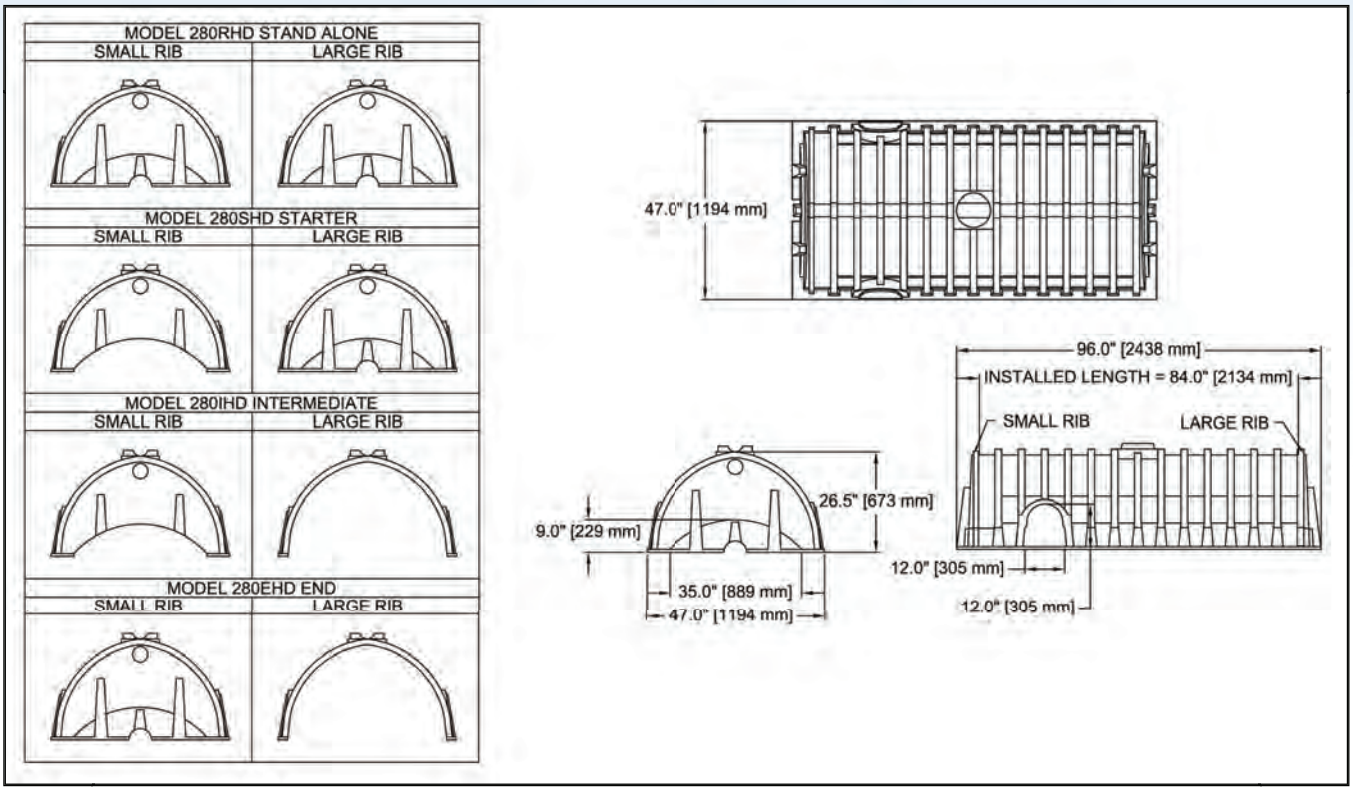
| Elevation | | Incremental Storage Volume | | | | Cumulative Storage | |
|---|---|---|---|---|---|---|---|
| in. | mm | $ft^3/ft$ | $m^3/m$ | $ft^3$ | $m^3$ | $ft^3$ | $m^3$ |
| 26.5 | 686 | 0.000 | 0.000 | 0.000 | 0.000 | 42.553 | 1.205 |
| 26 | 660 | 0.018 | 0.002 | 0.126 | 0.004 | 42.553 | 1.205 |
| 25 | 635 | 0.047 | 0.004 | 0.329 | 0.009 | 42.427 | 1.202 |
| 24 | 609 | 0.100 | 0.009 | 0.700 | 0.020 | 42.098 | 1.192 |
| 23 | 584 | 0.134 | 0.012 | 0.938 | 0.027 | 41.398 | 1.172 |
| 22 | 559 | 0.159 | 0.015 | 1.113 | 0.032 | 40.460 | 1.146 |
| 21 | 533 | 0.179 | 0.017 | 1.253 | 0.035 | 39.347 | 1.114 |
| 20 | 508 | 0.195 | 0.018 | 1.365 | 0.039 | 38.094 | 1.079 |
| 19 | 483 | 0.209 | 0.019 | 1.463 | 0.041 | 36.729 | 1.040 |
| 18 | 457 | 0.221 | 0.021 | 1.547 | 0.044 | 35.266 | 0.999 |
| 17 | 432 | 0.232 | 0.022 | 1.624 | 0.046 | 33.719 | 0.955 |
| 16 | 406 | 0.241 | 0.022 | 1.687 | 0.048 | 32.095 | 0.909 |
