Appendix E:
Hydrology and Water Quality Supporting Information

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Thienes Engineering, Inc.
CIVIL ENGINEERING • LAND SURVEYING

PRELIMINARY HYDROLOGY CALCULATIONS

FOR

AGUA MANSA COMMERCE CENTER
AGUA MANSA ROAD
COLTON, CA 92324

PREPARED FOR

IDI Agua Mansa, LLC
840 APOLLO STREET, STE 343
EL SEGUNDO, CA 90245
P. (213) 330-8066

APRIL 09, 2020
REVISED MAY 18, 2020
REVISED SEPTEMBER 11, 2020

JOB NO. 3813

PREPARED BY

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PRELIMINARY HYDROLOGY CALCULATIONS

FOR

AGUA MANSA COMMERCE CENTER

PREPARED UNDER
THE SUPERVISION OF

REINHARD STENZEL DATE:
R.C.E. 56155
EXP. 12/31/2020

INTRODUCTION

A: PROJECT LOCATION

The project site is located on south side of Agua Mansa Road, west of Rancho Avenue, and east of the Walmart Distribution Center in the City of Colton. Please see following page for vicinity map.

B: STUDY PURPOSE

The purpose of this study is to determine the 100-year proposed condition hydrology for the project site.

C: PROJECT STAFF:

Thienes Engineering staff involved in this study include:

Reinhard Stenzel
Kristie Ferronato

Last Update:10/8/19
O:\3800-3899\3813\3813VicMap.dwg

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VICINITY MAP

FOR

AGUA MANSA LOGISTIC CENTER

DISCUSSION

Project Description

The project site encompasses approximately 59.00 acres. Proposed improvements to the site will include two warehouse type buildings approximately 520,000 and 668,000 square feet. The south portion of the site will be truck yards with trailer parking. Vehicle parking will be along the north, east, and west sides of the buildings. Landscape will be scattered along the perimeter of the project.

Existing Condition

The project site is undeveloped with areas that are barren and areas that have natural cover. The site drains to the Santa Ana River, which is the south border of the site.

Off-Site Drainage

The site receives run-on from the slope north of the project site. The slopes are along the north side of Agua Mansa. The street does not convey the entire flow rate, the run-off runs through the project site. A proposed earthen swale will be graded on the north side of Agua Mansa. A series of CMP risers will be installed to capture the runoff from the north side, along with catch basins in the south half of the street. A public storm drain will be installed to convey the runoff westerly towards the western drive aisle of the project. The total tributary area to Agua Mansa is approximately 32.15 acres. The 100-year peak flow rate is approximately 43.8 cfs (node 500-504 per the offsite hydrology map).

The public storm drain will turn southerly at the western drive aisle of the project and discharge to the Santa Ana River after the on-site flows are added.

See Appendix "C" for the offsite hydrology map.

Proposed Condition

The site will continue to drain southwesterly towards the Santa Ana River. There will be two main line storm drains, which will drain different portions of the site. These onsite storm drain systems will tie into the public storm drain (along the westerly portion of the site) at two separate locations (Node 562 and 564 per the offsite hydrology map).

Runoff from the easterly building lot (node 100-203 per the onsite hydrology map) will drain to several catch basins located north and south of the aforementioned building. Flows will be conveyed southerly, then westerly via onsite storm drain, where it will tie

into the public storm drain (at node 364 per the offsite hydrology map). The 100-year peak flow rate is approximately 83.4 cfs.
Runoff from the trailer parking (located in the center of the project site) and the majority of the westerly building lot will be conveyed to the northwesterly portion of the site via onsite storm drain (node 300-403) and tie into the public storm drain (at node 362 per the offsite hydrology map).

Flows from the trailer parking all drain southerly, where it will be picked up by several catch basins along the southerly portion of the site. Flows are conveyed westerly (node 300-342). Runoff from the southeasterly portion of the building will drain to a catch basin in the southerly drive aisle (node 340-341). This catch basin will tie into the onsite storm drain at node 342. The onsite storm drain will continue northerly through the vehicle parking lot easterly adjacent to the building (node 342-352). Flows from the vehicle parking lot will also drain to this storm drain. The storm drain wraps around the northeasterly portion of the building, then jogs westerly along the truckyard, where it will tie into the public storm drain (at node 403). Flows from the aforementioned truckyard will also drain into the onsite storm drain (node 360-402). The 100-year peak flow rate conveyed by this particular onsite storm drain is approximately 87.5 cfs.

The westerly drive aisle that runs along the westerly property line of the site will receive some runoff from the southwest portion of the building roof. There will be catch basins in the drive aisle, which will tie directly into the public storm drain system. The 100-year peak flow rate draining to the drive aisle is approximately 11.6 cfs.

Overall, the Q100 from the site draining to the Santa Ana River is approximately 182.6 cfs. This value is the sum of peak flow rates as mentioned above. See table below for a summary of onsite and offsite flows.

rational method file name	description of area	node	acres	Q100
P100 (onsite)	easterly portion of site	100-204	23.35	83.35
P300 (onsite)	central and westerly portion of site	300-403	31.75	87.49
X200 (offsite only)	undeveloped areas north of the site	500-504	32.15	43.78
X200 (onsite)	southwest portion of the site and westerly drive aisle	600 - 563	3.9	11.8
X200 sum	all areas tributary to the proposed onsite and offsite storm drains	565	**91.15**	**203.96**

The overall Q100 draining to the Santa Ana River when analyzing the onsite and offsite areas tributary to the project site is approximately 204.0 cfs.

See Appendix "A" for pertinent reference material, Appendix "B" for hydrology calculations, and Appendix "C" for hydrology maps.

DETENTION

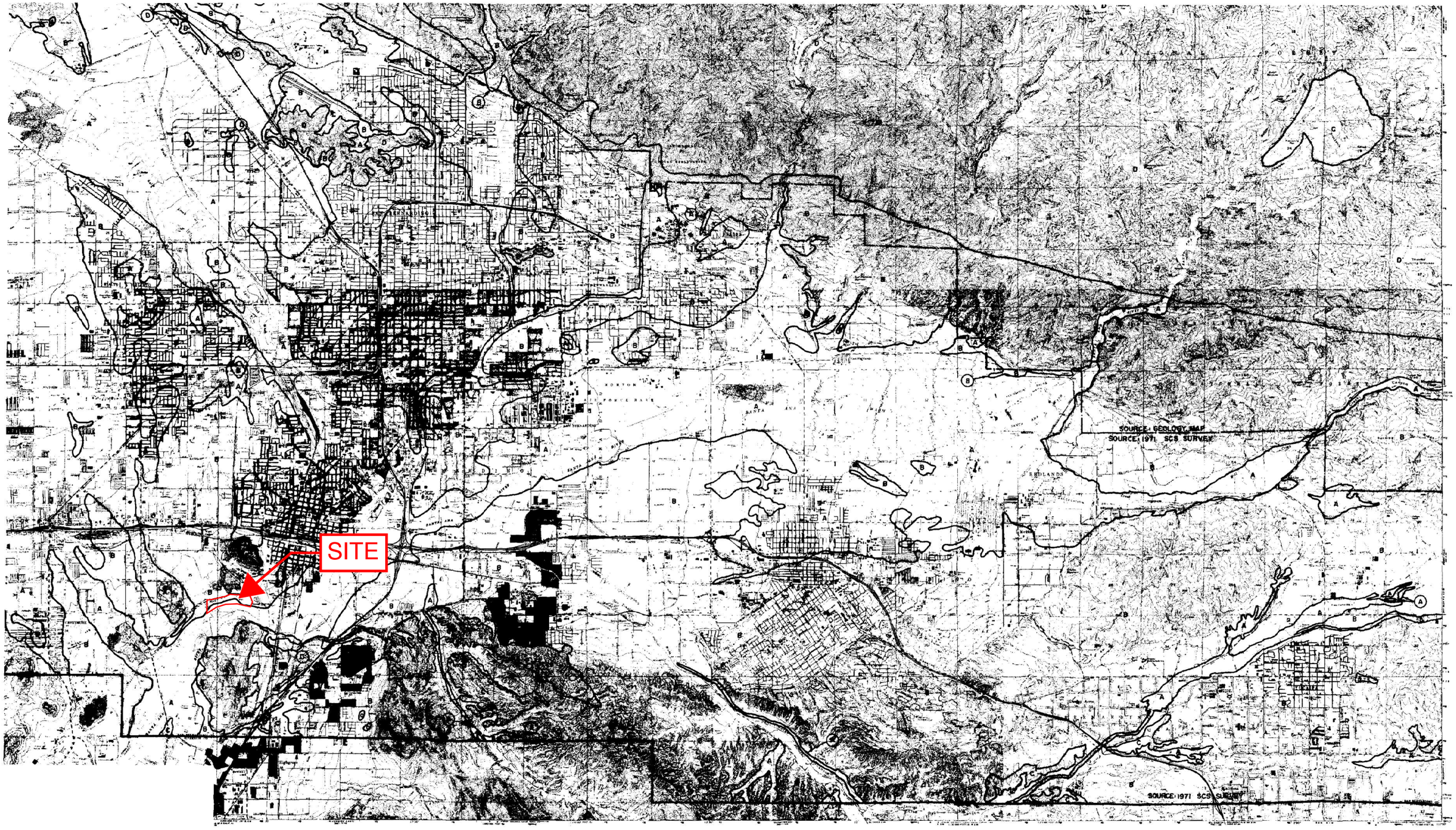
The HGL in the Santa Ana River is high at the connection point. The HGL in the proposed public system which the private storm drain connects to is approximately 882.6. This elevation is above the grate elevations in the truck yard of building 1. This will cause ponding in the truck yard during 100 year peak flow events. A flap gate will be installed at the connection point to prevent river water from entering the storm drain and truck yards.

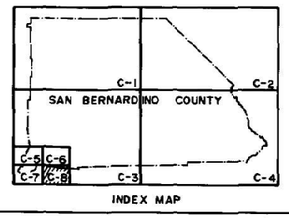
Methodology

San Bernardino County Rational Method program (AES Software) was used for the hydrology calculations. The San Bernardino County Flood Routing Analysis program (also by AES Software) was used for detention calculations. The site is composed of soil type "B" per the San Bernardino County Hydrology Manual.

APPENDIX A

REFERENCE MATERIALS





INDEX MAP

LEGEND

SOIL GROUP BOUNDARY

A SOIL GROUP DESIGNATION

BOUNDARY OF INDICATED SOURCE

SCALE 1:48,000

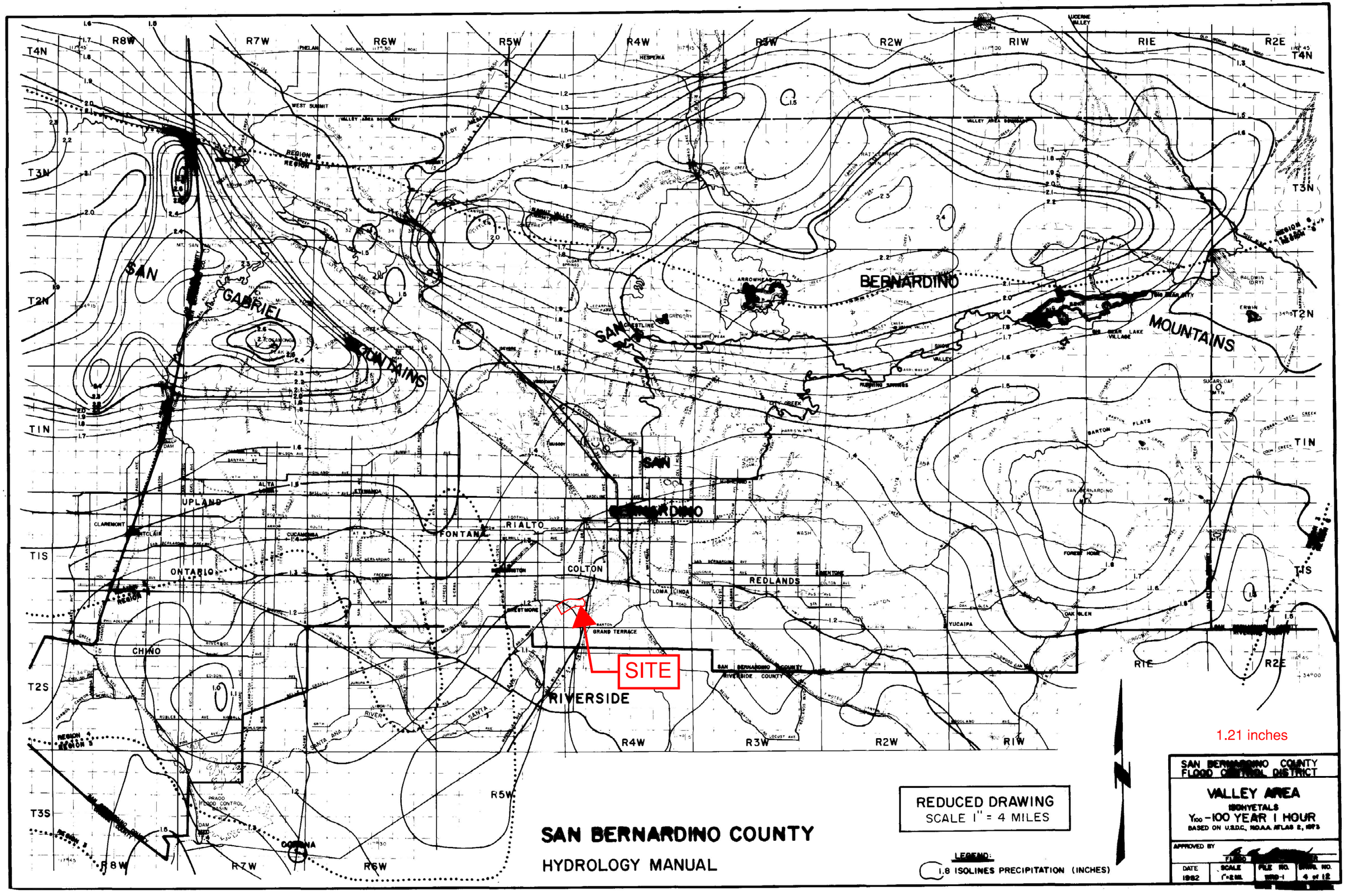
SCALE REDUCED BY 1/2

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

HYDROLOGIC SOILS GROUP MAP
FOR
SOUTHWEST-D AREA

FIGURE C-16



1.21 inches

FIGURE B-4

APPENDIX B

HYDROLOGY CALCULATIONS

PROPOSED CONDITION

```
**************************************************************************
            RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
         (Reference: 1986 SAN BERNARDINO CO. HYDROLOGY CRITERION)
        (c) Copyright 1983-2016 Advanced Engineering Software (aes)
            Ver. 23.0  Release Date: 07/01/2016  License ID 1435

                          Analysis prepared by:




 ************************ DESCRIPTION OF STUDY ************************
* AGUA MANSA COMMERCE CENTER                                          *
* PROPOSED CONDITION 100 YEAR ON SITE                                 *
* NODE 100-204 (TIES IN AT NODE 364 OF OFFSITE SD)                    *
 **********************************************************************

  FILE NAME: W:\3813\P100.DAT
  TIME/DATE OF STUDY: 15:42 09/11/2020
==========================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
==========================================================================
                    --*TIME-OF-CONCENTRATION MODEL*--

  USER SPECIFIED STORM EVENT(YEAR) =  100.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =  12.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.95
  *USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL*

  SLOPE OF INTENSITY DURATION CURVE(LOG(I;IN/HR) vs. LOG(Tc;MIN)) = 0.6000
  USER SPECIFIED 1-HOUR INTENSITY(INCH/HOUR) = 1.2100

  *ANTECEDENT MOISTURE CONDITION (AMC) III ASSUMED FOR RATIONAL METHOD*

  *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.*
  *USER-SPECIFIED MINIMUM TOPOGRAPHIC SLOPE ADJUSTMENT NOT SELECTED

**************************************************************************
  FLOW PROCESS FROM NODE    100.00 TO NODE    101.00 IS CODE =  21
--------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
==========================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   734.00
  ELEVATION DATA: UPSTREAM(FEET) =    901.98  DOWNSTREAM(FEET) =    888.34

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    9.448
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  3.668
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp          Ap      SCS   Tc
        LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                  A        0.25      0.74      0.100    52    9.45
  COMMERCIAL                  B        5.35      0.42      0.100    76    9.45
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.44
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA RUNOFF(CFS) =     18.27
  TOTAL AREA(ACRES) =      5.60   PEAK FLOW RATE(CFS) =     18.27

**************************************************************************
  FLOW PROCESS FROM NODE    101.00 TO NODE    112.00 IS CODE =  31
--------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
==========================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   884.34  DOWNSTREAM(FEET) =   883.37
  FLOW LENGTH(FEET) =   243.00   MANNING'S N =  0.012
  DEPTH OF FLOW IN  27.0 INCH PIPE IS  19.7 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   5.87
  ESTIMATED PIPE DIAMETER(INCH) =  27.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      18.27
  PIPE TRAVEL TIME(MIN.) =   0.69    Tc(MIN.) =   10.14
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    112.00 =     977.00 FEET.

**************************************************************************
  FLOW PROCESS FROM NODE    112.00 TO NODE    112.00 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.) =   10.14
  RAINFALL INTENSITY(INCH/HR) =   3.52
  AREA-AVERAGED Fm(INCH/HR) =  0.04
  AREA-AVERAGED Fp(INCH/HR) =  0.44
  AREA-AVERAGED Ap =  0.10
  EFFECTIVE STREAM AREA(ACRES) =       5.60
  TOTAL STREAM AREA(ACRES) =       5.60
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      18.27

**************************************************************************
  FLOW PROCESS FROM NODE    110.00 TO NODE    111.00 IS CODE =  21
--------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
==========================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   147.00
  ELEVATION DATA: UPSTREAM(FEET) =    889.96  DOWNSTREAM(FEET) =    888.68

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
```

```
 SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    5.779
 * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  4.927
 SUBAREA Tc AND LOSS RATE DATA(AMC III):
  DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap     SCS   Tc
      LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
 COMMERCIAL                  A        0.05      0.74     0.100    52    5.78
 COMMERCIAL                  B        1.45      0.42     0.100    76    5.78
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.43
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
 SUBAREA RUNOFF(CFS) =      6.59
 TOTAL AREA(ACRES) =      1.50   PEAK FLOW RATE(CFS) =      6.59

****************************************************************************
 FLOW PROCESS FROM NODE    111.00 TO NODE    112.00 IS CODE =  31
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   884.68  DOWNSTREAM(FEET) =   883.37
 FLOW LENGTH(FEET) =    12.00   MANNING'S N =  0.012
 DEPTH OF FLOW IN  12.0 INCH PIPE IS   6.2 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =  16.06
 ESTIMATED PIPE DIAMETER(INCH) =  12.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =       6.59
 PIPE TRAVEL TIME(MIN.) =   0.01    Tc(MIN.) =    5.79
 LONGEST FLOWPATH FROM NODE    110.00 TO NODE    112.00 =     159.00 FEET.

****************************************************************************
 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 =  2
 CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
 TIME OF CONCENTRATION(MIN.) =    5.79
 RAINFALL INTENSITY(INCH/HR) =   4.92
 AREA-AVERAGED Fm(INCH/HR) =  0.04
 AREA-AVERAGED Fp(INCH/HR) =  0.43
 AREA-AVERAGED Ap =  0.10
 EFFECTIVE STREAM AREA(ACRES) =       1.50
 TOTAL STREAM AREA(ACRES) =       1.50
 PEAK FLOW RATE(CFS) AT CONFLUENCE =       6.59

 ** CONFLUENCE DATA **
  STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
  NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)     NODE
     1       18.27   10.14    3.516  0.44( 0.04) 0.10       5.6     100.00
     2        6.59    5.79    4.921  0.43( 0.04) 0.10       1.5     110.00

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

 ** PEAK FLOW RATE TABLE **
  STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
  NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)     NODE
     1       21.25    5.79    4.921  0.44( 0.04) 0.10       4.7     110.00
     2       22.96   10.14    3.516  0.44( 0.04) 0.10       7.1     100.00

 COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
 PEAK FLOW RATE(CFS) =      22.96    Tc(MIN.) =    10.14
 EFFECTIVE AREA(ACRES) =       7.10   AREA-AVERAGED Fm(INCH/HR) =  0.04
 AREA-AVERAGED Fp(INCH/HR) =  0.44  AREA-AVERAGED Ap =  0.10
 TOTAL AREA(ACRES) =       7.1
 LONGEST FLOWPATH FROM NODE    100.00 TO NODE    112.00 =     977.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    112.00 TO NODE    122.00 IS CODE =  31
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   883.37  DOWNSTREAM(FEET) =   882.72
 FLOW LENGTH(FEET) =   161.00   MANNING'S N =  0.012
 DEPTH OF FLOW IN  30.0 INCH PIPE IS  20.9 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =   6.27
 ESTIMATED PIPE DIAMETER(INCH) =  30.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =      22.96
 PIPE TRAVEL TIME(MIN.) =   0.43    Tc(MIN.) =   10.57
 LONGEST FLOWPATH FROM NODE    100.00 TO NODE    122.00 =    1138.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    122.00 TO NODE    122.00 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.) =   10.57
 RAINFALL INTENSITY(INCH/HR) =   3.43
 AREA-AVERAGED Fm(INCH/HR) =  0.04
 AREA-AVERAGED Fp(INCH/HR) =  0.44
 AREA-AVERAGED Ap =  0.10
 EFFECTIVE STREAM AREA(ACRES) =       7.10
 TOTAL STREAM AREA(ACRES) =       7.10
 PEAK FLOW RATE(CFS) AT CONFLUENCE =      22.96

****************************************************************************
 FLOW PROCESS FROM NODE    120.00 TO NODE    121.00 IS CODE =  21
----------------------------------------------------------------------------
 >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
 >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
 INITIAL SUBAREA FLOW-LENGTH(FEET) =   147.00
 ELEVATION DATA: UPSTREAM(FEET) =    889.96  DOWNSTREAM(FEET) =    888.68

 Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
 SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    5.779
 * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  4.927
 SUBAREA Tc AND LOSS RATE DATA(AMC III):
  DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap     SCS   Tc
      LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
 COMMERCIAL                  A        0.40      0.74     0.100    52    5.78
 COMMERCIAL                  B        1.75      0.42     0.100    76    5.78
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.48
```

```
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA RUNOFF(CFS) =      9.44
  TOTAL AREA(ACRES) =      2.15   PEAK FLOW RATE(CFS) =      9.44

****************************************************************************
  FLOW PROCESS FROM NODE    121.00 TO NODE    122.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   884.68  DOWNSTREAM(FEET) =   882.72
  FLOW LENGTH(FEET) =    13.00   MANNING'S N =  0.012
  DEPTH OF FLOW IN  12.0 INCH PIPE IS   7.0 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =  19.77
  ESTIMATED PIPE DIAMETER(INCH) =  12.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       9.44
  PIPE TRAVEL TIME(MIN.) =   0.01    Tc(MIN.) =    5.79
  LONGEST FLOWPATH FROM NODE    120.00 TO NODE    122.00 =     160.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    122.00 TO NODE    122.00 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.) =    5.79
  RAINFALL INTENSITY(INCH/HR) =   4.92
  AREA-AVERAGED Fm(INCH/HR) =  0.05
  AREA-AVERAGED Fp(INCH/HR) =  0.48
  AREA-AVERAGED Ap =  0.10
  EFFECTIVE STREAM AREA(ACRES) =       2.15
  TOTAL STREAM AREA(ACRES) =       2.15
  PEAK FLOW RATE(CFS) AT CONFLUENCE =       9.44

  ** CONFLUENCE DATA **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1       21.25    6.22    4.712  0.44( 0.04) 0.10       4.7     110.00
      1       22.96   10.57    3.430  0.44( 0.04) 0.10       7.1     100.00
      2        9.44    5.79    4.921  0.48( 0.05) 0.10       2.2     120.00

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

  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1       30.09    5.79    4.921  0.45( 0.05) 0.10       6.5     120.00
      2       30.28    6.22    4.712  0.45( 0.05) 0.10       6.8     110.00
      3       29.52   10.57    3.430  0.45( 0.04) 0.10       9.2     100.00

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      30.28    Tc(MIN.) =     6.22
  EFFECTIVE AREA(ACRES) =       6.85   AREA-AVERAGED Fm(INCH/HR) =  0.05
  AREA-AVERAGED Fp(INCH/HR) =  0.45  AREA-AVERAGED Ap =  0.10
  TOTAL AREA(ACRES) =       9.2
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    122.00 =    1138.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    122.00 TO NODE    132.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   882.72  DOWNSTREAM(FEET) =   882.08
  FLOW LENGTH(FEET) =   161.00   MANNING'S N =  0.012
  DEPTH OF FLOW IN  33.0 INCH PIPE IS  23.6 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   6.66
  ESTIMATED PIPE DIAMETER(INCH) =  33.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      30.28
  PIPE TRAVEL TIME(MIN.) =   0.40    Tc(MIN.) =    6.63
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    132.00 =    1299.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    132.00 TO NODE    132.00 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.) =    6.63
  RAINFALL INTENSITY(INCH/HR) =   4.54
  AREA-AVERAGED Fm(INCH/HR) =  0.05
  AREA-AVERAGED Fp(INCH/HR) =  0.45
  AREA-AVERAGED Ap =  0.10
  EFFECTIVE STREAM AREA(ACRES) =       6.85
  TOTAL STREAM AREA(ACRES) =       9.25
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      30.28

****************************************************************************
  FLOW PROCESS FROM NODE    130.00 TO NODE    131.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   147.00
  ELEVATION DATA: UPSTREAM(FEET) =    889.96  DOWNSTREAM(FEET) =    888.68

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    5.779
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  4.927
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/       SCS SOIL   AREA       Fp          Ap     SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                  B        1.45      0.42     0.100     76    5.78
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.42
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA RUNOFF(CFS) =      6.37
  TOTAL AREA(ACRES) =      1.45   PEAK FLOW RATE(CFS) =      6.37

****************************************************************************
  FLOW PROCESS FROM NODE    131.00 TO NODE    132.00 IS CODE =  31
----------------------------------------------------------------------------
```

```
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   884.68  DOWNSTREAM(FEET) =   882.08
  FLOW LENGTH(FEET) =    13.00   MANNING'S N =  0.012
  ESTIMATED PIPE DIAMETER(INCH) INCREASED TO 12.000
  DEPTH OF FLOW IN  12.0 INCH PIPE IS   5.1 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =  19.93
  ESTIMATED PIPE DIAMETER(INCH) =  12.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       6.37
  PIPE TRAVEL TIME(MIN.) =   0.01    Tc(MIN.) =    5.79
  LONGEST FLOWPATH FROM NODE    130.00 TO NODE    132.00 =     160.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    132.00 TO NODE    132.00 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.) =    5.79
  RAINFALL INTENSITY(INCH/HR) =   4.92
  AREA-AVERAGED Fm(INCH/HR) =  0.04
  AREA-AVERAGED Fp(INCH/HR) =  0.42
  AREA-AVERAGED Ap =  0.10
  EFFECTIVE STREAM AREA(ACRES) =       1.45
  TOTAL STREAM AREA(ACRES) =       1.45
  PEAK FLOW RATE(CFS) AT CONFLUENCE =       6.37

  ** CONFLUENCE DATA **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1       30.09    6.19    4.727  0.45( 0.05) 0.10       6.5     120.00
      1       30.28    6.63    4.538  0.45( 0.05) 0.10       6.8     110.00
      1       29.52   10.97    3.354  0.45( 0.04) 0.10       9.2     100.00
      2        6.37    5.79    4.921  0.42( 0.04) 0.10       1.5     130.00

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

  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1       35.68    5.79    4.921  0.45( 0.04) 0.10       7.5     130.00
      2       36.21    6.19    4.727  0.45( 0.04) 0.10       8.0     120.00
      3       36.16    6.63    4.538  0.45( 0.04) 0.10       8.3     110.00
      4       33.84   10.97    3.354  0.44( 0.04) 0.10      10.7     100.00

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      36.21    Tc(MIN.) =     6.19
  EFFECTIVE AREA(ACRES) =       7.97   AREA-AVERAGED Fm(INCH/HR) =  0.04
  AREA-AVERAGED Fp(INCH/HR) =  0.45  AREA-AVERAGED Ap =  0.10
  TOTAL AREA(ACRES) =       10.7
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    132.00 =    1299.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    132.00 TO NODE    142.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   882.08  DOWNSTREAM(FEET) =   881.45
  FLOW LENGTH(FEET) =   157.00   MANNING'S N =  0.012
  DEPTH OF FLOW IN  36.0 INCH PIPE IS  24.6 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   7.03
  ESTIMATED PIPE DIAMETER(INCH) =  36.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      36.21
  PIPE TRAVEL TIME(MIN.) =   0.37    Tc(MIN.) =    6.57
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    142.00 =    1456.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    142.00 TO NODE    142.00 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.) =    6.57
  RAINFALL INTENSITY(INCH/HR) =   4.56
  AREA-AVERAGED Fm(INCH/HR) =  0.04
  AREA-AVERAGED Fp(INCH/HR) =  0.45
  AREA-AVERAGED Ap =  0.10
  EFFECTIVE STREAM AREA(ACRES) =       7.97
  TOTAL STREAM AREA(ACRES) =      10.70
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      36.21

****************************************************************************
  FLOW PROCESS FROM NODE    140.00 TO NODE    141.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   147.00
  ELEVATION DATA: UPSTREAM(FEET) =    889.96  DOWNSTREAM(FEET) =    888.68

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    5.779
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  4.927
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp          Ap     SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                  A        0.55      0.74     0.100    52    5.78
  COMMERCIAL                  B        0.95      0.42     0.100    76    5.78
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.54
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA RUNOFF(CFS) =      6.58
  TOTAL AREA(ACRES) =      1.50   PEAK FLOW RATE(CFS) =      6.58

****************************************************************************
  FLOW PROCESS FROM NODE    141.00 TO NODE    142.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
```

```
 ELEVATION DATA: UPSTREAM(FEET) =   884.68  DOWNSTREAM(FEET) =   881.43
 FLOW LENGTH(FEET) =    12.00   MANNING'S N =  0.012
 ESTIMATED PIPE DIAMETER(INCH) INCREASED TO 12.000
 DEPTH OF FLOW IN  12.0 INCH PIPE IS   4.8 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =  22.45
 ESTIMATED PIPE DIAMETER(INCH) =  12.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =        6.58
 PIPE TRAVEL TIME(MIN.) =   0.01    Tc(MIN.) =    5.79
 LONGEST FLOWPATH FROM NODE    140.00 TO NODE    142.00 =     159.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    142.00 TO NODE    142.00 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.) =    5.79
 RAINFALL INTENSITY(INCH/HR) =   4.92
 AREA-AVERAGED Fm(INCH/HR) =  0.05
 AREA-AVERAGED Fp(INCH/HR) =  0.54
 AREA-AVERAGED Ap =  0.10
 EFFECTIVE STREAM AREA(ACRES) =       1.50
 TOTAL STREAM AREA(ACRES) =       1.50
 PEAK FLOW RATE(CFS) AT CONFLUENCE =       6.58

 ** CONFLUENCE DATA **
  STREAM       Q      Tc   Intensity   Fp(Fm)     Ap      Ae     HEADWATER
  NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)          (ACRES)     NODE
     1       35.68    6.16    4.740  0.45( 0.04) 0.10       7.5     130.00
     1       36.21    6.57    4.564  0.45( 0.04) 0.10       8.0     120.00
     1       36.16    7.00    4.392  0.45( 0.04) 0.10       8.3     110.00
     1       33.84   11.36    3.285  0.44( 0.04) 0.10      10.7     100.00
     2        6.58    5.79    4.922  0.54( 0.05) 0.10       1.5     140.00

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

 ** PEAK FLOW RATE TABLE **
  STREAM       Q      Tc   Intensity   Fp(Fm)     Ap      Ae     HEADWATER
  NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)          (ACRES)     NODE
     1       41.38    5.79    4.922  0.46( 0.05) 0.10       8.6     140.00
     2       42.01    6.16    4.740  0.46( 0.05) 0.10       9.0     130.00
     3       42.30    6.57    4.564  0.46( 0.05) 0.10       9.5     120.00
     4       42.02    7.00    4.392  0.46( 0.05) 0.10       9.8     110.00
     5       38.21   11.36    3.285  0.46( 0.05) 0.10      12.2     100.00

 COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
 PEAK FLOW RATE(CFS) =      42.30    Tc(MIN.) =     6.57
 EFFECTIVE AREA(ACRES) =       9.47   AREA-AVERAGED Fm(INCH/HR) =  0.05
 AREA-AVERAGED Fp(INCH/HR) =  0.46  AREA-AVERAGED Ap =  0.10
 TOTAL AREA(ACRES) =       12.2
 LONGEST FLOWPATH FROM NODE    100.00 TO NODE    142.00 =    1456.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    142.00 TO NODE    152.00 IS CODE =  31
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   881.43  DOWNSTREAM(FEET) =   880.79
 FLOW LENGTH(FEET) =   177.00   MANNING'S N =  0.012
 DEPTH OF FLOW IN  36.0 INCH PIPE IS  29.5 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =   6.83
 ESTIMATED PIPE DIAMETER(INCH) =  36.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =      42.30
 PIPE TRAVEL TIME(MIN.) =   0.43    Tc(MIN.) =    7.00
 LONGEST FLOWPATH FROM NODE    100.00 TO NODE    152.00 =    1633.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    152.00 TO NODE    152.00 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.) =    7.00
 RAINFALL INTENSITY(INCH/HR) =   4.39
 AREA-AVERAGED Fm(INCH/HR) =  0.05
 AREA-AVERAGED Fp(INCH/HR) =  0.46
 AREA-AVERAGED Ap =  0.10
 EFFECTIVE STREAM AREA(ACRES) =       9.47
 TOTAL STREAM AREA(ACRES) =      12.20
 PEAK FLOW RATE(CFS) AT CONFLUENCE =      42.30

****************************************************************************
 FLOW PROCESS FROM NODE    150.00 TO NODE    151.00 IS CODE =  21
----------------------------------------------------------------------------
 >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
 >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
 INITIAL SUBAREA FLOW-LENGTH(FEET) =   147.00
 ELEVATION DATA: UPSTREAM(FEET) =    889.96  DOWNSTREAM(FEET) =    888.68

 Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
 SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    5.779
 * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  4.927
 SUBAREA Tc AND LOSS RATE DATA(AMC III):
  DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp          Ap     SCS   Tc
      LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
 COMMERCIAL                 A        1.20      0.74      0.100    52    5.78
 COMMERCIAL                 B        0.30      0.42      0.100    76    5.78
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.68
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
 SUBAREA RUNOFF(CFS) =      6.56
 TOTAL AREA(ACRES) =      1.50   PEAK FLOW RATE(CFS) =      6.56

****************************************************************************
 FLOW PROCESS FROM NODE    151.00 TO NODE    152.00 IS CODE =  31
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   884.68  DOWNSTREAM(FEET) =   880.79
```

```
 FLOW LENGTH(FEET) =    13.00   MANNING'S N =  0.012
 ESTIMATED PIPE DIAMETER(INCH) INCREASED TO 12.000
 DEPTH OF FLOW IN  12.0 INCH PIPE IS   4.7 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =  23.26
 ESTIMATED PIPE DIAMETER(INCH) =  12.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =       6.56
 PIPE TRAVEL TIME(MIN.) =   0.01    Tc(MIN.) =    5.79
 LONGEST FLOWPATH FROM NODE    150.00 TO NODE    152.00 =     160.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    152.00 TO NODE    152.00 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.) =    5.79
 RAINFALL INTENSITY(INCH/HR) =   4.92
 AREA-AVERAGED Fm(INCH/HR) =  0.07
 AREA-AVERAGED Fp(INCH/HR) =  0.68
 AREA-AVERAGED Ap =  0.10
 EFFECTIVE STREAM AREA(ACRES) =       1.50
 TOTAL STREAM AREA(ACRES) =       1.50
 PEAK FLOW RATE(CFS) AT CONFLUENCE =       6.56

 ** CONFLUENCE DATA **
  STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
  NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)     NODE
     1       41.38    6.22    4.714  0.46( 0.05) 0.10       8.6     140.00
     1       42.01    6.60    4.551  0.46( 0.05) 0.10       9.0     130.00
     1       42.30    7.00    4.393  0.46( 0.05) 0.10       9.5     120.00
     1       42.02    7.43    4.236  0.46( 0.05) 0.10       9.8     110.00
     1       38.21   11.79    3.212  0.46( 0.05) 0.10      12.2     100.00
     2        6.56    5.79    4.922  0.68( 0.07) 0.10       1.5     150.00

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

 ** PEAK FLOW RATE TABLE **
  STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
  NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)     NODE
     1       46.78    5.79    4.922  0.50( 0.05) 0.10       9.5     150.00
     2       47.66    6.22    4.714  0.49( 0.05) 0.10      10.1     140.00
     3       48.07    6.60    4.551  0.49( 0.05) 0.10      10.5     130.00
     4       48.15    7.00    4.393  0.49( 0.05) 0.10      11.0     120.00
     5       47.65    7.43    4.236  0.49( 0.05) 0.10      11.3     110.00
     6       42.46   11.79    3.212  0.48( 0.05) 0.10      13.7     100.00

 COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
 PEAK FLOW RATE(CFS) =      48.15    Tc(MIN.) =     7.00
 EFFECTIVE AREA(ACRES) =      10.97   AREA-AVERAGED Fm(INCH/HR) =  0.05
 AREA-AVERAGED Fp(INCH/HR) =  0.49  AREA-AVERAGED Ap =  0.10
 TOTAL AREA(ACRES) =       13.7
 LONGEST FLOWPATH FROM NODE    100.00 TO NODE    152.00 =    1633.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    152.00 TO NODE    162.00 IS CODE =  31
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   880.79  DOWNSTREAM(FEET) =   880.15
 FLOW LENGTH(FEET) =   161.00   MANNING'S N =  0.012
 DEPTH OF FLOW IN  39.0 INCH PIPE IS  28.3 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =   7.47
 ESTIMATED PIPE DIAMETER(INCH) =  39.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =      48.15
 PIPE TRAVEL TIME(MIN.) =   0.36    Tc(MIN.) =    7.36
 LONGEST FLOWPATH FROM NODE    100.00 TO NODE    162.00 =    1794.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    162.00 TO NODE    162.00 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.) =    7.36
 RAINFALL INTENSITY(INCH/HR) =   4.26
 AREA-AVERAGED Fm(INCH/HR) =  0.05
 AREA-AVERAGED Fp(INCH/HR) =  0.49
 AREA-AVERAGED Ap =  0.10
 EFFECTIVE STREAM AREA(ACRES) =      10.97
 TOTAL STREAM AREA(ACRES) =      13.70
 PEAK FLOW RATE(CFS) AT CONFLUENCE =      48.15

****************************************************************************
 FLOW PROCESS FROM NODE    160.00 TO NODE    161.00 IS CODE =  21
----------------------------------------------------------------------------
 >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
 >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
 INITIAL SUBAREA FLOW-LENGTH(FEET) =   549.00
 ELEVATION DATA: UPSTREAM(FEET) =    891.65  DOWNSTREAM(FEET) =    888.68

 Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
 SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =  10.766
 * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  3.392
 SUBAREA Tc AND LOSS RATE DATA(AMC III):
  DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp          Ap     SCS   Tc
      LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
 COMMERCIAL                  A        1.90      0.74      0.100    52   10.77
 COMMERCIAL                  B        0.25      0.42      0.100    76   10.77
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.70
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
 SUBAREA RUNOFF(CFS) =      6.43
 TOTAL AREA(ACRES) =      2.15   PEAK FLOW RATE(CFS) =      6.43

****************************************************************************
 FLOW PROCESS FROM NODE    161.00 TO NODE    162.00 IS CODE =  31
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
```

```
 ELEVATION DATA: UPSTREAM(FEET) =   884.68  DOWNSTREAM(FEET) =   880.15
 FLOW LENGTH(FEET) =    13.00   MANNING'S N =  0.012
 ESTIMATED PIPE DIAMETER(INCH) INCREASED TO 12.000
 DEPTH OF FLOW IN  12.0 INCH PIPE IS   4.4 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =  24.46
 ESTIMATED PIPE DIAMETER(INCH) =  12.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =        6.43
 PIPE TRAVEL TIME(MIN.) =   0.01    Tc(MIN.) =   10.78
 LONGEST FLOWPATH FROM NODE    160.00 TO NODE    162.00 =     562.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    162.00 TO NODE    162.00 IS CODE =   1
----------------------------------------------------------------------------
 >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
 >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
 TOTAL NUMBER OF STREAMS =  2
 CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
 TIME OF CONCENTRATION(MIN.) =   10.78
 RAINFALL INTENSITY(INCH/HR) =   3.39
 AREA-AVERAGED Fm(INCH/HR) =  0.07
 AREA-AVERAGED Fp(INCH/HR) =  0.70
 AREA-AVERAGED Ap =  0.10
 EFFECTIVE STREAM AREA(ACRES) =       2.15
 TOTAL STREAM AREA(ACRES) =       2.15
 PEAK FLOW RATE(CFS) AT CONFLUENCE =       6.43

 ** CONFLUENCE DATA **
  STREAM       Q      Tc   Intensity   Fp(Fm)     Ap      Ae     HEADWATER
  NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)          (ACRES)    NODE
     1       46.78    6.15    4.747  0.50( 0.05) 0.10       9.5     150.00
     1       47.66    6.58    4.558  0.49( 0.05) 0.10      10.1     140.00
     1       48.07    6.95    4.409  0.49( 0.05) 0.10      10.5     130.00
     1       48.15    7.36    4.262  0.49( 0.05) 0.10      11.0     120.00
     1       47.65    7.79    4.118  0.49( 0.05) 0.10      11.3     110.00
     1       42.46   12.17    3.152  0.48( 0.05) 0.10      13.7     100.00
     2        6.43   10.78    3.390  0.70( 0.07) 0.10       2.2     160.00

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

 ** PEAK FLOW RATE TABLE **
  STREAM       Q      Tc   Intensity   Fp(Fm)     Ap      Ae     HEADWATER
  NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)          (ACRES)    NODE
     1       51.95    6.15    4.747  0.52( 0.05) 0.10      10.7     150.00
     2       52.96    6.58    4.558  0.52( 0.05) 0.10      11.4     140.00
     3       53.49    6.95    4.409  0.52( 0.05) 0.10      11.9     130.00
     4       53.69    7.36    4.262  0.52( 0.05) 0.10      12.4     120.00
     5       53.32    7.79    4.118  0.52( 0.05) 0.10      12.9     110.00
     6       50.54   10.78    3.390  0.51( 0.05) 0.10      15.1     160.00
     7       48.42   12.17    3.152  0.51( 0.05) 0.10      15.9     100.00

 COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
 PEAK FLOW RATE(CFS) =      53.69    Tc(MIN.) =     7.36
 EFFECTIVE AREA(ACRES) =      12.44   AREA-AVERAGED Fm(INCH/HR) =  0.05
 AREA-AVERAGED Fp(INCH/HR) =  0.52  AREA-AVERAGED Ap =  0.10
 TOTAL AREA(ACRES) =      15.9
 LONGEST FLOWPATH FROM NODE    100.00 TO NODE    162.00 =    1794.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    162.00 TO NODE    203.00 IS CODE =  31
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   880.15  DOWNSTREAM(FEET) =   879.65
 FLOW LENGTH(FEET) =   124.00   MANNING'S N =  0.012
 DEPTH OF FLOW IN  39.0 INCH PIPE IS  31.0 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =   7.60
 ESTIMATED PIPE DIAMETER(INCH) =  39.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =      53.69
 PIPE TRAVEL TIME(MIN.) =   0.27    Tc(MIN.) =    7.63
 LONGEST FLOWPATH FROM NODE    100.00 TO NODE    203.00 =    1918.00 FEET.

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

****************************************************************************
 FLOW PROCESS FROM NODE    170.00 TO NODE    171.00 IS CODE =  21
----------------------------------------------------------------------------
 >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
 >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
 INITIAL SUBAREA FLOW-LENGTH(FEET) =   477.00
 ELEVATION DATA: UPSTREAM(FEET) =    902.04  DOWNSTREAM(FEET) =    891.53

 Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
 SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    7.685
 * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  4.152
 SUBAREA Tc AND LOSS RATE DATA(AMC III):
  DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
 COMMERCIAL                  B        2.75      0.42     0.100    76    7.69
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.42
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
 SUBAREA RUNOFF(CFS) =     10.17
 TOTAL AREA(ACRES) =      2.75   PEAK FLOW RATE(CFS) =     10.17

****************************************************************************
 FLOW PROCESS FROM NODE    171.00 TO NODE    182.00 IS CODE =  31
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   887.53  DOWNSTREAM(FEET) =   886.50
 FLOW LENGTH(FEET) =   206.00   MANNING'S N =  0.012
 DEPTH OF FLOW IN  21.0 INCH PIPE IS  15.0 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =   5.53
 ESTIMATED PIPE DIAMETER(INCH) =  21.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =      10.17
 PIPE TRAVEL TIME(MIN.) =   0.62    Tc(MIN.) =    8.31
 LONGEST FLOWPATH FROM NODE    170.00 TO NODE    182.00 =     683.00 FEET.
```

```
****************************************************************************
  FLOW PROCESS FROM NODE    182.00 TO NODE    182.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =    8.31
  RAINFALL INTENSITY(INCH/HR) =   3.96
  AREA-AVERAGED Fm(INCH/HR) =  0.04
  AREA-AVERAGED Fp(INCH/HR) =  0.42
  AREA-AVERAGED Ap =  0.10
  EFFECTIVE STREAM AREA(ACRES) =       2.75
  TOTAL STREAM AREA(ACRES) =       2.75
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      10.17

****************************************************************************
  FLOW PROCESS FROM NODE    180.00 TO NODE    181.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   136.00
  ELEVATION DATA: UPSTREAM(FEET) =    893.41  DOWNSTREAM(FEET) =    891.53

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    5.107
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  5.306
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
        LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                  B        1.45      0.42      0.100    76    5.11
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.42
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA RUNOFF(CFS) =      6.87
  TOTAL AREA(ACRES) =      1.45   PEAK FLOW RATE(CFS) =      6.87

****************************************************************************
  FLOW PROCESS FROM NODE    181.00 TO NODE    182.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   887.53  DOWNSTREAM(FEET) =   886.48
  FLOW LENGTH(FEET) =     9.00   MANNING'S N =  0.012
  DEPTH OF FLOW IN  12.0 INCH PIPE IS   6.2 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =  16.62
  ESTIMATED PIPE DIAMETER(INCH) =  12.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =        6.87
  PIPE TRAVEL TIME(MIN.) =   0.01    Tc(MIN.) =    5.12
  LONGEST FLOWPATH FROM NODE    180.00 TO NODE    182.00 =     145.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    182.00 TO NODE    182.00 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.) =    5.12
  RAINFALL INTENSITY(INCH/HR) =   5.30
  AREA-AVERAGED Fm(INCH/HR) =  0.04
  AREA-AVERAGED Fp(INCH/HR) =  0.42
  AREA-AVERAGED Ap =  0.10
  EFFECTIVE STREAM AREA(ACRES) =       1.45
  TOTAL STREAM AREA(ACRES) =       1.45
  PEAK FLOW RATE(CFS) AT CONFLUENCE =       6.87

  ** CONFLUENCE DATA **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1       10.17    8.31    3.963  0.42( 0.04) 0.10       2.8     170.00
      2        6.87    5.12    5.300  0.42( 0.04) 0.10       1.5     180.00

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

  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1       15.27    5.12    5.300  0.42( 0.04) 0.10       3.1     180.00
      2       15.29    8.31    3.963  0.42( 0.04) 0.10       4.2     170.00

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      15.29    Tc(MIN.) =     8.31
  EFFECTIVE AREA(ACRES) =       4.20   AREA-AVERAGED Fm(INCH/HR) =  0.04
  AREA-AVERAGED Fp(INCH/HR) =  0.42  AREA-AVERAGED Ap =  0.10
  TOTAL AREA(ACRES) =       4.2
  LONGEST FLOWPATH FROM NODE    170.00 TO NODE    182.00 =     683.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    182.00 TO NODE    192.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   886.48  DOWNSTREAM(FEET) =   885.48
  FLOW LENGTH(FEET) =   200.00   MANNING'S N =  0.012
  DEPTH OF FLOW IN  24.0 INCH PIPE IS  17.9 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   6.08
  ESTIMATED PIPE DIAMETER(INCH) =  24.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      15.29
  PIPE TRAVEL TIME(MIN.) =   0.55    Tc(MIN.) =    8.85
  LONGEST FLOWPATH FROM NODE    170.00 TO NODE    192.00 =     883.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    192.00 TO NODE    192.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =    8.85
```

```
 RAINFALL INTENSITY(INCH/HR) =   3.81
 AREA-AVERAGED Fm(INCH/HR) =  0.04
 AREA-AVERAGED Fp(INCH/HR) =  0.42
 AREA-AVERAGED Ap =  0.10
 EFFECTIVE STREAM AREA(ACRES) =       4.20
 TOTAL STREAM AREA(ACRES) =       4.20
 PEAK FLOW RATE(CFS) AT CONFLUENCE =      15.29

****************************************************************************
 FLOW PROCESS FROM NODE    190.00 TO NODE    191.00 IS CODE =  21
----------------------------------------------------------------------------
 >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
 >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
 INITIAL SUBAREA FLOW-LENGTH(FEET) =   136.00
 ELEVATION DATA: UPSTREAM(FEET) =    893.41  DOWNSTREAM(FEET) =    891.53

 Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
 SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    5.107
 * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  5.306
 SUBAREA Tc AND LOSS RATE DATA(AMC III):
  DEVELOPMENT TYPE/       SCS SOIL    AREA      Fp         Ap      SCS   Tc
      LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
 COMMERCIAL                  B        1.45      0.42     0.100    76    5.11
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.42
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
 SUBAREA RUNOFF(CFS) =      6.87
 TOTAL AREA(ACRES) =      1.45   PEAK FLOW RATE(CFS) =      6.87

****************************************************************************
 FLOW PROCESS FROM NODE    191.00 TO NODE    192.00 IS CODE =  31
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   887.53  DOWNSTREAM(FEET) =   885.48
 FLOW LENGTH(FEET) =    10.00   MANNING'S N =  0.012
 ESTIMATED PIPE DIAMETER(INCH) INCREASED TO 12.000
 DEPTH OF FLOW IN  12.0 INCH PIPE IS   5.3 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =  20.52
 ESTIMATED PIPE DIAMETER(INCH) =  12.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =       6.87
 PIPE TRAVEL TIME(MIN.) =   0.01    Tc(MIN.) =    5.12
 LONGEST FLOWPATH FROM NODE    190.00 TO NODE    192.00 =     146.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    192.00 TO NODE    192.00 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.) =    5.12
 RAINFALL INTENSITY(INCH/HR) =   5.30
 AREA-AVERAGED Fm(INCH/HR) =  0.04
 AREA-AVERAGED Fp(INCH/HR) =  0.42
 AREA-AVERAGED Ap =  0.10
 EFFECTIVE STREAM AREA(ACRES) =       1.45
 TOTAL STREAM AREA(ACRES) =       1.45
 PEAK FLOW RATE(CFS) AT CONFLUENCE =       6.87

 ** CONFLUENCE DATA **
  STREAM       Q      Tc   Intensity   Fp(Fm)     Ap      Ae     HEADWATER
  NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)          (ACRES)    NODE
     1       15.27    5.66    4.987  0.42( 0.04) 0.10       3.1     180.00
     1       15.29    8.85    3.814  0.42( 0.04) 0.10       4.2     170.00
     2        6.87    5.12    5.301  0.42( 0.04) 0.10       1.5     190.00

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

 ** PEAK FLOW RATE TABLE **
  STREAM       Q      Tc   Intensity   Fp(Fm)     Ap      Ae     HEADWATER
  NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)          (ACRES)    NODE
     1       21.54    5.12    5.301  0.42( 0.04) 0.10       4.3     190.00
     2       21.73    5.66    4.987  0.42( 0.04) 0.10       4.6     180.00
     3       20.22    8.85    3.814  0.42( 0.04) 0.10       5.6     170.00

 COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
 PEAK FLOW RATE(CFS) =      21.73    Tc(MIN.) =     5.66
 EFFECTIVE AREA(ACRES) =       4.59   AREA-AVERAGED Fm(INCH/HR) =  0.04
 AREA-AVERAGED Fp(INCH/HR) =  0.42  AREA-AVERAGED Ap =  0.10
 TOTAL AREA(ACRES) =       5.6
 LONGEST FLOWPATH FROM NODE    170.00 TO NODE    192.00 =     883.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    192.00 TO NODE    202.00 IS CODE =  31
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   885.48  DOWNSTREAM(FEET) =   884.48
 FLOW LENGTH(FEET) =   200.00   MANNING'S N =  0.012
 DEPTH OF FLOW IN  27.0 INCH PIPE IS  20.8 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =   6.61
 ESTIMATED PIPE DIAMETER(INCH) =  27.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =      21.73
 PIPE TRAVEL TIME(MIN.) =   0.50    Tc(MIN.) =    6.17
 LONGEST FLOWPATH FROM NODE    170.00 TO NODE    202.00 =    1083.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    202.00 TO NODE    202.00 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.) =    6.17
 RAINFALL INTENSITY(INCH/HR) =   4.74
 AREA-AVERAGED Fm(INCH/HR) =  0.04
 AREA-AVERAGED Fp(INCH/HR) =  0.42
 AREA-AVERAGED Ap =  0.10
 EFFECTIVE STREAM AREA(ACRES) =       4.59
 TOTAL STREAM AREA(ACRES) =       5.65
```

```
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      21.73

****************************************************************************
  FLOW PROCESS FROM NODE    200.00 TO NODE    201.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   185.00
  ELEVATION DATA: UPSTREAM(FEET) =    894.99  DOWNSTREAM(FEET) =    891.53

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    5.437
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  5.110
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp          Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 B        1.85      0.42     0.100    76    5.44
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.42
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA RUNOFF(CFS) =      8.44
  TOTAL AREA(ACRES) =      1.85   PEAK FLOW RATE(CFS) =      8.44

****************************************************************************
  FLOW PROCESS FROM NODE    201.00 TO NODE    202.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   887.53  DOWNSTREAM(FEET) =   884.48
  FLOW LENGTH(FEET) =    10.00   MANNING'S N =  0.012
  ESTIMATED PIPE DIAMETER(INCH) INCREASED TO 12.000
  DEPTH OF FLOW IN  12.0 INCH PIPE IS   5.3 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =  25.06
  ESTIMATED PIPE DIAMETER(INCH) =  12.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      8.44
  PIPE TRAVEL TIME(MIN.) =   0.01    Tc(MIN.) =    5.44
  LONGEST FLOWPATH FROM NODE    200.00 TO NODE    202.00 =     195.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    202.00 TO NODE    202.00 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.) =    5.44
  RAINFALL INTENSITY(INCH/HR) =   5.11
  AREA-AVERAGED Fm(INCH/HR) =  0.04
  AREA-AVERAGED Fp(INCH/HR) =  0.42
  AREA-AVERAGED Ap =  0.10
  EFFECTIVE STREAM AREA(ACRES) =       1.85
  TOTAL STREAM AREA(ACRES) =       1.85
  PEAK FLOW RATE(CFS) AT CONFLUENCE =       8.44

  ** CONFLUENCE DATA **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1       21.54    5.62    5.010  0.42( 0.04) 0.10       4.3     190.00
      1       21.73    6.17    4.738  0.42( 0.04) 0.10       4.6     180.00
      1       20.22    9.36    3.688  0.42( 0.04) 0.10       5.6     170.00
      2        8.44    5.44    5.107  0.42( 0.04) 0.10       1.9     200.00

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

  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1       29.71    5.44    5.107  0.42( 0.04) 0.10       6.0     200.00
      2       29.82    5.62    5.010  0.42( 0.04) 0.10       6.1     190.00
      3       29.55    6.17    4.738  0.42( 0.04) 0.10       6.4     180.00
      4       26.30    9.36    3.688  0.42( 0.04) 0.10       7.5     170.00

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      29.82    Tc(MIN.) =     5.62
  EFFECTIVE AREA(ACRES) =       6.14   AREA-AVERAGED Fm(INCH/HR) =  0.04
  AREA-AVERAGED Fp(INCH/HR) =  0.42  AREA-AVERAGED Ap =  0.10
  TOTAL AREA(ACRES) =        7.5
  LONGEST FLOWPATH FROM NODE    170.00 TO NODE    202.00 =    1083.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    202.00 TO NODE    203.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   884.48  DOWNSTREAM(FEET) =   880.65
  FLOW LENGTH(FEET) =   735.00   MANNING'S N =  0.012
  DEPTH OF FLOW IN  30.0 INCH PIPE IS  23.4 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   7.24
  ESTIMATED PIPE DIAMETER(INCH) =  30.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      29.82
  PIPE TRAVEL TIME(MIN.) =   1.69    Tc(MIN.) =    7.31
  LONGEST FLOWPATH FROM NODE    170.00 TO NODE    203.00 =    1818.00 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       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1       29.71    7.13    4.342  0.42( 0.04) 0.10       6.0     200.00
      2       29.82    7.31    4.279  0.42( 0.04) 0.10       6.1     190.00
      3       29.55    7.86    4.096  0.42( 0.04) 0.10       6.4     180.00
      4       26.30   11.08    3.334  0.42( 0.04) 0.10       7.5     170.00
  LONGEST FLOWPATH FROM NODE    170.00 TO NODE    203.00 =    1818.00 FEET.

  ** MEMORY BANK #  1 CONFLUENCE DATA **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
```

```
      1       51.95    6.42    4.625  0.52( 0.05) 0.10      10.7     150.00
      2       52.96    6.85    4.448  0.52( 0.05) 0.10      11.4     140.00
      3       53.49    7.23    4.308  0.52( 0.05) 0.10      11.9     130.00
      4       53.69    7.63    4.171  0.52( 0.05) 0.10      12.4     120.00
      5       53.32    8.06    4.034  0.52( 0.05) 0.10      12.9     110.00
      6       50.54   11.05    3.340  0.51( 0.05) 0.10      15.1     160.00
      7       48.42   12.44    3.110  0.51( 0.05) 0.10      15.9     100.00
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    203.00 =    1918.00 FEET.

  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)          (ACRES)    NODE
      1       80.45    6.42    4.625  0.49( 0.05) 0.10      16.1     150.00
      2       82.20    6.85    4.448  0.49( 0.05) 0.10      17.2     140.00
      3       83.07    7.13    4.342  0.49( 0.05) 0.10      17.8     200.00
      4       83.25    7.23    4.308  0.49( 0.05) 0.10      18.0     130.00
      5       83.34    7.31    4.279  0.49( 0.05) 0.10      18.2     190.00
      6       83.35    7.63    4.171  0.48( 0.05) 0.10      18.8     120.00
      7       83.04    7.86    4.096  0.48( 0.05) 0.10      19.1     180.00
      8       82.66    8.06    4.034  0.48( 0.05) 0.10      19.4     110.00
      9       76.86   11.05    3.340  0.48( 0.05) 0.10      22.6     160.00
     10       76.78   11.08    3.334  0.48( 0.05) 0.10      22.6     170.00
     11       72.93   12.44    3.110  0.48( 0.05) 0.10      23.4     100.00
    TOTAL AREA(ACRES) =         23.4

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =       83.35  Tc(MIN.) =    7.629
  EFFECTIVE AREA(ACRES) =     18.75  AREA-AVERAGED Fm(INCH/HR) =  0.05
  AREA-AVERAGED Fp(INCH/HR) =  0.48  AREA-AVERAGED Ap =  0.10
  TOTAL AREA(ACRES) =       23.4
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    203.00 =    1918.00 FEET.

****************************************************************************
  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    204.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   879.63  DOWNSTREAM(FEET) =   868.48
  FLOW LENGTH(FEET) =  2073.00   MANNING'S N =  0.012
  DEPTH OF FLOW IN  45.0 INCH PIPE IS  33.1 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   9.58
  ESTIMATED PIPE DIAMETER(INCH) =  45.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      83.35
  PIPE TRAVEL TIME(MIN.) =   3.61    Tc(MIN.) =   11.23
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    204.00 =    3991.00 FEET.
============================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =       23.4  TC(MIN.) =     11.23
  EFFECTIVE AREA(ACRES) =     18.75  AREA-AVERAGED Fm(INCH/HR)=  0.05
  AREA-AVERAGED Fp(INCH/HR) =  0.48  AREA-AVERAGED Ap = 0.100
  PEAK FLOW RATE(CFS)   =      83.35

  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)          (ACRES)    NODE
      1       80.45   10.05    3.536  0.49( 0.05) 0.10      16.1     150.00
      2       82.20   10.46    3.450  0.49( 0.05) 0.10      17.2     140.00
      3       83.07   10.74    3.396  0.49( 0.05) 0.10      17.8     200.00
      4       83.25   10.83    3.379  0.49( 0.05) 0.10      18.0     130.00
      5       83.34   10.92    3.364  0.49( 0.05) 0.10      18.2     190.00
      6       83.35   11.23    3.306  0.48( 0.05) 0.10      18.8     120.00
      7       83.04   11.47    3.266  0.48( 0.05) 0.10      19.1     180.00
      8       82.66   11.67    3.231  0.48( 0.05) 0.10      19.4     110.00
      9       76.86   14.79    2.803  0.48( 0.05) 0.10      22.6     160.00
     10       76.78   14.82    2.800  0.48( 0.05) 0.10      22.6     170.00
     11       72.93   16.20    2.655  0.48( 0.05) 0.10      23.4     100.00
============================================================================
============================================================================
  END OF RATIONAL METHOD ANALYSIS
```

♀

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******************************************************************************
            RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
         (Reference: 1986 SAN BERNARDINO CO. HYDROLOGY CRITERION)
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            Ver. 23.0  Release Date: 07/01/2016  License ID 1435

                          Analysis prepared by:



 ************************ DESCRIPTION OF STUDY ************************
* AGUA MANSA COMMERCE CENTER                                          *
* PROPOSED CONDITION 100 YEAERE ON SITE                               *
* NODES 300-403                                                       *
 **********************************************************************

  FILE NAME: W:\3813\P300.DAT
  TIME/DATE OF STUDY: 18:22 09/11/2020
==============================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
==============================================================================
                     --*TIME-OF-CONCENTRATION MODEL*--

  USER SPECIFIED STORM EVENT(YEAR) =  100.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =  12.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.95
  *USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL*

  SLOPE OF INTENSITY DURATION CURVE(LOG(I;IN/HR) vs. LOG(Tc;MIN)) = 0.6000
  USER SPECIFIED 1-HOUR INTENSITY(INCH/HOUR) = 1.2100

  *ANTECEDENT MOISTURE CONDITION (AMC) III ASSUMED FOR RATIONAL METHOD*

  *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 0.0312 0.167 0.0150

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

******************************************************************************
  FLOW PROCESS FROM NODE    300.00 TO NODE    301.00 IS CODE =  21
------------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
==============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   656.00
  ELEVATION DATA: UPSTREAM(FEET) =    889.37  DOWNSTREAM(FEET) =    885.66

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =  11.459
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  3.267
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp          Ap      SCS   Tc
        LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                  A        2.05      0.74      0.100    52   11.46
  COMMERCIAL                  B        3.50      0.42      0.100    76   11.46
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.54
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA RUNOFF(CFS) =     16.05
  TOTAL AREA(ACRES) =      5.55   PEAK FLOW RATE(CFS) =     16.05

******************************************************************************
  FLOW PROCESS FROM NODE    301.00 TO NODE    312.00 IS CODE =  31
------------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
==============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   882.66  DOWNSTREAM(FEET) =   881.26
  FLOW LENGTH(FEET) =   350.00   MANNING'S N =  0.012
  DEPTH OF FLOW IN  27.0 INCH PIPE IS  17.9 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   5.75
  ESTIMATED PIPE DIAMETER(INCH) =  27.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      16.05
  PIPE TRAVEL TIME(MIN.) =   1.02    Tc(MIN.) =   12.47
  LONGEST FLOWPATH FROM NODE    300.00 TO NODE    312.00 =    1006.00 FEET.

******************************************************************************
  FLOW PROCESS FROM NODE    312.00 TO NODE    312.00 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.) =   12.47
  RAINFALL INTENSITY(INCH/HR) =   3.11
  AREA-AVERAGED Fm(INCH/HR) =  0.05
  AREA-AVERAGED Fp(INCH/HR) =  0.54
  AREA-AVERAGED Ap =  0.10
  EFFECTIVE STREAM AREA(ACRES) =       5.55
  TOTAL STREAM AREA(ACRES) =       5.55
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      16.05

******************************************************************************
  FLOW PROCESS FROM NODE    310.00 TO NODE    311.00 IS CODE =  21
------------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
==============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   653.00
  ELEVATION DATA: UPSTREAM(FEET) =    889.37  DOWNSTREAM(FEET) =    885.48

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
```

```
 SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   11.320
 * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  3.291
 SUBAREA Tc AND LOSS RATE DATA(AMC III):
  DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap     SCS   Tc
      LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
 COMMERCIAL                  A        1.75      0.74     0.100    52   11.32
 COMMERCIAL                  B        2.00      0.42     0.100    76   11.32
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.57
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
 SUBAREA RUNOFF(CFS) =     10.92
 TOTAL AREA(ACRES) =      3.75   PEAK FLOW RATE(CFS) =     10.92

****************************************************************************
 FLOW PROCESS FROM NODE    311.00 TO NODE    312.00 IS CODE =  31
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   881.48  DOWNSTREAM(FEET) =   881.26
 FLOW LENGTH(FEET) =    18.00   MANNING'S N =  0.012
 DEPTH OF FLOW IN  18.0 INCH PIPE IS  13.2 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =   7.84
 ESTIMATED PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =      10.92
 PIPE TRAVEL TIME(MIN.) =   0.04    Tc(MIN.) =   11.36
 LONGEST FLOWPATH FROM NODE    310.00 TO NODE    312.00 =     671.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    312.00 TO NODE    312.00 IS CODE =   1
----------------------------------------------------------------------------
 >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
 >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
 TOTAL NUMBER OF STREAMS =  2
 CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
 TIME OF CONCENTRATION(MIN.) =   11.36
 RAINFALL INTENSITY(INCH/HR) =   3.28
 AREA-AVERAGED Fm(INCH/HR) =  0.06
 AREA-AVERAGED Fp(INCH/HR) =  0.57
 AREA-AVERAGED Ap =  0.10
 EFFECTIVE STREAM AREA(ACRES) =       3.75
 TOTAL STREAM AREA(ACRES) =       3.75
 PEAK FLOW RATE(CFS) AT CONFLUENCE =      10.92

 ** CONFLUENCE DATA **
  STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
  NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
     1       16.05   12.47    3.105  0.54( 0.05) 0.10       5.6     300.00
     2       10.92   11.36    3.285  0.57( 0.06) 0.10       3.8     310.00

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

 ** PEAK FLOW RATE TABLE **
  STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
  NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
     1       26.39   11.36    3.285  0.55( 0.06) 0.10       8.8     310.00
     2       26.36   12.47    3.105  0.55( 0.06) 0.10       9.3     300.00

 COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
 PEAK FLOW RATE(CFS) =      26.39    Tc(MIN.) =    11.36
 EFFECTIVE AREA(ACRES) =       8.80   AREA-AVERAGED Fm(INCH/HR) =  0.06
 AREA-AVERAGED Fp(INCH/HR) =  0.55  AREA-AVERAGED Ap =  0.10
 TOTAL AREA(ACRES) =       9.3
 LONGEST FLOWPATH FROM NODE    300.00 TO NODE    312.00 =    1006.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    312.00 TO NODE    322.00 IS CODE =  31
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   881.26  DOWNSTREAM(FEET) =   880.02
 FLOW LENGTH(FEET) =   309.00   MANNING'S N =  0.012
 DEPTH OF FLOW IN  30.0 INCH PIPE IS  23.6 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =   6.36
 ESTIMATED PIPE DIAMETER(INCH) =  30.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =      26.39
 PIPE TRAVEL TIME(MIN.) =   0.81    Tc(MIN.) =   12.17
 LONGEST FLOWPATH FROM NODE    300.00 TO NODE    322.00 =    1315.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    322.00 TO NODE    322.00 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.) =   12.17
 RAINFALL INTENSITY(INCH/HR) =   3.15
 AREA-AVERAGED Fm(INCH/HR) =  0.06
 AREA-AVERAGED Fp(INCH/HR) =  0.55
 AREA-AVERAGED Ap =  0.10
 EFFECTIVE STREAM AREA(ACRES) =       8.80
 TOTAL STREAM AREA(ACRES) =       9.30
 PEAK FLOW RATE(CFS) AT CONFLUENCE =      26.39

****************************************************************************
 FLOW PROCESS FROM NODE    320.00 TO NODE    321.00 IS CODE =  21
----------------------------------------------------------------------------
 >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
 >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
 INITIAL SUBAREA FLOW-LENGTH(FEET) =   753.00
 ELEVATION DATA: UPSTREAM(FEET) =    889.39  DOWNSTREAM(FEET) =    885.06

 Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
 SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   12.068
 * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  3.167
 SUBAREA Tc AND LOSS RATE DATA(AMC III):
  DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap     SCS   Tc
      LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
 COMMERCIAL                  A        1.65      0.74     0.100    52   12.07
 COMMERCIAL                  B        4.50      0.42     0.100    76   12.07
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.51
```

```
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA RUNOFF(CFS) =     17.25
  TOTAL AREA(ACRES) =      6.15   PEAK FLOW RATE(CFS) =     17.25

****************************************************************************
  FLOW PROCESS FROM NODE    321.00 TO NODE    322.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   881.06  DOWNSTREAM(FEET) =   880.02
  FLOW LENGTH(FEET) =    17.00   MANNING'S N =  0.012
  DEPTH OF FLOW IN  18.0 INCH PIPE IS  10.4 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =  16.39
  ESTIMATED PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      17.25
  PIPE TRAVEL TIME(MIN.) =   0.02    Tc(MIN.) =   12.09
  LONGEST FLOWPATH FROM NODE    320.00 TO NODE    322.00 =     770.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    322.00 TO NODE    322.00 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.) =   12.09
  RAINFALL INTENSITY(INCH/HR) =   3.16
  AREA-AVERAGED Fm(INCH/HR) =  0.05
  AREA-AVERAGED Fp(INCH/HR) =  0.51
  AREA-AVERAGED Ap =  0.10
  EFFECTIVE STREAM AREA(ACRES) =       6.15
  TOTAL STREAM AREA(ACRES) =       6.15
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      17.25

  ** CONFLUENCE DATA **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1       26.39   12.17    3.152  0.55( 0.06) 0.10       8.8     310.00
      1       26.36   13.28    2.990  0.55( 0.06) 0.10       9.3     300.00
      2       17.25   12.09    3.165  0.51( 0.05) 0.10       6.2     320.00

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

  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1       43.57   12.09    3.165  0.54( 0.05) 0.10      14.9     320.00
      2       43.57   12.17    3.152  0.54( 0.05) 0.10      15.0     310.00
      3       42.64   13.28    2.990  0.54( 0.05) 0.10      15.5     300.00

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      43.57    Tc(MIN.) =    12.09
  EFFECTIVE AREA(ACRES) =      14.89   AREA-AVERAGED Fm(INCH/HR) =  0.05
  AREA-AVERAGED Fp(INCH/HR) =  0.54  AREA-AVERAGED Ap =  0.10
  TOTAL AREA(ACRES) =      15.5
  LONGEST FLOWPATH FROM NODE    300.00 TO NODE    322.00 =    1315.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    322.00 TO NODE    332.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   880.02  DOWNSTREAM(FEET) =   878.86
  FLOW LENGTH(FEET) =   290.00   MANNING'S N =  0.012
  DEPTH OF FLOW IN  36.0 INCH PIPE IS  28.8 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   7.18
  ESTIMATED PIPE DIAMETER(INCH) =  36.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      43.57
  PIPE TRAVEL TIME(MIN.) =   0.67    Tc(MIN.) =   12.76
  LONGEST FLOWPATH FROM NODE    300.00 TO NODE    332.00 =    1605.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    332.00 TO NODE    332.00 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.) =   12.76
  RAINFALL INTENSITY(INCH/HR) =   3.06
  AREA-AVERAGED Fm(INCH/HR) =  0.05
  AREA-AVERAGED Fp(INCH/HR) =  0.54
  AREA-AVERAGED Ap =  0.10
  EFFECTIVE STREAM AREA(ACRES) =      14.89
  TOTAL STREAM AREA(ACRES) =      15.45
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      43.57

****************************************************************************
  FLOW PROCESS FROM NODE    330.00 TO NODE    331.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   528.00
  ELEVATION DATA: UPSTREAM(FEET) =    889.65  DOWNSTREAM(FEET) =    884.24

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    9.329
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  3.696
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp          Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                  A        0.90      0.74     0.100     52    9.33
  COMMERCIAL                  B        1.00      0.42     0.100     76    9.33
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.57
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA RUNOFF(CFS) =      6.22
  TOTAL AREA(ACRES) =      1.90   PEAK FLOW RATE(CFS) =      6.22

****************************************************************************
  FLOW PROCESS FROM NODE    331.00 TO NODE    332.00 IS CODE =  31
```

```
------------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
==============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   880.24  DOWNSTREAM(FEET) =   878.86
  FLOW LENGTH(FEET) =    12.00   MANNING'S N =  0.012
  DEPTH OF FLOW IN  12.0 INCH PIPE IS   5.9 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =  16.13
  ESTIMATED PIPE DIAMETER(INCH) =  12.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       6.22
  PIPE TRAVEL TIME(MIN.) =   0.01    Tc(MIN.) =    9.34
  LONGEST FLOWPATH FROM NODE    330.00 TO NODE    332.00 =     540.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    332.00 TO NODE    332.00 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.) =    9.34
  RAINFALL INTENSITY(INCH/HR) =   3.69
  AREA-AVERAGED Fm(INCH/HR) =  0.06
  AREA-AVERAGED Fp(INCH/HR) =  0.57
  AREA-AVERAGED Ap =  0.10
  EFFECTIVE STREAM AREA(ACRES) =       1.90
  TOTAL STREAM AREA(ACRES) =       1.90
  PEAK FLOW RATE(CFS) AT CONFLUENCE =       6.22

  ** CONFLUENCE DATA **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1       43.57   12.76    3.063  0.54( 0.05) 0.10      14.9     320.00
      1       43.57   12.84    3.052  0.54( 0.05) 0.10      15.0     310.00
      1       42.64   13.96    2.903  0.54( 0.05) 0.10      15.5     300.00
      2        6.22    9.34    3.694  0.57( 0.06) 0.10       1.9     330.00

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

  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1       44.80    9.34    3.694  0.54( 0.05) 0.10      12.8     330.00
      2       48.71   12.76    3.063  0.54( 0.05) 0.10      16.8     320.00
      3       48.69   12.84    3.052  0.54( 0.05) 0.10      16.9     310.00
      4       47.51   13.96    2.903  0.54( 0.05) 0.10      17.4     300.00

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      48.71    Tc(MIN.) =    12.76
  EFFECTIVE AREA(ACRES) =      16.79   AREA-AVERAGED Fm(INCH/HR) =  0.05
  AREA-AVERAGED Fp(INCH/HR) =  0.54  AREA-AVERAGED Ap =  0.10
  TOTAL AREA(ACRES) =       17.4
  LONGEST FLOWPATH FROM NODE    300.00 TO NODE    332.00 =    1605.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    332.00 TO NODE    342.00 IS CODE =  31
------------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
==============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   878.86  DOWNSTREAM(FEET) =   878.70
  FLOW LENGTH(FEET) =    41.00   MANNING'S N =  0.012
  DEPTH OF FLOW IN  39.0 INCH PIPE IS  28.8 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   7.42
  ESTIMATED PIPE DIAMETER(INCH) =  39.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      48.71
  PIPE TRAVEL TIME(MIN.) =   0.09    Tc(MIN.) =   12.85
  LONGEST FLOWPATH FROM NODE    300.00 TO NODE    342.00 =    1646.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    342.00 TO NODE    342.00 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.) =   12.85
  RAINFALL INTENSITY(INCH/HR) =   3.05
  AREA-AVERAGED Fm(INCH/HR) =  0.05
  AREA-AVERAGED Fp(INCH/HR) =  0.54
  AREA-AVERAGED Ap =  0.10
  EFFECTIVE STREAM AREA(ACRES) =      16.79
  TOTAL STREAM AREA(ACRES) =      17.35
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      48.71

****************************************************************************
  FLOW PROCESS FROM NODE    340.00 TO NODE    341.00 IS CODE =  21
------------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
==============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   227.00
  ELEVATION DATA: UPSTREAM(FEET) =    885.85  DOWNSTREAM(FEET) =    884.53

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   7.454
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  4.229
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp          Ap     SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                  A        2.65      0.74     0.100    52    7.45
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.74
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA RUNOFF(CFS) =      9.91
  TOTAL AREA(ACRES) =      2.65   PEAK FLOW RATE(CFS) =      9.91

****************************************************************************
  FLOW PROCESS FROM NODE    341.00 TO NODE    342.00 IS CODE =  31
------------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
==============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   880.53  DOWNSTREAM(FEET) =   878.70
```

```
 FLOW LENGTH(FEET) =   300.00   MANNING'S N =  0.012
 DEPTH OF FLOW IN  21.0 INCH PIPE IS  13.7 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =   5.97
 ESTIMATED PIPE DIAMETER(INCH) =  21.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =       9.91
 PIPE TRAVEL TIME(MIN.) =   0.84    Tc(MIN.) =    8.29
 LONGEST FLOWPATH FROM NODE    340.00 TO NODE    342.00 =     527.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    342.00 TO NODE    342.00 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.) =    8.29
 RAINFALL INTENSITY(INCH/HR) =   3.97
 AREA-AVERAGED Fm(INCH/HR) =  0.07
 AREA-AVERAGED Fp(INCH/HR) =  0.74
 AREA-AVERAGED Ap =  0.10
 EFFECTIVE STREAM AREA(ACRES) =       2.65
 TOTAL STREAM AREA(ACRES) =       2.65
 PEAK FLOW RATE(CFS) AT CONFLUENCE =       9.91

 ** CONFLUENCE DATA **
  STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
  NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)     NODE
     1       44.80    9.43    3.672  0.54( 0.05) 0.10      12.8     330.00
     1       48.71   12.85    3.050  0.54( 0.05) 0.10      16.8     320.00
     1       48.69   12.93    3.038  0.54( 0.05) 0.10      16.9     310.00
     1       47.51   14.05    2.891  0.54( 0.05) 0.10      17.4     300.00
     2        9.91    8.29    3.967  0.74( 0.07) 0.10       2.7     340.00

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

 ** PEAK FLOW RATE TABLE **
  STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
  NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)     NODE
     1       52.50    8.29    3.967  0.58( 0.06) 0.10      13.9     340.00
     2       53.96    9.43    3.672  0.58( 0.06) 0.10      15.5     330.00
     3       56.29   12.85    3.050  0.57( 0.06) 0.10      19.4     320.00
     4       56.24   12.93    3.038  0.57( 0.06) 0.10      19.5     310.00
     5       54.68   14.05    2.891  0.57( 0.06) 0.10      20.0     300.00

 COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
 PEAK FLOW RATE(CFS) =      56.29    Tc(MIN.) =    12.85
 EFFECTIVE AREA(ACRES) =      19.44   AREA-AVERAGED Fm(INCH/HR) =  0.06
 AREA-AVERAGED Fp(INCH/HR) =  0.57  AREA-AVERAGED Ap =  0.10
 TOTAL AREA(ACRES) =       20.0
 LONGEST FLOWPATH FROM NODE    300.00 TO NODE    342.00 =    1646.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    342.00 TO NODE    352.00 IS CODE =  31
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   878.68  DOWNSTREAM(FEET) =   878.29
 FLOW LENGTH(FEET) =    97.00   MANNING'S N =  0.012
 DEPTH OF FLOW IN  42.0 INCH PIPE IS  29.4 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =   7.83
 ESTIMATED PIPE DIAMETER(INCH) =  42.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =      56.29
 PIPE TRAVEL TIME(MIN.) =   0.21    Tc(MIN.) =   13.06
 LONGEST FLOWPATH FROM NODE    300.00 TO NODE    352.00 =    1743.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    352.00 TO NODE    352.00 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.) =   13.06
 RAINFALL INTENSITY(INCH/HR) =   3.02
 AREA-AVERAGED Fm(INCH/HR) =  0.06
 AREA-AVERAGED Fp(INCH/HR) =  0.57
 AREA-AVERAGED Ap =  0.10
 EFFECTIVE STREAM AREA(ACRES) =      19.44
 TOTAL STREAM AREA(ACRES) =      20.00
 PEAK FLOW RATE(CFS) AT CONFLUENCE =      56.29

****************************************************************************
 FLOW PROCESS FROM NODE    350.00 TO NODE    351.00 IS CODE =  21
----------------------------------------------------------------------------
 >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
 >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
 INITIAL SUBAREA FLOW-LENGTH(FEET) =   658.00
 ELEVATION DATA: UPSTREAM(FEET) =    888.87  DOWNSTREAM(FEET) =    883.82

 Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
 SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   10.793
 * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  3.387
 SUBAREA Tc AND LOSS RATE DATA(AMC III):
  DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp          Ap     SCS   Tc
      LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
 COMMERCIAL                 A        0.65      0.74      0.100    52   10.79
 COMMERCIAL                 B        1.45      0.42      0.100    76   10.79
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.52
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
 SUBAREA RUNOFF(CFS) =      6.30
 TOTAL AREA(ACRES) =      2.10   PEAK FLOW RATE(CFS) =      6.30

****************************************************************************
 FLOW PROCESS FROM NODE    351.00 TO NODE    352.00 IS CODE =  31
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   879.82  DOWNSTREAM(FEET) =   878.29
 FLOW LENGTH(FEET) =     9.00   MANNING'S N =  0.012
 ESTIMATED PIPE DIAMETER(INCH) INCREASED TO 12.000
```

```
 DEPTH OF FLOW IN  12.0 INCH PIPE IS   5.3 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =  18.72
 ESTIMATED PIPE DIAMETER(INCH) =  12.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =       6.30
 PIPE TRAVEL TIME(MIN.) =   0.01    Tc(MIN.) =   10.80
 LONGEST FLOWPATH FROM NODE    350.00 TO NODE    352.00 =     667.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    352.00 TO NODE    352.00 IS CODE =   1
----------------------------------------------------------------------------
 >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
 >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
 TOTAL NUMBER OF STREAMS =  2
 CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
 TIME OF CONCENTRATION(MIN.) =   10.80
 RAINFALL INTENSITY(INCH/HR) =   3.39
 AREA-AVERAGED Fm(INCH/HR) =  0.05
 AREA-AVERAGED Fp(INCH/HR) =  0.52
 AREA-AVERAGED Ap =  0.10
 EFFECTIVE STREAM AREA(ACRES) =       2.10
 TOTAL STREAM AREA(ACRES) =       2.10
 PEAK FLOW RATE(CFS) AT CONFLUENCE =       6.30

 ** CONFLUENCE DATA **
  STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
  NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)          (ACRES)    NODE
     1       52.50    8.50    3.907  0.58( 0.06) 0.10      13.9     340.00
     1       53.96    9.65    3.623  0.58( 0.06) 0.10      15.5     330.00
     1       56.29   13.06    3.021  0.57( 0.06) 0.10      19.4     320.00
     1       56.24   13.14    3.010  0.57( 0.06) 0.10      19.5     310.00
     1       54.68   14.26    2.865  0.57( 0.06) 0.10      20.0     300.00
     2        6.30   10.80    3.385  0.52( 0.05) 0.10       2.1     350.00

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

 ** PEAK FLOW RATE TABLE **
  STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
  NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)          (ACRES)    NODE
     1       58.24    8.50    3.907  0.57( 0.06) 0.10      15.6     340.00
     2       59.99    9.65    3.623  0.57( 0.06) 0.10      17.3     330.00
     3       61.05   10.80    3.385  0.57( 0.06) 0.10      18.9     350.00
     4       61.90   13.06    3.021  0.56( 0.06) 0.10      21.5     320.00
     5       61.83   13.14    3.010  0.56( 0.06) 0.10      21.6     310.00
     6       60.00   14.26    2.865  0.56( 0.06) 0.10      22.1     300.00

 COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
 PEAK FLOW RATE(CFS) =      61.90    Tc(MIN.) =    13.06
 EFFECTIVE AREA(ACRES) =      21.54   AREA-AVERAGED Fm(INCH/HR) =  0.06
 AREA-AVERAGED Fp(INCH/HR) =  0.56  AREA-AVERAGED Ap =  0.10
 TOTAL AREA(ACRES) =       22.1
 LONGEST FLOWPATH FROM NODE    300.00 TO NODE    352.00 =    1743.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    352.00 TO NODE    362.00 IS CODE =  31
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   878.29  DOWNSTREAM(FEET) =   875.48
 FLOW LENGTH(FEET) =   702.00   MANNING'S N =  0.012
 DEPTH OF FLOW IN  42.0 INCH PIPE IS  31.8 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =   7.93
 ESTIMATED PIPE DIAMETER(INCH) =  42.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =      61.90
 PIPE TRAVEL TIME(MIN.) =   1.48    Tc(MIN.) =   14.53
 LONGEST FLOWPATH FROM NODE    300.00 TO NODE    362.00 =    2445.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    362.00 TO NODE    362.00 IS CODE =   1
----------------------------------------------------------------------------
 >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
 TOTAL NUMBER OF STREAMS =  2
 CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
 TIME OF CONCENTRATION(MIN.) =   14.53
 RAINFALL INTENSITY(INCH/HR) =   2.83
 AREA-AVERAGED Fm(INCH/HR) =  0.06
 AREA-AVERAGED Fp(INCH/HR) =  0.56
 AREA-AVERAGED Ap =  0.10
 EFFECTIVE STREAM AREA(ACRES) =      21.54
 TOTAL STREAM AREA(ACRES) =      22.10
 PEAK FLOW RATE(CFS) AT CONFLUENCE =      61.90

****************************************************************************
 FLOW PROCESS FROM NODE    360.00 TO NODE    361.00 IS CODE =  21
----------------------------------------------------------------------------
 >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
 >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
 INITIAL SUBAREA FLOW-LENGTH(FEET) =   351.00
 ELEVATION DATA: UPSTREAM(FEET) =    887.47  DOWNSTREAM(FEET) =    882.36

 Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
 SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    7.385
 * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  4.253
 SUBAREA Tc AND LOSS RATE DATA(AMC III):
  DEVELOPMENT TYPE/       SCS SOIL    AREA      Fp          Ap      SCS   Tc
      LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
 COMMERCIAL                  A        0.05      0.74      0.100    52    7.39
 COMMERCIAL                  B        2.00      0.42      0.100    76    7.39
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.43
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
 SUBAREA RUNOFF(CFS) =      7.77
 TOTAL AREA(ACRES) =      2.05   PEAK FLOW RATE(CFS) =      7.77

****************************************************************************
 FLOW PROCESS FROM NODE    361.00 TO NODE    362.00 IS CODE =  31
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   878.36  DOWNSTREAM(FEET) =   875.48
 FLOW LENGTH(FEET) =    16.00   MANNING'S N =  0.012
```

```
 DEPTH OF FLOW IN  12.0 INCH PIPE IS   5.9 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =  20.17
 ESTIMATED PIPE DIAMETER(INCH) =  12.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =       7.77
 PIPE TRAVEL TIME(MIN.) =   0.01    Tc(MIN.) =    7.40
 LONGEST FLOWPATH FROM NODE    360.00 TO NODE    362.00 =     367.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    362.00 TO NODE    362.00 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.) =    7.40
 RAINFALL INTENSITY(INCH/HR) =   4.25
 AREA-AVERAGED Fm(INCH/HR) =  0.04
 AREA-AVERAGED Fp(INCH/HR) =  0.43
 AREA-AVERAGED Ap =  0.10
 EFFECTIVE STREAM AREA(ACRES) =       2.05
 TOTAL STREAM AREA(ACRES) =       2.05
 PEAK FLOW RATE(CFS) AT CONFLUENCE =       7.77

 ** CONFLUENCE DATA **
  STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
  NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)          (ACRES)    NODE
     1       58.24    9.99    3.547  0.57( 0.06) 0.10      15.6     340.00
     1       59.99   11.13    3.325  0.57( 0.06) 0.10      17.3     330.00
     1       61.05   12.28    3.134  0.57( 0.06) 0.10      18.9     350.00
     1       61.90   14.53    2.833  0.56( 0.06) 0.10      21.5     320.00
     1       61.83   14.62    2.823  0.56( 0.06) 0.10      21.6     310.00
     1       60.00   15.74    2.700  0.56( 0.06) 0.10      22.1     300.00
     2        7.77    7.40    4.248  0.43( 0.04) 0.10       2.0     360.00

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

 ** PEAK FLOW RATE TABLE **
  STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
  NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)          (ACRES)    NODE
     1       59.55    7.40    4.248  0.55( 0.06) 0.10      13.6     360.00
     2       64.71    9.99    3.547  0.56( 0.06) 0.10      17.6     340.00
     3       66.05   11.13    3.325  0.55( 0.06) 0.10      19.4     330.00
     4       66.76   12.28    3.134  0.55( 0.06) 0.10      21.0     350.00
     5       67.06   14.53    2.833  0.55( 0.06) 0.10      23.6     320.00
     6       66.97   14.62    2.823  0.55( 0.06) 0.10      23.7     310.00
     7       64.91   15.74    2.700  0.55( 0.06) 0.10      24.1     300.00

 COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
 PEAK FLOW RATE(CFS) =      67.06    Tc(MIN.) =    14.53
 EFFECTIVE AREA(ACRES) =      23.59   AREA-AVERAGED Fm(INCH/HR) =  0.06
 AREA-AVERAGED Fp(INCH/HR) =  0.55  AREA-AVERAGED Ap =  0.10
 TOTAL AREA(ACRES) =       24.1
 LONGEST FLOWPATH FROM NODE    300.00 TO NODE    362.00 =    2445.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    362.00 TO NODE    372.00 IS CODE =  31
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   875.48  DOWNSTREAM(FEET) =   874.88
 FLOW LENGTH(FEET) =   149.00   MANNING'S N =  0.012
 DEPTH OF FLOW IN  42.0 INCH PIPE IS  34.3 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =   7.98
 ESTIMATED PIPE DIAMETER(INCH) =  42.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =      67.06
 PIPE TRAVEL TIME(MIN.) =   0.31    Tc(MIN.) =   14.84
 LONGEST FLOWPATH FROM NODE    300.00 TO NODE    372.00 =    2594.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    372.00 TO NODE    372.00 IS CODE =   1
----------------------------------------------------------------------------
 >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
 TOTAL NUMBER OF STREAMS =  2
 CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
 TIME OF CONCENTRATION(MIN.) =   14.84
 RAINFALL INTENSITY(INCH/HR) =   2.80
 AREA-AVERAGED Fm(INCH/HR) =  0.06
 AREA-AVERAGED Fp(INCH/HR) =  0.55
 AREA-AVERAGED Ap =  0.10
 EFFECTIVE STREAM AREA(ACRES) =      23.59
 TOTAL STREAM AREA(ACRES) =      24.15
 PEAK FLOW RATE(CFS) AT CONFLUENCE =      67.06

****************************************************************************
 FLOW PROCESS FROM NODE    370.00 TO NODE    371.00 IS CODE =  21
----------------------------------------------------------------------------
 >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
 >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
 INITIAL SUBAREA FLOW-LENGTH(FEET) =   151.00
 ELEVATION DATA: UPSTREAM(FEET) =    883.96  DOWNSTREAM(FEET) =    882.29

 Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
 SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    5.568
 * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  5.038
 SUBAREA Tc AND LOSS RATE DATA(AMC III):
  DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp          Ap     SCS   Tc
      LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
 COMMERCIAL                  A        0.20      0.74     0.100    52    5.57
 COMMERCIAL                  B        1.40      0.42     0.100    76    5.57
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.46
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
 SUBAREA RUNOFF(CFS) =      7.19
 TOTAL AREA(ACRES) =      1.60   PEAK FLOW RATE(CFS) =      7.19

****************************************************************************
 FLOW PROCESS FROM NODE    371.00 TO NODE    372.00 IS CODE =  31
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
```

```
 ELEVATION DATA: UPSTREAM(FEET) =   878.29  DOWNSTREAM(FEET) =   874.88
 FLOW LENGTH(FEET) =    16.00   MANNING'S N =  0.012
 ESTIMATED PIPE DIAMETER(INCH) INCREASED TO 12.000
 DEPTH OF FLOW IN  12.0 INCH PIPE IS   5.4 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =  21.06
 ESTIMATED PIPE DIAMETER(INCH) =  12.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =        7.19
 PIPE TRAVEL TIME(MIN.) =   0.01    Tc(MIN.) =    5.58
 LONGEST FLOWPATH FROM NODE    370.00 TO NODE    372.00 =     167.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    372.00 TO NODE    372.00 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.) =    5.58
 RAINFALL INTENSITY(INCH/HR) =   5.03
 AREA-AVERAGED Fm(INCH/HR) =  0.05
 AREA-AVERAGED Fp(INCH/HR) =  0.46
 AREA-AVERAGED Ap =  0.10
 EFFECTIVE STREAM AREA(ACRES) =       1.60
 TOTAL STREAM AREA(ACRES) =       1.60
 PEAK FLOW RATE(CFS) AT CONFLUENCE =       7.19

 ** CONFLUENCE DATA **
  STREAM       Q      Tc   Intensity   Fp(Fm)     Ap      Ae     HEADWATER
  NUMBER     (CFS)   (MIN.) (INCH/HR) (INCH/HR)          (ACRES)    NODE
     1       59.55    7.71    4.143  0.55( 0.06) 0.10      13.6     360.00
     1       64.71   10.30    3.482  0.56( 0.06) 0.10      17.6     340.00
     1       66.05   11.44    3.271  0.55( 0.06) 0.10      19.4     330.00
     1       66.76   12.59    3.088  0.55( 0.06) 0.10      21.0     350.00
     1       67.06   14.84    2.797  0.55( 0.06) 0.10      23.6     320.00
     1       66.97   14.93    2.788  0.55( 0.06) 0.10      23.7     310.00
     1       64.91   16.06    2.669  0.55( 0.06) 0.10      24.1     300.00
     2        7.19    5.58    5.031  0.46( 0.05) 0.10       1.6     370.00

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

 ** PEAK FLOW RATE TABLE **
  STREAM       Q      Tc   Intensity   Fp(Fm)     Ap      Ae     HEADWATER
  NUMBER     (CFS)   (MIN.) (INCH/HR) (INCH/HR)          (ACRES)    NODE
     1       59.63    5.58    5.031  0.54( 0.05) 0.10      11.4     370.00
     2       65.46    7.71    4.143  0.54( 0.05) 0.10      15.2     360.00
     3       69.67   10.30    3.482  0.55( 0.05) 0.10      19.2     340.00
     4       70.70   11.44    3.271  0.55( 0.05) 0.10      21.0     330.00
     5       71.14   12.59    3.088  0.55( 0.05) 0.10      22.6     350.00
     6       71.02   14.84    2.797  0.55( 0.05) 0.10      25.2     320.00
     7       70.92   14.93    2.788  0.55( 0.05) 0.10      25.3     310.00
     8       68.69   16.06    2.669  0.55( 0.05) 0.10      25.8     300.00

 COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
 PEAK FLOW RATE(CFS) =      71.14    Tc(MIN.) =    12.59
 EFFECTIVE AREA(ACRES) =      22.55   AREA-AVERAGED Fm(INCH/HR) =  0.05
 AREA-AVERAGED Fp(INCH/HR) =  0.55  AREA-AVERAGED Ap =  0.10
 TOTAL AREA(ACRES) =       25.8
 LONGEST FLOWPATH FROM NODE    300.00 TO NODE    372.00 =    2594.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    372.00 TO NODE    382.00 IS CODE =  31
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   874.88  DOWNSTREAM(FEET) =   874.17
 FLOW LENGTH(FEET) =   178.00   MANNING'S N =  0.012
 DEPTH OF FLOW IN  45.0 INCH PIPE IS  32.8 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =   8.24
 ESTIMATED PIPE DIAMETER(INCH) =  45.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =      71.14
 PIPE TRAVEL TIME(MIN.) =   0.36    Tc(MIN.) =   12.95
 LONGEST FLOWPATH FROM NODE    300.00 TO NODE    382.00 =    2772.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    382.00 TO NODE    382.00 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.) =   12.95
 RAINFALL INTENSITY(INCH/HR) =   3.04
 AREA-AVERAGED Fm(INCH/HR) =  0.05
 AREA-AVERAGED Fp(INCH/HR) =  0.55
 AREA-AVERAGED Ap =  0.10
 EFFECTIVE STREAM AREA(ACRES) =      22.55
 TOTAL STREAM AREA(ACRES) =      25.75
 PEAK FLOW RATE(CFS) AT CONFLUENCE =      71.14

****************************************************************************
 FLOW PROCESS FROM NODE    380.00 TO NODE    381.00 IS CODE =  21
----------------------------------------------------------------------------
 >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
 >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
 INITIAL SUBAREA FLOW-LENGTH(FEET) =   151.00
 ELEVATION DATA: UPSTREAM(FEET) =    883.96  DOWNSTREAM(FEET) =    882.29

 Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
 SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    5.568
 * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  5.038
 SUBAREA Tc AND LOSS RATE DATA(AMC III):
  DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp          Ap     SCS   Tc
      LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
 COMMERCIAL                  B        1.75      0.42      0.100    76    5.57
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.42
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
 SUBAREA RUNOFF(CFS) =      7.87
 TOTAL AREA(ACRES) =      1.75   PEAK FLOW RATE(CFS) =      7.87

****************************************************************************
 FLOW PROCESS FROM NODE    381.00 TO NODE    382.00 IS CODE =  31
```

```
------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
========================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   878.29  DOWNSTREAM(FEET) =   874.17
  FLOW LENGTH(FEET) =    16.00   MANNING'S N =  0.012
  ESTIMATED PIPE DIAMETER(INCH) INCREASED TO 12.000
  DEPTH OF FLOW IN  12.0 INCH PIPE IS   5.4 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =  23.12
  ESTIMATED PIPE DIAMETER(INCH) =  12.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       7.87
  PIPE TRAVEL TIME(MIN.) =   0.01    Tc(MIN.) =    5.58
  LONGEST FLOWPATH FROM NODE    380.00 TO NODE    382.00 =     167.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    382.00 TO NODE    382.00 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.) =    5.58
  RAINFALL INTENSITY(INCH/HR) =   5.03
  AREA-AVERAGED Fm(INCH/HR) =  0.04
  AREA-AVERAGED Fp(INCH/HR) =  0.42
  AREA-AVERAGED Ap =  0.10
  EFFECTIVE STREAM AREA(ACRES) =       1.75
  TOTAL STREAM AREA(ACRES) =       1.75
  PEAK FLOW RATE(CFS) AT CONFLUENCE =       7.87

  ** CONFLUENCE DATA **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)          (ACRES)    NODE
      1       59.63    5.96    4.838  0.54( 0.05) 0.10      11.4     370.00
      1       65.46    8.09    4.027  0.54( 0.05) 0.10      15.2     360.00
      1       69.67   10.66    3.411  0.55( 0.05) 0.10      19.2     340.00
      1       70.70   11.80    3.210  0.55( 0.05) 0.10      21.0     330.00
      1       71.14   12.95    3.036  0.55( 0.05) 0.10      22.6     350.00
      1       71.02   15.21    2.757  0.55( 0.05) 0.10      25.2     320.00
      1       70.92   15.29    2.748  0.55( 0.05) 0.10      25.3     310.00
      1       68.69   16.42    2.633  0.55( 0.05) 0.10      25.8     300.00
      2        7.87    5.58    5.032  0.42( 0.04) 0.10       1.8     380.00

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

  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)          (ACRES)    NODE
      1       65.99    5.58    5.032  0.52( 0.05) 0.10      12.4     380.00
      2       67.20    5.96    4.838  0.52( 0.05) 0.10      13.2     370.00
      3       71.74    8.09    4.027  0.53( 0.05) 0.10      16.9     360.00
      4       74.98   10.66    3.411  0.54( 0.05) 0.10      21.0     340.00
      5       75.69   11.80    3.210  0.54( 0.05) 0.10      22.7     330.00
      6       75.86   12.95    3.036  0.54( 0.05) 0.10      24.3     350.00
      7       75.30   15.21    2.757  0.54( 0.05) 0.10      26.9     320.00
      8       75.19   15.29    2.748  0.54( 0.05) 0.10      27.0     310.00
      9       72.77   16.42    2.633  0.54( 0.05) 0.10      27.5     300.00