| 15 | 381 | 0.249 | 0.023 | 1.743 | 0.049 | 30.408 | 0.861 |
| 14 | 356 | 0.263 | 0.024 | 1.841 | 0.052 | 28.665 | 0.812 |
| 13 | 330 | 0.267 | 0.025 | 1.869 | 0.053 | 26.824 | 0.760 |
| 12 | 305 | 0.271 | 0.025 | 1.897 | 0.054 | 24.955 | 0.707 |
| 11 | 279 | 0.275 | 0.026 | 1.925 | 0.055 | 23.058 | 0.653 |
| 10 | 254 | 0.279 | 0.026 | 1.953 | 0.055 | 21.133 | 0.598 |
| 9 | 229 | 0.287 | 0.027 | 2.009 | 0.057 | 19.180 | 0.543 |
| 8 | 203 | 0.292 | 0.027 | 2.044 | 0.058 | 17.171 | 0.486 |
| 7 | 178 | 0.294 | 0.027 | 2.058 | 0.058 | 15.127 | 0.428 |
| 6 | 152 | 0.305 | 0.028 | 2.135 | 0.060 | 13.069 | 0.370 |
| 5 | 127 | 0.306 | 0.028 | 2.142 | 0.061 | 10.934 | 0.310 |
| 4 | 102 | 0.308 | 0.029 | 2.156 | 0.061 | 8.792 | 0.249 |
| 3 | 76 | 0.310 | 0.029 | 2.170 | 0.061 | 6.636 | 0.188 |
| 2 | 51 | 0.312 | 0.029 | 2.184 | 0.062 | 4.466 | 0.126 |
| 1 | 25 | 0.326 | 0.030 | 2.282 | 0.065 | 2.282 | 0.065 |
| Total | | 6.079 | 0.565 | 42.553 | 1.205 | 42.553 | 1.205 |