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      75.86    Tc(MIN.) =    12.95
  EFFECTIVE AREA(ACRES) =      24.30   AREA-AVERAGED Fm(INCH/HR) =  0.05
  AREA-AVERAGED Fp(INCH/HR) =  0.54  AREA-AVERAGED Ap =  0.10
  TOTAL AREA(ACRES) =       27.5
  LONGEST FLOWPATH FROM NODE    300.00 TO NODE    382.00 =    2772.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    382.00 TO NODE    392.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
========================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   874.17  DOWNSTREAM(FEET) =   873.46
  FLOW LENGTH(FEET) =   177.00   MANNING'S N =  0.012
  DEPTH OF FLOW IN  45.0 INCH PIPE IS  34.6 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   8.32
  ESTIMATED PIPE DIAMETER(INCH) =  45.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      75.86
  PIPE TRAVEL TIME(MIN.) =   0.35    Tc(MIN.) =   13.31
  LONGEST FLOWPATH FROM NODE    300.00 TO NODE    392.00 =    2949.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    392.00 TO NODE    392.00 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.) =   13.31
  RAINFALL INTENSITY(INCH/HR) =   2.99
  AREA-AVERAGED Fm(INCH/HR) =  0.05
  AREA-AVERAGED Fp(INCH/HR) =  0.54
  AREA-AVERAGED Ap =  0.10
  EFFECTIVE STREAM AREA(ACRES) =      24.30
  TOTAL STREAM AREA(ACRES) =      27.50
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      75.86

****************************************************************************
  FLOW PROCESS FROM NODE    390.00 TO NODE    391.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
========================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   196.00
  ELEVATION DATA: UPSTREAM(FEET) =    887.96  DOWNSTREAM(FEET) =    882.29

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    5.099
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  5.311
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                  B        1.85      0.42     0.100    76    5.10
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.42
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  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA RUNOFF(CFS) =      8.77
  TOTAL AREA(ACRES) =      1.85   PEAK FLOW RATE(CFS) =      8.77

****************************************************************************
  FLOW PROCESS FROM NODE    391.00 TO NODE    392.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   878.29  DOWNSTREAM(FEET) =   873.46
  FLOW LENGTH(FEET) =    16.00   MANNING'S N =  0.012
  ESTIMATED PIPE DIAMETER(INCH) INCREASED TO 12.000
  DEPTH OF FLOW IN  12.0 INCH PIPE IS   5.5 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =  25.23
  ESTIMATED PIPE DIAMETER(INCH) =  12.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       8.77
  PIPE TRAVEL TIME(MIN.) =   0.01    Tc(MIN.) =    5.11
  LONGEST FLOWPATH FROM NODE    390.00 TO NODE    392.00 =     212.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    392.00 TO NODE    392.00 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.) =    5.11
  RAINFALL INTENSITY(INCH/HR) =   5.30
  AREA-AVERAGED Fm(INCH/HR) =  0.04
  AREA-AVERAGED Fp(INCH/HR) =  0.42
  AREA-AVERAGED Ap =  0.10
  EFFECTIVE STREAM AREA(ACRES) =       1.85
  TOTAL STREAM AREA(ACRES) =       1.85
  PEAK FLOW RATE(CFS) AT CONFLUENCE =       8.77

  ** CONFLUENCE DATA **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1       65.99    5.95    4.841  0.52( 0.05) 0.10      12.4     380.00
      1       67.20    6.33    4.666  0.52( 0.05) 0.10      13.2     370.00
      1       71.74    8.44    3.924  0.53( 0.05) 0.10      16.9     360.00
      1       74.98   11.02    3.345  0.54( 0.05) 0.10      21.0     340.00
      1       75.69   12.16    3.154  0.54( 0.05) 0.10      22.7     330.00
      1       75.86   13.31    2.987  0.54( 0.05) 0.10      24.3     350.00
      1       75.30   15.56    2.719  0.54( 0.05) 0.10      26.9     320.00
      1       75.19   15.64    2.711  0.54( 0.05) 0.10      27.0     310.00
      1       72.77   16.77    2.600  0.54( 0.05) 0.10      27.5     300.00
      2        8.77    5.11    5.304  0.42( 0.04) 0.10       1.9     390.00

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

  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1       70.92    5.11    5.304  0.51( 0.05) 0.10      12.5     390.00
      2       73.99    5.95    4.841  0.51( 0.05) 0.10      14.3     380.00
      3       74.90    6.33    4.666  0.51( 0.05) 0.10      15.0     370.00
      4       78.22    8.44    3.924  0.52( 0.05) 0.10      18.8     360.00
      5       80.49   11.02    3.345  0.53( 0.05) 0.10      22.8     340.00
      6       80.88   12.16    3.154  0.53( 0.05) 0.10      24.6     330.00
      7       80.77   13.31    2.987  0.53( 0.05) 0.10      26.2     350.00
      8       79.77   15.56    2.719  0.53( 0.05) 0.10      28.8     320.00
      9       79.63   15.64    2.711  0.53( 0.05) 0.10      28.9     310.00
     10       77.04   16.77    2.600  0.53( 0.05) 0.10      29.4     300.00

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      80.88    Tc(MIN.) =    12.16
  EFFECTIVE AREA(ACRES) =      24.58   AREA-AVERAGED Fm(INCH/HR) =  0.05
  AREA-AVERAGED Fp(INCH/HR) =  0.53  AREA-AVERAGED Ap =  0.10
  TOTAL AREA(ACRES) =       29.4
  LONGEST FLOWPATH FROM NODE    300.00 TO NODE    392.00 =    2949.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    392.00 TO NODE    402.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   873.46  DOWNSTREAM(FEET) =   872.75
  FLOW LENGTH(FEET) =   178.00   MANNING'S N =  0.012
  DEPTH OF FLOW IN  48.0 INCH PIPE IS  33.8 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   8.54
  ESTIMATED PIPE DIAMETER(INCH) =  48.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      80.88
  PIPE TRAVEL TIME(MIN.) =   0.35    Tc(MIN.) =   12.50
  LONGEST FLOWPATH FROM NODE    300.00 TO NODE    402.00 =    3127.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    402.00 TO NODE    402.00 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.) =   12.50
  RAINFALL INTENSITY(INCH/HR) =   3.10
  AREA-AVERAGED Fm(INCH/HR) =  0.05
  AREA-AVERAGED Fp(INCH/HR) =  0.53
  AREA-AVERAGED Ap =  0.10
  EFFECTIVE STREAM AREA(ACRES) =      24.58
  TOTAL STREAM AREA(ACRES) =      29.35
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      80.88

****************************************************************************
  FLOW PROCESS FROM NODE    400.00 TO NODE    401.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   202.00
  ELEVATION DATA: UPSTREAM(FEET) =    887.96  DOWNSTREAM(FEET) =    882.29
```

```
  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    5.192
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  5.254
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 B        2.40      0.42      0.100    76    5.19
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.42
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA RUNOFF(CFS) =     11.26
  TOTAL AREA(ACRES) =      2.40   PEAK FLOW RATE(CFS) =     11.26

****************************************************************************
  FLOW PROCESS FROM NODE    401.00 TO NODE    402.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   878.29  DOWNSTREAM(FEET) =   872.75
  FLOW LENGTH(FEET) =    16.00   MANNING'S N =  0.012
  DEPTH OF FLOW IN  12.0 INCH PIPE IS   6.1 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =  28.29
  ESTIMATED PIPE DIAMETER(INCH) =  12.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      11.26
  PIPE TRAVEL TIME(MIN.) =   0.01    Tc(MIN.) =    5.20
  LONGEST FLOWPATH FROM NODE    400.00 TO NODE    402.00 =     218.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    402.00 TO NODE    402.00 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.) =    5.20
  RAINFALL INTENSITY(INCH/HR) =   5.25
  AREA-AVERAGED Fm(INCH/HR) =  0.04
  AREA-AVERAGED Fp(INCH/HR) =  0.42
  AREA-AVERAGED Ap =  0.10
  EFFECTIVE STREAM AREA(ACRES) =       2.40
  TOTAL STREAM AREA(ACRES) =       2.40
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      11.26

  ** CONFLUENCE DATA **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1       70.92    5.47    5.092  0.51( 0.05) 0.10      12.5     390.00
      1       73.99    6.31    4.674  0.51( 0.05) 0.10      14.3     380.00
      1       74.90    6.69    4.514  0.51( 0.05) 0.10      15.0     370.00
      1       78.22    8.80    3.828  0.52( 0.05) 0.10      18.8     360.00
      1       80.49   11.38    3.282  0.53( 0.05) 0.10      22.8     340.00
      1       80.88   12.50    3.101  0.53( 0.05) 0.10      24.6     330.00
      1       80.77   13.65    2.941  0.53( 0.05) 0.10      26.2     350.00
      1       79.77   15.92    2.683  0.53( 0.05) 0.10      28.8     320.00
      1       79.63   16.00    2.674  0.53( 0.05) 0.10      28.9     310.00
      1       77.04   17.13    2.567  0.53( 0.05) 0.10      29.4     300.00
      2       11.26    5.20    5.248  0.42( 0.04) 0.10       2.4     400.00

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

  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1       80.78    5.20    5.248  0.49( 0.05) 0.10      14.3     400.00
      2       81.84    5.47    5.092  0.49( 0.05) 0.10      14.9     390.00
      3       84.00    6.31    4.674  0.50( 0.05) 0.10      16.7     380.00
      4       84.57    6.69    4.514  0.50( 0.05) 0.10      17.4     370.00
      5       86.40    8.80    3.828  0.51( 0.05) 0.10      21.2     360.00
      6       87.49   11.38    3.282  0.52( 0.05) 0.10      25.2     340.00
      7       87.49   12.50    3.101  0.52( 0.05) 0.10      27.0     330.00
      8       87.04   13.65    2.941  0.52( 0.05) 0.10      28.6     350.00
      9       85.48   15.92    2.683  0.52( 0.05) 0.10      31.2     320.00
     10       85.33   16.00    2.674  0.52( 0.05) 0.10      31.3     310.00
     11       82.50   17.13    2.567  0.52( 0.05) 0.10      31.8     300.00

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      87.49    Tc(MIN.) =    12.50
  EFFECTIVE AREA(ACRES) =      26.98   AREA-AVERAGED Fm(INCH/HR) =  0.05
  AREA-AVERAGED Fp(INCH/HR) =  0.52  AREA-AVERAGED Ap =  0.10
  TOTAL AREA(ACRES) =       31.8
  LONGEST FLOWPATH FROM NODE    300.00 TO NODE    402.00 =    3127.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    402.00 TO NODE    403.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   872.75  DOWNSTREAM(FEET) =   870.13
  FLOW LENGTH(FEET) =   105.00   MANNING'S N =  0.012
  DEPTH OF FLOW IN  33.0 INCH PIPE IS  26.8 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =  16.93
  ESTIMATED PIPE DIAMETER(INCH) =  33.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      87.49
  PIPE TRAVEL TIME(MIN.) =   0.10    Tc(MIN.) =   12.61
  LONGEST FLOWPATH FROM NODE    300.00 TO NODE    403.00 =    3232.00 FEET.
============================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =       31.8  TC(MIN.) =     12.61
  EFFECTIVE AREA(ACRES) =     26.98  AREA-AVERAGED Fm(INCH/HR)=  0.05
  AREA-AVERAGED Fp(INCH/HR) =  0.52  AREA-AVERAGED Ap = 0.100
  PEAK FLOW RATE(CFS)   =      87.49

  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1       80.78    5.31    5.186  0.49( 0.05) 0.10      14.3     400.00
      2       81.84    5.57    5.035  0.49( 0.05) 0.10      14.9     390.00
      3       84.00    6.41    4.629  0.50( 0.05) 0.10      16.7     380.00
      4       84.57    6.79    4.473  0.50( 0.05) 0.10      17.4     370.00
      5       86.40    8.90    3.801  0.51( 0.05) 0.10      21.2     360.00
      6       87.49   11.48    3.264  0.52( 0.05) 0.10      25.2     340.00
      7       87.49   12.61    3.086  0.52( 0.05) 0.10      27.0     330.00
```

8	87.04	13.76	2.928	0.52(0.05) 0.10	28.6	350.00
9	85.48	16.02	2.672	0.52(0.05) 0.10	31.2	320.00
10	85.33	16.10	2.664	0.52(0.05) 0.10	31.3	310.00
11	82.50	17.23	2.558	0.52(0.05) 0.10	31.8	300.00

END OF RATIONAL METHOD ANALYSIS

♀

OFF-SITE CONDITION

```
******************************************************************************
            RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
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                          Analysis prepared by:




 ************************ DESCRIPTION OF STUDY ************************
* AGUA MANSA LOGISTICS CENTER                                         *
* STORM EVENT 100-YEAR                                                *
* PUBLIC STORM DRAIN CONNECTION TO RIVER                              *
 **********************************************************************

  FILE NAME: W:\3813\200X.DAT
  TIME/DATE OF STUDY: 10:45 09/14/2020
==============================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
==============================================================================
                    --*TIME-OF-CONCENTRATION MODEL*--

  USER SPECIFIED STORM EVENT(YEAR) =  100.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =   6.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.95
  *USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL*

  SLOPE OF INTENSITY DURATION CURVE(LOG(I;IN/HR) vs. LOG(Tc;MIN)) = 0.6000
  USER SPECIFIED 1-HOUR INTENSITY(INCH/HOUR) = 1.2000

  *ANTECEDENT MOISTURE CONDITION (AMC) III ASSUMED FOR RATIONAL METHOD*

  *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)
  *USER-SPECIFIED MINIMUM TOPOGRAPHIC SLOPE ADJUSTMENT NOT SELECTED

******************************************************************************
  FLOW PROCESS FROM NODE    500.00 TO NODE    501.00 IS CODE =  21
------------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
==============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =  1000.00
  ELEVATION DATA: UPSTREAM(FEET) =    913.80  DOWNSTREAM(FEET) =    900.56

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   19.760
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  2.337
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/       SCS SOIL    AREA      Fp          Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  NATURAL POOR COVER
  "BARREN"                    B        7.25      0.11      1.000    97   19.76
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.11
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  1.000
  SUBAREA RUNOFF(CFS) =     14.56
  TOTAL AREA(ACRES) =      7.25   PEAK FLOW RATE(CFS) =     14.56

******************************************************************************
  FLOW PROCESS FROM NODE    501.00 TO NODE    501.00 IS CODE =  81
------------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
==============================================================================
  MAINLINE Tc(MIN.) =   19.76
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  2.337
  SUBAREA LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp          Ap      SCS
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
  COMMERCIAL                  B        0.30      0.42      0.100    76
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.42
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA AREA(ACRES) =    0.30      SUBAREA RUNOFF(CFS) =    0.62
  EFFECTIVE AREA(ACRES) =      7.55   AREA-AVERAGED Fm(INCH/HR) =  0.10
  AREA-AVERAGED Fp(INCH/HR) =  0.11  AREA-AVERAGED Ap =  0.96
  TOTAL AREA(ACRES) =        7.6       PEAK FLOW RATE(CFS) =      15.17

******************************************************************************
  FLOW PROCESS FROM NODE    501.00 TO NODE    502.00 IS CODE =  61
------------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STANDARD CURB SECTION USED)<<<<<
==============================================================================
  UPSTREAM ELEVATION(FEET) =  900.56  DOWNSTREAM ELEVATION(FEET) =  887.97
  STREET LENGTH(FEET) =  1734.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 37.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  17.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0149
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      21.04
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.62
    HALFSTREET FLOOD WIDTH(FEET) =   30.68
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    3.20
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.99
```

```
  STREET FLOW TRAVEL TIME(MIN.) =   9.02   Tc(MIN.) =   28.78
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  1.865
  SUBAREA LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap     SCS
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
  NATURAL POOR COVER
  "BARREN"                   B        7.40      0.11     1.000    97
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.11
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  1.000
  SUBAREA AREA(ACRES) =    7.40      SUBAREA RUNOFF(CFS) =   11.71
  EFFECTIVE AREA(ACRES) =     14.95    AREA-AVERAGED Fm(INCH/HR) =  0.10
  AREA-AVERAGED Fp(INCH/HR) =  0.11  AREA-AVERAGED Ap =  0.98
  TOTAL AREA(ACRES) =       15.0        PEAK FLOW RATE(CFS) =      23.68

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.64   HALFSTREET FLOOD WIDTH(FEET) =  32.80
  FLOW VELOCITY(FEET/SEC.) =  3.27   DEPTH*VELOCITY(FT*FT/SEC.) =   2.10
  *NOTE: INITIAL SUBAREA NOMOGRAPH WITH SUBAREA PARAMETERS,
         AND L = 1734.0 FT WITH ELEVATION-DROP =  12.6 FT, IS   12.0 CFS,
         WHICH EXCEEDS THE TOP-OF-CURB STREET CAPACITY AT NODE    502.00
  LONGEST FLOWPATH FROM NODE    500.00 TO NODE    502.00 =    2734.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    502.00 TO NODE    502.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
  MAINLINE Tc(MIN.) =   28.78
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  1.865
  SUBAREA LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap     SCS
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
  COMMERCIAL                 B        1.75      0.42     0.100    76
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.42
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA AREA(ACRES) =    1.75      SUBAREA RUNOFF(CFS) =    2.87
  EFFECTIVE AREA(ACRES) =     16.70   AREA-AVERAGED Fm(INCH/HR) =  0.10
  AREA-AVERAGED Fp(INCH/HR) =  0.11  AREA-AVERAGED Ap =  0.89
  TOTAL AREA(ACRES) =       16.7       PEAK FLOW RATE(CFS) =      26.55

****************************************************************************
  FLOW PROCESS FROM NODE    502.00 TO NODE    503.00 IS CODE =  61
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STANDARD CURB SECTION USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  887.97  DOWNSTREAM ELEVATION(FEET) =  884.57
  STREET LENGTH(FEET) =   671.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 37.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  17.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0149
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      29.91
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.72
    HALFSTREET FLOOD WIDTH(FEET) =   40.90
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    2.92
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    2.11
  STREET FLOW TRAVEL TIME(MIN.) =   3.82   Tc(MIN.) =   32.61
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  1.730
  SUBAREA LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap     SCS
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
  NATURAL POOR COVER
  "BARREN"                   B        4.60      0.11     1.000    97
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.11
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  1.000
  SUBAREA AREA(ACRES) =    4.60      SUBAREA RUNOFF(CFS) =    6.72
  EFFECTIVE AREA(ACRES) =     21.30    AREA-AVERAGED Fm(INCH/HR) =  0.10
  AREA-AVERAGED Fp(INCH/HR) =  0.11  AREA-AVERAGED Ap =  0.91
  TOTAL AREA(ACRES) =       21.3        PEAK FLOW RATE(CFS) =      31.25

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.73   HALFSTREET FLOOD WIDTH(FEET) =  41.83
  FLOW VELOCITY(FEET/SEC.) =  2.94   DEPTH*VELOCITY(FT*FT/SEC.) =   2.15
  *NOTE: INITIAL SUBAREA NOMOGRAPH WITH SUBAREA PARAMETERS,
         AND L =  671.0 FT WITH ELEVATION-DROP =   3.4 FT, IS    9.0 CFS,
         WHICH EXCEEDS THE TOP-OF-CURB STREET CAPACITY AT NODE    503.00
  LONGEST FLOWPATH FROM NODE    500.00 TO NODE    503.00 =    3405.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    503.00 TO NODE    503.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
  MAINLINE Tc(MIN.) =   32.61
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  1.730
  SUBAREA LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap     SCS
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
  COMMERCIAL                 B        0.70      0.42     0.100    76
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.42
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA AREA(ACRES) =    0.70      SUBAREA RUNOFF(CFS) =    1.06
  EFFECTIVE AREA(ACRES) =     22.00   AREA-AVERAGED Fm(INCH/HR) =  0.10
  AREA-AVERAGED Fp(INCH/HR) =  0.11  AREA-AVERAGED Ap =  0.89
  TOTAL AREA(ACRES) =       22.0       PEAK FLOW RATE(CFS) =      32.32

****************************************************************************
  FLOW PROCESS FROM NODE    503.00 TO NODE    504.00 IS CODE =  61
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STANDARD CURB SECTION USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  884.57  DOWNSTREAM ELEVATION(FEET) =  880.77
  STREET LENGTH(FEET) =   748.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 37.00
```

```
 DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  17.00
 INSIDE STREET CROSSFALL(DECIMAL) =  0.020
 OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

 SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
 STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
 Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0149
 Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

   **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      38.65
   STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
   STREET FLOW DEPTH(FEET) =  0.78
   HALFSTREET FLOOD WIDTH(FEET) =   46.48
   AVERAGE FLOW VELOCITY(FEET/SEC.) =    3.05
   PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    2.37
 STREET FLOW TRAVEL TIME(MIN.) =   4.09   Tc(MIN.) =   36.69
 * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  1.612
 SUBAREA LOSS RATE DATA(AMC III):
  DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS
      LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
 NATURAL POOR COVER
 "BARREN"                  B         9.35      0.11     1.000    97
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.11
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  1.000
 SUBAREA AREA(ACRES) =    9.35      SUBAREA RUNOFF(CFS) =   12.67
 EFFECTIVE AREA(ACRES) =     31.35    AREA-AVERAGED Fm(INCH/HR) =  0.10
 AREA-AVERAGED Fp(INCH/HR) =  0.11  AREA-AVERAGED Ap =  0.92
 TOTAL AREA(ACRES) =       31.4        PEAK FLOW RATE(CFS) =      42.65

 END OF SUBAREA STREET FLOW HYDRAULICS:
 DEPTH(FEET) = 0.80   HALFSTREET FLOOD WIDTH(FEET) =  48.61
 FLOW VELOCITY(FEET/SEC.) =  3.12   DEPTH*VELOCITY(FT*FT/SEC.) =   2.49
 *NOTE: INITIAL SUBAREA NOMOGRAPH WITH SUBAREA PARAMETERS,
        AND L =  748.0 FT WITH ELEVATION-DROP =   3.8 FT, IS   17.9 CFS,
        WHICH EXCEEDS THE TOP-OF-CURB STREET CAPACITY AT NODE    504.00
 LONGEST FLOWPATH FROM NODE    500.00 TO NODE    504.00 =    4153.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    504.00 TO NODE    504.00 IS CODE =  81
----------------------------------------------------------------------------
 >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
 MAINLINE Tc(MIN.) =   36.69
 * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  1.612
 SUBAREA LOSS RATE DATA(AMC III):
  DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS
      LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
 COMMERCIAL                B         0.80      0.42     0.100    76
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.42
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
 SUBAREA AREA(ACRES) =    0.80      SUBAREA RUNOFF(CFS) =    1.13
 EFFECTIVE AREA(ACRES) =     32.15   AREA-AVERAGED Fm(INCH/HR) =  0.10
 AREA-AVERAGED Fp(INCH/HR) =  0.11  AREA-AVERAGED Ap =  0.90
 TOTAL AREA(ACRES) =       32.2        PEAK FLOW RATE(CFS) =      43.78

****************************************************************************
 FLOW PROCESS FROM NODE    504.00 TO NODE    561.00 IS CODE =  31
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   870.79  DOWNSTREAM(FEET) =   870.05
 FLOW LENGTH(FEET) =   262.00   MANNING'S N =  0.013
 DEPTH OF FLOW IN  42.0 INCH PIPE IS  29.5 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =   6.07
 ESTIMATED PIPE DIAMETER(INCH) =  42.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =      43.78
 PIPE TRAVEL TIME(MIN.) =   0.72    Tc(MIN.) =   37.41
 LONGEST FLOWPATH FROM NODE    500.00 TO NODE    561.00 =    4415.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    561.00 TO NODE    561.00 IS CODE =  81
----------------------------------------------------------------------------
 >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
 MAINLINE Tc(MIN.) =   37.41
 * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  1.593
 SUBAREA LOSS RATE DATA(AMC III):
  DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS
      LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
 COMMERCIAL                B         0.25      0.42     0.100    76
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.42
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
 SUBAREA AREA(ACRES) =    0.25      SUBAREA RUNOFF(CFS) =    0.35
 EFFECTIVE AREA(ACRES) =     32.40   AREA-AVERAGED Fm(INCH/HR) =  0.10
 AREA-AVERAGED Fp(INCH/HR) =  0.11  AREA-AVERAGED Ap =  0.89
 TOTAL AREA(ACRES) =       32.4        PEAK FLOW RATE(CFS) =      43.78
 NOTE: PEAK FLOW RATE DEFAULTED TO UPSTREAM VALUE

****************************************************************************
 FLOW PROCESS FROM NODE    561.00 TO NODE    562.00 IS CODE =  31
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   870.05  DOWNSTREAM(FEET) =   869.68
 FLOW LENGTH(FEET) =   124.00   MANNING'S N =  0.013
 DEPTH OF FLOW IN  39.0 INCH PIPE IS  31.8 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =   6.04
 ESTIMATED PIPE DIAMETER(INCH) =  39.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =      43.78
 PIPE TRAVEL TIME(MIN.) =   0.34    Tc(MIN.) =   37.75
 LONGEST FLOWPATH FROM NODE    500.00 TO NODE    562.00 =    4539.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE    562.00 TO NODE    562.00 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.) =   37.75
 RAINFALL INTENSITY(INCH/HR) =   1.58
 AREA-AVERAGED Fm(INCH/HR) =  0.10
 AREA-AVERAGED Fp(INCH/HR) =  0.11
```

```
  AREA-AVERAGED Ap =  0.89
  EFFECTIVE STREAM AREA(ACRES) =      32.40
  TOTAL STREAM AREA(ACRES) =      32.40
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      43.78

****************************************************************************
  FLOW PROCESS FROM NODE    562.00 TO NODE    562.00 IS CODE =   7
----------------------------------------------------------------------------
  >>>>>USER SPECIFIED HYDROLOGY INFORMATION AT NODE<<<<<
============================================================================
  USER-SPECIFIED VALUES ARE AS FOLLOWS:
  TC(MIN.) =   11.37   RAINFALL INTENSITY(INCH/HR) =  3.26
  EFFECTIVE AREA(ACRES) =    25.01
  TOTAL AREA(ACRES) =    31.75        PEAK FLOW RATE(CFS) =     87.09
  AREA-AVERAGED Fm(INCH/HR) =   0.05  AREA-AVERAGED Fp(INCH/HR) =   0.52
  AREA-AVERAGED Ap =  0.10
  NOTE: EFFECTIVE AREA IS USED AS THE TOTAL CONTRIBUTING AREA FOR ALL
        CONFLUENCE ANALYSES.

****************************************************************************
  FLOW PROCESS FROM NODE    562.00 TO NODE    562.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =   11.37
  RAINFALL INTENSITY(INCH/HR) =   3.26
  AREA-AVERAGED Fm(INCH/HR) =  0.05
  AREA-AVERAGED Fp(INCH/HR) =  0.52
  AREA-AVERAGED Ap =  0.10
  EFFECTIVE STREAM AREA(ACRES) =      25.01
  TOTAL STREAM AREA(ACRES) =      31.75
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      87.09

  ** CONFLUENCE DATA **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1       43.78   37.75    1.585  0.11( 0.10) 0.89      32.4     500.00
      2       87.09   11.37    3.255  0.52( 0.05) 0.10      25.0     562.00

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

  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1      115.10   11.37    3.255  0.20( 0.07) 0.32      34.8     562.00
      2       85.44   37.75    1.585  0.14( 0.08) 0.55      57.4     500.00

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =     115.10    Tc(MIN.) =    11.37
  EFFECTIVE AREA(ACRES) =      34.77   AREA-AVERAGED Fm(INCH/HR) =  0.07
  AREA-AVERAGED Fp(INCH/HR) =  0.20  AREA-AVERAGED Ap =  0.32
  TOTAL AREA(ACRES) =      64.2
  LONGEST FLOWPATH FROM NODE    500.00 TO NODE    562.00 =    4539.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    562.00 TO NODE    563.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   869.68  DOWNSTREAM(FEET) =   868.27
  FLOW LENGTH(FEET) =   466.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  57.0 INCH PIPE IS  44.1 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   7.82
  ESTIMATED PIPE DIAMETER(INCH) =  57.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =     115.10
  PIPE TRAVEL TIME(MIN.) =   0.99    Tc(MIN.) =   12.36
  LONGEST FLOWPATH FROM NODE    500.00 TO NODE    563.00 =    5005.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    563.00 TO NODE    563.00 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.) =   12.36
  RAINFALL INTENSITY(INCH/HR) =   3.10
  AREA-AVERAGED Fm(INCH/HR) =  0.07
  AREA-AVERAGED Fp(INCH/HR) =  0.20
  AREA-AVERAGED Ap =  0.32
  EFFECTIVE STREAM AREA(ACRES) =      34.77
  TOTAL STREAM AREA(ACRES) =      64.15
  PEAK FLOW RATE(CFS) AT CONFLUENCE =     115.10

****************************************************************************
  FLOW PROCESS FROM NODE    600.00 TO NODE    601.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   576.00
  ELEVATION DATA: UPSTREAM(FEET) =    885.85  DOWNSTREAM(FEET) =    878.79

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    9.319
  * 100 YEAR RAINFALL INTENSITY(INCH/HR) =  3.668
  SUBAREA Tc AND LOSS RATE DATA(AMC III):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                  A        2.45      0.74      0.100    52    9.32
  COMMERCIAL                  B        1.20      0.42      0.100    76    9.32
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.64
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA RUNOFF(CFS) =     11.84
  TOTAL AREA(ACRES) =      3.65   PEAK FLOW RATE(CFS) =     11.84

****************************************************************************
  FLOW PROCESS FROM NODE    601.00 TO NODE    563.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
```

```
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
==========================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   870.00  DOWNSTREAM(FEET) =   868.77
  FLOW LENGTH(FEET) =     8.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  12.0 INCH PIPE IS   8.7 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =  19.53
  ESTIMATED PIPE DIAMETER(INCH) =  12.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      11.84
  PIPE TRAVEL TIME(MIN.) =   0.01    Tc(MIN.) =    9.33
  LONGEST FLOWPATH FROM NODE    600.00 TO NODE    563.00 =     584.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    563.00 TO NODE    563.00 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.) =    9.33
  RAINFALL INTENSITY(INCH/HR) =   3.67
  AREA-AVERAGED Fm(INCH/HR) =  0.06
  AREA-AVERAGED Fp(INCH/HR) =  0.64
  AREA-AVERAGED Ap =  0.10
  EFFECTIVE STREAM AREA(ACRES) =       3.65
  TOTAL STREAM AREA(ACRES) =       3.65
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      11.84

  ** CONFLUENCE DATA **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1      115.10   12.36    3.096  0.20( 0.07) 0.32      34.8     562.00
      1       85.44   38.82    1.558  0.14( 0.08) 0.55      57.4     500.00
      2       11.84    9.33    3.667  0.64( 0.06) 0.10       3.7     600.00

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

  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)         (ACRES)    NODE
      1      115.01    9.33    3.667  0.22( 0.06) 0.30      29.9     600.00
      2      125.06   12.36    3.096  0.22( 0.06) 0.30      38.4     562.00
      3       90.35   38.82    1.558  0.15( 0.08) 0.52      61.1     500.00

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =     125.06    Tc(MIN.) =    12.36
  EFFECTIVE AREA(ACRES) =      38.42   AREA-AVERAGED Fm(INCH/HR) =  0.06
  AREA-AVERAGED Fp(INCH/HR) =  0.22  AREA-AVERAGED Ap =  0.30
  TOTAL AREA(ACRES) =      67.8
  LONGEST FLOWPATH FROM NODE    500.00 TO NODE    563.00 =    5005.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    563.00 TO NODE    564.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
==========================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   868.27  DOWNSTREAM(FEET) =   867.96
  FLOW LENGTH(FEET) =   101.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  60.0 INCH PIPE IS  44.1 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   8.09
  ESTIMATED PIPE DIAMETER(INCH) =  60.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =     125.06
  PIPE TRAVEL TIME(MIN.) =   0.21    Tc(MIN.) =   12.57
  LONGEST FLOWPATH FROM NODE    500.00 TO NODE    564.00 =    5106.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    564.00 TO NODE    564.00 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.) =   12.57
  RAINFALL INTENSITY(INCH/HR) =   3.07
  AREA-AVERAGED Fm(INCH/HR) =  0.06
  AREA-AVERAGED Fp(INCH/HR) =  0.22
  AREA-AVERAGED Ap =  0.30
  EFFECTIVE STREAM AREA(ACRES) =      38.42
  TOTAL STREAM AREA(ACRES) =      67.80
  PEAK FLOW RATE(CFS) AT CONFLUENCE =     125.06

****************************************************************************
  FLOW PROCESS FROM NODE    564.00 TO NODE    564.00 IS CODE =   7
----------------------------------------------------------------------------
  >>>>>USER SPECIFIED HYDROLOGY INFORMATION AT NODE<<<<<
==========================================================================
  USER-SPECIFIED VALUES ARE AS FOLLOWS:
  TC(MIN.) =   11.23   RAINFALL INTENSITY(INCH/HR) =  3.28
  EFFECTIVE AREA(ACRES) =    18.75
  TOTAL AREA(ACRES) =    23.35        PEAK FLOW RATE(CFS) =     83.35
  AREA-AVERAGED Fm(INCH/HR) =   0.05  AREA-AVERAGED Fp(INCH/HR) =   0.48
  AREA-AVERAGED Ap =  0.10
  NOTE: EFFECTIVE AREA IS USED AS THE TOTAL CONTRIBUTING AREA FOR ALL
        CONFLUENCE ANALYSES.

****************************************************************************
  FLOW PROCESS FROM NODE    564.00 TO NODE    564.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
==========================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =   11.23
  RAINFALL INTENSITY(INCH/HR) =   3.28
  AREA-AVERAGED Fm(INCH/HR) =  0.05
  AREA-AVERAGED Fp(INCH/HR) =  0.48
  AREA-AVERAGED Ap =  0.10
  EFFECTIVE STREAM AREA(ACRES) =      18.75
  TOTAL STREAM AREA(ACRES) =      23.35
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      83.35

  ** CONFLUENCE DATA **
```

STREAM NUMBER	Q (CFS)	Tc (MIN.)	Intensity (INCH/HR)	Fp(Fm) (INCH/HR)	Ap	Ae (ACRES)	HEADWATER NODE
1	115.01	9.54	3.617	0.22(0.06)	0.30	29.9	600.00
1	125.06	12.57	3.065	0.22(0.06)	0.30	38.4	562.00
1	90.35	39.05	1.553	0.15(0.08)	0.52	61.1	500.00
2	83.35	11.23	3.280	0.48(0.05)	0.10	18.8	564.00

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

** PEAK FLOW RATE TABLE **

STREAM NUMBER	Q (CFS)	Tc (MIN.)	Intensity (INCH/HR)	Fp(Fm) (INCH/HR)	Ap	Ae (ACRES)	HEADWATER NODE
1	193.20	9.54	3.617	0.26(0.06)	0.23	45.8	600.00
2	203.96	11.23	3.280	0.26(0.06)	0.23	53.4	564.00
3	202.88	12.57	3.065	0.25(0.06)	0.24	57.2	562.00
4	129.16	39.05	1.553	0.17(0.07)	0.42	79.8	500.00

COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
PEAK FLOW RATE(CFS) = 203.96 Tc(MIN.) = 11.23
EFFECTIVE AREA(ACRES) = 53.39 AREA-AVERAGED Fm(INCH/HR) = 0.06
AREA-AVERAGED Fp(INCH/HR) = 0.26 AREA-AVERAGED Ap = 0.23
TOTAL AREA(ACRES) = 91.2
LONGEST FLOWPATH FROM NODE 500.00 TO NODE 564.00 = 5106.00 FEET.

****
FLOW PROCESS FROM NODE 564.00 TO NODE 565.00 IS CODE = 31

>>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
>>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
==========
ELEVATION DATA: UPSTREAM(FEET) = 867.96 DOWNSTREAM(FEET) = 863.06
FLOW LENGTH(FEET) = 229.00 MANNING'S N = 0.013
DEPTH OF FLOW IN 48.0 INCH PIPE IS 39.2 INCHES
PIPE-FLOW VELOCITY(FEET/SEC.) = 18.58
ESTIMATED PIPE DIAMETER(INCH) = 48.00 NUMBER OF PIPES = 1
PIPE-FLOW(CFS) = 203.96
PIPE TRAVEL TIME(MIN.) = 0.21 Tc(MIN.) = 11.44
LONGEST FLOWPATH FROM NODE 500.00 TO NODE 565.00 = 5335.00 FEET.
==========
END OF STUDY SUMMARY:
TOTAL AREA(ACRES) = 91.2 TC(MIN.) = 11.44
EFFECTIVE AREA(ACRES) = 53.39 AREA-AVERAGED Fm(INCH/HR)= 0.06
AREA-AVERAGED Fp(INCH/HR) = 0.26 AREA-AVERAGED Ap = 0.229
PEAK FLOW RATE(CFS) = 203.96

** PEAK FLOW RATE TABLE **

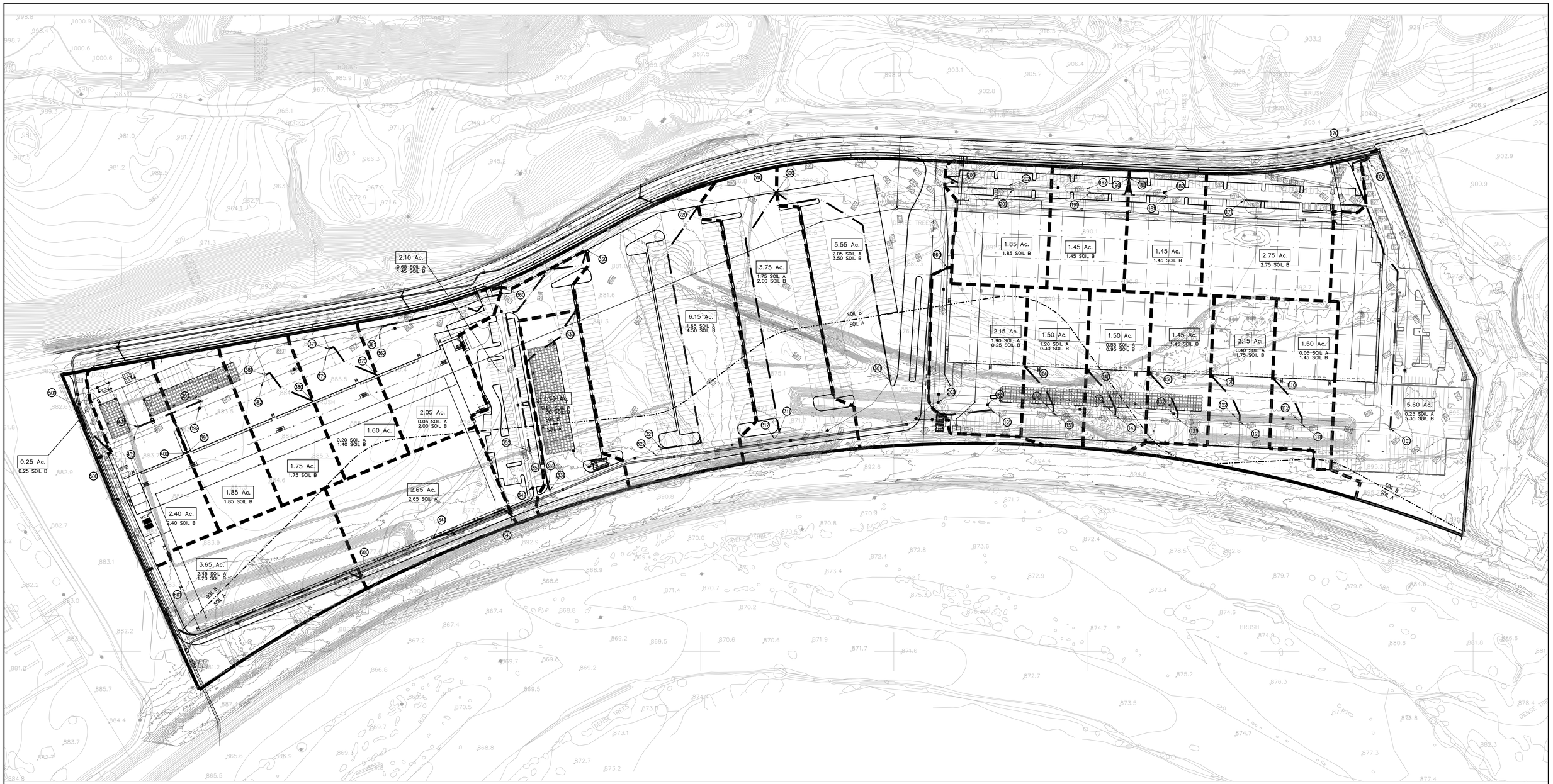
STREAM NUMBER	Q (CFS)	Tc (MIN.)	Intensity (INCH/HR)	Fp(Fm) (INCH/HR)	Ap	Ae (ACRES)	HEADWATER NODE
1	193.20	9.75	3.571	0.26(0.06)	0.23	45.8	600.00
2	203.96	11.44	3.244	0.26(0.06)	0.23	53.4	564.00
3	202.88	12.78	3.035	0.25(0.06)	0.24	57.2	562.00
4	129.16	39.28	1.547	0.17(0.07)	0.42	79.8	500.00

==========
==========
END OF RATIONAL METHOD ANALYSIS

♀

APPENDIX C

HYDROLOGY MAPS



LEGEND

- PROJECT BOUNDARY
- SUBAREA BOUNDARY
- FLOW PATH
- LIMIT OF SOIL TYPE
- 9.1 AC. — SUBAREA AREA
- (100) — SUBAREA NUMBER

0 50 100 200 300

SCALE: 1"=100'

Last Update: 9/11/20
G:\3800-3899\3813\3813HYD.dwg

CITY OF COLTON
PUBLIC WORKS DEPARTMENT

HYDROLOGY MAP
(PROPOSED CONDITION)
AQUA MANSA COMMERCE CENTER
AQUA MANSA ROAD
COLTON, CA

REGISTERED PROFESSIONAL ENGINEER
REINHARD STENZEL
R.C.E. NO. 56155
Exp. 12-31-20
CIVIL
STATE OF CALIFORNIA

PREPARED FOR:
IDI AGUA MANSA, LLC
840 APOLLO STREET, SUITE 100
EL SEGUNDO, CA 90245
PHONE: (213) 330-8066

PREPARED BY:
Thienes Engineering, Inc.
CIVIL ENGINEERING • LAND SURVEYING
14349 FIRESTONE BOULEVARD
LA MIRADA, CALIFORNIA 90638
PH:(714)521-4811 FAX(714)521-4173

DESIGN BY: _____ DATE: _____
CHEKED BY: _____ DATE: _____

Approved by: _____ Date: _____
Public Works Director R.C.E. _____

Sheet 1 of 1 Sheets

3813/ 1 of 1 SHEET

LEGEND	
(solid heavy line)	PROJECT BOUNDARY
(heavy dashed line)	SUBAREA BOUNDARY
(line)	FLOW PATH
(dash-dot line)	LIMIT OF SOIL TYPE
9.1 AC.	SUBAREA AREA
100	SUBAREA NUMBER

0 60 120 240 360
SCALE:1"=120'

REGISTERED PROFESSIONAL ENGINEER
REINHARD STENZEL
R.C.E. NO. 56155
Exp. 12-31-20
CIVIL
STATE OF CALIFORNIA

PREPARED FOR:

IDI AGUA MANSA, LLC
840 APOLLO STREET, SUITE 100
EL SEGUNDO, CA 90245
PHONE: (213) 330-8066

PREPARED BY:

Thienes Engineering, Inc.
CIVIL ENGINEERING • LAND SURVEYING
14349 FIRESTONE BOULEVARD
LA MIRADA, CALIFORNIA 90638
PH.(714)521-4811 FAX(714)521-4173

Last Update: 9/11/20
O:\3800-3899\3813\3813HYD-OFF SITE.dwg

CITY OF COLTON
PUBLIC WORKS DEPARTMENT

OFF-SITE HYDROLOGY MAP
AGUA MANSA COMMERCE CENTER
AGUA MANSA ROAD
COLTON, CA

DESIGN BY: ________
DATE: ________
CHEKED BY: ________
DATE: ________

Approved by: Date: ________

Public Works Director R.C.E. ________

Sheet 1 of 1 Sheets

3813/ 1 of 1 SHEET

Thienes Engineering, Inc.
CIVIL ENGINEERING • LAND SURVEYING

Water Quality Management Plan (WQMP)

For:

Agua Mansa Commerce Center
Agua Mansa Road
Colton, CA 92324

DAP-XXX-XXX
APNs: 0275-041-07, -08, -09, -27, -28, -29, -30, -31 and 0260-072-08, -12, -13

Prepared for:
IDI Agua Mansa, LLC
840 Apollo Street, Suite 343
El Segundo, CA 90245
Phone: (213) 330-8066

Prepared by:
Thienes Engineering, Inc.
14349 Firestone Boulevard
La Mirada, CA 90638
Phone: (714) 521-4811
Contact: Luis Prado (luisp@thieneseng.com)
JN 3813

Submittal Date: September 14, 2020
Revision Date: _____
Revision Date: _____

Approval Date: _____

Project Owner's Certification

This Water Quality Management Plan (WQMP) has been prepared for IDI Agua Mansa, LLC by Thienes Engineering, Inc. The WQMP is intended to comply with the requirements of the City of Colton and the NPDES Areawide Stormwater Program requiring the preparation of a WQMP. The undersigned, while it owns the subject property, is responsible for the implementation of the provisions of this plan and will ensure that this plan is amended as appropriate to reflect up-to-date conditions on the site consistent with San Bernardino County's Municipal Storm Water Management Program and the intent of the NPDES Permit for San Bernardino County and the incorporated cities of San Bernardino County within the Santa Ana Region. Once the undersigned transfers its interest in the property, its successors in interest and the city/county shall be notified of the transfer. The new owner will be informed of its responsibility under this WQMP. A copy of the approved WQMP shall be available on the subject site in perpetuity.

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

.

Project Data			
Permit/Application Number(s):	DAP-XXX-XXX	Grading Permit Number(s):	
Tract/Parcel Map Number(s):	PM XXXXX	Building Permit Number(s):	
CUP, SUP, and/or APN (Specify Lot Numbers if Portions of Tract):			APNs: 0275-041-07, -08, -09, -27, -28, -29, -30, -31 and 0260-072-08, -12, -13

Owner's Signature		
Owner Name: IDI Agua Mansa, LLC		
Title	Steve Hollis, Owner	
Company	IDI Agua Mansa, LLC	
Address	840 Apollo Street, Suite 343, El Segundo, CA 90245	
Email	Steve.hollis@idilogistics.com	
Telephone #	(213) 330-8066	
Signature	Date	

Preparer's Certification

Project Data			
Permit/Application Number(s):	DAP-XXX-XXX	Grading Permit Number(s):	
Tract/Parcel Map Number(s):	PM XXXXX	Building Permit Number(s):	
CUP, SUP, and/or APN (Specify Lot Numbers if Portions of Tract):			APNs: 0275-041-07, -08, -09, -27, -28, -29, -30, -31 and 0260-072-08, -12, -13

"The selection, sizing and design of stormwater treatment and other stormwater quality and quantity control measures in this plan were prepared under my oversight and meet the requirements of Regional Water Quality Control Board Order No. R8-2010-0036."

Engineer: Reinhard Stenzel	
Title	Director of Engineering
Company	Thienes Engineering, Inc.
Address	14349 Firestone Boulevard, La Mirada, CA 90638
Email	reinhard@thieneseng.com
Telephone #	(714) 521-4811
Signature	
Date	9/14/2020

PE Stamp Below

Table of Contents

Forms

Section 1 Discretionary Permit(s)

Form 1-1 Project Information

Project Name	Agua Mansa Commerce Center				
Project Owner Contact Name:	Steve Hollis				
Mailing Address:	840 Apollo Street, Suite 343 El Segundo, CA 90245	E-mail Address:	steve.hollis@idilogistics.com	Telephone:	(213) 330-8066
Permit/Application Number(s):	DAP-XXX-XXX	Tract/Parcel Map Number(s):	PM XXXXX		
Additional Information/ Comments:	n/a				
Description of Project:	The project site is currently undeveloped and consists of grass and dirt. The proposed project site encompasses approximately 64.00 acres, where 59.00 acres consists of onsite improvements and 5.00 acres consists of offsite improvements along Agua Mansa Road. Proposed improvements to the site include two warehouse type buildings. Building 1 has an area of approximately 457,743 square feet, and Building 2 has an area of approximately 456,000 square feet. Truck yards will be located on the north side of Building 1 and on the south side of Building 2. Trailer parking will be located north and east sides of Building 1. Building 2's trailer parking is only along the south side. Vehicular parking located on the east side of Building 1 and the north and east sides of Building 2. A proposed public storm drain in Agua Mansa Road will cross through the site along the westerly property line, runs southerly, and ultimately discharges to the Santa Ana River. Onsite runoff will discharge into the public storm drain before discharging offsite. The DCV from the onsite and offsite improvements will bleed off via "low flow" pipes towards the detention systems and treatment devices. Hydrodynamic separators will be used for pretreatment of runoff prior to entering the detention systems. The DCV will then be pumped up from the underground detention system to Modular Wetlands Systems (MWS) for treatment. When the detention systems are full and the DCV has been met, runoff greater than the DCV will continue to drain via the main storm drain systems. The entire DCV will be biofiltered through the MWS within 48 hours. Flows will ultimately drain to the southwest corner of the project site and discharge into the Santa Ana River. A site-specific infiltration report is pending. However, based on current site conditions, the site is expected to be in fill. As a result, volume-based biofiltration systems is proposed for water quality treatment.				
Provide summary of Conceptual WQMP conditions (if previously submitted and approved). Attach complete copy.	n/a				

Section 2 Project Description

2.1 Project Information

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

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

Form 2.1-1 Description of Proposed Project

1 Development Category (Select all that apply):

☐ Significant re-development involving the addition or replacement of 5,000 ft² or more of impervious surface on an already developed site	☒ New development involving the creation of 10,000 ft² or more of impervious surface collectively over entire site	☐ Automotive repair shops with standard industrial classification (SIC) codes 5013, 5014, 5541, 7532-7534, 7536-7539	☐ Restaurants (with SIC code 5812) where the land area of development is 5,000 ft² or more
☐ Hillside developments of 5,000 ft² or more which are located on areas with known erosive soil conditions or where the natural slope is 25 percent or more	☐ Developments of 2,500 ft² of impervious surface or more adjacent to (within 200 ft) or discharging directly into environmentally sensitive areas or waterbodies listed on the CWA Section 303(d) list of impaired waters.	☒ Parking lots of 5,000 ft² or more exposed to storm water	☐ Retail gasoline outlets that are either 5,000 ft² or more, or have a projected average daily traffic of 100 or more vehicles per day

☐ Non-Priority / Non-Category Project *May require source control LID BMPs and other LIP requirements. Please consult with local jurisdiction on specific requirements*.

2 Project Area (ft2):	2,787,840 (64.00 acres)*	**3** Number of Dwelling Units:	n/a	**4** SIC Code:	4222 (Building 1) 4225 (Building 2)

5 Is Project going to be phased? Yes ☐ No ☒ *If yes, ensure that the WQMP evaluates each phase as a distinct DA, requiring LID BMPs to address runoff at time of completion.*

6 Does Project include roads? Yes ☒ No ☐ *If yes, ensure that applicable requirements for transportation projects are addressed (see Appendix A of TGD for WQMP)*

*This value includes 59.00 acres consists of onsite improvements and 5.00 acres consists of offsite improvements along Agua Mansa Road.

2.2 Property Ownership/Management

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

Form 2.2-1 Property Ownership/Management

Describe property ownership/management responsible for long-term maintenance of WQMP stormwater facilities:

IDI Agua Mansa, LLC
840 Apollo Street, Suite 343
El Segundo, CA 90245
Phone: (213) 330-8066
Contact: Steve Hollis

LID BMP infrastructure will not be transferred to a public agency after project completion.
A property owner's association (POA) will be formed for long-term maintenance of proposed project stormwater facilities.

2.3 Potential Stormwater Pollutants

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

Form 2.3-1 Pollutants of Concern

Pollutant	Please check: E=Expected, N=Not Expected		Additional Information and Comments
Pathogens (Bacterial / Virus)	E ☒	N ☐	Including petroleum hydrocarbons. Bacterial indicators are routinely detected in pavement runoff.
Nutrients - Phosphorous	E ☒	N ☐	Expected pollutant from landscaped areas on-site.
Nutrients - Nitrogen	E ☒	N ☐	Expected pollutant from landscaping on-site.
Noxious Aquatic Plants	E ☐	N ☒	Not an expected pollutant.
Sediment	E ☒	N ☐	Expected pollutant from landscaping, roof runoff and parking areas.
Metals	E ☒	N ☐	Expected pollutant from parking lots on-site.
Oil and Grease	E ☒	N ☐	Expected pollutant from parking lots on-site.
Trash/Debris	E ☒	N ☐	Expected pollutant from landscaping and parking lots on-site.
Pesticides / Herbicides	E ☒	N ☐	Expected pollutant from landscaping on-site.
Organic Compounds	E ☒	N ☐	Expected pollutant from landscaping on-site and vehicle fluid deposition on pavement.
Other:	E ☐	N ☐	
Other:	E ☐	N ☐	
Other:	E ☐	N ☐	
Other:	E ☐	N ☐	

The expected POCs for the project site are **Pathogens, Nitrogen, and Metals.**

2.4 Water Quality Credits

A water quality credit program is applicable for certain types of development projects if it is not feasible to meet the requirements for on-site LID. Proponents for eligible projects, as described below, can apply for water quality credits that would reduce project obligations for selecting and sizing other treatment BMP or participating in other alternative compliance programs. Refer to Section 6.2 in the TGD for WQMP to determine if water quality credits are applicable for the project.

Form 2.4-1 Water Quality Credits

1 Project Types that Qualify for Water Quality Credits: *Select all that apply*

☐ Redevelopment projects that reduce the overall impervious footprint of the project site. [Credit = % impervious reduced]	Higher density development projects ☐ Vertical density [20%] ☐ 7 units/ acre [5%]	☐ Mixed use development, (combination of residential, commercial, industrial, office, institutional, or other land uses which incorporate design principles that demonstrate environmental benefits not realized through single use projects) [20%]	☐ Brownfield redevelopment (redevelop real property complicated by presence or potential of hazardous contaminants) [25%]
☐ Redevelopment projects in established historic district, historic preservation area, or similar significant core city center areas [10%]	☐ Transit-oriented developments (mixed use residential or commercial area designed to maximize access to public transportation) [20%]	☐ In-fill projects (conversion of empty lots & other underused spaces < 5 acres, substantially surrounded by urban land uses, into more beneficially used spaces, such as residential or commercial areas) [10%]	☐ Live-Work developments (variety of developments designed to support residential and vocational needs) [20%]

2 Total Credit % n/a *(Total all credit percentages up to a maximum allowable credit of 50 percent)*

Description of Water Quality Credit Eligibility (if applicable)	n/a

Section 3 Site and Watershed Description

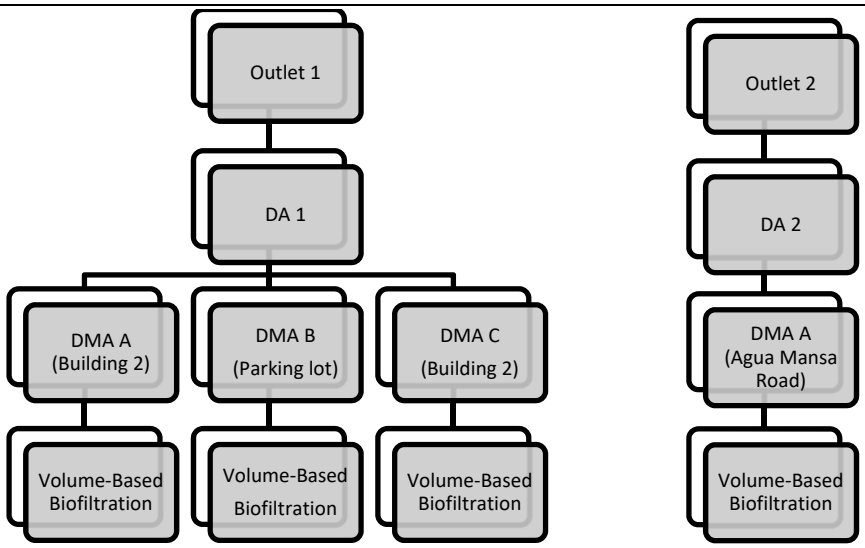
Describe the project site conditions that will facilitate the selection of BMP through an analysis of the physical conditions and limitations of the site and its receiving waters. Identify distinct drainage areas (DA) that collect flow from a portion of the site and describe how runoff from each DA (and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

Form 3-1 Site Location and Hydrologic Features

Site coordinates *take GPS measurement at approximate center of site*	Latitude 34.051835	Longitude -117.344307	Thomas Bros Map page Page 646

1 San Bernardino County climatic region: ☒ Valley ☐ Mountain

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



	Briefly describe on-site drainage features to convey runoff that is not retained within a DMA
DA 1 DMA A to Outlet 1	This area, Building 2, will be treated via a biofiltration system. A low flow pipe, set at a low invert elevation, will be used to direct the DCV into the pre-treatment unit and detention system. The DCV will be held in the underground detention system and slowly biofiltered through the biofiltration unit over 48 hours. A high flow pipe, set at a higher invert elevation, will take flows greater than the DCV and direct them along the mainline storm drain to outlet at the southwest corner of the site and ultimately into Santa Ana River.
DA 1 DMA B to Outlet 1	This area, predominantly trailer parking lot and a portion of Building 2, will be treated via a biofiltration system. A low flow pipe, set at a low invert elevation, will be used to direct the DCV into the pre-treatment unit and detention system. The DCV will be held in the underground detention system and slowly biofiltered through the biofiltration unit over 48 hours. A high flow pipe, set at a higher invert elevation, will take flows greater than the DCV and direct them along the mainline storm drain to outlet at the southwest corner of the site and ultimately into Santa Ana River.
DA 1 DMA C to Outlet 1	This area, Building 1, will be treated via a biofiltration system. A low flow pipe, set at a low invert elevation, will be used to direct the DCV into the pre-treatment unit and detention system. The DCV will be held in the underground detention system and slowly biofiltered through the biofiltration unit over 48 hours. A high flow pipe, set at a higher invert elevation, will take flows greater than the DCV and direct them along the mainline storm drain to outlet at the southwest corner of the site and ultimately into Santa Ana River.
DA 2 DMA A to Outlet 2	This area, street runoff from Agua Mansa Road, will be treated via a biofiltration system. A low flow pipe, set at a low invert elevation, will be used to direct the DCV into the pre-treatment unit and detention system. The DCV will be held in the underground detention system and slowly biofiltered through the biofiltration unit over 48 hours. Flows greater than the DCV will continue draining southerly, within the proposed public storm drain, and ultimately into Santa Ana River.

Form 3-2 Existing Hydrologic Characteristics for Drainage Area 1

For Drainage Area 1's sub-watershed DMA, provide the following characteristics	Hydrology Nodes XXX-XXX	TBD	TBD	TBD
1 DMA drainage area (ft^2)	2,570,040* (59.00 acres)	TBD	TBD	TBD
2 Existing site impervious area (ft^2)	0	TBD	TBD	TBD
3 Antecedent moisture condition *For desert areas, use http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_map.pdf*	AMC II	TBD	TBD	TBD
4 Hydrologic soil group *Refer to Watershed Mapping Tool – http://permitrack.sbcounty.gov/wap/*	A & B	TBD	TBD	TBD
5 Longest flowpath length (ft)	TBD	TBD	TBD	TBD
6 Longest flowpath slope (ft/ft)	TBD	TBD	TBD	TBD
7 Current land cover type(s) *Select from Fig C-3 of Hydrology Manual*	Barren	TBD	TBD	TBD
8 Pre-developed pervious area condition: *Based on the extent of wet season vegetated cover good >75%; Fair 50-75%; Poor <50% Attach photos of site to support rating*	Poor	TBD	TBD	TBD

* This value does not include 5.0 acres of offsite improvements.

Form 3-3 Watershed Description for Drainage Area

Receiving waters *Refer to Watershed Mapping Tool - http://permitrack.sbcounty.gov/wap/ See 'Drainage Facilities" link at this website*	Santa Ana River, Reach 4 Santa Ana River, Reach 3 Prado Dam Santa Ana River, Reach 2 Santa Ana River, Reach 1 Pacific Ocean
Applicable TMDLs *Refer to Local Implementation Plan*	Santa Ana River, Reach 4: None Santa Ana River, Reach 3: Indicator Bacteria Santa Ana River, Reach 2: None Santa Ana River, Reach 1: None Pacific Ocean: None
303(d) listed impairments *Refer to Local Implementation Plan and Watershed Mapping Tool – http://permitrack.sbcounty.gov/wap/ and State Water Resources Control Board website – http://www.waterboards.ca.gov/santaana/water_issues/programs/tmdl/index.shtml*	Santa Ana River, Reach 4: Indicator Bacteria Santa Ana River, Reach 3: Copper, Indicator Bacteria, Lead Prado Basin Management Zone: pH Santa Ana River, Reach 2: None Santa Ana River, Reach 1: None Pacific Ocean: None
Environmentally Sensitive Areas (ESA) *Refer to Watershed Mapping Tool – http://permitrack.sbcounty.gov/wap/*	n/a
Unlined Downstream Water Bodies *Refer to Watershed Mapping Tool – http://permitrack.sbcounty.gov/wap/*	Santa Ana River
Hydrologic Conditions of Concern	☐ Yes *Complete Hydrologic Conditions of Concern (HCOC) Assessment. Include Forms 4.2-2 through Form 4.2-5 and Hydromodification BMP Form 4.3-10 in submittal* ☒ No
Watershed–based BMP included in a RWQCB approved WAP	☐ Yes *Attach verification of regional BMP evaluation criteria in WAP* • *More Effective than On-site LID* • *Remaining Capacity for Project DCV* • *Upstream of any Water of the US* • *Operational at Project Completion* • *Long-Term Maintenance Plan* ☒ No

Section 4 Best Management Practices (BMP)

4.1 Source Control BMP

4.1.1 Pollution Prevention

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

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

Form 4.1-1 Non-Structural Source Control BMPs

Identifier	Name	Check One		Describe BMP Implementation OR, if not applicable, state reason
		Included	Not Applicable	
N1	Education of Property Owners, Tenants and Occupants on Stormwater BMPs	☒	☐	The property owner(s) shall familiarize him/herself with the WQMP document and content, including BMP educational materials in Attachment E (Section 6.4) of this WQMP and shall ensure that all employees are also educated on stormwater BMPs. Maintenance activity includes, but not limited to: inspecting the hydrodynamic separator; inspecting underground systems for the depth of sediment/debris, jetting and vacuuming sediment/debris; inspecting pump functions; and inspecting/replacing biofiltration media of proprietary biofiltration units.
N2	Activity Restrictions	☒	☐	The property owner shall control the discharge of stormwater pollutants from this site through activity restrictions, training of employees on stormwater quality BMPs included in Section 6.4 and control of tenant activities.
N3	Landscape Management BMPs	☒	☐	Maintenance shall be conducted by a landscape contractor on a weekly basis to verify that the irrigation system is functioning properly and to repair as needed. Landscape contractor will also verify that there are no leaks or run-off from landscaped areas. Adjust irrigation heads, system run times or use weather-based controllers as necessary to prevent overwatering of vegetation, overspray or run-off from landscaped areas to ensure the health and aesthetic quality of the landscape. Mowing and trimming waste shall be properly removed from the site and herbicides, pesticides and fertilizers shall be properly applied to prevent storm drainage contamination.
N4	BMP Maintenance	☒	☐	BMP maintenance, implementation schedules, and responsible parties are included with each specific BMP narrative and are listed in Form 5-1 of this document.
N5	Title 22 CCR Compliance (How development will comply)	☐	☒	No hazardous materials are expected to be stored on the site at the time this WQMP was prepared. If future occupants store these materials, they must comply with all Title 22 CCR regulations.
N6	Local Water Quality Ordinances	☒	☐	The owner shall comply with the City of Colton's stormwater ordinance through the implementation of BMPs.
N7	Spill Contingency Plan	☒	☐	All liquid chemicals and fluid storage on-site shall comply with hazmat regulations and any required spill contingency plans per the San Bernardino County Fire Hazmat Agency.

Form 4.1-1 Non-Structural Source Control BMPs

Identifier	Name	Check One		Describe BMP Implementation OR, if not applicable, state reason
		Included	Not Applicable	
N8	Underground Storage Tank Compliance	☐	☒	No USTs onsite.
N9	Hazardous Materials Disclosure Compliance	☐	☒	No hazardous materials are expected to be stored on the site at the time this WQMP was prepared. However, if hazardous materials are present, then the occupant will comply with all Title 22 CCR regulations.
N10	Uniform Fire Code Implementation	☒	☐	Owner will comply with Article 80 of the Uniform Fire Code enforced by the fire protection agency.
N11	Litter/Debris Control Program	☒	☐	Trash and litter shall be swept from the site and disposed of into a dumpster with lids. Owner shall ensure that tenant/occupant contracts with the local trash collector to empty dumpsters on a weekly basis.
N12	Employee Training	☒	☐	The owner will ensure that tenants/occupants are also familiar with onsite structural BMPs and necessary source control BMPs required of all site occupants. Owner will check with City and County at least once a year to obtain new or updated educational materials and provide these materials to tenants. Employees shall be trained to clean up spills and participate in ongoing maintenance. The WQMP requires annual employee training and for new hires, within 2 months.
N13	Housekeeping of Loading Docks	☒	☐	Keep all fluids indoors. Clean up spills immediately and keep spills from entering storm drain system. No discharges of wastewater or cleanup water from maintenance of loading docks shall be directed into the storm drain system. Area shall be inspected weekly for proper containment and practices with spills cleaned up immediately and disposed of properly. Cleanup procedures should minimize or eliminate the use for water if plumbed to the sewer system.
N14	Catch Basin Inspection Program	☒	☐	Inspected semi-annually (by October 1st and February 1st) by owner's designee. Basin sump areas shall be vacuumed and disposed of properly. The owner shall clean all catch basins whenever debris, trash or sediment accumulates and shall investigate any suspected illegal dumping into these drains.
N15	Vacuum Sweeping of Private Streets and Parking Lots	☒	☐	All landscape maintenance contractors will be required to sweep up all landscape cuttings, mowings and fertilizer materials off paved areas weekly and dispose of properly. Parking areas and drive ways will be vacuum swept monthly, by sweeping contractor.

Form 4.1-1 Non-Structural Source Control BMPs

Identifier	Name	Check One		Describe BMP Implementation OR, if not applicable, state reason
		Included	Not Applicable	
N16	Other Non-structural Measures for Public Agency Projects	☐	☒	No public agency projects associated, this is a private project.
N17	Comply with all other applicable NPDES permits	☒	☐	The developer will comply with the Construction General Permit during construction and all future occupants of the site shall comply with the requirements of the Industrial General Stormwater Permit.

Form 4.1-2 Structural Source Control BMPs

Identifier	Name	Check One		Describe BMP Implementation OR, If not applicable, state reason
		Included	Not Applicable	
S1	Provide storm drain system stencilling and signage (CASQA New Development BMP Handbook SD-13)	☒	☐	A "No Dumping – Drains to River" message shall be painted with stencil, onto each catch basin inlet. Legibility of stencil will be maintained on a yearly basis.
S2	Design and construct outdoor material storage areas to reduce pollution introduction (CASQA New Development BMP Handbook SD-34)	☐	☒	No outdoor storage shall be allowed on-site.
S3	Design and construct trash and waste storage areas to reduce pollution introduction (CASQA New Development BMP Handbook SD-32)	☒	☐	Paved with an impervious surface, designed not to allow run-on from adjoining areas, designed to divert drainage from adjoining roofs and pavements diverted around the area, screened or walled to prevent off-site transport of trash, and designed with a solid roof to cover dumpsters.
S4	Use efficient irrigation systems & landscape design, water conservation, smart controllers, and source control (Statewide Model Landscape Ordinance; CASQA New Development BMP Handbook SD-12)	☒	☐	The irrigation system will include devices to prevent low head drainage, overspray and run off through the use of pressure regulating devices, check valves, flow sensors, proper spacing, low precipitation emission devices and ET or weather based controllers. Landscape and irrigation shall be consistent with the State Model Water Efficient landscape Ordinance and the City of Colton landscape requirements. Plants installed will be arranged according to similar hydrozones and meet the required water budget for the site. Shade trees shall be used to intercept rainwater and reduce heat gain on paving.
S5	Finish grade of landscaped areas at a minimum of 1-2 inches below top of curb, sidewalk, or pavement	☒	☐	Landscaped areas will be depressed in order to increase retention of stormwater/irrigation water and promote infiltration. 1"-2" below top of curb elevations.
S6	Protect slopes and channels and provide energy dissipation (CASQA New Development BMP Handbook SD-10)	☒	☐	All slopes will be vegetated and maintained to prevent erosion and transport of sediment.
S7	Covered dock areas (CASQA New Development BMP Handbook SD-31)	☐	☒	Not necessary due to installation of "dock high" doors for freight delivery.
S8	Covered maintenance bays with spill containment plans (CASQA New Development BMP Handbook SD-31)	☐	☒	No maintenance bays onsite. Owner will not allow vehicle maintenance on this site.

Form 4.1-2 Structural Source Control BMPs

Identifier	Name	Check One		Describe BMP Implementation OR, *If not applicable, state reason
		Included	Not Applicable	
S9	Vehicle wash areas with spill containment plans (CASQA New Development BMP Handbook SD-33)	☐	☒	No vehicle wash areas onsite. Owner will not allow vehicle washing on this site.
S10	Covered outdoor processing areas (CASQA New Development BMP Handbook SD-36)	☐	☒	No outdoor processing areas onsite. Owner will not allow outdoor processing onsite.
S11	Equipment wash areas with spill containment plans (CASQA New Development BMP Handbook SD-33)	☐	☒	No equipment wash areas onsite and no equipment will be allowed onsite.
S12	Fueling areas (CASQA New Development BMP Handbook SD-30)	☐	☒	No fueling areas onsite. No mobile fueling will be allowed by owner.
S13	Hillside landscaping (CASQA New Development BMP Handbook SD-10)	☒	☐	All slopes will be vegetated and maintained to prevent erosion and transport of sediment.
S14	Wash water control for food preparation areas	☐	☒	No food preparation onsite.
S15	Community car wash racks (CASQA New Development BMP Handbook SD-33)	☐	☒	No community cars wash racks onsite.

4.1.2 Preventative LID Site Design Practices

Site design practices associated with new LID requirements in the MS4 Permit should be considered in the earliest phases of a project. Preventative site design practices can result in smaller DCV for LID BMP and hydromodification control BMP by reducing runoff generation. Describe site design and drainage plan including:

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

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

Form 4.1-3 Preventative LID Site Design Practices Checklist

Site Design Practices *If yes, explain how preventative site design practice is addressed in project site plan. If no, other LID BMPs must be selected to meet targets*
Minimize impervious areas: Yes ☐ No ☒ Explanation: Impervious areas were minimized to the Maximum Extent Practicable (MEP). In addition, the project will utilize onsite and offsite LID BMPs to collect runoff from impervious areas for treatment.
Maximize natural infiltration capacity: Yes ☐ No ☒ Explanation: Due to the site constraints discussed in Section 1 of this WQMP report, infiltration facilities could not be utilized since infiltration appears to be infeasible.
Preserve existing drainage patterns and time of concentration: Yes ☒ No ☐ Explanation: Post-development drainage patterns will mimic pre-development conditions. Proposed onsite volume-based biofiltration LID BMPs will assist in increasing the time of concentration compared to existing condition.
Disconnect impervious areas: Yes ☒ No ☐ Explanation: The onsite volume-based biofiltration facilities will disconnect impervious areas before discharging offsite.
Protect existing vegetation and sensitive areas: Yes ☐ No ☒ Explanation: Not applicable, development consists of two light industrial buildings. In addition there is no sensitive areas to protect.
Re-vegetate disturbed areas: Yes ☐ No ☒ Explanation: Not applicable, development consists of two light industrial buildings. Most of the disturbed areas will be paved; however, all disturbed areas will be collected by the volume-based biofiltration LID BMPs. However, landscape will be provided throughout the site.
Minimize unnecessary compaction in stormwater retention/infiltration basin/trench areas: Yes ☐ No ☒ Explanation: No infiltration/retention BMP is proposed.
Utilize vegetated drainage swales in place of underground piping or imperviously lined swales: Yes ☐ No ☒ Explanation: Underground piping and imperviously lined swales are located at truck and car parking areas that could not be substituted with vegetated swales. All Imperviously lined swales will drain to LID BMPs for treatment.
Stake off areas that will be used for landscaping to minimize compaction during construction : Yes ☒ No ☐ Explanation: Landscaped areas will be staked to minimize unnecessary compaction during construction.

4.2 Project Performance Criteria

The purpose of this section of the Project WQMP is to establish targets for post-development hydrology based on performance criteria specified in the MS4 Permit. These targets include runoff volume for water quality control (referred to as LID design capture volume), and runoff volume, time of concentration, and peak runoff for protection of any downstream waterbody segments with a HCOC. ***If the project has more than one outlet for stormwater runoff, then complete additional versions of these forms for each DA / outlet.***

Methods applied in the following forms include:

- For LID BMP Design Capture Volume (DCV), the San Bernardino County Stormwater Program requires use of the P_6 method (MS4 Permit Section XI.D.6a.ii) – Form 4.2-1
- For HCOC pre- and post-development hydrologic calculation, the San Bernardino County Stormwater Program requires the use of the Rational Method (San Bernardino County Hydrology Manual Section D). Forms 4.2-2 through Form 4.2-5 calculate hydrologic variables including runoff volume, time of concentration, and peak runoff from the project site pre- and post-development using the Hydrology Manual Rational Method approach. For projects greater than 640 acres (1.0 mi²), the Rational Method and these forms should not be used. For such projects, the Unit Hydrograph Method (San Bernardino County Hydrology Manual Section E) shall be applied for hydrologic calculations for HCOC performance criteria.

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

Form 4.2-1 LID BMP Performance Criteria for Design Capture Volume (DA 1)

1 Project area (ft²): 590,238 (13.55 acres) DA 1 DMA A	**2** Imperviousness after applying preventative site design practices (Imp%): 95%	**3** Runoff Coefficient (Rc): 0.807 *$R_c = 0.858(Imp\%)^{\wedge 3}-0.78(Imp\%)^{\wedge 2}+0.774(Imp\%)+0.04$*
4 Determine 1-hour rainfall depth for a 2-year return period $P_{2yr\text{-}1hr}$ (in): 0.491 http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html		
5 Compute P_6, Mean 6-hr Precipitation (inches): 0.727 *P_6 = Item 4 *C_1, where C_1 is a function of site climatic region specified in Form 3-1 Item 1 (Valley = 1.4807; Mountain = 1.909; Desert = 1.2371)*		
6 Drawdown Rate *Use 48 hours as the default condition. Selection and use of the 24 hour drawdown time condition is subject to approval by the local jurisdiction. The necessary BMP footprint is a function of drawdown time. While shorter drawdown times reduce the performance criteria for LID BMP design capture volume, the depth of water that can be stored is also reduced.*		24-hrs ☐ 48-hrs ☒
7 Compute design capture volume, DCV (ft³): 56,647 *DCV = 1/12 * [Item 1* Item 3 *Item 5 * C_2], where C_2 is a function of drawdown rate (24-hr = 1.582; 48-hr = 1.963)* *Compute separate DCV for each outlet from the project site per schematic drawn in Form 3-1 Item 2*		

1 Project area (ft²): 962,676 (22.10 acres) DA 1 DMA B	**2** Imperviousness after applying preventative site design practices (Imp%): 95%	**3** Runoff Coefficient (Rc): 0.807 *$R_c = 0.858(Imp\%)^{\wedge 3}-0.78(Imp\%)^{\wedge 2}+0.774(Imp\%)+0.04$*
4 Determine 1-hour rainfall depth for a 2-year return period $P_{2yr\text{-}1hr}$ (in): 0.491 http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html		
5 Compute P_6, Mean 6-hr Precipitation (inches): 0.727 *P_6 = Item 4 *C_1, where C_1 is a function of site climatic region specified in Form 3-1 Item 1 (Valley = 1.4807; Mountain = 1.909; Desert = 1.2371)*		

6 Drawdown Rate *Use 48 hours as the default condition. Selection and use of the 24 hour drawdown time condition is subject to approval by the local jurisdiction. The necessary BMP footprint is a function of drawdown time. While shorter drawdown times reduce the performance criteria for LID BMP design capture volume, the depth of water that can be stored is also reduced.*	24-hrs ☐ 48-hrs ☒
7 Compute design capture volume, DCV (ft^3): 92,391 *DCV = 1/12 * [Item 1* Item 3 *Item 5 * C_2], where C_2 is a function of drawdown rate (24-hr = 1.582; 48-hr = 1.963)* *Compute separate DCV for each outlet from the project site per schematic drawn in Form 3-1 Item 2*	

1 Project area (ft^2): 1,017,126 (23.35 acres) DA 1 DMA C	**2** Imperviousness after applying preventative site design practices (Imp%): 95%	**3** Runoff Coefficient (Rc): 0.807 *$R_c = 0.858(Imp\%)^{\wedge 3}-0.78(Imp\%)^{\wedge 2}+0.774(Imp\%)+0.04$*
4 Determine 1-hour rainfall depth for a 2-year return period $P_{2yr\text{-}1hr}$ (in): 0.491 http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html		
5 Compute P_6, Mean 6-hr Precipitation (inches): 0.727 *P_6 = Item 4 *C_1, where C_1 is a function of site climatic region specified in Form 3-1 Item 1 (Valley = 1.4807; Mountain = 1.909; Desert = 1.2371)*		
6 Drawdown Rate *Use 48 hours as the default condition. Selection and use of the 24 hour drawdown time condition is subject to approval by the local jurisdiction. The necessary BMP footprint is a function of drawdown time. While shorter drawdown times reduce the performance criteria for LID BMP design capture volume, the depth of water that can be stored is also reduced.*		24-hrs ☐ 48-hrs ☒
7 Compute design capture volume, DCV (ft^3): 97,617 *DCV = 1/12 * [Item 1* Item 3 *Item 5 * C_2], where C_2 is a function of drawdown rate (24-hr = 1.582; 48-hr = 1.963)* *Compute separate DCV for each outlet from the project site per schematic drawn in Form 3-1 Item 2*		

Form 4.2-1 LID BMP Performance Criteria for Design Capture Volume (DA 2)

1 Project area (ft^2): 217,800 (5.00 ac) DA 2 DMA A	**2** Imperviousness after applying preventative site design practices (Imp%): 95%	**3** Runoff Coefficient (Rc): 0.807 *$R_c = 0.858(Imp\%)^{\wedge 3}-0.78(Imp\%)^{\wedge 2}+0.774(Imp\%)+0.04$*
4 Determine 1-hour rainfall depth for a 2-year return period $P_{2yr\text{-}1hr}$ (in): 0.491 http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html		
5 Compute P_6, Mean 6-hr Precipitation (inches): 0.727 *P_6 = Item 4 *C_1, where C_1 is a function of site climatic region specified in Form 3-1 Item 1 (Valley = 1.4807; Mountain = 1.909; Desert = 1.2371)*		
6 Drawdown Rate *Use 48 hours as the default condition. Selection and use of the 24 hour drawdown time condition is subject to approval by the local jurisdiction. The necessary BMP footprint is a function of drawdown time. While shorter drawdown times reduce the performance criteria for LID BMP design capture volume, the depth of water that can be stored is also reduced.*		24-hrs ☐ 48-hrs ☒
7 Compute design capture volume, DCV (ft^3): 20,903 *DCV = 1/12 * [Item 1* Item 3 *Item 5 * C_2], where C_2 is a function of drawdown rate (24-hr = 1.582; 48-hr = 1.963)* *Compute separate DCV for each outlet from the project site per schematic drawn in Form 3-1 Item 2*		

DA DMA ID	AREA (ACRES)	DCV (CF)
DA 1 DMA A	13.55	56,647
DA 1 DMA B	22.10	92,391
DA 1 DMA C	23.35	97,617
DA 2 DMA A	5.00	20,903
TOTAL	**64.00**	**267,557**

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

Does project have the potential to cause or contribute to an HCOC in a downstream channel: Yes ☐ No ☒

Go to: *http://permitrack.sbcounty.gov/wap/*

If "Yes", then complete HCOC assessment of site hydrology for 2yr storm event using Forms 4.2-3 through 4.2-5 and insert results below *(Forms 4.2-3 through 4.2-5 may be replaced by computer software analysis based on the San Bernardino County Hydrology Manual)*

If "No," then proceed to Section 4.3 Project Conformance Analysis