Calculations are based on installed chamber length.

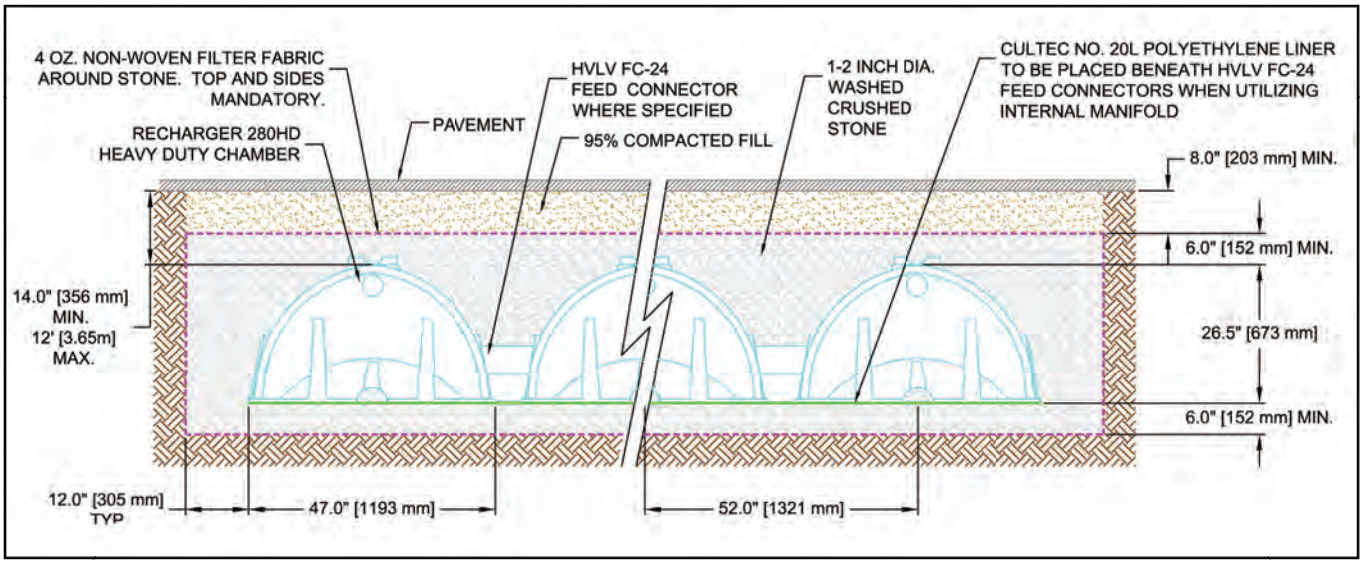
# Technical Information

## CULTEC Recharger® 280HD

### Three View Drawing




### Typical Cross Section for Paved Traffic Application



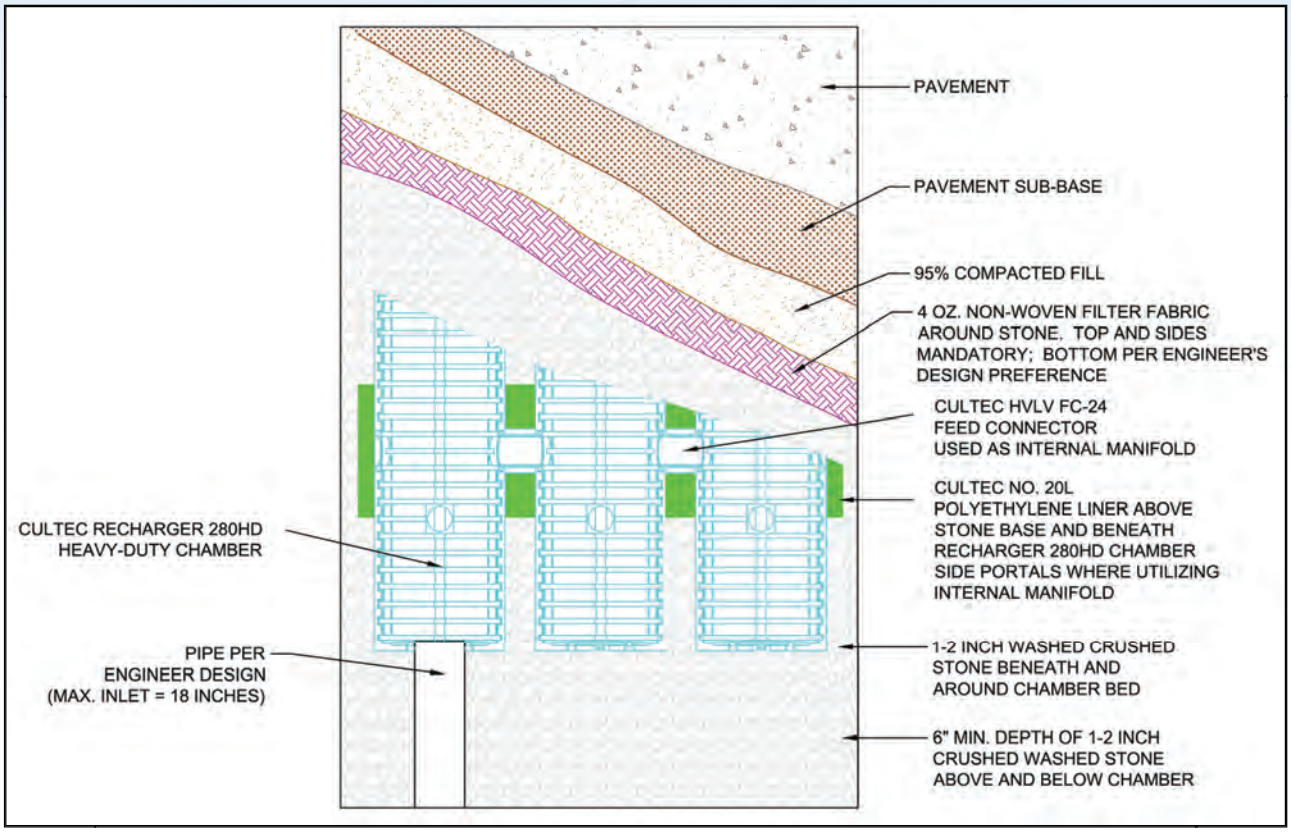

Scan for Recharger 280HD downloads

Recharger® 280HD

# Technical Information

## CULTEC Recharger® 280HD

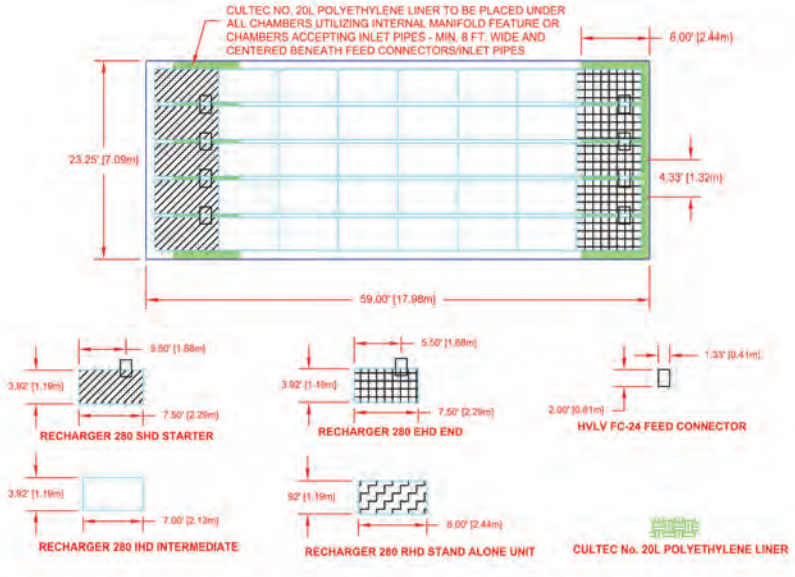
### Plan View Drawing




### Typical Bed Layout

#### Using AutoCAD Array Function

1. Add Alternate Units to your Dimension Style and use 0.3048 as the Multiplier
2. Using the Rectangle command, create the three chamber outlines and the feed connectors:
   - Starter: 3.92' x 7.5'
   - Intermediate: 3.92' x 7.0'
   - End: 3.92' x 7.5'
   - Feed Connector: 1.33' x 2'
3. Hatch the Starter and End chambers to differentiate them. Place a feed connector (as shown) at one end of the starter and end chambers.
4. Select the Intermediate chamber and select the array command.
5. Specify the number of rows and columns (ex. 10 rows, 7 columns). Do not included the starter and end chambers in the column count.
6. The chambers should be oriented horizontally (as shown). Set the row offset to 4.33' and the column offset to 7'. The rotation angle should be 0.
7. Click accept to create the bed.
8. If R-Model chamber is incorporated into the design, use the Rectangle command to create a chamber outline 8.00' x 3.92'. Hatch the R-Model chambers using a unique pattern to differntiate them. Orient the R-Model chambers horizontally, and orient the chambers so there is a .42' spacing between the R-Model and the rest of the chamber rows. Proceed to steps 9 and 10 using the Polyline command instead of the Rectange command to show the stone border and polyethylene liner. If no R-Model is incorporated into the design, proceed to steps 9 and 10.
9. Using the Rectangle command to surround the bed. Offset the rectangle 1' to represent the stone border.
10. Using the Rectangle command create a polyethylene liner underneath the feed connectors at both ends of the bed. It should be 5' wide and span the width of the bed. Apply correct hatching and label the liner.