Condition	Runoff Volume (ft^3)	Time of Concentration (min)	Peak Runoff (cfs)
Pre-developed	**1** n/a *Form 4.2-3 Item 12*	**2** n/a *Form 4.2-4 Item 13*	**3** n/a *Form 4.2-5 Item 10*
Post-developed	**4** n/a *Form 4.2-3 Item 13*	**5** n/a *Form 4.2-4 Item 14*	**6** n/a *Form 4.2-5 Item 14*
Difference	**7** n/a *Item 4 – Item 1*	**8** n/a *Item 2 – Item 5*	**9** n/a *Item 6 – Item 3*
Difference (as % of pre-developed)	**10** n/a*%* *Item 7 / Item 1*	**11** n/a *%* *Item 8 / Item 2*	**12** n/a *%* *Item 9 / Item 3*

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

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

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

11 Precipitation for 2 yr, 24 hr storm (in): n/a
Go to: http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html

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

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

14 Volume Reduction needed to meet HCOC Requirement, (ft^3): n/a
*V_{HCOC} = (Item 13 * 0.95) – Item 12*

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

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

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

13 Pre-developed time of concentration (min): n/a *Minimum of Item 12 pre-developed DMA*

14 Post-developed time of concentration (min): n/a *Minimum of Item 12 post-developed DMA*

15 Additional time of concentration needed to meet HCOC requirement (min): n/a $T_{C\text{-}HCOC}$ *= (Item 13 * 0.95) – Item 14*

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

Compute peak runoff for pre- and post-developed conditions

Variables		Pre-developed DA to Project Outlet (*Use additional forms if more than 3 DMA)*			Post-developed DA to Project Outlet (*Use additional forms if more than 3 DMA)*		
		DMA A	DMA B	DMA C	DMA A	DMA B	DMA C
1 Rainfall Intensity for storm duration equal to time of concentration *I_{peak} = 10^(LOG Form 4.2-1 Item 4 - 0.6 LOG Form 4.2-4 Item 5 /60)*		n/a	n/a	n/a	n/a	n/a	n/a
2 Drainage Area of each DMA (Acres) *For DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)*		n/a	n/a	n/a	n/a	n/a	n/a
3 Ratio of pervious area to total area *For DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)*		n/a	n/a	n/a	n/a	n/a	n/a
4 Pervious area infiltration rate (in/hr) *Use pervious area CN and antecedent moisture condition with Appendix C-3 of the TGD for WQMP*		n/a	n/a	n/a	n/a	n/a	n/a
5 Maximum loss rate (in/hr) *F_m = Item 3 * Item 4* *Use area-weighted F_m from DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)*		n/a	n/a	n/a	n/a	n/a	n/a
6 Peak Flow from DMA (cfs) *Q_p =Item 2 * 0.9 * (Item 1 - Item 5)*		n/a	n/a	n/a	n/a	n/a	n/a
7 Time of concentration adjustment factor for other DMA to site discharge point *Form 4.2-4 Item 12 DMA / Other DMA upstream of site discharge point (If ratio is greater than 1.0, then use maximum value of 1.0)*	DMA A	*n/a*			*n/a*		
	DMA B		*n/a*			*n/a*	
	DMA C			*n/a*			*n/a*

8 Pre-developed Q_p at T_c for DMA A: n/a *Q_p = Item 6_{DMAA} + [Item 6_{DMAB} * (Item 1_{DMAA} - Item 5_{DMAB})/(Item 1_{DMAB} - Item 5_{DMAB})* Item $7_{DMAA/2}$] + [Item 6_{DMAC} * (Item 1_{DMAA} - Item 5_{DMAC})/(Item 1_{DMAC} - Item 5_{DMAC})* Item $7_{DMAA/3}$]*

9 Pre-developed Q_p at T_c for DMA B: n/a *Q_p = Item 6_{DMAB} + [Item 6_{DMAA} * (Item 1_{DMAB} - Item 5_{DMAA})/(Item 1_{DMAA} - Item 5_{DMAA})* Item $7_{DMAB/1}$] + [Item 6_{DMAC} * (Item 1_{DMAB} - Item 5_{DMAC})/(Item 1_{DMAC} - Item 5_{DMAC})* Item $7_{DMAB/3}$]*

10 Pre-developed Q_p at T_c for DMA C: n/a *Q_p = Item 6_{DMAC} + [Item 6_{DMAA} * (Item 1_{DMAC} - Item 5_{DMAA})/(Item 1_{DMAA} - Item 5_{DMAA})* Item $7_{DMAC/1}$] + [Item 6_{DMAB} * (Item 1_{DMAC} - Item 5_{DMAB})/(Item 1_{DMAB} - Item 5_{DMAB})* Item $7_{DMAC/2}$]*

10 Peak runoff from pre-developed condition confluence analysis (cfs): n/a *Maximum of Item 8, 9, and 10 (including additional forms as needed)*

11 Post-developed Q_p at T_c for DMA A: n/a
Same as Item 8 for post-developed values

12 Post-developed Q_p at T_c for DMA B: n/a
Same as Item 9 for post-developed values

13 Post-developed Q_p at T_c for DMA C: n/a
Same as Item 10 for post-developed values

14 Peak runoff from post-developed condition confluence analysis (cfs): n/a *Maximum of Item 11, 12, and 13 (including additional forms as needed)*

15 Peak runoff reduction needed to meet HCOC Requirement (cfs): n/a *$Q_{p\text{-}HCOC}$ = (Item 14 * 0.95) – Item 10*

4.3 Project Conformance Analysis

Complete the following forms for each project site DA to document that the proposed LID BMPs conform to the project DCV developed to meet performance criteria specified in the MS4 Permit (WQMP Template Section 4.2). For the LID DCV, the forms are ordered according to hierarchy of BMP selection as required by the MS4 Permit (see Section 5.3.1 in the TGD for WQMP). The forms compute the following for on-site LID BMP:

- Site Design and Hydrologic Source Controls (Form 4.3-2)
- Retention and Infiltration (Form 4.3-3)
- Harvested and Use (Form 4.3-4) or
- Biotreatment (Form 4.3-5).

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

The first step in the analysis, using Section 5.3.2.1 of the TGD for WQMP, is to complete Forms 4.3-1 and 4.3-3) to determine if retention and infiltration BMPs are infeasible for the project. For each feasibility criterion in Form 4.3-1, if the answer is "Yes," provide all study findings that includes relevant calculations, maps, data sources, etc. used to make the determination of infeasibility.

Next, complete Forms 4.3-2 and 4.3-4 to determine the feasibility of applicable HSC and harvest and use BMPs, and, if their implementation is feasible, the extent of mitigation of the DCV.

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

If the combination of LID HSC, retention and infiltration, and harvest and use BMPs are unable to mitigate the entire DCV, then biotreatment BMPs may be implemented by the project proponent. If biotreatment BMPs are used, then they must be sized to provide sufficient capacity for effective treatment of the remainder of the volume-based performance criteria that cannot be achieved with LID BMPs (TGD for WQMP Section 5.4.4.2). **Under no circumstances shall any portion of the DCV be released from the site without effective mitigation and/or treatment**.

Form 4.3-1 Infiltration BMP Feasibility (DA 1)

Feasibility Criterion – Complete evaluation for each DA on the Project Site

[1] Would infiltration BMP pose significant risk for groundwater related concerns? Yes ☒ No ☐
Refer to Section 5.3.2.1 of the TGD for WQMP

If Yes, Provide basis: (attach) PENDING, INFILTRATION REPORT.

[2] Would installation of infiltration BMP significantly increase the risk of geotechnical hazards? Yes ☒ No ☐
(Yes, if the answer to any of the following questions is yes, as established by a geotechnical expert):

- The location is less than 50 feet away from slopes steeper than 15 percent
- The location is less than eight feet from building foundations or an alternative setback.
- A study certified by a geotechnical professional or an available watershed study determines that stormwater infiltration would result in significantly increased risks of geotechnical hazards.

If Yes, Provide basis: PENDING, INFILTRATION REPORT.

[3] Would infiltration of runoff on a Project site violate downstream water rights? Yes ☐ No ☒

If Yes, Provide basis: (attach)

[4] Is proposed infiltration facility located on hydrologic soil group (HSG) D soils or does the site geotechnical investigation indicate presence of soil characteristics, which support categorization as D soils? Yes ☐ No ☒

If Yes, Provide basis: (attach)

[5] Is the design infiltration rate, after accounting for safety factor of 2.0, below proposed facility less than 0.3 in/hr (accounting for soil amendments)? Yes ☒ No ☐

If Yes, Provide basis: (attach) PENDING, INFILTRATION REPORT.

[6] Would on-site infiltration or reduction of runoff over pre-developed conditions be partially or fully inconsistent with watershed management strategies as defined in the WAP, or impair beneficial uses? Yes ☐ No ☒
See Section 3.5 of the TGD for WQMP and WAP

If Yes, Provide basis: (attach)

[7] Any answer from Item 1 through Item 3 is "Yes": Yes ☒ No ☐
If yes, infiltration of any volume is not feasible onsite. Proceed to Form 4.3-4, Harvest and Use BMP. If no, then proceed to Item 8 below.

[8] Any answer from Item 4 through Item 6 is "Yes": Yes ☒ No ☐
If yes, infiltration is permissible but is not required to be considered. Proceed to Form 4.3-2, Hydrologic Source Control BMP.
If no, then proceed to Item 9, below.

[9] All answers to Item 1 through Item 6 are "No":
Infiltration of the full DCV is potentially feasible, LID infiltration BMP must be designed to infiltrate the full DCV to the MEP.
Proceed to Form 4.3-2, Hydrologic Source Control BMP.

Form 4.3-1 Infiltration BMP Feasibility (DA 2)

Feasibility Criterion – Complete evaluation for each DA on the Project Site

[1] Would infiltration BMP pose significant risk for groundwater related concerns? Yes ☒ No ☐
Refer to Section 5.3.2.1 of the TGD for WQMP

If Yes, Provide basis: (attach) PENDING, INFILTRATION REPORT.

[2] Would installation of infiltration BMP significantly increase the risk of geotechnical hazards? Yes ☒ No ☐
(Yes, if the answer to any of the following questions is yes, as established by a geotechnical expert):

- The location is less than 50 feet away from slopes steeper than 15 percent
- The location is less than eight feet from building foundations or an alternative setback.
- A study certified by a geotechnical professional or an available watershed study determines that stormwater infiltration would result in significantly increased risks of geotechnical hazards.

If Yes, Provide basis: PENDING, INFILTRATION REPORT.

[3] Would infiltration of runoff on a Project site violate downstream water rights? Yes ☐ No ☒

If Yes, Provide basis: (attach)

[4] Is proposed infiltration facility located on hydrologic soil group (HSG) D soils or does the site geotechnical investigation indicate presence of soil characteristics, which support categorization as D soils? Yes ☐ No ☒

If Yes, Provide basis: (attach)

[5] Is the design infiltration rate, after accounting for safety factor of 2.0, below proposed facility less than 0.3 in/hr (accounting for soil amendments)? Yes ☒ No ☐

If Yes, Provide basis: (attach) PENDING, INFILTRATION REPORT.

[6] Would on-site infiltration or reduction of runoff over pre-developed conditions be partially or fully inconsistent with watershed management strategies as defined in the WAP, or impair beneficial uses? Yes ☐ No ☒
See Section 3.5 of the TGD for WQMP and WAP

If Yes, Provide basis: (attach)

[7] Any answer from Item 1 through Item 3 is "Yes": Yes ☒ No ☐
If yes, infiltration of any volume is not feasible onsite. Proceed to Form 4.3-4, Harvest and Use BMP. If no, then proceed to Item 8 below.

[8] Any answer from Item 4 through Item 6 is "Yes": Yes ☒ No ☐
If yes, infiltration is permissible but is not required to be considered. Proceed to Form 4.3-2, Hydrologic Source Control BMP.
If no, then proceed to Item 9, below.

[9] All answers to Item 1 through Item 6 are "No":
Infiltration of the full DCV is potentially feasible, LID infiltration BMP must be designed to infiltrate the full DCV to the MEP.
Proceed to Form 4.3-2, Hydrologic Source Control BMP.

4.3.1 Site Design Hydrologic Source Control BMP

Section XI.E. of the Permit emphasizes the use of LID preventative measures; and the use of LID HSC BMPs reduces the portion of the DCV that must be addressed in downstream BMPs. Therefore, all applicable HSC shall be provided except where they are mutually exclusive with each other, or with other BMPs. Mutual exclusivity may result from overlapping BMP footprints such that either would be potentially feasible by itself, but both could not be implemented. Please note that while there are no numeric standards regarding the use of HSC, if a project cannot feasibly meet BMP sizing requirements or cannot fully address HCOCs, feasibility of all applicable HSC must be part of demonstrating that the BMP system has been designed to retain the maximum feasible portion of the DCV. Complete Form 4.3-2 to identify and calculate estimated retention volume from implementing site design HSC BMP. Refer to Section 5.4.1 in the TGD for more detailed guidance.

Form 4.3-2 Site Design Hydrologic Source Control BMPs (DA 1)

1 Implementation of Impervious Area Dispersion BMP (i.e. routing runoff from impervious to pervious areas), excluding impervious areas planned for routing to on-lot infiltration BMP: Yes ☐ No ☒ *If yes, complete Items 2-5; If no, proceed to Item 6*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
2 Total impervious area draining to pervious area (ft^2)	n/a	n/a	n/a
3 Ratio of pervious area receiving runoff to impervious area	n/a	n/a	n/a
4 Retention volume achieved from impervious area dispersion (ft^3) *V = Item2 * Item 3 * (0.5/12), assuming retention of 0.5 inches of runoff*	n/a	n/a	n/a
5 Sum of retention volume achieved from impervious area dispersion (ft^3): 0 $V_{retention}$ *=Sum of Item 4 for all BMPs*			
6 Implementation of Localized On-lot Infiltration BMPs (e.g. on-lot rain gardens): Yes ☐ No ☒ *If yes, complete Items 7-13 for aggregate of all on-lot infiltration BMP in each DA; If no, proceed to Item 14*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
7 Ponding surface area (ft^2)	n/a	n/a	n/a
8 Ponding depth (ft)	n/a	n/a	n/a
9 Surface area of amended soil/gravel (ft^2)	n/a	n/a	n/a
10 Average depth of amended soil/gravel (ft)	n/a	n/a	n/a
11 Average porosity of amended soil/gravel	n/a	n/a	n/a
12 Retention volume achieved from on-lot infiltration (ft^3) $V_{retention}$ *= (Item 7 *Item 8) + (Item 9 * Item 10 * Item 11)*	n/a	n/a	n/a
13 Runoff volume retention from on-lot infiltration (ft^3): 0 $V_{retention}$ *=Sum of Item 12 for all BMPs*			

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

14 Implementation of evapotranspiration BMP (green, brown, or blue roofs): Yes ☐ No ☒ *If yes, complete Items 15-20. If no, proceed to Item 21*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
15 Rooftop area planned for ET BMP (ft^2)	n/a	n/a	n/a
16 Average wet season ET demand (in/day) *Use local values, typical ~ 0.1*	n/a	n/a	n/a
17 Daily ET demand (ft^3/day) *Item 15 * (Item 16 / 12)*	n/a	n/a	n/a
18 Drawdown time (hrs) *Copy Item 6 in Form 4.2-1*	n/a	n/a	n/a
19 Retention Volume (ft^3) $V_{retention}$ *= Item 17 * (Item 18 / 24)*	n/a	n/a	n/a
20 Runoff volume retention from evapotranspiration BMPs (ft^3): 0 $V_{retention}$ *=Sum of Item 19 for all BMPs*			
21 Implementation of Street Trees: Yes ☐ No ☒ *If yes, complete Items 22-25. If no, proceed to Item 26*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
22 Number of Street Trees	n/a	n/a	n/a
23 Average canopy cover over impervious area (ft^2)	n/a	n/a	n/a
24 Runoff volume retention from street trees (ft^3) $V_{retention}$ *= Item 22 * Item 23 * (0.05/12) assume runoff retention of 0.05 inches*	n/a	n/a	n/a
25 Runoff volume retention from street tree BMPs (ft^3): 0 $V_{retention}$ *= Sum of Item 24 for all BMPs*			
26 Implementation of residential rain barrel/cisterns: Yes☐ No ☒ *If yes, complete Items 27-29; If no, proceed to Item 30*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
27 Number of rain barrels/cisterns	n/a	n/a	n/a
28 Runoff volume retention from rain barrels/cisterns (ft^3) $V_{retention}$ *= Item 27 * 3*	n/a	n/a	n/a
29 Runoff volume retention from residential rain barrels/Cisterns (ft3): 0 $V_{retention}$ *=Sum of Item 28 for all BMPs*			
30 Total Retention Volume from Site Design Hydrologic Source Control BMPs: n/a *Sum of Items 5, 13, 20, 25 and 29*			

4.3.2 Infiltration BMPs

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

If site constraints limit the use of BMPs to a single type and implementation of retention and infiltration BMPs mitigate no more than 40% of the DCV, then they are considered infeasible and the Project Proponent may evaluate the effectiveness of BMPs lower in the LID hierarchy of use (Section 5.5.1 of the TGD for WQMP)

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

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

1 Remaining LID DCV not met by site design HSC BMP (ft^3): 246,655 *V_{unmet} = Form 4.2-1 Item 7 - Form 4.3-2 Item 30*

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

16 Total Retention Volume from LID Infiltration BMPs: 0 *(Sum of Items 14 and 15 for all infiltration BMP included in plan)*

17 Fraction of DCV achieved with infiltration BMP: 0 % *Retention% = Item 16 / Form 4.2-1 Item 7*

18 Is full LID DCV retained onsite with combination of hydrologic source control and LID retention/infiltration BMPs? Yes ☐ No ☒

If yes, demonstrate conformance using Form 4.3-10; If no, then reduce Item 3, Factor of Safety to 2.0 and increase Item 8, Infiltrating Surface Area, such that the portion of the site area used for retention and infiltration BMPs equals or exceeds the minimum effective area thresholds (Table 5-7 of the TGD for WQMP) for the applicable category of development and repeat all above calculations.

Form 4.3-3 Infiltration LID BMP - including underground BMPs (DA 2)

1 Remaining LID DCV not met by site design HSC BMP (ft^3): 20,903 *V_{unmet} = Form 4.2-1 Item 7 - Form 4.3-2 Item 30*

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

16 Total Retention Volume from LID Infiltration BMPs: 0 *(Sum of Items 14 and 15 for all infiltration BMP included in plan)*

17 Fraction of DCV achieved with infiltration BMP: 0 % *Retention% = Item 16 / Form 4.2-1 Item 7*

18 Is full LID DCV retained onsite with combination of hydrologic source control and LID retention/infiltration BMPs? Yes ☐ No ☒

If yes, demonstrate conformance using Form 4.3-10; If no, then reduce Item 3, Factor of Safety to 2.0 and increase Item 8, Infiltrating Surface Area, such that the portion of the site area used for retention and infiltration BMPs equals or exceeds the minimum effective area thresholds (Table 5-7 of the TGD for WQMP) for the applicable category of development and repeat all above calculations.

4.3.3 Harvest and Use BMP

Harvest and use BMP may be considered if the full LID DCV cannot be met by maximizing infiltration BMPs. Use Form 4.3-4 to compute on-site retention of runoff from proposed harvest and use BMPs.

Volume retention estimates for harvest and use BMPs are sensitive to the on-site demand for captured stormwater. Since irrigation water demand is low in the wet season, when most rainfall events occur in San Bernardino County, the volume of water that can be used within a specified drawdown period is relatively low. The bottom portion of Form 4.3-4 facilitates the necessary computations to show infeasibility if a minimum incremental benefit of 40 percent of the LID DCV would not be achievable with MEP implementation of on-site harvest and use of stormwater (Section 5.5.4 of the TGD for WQMP).

Form 4.3-4 Harvest and Use BMPs (DA 1)

1 Remaining LID DCV not met by site design HSC or infiltration BMP (ft^3): 246,655

V_{unmet} = Form 4.2-1 Item 7 - Form 4.3-2 Item 30 – Form 4.3-3 Item 16

BMP Type(s) *Compute runoff volume retention from proposed harvest and use BMP (Select BMPs from Table 5-4 of the TGD for WQMP) - Use additional forms for more BMPs*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
2 Describe cistern or runoff detention facility	n/a	n/a	n/a
3 Storage volume for proposed detention type (ft^3) *Volume of cistern*	n/a	n/a	n/a
4 Landscaped area planned for use of harvested stormwater (ft^2)	n/a	n/a	n/a
5 Average wet season daily irrigation demand (in/day) Use local values, typical ~ 0.1 in/day	n/a	n/a	n/a
6 Daily water demand (ft^3/day) *Item 4 * (Item 5 / 12)*	n/a	n/a	n/a
7 Drawdown time (hrs) *Copy Item 6 from Form 4.2-1*	n/a	n/a	n/a
8 Retention Volume (ft^3) *$V_{retention}$ = Minimum of (Item 3) or (Item 6 * (Item 7 / 24))*	n/a	n/a	n/a

9 Total Retention Volume (ft^3) from Harvest and Use BMP 0 *Sum of Item 8 for all harvest and use BMP included in plan*

10 Is the full DCV retained with a combination of LID HSC, retention and infiltration, and harvest & use BMPs? Yes ☐ No ☒

If yes, demonstrate conformance using Form 4.3-10. If no, then re-evaluate combinations of all LID BMP and optimize their implementation such that the maximum portion of the DCV is retained on-site (using a single BMP type or combination of BMP types). If the full DCV cannot be mitigated after this optimization process, proceed to Section 4.3.4.

Form 4.3-4 Harvest and Use BMPs (DA 2)

1 Remaining LID DCV not met by site design HSC or infiltration BMP (ft^3): 20,903

V_{unmet} = Form 4.2-1 Item 7 - Form 4.3-2 Item 30 – Form 4.3-3 Item 16

BMP Type(s) *Compute runoff volume retention from proposed harvest and use BMP (Select BMPs from Table 5-4 of the TGD for WQMP) - Use additional forms for more BMPs*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
2 Describe cistern or runoff detention facility	n/a	n/a	n/a
3 Storage volume for proposed detention type (ft^3) *Volume of cistern*	n/a	n/a	n/a
4 Landscaped area planned for use of harvested stormwater (ft^2)	n/a	n/a	n/a
5 Average wet season daily irrigation demand (in/day) Use local values, typical ~ 0.1 in/day	n/a	n/a	n/a
6 Daily water demand (ft^3/day) *Item 4 * (Item 5 / 12)*	n/a	n/a	n/a
7 Drawdown time (hrs) *Copy Item 6 from Form 4.2-1*	n/a	n/a	n/a
8 Retention Volume (ft^3) *$V_{retention}$ = Minimum of (Item 3) or (Item 6 * (Item 7 / 24))*	n/a	n/a	n/a

9 Total Retention Volume (ft^3) from Harvest and Use BMP 0 *Sum of Item 8 for all harvest and use BMP included in plan*

10 Is the full DCV retained with a combination of LID HSC, retention and infiltration, and harvest & use BMPs? Yes ☐ No ☒

If yes, demonstrate conformance using Form 4.3-10. If no, then re-evaluate combinations of all LID BMP and optimize their implementation such that the maximum portion of the DCV is retained on-site (using a single BMP type or combination of BMP types). If the full DCV cannot be mitigated after this optimization process, proceed to Section 4.3.4.

4.3.4 Biotreatment BMP

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

Use Form 4.3-5 to summarize the potential for volume based and/or flow based biotreatment options to biotreat the remaining unmet LID DCV w. Biotreatment computations are included as follows:

- Use Form 4.3-6 to compute biotreatment in small volume based biotreatment BMP (e.g. bioretention w/underdrains);
- Use Form 4.3-7 to compute biotreatment in large volume based biotreatment BMP (e.g. constructed wetlands);
- Use Form 4.3-8 to compute sizing criteria for flow-based biotreatment BMP (e.g. bioswale)

Form 4.3-5 Selection and Evaluation of Biotreatment BMP (DA 1)

1 Remaining LID DCV not met by site design HSC, infiltration, or harvest and use BMP for potential biotreatment (ft^3): 246,655 *Form 4.2-1 Item 7 - Form 4.3-2 Item 30 – Form 4.3-3 Item 16- Form 4.3-4 Item 9*

List pollutants of concern *Copy from Form 2.3-1.*
Pathogens
Nitrogen
Metals

2 Biotreatment BMP Selected
(Select biotreatment BMP(s) necessary to ensure all pollutants of concern are addressed through Unit Operations and Processes, described in Table 5-5 of the TGD for WQMP)

Volume-based biotreatment *Use Forms 4.3-6 and 4.3-7 to compute treated volume*	Flow-based biotreatment *Use Form 4.3-8 to compute treated volume*
☐ Bioretention with underdrain ☐ Planter box with underdrain ☐ Constructed wetlands ☐ Wet extended detention ☐ Dry extended detention ☒ Proprietary biotreatment	☐ Vegetated swale ☐ Vegetated filter strip ☐ Proprietary biotreatment

3 Volume biotreated in volume based biotreatment BMP (ft^3): 249,410 *Form 4.3-6 Item 15 + Form 4.3-7 Item 13*

4 Compute remaining LID DCV with implementation of volume based biotreatment BMP (ft^3): 0 *Item 1 – Item 3*

5 Remaining fraction of LID DCV for sizing flow based biotreatment BMP: 0 % *Item 4 / Item 1*

6 Flow-based biotreatment BMP capacity provided (cfs): n/a *Use Figure 5-2 of the TGD for WQMP to determine flow capacity required to provide biotreatment of remaining percentage of unmet LID DCV (Item 5), for the project's precipitation zone (Form 3-1 Item 1)*

7 Metrics for MEP determination:

- Provided a WQMP with the portion of site area used for suite of LID BMP equal to minimum thresholds in Table 5-7 of the TGD for WQMP for the proposed category of development: ☐ *If maximized on-site retention BMPs is feasible for partial capture, then LID BMP implementation must be optimized to retain and infiltrate the maximum portion of the DCV possible within the prescribed minimum effective area. The remaining portion of the DCV shall then be mitigated using biotreatment BMP.*

Form 4.3-5 Selection and Evaluation of Biotreatment BMP (DA 2)

1 Remaining LID DCV not met by site design HSC, infiltration, or harvest and use BMP for potential biotreatment (ft^3): 20,903 *Form 4.2-1 Item 7 - Form 4.3-2 Item 30 – Form 4.3-3 Item 16- Form 4.3-4 Item 9*

List pollutants of concern *Copy from Form 2.3-1.*
Pathogens
Nitrogen
Metals

2 Biotreatment BMP Selected *(Select biotreatment BMP(s) necessary to ensure all pollutants of concern are addressed through Unit Operations and Processes, described in Table 5-5 of the TGD for WQMP)*	Volume-based biotreatment *Use Forms 4.3-6 and 4.3-7 to compute treated volume*	Flow-based biotreatment *Use Form 4.3-8 to compute treated volume*
	☐ Bioretention with underdrain ☐ Planter box with underdrain ☐ Constructed wetlands ☐ Wet extended detention ☐ Dry extended detention ☒ Proprietary biotreatment	☐ Vegetated swale ☐ Vegetated filter strip ☐ Proprietary biotreatment

3 Volume biotreated in volume based biotreatment BMP (ft^3): 21,354 *Form 4.3-6 Item 15 + Form 4.3-7 Item 13*	**4** Compute remaining LID DCV with implementation of volume based biotreatment BMP (ft^3): 0 *Item 1 – Item 3*	**5** Remaining fraction of LID DCV for sizing flow based biotreatment BMP: 0 % *Item 4 / Item 1*

6 Flow-based biotreatment BMP capacity provided (cfs): n/a *Use Figure 5-2 of the TGD for WQMP to determine flow capacity required to provide biotreatment of remaining percentage of unmet LID DCV (Item 5), for the project's precipitation zone (Form 3-1 Item 1)*

7 Metrics for MEP determination:

- Provided a WQMP with the portion of site area used for suite of LID BMP equal to minimum thresholds in Table 5-7 of the TGD for WQMP for the proposed category of development: ☐ *If maximized on-site retention BMPs is feasible for partial capture, then LID BMP implementation must be optimized to retain and infiltrate the maximum portion of the DCV possible within the prescribed minimum effective area. The remaining portion of the DCV shall then be mitigated using biotreatment BMP.*

* See Attachment B for manufacturer's calculation

Form 4.3-6 Volume Based Biotreatment (DA 1) – Bioretention and Planter Boxes with Underdrains

Biotreatment BMP Type *(Bioretention w/underdrain, planter box w/underdrain, other comparable BMP)*	**Chambers + Biofiltration DMA A**	**Chambers + Biofiltration DMA B**	**Chambers + Biofiltration DMA C**
1 Pollutants addressed with BMP *List all pollutant of concern that will be effectively reduced through specific Unit Operations and Processes described in Table 5-5 of the TGD for WQMP*	*	*	*
2 Amended soil infiltration rate *Typical ~ 5.0*	*	*	*
3 Amended soil infiltration safety factor *Typical ~ 2.0*	*	*	*
4 Amended soil design percolation rate (in/hr) P_{design} *= Item 2 / Item 3*	*	*	*
5 Ponded water drawdown time (hr) *Copy Item 6 from Form 4.2-1*	*	*	*
6 Maximum ponding depth (ft) *see Table 5-6 of the TGD for WQMP for reference to BMP design details*	*	*	*
7 Ponding Depth (ft) d_{BMP} *= Minimum of (1/12 * Item 4 * Item 5) or Item 6*	*	*	*
8 Amended soil surface area (ft^2)	*	*	*
9 Amended soil depth (ft) *see Table 5-6 of the TGD for WQMP for reference to BMP design details*	*	*	*
10 Amended soil porosity, *n*	*	*	*
11 Gravel depth (ft) *see Table 5-6 of the TGD for WQMP for reference to BMP design details*	*	*	*
12 Gravel porosity, *n*	*	*	*
13 Duration of storm as basin is filling (hrs) *Typical ~ 3hrs*	*	*	*
14 Biotreated Volume (ft^3) $V_{biotreated}$ *= Item 8 * [(Item 7/2) + (Item 9 * Item 10) +(Item 11 * Item 12) + (Item 13 * (Item 4 / 12))]*	**57,187	**93,461	**98,762
15 Total biotreated volume from bioretention and/or planter box with underdrains BMP: 249,410 *Sum of Item 14 for all volume-based BMPs included in this form*			

** Volume processed through MWS during first 3 hours + Static capacity volume + Volume provided in underground detention system. Summary table provided on next page. See Attachment B for software calculations.

* See Attachment B for manufacturer's calculation

Form 4.3-6 Volume Based Biotreatment (DA 2) – Bioretention and Planter Boxes with Underdrains

Biotreatment BMP Type *(Bioretention w/underdrain, planter box w/underdrain, other comparable BMP)*	**Chambers + Biofiltration DMA A**	**n/a**	**n/a**
1 Pollutants addressed with BMP *List all pollutant of concern that will be effectively reduced through specific Unit Operations and Processes described in Table 5-5 of the TGD for WQMP*	*	n/a	n/a
2 Amended soil infiltration rate *Typical ~ 5.0*	*	n/a	n/a
3 Amended soil infiltration safety factor *Typical ~ 2.0*	*	n/a	n/a
4 Amended soil design percolation rate (in/hr) P_{design} *= Item 2 / Item 3*	*	n/a	n/a
5 Ponded water drawdown time (hr) *Copy Item 6 from Form 4.2-1*	*	n/a	n/a
6 Maximum ponding depth (ft) *see Table 5-6 of the TGD for WQMP for reference to BMP design details*	*	n/a	n/a
7 Ponding Depth (ft) d_{BMP} *= Minimum of (1/12 * Item 4 * Item 5) or Item 6*	*	n/a	n/a
8 Amended soil surface area (ft^2)	*	n/a	n/a
9 Amended soil depth (ft) *see Table 5-6 of the TGD for WQMP for reference to BMP design details*	*	n/a	n/a
10 Amended soil porosity, *n*	*	n/a	n/a
11 Gravel depth (ft) *see Table 5-6 of the TGD for WQMP for reference to BMP design details*	*	n/a	n/a
12 Gravel porosity, *n*	*	n/a	n/a
13 Duration of storm as basin is filling (hrs) *Typical ~ 3hrs*	*	n/a	n/a
14 Biotreated Volume (ft^3) $V_{biotreated}$ *= Item 8 * [(Item 7/2) + (Item 9 * Item 10) +(Item 11 * Item 12) + (Item 13 * (Item 4 / 12))]*	**21,354	n/a	n/a
15 Total biotreated volume from bioretention and/or planter box with underdrains BMP: 21,354 *Sum of Item 14 for all volume-based BMPs included in this form*			

** Volume processed through MWS during first 3 hours + Static capacity volume + Volume provided in underground detention system. Summary table provided on next page. See Attachment B for software calculations.

SUMMARY TABLE										
			MODULAR WETLANDS SYSTEM (MWS)					MC-3500 CHAMBERS		
DA DMA ID	AREA (ACRES)	DCV (CF)	MWS MODEL	# OF UNITS	VOLUME PROCESSED THROUGH MWS (CF) (DURING 1ST 3 HRS OF STORM EVENT)	LINEAR STATIC CAPACITY (CF)	UPSTREAM DETENTION NEEDED (CF)*	UPSTREAM DETENTION PROVIDED (CF)	# OF CHAMBERS	VOLUME TREATED FOLLOWING EVENT (CF)
DA 1 DMA A	13.55	56,647	MWS-L-10-20	2	3,768	349	52,530	53,070	202	57,187
DA 1 DMA B	22.10	92,391	MWS-L-8-20	4	6,280	348	85,763	86,833	324	93,461
DA 1 DMA C	23.35	97,617	MWS-L-8-20	4	6,280	348	90,989	92,134	356	98,762
DA 2 DMA A	5.00	20,903	MWS-L-8-16	1	1,256	268	19,379	19,830	72	21,354
TOTAL	**64.00**	**267,557**	**--**	**11**	**17,584**	**1,313**	**248,660**	**251,867**	**954**	**270,764**
*DCV - 3 HR. DURATION VOLUME - STATIC CAPACITY = UPSTREAM DETENTION NEEDED										

Form 4.3-7 Volume Based Biotreatment (DA 1) – Constructed Wetlands and Extended Detention

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

Form 4.3-8 Flow Based Biotreatment (DA 1)

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

4.3.5 Conformance Summary

Complete Form 4.3-9 to demonstrate how on-site LID DCV is met with proposed site design hydrologic source control, infiltration, harvest and use, and/or biotreatment BMP. The bottom line of the form is used to describe the basis for infeasibility determination for on-site LID BMP to achieve full LID DCV, and provides methods for computing remaining volume to be addressed in an alternative compliance plan. If the project has more than one outlet, then complete additional versions of this form for each outlet.

Form 4.3-9 Conformance Summary and Alternative Compliance Volume Estimate (DA 1)

1 Total LID DCV for the Project DA-1 (ft^3): 246,655 *Copy Item 7 in Form 4.2-1*

2 On-site retention with site design hydrologic source control LID BMP (ft^3): 0 *Copy Item 30 in Form 4.3-2*

3 On-site retention with LID infiltration BMP (ft^3): 0 *Copy Item 16 in Form 4.3-3*

4 On-site retention with LID harvest and use BMP (ft^3): 0 *Copy Item 9 in Form 4.3-4*

5 On-site biotreatment with volume based biotreatment BMP (ft^3): 249,410 *Copy Item 3 in Form 4.3-5*

6 Flow capacity provided by flow based biotreatment BMP (cfs): 0 *Copy Item 6 in Form 4.3-5*

7 LID BMP performance criteria are achieved if answer to any of the following is "Yes":

- Full retention of LID DCV with site design HSC, infiltration, or harvest and use BMP: Yes ☐ No ☒
  If yes, sum of Items 2, 3, and 4 is greater than Item 1
- Combination of on-site retention BMPs for a portion of the LID DCV and volume-based biotreatment BMP that address all pollutants of concern for the remaining LID DCV: Yes ☐ No ☒
  If yes, a) sum of Items 2, 3, 4, and 5 is greater than Item 1, and Items 2, 3 and 4 are maximized; or b) Item 6 is greater than Form 4.3--5 Item 6 and Items 2, 3 and 4 are maximized
- On-site retention and infiltration is determined to be infeasible and biotreatment BMP provide biotreatment for all pollutants of concern for full LID DCV: Yes ☒ No ☐
  If yes, Form 4.3-1 Items 7 and 8 were both checked yes

8 If the LID DCV is not achieved by any of these means, then the project may be allowed to develop an alternative compliance plan. Check box that describes the scenario which caused the need for alternative compliance:

- Combination of HSC, retention and infiltration, harvest and use, and biotreatment BMPs provide less than full LID DCV capture: ☐
  Checked yes for Form 4.3-5 Item 7, Item 6 is zero, and sum of Items 2, 3, 4, and 5 is less than Item 1. If so, apply water quality credits and calculate volume for alternative compliance, V_{alt} *= (Item 1 – Item 2 – Item 3 – Item 4 – Item 5) * (100 - Form 2.4-1 Item 2)%*
- An approved Watershed Action Plan (WAP) demonstrates that water quality and hydrologic impacts of urbanization are more effective when managed in at an off-site facility: ☐
  Attach appropriate WAP section, including technical documentation, showing effectiveness comparisons for the project site and regional watershed

Form 4.3-9 Conformance Summary and Alternative Compliance Volume Estimate (DA 2)

1 Total LID DCV for the Project DA-1 (ft^3): 20,903 *Copy Item 7 in Form 4.2-1*

2 On-site retention with site design hydrologic source control LID BMP (ft^3): 0 *Copy Item 30 in Form 4.3-2*

3 On-site retention with LID infiltration BMP (ft^3): 0 *Copy Item 16 in Form 4.3-3*

4 On-site retention with LID harvest and use BMP (ft^3): 0 *Copy Item 9 in Form 4.3-4*

5 On-site biotreatment with volume based biotreatment BMP (ft^3): 21,354 *Copy Item 3 in Form 4.3-5*

6 Flow capacity provided by flow based biotreatment BMP (cfs): 0 *Copy Item 6 in Form 4.3-5*

7 LID BMP performance criteria are achieved if answer to any of the following is "Yes":

- Full retention of LID DCV with site design HSC, infiltration, or harvest and use BMP: Yes ☐ No ☒
  If yes, sum of Items 2, 3, and 4 is greater than Item 1
- Combination of on-site retention BMPs for a portion of the LID DCV and volume-based biotreatment BMP that address all pollutants of concern for the remaining LID DCV: Yes ☐ No ☒
  If yes, a) sum of Items 2, 3, 4, and 5 is greater than Item 1, and Items 2, 3 and 4 are maximized; or b) Item 6 is greater than Form 4.3--5 Item 6 and Items 2, 3 and 4 are maximized
- On-site retention and infiltration is determined to be infeasible and biotreatment BMP provide biotreatment for all pollutants of concern for full LID DCV: Yes ☒ No ☐
  If yes, Form 4.3-1 Items 7 and 8 were both checked yes

8 If the LID DCV is not achieved by any of these means, then the project may be allowed to develop an alternative compliance plan. Check box that describes the scenario which caused the need for alternative compliance:

- Combination of HSC, retention and infiltration, harvest and use, and biotreatment BMPs provide less than full LID DCV capture: ☐
  Checked yes for Form 4.3-5 Item 7, Item 6 is zero, and sum of Items 2, 3, 4, and 5 is less than Item 1. If so, apply water quality credits and calculate volume for alternative compliance, V_{alt} *= (Item 1 – Item 2 – Item 3 – Item 4 – Item 5) * (100 - Form 2.4-1 Item 2)%*
- An approved Watershed Action Plan (WAP) demonstrates that water quality and hydrologic impacts of urbanization are more effective when managed in at an off-site facility: ☐
  Attach appropriate WAP section, including technical documentation, showing effectiveness comparisons for the project site and regional watershed

4.3.6 Hydromodification Control BMP

Use Form 4.3-10 to compute the remaining runoff volume retention, after LID BMP are implemented, needed to address HCOC, and the increase in time of concentration and decrease in peak runoff necessary to meet targets for protection of waterbodies with a potential HCOC. Describe hydromodification control BMP that address HCOC, which may include off-site BMP and/or in-stream controls. Section 5.6 of the TGD for WQMP provides additional details on selection and evaluation of hydromodification control BMP.

Form 4.3-10 Hydromodification Control BMPs (DA 1)

1 Volume reduction needed for HCOC performance criteria (ft^3): n/a
*(Form 4.2-2 Item 4 * 0.95) – Form 4.2-2 Item 1*

2 On-site retention with site design hydrologic source control, infiltration, and harvest and use LID BMP (ft^3): n/a *Sum of Form 4.3-9 Items 2, 3, and 4 Evaluate option to increase implementation of on-site retention in Forms 4.3-2, 4.3-3, and 4.3-4 in excess of LID DCV toward achieving HCOC volume reduction*

3 Remaining volume for HCOC volume capture (ft^3): n/a *Item 1 – Item 2*

4 Volume capture provided by incorporating additional on-site or off-site retention BMPs (ft^3): n/a *Existing downstream BMP may be used to demonstrate additional volume capture (if so, attach to this WQMP a hydrologic analysis showing how the additional volume would be retained during a 2-yr storm event for the regional watershed)*

5 If Item 4 is less than Item 3, incorporate in-stream controls on downstream waterbody segment to prevent impacts due to hydromodification ☐ *Attach in-stream control BMP selection and evaluation to this WQMP*

6 Is Form 4.2-2 Item 11 less than or equal to 5%: Yes ☐ No ☐

If yes, HCOC performance criteria is achieved. If no, select one or more mitigation options below:

- Demonstrate increase in time of concentration achieved by proposed LID site design, LID BMP, and additional on-site or off-site retention BMP ☐
  BMP upstream of a waterbody segment with a potential HCOC may be used to demonstrate increased time of concentration through hydrograph attenuation (if so, show that the hydraulic residence time provided in BMP for a 2-year storm event is equal or greater than the addition time of concentration requirement in Form 4.2-4 Item 15)
- Increase time of concentration by preserving pre-developed flow path and/or increase travel time by reducing slope and increasing cross-sectional area and roughness for proposed on-site conveyance facilities ☐
- Incorporate appropriate in-stream controls for downstream waterbody segment to prevent impacts due to hydromodification, in a plan approved and signed by a licensed engineer in the State of California ☐

7 Form 4.2-2 Item 12 less than or equal to 5%: Yes ☐ No ☐

If yes, HCOC performance criteria is achieved. If no, select one or more mitigation options below:

- Demonstrate reduction in peak runoff achieved by proposed LID site design, LID BMPs, and additional on-site or off-site retention BMPs ☐
  BMPs upstream of a waterbody segment with a potential HCOC may be used to demonstrate additional peak runoff reduction through hydrograph attenuation (if so, attach to this WQMP, a hydrograph analysis showing how the peak runoff would be reduced during a 2-yr storm event)
- Incorporate appropriate in-stream controls for downstream waterbody segment to prevent impacts due to hydromodification, in a plan approved and signed by a licensed engineer in the State of California ☐

4.4 Alternative Compliance Plan (if applicable)

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

- On-site structural treatment control BMP - All treatment control BMP should be located as close to possible to the pollutant sources and should not be located within receiving waters;
- Off-site structural treatment control BMP - Pollutant removal should occur prior to discharge of runoff to receiving waters;
- Urban runoff fund or In-lieu program, if available

Depending upon the proposed alternative compliance plan, approval by the executive officer may or may not be required (see Section 6 of the TGD for WQMP).

Section 5 Inspection and Maintenance Responsibility for Post Construction BMP

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

Form 5-1 BMP Inspection and Maintenance

BMP	Responsible Party(ies)	Inspection/Maintenance Activities Required	Minimum Frequency of Activities
Proprietary Biofiltration (volume-based)	Owner	Remove trash from Screening Device, sediment from Separation Chamber and replace cartridge Filter Media, and Drain Down Filter Media. The owner should keep maintenance/inspection record(s) for a minimum of five years from the date of maintenance. These records should be made available to the governing municipality for inspection upon request at any time. Transport all debris, trash, organics and sediments to approved facility for disposal in accordance with local and state requirements.	Average maintenance interval of 6 to 12 months for removing trash from Screening Device. Average interval of 12 to 24 months for removing sediment, replacing Cartridge Filter Media, replacing Drain Down Filter Media and trimming vegetation.
Hydrodynamic Separator (pretreatment)	Owner	Open access hatches or manholes. Remove gross solids from screening basket upon reaching 25% capacity. Hinges open the bottom screen panels to access sedimentation chambers. Vacuum out sedimentation chamber when any chamber reaches 25% capacity.	Semi-annually (Oct 1st and Feb 1st per maintenance service contract with vendor)
Underground Detention Chambers	Owner	The isolator rows shall be inspected and maintained by a qualified technician and he/she will properly dispose of all wastes and inspect for standing water. A manhole is installed in order to inspect and maintain the inlet row. All entry into the chamber system must be done per OSHA codes to ensure operator and inspector safety. Inspection ports should be checked 48 hours after storm events to see that the water is draining down, at least once each rainy season, following a major storm event. Records shall be maintained by owner to document inspections.	The isolator rows shall be inspected semi-annually (by October 1st and February 1st) and cleaned by water-flush and vacuum when solids accumulate to 3" depth. Maintenance to be conducted through service contract with the vendor or equally qualified contractor.

Pumps	Owner	Preventive maintenance and service to be performed by a qualified technician is recommended. Check automatic operation of system as well as manual operation by use of float activation and selector switch, respectively. Inspect floats for proper elevation and movement. Check voltage and amperage for each motor. Hose down lift station to clean walls, pumps, and floats. Inspection of mechanical seals to be done once every two (2) years.	One (1) per year per manufacturer's recommendations1
N1: Education of Property Owners, Tenants and Occupants on Stormwater BMPs	Owner	Property owner will familiarize him/herself with the educational materials in Attachment "E" and the contents of the WQMP.	Annually for all employees and within 2 months for new hires.
N2: Activity Restrictions	Owner	Activities are restricted to only those for which a BMP has been implemented. The owner shall develop ongoing activity restrictions that include those that have the potential to create adverse impacts on water quality. Activities include, but are not limited to: handling and disposal of contaminants, fertilizer and pesticide application restrictions, litter control and pick-up, and vehicle or equipment repair as well as any other activities that may potentially contribute to water pollution.	Ongoing
N3: Landscape Management BMPs	Owner	Irrigation must be consistent with City's Water Conservation Ordinance. Fertilizer and pesticide usage will be consistent with County Management Guidelines for Use of Fertilizers and Pesticides.	Ongoing
N4: BMP Maintenance	Owner	BMP maintenance, implementation schedules, and responsible parties are included with each specific BMP narrative.	As described in each BMP.
N7: Spill Contingency Plan	Owner	Owner/tenant will have a spill contingency plan, a separate document, based on specific site needs.	Ongoing
N10: Uniform Fire Code Implementation	Owner	If applicable, owner will comply with Article 80 of the Uniform Fire Code enforced by the fire protection agency. The facility operators will be educated annually regarding requirements for handling, storage and proper disposal of hazardous substances.	Ongoing
N11: Litter/Debris Control Program	Owner	Contract with their landscape maintenance firm to provide this service during regularly schedule maintenance. They are required to implement trash management and litter control procedures in	Weekly

		the common areas aimed at reducing pollution of drainage water.	
N12: Employee Training	Owner	The owner will ensure that tenants are also familiar with onsite BMPs and necessary maintenance required of the tenants. Owner will check with City and County at least once a year to obtain new or updated educational materials and provide these materials to tenants. Employees shall be trained to clean up spills and participate in ongoing maintenance. The WQMP requires annual employee training and new hires within 2 months.	Annually for all employees and within 2 months for new hires.
N13: Housekeeping of Loading Docks	Owner	Keep all fluids indoors. Clean up spills immediately and keep spills from entering storm drain system. No direct discharges into the storm drain system. Area shall be inspected weekly for proper containment and practices with spills cleaned up immediately and disposed of properly.	Ongoing
N14: Catch Basin Inspection Program	Owner	Monthly inspection by property owner's designee. Inspection consists of immediate repair of any deterioration of the structures and maintenance of drain inserts before and after major rain events. Drain insert maintenance shall be per manufacturer's guidelines.	Monthly inspection and maintain as necessary.
N15: Vacuum Sweeping of Private Streets and Parking Lots	Owner	All landscape maintenance contractors will be required to sweep up all landscape cuttings, mowings and fertilizer materials off paved areas weekly and dispose of properly. Parking areas and drive ways will be swept monthly by sweeping contractor.	Monthly
S1: Provide storm drain system stenciling and signage (CASQA New Development BMP Handbook SD-13)	Owner	"No Dumping – Drains to River" stencils will be applied. Legibility of stencil will be maintained on a yearly basis.	Annually
S3: Design and construct trash and waste storage areas to reduce pollution introduction (CASQA New Development BMP Handbook SD-32)	Owner	Paved with an impervious surface, designed not to allow run-on from adjoining areas, designed to divert drainage from adjoining roofs and pavements diverted around the area, screened or walled to prevent off-site transport of trash.	Ongoing

S4: Use efficient irrigation systems & landscape design, water conservation, smart controllers, and source control (Statewide Model Landscape Ordinance; CASQA New Development BMP Handbook SD-12)	Owner	Irrigation systems shall include reducers or shutoff valves triggered by a pressure drop to control water loss in the event of broken sprinkler heads or lines. Timers will be used to avoid over watering and watering cycles and duration shall be adjusted seasonally by the landscape maintenance contractor. The landscaping areas will be grouped with plants that have similar water requirements. Native or drought tolerant species shall also be used where appropriate to reduce excess irrigation runoff and promote surface filtration.	Adjust watering cycles and duration seasonally / quarterly.
S5: Finish grade of landscaped areas at a minimum of 1-2 inches below top of curb, sidewalk, or pavement	Owner	Landscaped areas will be depressed in order to increase retention of stormwater/irrigation water and promote infiltration.	Ongoing

Section 6 WQMP Attachments

6.1. Site Plan and Drainage Plan

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

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

See Attachment C for the WQMP Site Map.

6.2 Electronic Data Submittal

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

6.3 Post Construction

Attach all O&M Plans and Maintenance Agreements for BMP to the WQMP (Attachment D).

6.4 Other Supporting Documentation

- Educational Materials (Attachment E)
- Infiltration Report (Attachment F)

Section 6.1

Attachment A
Existing Condition Site Photos

Section 6.1

Attachment B
BMP Design Calculations & Supporting Documentation

www.nws.noaa.gov

NOAA's National Weather Service
Hydrometeorological Design Studies Center
Precipitation Frequency Data Server (PFDS)

NOAA ATLAS 14 POINT PRECIPITATION FREQUENCY ESTIMATES: CA

Data description

Data type: Precipitation depth **Units:** English **Time series type:** Partial duration

Select location

1) Manually:

a) By location (decimal degrees, use "-" for S and W): Latitude: 34.051143 Longitude: -117.34645 Submit

b) By station (list of CA stations): Select station

c) By address Search

2) Use map (if ESRI interactive map is not loading, try adding the host: **https://js.arcgis.com/** to the firewall, or contact us at hdsc.questions@noaa.gov):

a) Select location
Move crosshair or double click

b) Click on station icon
Show stations on map

Location information:
Name: Colton, California, USA*
Latitude: 34.0511°
Longitude: -117.3465°
Elevation: 886.51 ft **

* Source: ESRI Maps
** Source: USGS

POINT PRECIPITATION FREQUENCY (PF) ESTIMATES

WITH 90% CONFIDENCE INTERVALS AND SUPPLEMENTARY INFORMATION
NOAA Atlas 14, Volume 6, Version 2

PF tabular PF graphical Supplementary information Print page

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

Duration	Average recurrence interval (years) 1	2	5	10	25	50	100	200	500	1000
5-min	**0.101** (0.084-0.123)	**0.130** (0.108-0.158)	**0.169** (0.140-0.205)	**0.201** (0.165-0.246)	**0.245** (0.194-0.311)	**0.279** (0.217-0.362)	**0.314** (0.238-0.418)	**0.351** (0.259-0.481)	**0.402** (0.284-0.576)	**0.443** (0.302-0.657)
10-min	**0.145** (0.121-0.176)	**0.187** (0.155-0.227)	**0.242** (0.201-0.294)	**0.288** (0.237-0.353)	**0.351** (0.279-0.445)	**0.400** (0.311-0.519)	**0.450** (0.341-0.600)	**0.503** (0.371-0.690)	**0.577** (0.407-0.825)	**0.635** (0.432-0.941)
15-min	**0.175** (0.146-0.212)	**0.226** (0.188-0.274)	**0.293** (0.243-0.356)	**0.348** (0.286-0.427)	**0.424** (0.337-0.539)	**0.483** (0.376-0.628)	**0.544** (0.413-0.725)	**0.609** (0.448-0.834)	**0.697** (0.492-0.998)	**0.768** (0.523-1.14)
30-min	**0.263** (0.219-0.319)	**0.339** (0.282-0.412)	**0.440** (0.365-0.535)	**0.523** (0.430-0.642)	**0.637** (0.506-0.809)	**0.726** (0.565-0.943)	**0.818** (0.621-1.09)	**0.915** (0.674-1.25)	**1.05** (0.740-1.50)	**1.15** (0.786-1.71)
60-min	**0.382** (0.318-0.463)	**0.491** (0.409-0.597)	**0.637** (0.529-0.775)	**0.757** (0.623-0.930)	**0.923** (0.734-1.17)	**1.05** (0.819-1.37)	**1.19** (0.899-1.58)	**1.33** (0.976-1.82)	**1.52** (1.07-2.17)	**1.67** (1.14-2.48)
2-hr	**0.548** (0.456-0.664)	**0.701** (0.583-0.850)	**0.902** (0.749-1.10)	**1.07** (0.879-1.31)	**1.30** (1.03-1.65)	**1.47** (1.14-1.91)	**1.65** (1.25-2.20)	**1.84** (1.36-2.52)	**2.10** (1.48-3.00)	**2.30** (1.57-3.41)
3-hr	**0.676** (0.563-0.819)	**0.863** (0.718-1.05)	**1.11** (0.920-1.35)	**1.31** (1.08-1.61)	**1.59** (1.26-2.02)	**1.80** (1.40-2.34)	**2.02** (1.53-2.69)	**2.24** (1.65-3.08)	**2.55** (1.80-3.66)	**2.80** (1.91-4.15)
6-hr	**0.947** (0.789-1.15)	**1.21** (1.01-1.47)	**1.55** (1.29-1.89)	**1.83** (1.51-2.25)	**2.21** (1.76-2.81)	**2.51** (1.95-3.26)	**2.81** (2.13-3.74)	**3.12** (2.30-4.27)	**3.54** (2.50-5.06)	**3.87** (2.64-5.74)
12-hr	**1.26**	**1.61**	**2.07**	**2.45**	**2.96**	**3.35**	**3.74**	**4.15**	**4.70**	**5.13**

	(1.05-1.53)	(1.34-1.96)	(1.72-2.52)	(2.01-3.01)	(2.35-3.76)	(2.60-4.34)	(2.84-4.98)	(3.06-5.69)	(3.32-6.73)	(3.50-7.61)
24-hr	**1.67** (1.48-1.93)	**2.16** (1.91-2.49)	**2.79** (2.46-3.23)	**3.31** (2.89-3.86)	**4.00** (3.39-4.82)	**4.53** (3.76-5.58)	**5.07** (4.11-6.39)	**5.62** (4.43-7.28)	**6.37** (4.82-8.59)	**6.95** (5.09-9.69)
2-day	**2.04** (1.80-2.35)	**2.67** (2.36-3.08)	**3.50** (3.09-4.05)	**4.18** (3.66-4.88)	**5.10** (4.32-6.15)	**5.81** (4.82-7.15)	**6.54** (5.29-8.23)	**7.28** (5.74-9.43)	**8.30** (6.28-11.2)	**9.09** (6.65-12.7)
3-day	**2.17** (1.92-2.51)	**2.90** (2.56-3.34)	**3.85** (3.40-4.46)	**4.64** (4.06-5.41)	**5.72** (4.84-6.89)	**6.56** (5.44-8.06)	**7.42** (6.01-9.34)	**8.31** (6.55-10.8)	**9.54** (7.22-12.9)	**10.5** (7.68-14.7)
4-day	**2.33** (2.06-2.69)	**3.14** (2.77-3.62)	**4.20** (3.71-4.86)	**5.09** (4.45-5.93)	**6.31** (5.34-7.60)	**7.26** (6.02-8.93)	**8.24** (6.68-10.4)	**9.27** (7.31-12.0)	**10.7** (8.08-14.4)	**11.8** (8.63-16.5)
7-day	**2.67** (2.36-3.07)	**3.62** (3.20-4.18)	**4.89** (4.31-5.66)	**5.94** (5.20-6.93)	**7.39** (6.26-8.91)	**8.53** (7.08-10.5)	**9.71** (7.86-12.2)	**10.9** (8.62-14.2)	**12.6** (9.57-17.1)	**14.0** (10.2-19.5)
10-day	**2.89** (2.56-3.34)	**3.95** (3.50-4.56)	**5.36** (4.73-6.20)	**6.53** (5.71-7.62)	**8.15** (6.90-9.82)	**9.42** (7.82-11.6)	**10.7** (8.70-13.5)	**12.1** (9.55-15.7)	**14.0** (10.6-18.9)	**15.6** (11.4-21.7)
20-day	**3.51** (3.11-4.05)	**4.84** (4.28-5.58)	**6.61** (5.83-7.65)	**8.09** (7.08-9.44)	**10.1** (8.60-12.2)	**11.8** (9.77-14.5)	**13.5** (10.9-17.0)	**15.3** (12.0-19.8)	**17.8** (13.4-23.9)	**19.8** (14.5-27.6)
30-day	**4.17** (3.69-4.80)	**5.75** (5.08-6.63)	**7.87** (6.94-9.11)	**9.65** (8.44-11.3)	**12.1** (10.3-14.6)	**14.1** (11.7-17.4)	**16.2** (13.1-20.4)	**18.4** (14.5-23.8)	**21.4** (16.2-28.9)	**23.9** (17.5-33.4)
45-day	**4.98** (4.41-5.74)	**6.84** (6.05-7.90)	**9.36** (8.25-10.8)	**11.5** (10.0-13.4)	**14.4** (12.2-17.4)	**16.8** (13.9-20.7)	**19.3** (15.6-24.3)	**21.9** (17.3-28.4)	**25.7** (19.4-34.6)	**28.7** (21.0-40.0)
60-day	**5.81** (5.15-6.70)	**7.94** (7.02-9.16)	**10.8** (9.53-12.5)	**13.2** (11.6-15.4)	**16.6** (14.1-20.0)	**19.3** (16.1-23.8)	**22.2** (18.0-28.0)	**25.3** (19.9-32.7)	**29.6** (22.4-39.9)	**33.1** (24.2-46.2)

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

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

Please refer to NOAA Atlas 14 document for more information.

Estimates from the table in CSV format: Precipitation frequency estimates Submit

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National Oceanic and Atmospheric Administration
National Weather Service
Office of Water Prediction (OWP)
1325 East West Highway
Silver Spring, MD 20910
Page Author: HDSC webmaster
Page last modified: April 21, 2017

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SUMMARY TABLE										
			MODULAR WETLANDS SYSTEM (MWS)					MC-3500 CHAMBERS		VOLUME TREATED FOLLOWING EVENT (CF)
DA DMA ID	AREA (ACRES)	DCV (CF)	MWS MODEL	# OF UNITS	VOLUME PROCESSED THROUGH MWS (CF) (DURING 1ST 3 HRS OF STORM EVENT)	LINEAR STATIC CAPACITY (CF)	UPSTREAM DETENTION NEEDED (CF)*	UPSTREAM DETENTION PROVIDED (CF)	# OF CHAMBERS	
DA 1 DMA A	13.55	56,647	MWS-L-10-20	2	3,768	349	52,530	53,070	202	57,187
DA 1 DMA B	22.10	92,391	MWS-L-8-20	4	6,280	348	85,763	86,833	324	93,461
DA 1 DMA C	23.35	97,617	MWS-L-8-20	4	6,280	348	90,989	92,134	356	98,762
DA 2 DMA A	5.00	20,903	MWS-L-8-16	1	1,256	268	19,379	19,830	72	21,354
TOTAL	**64.00**	**267,557**	**--**	**11**	**17,584**	**1,313**	**248,660**	**251,867**	**954**	**270,764**
*DCV - 3 HR. DURATION VOLUME - STATIC CAPACITY = UPSTREAM DETENTION NEEDED										

FLOW-BASED BMP DESIGN

$C_{BMP} = 0.858(imp)^3 - 0.78(imp)^2 + 0.774(imp) + 0.04$
$I_{BMP} = (0.491)(0.2787)(2) = 0.268$ in/hr
$Q = C_{BMP} * 0.268 * Area$

DA 1 DMA A – DEBRIS SEPARATING BAFFLE BOX (DSBB-A)

Region		Valley	
Drainage Area (acres)		13.55	acres
Drainage Area (sq-ft)		590,238	sq-ft
Impervious Coeff	i =	0.95	< 1.0
Runoff Coeff	**C =**	0.81	
1-hr 2-yr from NOAA		0.491	
Itensity Coeff		0.2787	
Intensity BMP (in/hr)		0.274	
Flow (cfs)	Q =	2.99	

Use DSBB-6-12
Q-required = 2.99 cfs
Q-provided = 3.19 cfs

DA 1 DMA B – DEBRIS SEPARATING BAFFLE BOX (DSBB-B)

Region		Valley	
Drainage Area (acres)		22.10	acres
Drainage Area (sq-ft)		962,676	sq-ft
Impervious Coeff	i =	0.95	< 1.0
Runoff Coeff	**C =**	0.81	
1-hr 2-yr from NOAA		0.491	
Itensity Coeff		0.2787	
Intensity BMP (in/hr)		0.274	
Flow (cfs)	Q =	4.88	

Use DSBB-8-14
Q-required = 4.88 cfs
Q-provided = 4.96 cfs

DA 1 DMA C – DEBRIS SEPARATING BAFFLE BOX (DSBB-C)

Region		Valley	
Drainage Area (acres)		23.35	acres
Drainage Area (sq-ft)		1,017,126	sq-ft
Impervious Coeff	i =	0.95	< 1.0
Runoff Coeff	**C =**	**0.81**	
1-hr 2-yr from NOAA		0.491	
Itensity Coeff		**0.2787**	
Intensity BMP (in/hr)		**0.274**	
Flow (cfs)	Q =	**5.16**	

Use DSBB-8-16
Q-required = 5.16 cfs
Q-provided = 5.67 cfs

DA 2 STREET – DEBRIS SEPARATING BAFFLE BOX (DSBB-D)

Region		Valley	
Drainage Area (acres)		5.00	acres
Drainage Area (sq-ft)		**217,800**	sq-ft
Impervious Coeff	i =	0.95	< 1.0
Runoff Coeff	**C =**	**0.81**	
1-hr 2-yr from NOAA		0.491	
Itensity Coeff		**0.2787**	
Intensity BMP (in/hr)		**0.274**	
Flow (cfs)	Q =	**1.10**	

Use DSBB-4-8
Q-required = 1.10 cfs
Q-provided = 1.42 cfs

VOLUME-BASED BMP DESIGN

$C_{BMP} = 0.858(imp)^3 - 0.78(imp)^2 + 0.774(imp) + 0.04$
P6 = (0.491)(1.4807) = 0.727 inches
$P0 = (1.963)(C_{BMP})(0.727)$
DCV = (P0 * Area) / 12

DA 1 DMA A – STORMTECH CHAMBERS & MODULAR WETLANDS SYSTEM (STC-A & MWS-A)

Region		Valley	
Drainage Area (acres)		13.55	acres
Drainage Area (sq-ft)		**590,238**	sq-ft
Impervious Coeff	i =	0.95	< 1.0
Runoff Coeff	**C =**	**0.807**	
1-hr 2-yr from NOAA		0.491	
P6 Coeff		**1.4807**	
Mean 6-hr (P6)		**0.727**	
Drawdown Rate (a)		1.963	
DCV		**56,647**	cu-ft
DCV		**1.300**	acre-ft

WetlandMOD VOLUME BASED SIZING SHEET

Horizontal Flow Biofiltration System

Project Location

Project Name	Agua Mansa Road (DA 1 DMA A)
City/Town	Colton
State	California
Zip Code	92324

SIZING CALCULATIONS	Inputs	Units	Notes/References
Impervious Area			
BMP Drainage Area (not required - manual entry - not part of formula)	13.55	Acres	This includes all areas that will contribute runoff to the proposed BMP, including pervious areas, impervious areas, and off-site areas, whether or not they are directly or indirectly connected to the BMP.
Watershed Impervious Ratio (not required - manual entry - not part of formula)			Watershed Imperviousness Ratio", is equal to the percent of total impervious area in the "BMP Drainage Area" divided by 100
Runoff Coefficient "C" (not required - manual entry - not part of formula)			
Water Quality Volume (required)	56647	cubic feet	Use sizing procedures provided by state or local agencies to determine the appropriate Water Quality Volume. Intensities and design storms vary widely by region and method.
Design Storm Duration	3	hours	Varies depending on geographical region. Set at 0 for pump system set up. LA County 3 hours. Call for details.
MWS - Linear Sizing			
MWS - Linear Model Number (from matrix)	MWS-L-10-20	quantity	Please choose size from "Model Size Matrix" Tab
# Of Units	2	quantity	Select the number of systems required to treat the water quality volume. Will very depending on drain down time regulaitons.
Discharge Rate (from matrix)	78.50	gallons/minute	Rate of 0.26 gpm/sq ft or 25 in/hr. Field Verified.
Volume Treated During Event			
Processed through MWS - Linear	3768.0	cubic feet	157.00 gals/minute
Volume Treated Following Event			
MWS - Linear Static Capacity (from matrix)	349	cubic feet	
Volume Needed in *Pre-Storage*	52530	cubic feet	Set at zero to start. Size pre-storage system to hold this volume
			Sizing complete when eqaul to value of zero.
TOTAL STORMWATER TREATED	56647	cubic feet	Note: This amount should be equal to the "Water Quality Volume"
Drain Down Time	42.10	hours	Drain down time must be equal to or less than requirement of local juristiction. Default 48 hours.

Feel free to fax or email proposed sizing calculations to Modular Wetlands Systems, Inc. for assistance with sizing, compliance, and design.

Phone: 760.433.7640

Fax: 760.433.3176

Email: Info@modularwetlands.com

Project: **Agua Mansa Rd DA 1 DMA A**

StormTech
Detention • Retention • Water Quality
A division of ADS

Chamber Model -	MC-3500	
Units -	**Imperial**	Click Here for Metric
Number of Chambers -	202	
Number of End Caps -	12	
Voids in the stone (porosity) -	40	%
Base of Stone Elevation -	863.30	ft
Amount of Stone Above Chambers -	12	in
Amount of Stone Below Chambers -	36	in
Amount of Stone Between Chambers -	9	in
Area of system -	12786	sf

☑ Include Perimeter Stone in Calculations

Min. Area - 10599 sf min. area

StormTech MC-3500 Cumulative Storage Volumes

Height of System *(inches)*	Incremental Single Chamber *(cubic feet)*	Incremental Single End Cap *(cubic feet)*	Incremental Chambers *(cubic feet)*	Incremental End Cap *(cubic feet)*	Incremental Stone *(cubic feet)*	Incremental Ch, EC and Stone *(cubic feet)*	Cumulative System (cubic feet)	Elevation (feet)
93	0.00	0.00	0.00	0.00	426.20	426.20	53069.88	871.05
92	0.00	0.00	0.00	0.00	426.20	426.20	52643.68	870.97
91	0.00	0.00	0.00	0.00	426.20	426.20	52217.48	870.88
90	0.00	0.00	0.00	0.00	426.20	426.20	51791.28	870.80
89	0.00	0.00	0.00	0.00	426.20	426.20	51365.08	870.72
88	0.00	0.00	0.00	0.00	426.20	426.20	50938.88	870.63
87	0.00	0.00	0.00	0.00	426.20	426.20	50512.68	870.55
86	0.00	0.00	0.00	0.00	426.20	426.20	50086.48	870.47
85	0.00	0.00	0.00	0.00	426.20	426.20	49660.28	870.38
84	0.00	0.00	0.00	0.00	426.20	426.20	49234.08	870.30
83	0.00	0.00	0.00	0.00	426.20	426.20	48807.88	870.22
82	0.00	0.00	0.00	0.00	426.20	426.20	48381.68	870.13
81	0.06	0.00	11.73	0.00	421.51	433.24	47955.48	870.05
80	0.19	0.02	39.21	0.29	410.40	449.90	47522.24	869.97
79	0.29	0.04	59.38	0.45	402.27	462.10	47072.34	869.88
78	0.40	0.05	81.54	0.62	393.34	475.49	46610.25	869.80
77	0.69	0.07	138.81	0.81	370.35	509.97	46134.75	869.72
76	1.03	0.09	207.72	1.06	342.69	551.46	45624.78	869.63
75	1.25	0.11	252.40	1.29	324.72	578.41	45073.31	869.55
74	1.42	0.13	287.29	1.52	310.68	599.48	44494.90	869.47
73	1.57	0.14	317.77	1.73	298.40	617.90	43895.42	869.38
72	1.71	0.16	344.84	1.95	287.48	634.28	43277.51	869.30
71	1.83	0.18	369.36	2.18	277.59	649.12	42643.23	869.22
70	1.94	0.20	391.43	2.41	268.67	662.50	41994.11	869.13
69	2.04	0.22	412.25	2.62	260.25	675.12	41331.61	869.05
68	2.13	0.23	431.21	2.82	252.59	686.62	40656.49	868.97
67	2.22	0.25	449.29	3.01	245.28	697.58	39969.87	868.88
66	2.31	0.27	465.97	3.19	238.54	707.70	39272.30	868.80
65	2.38	0.28	481.72	3.36	232.17	717.25	38564.60	868.72
64	2.46	0.29	496.74	3.53	226.09	726.36	37847.35	868.63
63	2.53	0.31	510.69	3.69	220.45	734.83	37120.99	868.55
62	2.59	0.32	523.94	3.85	215.08	742.87	36386.16	868.47
61	2.66	0.33	536.52	4.01	209.99	750.52	35643.29	868.38
60	2.72	0.35	548.45	4.16	205.15	757.77	34892.76	868.30
59	2.77	0.36	559.80	4.32	200.55	764.67	34135.00	868.22
58	2.82	0.37	570.58	4.47	196.18	771.23	33370.32	868.13
57	2.88	0.38	580.84	4.61	192.02	777.47	32599.09	868.05
56	2.92	0.40	590.68	4.75	188.03	783.46	31821.62	867.97
55	2.97	0.41	599.92	4.89	184.28	789.09	31038.17	867.88
54	3.01	0.42	608.51	5.02	180.78	794.32	30249.08	867.80
53	3.05	0.43	616.76	5.16	177.43	799.35	29454.76	867.72
52	3.09	0.44	625.04	5.28	174.07	804.40	28655.41	867.63
51	3.13	0.45	632.37	5.41	171.09	808.87	27851.01	867.55
50	3.17	0.46	639.46	5.53	168.20	813.20	27042.14	867.47
49	3.20	0.47	646.29	5.65	165.43	817.36	26228.95	867.38

48	3.23	0.48	652.69	5.76	162.82	821.27	25411.58	867.30
47	3.26	0.49	658.80	5.87	160.33	825.00	24590.32	867.22
46	3.29	0.50	664.63	5.98	157.96	828.56	23765.31	867.13
45	3.32	0.51	670.23	6.08	155.68	831.98	22936.75	867.05
44	3.34	0.51	675.51	6.17	153.53	835.21	22104.76	866.97
43	3.37	0.52	680.46	6.27	151.51	838.24	21269.55	866.88
42	3.39	0.53	685.29	6.35	149.54	841.18	20431.31	866.80
41	3.41	0.54	689.74	6.44	147.73	843.91	19590.13	866.72
40	3.44	0.54	694.28	6.52	145.88	846.68	18746.22	866.63
39	3.46	0.55	698.46	6.59	144.18	849.23	17899.55	866.55
38	3.48	0.56	702.70	6.66	142.46	851.82	17050.32	866.47
37	3.51	0.59	708.03	7.14	140.13	855.30	16198.50	866.38
36	0.00	0.00	0.00	0.00	426.20	426.20	15343.20	866.30
35	0.00	0.00	0.00	0.00	426.20	426.20	14917.00	866.22
34	0.00	0.00	0.00	0.00	426.20	426.20	14490.80	866.13
33	0.00	0.00	0.00	0.00	426.20	426.20	14064.60	866.05
32	0.00	0.00	0.00	0.00	426.20	426.20	13638.40	865.97
31	0.00	0.00	0.00	0.00	426.20	426.20	13212.20	865.88
30	0.00	0.00	0.00	0.00	426.20	426.20	12786.00	865.80
29	0.00	0.00	0.00	0.00	426.20	426.20	12359.80	865.72
28	0.00	0.00	0.00	0.00	426.20	426.20	11933.60	865.63

DA 1 DMA B – STORMTECH CHAMBERS & MODULAR WETLANDS SYSTEM (STC-B & MWS-B)

Region		Valley	
Drainage Area (acres)		22.10	acres
Drainage Area (sq-ft)		**962,676**	sq-ft
Impervious Coeff	i =	0.95	< 1.0
Runoff Coeff	**C =**	**0.807**	
1-hr 2-yr from NOAA		0.491	
P6 Coeff		**1.4807**	
Mean 6-hr (P6)		**0.727**	
Drawdown Rate (a)		1.963	
DCV		**92,391**	cu-ft
DCV		**2.121**	acre-ft

WetlandMOD VOLUME BASED SIZING SHEET

Project Location

Project Name	Agua Mansa Road (DA 1 DMA B)
City/Town	Colton
State	California
Zip Code	92324

Horizontal Flow Biofiltration System

SIZING CALCULATIONS	Inputs	Units	Notes/References
Impervious Area			
BMP Drainage Area (not required - manual entry - not part of formula)	22.1	Acres	This includes all areas that will contribute runoff to the proposed BMP, including pervious areas, impervious areas, and off-site areas, whether or not they are directly or indirectly connected to the BMP.
Watershed Impervious Ratio (not required - manual entry - not part of formula)			Watershed Imperviousness Ratio", is equal to the percent of total impervious area in the "BMP Drainage Area" divided by 100
Runoff Coefficient "C" (not required - manual entry - not part of formula)			
Water Quality Volume (required)	92391	cubic feet	Use sizing procedures provided by state or local agencies to determine the appropriate Water Quality Volume. Intensities and design storms vary widely by region and method.
Design Storm Duration	3	hours	Varies depending on geographical region. Set at 0 for pump system set up. LA County 3 hours. Call for details.
MWS - Linear Sizing			
MWS - Linear Model Number (from matrix)	MWS-L-8-20	quantity	Please choose size from "Model Size Matrix" Tab
# Of Units	4	quantity	Select the number of systems required to treat the water quality volume. Will very depending on drain down time regulaitons.
Discharge Rate (from matrix)	65.42	gallons/minute	Rate of 0.26 gpm/sq ft or 25 in/hr. Field Verified.
Volume Treated During Event			
Processed through MWS - Linear	6279.9	cubic feet	261.66 gals/minute
Volume Treated Following Event			
MWS - Linear Static Capacity (from matrix)	348	cubic feet	
Volume Needed in *Pre-Storage*	85763	cubic feet	Set at zero to start. Size pre-storage system to hold this volume
			Sizing complete when eqaul to value of zero.
TOTAL STORMWATER TREATED	92391	cubic feet	Note: This amount should be equal to the "Water Quality Volume"
Drain Down Time	41.14	hours	Drain down time must be equal to or less than requirement of local juristiction. Default 48 hours.

Feel free to fax or email proposed sizing calculations to Modular Wetlands Systems, Inc. for assistance with sizing, compliance, and design.

Phone: 760.433.7640

Fax: 760.433.3176

Email: Info@modularwetlands.com

Project: **Agua Mansa Rd DA 1 DMA B**

Chamber Model -	MC-3500	
Units -	**Imperial**	Click Here for Metric
Number of Chambers -	324	
Number of End Caps -	18	
Voids in the stone (porosity) -	40	%
Base of Stone Elevation -	869.00	ft
Amount of Stone Above Chambers -	12	in
Amount of Stone Below Chambers -	36	in
Amount of Stone Between Chambers -	9	in
Area of system -	21064	sf Min. Area - 16976 sf min. area

☑ Include Perimeter Stone in Calculations

StormTech MC-3500 Cumulative Storage Volumes

Height of System (inches)	Incremental Single Chamber (cubic feet)	Incremental Single End Cap (cubic feet)	Incremental Chambers (cubic feet)	Incremental End Cap (cubic feet)	Incremental Stone (cubic feet)	Incremental Ch, EC and Stone (cubic feet)	Cumulative System (cubic feet)	Elevation (feet)
93	0.00	0.00	0.00	0.00	702.13	702.13	86833.66	876.75
92	0.00	0.00	0.00	0.00	702.13	702.13	86131.52	876.67
91	0.00	0.00	0.00	0.00	702.13	702.13	85429.39	876.58
90	0.00	0.00	0.00	0.00	702.13	702.13	84727.26	876.50
89	0.00	0.00	0.00	0.00	702.13	702.13	84025.12	876.42
88	0.00	0.00	0.00	0.00	702.13	702.13	83322.99	876.33
87	0.00	0.00	0.00	0.00	702.13	702.13	82620.86	876.25
86	0.00	0.00	0.00	0.00	702.13	702.13	81918.72	876.17
85	0.00	0.00	0.00	0.00	702.13	702.13	81216.59	876.08
84	0.00	0.00	0.00	0.00	702.13	702.13	80514.46	876.00
83	0.00	0.00	0.00	0.00	702.13	702.13	79812.32	875.92
82	0.00	0.00	0.00	0.00	702.13	702.13	79110.19	875.83
81	0.06	0.00	18.82	0.00	694.61	713.43	78408.06	875.75
80	0.19	0.02	62.89	0.43	676.81	740.12	77694.63	875.67
79	0.29	0.04	95.24	0.68	663.77	759.69	76954.51	875.58
78	0.40	0.05	130.78	0.93	649.45	781.16	76194.82	875.50
77	0.69	0.07	222.65	1.22	612.59	836.45	75413.66	875.42
76	1.03	0.09	333.17	1.59	568.23	902.99	74577.21	875.33
75	1.25	0.11	404.85	1.93	539.42	946.20	73674.22	875.25
74	1.42	0.13	460.80	2.27	516.90	979.98	72728.03	875.17
73	1.57	0.14	509.70	2.60	497.22	1009.51	71748.05	875.08
72	1.71	0.16	553.12	2.93	479.71	1035.76	70738.54	875.00
71	1.83	0.18	592.43	3.27	463.85	1059.56	69702.77	874.92
70	1.94	0.20	627.84	3.61	449.55	1081.00	68643.22	874.83
69	2.04	0.22	661.23	3.93	436.07	1101.23	67562.22	874.75
68	2.13	0.23	691.64	4.23	423.79	1119.65	66460.99	874.67
67	2.22	0.25	720.65	4.51	412.07	1137.23	65341.34	874.58
66	2.31	0.27	747.40	4.78	401.26	1153.44	64204.11	874.50
65	2.38	0.28	772.67	5.04	391.05	1168.76	63050.67	874.42
64	2.46	0.29	796.75	5.29	381.32	1183.36	61881.91	874.33
63	2.53	0.31	819.13	5.54	372.27	1196.93	60698.55	874.25
62	2.59	0.32	840.37	5.78	363.67	1209.83	59501.62	874.17
61	2.66	0.33	860.56	6.02	355.50	1222.08	58291.79	874.08
60	2.72	0.35	879.69	6.25	347.76	1233.70	57069.71	874.00
59	2.77	0.36	897.90	6.48	340.38	1244.76	55836.01	873.92
58	2.82	0.37	915.19	6.70	333.38	1255.27	54591.25	873.83
57	2.88	0.38	931.65	6.92	326.71	1265.27	53335.99	873.75
56	2.92	0.40	947.42	7.13	320.31	1274.86	52070.71	873.67
55	2.97	0.41	962.24	7.34	314.30	1283.88	50795.85	873.58
54	3.01	0.42	976.03	7.54	308.71	1292.28	49511.97	873.50
53	3.05	0.43	989.26	7.73	303.34	1300.33	48219.69	873.42
52	3.09	0.44	1002.54	7.93	297.94	1308.42	46919.37	873.33
51	3.13	0.45	1014.30	8.11	293.17	1315.58	45610.95	873.25
50	3.17	0.46	1025.67	8.30	288.55	1322.52	44295.37	873.17
49	3.20	0.47	1036.62	8.47	284.10	1329.19	42972.85	873.08

48	3.23	0.48	1046.88	8.64	279.92	1335.45	41643.66	873.00
47	3.26	0.49	1056.70	8.81	275.93	1341.43	40308.22	872.92
46	3.29	0.50	1066.04	8.96	272.13	1347.14	38966.78	872.83
45	3.32	0.51	1075.02	9.12	268.48	1352.61	37619.64	872.75
44	3.34	0.51	1083.50	9.26	265.03	1357.79	36267.03	872.67
43	3.37	0.52	1091.43	9.40	261.80	1362.63	34909.24	872.58
42	3.39	0.53	1099.17	9.53	258.65	1367.36	33546.61	872.50
41	3.41	0.54	1106.31	9.66	255.75	1371.71	32179.25	872.42
40	3.44	0.54	1113.59	9.78	252.78	1376.16	30807.54	872.33
39	3.46	0.55	1120.30	9.89	250.06	1380.25	29431.38	872.25
38	3.48	0.56	1127.10	9.99	247.30	1384.39	28051.14	872.17
37	3.51	0.59	1135.65	10.71	243.59	1389.95	26666.75	872.08
36	0.00	0.00	0.00	0.00	702.13	702.13	25276.80	872.00
35	0.00	0.00	0.00	0.00	702.13	702.13	24574.67	871.92
34	0.00	0.00	0.00	0.00	702.13	702.13	23872.53	871.83
33	0.00	0.00	0.00	0.00	702.13	702.13	23170.40	871.75
32	0.00	0.00	0.00	0.00	702.13	702.13	22468.27	871.67
31	0.00	0.00	0.00	0.00	702.13	702.13	21766.13	871.58
30	0.00	0.00	0.00	0.00	702.13	702.13	21064.00	871.50
29	0.00	0.00	0.00	0.00	702.13	702.13	20361.87	871.42
28	0.00	0.00	0.00	0.00	702.13	702.13	19659.73	871.33

DA 1 DMA C – STORMTECH CHAMBERS & MODULAR WETLANDS SYSTEM (STC-C & MWS-C)

Region		Valley	
Drainage Area (acres)		23.35	acres
Drainage Area (sq-ft)		1,017,126	sq-ft
Impervious Coeff	i =	0.95	< 1.0
Runoff Coeff	**C =**	0.807	
1-hr 2-yr from NOAA		0.491	
P6 Coeff		1.4807	
Mean 6-hr (P6)		0.727	
Drawdown Rate (a)		1.963	
DCV		97,617	cu-ft
DCV		2.241	acre-ft

WetlandMOD VOLUME BASED SIZING SHEET

Project Location

Project Name	Agua Mansa Road (DA 1 DMA C)
City/Town	Colton
State	California
Zip Code	92324

Horizontal Flow Biofiltration System

SIZING CALCULATIONS	Inputs	Units	Notes/References
Impervious Area			
BMP Drainage Area (not required - manual entry - not part of formula)	23.35	Acres	This includes all areas that will contribute runoff to the proposed BMP, including pervious areas, impervious areas, and off-site areas, whether or not they are directly or indirectly connected to the BMP.
Watershed Impervious Ratio (not required - manual entry - not part of formula)			Watershed Imperviousness Ratio", is equal to the percent of total impervious area in the "BMP Drainage Area" divided by 100
Runoff Coefficient "C" (not required - manual entry - not part of formula)			
Water Quality Volume (required)	97617	cubic feet	Use sizing procedures provided by state or local agencies to determine the appropriate Water Quality Volume. Intensities and design storms vary widely by region and method.
Design Storm Duration	3	hours	Varies depending on geographical region. Set at 0 for pump system set up. LA County 3 hours. Call for details.
MWS - Linear Sizing			
MWS - Linear Model Number (from matrix)	MWS-L-8-20	quantity	Please choose size from "Model Size Matrix" Tab
# Of Units	4	quantity	Select the number of systems required to treat the water quality volume. Will very depending on drain down time regulaitons.
Discharge Rate (from matrix)	65.42	gallons/minute	Rate of 0.26 gpm/sq ft or 25 in/hr. Field Verified.
Volume Treated During Event			
Processed through MWS - Linear	6279.9	cubic feet	261.66 gals/minute
Volume Treated Following Event			
MWS - Linear Static Capacity (from matrix)	348	cubic feet	
Volume Needed in *Pre-Storage*	90989	cubic feet	Set at zero to start. Size pre-storage system to hold this volume
			Sizing complete when eqaul to value of zero.
TOTAL STORMWATER TREATED	97617	cubic feet	Note: This amount should be equal to the "Water Quality Volume"
Drain Down Time	43.63	hours	Drain down time must be equal to or less than requirement of local juristiction. Default 48 hours.

Feel free to fax or email proposed sizing calculations to Modular Wetlands Systems, Inc. for assistance with sizing, compliance, and design.

Phone: 760.433.7640
Fax: 760.433.3176
Email: Info@modularwetlands.com

Project: **Agua Mansa Rd DA 1 DMA C**

Chamber Model -	MC-3500	
Units -	**Imperial**	Click Here for Metric
Number of Chambers -	356	
Number of End Caps -	10	
Voids in the stone (porosity) -	40	%
Base of Stone Elevation -	872.40	ft
Amount of Stone Above Chambers -	12	in
Amount of Stone Below Chambers -	36	in
Amount of Stone Between Chambers -	9	in
Area of system -	22116	sf Min. Area - 18471 sf min. area

☑ Include Perimeter Stone in Calculations

StormTech MC-3500 Cumulative Storage Volumes

Height of System (inches)	Incremental Single Chamber (cubic feet)	Incremental Single End Cap (cubic feet)	Incremental Chambers (cubic feet)	Incremental End Cap (cubic feet)	Incremental Stone (cubic feet)	Incremental Ch, EC and Stone (cubic feet)	Cumulative System (cubic feet)	Elevation (feet)
93	0.00	0.00	0.00	0.00	737.20	737.20	92134.05	880.15
92	0.00	0.00	0.00	0.00	737.20	737.20	91396.85	880.07
91	0.00	0.00	0.00	0.00	737.20	737.20	90659.65	879.98
90	0.00	0.00	0.00	0.00	737.20	737.20	89922.45	879.90
89	0.00	0.00	0.00	0.00	737.20	737.20	89185.25	879.82
88	0.00	0.00	0.00	0.00	737.20	737.20	88448.05	879.73
87	0.00	0.00	0.00	0.00	737.20	737.20	87710.85	879.65
86	0.00	0.00	0.00	0.00	737.20	737.20	86973.65	879.57
85	0.00	0.00	0.00	0.00	737.20	737.20	86236.45	879.48
84	0.00	0.00	0.00	0.00	737.20	737.20	85499.25	879.40
83	0.00	0.00	0.00	0.00	737.20	737.20	84762.05	879.32
82	0.00	0.00	0.00	0.00	737.20	737.20	84024.85	879.23
81	0.06	0.00	20.68	0.00	728.93	749.61	83287.65	879.15
80	0.19	0.02	69.10	0.24	709.46	778.80	82538.05	879.07
79	0.29	0.04	104.65	0.38	695.19	800.22	81759.24	878.98
78	0.40	0.05	143.70	0.52	679.51	823.73	80959.03	878.90
77	0.69	0.07	244.64	0.68	639.08	884.39	80135.30	878.82
76	1.03	0.09	366.07	0.88	590.42	957.37	79250.91	878.73
75	1.25	0.11	444.83	1.07	558.84	1004.74	78293.54	878.65
74	1.42	0.13	506.31	1.26	534.17	1041.75	77288.80	878.57
73	1.57	0.14	560.04	1.44	512.61	1074.09	76247.05	878.48
72	1.71	0.16	607.75	1.63	493.45	1102.82	75172.96	878.40
71	1.83	0.18	650.95	1.82	476.10	1128.86	74070.14	878.32
70	1.94	0.20	689.85	2.01	460.46	1152.31	72941.28	878.23
69	2.04	0.22	726.53	2.18	445.71	1174.43	71788.97	878.15
68	2.13	0.23	759.95	2.35	432.28	1194.58	70614.54	878.07
67	2.22	0.25	791.82	2.51	419.47	1213.80	69419.96	877.98
66	2.31	0.27	821.22	2.66	407.65	1231.52	68206.16	877.90
65	2.38	0.28	848.98	2.80	396.49	1248.27	66974.64	877.82
64	2.46	0.29	875.44	2.94	385.85	1264.23	65726.37	877.73
63	2.53	0.31	900.03	3.08	375.96	1279.06	64462.15	877.65
62	2.59	0.32	923.37	3.21	366.57	1293.15	63183.08	877.57
61	2.66	0.33	945.56	3.34	357.64	1306.54	61889.93	877.48
60	2.72	0.35	966.58	3.47	349.18	1319.23	60583.39	877.40
59	2.77	0.36	986.58	3.60	341.13	1331.31	59264.16	877.32
58	2.82	0.37	1005.58	3.72	333.48	1342.78	57932.85	877.23
57	2.88	0.38	1023.66	3.84	326.20	1353.70	56590.08	877.15
56	2.92	0.40	1040.99	3.96	319.22	1364.17	55236.37	877.07
55	2.97	0.41	1057.28	4.08	312.66	1374.01	53872.20	876.98
54	3.01	0.42	1072.43	4.19	306.55	1383.17	52498.19	876.90
53	3.05	0.43	1086.96	4.30	300.70	1391.95	51115.01	876.82
52	3.09	0.44	1101.56	4.40	294.81	1400.78	49723.06	876.73
51	3.13	0.45	1114.48	4.51	289.61	1408.59	48322.28	876.65
50	3.17	0.46	1126.98	4.61	284.57	1416.15	46913.69	876.57
49	3.20	0.47	1139.01	4.71	279.72	1423.43	45497.54	876.48

48	3.23	0.48	1150.28	4.80	275.17	1430.25	44074.11	876.40
47	3.26	0.49	1161.06	4.89	270.82	1436.77	42643.87	876.32
46	3.29	0.50	1171.33	4.98	266.68	1442.99	41207.09	876.23
45	3.32	0.51	1181.20	5.06	262.70	1448.96	39764.11	876.15
44	3.34	0.51	1190.51	5.14	258.94	1454.59	38315.15	876.07
43	3.37	0.52	1199.23	5.22	255.42	1459.87	36860.56	875.98
42	3.39	0.53	1207.73	5.30	251.99	1465.02	35400.69	875.90
41	3.41	0.54	1215.58	5.37	248.82	1469.77	33935.67	875.82
40	3.44	0.54	1223.58	5.43	245.60	1474.61	32465.91	875.73
39	3.46	0.55	1230.95	5.49	242.62	1479.06	30991.30	875.65
38	3.48	0.56	1238.42	5.55	239.61	1483.58	29512.24	875.57
37	3.51	0.59	1247.81	5.95	235.70	1489.46	28028.66	875.48
36	0.00	0.00	0.00	0.00	737.20	737.20	26539.20	875.40
35	0.00	0.00	0.00	0.00	737.20	737.20	25802.00	875.32
34	0.00	0.00	0.00	0.00	737.20	737.20	25064.80	875.23
33	0.00	0.00	0.00	0.00	737.20	737.20	24327.60	875.15
32	0.00	0.00	0.00	0.00	737.20	737.20	23590.40	875.07
31	0.00	0.00	0.00	0.00	737.20	737.20	22853.20	874.98
30	0.00	0.00	0.00	0.00	737.20	737.20	22116.00	874.90
29	0.00	0.00	0.00	0.00	737.20	737.20	21378.80	874.82
28	0.00	0.00	0.00	0.00	737.20	737.20	20641.60	874.73
27	0.00	0.00	0.00	0.00	737.20	737.20	19904.40	874.65
26	0.00	0.00	0.00	0.00	737.20	737.20	19167.20	874.57
25	0.00	0.00	0.00	0.00	737.20	737.20	18430.00	874.48
24	0.00	0.00	0.00	0.00	737.20	737.20	17692.80	874.40
23	0.00	0.00	0.00	0.00	737.20	737.20	16955.60	874.32
22	0.00	0.00	0.00	0.00	737.20	737.20	16218.40	874.23
21	0.00	0.00	0.00	0.00	737.20	737.20	15481.20	874.15
20	0.00	0.00	0.00	0.00	737.20	737.20	14744.00	874.07
19	0.00	0.00	0.00	0.00	737.20	737.20	14006.80	873.98
18	0.00	0.00	0.00	0.00	737.20	737.20	13269.60	873.90
17	0.00	0.00	0.00	0.00	737.20	737.20	12532.40	873.82
16	0.00	0.00	0.00	0.00	737.20	737.20	11795.20	873.73
15	0.00	0.00	0.00	0.00	737.20	737.20	11058.00	873.65
14	0.00	0.00	0.00	0.00	737.20	737.20	10320.80	873.57
13	0.00	0.00	0.00	0.00	737.20	737.20	9583.60	873.48
12	0.00	0.00	0.00	0.00	737.20	737.20	8846.40	873.40
11	0.00	0.00	0.00	0.00	737.20	737.20	8109.20	873.32
10	0.00	0.00	0.00	0.00	737.20	737.20	7372.00	873.23
9	0.00	0.00	0.00	0.00	737.20	737.20	6634.80	873.15
8	0.00	0.00	0.00	0.00	737.20	737.20	5897.60	873.07
7	0.00	0.00	0.00	0.00	737.20	737.20	5160.40	872.98
6	0.00	0.00	0.00	0.00	737.20	737.20	4423.20	872.90
5	0.00	0.00	0.00	0.00	737.20	737.20	3686.00	872.82
4	0.00	0.00	0.00	0.00	737.20	737.20	2948.80	872.73
3	0.00	0.00	0.00	0.00	737.20	737.20	2211.60	872.65
2	0.00	0.00	0.00	0.00	737.20	737.20	1474.40	872.57
1	0.00	0.00	0.00	0.00	737.20	737.20	737.20	872.48

DA 2 STREET – STORMTECH CHAMBERS & MODULAR WETLANDS SYSTEM (STC-D & MWS-D)

Region		Valley	
Drainage Area (acres)		5.00	acres
Drainage Area (sq-ft)		**217,800**	sq-ft
Impervious Coeff	i =	0.95	< 1.0
Runoff Coeff	**C =**	**0.807**	
1-hr 2-yr from NOAA		0.491	
P6 Coeff		**1.4807**	
Mean 6-hr (P6)		**0.727**	
Drawdown Rate (a)		1.963	
DCV		**20,903**	cu-ft
DCV		**0.480**	acre-ft

WetlandMOD VOLUME BASED SIZING SHEET

Horizontal Flow Biofiltration System

Project Location

Project Name	Agua Mansa Road (DA 2 Street)
City/Town	Colton
State	California
Zip Code	92324

SIZING CALCULATIONS	**Inputs**	**Units**	**Notes/References**
Impervious Area			
BMP Drainage Area (not required - manual entry - not part of formula)	5	**Acres**	This includes all areas that will contribute runoff to the proposed BMP, including pervious areas, impervious areas, and off-site areas, whether or not they are directly or indirectly connected to the BMP.