Bed Design Aide download available online

CULTEC

## CULTEC Recharger® 280HD Specifications

### GENERAL

CULTEC Recharger® 280HD chambers are designed for underground stormwater management. The chambers may be used for retention, recharging, detention or controlling the flow of on-site stormwater runoff.

### CHAMBER PARAMETERS

1. The chambers will be manufactured by CULTEC, Inc. of Brookfield, CT. (203-775-4416 or 1-800-428-5832)
2. The chamber will be vacuum thermoformed of black high molecular weight high density polyethylene (HMWHDPE).
3. The chamber will be arched in shape.
4. The chamber will be open-bottomed.
5. The chamber will be joined using an interlocking overlapping rib method. Connections must be fully shouldered overlapping ribs, having no separate couplings or separate end walls.
6. The nominal chamber dimensions of the CULTEC Recharger® 280HD shall be 26.5 inches (673 mm) tall, 47 inches (1194 mm) wide and 8 feet (2.44 m) long. The installed length of a joined Recharger® 280HD shall be 7 feet (2.13 m).
7. Maximum inlet opening on the chamber endwall is 18 inches (450 mm).
8. The chamber will have two side portals to accept CULTEC HVLV® FC-24 Feed Connectors to create an internal manifold. The nominal dimensions of each side portal will be 12 inches (305 mm) high by 12 inches (305 mm) wide. Maximum allowable pipe size in the side portal is 10 inches (250 mm).
9. The nominal chamber dimensions of the CULTEC HVLV® FC-24 Feed Connector shall be 12 inches (305 mm) tall, 16 inches (406 mm) wide and 24.2 inches (614 mm) long.
10. The nominal storage volume of the Recharger® 280HD chamber will be 6.079 $ft^3$ / ft (0.565 $m^3$ / m) - without stone. The nominal storage volume of a single Recharger 280RHD Stand Alone unit shall be 48.63 $ft^3$ (1.38 $m^3$) - without stone. The nominal storage volume of a joined Recharger® 280IHD Intermediate unit shall be 42.553 $ft^3$ (1.205 $m^3$) - without stone. The nominal storage volume of the length adjustment amount per run shall be 6.08 $ft^3$ (0.56 $m^3$) - without stone.
11. The nominal storage volume of the HVLV® FC-24 Feed Connector will be 0.913 $ft^3$ / ft (0.085 $m^3$ / m) - without stone.
12. The Recharger® 280HD chamber will have eighty-two discharge holes bored into the sidewalls of the unit's core to promote lateral conveyance of water.
13. The Recharger® 280HD chamber shall have 15 corrugations.
14. The endwall of the chamber, when present, will be an integral part of the continuously formed unit. Separate end plates cannot be used with this unit.
15. The Recharger® 280RHD Stand Alone unit must be formed as a whole chamber having two fully formed integral endwalls and having no separate end plates or separate end walls.
16. The Recharger® 280SHD Starter unit must be formed as a whole chamber having one fully formed integral endwall and one partially formed integral endwall with a lower transfer opening of 9 inches (229 mm) high x 35 inches (889 mm) wide.
17. The Recharger® 280IHD Intermediate unit must be formed as a whole chamber having one fully open endwall and one partially formed integral endwall with a lower transfer opening of 9 inches (229 mm) high x 35 inches (889 mm) wide.
18. The Recharger® 280EHD End unit must be formed as a whole chamber having one fully formed integral endwall and one fully open end wall and having no separate end plates or end walls.
19. The HVLV® FC-24 Feed Connector must be formed as a whole chamber having two open end walls and having no separate end plates or separate end walls. The unit will fit into the side portals of the Recharger® 280HD and act as cross feed connections.
20. Chambers must have horizontal stiffening flex reduction steps between the ribs.
21. Heavy duty units are designated by a colored stripe formed into the part along the length of the chamber.
22. The chamber will have a raised integral cap at the top of the arch in the center of each unit to be used as an optional inspection port or clean-out.
23. The units may be trimmed to custom lengths by cutting back to any corrugation on the large rib end.
24. The chamber shall be manufactured in an ISO 9001:2000 certified facility.
25. Maximum allowable cover over the top of the chamber shall be 12' (3.66 m).
26. The chamber will be designed to withstand traffic loads when installed according to CULTEC's recommended installation instructions.