Watershed Impervious Ratio (not required - manual entry - not part of formula)			Watershed Imperviousness Ratio", is equal to the percent of total impervious area in the "BMP Drainage Area" divided by 100
Runoff Coefficient "C" (not required - manual entry - not part of formula)			
Water Quality Volume (required)	20903	cubic feet	Use sizing procedures provided by state or local agencies to determine the appropriate Water Quality Volume. Intensities and design storms vary widely by region and method.
Design Storm Duration	3	hours	Varies depending on geographical region. Set at 0 for pump system set up. LA County 3 hours. Call for details.
MWS - Linear Sizing			
MWS - Linear Model Number (from matrix)	MWS-L-8-16	quantity	Please choose size from "Model Size Matrix" Tab
# Of Units	1	quantity	Select the number of systems required to treat the water quality volume. Will very depending on drain down time regulaitons.
Discharge Rate (from matrix)	52.33	gallons/minute	Rate of 0.26 gpm/sq ft or 25 in/hr. Field Verified.
Volume Treated During Event			
Processed through MWS - Linear	1256.0	cubic feet	**52.33 gals/minute**
Volume Treated Following Event			
MWS - Linear Static Capacity (from matrix)	268	cubic feet	
Volume Needed in *Pre-Storage*	19379	cubic feet	Set at zero to start. Size pre-storage system to hold this volume
			Sizing complete when eqaul to value of zero.
TOTAL STORMWATER TREATED	**20903**	cubic feet	Note: This amount should be equal to the "Water Quality Volume"
Drain Down Time	**46.93**	hours	Drain down time must be equal to or less than requirement of local juristiction. Default 48 hours.

Feel free to fax or email proposed sizing calculations to Modular Wetlands Systems, Inc. for assistance with sizing, compliance, and design.

Phone: 760.433.7640
Fax: 760.433.3176
Email: Info@modularwetlands.com

Project: **Agua Mansa Rd DA 2 DMA STREET**

Chamber Model -	MC-3500	
Units -	**Imperial**	Click Here for Metric
Number of Chambers -	72	
Number of End Caps -	14	
Voids in the stone (porosity) -	40	%
Base of Stone Elevation -	862.40	ft
Amount of Stone Above Chambers -	12	in
Amount of Stone Below Chambers -	36	in
Amount of Stone Between Chambers -	9	in
Area of system -	4824	sf Min. Area - 3959 sf min. area

☑ Include Perimeter Stone in Calculations

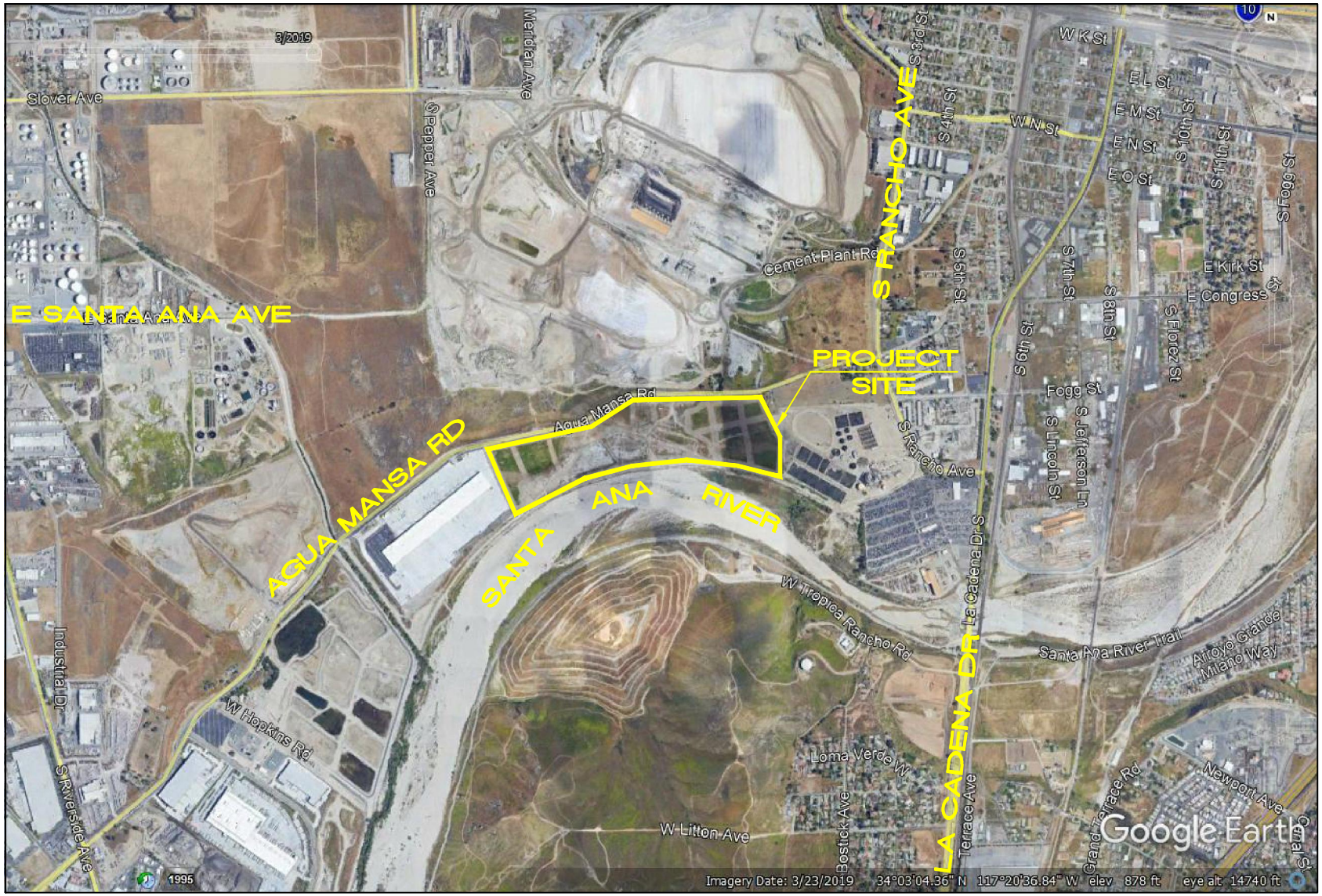
StormTech MC-3500 Cumulative Storage Volumes

Height of System (inches)	Incremental Single Chamber (cubic feet)	Incremental Single End Cap (cubic feet)	Incremental Chambers (cubic feet)	Incremental End Cap (cubic feet)	Incremental Stone (cubic feet)	Incremental Ch, EC and Stone (cubic feet)	Cumulative System (cubic feet)	Elevation (feet)
93	0.00	0.00	0.00	0.00	160.80	160.80	19829.75	870.15
92	0.00	0.00	0.00	0.00	160.80	160.80	19668.95	870.07
91	0.00	0.00	0.00	0.00	160.80	160.80	19508.15	869.98
90	0.00	0.00	0.00	0.00	160.80	160.80	19347.35	869.90
89	0.00	0.00	0.00	0.00	160.80	160.80	19186.55	869.82
88	0.00	0.00	0.00	0.00	160.80	160.80	19025.75	869.73
87	0.00	0.00	0.00	0.00	160.80	160.80	18864.95	869.65
86	0.00	0.00	0.00	0.00	160.80	160.80	18704.15	869.57
85	0.00	0.00	0.00	0.00	160.80	160.80	18543.35	869.48
84	0.00	0.00	0.00	0.00	160.80	160.80	18382.55	869.40
83	0.00	0.00	0.00	0.00	160.80	160.80	18221.75	869.32
82	0.00	0.00	0.00	0.00	160.80	160.80	18060.95	869.23
81	0.06	0.00	4.18	0.00	159.13	163.31	17900.15	869.15
80	0.19	0.02	13.98	0.33	155.08	169.39	17736.84	869.07
79	0.29	0.04	21.17	0.53	152.12	173.81	17567.45	868.98
78	0.40	0.05	29.06	0.72	148.89	178.67	17393.64	868.90
77	0.69	0.07	49.48	0.95	140.63	191.05	17214.97	868.82
76	1.03	0.09	74.04	1.24	130.69	205.96	17023.91	868.73
75	1.25	0.11	89.97	1.50	124.21	215.68	16817.95	868.65
74	1.42	0.13	102.40	1.77	119.13	223.30	16602.27	868.57
73	1.57	0.14	113.27	2.02	114.68	229.97	16378.97	868.48
72	1.71	0.16	122.91	2.28	110.72	235.92	16149.00	868.40
71	1.83	0.18	131.65	2.54	107.12	241.32	15913.08	868.32
70	1.94	0.20	139.52	2.81	103.87	246.20	15671.76	868.23
69	2.04	0.22	146.94	3.06	100.80	250.80	15425.57	868.15
68	2.13	0.23	153.70	3.29	98.01	254.99	15174.77	868.07
67	2.22	0.25	160.14	3.51	95.34	258.99	14919.78	867.98
66	2.31	0.27	166.09	3.72	92.88	262.68	14660.79	867.90
65	2.38	0.28	171.70	3.92	90.55	266.17	14398.10	867.82
64	2.46	0.29	177.05	4.12	88.33	269.50	14131.93	867.73
63	2.53	0.31	182.03	4.31	86.26	272.60	13862.43	867.65
62	2.59	0.32	186.75	4.50	84.30	275.55	13589.82	867.57
61	2.66	0.33	191.24	4.68	82.43	278.35	13314.28	867.48
60	2.72	0.35	195.49	4.86	80.66	281.01	13035.93	867.40
59	2.77	0.36	199.53	5.04	78.97	283.54	12754.92	867.32
58	2.82	0.37	203.37	5.21	77.37	285.95	12471.37	867.23
57	2.88	0.38	207.03	5.38	75.83	288.25	12185.42	867.15
56	2.92	0.40	210.54	5.54	74.37	290.45	11897.17	867.07
55	2.97	0.41	213.83	5.71	72.98	292.52	11606.72	866.98
54	3.01	0.42	216.90	5.86	71.70	294.45	11314.20	866.90
53	3.05	0.43	219.83	6.02	70.46	296.31	11019.75	866.82
52	3.09	0.44	222.79	6.17	69.22	298.17	10723.44	866.73
51	3.13	0.45	225.40	6.31	68.12	299.83	10425.26	866.65
50	3.17	0.46	227.93	6.45	67.05	301.43	10125.44	866.57
49	3.20	0.47	230.36	6.59	66.02	302.97	9824.01	866.48

48	3.23	0.48	232.64	6.72	65.06	304.42	9521.04	866.40
47	3.26	0.49	234.82	6.85	64.13	305.80	9216.62	866.32
46	3.29	0.50	236.90	6.97	63.25	307.12	8910.82	866.23
45	3.32	0.51	238.89	7.09	62.41	308.39	8603.70	866.15
44	3.34	0.51	240.78	7.20	61.61	309.59	8295.31	866.07
43	3.37	0.52	242.54	7.31	60.86	310.71	7985.72	865.98
42	3.39	0.53	244.26	7.41	60.13	311.80	7675.01	865.90
41	3.41	0.54	245.85	7.51	59.46	312.82	7363.21	865.82
40	3.44	0.54	247.47	7.60	58.77	313.84	7050.39	865.73
39	3.46	0.55	248.96	7.69	58.14	314.79	6736.55	865.65
38	3.48	0.56	250.47	7.77	57.50	315.74	6421.76	865.57
37	3.51	0.59	252.37	8.33	56.52	317.22	6106.02	865.48
36	0.00	0.00	0.00	0.00	160.80	160.80	5788.80	865.40
35	0.00	0.00	0.00	0.00	160.80	160.80	5628.00	865.32
34	0.00	0.00	0.00	0.00	160.80	160.80	5467.20	865.23
33	0.00	0.00	0.00	0.00	160.80	160.80	5306.40	865.15
32	0.00	0.00	0.00	0.00	160.80	160.80	5145.60	865.07
31	0.00	0.00	0.00	0.00	160.80	160.80	4984.80	864.98
30	0.00	0.00	0.00	0.00	160.80	160.80	4824.00	864.90
29	0.00	0.00	0.00	0.00	160.80	160.80	4663.20	864.82
28	0.00	0.00	0.00	0.00	160.80	160.80	4502.40	864.73

Section 6.1

Attachment C
WQMP Site Map



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Thienes Engineering, Inc.
CIVIL ENGINEERING • LAND SURVEYING
14349 FIRESTONE BOULEVARD
LA MIRADA, CALIFORNIA 90638
PH.(714)521-4811 FAX(714)521-4173

VICINITY MAP

FOR

AGUA MANSA ROAD, COLTON

LEGEND

1. ABOVEGROUND TRUCK DOCK
2. LANDSCAPE & EFFICIENT IRRIGATION
3. CATCH BASIN STORM DRAIN STENCIL "NO DUMPING–DRAINS TO RIVER"
4. MC–3500 STORMTECH CHAMBERS
5. TRASH STORAGE AREAS
6. BIO CLEAN – MODULAR WETLANDS SYSTEM (MWS)
7. SUMP PUMP
8. DISCHARGE PIPE
9. HYDRODYNAMIC SEPARATOR

NOTES

RD ROOF DRAIN

BOUNDARY

DRAINAGE AREAS

FLOW LINE

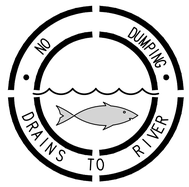
SD FLOW LINE

DA 1 DMA A

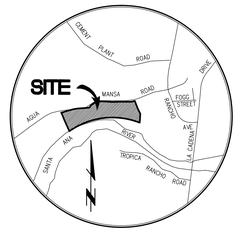
DA 1 DMA B

DA 1 DMA C

DA 2 STREET

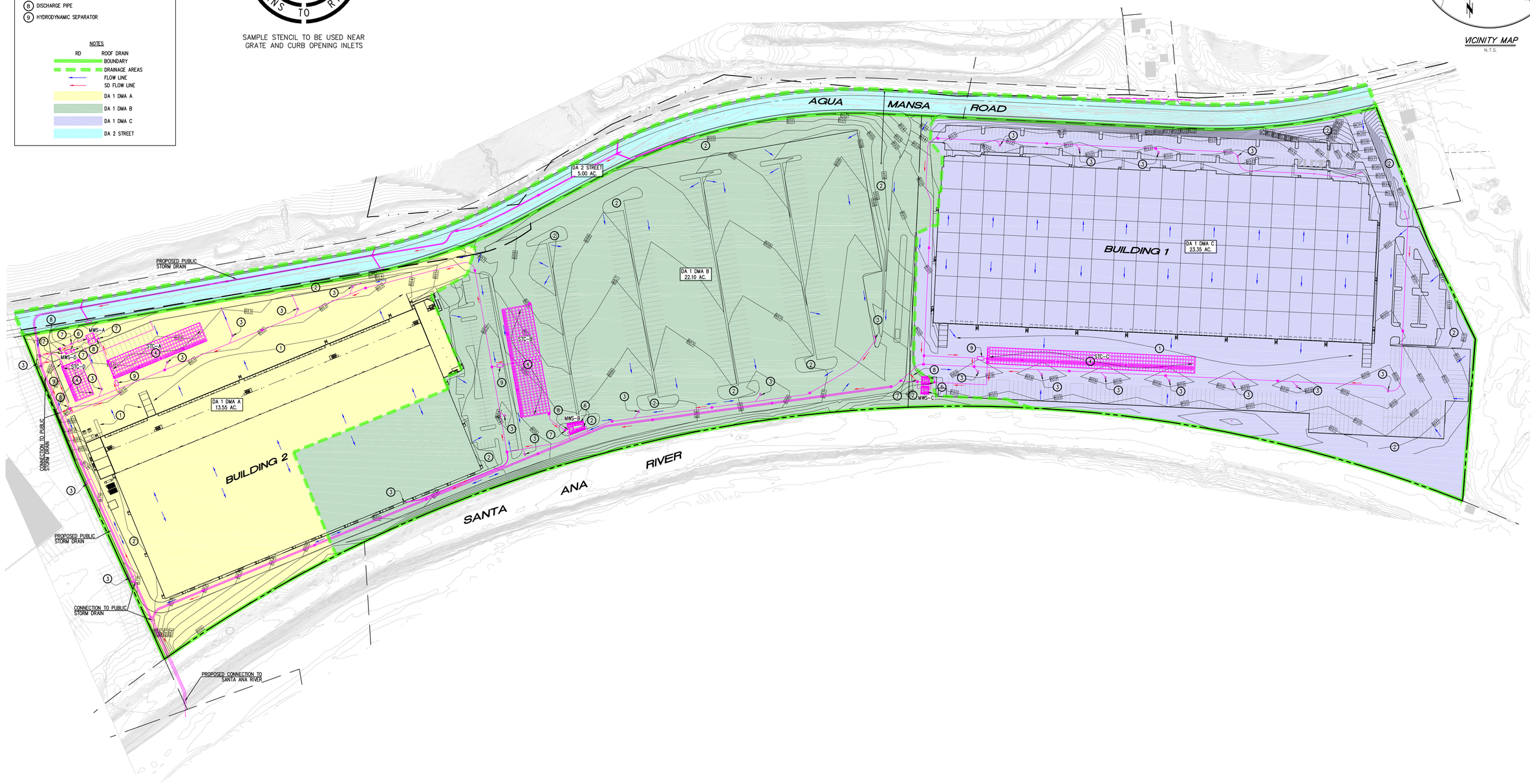


SAMPLE STENCIL TO BE USED NEAR GRATE AND CURB OPENING INLETS



VICINITY MAP

N.T.S.



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SCALE: 1"=100'

Last Update: 9/14/20
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CITY OF COLTON
PUBLIC WORKS DEPARTMENT

WQMP SITE MAP

AQUA MANSA COMMERCE CENTER

AQUA MANSA RD
COLTON, CA

3813/ 1 of 3 SHEET

PREPARED FOR:

IDI AGUA MANSA, LLC
840 APOLLO STREET SUITE 343
EL SEGUNDO CA 90245
PHONE: 213–330–8066

PREPARED BY:

Thienes Engineering, Inc.
CIVIL ENGINEERING • LAND SURVEYING
14349 FIRESTONE BOULEVARD
LA MIRADA, CALIFORNIA 90638
PH:(714)521–4811 FAX(714)521–4173

DESIGN BY: _____ DATE: _____
CHEKED BY: _____ DATE: _____

Approved by: _____ Date: _____

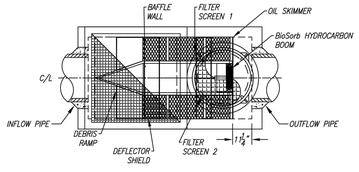
Public Works Director R.C.E. _____

Sheet 1 of 3 Sheets

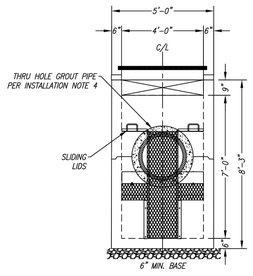
SITE SPECIFIC DATA			
PROJECT NUMBER			
PROJECT NAME			
PROJECT LOCATION			
STRUCTURE ID			
TREATMENT REQUIRED			
WATER QUALITY FLOW RATE (CFS)			
PEAK FLOW RATE (CFS)			
PEAK STORM DURATION (YEARS)			
PIPE & ELEVATION DATA			
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE			24"
OUTLET PIPE			24"
RIM ELEVATION			
LOADING & SOIL DATA			
SURFACE LOADING		PEDESTRIAN	
FRAME & COVER		(1) #30" (1) 4' X 4' HATCH	
CORROSIVE SOIL CONDITIONS		N/K	
GROUNDWATER ELEVATION		N/K	
NOTES: PRELIMINARY, NOT FOR CONSTRUCTION.			

DSBB PERFORMANCE DATA	
TREATMENT FLOW RATE (CFS)	
SETTLING AREA (SF)	32.0
LOADING RATE (GPM/SF)	////
SCREEN SYSTEM STORAGE CAPACITY (CF)	22.00
SEDIMENT STORAGE CAPACITY (CF)	96.60
80% TSS REMOVAL @ ---- MICRON	

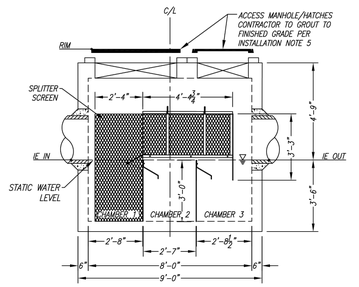
DSBB STORAGE CAPACITIES				
CAGE SCREEN CAPACITY	LENGTH (FT)	WIDTH (FT)	HEIGHT (FT)	TOTAL (CF)
SCREEN 1	4.40	1.25	2.00	11.00
SCREEN 2	4.40	1.25	2.00	11.00
SEDIMENT CHAMBER CAPACITY				
CHAMBER 1	2.67	4.00	3.00	32.04
CHAMBER 2	2.58	4.00	3.00	32.04
CHAMBER 3	2.71	4.00	3.00	32.52



PLAN VIEW



END VIEW



ELEVATION VIEW

GENERAL NOTES

1. BIO CLEAN TO PROVIDE ALL MATERIALS UNLESS OTHERWISE NOTED.
2. ALL DIMENSIONS, ELEVATIONS, SPECIFICATIONS, AND CAPACITIES ARE SUBJECT TO CHANGE. FOR PROJECT SPECIFIC DRAWINGS DETAILING EXACT DIMENSIONS, WEIGHTS, AND ACCESSORIES PLEASE CONTACT BIO CLEAN.
3. LIDS FOR SCREEN SYSTEM & ALTERNATIVE HATCHES AVAILABLE UPON REQUEST.

INSTALLATION NOTES

1. CONTRACTOR TO PROVIDE ALL LABOR, EQUIPMENT, MATERIALS, AND INCIDENTALS REQUIRED TO OFFLOAD AND INSTALL THE DSBB UNIT AND APPURTENANCES IN ACCORDANCE WITH THIS DRAWING AND THE MANUFACTURER'S SPECIFICATIONS, UNLESS OTHERWISE STATED IN MANUFACTURER'S CONTRACT.
2. MANUFACTURER RECOMMENDS A 6"-12" LEVEL ROCK BASE UNLESS SPECIFIED BY THE PROJECT ENGINEER. CONTRACTOR IS RESPONSIBLE TO VERIFY PROJECT ENGINEERS RECOMMENDED BASE SPECIFICATIONS.
3. ALL PIPES MUST BE FLUSH WITH INSIDE SURFACE OF CONCRETE. (PIPES CANNOT INTRUDE BEYOND FLUSH).
4. ALL GAPS AROUND PIPES SHALL BE SEALED WATER TIGHT WITH A NON-SHRINK GROUT PER MANUFACTURERS STANDARD CONNECTION DETAIL AND SHALL MEET OR EXCEED REGIONAL PIPE CONNECTION STANDARDS.
5. CONTRACTOR RESPONSIBLE FOR INSTALLATION OF ALL RISERS, MANHOLES, AND HATCHES. ALL COVERS SHALL BE SHIPPED LOOSE. CONTRACTOR TO GROUT ALL MANHOLES AND HATCHES TO MATCH FINISHED SURFACE UNLESS SPECIFIED OTHERWISE.

X:\CAD\DSBB\DSBB

Bio Clean
A Forterra Company

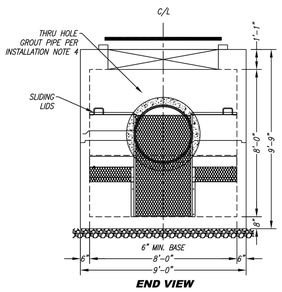
DSBB-4-8-84
DUAL STAGE HYDRODYNAMIC SEPARATOR
STANDARD DETAIL

SITE SPECIFIC DATA			
PROJECT NUMBER			
PROJECT NAME			
PROJECT LOCATION			
STRUCTURE ID			
TREATMENT REQUIRED			
WATER QUALITY FLOW RATE (CFS)			
PEAK FLOW RATE (CFS)			
PEAK STORM DURATION (YEARS)			
PIPE & ELEVATION DATA			
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE			24"
OUTLET PIPE			24"
RIM ELEVATION			
LOADING & SOIL DATA			
SURFACE LOADING		PEDESTRIAN	
FRAME & COVER		(1) #30" (2) 3' X 6' HATCH	
CORROSIVE SOIL CONDITIONS		N/K	
GROUNDWATER ELEVATION		N/K	
NOTES: PRELIMINARY, NOT FOR CONSTRUCTION.			

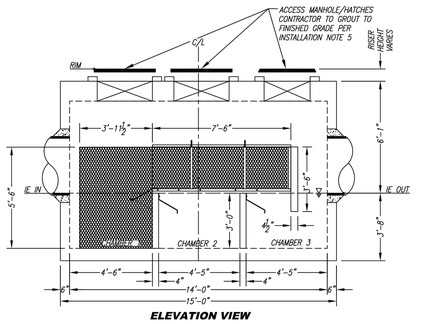
DSBB PERFORMANCE DATA	
TREATMENT FLOW RATE (CFS)	
SETTLING AREA (SF)	96.0
LOADING RATE (GPM/SF)	////
SCREEN SYSTEM STORAGE CAPACITY (CF)	84.38
SEDIMENT STORAGE CAPACITY (CF)	324.00
80% TSS REMOVAL @ ---- MICRON	

DSBB STORAGE CAPACITIES				
CAGE SCREEN CAPACITY	LENGTH (FT)	WIDTH (FT)	HEIGHT (FT)	TOTAL (CF)
SCREEN 1	7.50	2.50	2.25	42.19
SCREEN 2	7.50	2.50	2.25	42.19
SEDIMENT CHAMBER CAPACITY				
CHAMBER 1	4.50	8.00	3.00	108.00
CHAMBER 2	4.42	8.00	3.00	108.00
CHAMBER 3	4.50	8.00	3.00	108.00

PLAN VIEW



END VIEW



ELEVATION VIEW

GENERAL NOTES

1. BIO CLEAN TO PROVIDE ALL MATERIALS UNLESS OTHERWISE NOTED.
2. ALL DIMENSIONS, ELEVATIONS, SPECIFICATIONS, AND CAPACITIES ARE SUBJECT TO CHANGE. FOR PROJECT SPECIFIC DRAWINGS DETAILING EXACT DIMENSIONS, WEIGHTS, AND ACCESSORIES PLEASE CONTACT BIO CLEAN.
3. LIDS FOR SCREEN SYSTEM & ALTERNATIVE HATCHES AVAILABLE UPON REQUEST.

INSTALLATION NOTES

1. CONTRACTOR TO PROVIDE ALL LABOR, EQUIPMENT, MATERIALS, AND INCIDENTALS REQUIRED TO OFFLOAD AND INSTALL THE DSBB UNIT AND APPURTENANCES IN ACCORDANCE WITH THIS DRAWING AND THE MANUFACTURER'S SPECIFICATIONS, UNLESS OTHERWISE STATED IN MANUFACTURER'S CONTRACT.
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3. ALL PIPES MUST BE FLUSH WITH INSIDE SURFACE OF CONCRETE. (PIPES CANNOT INTRUDE BEYOND FLUSH).
4. ALL GAPS AROUND PIPES SHALL BE SEALED WATER TIGHT WITH A NON-SHRINK GROUT PER MANUFACTURERS STANDARD CONNECTION DETAIL AND SHALL MEET OR EXCEED REGIONAL PIPE CONNECTION STANDARDS.
5. CONTRACTOR RESPONSIBLE FOR INSTALLATION OF ALL RISERS, MANHOLES, AND HATCHES. ALL COVERS SHALL BE SHIPPED LOOSE. CONTRACTOR TO GROUT ALL MANHOLES AND HATCHES TO MATCH FINISHED SURFACE UNLESS SPECIFIED OTHERWISE.

X:\CAD\DSBB\DSBB

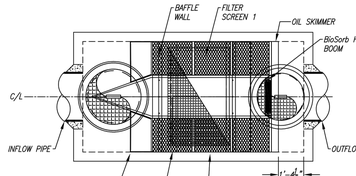
Bio Clean
A Forterra Company

DSBB-8-14-96
DUAL STAGE HYDRODYNAMIC SEPARATOR
STANDARD DETAIL

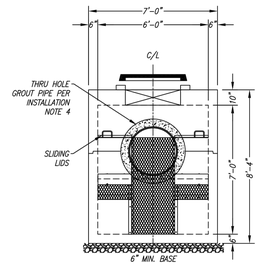
SITE SPECIFIC DATA			
PROJECT NUMBER			
PROJECT NAME			
PROJECT LOCATION			
STRUCTURE ID			
TREATMENT REQUIRED			
WATER QUALITY FLOW RATE (CFS)			
PEAK FLOW RATE (CFS)			
PEAK STORM DURATION (YEARS)			
PIPE & ELEVATION DATA			
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE			18"
OUTLET PIPE			18"
RIM ELEVATION			
LOADING & SOIL DATA			
SURFACE LOADING		PEDESTRIAN	
FRAME & COVER		(1) #36" (1) #30" (1) 3' X 5' HATCH	
CORROSIVE SOIL CONDITIONS		N/K	
GROUNDWATER ELEVATION		N/K	
NOTES: PRELIMINARY, NOT FOR CONSTRUCTION.			

DSBB PERFORMANCE DATA	
TREATMENT FLOW RATE (CFS)	
SETTLING AREA (SF)	72.0
LOADING RATE (GPM/SF)	////
SCREEN SYSTEM STORAGE CAPACITY (CF)	47.29
SEDIMENT STORAGE CAPACITY (CF)	203.94
80% TSS REMOVAL @ ---- MICRON	

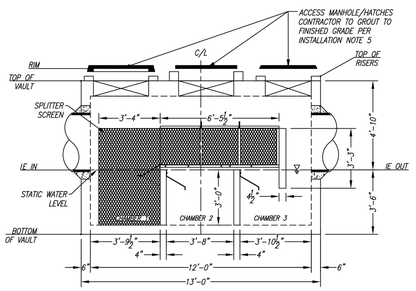
DSBB STORAGE CAPACITIES				
CAGE SCREEN CAPACITY	LENGTH (FT)	WIDTH (FT)	HEIGHT (FT)	TOTAL (CF)
SCREEN 1	6.46	1.83	2.00	23.64
SCREEN 2	6.46	1.83	2.00	23.64
SEDIMENT CHAMBER CAPACITY				
CHAMBER 1	3.79	6.00	3.00	68.22
CHAMBER 2	3.67	6.00	3.00	66.06
CHAMBER 3	3.87	6.00	3.00	69.66



PLAN VIEW



END VIEW



ELEVATION VIEW

GENERAL NOTES

1. BIO CLEAN TO PROVIDE ALL MATERIALS UNLESS OTHERWISE NOTED.
2. ALL DIMENSIONS, ELEVATIONS, SPECIFICATIONS, AND CAPACITIES ARE SUBJECT TO CHANGE. FOR PROJECT SPECIFIC DRAWINGS DETAILING EXACT DIMENSIONS, WEIGHTS, AND ACCESSORIES PLEASE CONTACT BIO CLEAN.
3. LIDS FOR SCREEN SYSTEM & ALTERNATIVE HATCHES AVAILABLE UPON REQUEST.

INSTALLATION NOTES

1. CONTRACTOR TO PROVIDE ALL LABOR, EQUIPMENT, MATERIALS, AND INCIDENTALS REQUIRED TO OFFLOAD AND INSTALL THE DSBB UNIT AND APPURTENANCES IN ACCORDANCE WITH THIS DRAWING AND THE MANUFACTURER'S SPECIFICATIONS, UNLESS OTHERWISE STATED IN MANUFACTURER'S CONTRACT.
2. MANUFACTURER RECOMMENDS A 6"-12" LEVEL ROCK BASE UNLESS SPECIFIED BY THE PROJECT ENGINEER. CONTRACTOR IS RESPONSIBLE TO VERIFY PROJECT ENGINEERS RECOMMENDED BASE SPECIFICATIONS.
3. ALL PIPES MUST BE FLUSH WITH INSIDE SURFACE OF CONCRETE. (PIPES CANNOT INTRUDE BEYOND FLUSH.)
4. ALL GAPS AROUND PIPES SHALL BE SEALED WATERTIGHT WITH A NON-SHRINK GROUT PER MANUFACTURER'S STANDARD CONNECTION DETAIL AND SHALL MEET OR EXCEED REGIONAL PIPE CONNECTION STANDARDS.
5. CONTRACTOR RESPONSIBLE FOR INSTALLATION OF ALL RISERS, MANHOLES, AND HATCHES. ALL COVERS SHALL BE SHIPPED LOOSE. CONTRACTOR TO GROUT ALL MANHOLES AND HATCHES TO MATCH FINISHED SURFACE UNLESS SPECIFIED OTHERWISE.

X:\ALL\DSBB\DSBB

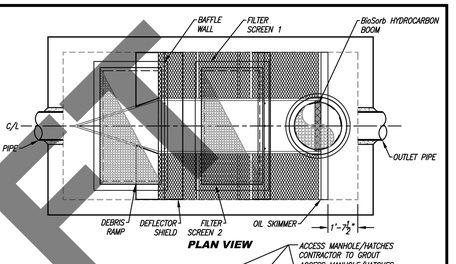
Bio Clean
A Forterra Company

DSBB-6-12-84
DUAL STAGE HYDRODYNAMIC SEPARATOR
STANDARD DETAIL

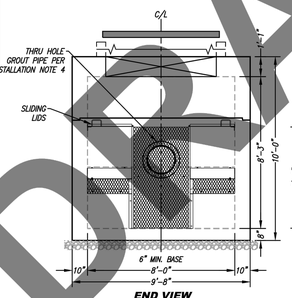
SITE SPECIFIC DATA			
PROJECT NUMBER	10227		
PROJECT NAME	ONTARIO RANCH LOGISTICS CENTER BLDG 2 (3785)		
PROJECT LOCATION	ONTARIO, CA		
STRUCTURE ID	DMA-1		
TREATMENT REQUIRED			
WATER QUALITY FLOW RATE (CFS)	5.50		
FULL CAPTURE TRASH FLOW RATE (CFS)	N/A		
PEAK FLOW RATE (CFS)	OFFLINE		
PEAK STORM DURATION (YEARS)	N/A		
PIPE & ELEVATION DATA			
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE	649.13	HDPE	18"
OUTLET PIPE	649.13	HDPE	18"
RIM ELEVATION	668.98 TO 669.01		
LOADING & SOIL DATA			
SURFACE LOADING		H-20 DIRECT	
FRAME & COVER		(1) #30" (2) 3' X 6' HATCH	
CORROSIVE SOIL CONDITIONS		N/K	
GROUNDWATER ELEVATION		31'+ BELOW GRADE	
NOTES: PRELIMINARY, NOT FOR CONSTRUCTION.			

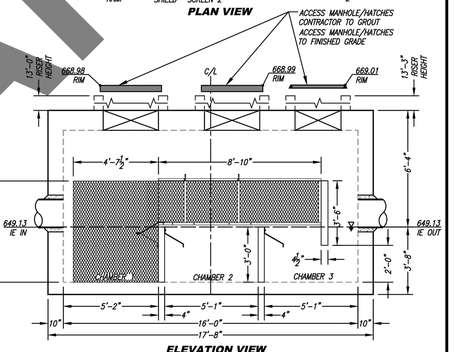
DSBB PERFORMANCE DATA	
TREATMENT FLOW RATE (CFS)	5.67
FULL CAPTURE TRASH FLOW RATE (CFS)	N/A
SETTLING AREA (SF)	128.0
LOADING RATE (GPM/SF)	19.88
SCREEN SYSTEM STORAGE CAPACITY (CF)	99.34
SEDIMENT STORAGE CAPACITY (CF)	370.08
80% TSS REMOVAL @ 75 MICRON	

DSBB STORAGE CAPACITIES				
CAGE SCREEN CAPACITY	LENGTH (FT)	WIDTH (FT)	HEIGHT (FT)	TOTAL (CF)
SCREEN 1	8.83	2.50	2.25	49.67
SCREEN 2	8.83	2.50	2.25	49.67
SEDIMENT CHAMBER CAPACITY				
CHAMBER 1	5.17	8.00	3.00	124.08
CHAMBER 2	5.08	8.00	3.00	124.08
CHAMBER 3	5.08	8.00	3.00	121.92



PLAN VIEW





ELEVATION VIEW

GENERAL NOTES

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3. MANHOLES AND ALTERNATIVE HATCHES AVAILABLE UPON REQUEST.

INSTALLATION NOTES

1. CONTRACTOR TO PROVIDE ALL LABOR, EQUIPMENT, MATERIALS, AND INCIDENTALS REQUIRED TO OFFLOAD AND INSTALL THE DEBRIS SEPARATING BAFFLE BOX UNIT AND APPURTENANCES IN ACCORDANCE WITH THIS DRAWING AND THE MANUFACTURER'S SPECIFICATIONS, UNLESS OTHERWISE STATED IN MANUFACTURER'S CONTRACT.
2. MANUFACTURER RECOMMENDS A 6"-12" LEVEL ROCK BASE UNLESS SPECIFIED BY THE PROJECT ENGINEER. CONTRACTOR IS RESPONSIBLE FOR VERIFYING PROJECT ENGINEER'S RECOMMENDED BASE SPECIFICATIONS.
3. ALL PIPES MUST BE FLUSH WITH INSIDE SURFACE OF CONCRETE. (PIPES CANNOT INTRUDE BEYOND FLUSH.)
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Bio Clean
A Forterra Company

DSBB-8-16-99
DUAL STAGE HYDRODYNAMIC SEPARATOR
STANDARD DETAIL

Last Update: 9/14/20
O:\3800-3899\3813\3813BMPSITEMAP.dwg

CITY OF COLTON
PUBLIC WORKS DEPARTMENT

WQMP SITE MAP

AQUA MANSA COMMERCE CENTER

AQUA MANSA RD
COLTON, CA

PREPARED FOR:
IDI AGUA MANSA, LLC
840 APOLLO STREET SUITE 343
EL SEGUNDO CA 90245
PHONE: 213-330-8066

PREPARED BY:
Thienes Engineering, Inc.
CIVIL ENGINEERING • LAND SURVEYING
14349 FIRESTONE BOULEVARD
LA MIRADA, CALIFORNIA 90638
PH.(714)521-4811 FAX(714)521-4173

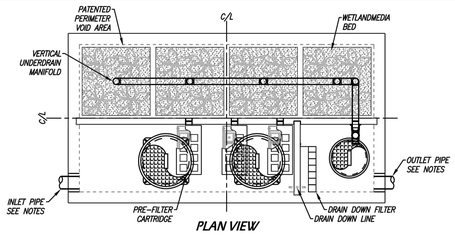
DESIGN BY: _____ DATE: _____
CHEKED BY: _____ DATE: _____

Approved by: _____ Date: _____
Public Works Director R.C.E. _____

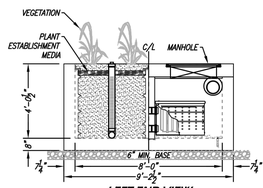
Sheet 2 of 3 Sheets

3813/ 2 of 3 SHEET

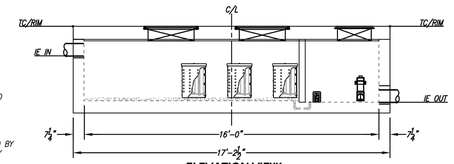
SITE SPECIFIC DATA			
PROJECT NAME			
PROJECT LOCATION			
STRUCTURE ID			
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
TREATMENT HGL AVAILABLE (FT)			
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1			
INLET PIPE 2			
OUTLET PIPE			
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION			
SURFACE LOAD	PARKWAY	OPEN PLANTER	PARKWAY
FRAME & COVER	ø30"	N/A	ø24"
WETLANDMEDIA VOLUME (CY)			7.26
WETLANDMEDIA DELIVERY METHOD			TBD
ORIFICE SIZE (DIA. INCHES)			ø3.07"
MAXIMUM PICK WEIGHT (LBS)			TBD
NOTES:			



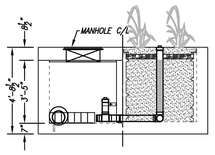
PLAN VIEW



LEFT END VIEW
BIOFILTRATION/PRETREATMENT



ELEVATION VIEW



RIGHT END VIEW
DISCHARGE/BIOFILTRATION

INSTALLATION NOTES

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6. DRIP OR SPRAY IRRIGATION REQUIRED ON ALL UNITS WITH VEGETATION.

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TREATMENT FLOW (CFS)	0.462
OPERATING HEAD (FT)	3.4
PRETREATMENT LOADING RATE (GPM/SF)	TBD
WETLAND MEDIA LOADING RATE (GPM/SF)	1.0

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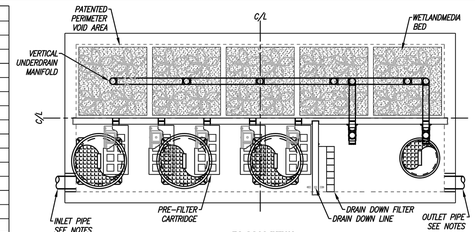
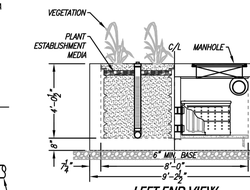
MWS-L-8-16-V
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

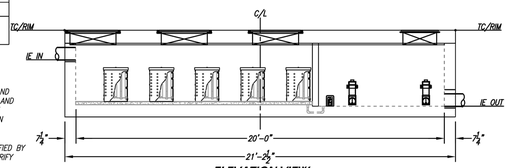
SITE SPECIFIC DATA			
PROJECT NAME			
PROJECT LOCATION			
STRUCTURE ID			
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
TREATMENT HGL AVAILABLE (FT)			
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1			
INLET PIPE 2			
OUTLET PIPE			
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION			
SURFACE LOAD	PARKWAY	OPEN PLANTER	PARKWAY
FRAME & COVER	ø30"	N/A	ø24"
WETLANDMEDIA VOLUME (CY)			11.85
WETLANDMEDIA DELIVERY METHOD			TBD
ORIFICE SIZE (DIA. INCHES)			ø2.43"
MAXIMUM PICK WEIGHT (LBS)			TBD
NOTES:			



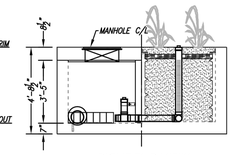
PLAN VIEW



LEFT END VIEW
BIOFILTRATION/PRETREATMENT



ELEVATION VIEW



RIGHT END VIEW
DISCHARGE/BIOFILTRATION

INSTALLATION NOTES

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TREATMENT FLOW (CFS)	0.577
OPERATING HEAD (FT)	3.4
PRETREATMENT LOADING RATE (GPM/SF)	TBD
WETLAND MEDIA LOADING RATE (GPM/SF)	1.0

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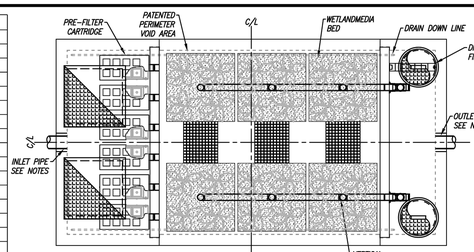
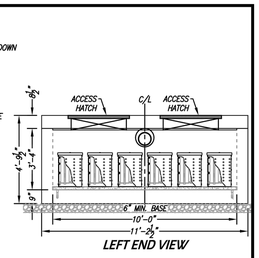
MWS-L-8-20-V
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

A2021/2020

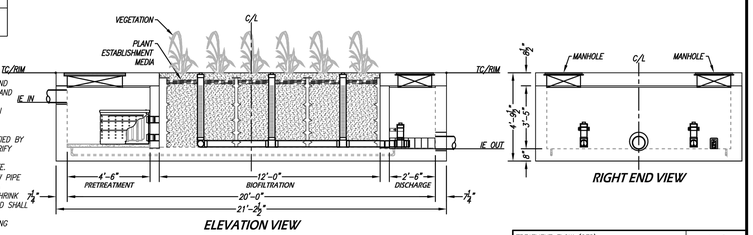
SITE SPECIFIC DATA			
PROJECT NAME			
PROJECT LOCATION			
STRUCTURE ID			
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
TREATMENT HGL AVAILABLE (FT)			
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1			
INLET PIPE 2			
OUTLET PIPE			
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION			
SURFACE LOAD	PARKWAY	OPEN PLANTER	PARKWAY
FRAME & COVER	.36" X .36"	N/A	ø24"
WETLANDMEDIA VOLUME (CY)			14.50
WETLANDMEDIA DELIVERY METHOD			TBD
ORIFICE SIZE (DIA. INCHES)			ø2.67"
MAXIMUM PICK WEIGHT (LBS)			TBD
NOTES:			



PLAN VIEW



LEFT END VIEW



ELEVATION VIEW

RIGHT END VIEW

INSTALLATION NOTES

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TREATMENT FLOW (CFS)	0.693
OPERATING HEAD (FT)	3.4
PRETREATMENT LOADING RATE (GPM/SF)	TBD
WETLAND MEDIA LOADING RATE (GPM/SF)	1.0

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MWS-L-10-20-V
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

A2021/2020

StormTech ADS

STORMTECH MC-3500 CHAMBER

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

STORMTECH MC-3500 CHAMBER
(not to scale)

Nominal Chamber Specifications

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

Chamber Storage
109.9 ft³ (3.11 m³)

Min. Installed Storage*
175.0 ft³ (4.96 m³)

Weight
134 lbs (60.8 kg)

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

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

STORMTECH MC-3500 END CAP
(not to scale)

Nominal End Cap Specifications

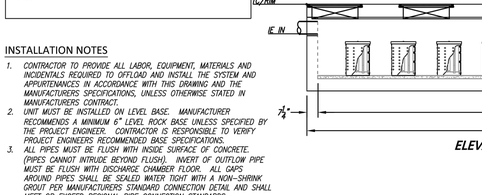
Size (L x W x H)
26.5" x 71" x 45.1"
673 mm x 1,803 mm x 1,145 mm

End Cap Storage
14.9 ft³ (0.42 m³)

Min. Installed Storage*
45.1ft³ (1.28 m³)

Weight
49 lbs (22.2 kg)

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



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

MC-3500 CHAMBER SPECIFICATION

STORAGE VOLUME PER CHAMBER FT³ (M³)

	Bare Chamber Storage ft³ (m³)	Chamber and Stone Foundation Depth in. (mm)			
		9" (230 mm)	12" (300 mm)	15" (375 mm)	18" (450 mm)
MC-3500 Chamber	109.9 (3.11)	175.0 (4.96)	179.9 (5.09)	184.9 (5.24)	189.9 (5.38)
MC-3500 End Cap	14.9 (.42)	45.1 (1.28)	46.6 (1.32)	48.3 (1.37)	49.9 (1.41)

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

AMOUNT OF STONE PER CHAMBER

ENGLISH TONS (yds³)	Stone Foundation Depth			
	9"	12"	15"	18"
MC-3500 Chamber	8.5 (6.5)	9.1 (6.5)	9.7 (6.9)	10.4 (7.4)
MC-3500 End Cap	3.9 (2.8)	4.1 (2.9)	4.3 (3.1)	4.5 (3.2)
METRIC KILOGRAMS (m³)	230 mm	300 mm	375 mm	450 mm
MC-3500 Chamber	7711 (4.6)	8255 (5.0)	8800 (5.3)	9435 (5.7)
MC-3500 End Cap	3538 (2.1)	3719 (2.2)	3901 (2.4)	4082 (2.5)

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

VOLUME EXCAVATION PER CHAMBER YD³ (M³)

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

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

ADS DESIGN TOOL 2.0

Working on a project?
Visit us at www.stormtech.com
and utilize the StormTech Design Tool

For more information on the StormTech MC-3500 Chamber and other ADS products, please contact our Customer Service Representatives at 1-800-821-6710

THE MOST ADVANCED NAME IN WATER MANAGEMENT SOLUTIONS®

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4640 Trueman Blvd., Hilliard, OH 43026
1-800-821-6710 www.ads-pipe.com

Last Update: 9/14/20
O:\3800-3899\3813\3813WPSITEMAP.dwg

CITY OF COLTON
PUBLIC WORKS DEPARTMENT

WQMP SITE MAP

AQUA MANSA COMMERCE CENTER

AQUA MANSA RD
COLTON, CA

PREPARED FOR:
IDI AGUA MANSA, LLC
840 APOLLO STREET SUITE 343
EL SEGUNDO CA 90245
PHONE: 213-330-8066

PREPARED BY:
Thienes Engineering, Inc.
CIVIL ENGINEERING • LAND SURVEYING
14349 FIRESTONE BOULEVARD
LA MIRADA, CALIFORNIA 90638
PH.(714)521-4811 FAX(714)521-4173

DESIGN BY: _____ DATE: _____
CHECKED BY: _____ DATE: _____
Approved by: _____ Date: _____
Public Works Director R.C.E. _____
Sheet 3 of 3 Sheets

3813/ 3 of 3 SHEET

Section 6.2

Electronic Submittal

Section 6.3

Attachment D
WQMP and Stormwater BMP Transfer, Access and Maintenance Agreement

RECORDING REQUESTED BY:
City of Colton
Department of Public Works

AND WHEN RECORDED MAIL TO:
City of Colton
Department of Public Works
160 S. 10th Street
Colton, CA 92324

SPACE ABOVE THIS LINE FOR RECORDER'S USE

COVENANT AND AGREEMENT REGARDING WATER QUALITY MANAGEMENT PLAN AND STORMWATER BEST MANAGEMENT PRACTICES TRANSFER, ACCESS AND MAINTENANCE

THIS PAGE ADDED TO PROVIDE ADEQUATE SPACE FOR RECORDING INFORMATION

Covenant and Agreement Regarding Water Quality Management Plan and Stormwater Best Management Practices Transfer, Access and Maintenance

OWNER NAME: IDI Agua Mansa, LLC

PROPERTY ADDRESS: Agua Mansa Road

Colton, CA 92324

APN: 0275-041-07, -08, -09, -27, -28, -29, -30, -31 and 0260-072-08, -12, -13

THIS AGREEMENT is made and entered into in

Colton ,California, this _____ day of

[MONTH] 2020 , by and between

IDI Agua Mansa, LLC , hereinafter

referred to as Owner, and the CITY OF COLTON, a political subdivision of the State of California, hereinafter referred to as "the City";

WHEREAS, the Owner owns real property ("Property") in the City of Colton, State of California, more specifically described in Exhibit "A" and depicted in Exhibit "B", each of which exhibits is attached hereto and incorporated herein by this reference; and

WHEREAS, at the time of initial approval of development project known as

Agua Mansa Commerce Center within the Property described herein, the City required the project to employ Best Management Practices, hereinafter referred to as "BMPs," to minimize pollutants in urban runoff; and

WHEREAS, the Owner has chosen to install and/or implement BMPs as described in the Water Quality Management Plan, dated _____, on file with the City and incorporated herein by this reference, hereinafter referred to as "WQMP", to minimize pollutants in urban runoff and to minimize other adverse impacts of urban runoff; and

WHEREAS, said WQMP has been certified by the Owner and reviewed and approved by the City; and

WHEREAS, the Owner is aware that periodic and continuous maintenance, including, but not necessarily limited to, filter material replacement and sediment removal, is required to assure peak performance of all BMPs in the WQMP and that, furthermore, such maintenance activity will require compliance with all Local, State, or Federal laws and regulations, including those pertaining to confined space and waste disposal methods, in effect at the time such maintenance occurs.

NOW THEREFORE, it is mutually stipulated and agreed as follows:

1. Owner shall comply with the WQMP.

2. All maintenance or replacement of BMPs proposed as part of the WQMP are the sole responsibility of the Owner in accordance with the terms of this Agreement.

3. Owner hereby provides the City's designee complete access, of any duration, to the BMPs and their immediate vicinity at any time, upon reasonable notice, or in the event of emergency, as determined by the City Engineer, no advance notice, for the purpose of inspection, sampling, testing of the BMPs, and in case of emergency, to undertake all necessary repairs or other preventative measures at owner's expense as provided in paragraph 5 below. The City shall make every effort at all times to minimize or avoid interference with Owner's use of the Property. Denial of access to any premises or facility that contains WQMP features is a breach of this Agreement and may also be a violation of the City's Pollutant Discharge Elimination System regulations. If there is reasonable cause to believe that an illicit discharge or breach of this Agreement is occurring on the premises then the authorized enforcement agency may seek issuance of a search warrant from any court of competent jurisdiction in addition to other enforcement actions. Owner recognizes that the City may perform routine and regular inspections, as well as emergency inspections, of the BMPs. Owner or Owner's successors or assigns shall pay City for all costs incurred by City in the inspection, sampling, testing of the BMPs within thirty (30) calendar days of City invoice.

4. Owner shall use its best efforts diligently to maintain all BMPs in a manner assuring peak performance at all times. All reasonable precautions shall be exercised by Owner and Owner's representative or contractor in the removal and extraction of any material(s) from the BMPs and the ultimate disposal of the material(s) in a manner consistent with all relevant laws and regulations in effect at the time. As may be requested from time to time by the City, the Owner shall provide the City with documentation identifying the material(s) removed, the quantity, and disposal destination), testing construction or reconstruction.

5. In the event Owner, or its successors or assigns, fails to accomplish the necessary maintenance contemplated by this Agreement, within five (5) business days of being given written notice by the City , the City is hereby authorized to cause any maintenance necessary to be done and charge the entire cost and expense against the Property and/or to the Owner or Owner's successors or assigns, including administrative costs, attorneys fees and interest thereon at the maximum rate authorized by the City Code from the date of the notice of expense until paid in full. Owner or Owner's successors or assigns shall pay City within thirty (30) calendar days of City invoice.

6. The City may require the owner to post security in form and for a time period satisfactory to the City to guarantee the performance of the obligations stated herein. Should the Owner fail to perform the obligations under the Agreement, the City may, in the case of a cash bond, act for the Owner using the proceeds from it, or in the case of a surety bond, require the surety(ies) to perform the obligations of this Agreement.

7. The City agrees, from time to time, within ten (10) business days after request of Owner, to execute and deliver to Owner, or Owner's designee, an estoppel certificate requested by Owner, stating that this Agreement is in full force and effect, and that Owner is not in

default hereunder with regard to any maintenance or payment obligations (or specifying in detail the nature of Owner's default). Owner shall pay all costs and expenses incurred by the City in its investigation of whether to issue an estoppel certificate within thirty (30) calendar days after receipt of a City invoice and prior to the City's issuance of such certificate. Where the City cannot issue an estoppel certificate, Owner shall pay the City within thirty (30) calendar days of receipt of a City invoice.

8. Owner shall not change any BMPs identified in the WQMP without an amendment to this Agreement approved by authorized representatives of both the City and the Owner.

9. City and Owner shall comply with all applicable laws, ordinances, rules, regulations, court orders and government agency orders now or hereinafter in effect in carrying out the terms of this Agreement. If a provision of this Agreement is terminated or held to be invalid, illegal or unenforceable, the validity, legality and enforceability of the remaining provisions shall remain in full effect.

10. In addition to any remedy available to City under this Agreement, if Owner violates any term of this Agreement and does not cure the violation within the time already provided in this Agreement, or, if not provided, within thirty (30) calendar days, or within such time authorized by the City if said cure reasonably requires more than the subject time, the City may bring an action at law or in equity in a court of competent jurisdiction to enforce compliance by the Owner with the terms of this Agreement. In such action, the City may recover any damages to which the City may be entitled for the violation, enjoin the violation by temporary or permanent injunction without the necessity of proving actual damages or the inadequacy of otherwise available legal remedies, or obtain other equitable relief, including, but not limited to, the restoration of the Property and/or the BMPs identified in the WQMP to the condition in which it/they existed prior to any such violation or injury.

11. This Agreement shall be recorded in the Office of the Recorder of San Bernardino County, California, at the expense of the Owner and shall constitute notice to all successors and assigns of the title to said Property of the obligation herein set forth, and also a lien in such amount as will fully reimburse the City, including interest as herein above set forth, subject to foreclosure in event of default in payment.

12. In event of legal action occasioned by any default or action of the Owner, or its successors or assigns, then the Owner and its successors or assigns agree(s) to hold the City harmless and pay all costs incurred by the City in enforcing the terms of this Agreement, including reasonable attorney's fees and costs, and that the same shall become a part of the lien against said Property.

13. It is the intent of the parties hereto that burdens and benefits herein undertaken shall constitute covenants that run with said Property and constitute a lien there against.

14. The obligations herein undertaken shall be binding upon the heirs, successors, executors, administrators and assigns of the parties hereto. The term "Owner" shall include not only the present Owner, but also its heirs, successors, executors, administrators, and assigns. Owner shall notify any successor to title of all or part of the Property about the existence of this Agreement. Owner shall provide such notice prior to such successor obtaining an interest in all or part of the Property. Owner shall provide a copy of such notice to the City at the same time such notice is provided to the successor.

15. Time is of the essence in the performance of this Agreement.

16. Any notice to a party required or called for in this Agreement shall be served in person, or by deposit in the U.S. Mail, first class postage prepaid, to the address set forth below. Notice(s) shall be deemed effective upon receipt, or seventy-two (72) hours after deposit in the U.S. Mail, whichever is earlier. A party may change a notice address only by providing written notice thereof to the other party.

17. Owner agrees to indemnify, defend (with counsel reasonably approved by the City) and hold harmless the City and its authorized officers, employees, agents and volunteers from any and all claims, actions, losses, damages, and/or liability arising out of this Agreement from any cause whatsoever, including the acts, errors or omissions of any person and for any costs or expenses incurred by the City on account of any claim except where such indemnification is prohibited by law. This indemnification provision shall apply regardless of the existence or degree of fault of indemnitees. The Owner's indemnification obligation applies to the City's "active" as well as "passive" negligence but does not apply to the City's "sole negligence" or "willful misconduct" within the meaning of Civil Code Section 2782, or to any claims, actions, losses, damages, and/or liabilities, to the extent caused by the acts or omissions of any third party contractors undertaking any work (other than field inspections) or other maintenance on the Property on behalf of the City under this Agreement..

[REMAINDER OF THIS PAGE INTENTIONALLY LEFT BLANK]

IF TO CITY :

Victor Ortiz, P.E., City Engineer

160 S. 10th Street

Colton, CA 92324

IF TO OWNER:

IDI Agua Mansa, LLC

840 Apollo Street, Suite 343

El Segundo, CA 90245

IN WITNESS THEREOF, the parties hereto have affixed their signatures as of the date first written above.

OWNER:

Company/Trust:_____

Signature: _____

Name: _____

Title: _____

Date: _____

FOR: Maintenance Agreement, dated

[MONTH DATE], 2020,

for the project known as

Agua Mansa Commerce Center

(APN)_ 0275-041-07, -08, -09, -27, -28, -29, -30, -31 and 0260-072-08, -12, -13,

As described in the WQMP dated _____.

NOTARIES ON FOLLOWING PAGE

A notary acknowledgement is required for recordation.

ACCEPTED BY:

VICTOR ORTIZ, P.E., City Engineer

Date: _____

Attachment: Notary Acknowledgement

ATTACHMENT 1
Notary Acknowledgement (OWNER)

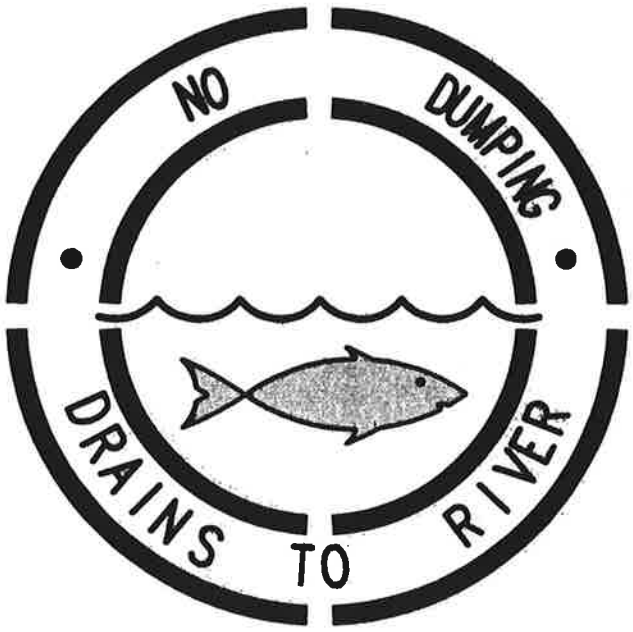
ATTACHMENT 1
Notary Acknowledgement (CITY)

EXHIBIT A
(Legal Description)

EXHIBIT B
(Map/illustration)

Section 6.4

Attachment E
Educational Materials



SAMPLE STENCIL TO BE USED NEAR GRATE AND CURB OPENING INLETS

SYMBOL TO BE 24" IN DIAMETER

Thienes Engineering
CIVIL ENGINEERING • LAND SURVEYING
14349 FIRESTONE BOULEVARD
LA MIRADA, CALIFORNIA 90638
PH.(714)521-4811 FAX(714)521-4173

SAMPLE CATCH BASIN STENCIL
PER BMP SD-13

Vortex Separator MP-51

Description

Vortex separators: (alternatively, swirl concentrators) are gravity separators, and in principle are essentially wet vaults. The difference from wet vaults, however, is that the vortex separator is round, rather than rectangular, and the water moves in a centrifugal fashion before exiting. By having the water move in a circular fashion, rather than a straight line as is the case with a standard wet vault, it is possible to obtain significant removal of suspended sediments and attached pollutants with less space. Vortex separators were originally developed for combined sewer overflows (CSOs), where it is used primarily to remove coarse inorganic solids. Vortex separation has been adapted to stormwater treatment by several manufacturers.

California Experience

There are currently about 100 installations in California.

Advantages

- May provide the desired performance in less space and therefore less cost.
- May be more cost-effective pre-treatment devices than traditional wet or dry basins.
- Mosquito control may be less of an issue than with traditional wet basins.

Limitations

- As some of the systems have standing water that remains between storms, there is concern about mosquito breeding.
- It is likely that vortex separators are not as effective as wet vaults at removing fine sediments, on the order 50 to 100 microns in diameter and less.
- The area served is limited by the capacity of the largest models.
- As the products come in standard sizes, the facilities will be oversized in many cases relative to the design treatment storm, increasing the cost.
- The non-steady flows of stormwater decreases the efficiency of vortex separators from what may be estimated or determined from testing under constant flow.
- Do not remove dissolved pollutants.

Design Considerations

- Service Area
- Settling Velocity
- Appropriate Sizing
- Inlet Pipe Diameter

Targeted Constituents

☑	Sediment	▲
☑	Nutrients	●
☑	Trash	
☑	Metals	●
	Bacteria	
☑	Oil and Grease	
☑	Organics	

Legend *(Removal Effectiveness)*

● Low ■ High

▲ Medium

CASQA
CALIFORNIA STORMWATER QUALITY ASSOCIATION

- A loss of dissolved pollutants may occur as accumulated organic matter (e.g., leaves) decomposes in the units.

Design and Sizing Guidelines

The stormwater enters, typically below the effluent line, tangentially into the basin, thereby imparting a circular motion in the system. Due to centrifugal forces created by the circular motion, the suspended particles move to the center of the device where they settle to the bottom. There are two general types of vortex separation: free vortex and dampened (or impeded) vortex. Free vortex separation becomes dampened vortex separation by the placement of radial baffles on the weir-plate that impede the free vortex-flow pattern

It has been stated with respect to CSOs that the practical lower limit of vortex separation is a particle with a settling velocity of 12 to 16.5 feet per hour (0.10 to 0.14 cm/s). As such, the focus for vortex separation in CSOs has been with settleable solids generally 200 microns and larger, given the presence of the lighter organic solids. For inorganic sediment, the above settling velocity range represents a particle diameter of 50 to 100 microns. Head loss is a function of the size of the target particle. At 200 microns it is normally minor but increases significantly if the goal is to remove smaller particles.

The commercial separators applied to stormwater treatment vary considerably with respect to geometry, and the inclusion of radial baffles and internal circular chambers. At one extreme is the inclusion of a chamber within the round concentrator. Water flows initially around the perimeter between the inner and outer chambers, and then into the inner chamber, giving rise to a sudden change in velocity that purportedly enhances removal efficiency. The opposite extreme is to introduce the water tangentially into a round manhole with no internal parts of any kind except for an outlet hood. Whether the inclusion of chambers and baffles gives better performance is unknown. Some contend that free vortex, also identified as swirl concentration, creates less turbulence thereby increasing removal efficiency. One product is unique in that it includes a static separator screen.

- Sized is based on the peak flow of the design treatment event as specified by local government.
- If an in-line facility, the design peak flow is four times the peak of the design treatment event.
- If an off-line facility, the design peak flow is equal to the peak of the design treatment event.
- Headloss differs with the product and the model but is generally on the order of one foot or less in most cases.

Construction/Inspection Considerations

No special considerations.

Performance

Manufacturer's differ with respect to performance claims, but a general statement is that the manufacturer's design and rated capacity (cfs) for each model is based on and believed to achieve an aggregate reduction of 90% of all particles with a specific gravity of 2.65 (glacial sand) down to 150 microns, and to capture the floatables, and oil and grease. Laboratory tests of

two products support this claim. The stated performance expectation therefore implies that a lesser removal efficiency is obtained with particles less than 150 microns, and the lighter, organic settleables. Laboratory tests of one of the products found about 60% removal of 50 micron sand at the expected average operating flow rate

Experience with the use of vortex separators for treating combined sewer overflows (CSOs), the original application of this technology, suggests that the lower practical limit for particle removal are particles with a settling velocity of 12 feet per hour (Sullivan, 1982), which represents a particle diameter of 100 to 200 microns, depending on the specific gravity of the particle. The CSO experience therefore seems consistent with the limited experience with treating stormwater, summarized above

Traditional treatment technologies such as wet ponds and extended detention basins are generally believed to be more effective at removing very small particles, down to the range of 10 to 20 microns. Hence, it is intuitively expected that vortex separators do not perform as well as the traditional wet and dry basins, and filters. Whether this matters depends on the particle size distribution of the sediments in stormwater. If the distribution leans towards small material, there should be a marked difference between vortex separators and, say, traditional wet vaults. There are little data to support this conjecture

In comparison to other treatment technologies, such as wet ponds and grass swales, there are few studies of vortex separators. Only two of manufactured products currently available have been field tested. Two field studies have been conducted. Both achieved in excess of 80% removal of TSS. However, the test was conducted in the Northeast (New York state and Maine) where it is possible the stormwater contained significant quantities of deicing sand. Consequently, the influent TSS concentrations and particle size are both likely considerably higher than is found in California stormwater. These data suggest that if the stormwater particles are for the most part fine (i.e., less than 50 microns), vortex separators will not be as efficient as traditional treatment BMPs such as wet ponds and swales, if the latter are sized according to the recommendations of this handbook.

There are no equations that provide a straightforward determination of efficiency as a function of unit configuration and size. Design specifications of commercial separators are derived from empirical equations that are unique and proprietary to each manufacturer. However, some general relationships between performance and the geometry of a separator have been developed. CSO studies have found that the primary determinants of performance of vortex separators are the diameters of the inlet pipe and chamber with all other geometry proportional to these two.

Sullivan et al. (1982) found that performance is related to the ratios of chamber to inlet diameters, D2/D1, and height between the inlet and outlet and the inlet diameter, H1/D1, shown in Figure 3. The relationships are: as D2/D1 approaches one, the efficiency decreases; and, as the H1/D1 ratio decreases, the efficiency decreases. These relationships may allow qualitative comparisons of the alternative designs of manufacturers. Engineers who wish to apply these concepts should review relevant publications presented in the References.

Siting Criteria

There are no particularly unique siting criteria. The size of the drainage area that can be served by vortex separators is directly related to the capacities of the largest models.

Additional Design Guidelines

Vortex separators have two capacities if positioned as in-line facilities, a treatment capacity and a hydraulic capacity. Failure to recognize the difference between the two may lead to significant under sizing; i.e., too small a model is selected. This observation is relevant to three of the five products. These three technologies all are designed to experience a unit flow rate of about 24 gallons/square foot of separator footprint at the peak of the design treatment event. This is the horizontal area of the separator zone within the container, not the total footprint of the unit. At this unit flow rate, laboratory tests by these manufacturers have established that the performance will meet the general claims previously described. However, the units are sized to handle 100 gallons/square foot at the peak of the hydraulic event. Hence, in selecting a particular model the design engineer must be certain to match the peak flow of the design event to the stated treatment capacity, not the hydraulic capacity. The former is one-fourth the latter. If the unit is positioned as an off-line facility, the model selected is based on the capacity equal to the peak of the design treatment event.

Maintenance

Maintenance consists of the removal of accumulated material with an eductor truck. It may be necessary to remove and dispose the floatables separately due to the presence of petroleum product.

Maintenance Requirements

Remove all accumulated sediment, and litter and other floatables, annually, unless experience indicates the need for more or less frequent maintenance.

Cost

Manufacturers provide costs for the units including delivery. Installation costs are generally on the order of 50 to 100 % of the manufacturer's cost. For most sites the units are cleaned annually.

Cost Considerations

The different geometry of the several manufactured separators suggests that when comparing the costs of these systems to each other, that local conditions (e.g., groundwater levels) may affect the relative cost-effectiveness.

References and Sources of Additional Information

Field, R., 1972, The swirl concentrator as a combined sewer overflow regulator facility, EPA/R2-72-008, U.S. Environmental Protection Agency, Washington, D.C.

Field, R., D. Averill, T.P. O'Connor, and P. Steel, 1997, Vortex separation technology, Water Qual. Res. J. Canada, 32, 1, 185

Manufacturers technical materials

Sullivan, R.H., et al., 1982, Design manual – swirl and helical bend pollution control devices, EPA-600/8-82/013, U.S. Environmental Protection Agency, Washington, D.C.

Sullivan, R.H., M.M. Cohn, J.E. Ure, F.F. Parkinson, and G. Caliana, 1974, Relationship between diameter and height for the design of a swirl concentrator as a combined sewer overflow regulator, EPA 670/2-74-039, U.S. Environmental Protection Agency, Washington, D.C.

Sullivan, R.H., M.M. Cohn, J.E. Ure, F.F. Parkinson, and G. Caliana, 1974, The swirl concentrator as a grit separator device, EPA670/2-74-026, U.S. Environmental Protection Agency, Washington, D.C.

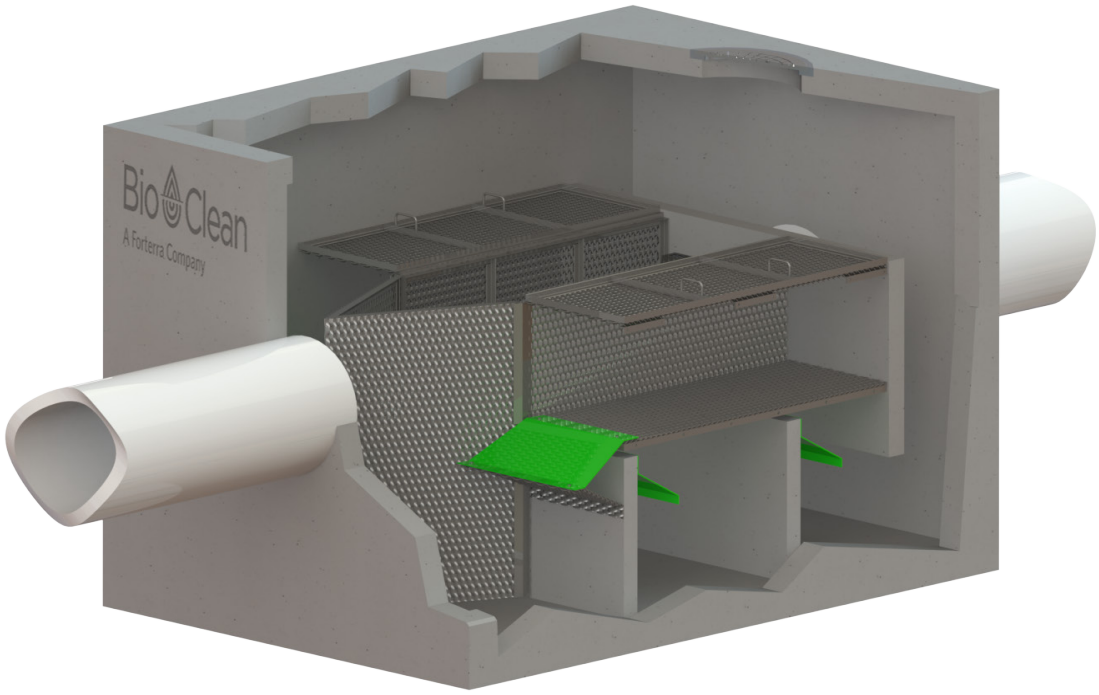
Sullivan, R.H., M.M. Cohn, J.E. Ure, F.F. Parkinson, and G. Caliana, 1978, Swirl primary separator device and pilot demonstration, EPA600/2-78-126, U.S. Environmental Protection Agency, Washington, D.C.

DUAL STAGE

Hydrodynamic Separator (DSBB)

Bio Clean
A Forterra Company

OPERATION & MAINTENANCE



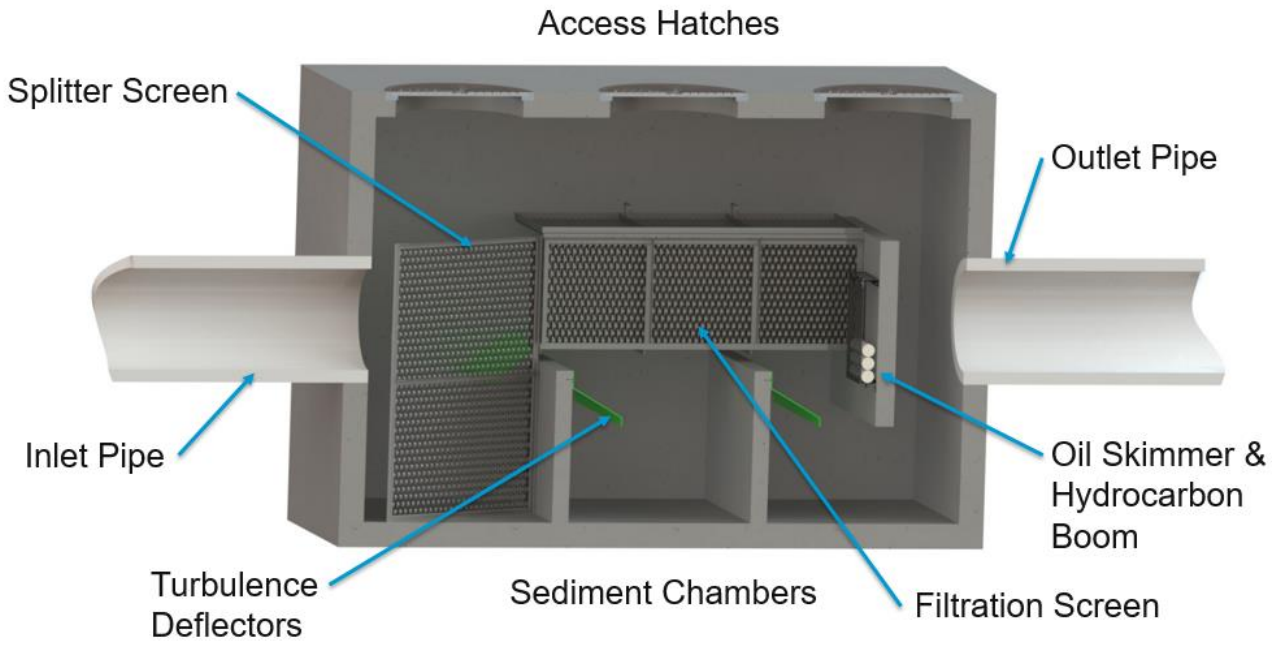
Bio Clean Environmental Services, Inc.
398 Via El Centro
Oceanside, CA 92058

www.BioCleanEnvironmental.com
p: 760.433.7640
f: 760.433.3176

OPERATION & MAINTENANCE

The Debris Separating Baffle Box (DSBB), a stormwater dual-stage Hydrodynamic Separator is designed to remove high levels of trash, debris, sediments and hydrocarbons. The innovative screening system directs floatable trash, debris, and organics into raised filtration screens for dry state storage which prevents septic conditions, odor, nutrient leaching and allows for easy removal. The raised filtration screens are assisted by a non-clogging inlet splitting screen which directs flows to the filtration screens while maintaining high treatment flow rates. The DSBB is able to effectively capture and store sediment with no maintenance or loss of treatment capacity for several years based on annual average loading in most regions.

Yet, as with all stormwater BMPs, inspection and maintenance on the DSBB Hydrodynamic Separator is necessary. Stormwater regulations require that all BMPs be inspected and maintained to ensure they are operating as designed to allow for effective pollutant removal and provide protection to receiving water bodies. It is recommended that inspections be performed multiple times during the first year to assess site-specific loading conditions. This is recommended because pollutant loading can vary greatly from site to site. Variables such as nearby soil erosion or construction sites, winter sanding of roads, amount of daily traffic and land use can increase pollutant loading on the system. The first year of inspections can be used to set inspection and maintenance intervals for subsequent years. Without appropriate maintenance a BMP can exceed its storage capacity which can negatively affect its continued performance in removing and retaining captured pollutants.



System Diagram:

Inspection Equipment

Following is a list of equipment to allow for simple and effective inspection of the DSBB Separator:

- Bio Clean Environmental Inspection Form (contained within this manual).
- Flashlight.
- Manhole hook or appropriate tools to remove access hatches and covers.
- Appropriate traffic control signage and procedures.
- Measuring pole and/or tape measure.
- Protective clothing and eye protection.
- Note: entering a confined space requires appropriate safety and certification. It is generally not required for routine inspections or maintenance of the system.

Inspection Steps

The core to any successful stormwater BMP maintenance program is routine inspections. The inspection steps required on the DSBB are quick and easy. As mentioned above the first year should be seen as the maintenance interval establishment phase. During the first year more frequent inspections should occur in order to gather loading data and maintenance requirements for that specific site. This information can be used to establish a base for long-term inspection and maintenance interval requirements.

The DSBB Separator can be inspected though visual observation without entry into the system. All necessary pre-inspection steps must be carried out before inspection occurs, especially traffic control and other safety measures to protect the inspector and nearby pedestrians from any dangers associated with an open access hatch or manhole. Once these access covers have been safely opened the inspection process can proceed:

- Prepare the inspection form by writing in the necessary information including project name, location, date & time, unit number and other info (see inspection form).
- Observe the inside of the system through the access hatches. If minimal light is available and vision into the unit is impaired utilize a flashlight to see inside the system.
- Look for any out of the ordinary obstructions in the inflow pipe, sediment chambers, filtration screens, splitter screen, or outflow pipe. Write down any observations on the inspection form.

- Through observation and/or digital photographs estimate the amount of floatable debris accumulated inside the filtration screens. Record this information on the inspection form. Check both the right and left filtration screens if applicable.
- Utilizing a tape measure or measuring stick estimate the amount of sediment accumulated in each of the three sediment chambers. Record this depth on the inspection form.
- Observe the condition and color of the hydrocarbon booms and any floating oils in front of the boom cage. Record this information on the inspection form.
- Finalize inspection report for analysis by the maintenance manager to determine if maintenance is required.

Maintenance Indicators

Based upon observations made during inspection, maintenance of the system may be required based on the following indicators:

- Missing or damaged internal components.
- Obstructions in the system or its inlet or outlet.
- Excessive accumulation of floatable trash, debris and foliage in the filtration screens in which the length and width of the chambers screens is more than half full and/or flow into the screens is fully impeded by these debris. Large items blocking the entrance.
- Excessive accumulation of sediment in any of the three separation chambers is more than half-full (18" to 27" depending on the model size). See chart below:

Model	Sediment Chamber				Screen Basket Dimensions				Hydrocarbon Boom Cage		
	ID Length (in)	ID Width (in)	Sediment Chamber Depth (in)	Sediment Chamber Capacity at 50% Full (cu ft)	Screen Basket Quantity	Screen Basket Width (in)	Screen Basket Height (in)	Screen Basket Capacity (cu ft)	Cage Height (in)	Cage Width (in)	Booms
2.5-4	48	30	36	14.8	2	9	12	3.3	9	5	1
3-6	72	36	36	26.8	2	11	18	9.0	15	7	1
4-6	72	48	36	35.8	2	15	18	12.3	15	11	1
4-8	96	48	36	47.8	2	15	24	22.0	21	11	2
5-10	120	60	36	70.0	2	19	24	34.0	21	15	2
6-12	144	72	36	102.0	2	22	24	47.4	21	21	2
8-12	144	96	36	136.0	2	30	27	72.7	24	29	2
8-14	168	96	36	160.0	2	30	27	84.4	24	29	2
10-14	168	120	36	200.0	2	38	27	106.9	24	37	2
11-16	192	132	45	309.4	2	40	33	160.4	30	45	3
11-24	288	132	54	569.3	2	40	36	263.3	33	45	3
11-34	408	132	54	816.8	2	40	36	373.3	33	45	3

Maintenance Equipment

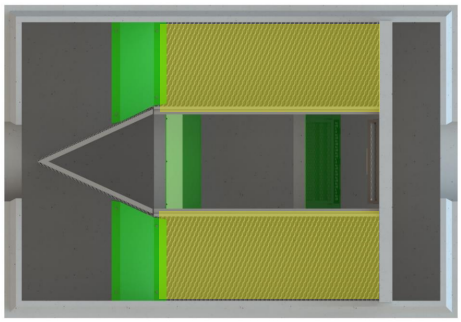
It is recommended that a vacuum truck be utilized to minimize the time required to maintain the DSBB Separator:

- Bio Clean Environmental Maintenance Form (contained in O&M Manual).
- Flashlight.
- Manhole hook or appropriate tools to access hatches and covers.
- Appropriate traffic control signage and procedures.
- Protective clothing and eye protection.
- Note: entering a confined space requires appropriate safety and certification. It is generally not required for routine maintenance of the system. Exception is deeper units entry may be required to open filtration screen lids and replace hydrocarbon booms.
- Vacuum truck (with pressure washer attachment preferred).

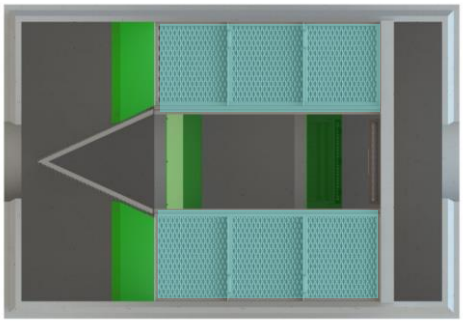
Maintenance Procedures

It is recommended that maintenance occurs at least three days after the most recent rain event to allow for drain down from any associated upstream detention systems. Maintaining the system while flows are still entering it will increase the time and complexity required for maintenance. Debris captured in the filtration screens requires time to dry out which decreases time to remove and associated weight. Cleaning of the filtration screens and sediment chambers can be performed from finish surface without entry into the vault utilizing a vacuum truck on most installations. Depth and configuration of the installation may create conditions which would require entry for some or all of the maintenance procedures. Configuration and size of access hatches also effects the conditions in which entry may be required. Once all safety measures have been set up cleaning of the filtration screens, hydrocarbon boom(s) and/or sediment chambers can proceed as followed:

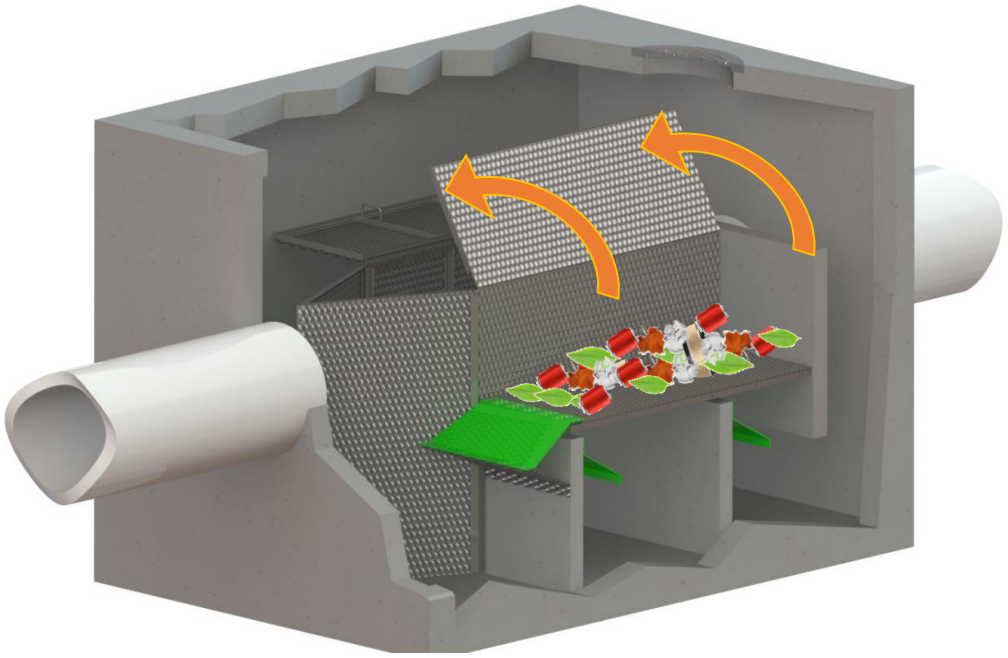
- Remove all access hatches (requires traffic control and safety measures to be completed prior).
- Locate the right and left filtration screens. Manhole or hatch access will be provided to each of these screens. As highlighted below. Depending on the configuration of the DSBB the filtration screens may or may not have hinged lids depending on factors such as online or offline bypass, water level at peak flow, back flow conditions amongst other site-specific variables. Units that have lids are designed with hinges and locking mechanisms along the sidewall of the structure that can be unlocked by finish surface with an extension rod. The length of this rod is limited and for deeper installs entry may be required to unlock and open the lids.



Top view into DSBB. Filtration screens highlighted in yellow without hinged lids.



Top view into DSBB. Filtration screens highlighted in turquoise with hinged lids.

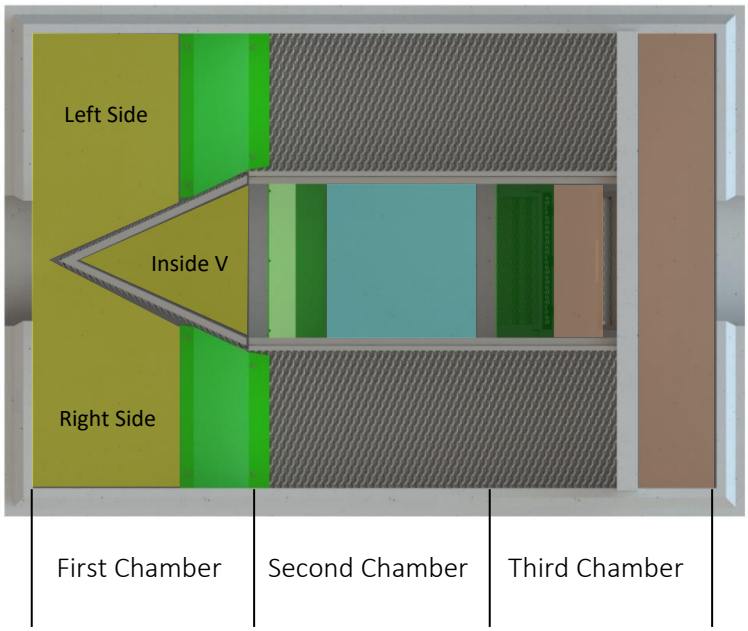


Isometric view into the DSBB illustrating the hinged lids of the filtration screens. Lids can hinge up and toward the center up to 180 degrees from closed & locked position for easy access for cleaning and removal of debris.

- Once filtration screens lids are opened (if applicable) the vacuum hose extension is inserted down into the screens for removal of debris. The width of the screen of the smallest model is 9” therefore allowing an standard 8” vacuum hose to be used for all models and sizes. All debris should be removed with the vacuum hose and the pressure washer should be used to

spray down and remove all debris on the bottom, side and top screens. Ensure all holes within in the screen are cleared of debris. This is critical to restoring the full hydraulic capacity of the filtration screens. Once completed close and lock lids (if applicable).

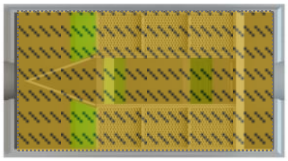
- Using an extension on a vacuum truck position the hose over the opened access hatch or hatches leading to the first sediment chamber adjacent to the pipe inlet and includes the splitter screen. Lower vacuum hose into the sediment chamber on the left and right side of the splitter screen. This is where a majority of the larger sediments and heavy debris will accumulate. Remove all floating debris, standing water and sediment from this sediment chamber. Vertical access to the bottom of the sediment chamber is unimpeded. The vac hose can be moved from side-to-side to fully remove sediments at the corners. A power washer can be used to assist if sediments have become hardened and stuck to the walls or the floor of the chamber. The power washer should also be used to spray the splitter screen clean of any accumulated debris. The vacuum hose can also be inserted on the outlet side of the splitter screen (inside the V) to remove any remaining accumulated sediment.



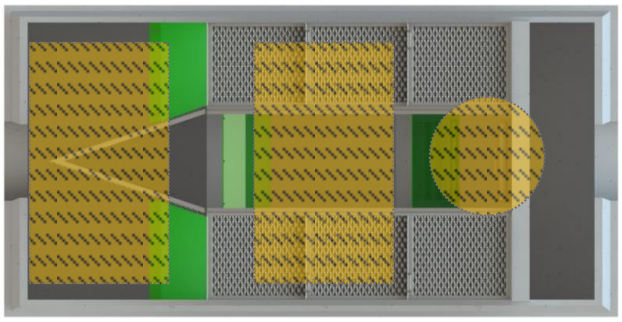
Top view into DSBB illustrating the three sediment chambers.

- The **yellow** highlighted areas show where the vacuum hose should be inserted for cleaning of the **first** sediment chamber.
- The **turquoise** highlighted area show where the vacuum hose should be inserted for cleaning of the **second** sediment chamber.
- The **orange** highlighted areas shows where the vacuum hose is inserted for cleaning of the **third** sediment chamber.

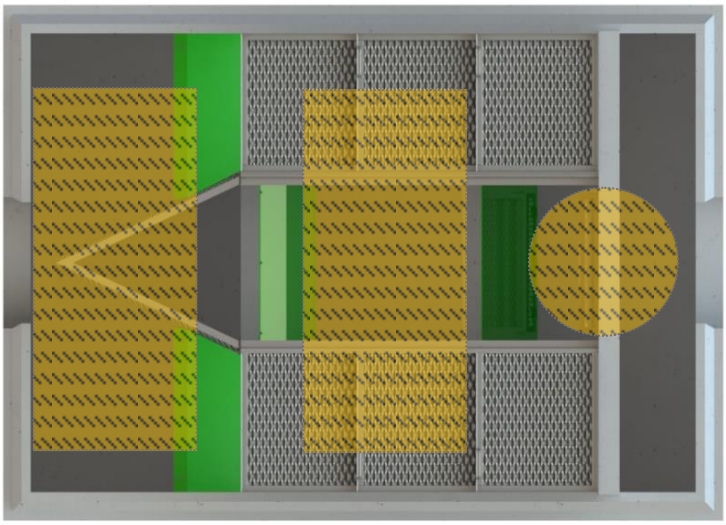
- Repeat the same procedure in the second and third sediment chambers in the locations shown in the above diagrams. Access to these two chambers is in the center of the system unlike the first sediment chamber. The filtration screens cover the sediment chamber along the sides, yet allow for unimpeded access in the middle without requirement to open filtration chamber tops or go through the filtration screens (hinged floor) as found with other baffle box systems. Hatch or manhole size, quantity and location vary based on model size and site specific project constraints. Various access hatch sizes and configurations are available to meet individual project requirements. Larger hatches, open assisted hatches and/or taller ID dimensions to increase headroom are available by request. Below are a few examples of various models and optimal hatch configurations.



A DSBB-2.5-4 is offered with a 2.5-4 access hatch in either parkway, direct or indirect traffic rating. This provides full access. Bolt and pull, hinged or hinged with lift-assisted options offered. *Figures not to scale.*

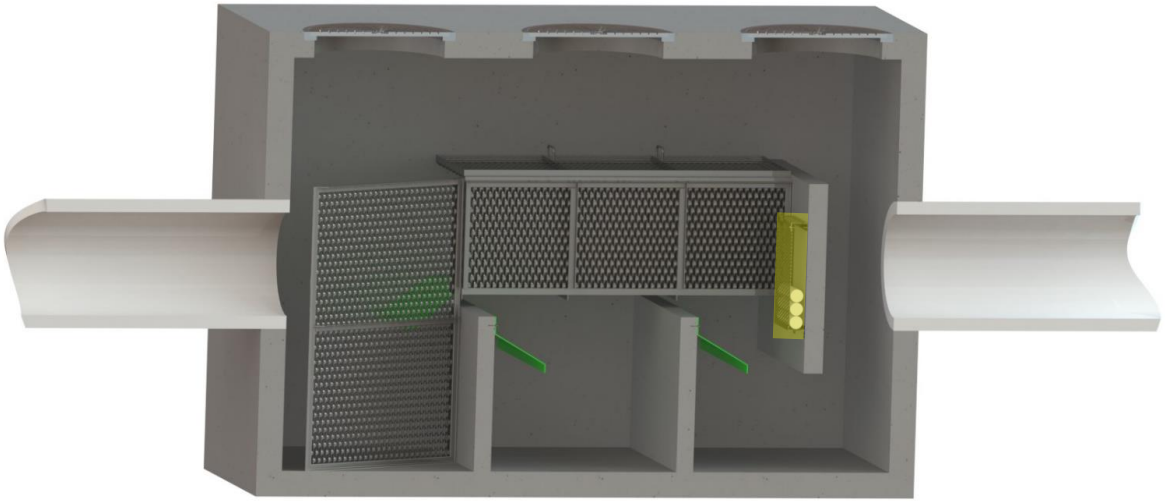


A DSBB-5-10 is offered with two 2.5-4 access hatches in either parkway, direct or indirect traffic rating along with a single 24” diameter manhole for access to the third sediment chamber and hydrocarbon booms. Bolt and pull, hinged or hinged with lift assisted options offered. *Figures not to scale.*

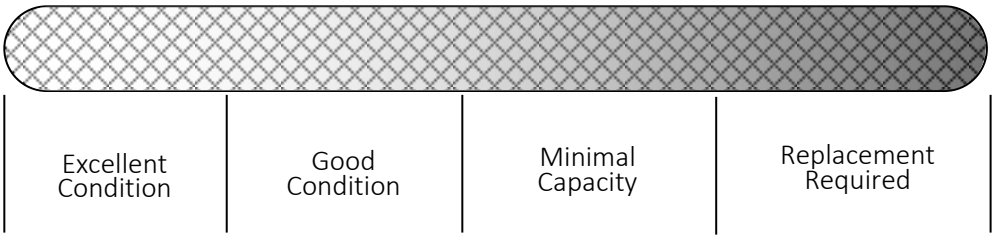


A DSBB-8-12 is offered with two 3-6 access hatches in either parkway, direct or indirect traffic rating along with a single 30” diameter manhole for access to the third sediment chamber and hydrocarbon booms. Bolt and pull, hinged or hinged with lift-assisted options offered. *Figures not to scale.*

- Based on the color of the hydrocarbon booms replacement may be necessary. The booms are housed inside the boom cage which is attached to the influent side of the oil skimmer wall. The cage has a hinged top which is opened allowing access to the hydrocarbon booms. Once old booms are removed new booms can be dropped in and the top closed. See below image.



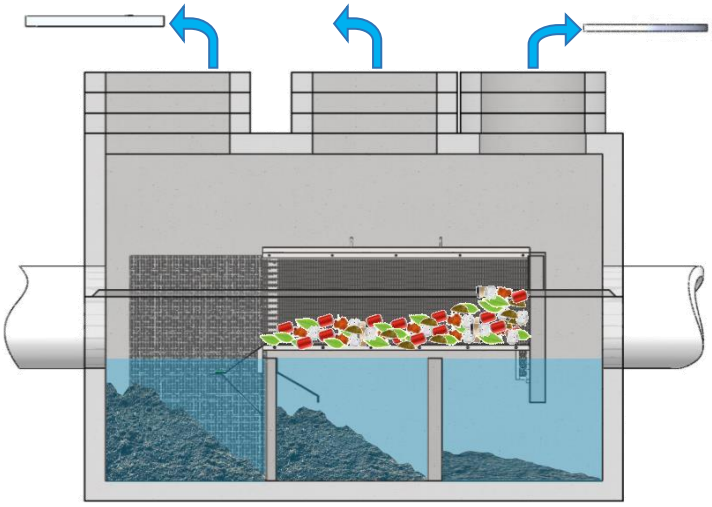
- Follow is a replacement indication color chart for the hydrocarbon booms:



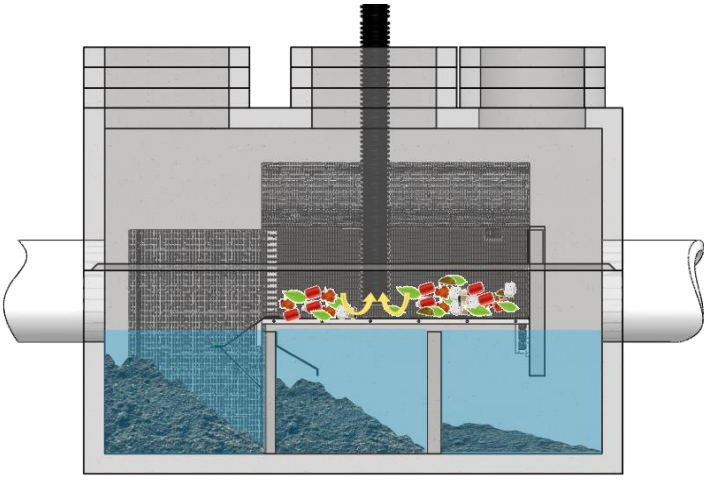
- NOTE: Filtration screens can be cleaned before or after cleaning and removal of sediment for the sediment chambers. Cleaning them before is preferred before removing sediment and standing water from the second and third chamber as debris and water will be deposited on the sediment chamber floors in the process of cleaning the filtration screens over the second and third chamber. Cleaning the first sediment chamber before the filtration screens allows the splitter screen to be fully exposed. Thus the pressure washing of all screens (splitter and filtration) can be done as the same time if needed.
- The last step is to close up and replace all access hatches and remove all traffic control.
- All removed debris and pollutants shall be disposed of following local and state requirements.

- Disposal requirements for recovered pollutants may vary depending on local guidelines. In most areas the sediment, once dewatered, can be disposed of in a sanitary landfill. It is not anticipated that the sediment would be classified as hazardous waste.
- In the case of damaged components, replacement parts can be ordered from the manufacturer. Hydrocarbon booms can also be ordered directly from the manufacturer.

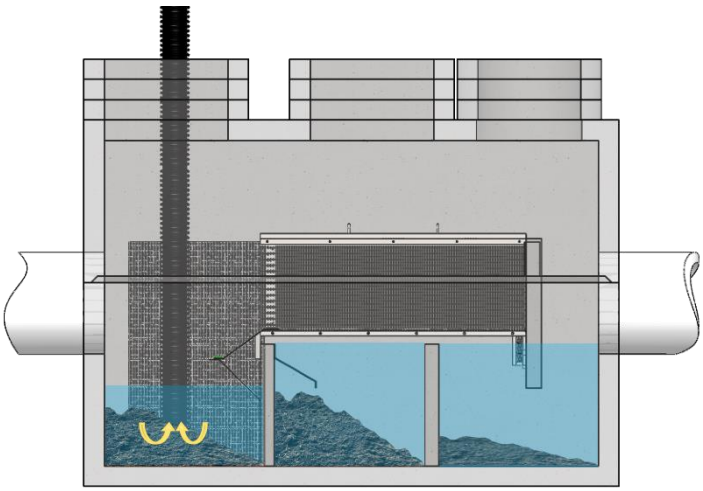
Maintenance Sequence



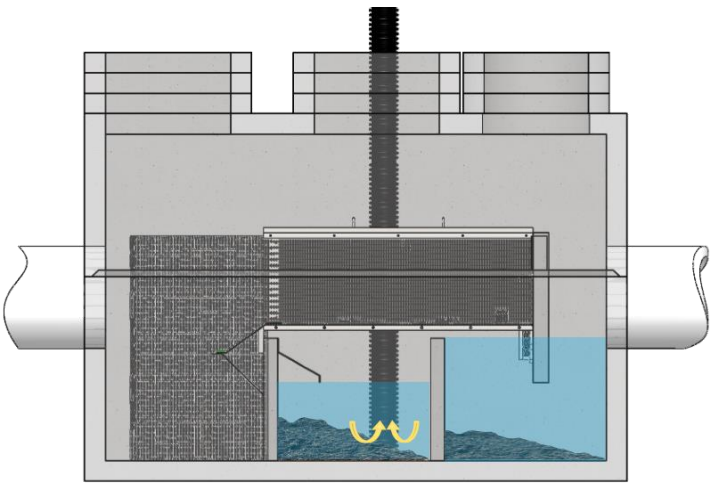
Remove access hatches set up vacuum truck to clean the filtration screens and sediment chamber. Locate positions of filtration screens and first, second and third sediment chambers plus the hydrocarbon boom cage.



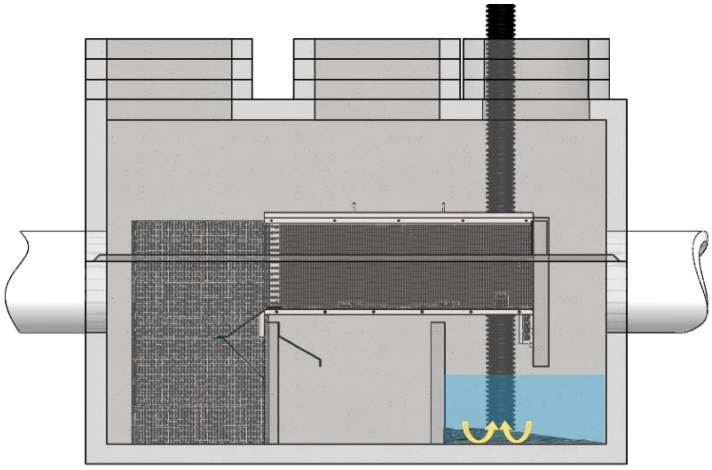
Unlock and open filtration screen lids (if applicable, some units will not have lids). Insert vacuum hose into the first filtration screen and clean out trash & debris. Use a pressure washer to remove any debris stuck on the screens.



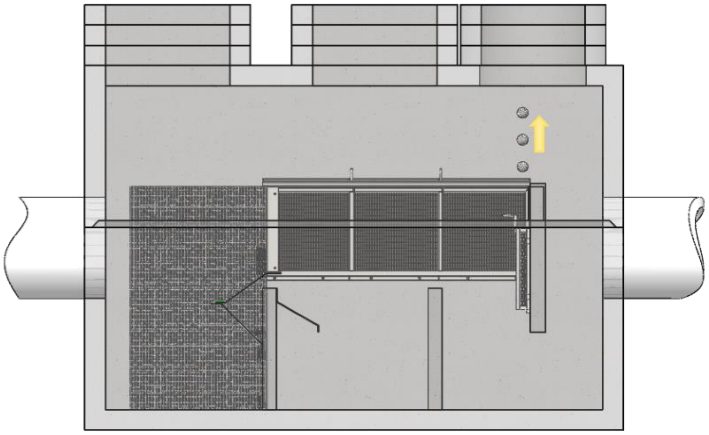
Insert vacuum hose in the first sediment chamber to remove sediment and debris. The vacuum hose will need to be inserted on the right and left side of the splitter screen to remove all sediment. Once completed use a pressure washer to clean off the splitter screen.



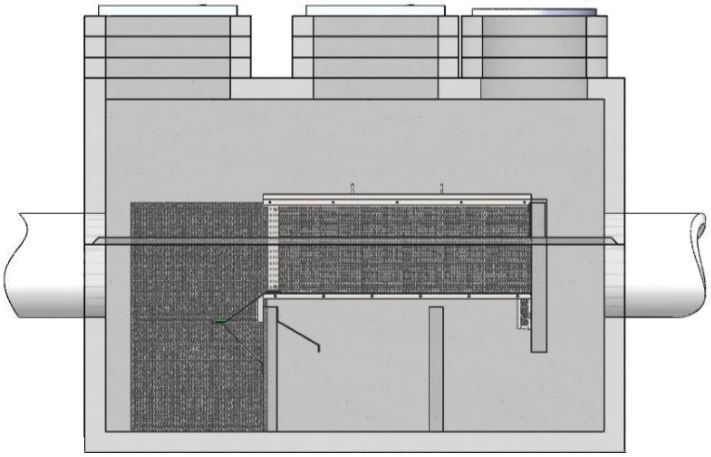
Repeat the above steps for cleaning the second sediment chamber. Compacted sediment can be loosened using a pressure washer.



Repeat the above steps for cleaning the third sediment chamber. Compacted sediment can be loosened using a pressure washer.



Once the unit is fully cleaned check the condition of the hydrocarbon booms in the boom cage hanging on the oil skimmer wall. Use color indicator in this manual to decide if replacement is required. If required open boom cage and replace booms.



Once cleaning and maintenance is complete ensure boom cage lid and filtration screen lids are closed and locked. Replace all manhole covers and or access hatches and remove traffic control.

For Maintenance Services or Information Please Contact Us At:
760-433-7640
Or Email: info@biocleanenvironmental.com

Bio Clean
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Inspection and Maintenance Report
Bio Clean Debris Separating Baffle Box

Project Name _____

Project Address _____
(city) (Zip Code)

Owner / Management Company _____

Contact _____ Phone ( ) –

For Office Use Only
(Reviewed By)
(Date)
Office personnel to complete section to the left.

Inspector Name _____ Date ____ / ____ / _____ Time _____ AM / PM

Type of Inspection ☐ Routine ☐ Follow Up ☐ Complaint ☐ Storm Storm Event in Last 72-hours? ☐ No ☐ Yes

Weather Condition _____ Additional Notes _____

Site Map #	GPS Coordinates of Vault	Model #	Debris, Trash and Foliage Accumilation Inside Filtration Screens (lbs)	Sediment Accumulation In Sediment Chambers (lbs) & Depth (inches)	Structural Notes	Operational Per Manufactures' Specifications (If not, why?)
	Lat: Long:					
	Lat: Long:					
	Lat: Long:					

Comments:

StormTech
Detention • Retention • Water Quality
An ADS company

Isolator® Row O&M Manual

THE MOST ADVANCED NAME IN WATER MANAGEMENT SOLUTIONS™

ADS®

THE ISOLATOR® ROW

INTRODUCTION

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

THE ISOLATOR ROW

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

Two different fabrics are used for the Isolator Row. A woven geotextile fabric is placed between the stone and the Isolator Row chambers. The tough geotextile provides a media for storm water filtration and provides a durable surface for maintenance operations. It is also designed to prevent scour of the underlying stone and remain intact during high pressure jetting. A non-woven fabric is placed over the chambers to provide a filter media for flows passing through the perforations in the sidewall of the chamber. The non-woven fabric is not required over the SC-160LP, DC-780, MC-3500 or MC-4500 models as these chambers do not have perforated side walls.

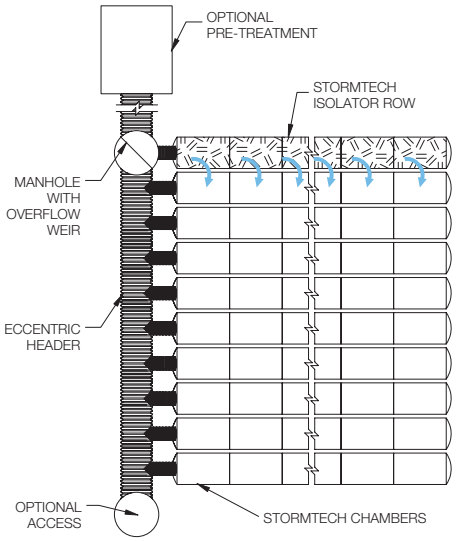
The Isolator Row is typically designed to capture the “first flush” and offers the versatility to be sized on a volume basis or flow rate basis. An upstream manhole not only provides access to the Isolator Row but typically includes a high flow weir such that storm water flowrates or volumes that exceed the capacity of the Isolator Row overtop the over flow weir and discharge through a manifold to the other chambers.

The Isolator Row may also be part of a treatment train. By treating storm water prior to entry into the chamber system, the service life can be extended and pollutants such as hydrocarbons can be captured. Pre-treatment best management practices can be as simple as deep sump catch basins, oil-water separators or can be innovative storm water treatment devices. The design of the treatment train and selection of pretreatment devices by the design engineer is often driven by regulatory requirements. Whether pretreatment is used or not, the Isolator Row is recommended by StormTech as an effective means to minimize maintenance requirements and maintenance costs.

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

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

StormTech Isolator Row with Overflow Spillway (not to scale)



ISOLATOR ROW INSPECTION/MAINTENANCE

INSPECTION

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

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

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

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

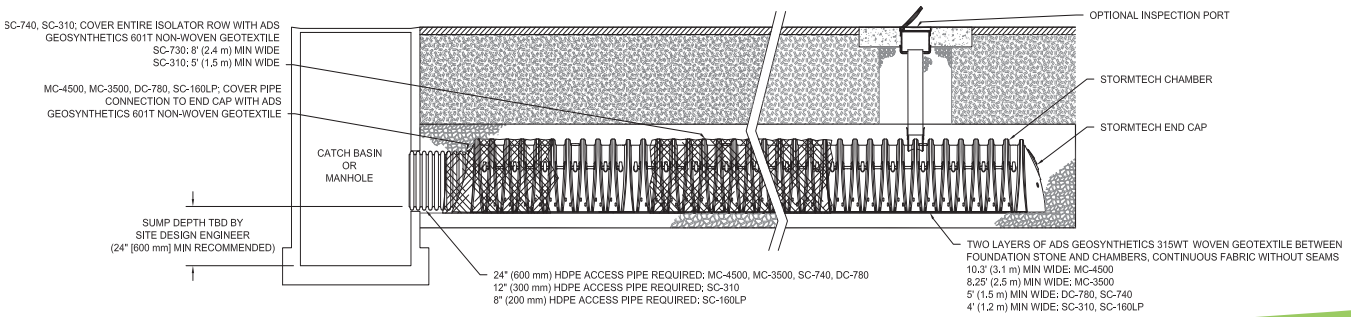
MAINTENANCE

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

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

StormTech Isolator Row (not to scale)

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



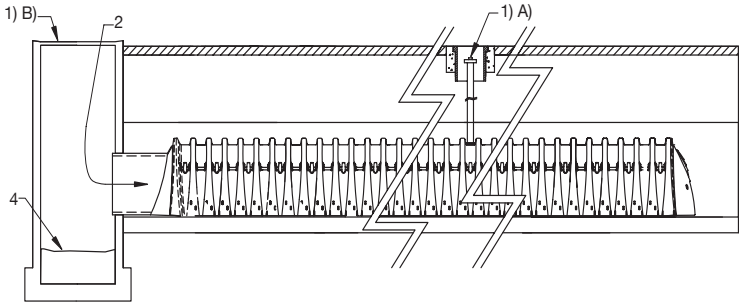
ISOLATOR ROW STEP BY STEP MAINTENANCE PROCEDURES

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

STEP 2
Clean out Isolator Row using the JetVac process.
- A) A fixed floor cleaning nozzle with rear facing nozzle spread of 45 inches or more is preferable
- B) Apply multiple passes of JetVac until backflush water is clean
- C) Vacuum manhole sump as required

STEP 3
Replace all caps, lids and covers, record observations and actions.

STEP 4
Inspect & clean catch basins and manholes upstream of the StormTech system.



SAMPLE MAINTENANCE LOG

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

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A division of ADS

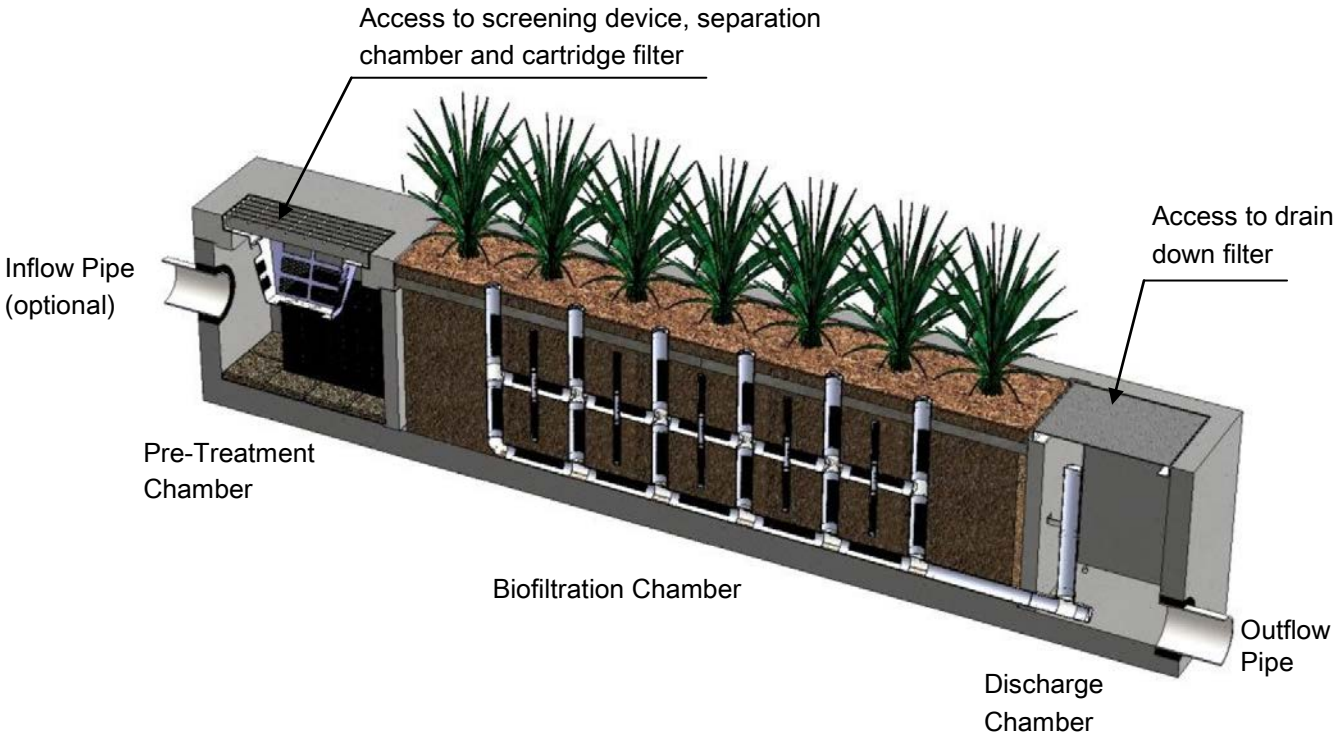
Advanced Drainage Systems, Inc.
4640 Trueman Blvd., Hilliard, OH 43026
1-800-821-6710 www.ads-pipe.com

Maintenance Guidelines for Modular Wetland System - Linear

Maintenance Summary

- Remove Trash from Screening Device – average maintenance interval is 6 to 12 months.
  - (*5 minute average service time*).
- Remove Sediment from Separation Chamber – average maintenance interval is 12 to 24 months.
  - (*10 minute average service time*).
- Replace Cartridge Filter Media – average maintenance interval 12 to 24 months.
  - (*10-15 minute per cartridge average service time*).
- Replace Drain Down Filter Media – average maintenance interval is 12 to 24 months.
  - (*5 minute average service time*).
- Trim Vegetation – average maintenance interval is 6 to 12 months.
  - (*Service time varies*).

System Diagram



Maintenance Procedures

Screening Device

1. Remove grate or manhole cover to gain access to the screening device in the Pre-Treatment Chamber. Vault type units do not have screening device. Maintenance can be performed without entry.
2. Remove all pollutants collected by the screening device. Removal can be done manually or with the use of a vacuum truck. The hose of the vacuum truck will not damage the screening device.
3. Screening device can easily be removed from the Pre-Treatment Chamber to gain access to separation chamber and media filters below. Replace grate or manhole cover when completed.

Separation Chamber

1. Perform maintenance procedures of screening device listed above before maintaining the separation chamber.
2. With a pressure washer spray down pollutants accumulated on walls and cartridge filters.
3. Vacuum out Separation Chamber and remove all accumulated pollutants. Replace screening device, grate or manhole cover when completed.

Cartridge Filters

1. Perform maintenance procedures on screening device and separation chamber before maintaining cartridge filters.
2. Enter separation chamber.
3. Unscrew the two bolts holding the lid on each cartridge filter and remove lid.
4. Remove each of 4 to 8 media cages holding the media in place.
5. Spray down the cartridge filter to remove any accumulated pollutants.
6. Vacuum out old media and accumulated pollutants.
7. Reinstall media cages and fill with new media from manufacturer or outside supplier. Manufacturer will provide specification of media and sources to purchase.
8. Replace the lid and tighten down bolts. Replace screening device, grate or manhole cover when completed.

Drain Down Filter

1. Remove hatch or manhole cover over discharge chamber and enter chamber.
2. Unlock and lift drain down filter housing and remove old media block. Replace with new media block. Lower drain down filter housing and lock into place.
3. Exit chamber and replace hatch or manhole cover.

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Maintenance Notes

1. Following maintenance and/or inspection, it is recommended the maintenance operator prepare a maintenance/inspection record. The record should include any maintenance activities performed, amount and description of debris collected, and condition of the system and its various filter mechanisms.

2. The owner should keep maintenance/inspection record(s) for a minimum of five years from the date of maintenance. These records should be made available to the governing municipality for inspection upon request at any time.

3. Transport all debris, trash, organics and sediments to approved facility for disposal in accordance with local and state requirements.

4. Entry into chambers may require confined space training based on state and local regulations.

5. No fertilizer shall be used in the Biofiltration Chamber.

6. Irrigation should be provided as recommended by manufacturer and/or landscape architect. Amount of irrigation required is dependent on plant species. Some plants may require irrigation.

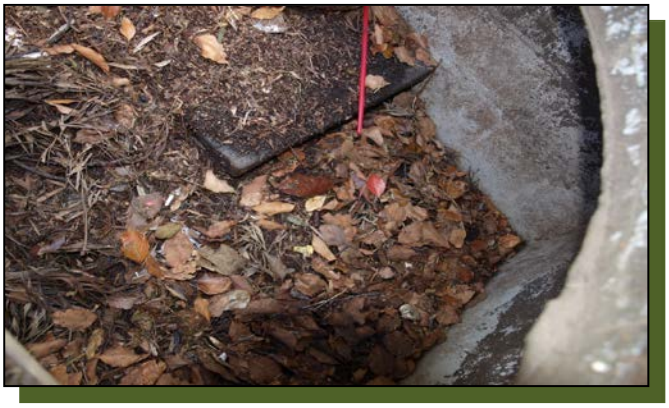
Maintenance Procedure Illustration

Screening Device

The screening device is located directly under the manhole or grate over the Pre-Treatment Chamber. It's mounted directly underneath for easy access and cleaning. Device can be cleaned by hand or with a vacuum truck.

Separation Chamber

The separation chamber is located directly beneath the screening device. It can be quickly cleaned using a vacuum truck or by hand. A pressure washer is useful to assist in the cleaning process.



Cartridge Filters

The cartridge filters are located in the Pre-Treatment chamber connected to the wall adjacent to the biofiltration chamber. The cartridges have removable tops to access the individual media filters. Once the cartridge is open media can be easily removed and replaced by hand or a vacuum truck.

Drain Down Filter

The drain down filter is located in the Discharge Chamber. The drain filter unlocks from the wall mount and hinges up. Remove filter block and replace with new block.

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Trim Vegetation

Vegetation should be maintained in the same manner as surrounding vegetation and trimmed as needed. No fertilizer shall be used on the plants. Irrigation per the recommendation of the manufacturer and or landscape architect. Different types of vegetation requires different amounts of irrigation.

Inspection Form

Bio Clean
P. 855-566-3938
F. 760-433-3176
E. Info@BioCleanEnvironmental.com

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Inspection Report
Modular Wetlands System

Project Name _____

Project Address _____
(city) (Zip Code)

Owner / Management Company _____

Contact _____ Phone ( ) –

Inspector Name _____ Date ___/___/___ Time _____ AM / PM

Type of Inspection ☐ Routine ☐ Follow Up ☐ Complaint ☐ Storm Storm Event in Last 72-hours? ☐ No ☐ Yes

Weather Condition _____ Additional Notes _____

For Office Use Only
(Reviewed By)
(Date)
Office personnel to complete section to the left.

Inspection Checklist

Modular Wetland System Type (Curb, Grate or UG Vault): _____ Size (22', 14' or etc.): _____

Structural Integrity:	**Yes**	**No**	**Comments**
Damage to pre-treatment access cover (manhole cover/grate) or cannot be opened using normal lifting pressure?			
Damage to discharge chamber access cover (manhole cover/grate) or cannot be opened using normal lifting pressure?			
Does the MWS unit show signs of structural deterioration (cracks in the wall, damage to frame)?			
Is the inlet/outlet pipe or drain down pipe damaged or otherwise not functioning properly?			
Working Condition:			
Is there evidence of illicit discharge or excessive oil, grease, or other automobile fluids entering and clogging the unit?			
Is there standing water in inappropriate areas after a dry period?			
Is the filter insert (if applicable) at capacity and/or is there an accumulation of debris/trash on the shelf system?			
Does the depth of sediment/trash/debris suggest a blockage of the inflow pipe, bypass or cartridge filter? If yes, specify which one in the comments section. Note depth of accumulation in in pre-treatment chamber.			Depth:
Does the cartridge filter media need replacement in pre-treatment chamber and/or discharge chamber?			Chamber:
Any signs of improper functioning in the discharge chamber? Note issues in comments section.			
Other Inspection Items:			
Is there an accumulation of sediment/trash/debris in the wetland media (if applicable)?			
Is it evident that the plants are alive and healthy (if applicable)? Please note Plant Information below.			
Is there a septic or foul odor coming from inside the system?			

Waste:	**Yes**	**No**
Sediment / Silt / Clay		
Trash / Bags / Bottles		
Green Waste / Leaves / Foliage		

Recommended Maintenance	
No Cleaning Needed	
Schedule Maintenance as Planned	
Needs Immediate Maintenance	

Plant Information	
Damage to Plants	
Plant Replacement	
Plant Trimming	

Additional Notes: _____

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Maintenance Report

Bio Clean
P. 855-566-3938
F. 760-433-3176
E. Info@BioCleanEnvironmental.com

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A Forterra Company

Cleaning and Maintenance Report
Modular Wetlands System

Project Name _____

Project Address _____
(city) (Zip Code)

Owner / Management Company _____

Contact _____ Phone ( ) –

Inspector Name _____ Date ____/____/____ Time _____ AM / PM

Type of Inspection ☐ Routine ☐ Follow Up ☐ Complaint ☐ Storm Storm Event in Last 72-hours? ☐ No ☐ Yes

Weather Condition _____ Additional Notes _____

For Office Use Only
(Reviewed By)
(Date)
Office personnel to complete section to the left.

Site Map #	GPS Coordinates of Insert	Manufacturer / Description / Sizing	Trash Accumulation	Foliage Accumulation	Sediment Accumulation	Total Debris Accumulation	Condition of Media 25/50/75/100 (will be changed @ 75%)	Operational Per Manufactures' Specifications (If not, why?)
	Lat: Long:	MWS Catch Basins						
		MWS Sedimentation Basin						
		Media Filter Condition						
		Plant Condition						
		Drain Down Media Condition						
		Discharge Chamber Condition						
		Drain Down Pipe Condition						
		Inlet and Outlet Pipe Condition						

Comments:

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Non-Stormwater Discharges SC-10

Description

Non-stormwater discharges (NSWDs) are flows that do not consist entirely of stormwater. Some non-stormwater discharges do not include pollutants and may be discharged to the storm drain if local regulations allow. These include uncontaminated groundwater and natural springs. There are also some non-stormwater discharges that typically do not contain pollutants and may be discharged to the storm drain with conditions. These include: potable water sources, fire hydrant flushing, air conditioner condensate, landscape irrigation drainage and landscape watering, emergency firefighting, etc. as discussed in Section 2.

However there are certain non-stormwater discharges that pose an environmental concern. These discharges may originate from illegal dumping of industrial material or wastes and illegal connections such as internal floor drains, appliances, industrial processes, sinks, and toilets that are illegally connected to the nearby storm drainage system through on-site drainage and piping. These unauthorized discharges (examples of which may include: process waste waters, cooling waters, wash waters, and sanitary wastewater) can carry substances such as paint, oil, fuel and other automotive fluids, chemicals and other pollutants into storm drains.

Non-stormwater discharges will need to be addressed through a combination of detection and elimination. The ultimate goal is to effectively eliminate unauthorized non-stormwater discharges to the stormwater drainage system through implementation of measures to detect, correct, and enforce against illicit connections and illegal discharges of

Objectives
■ *Cover*
■ *Contain*
■ *Educate*
■ *Reduce/Minimize*
■ *Product Substitution*

Targeted Constituents	
Sediment	
Nutrients	✓
Trash	
Metals	✓
Bacteria	✓
Oil and Grease	✓
Organics	✓

Minimum BMPs Covered	
Good Housekeeping	✓
Preventative Maintenance	
Spill and Leak Prevention and Response	✓
Material Handling & Waste Management	
Erosion and Sediment Controls	
Employee Training Program	✓
Quality Assurance Record Keeping	✓

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pollutants on streets and into the storm drain system and downstream water bodies.

Approach

Initially the Discharger must make an assessment of non-stormwater discharges to determine which types must be eliminated or addressed through BMPs. The focus of the following approach is the elimination of unauthorized non-stormwater discharges. See other BMP Fact Sheets for activity-specific pollution prevention procedures.

General Pollution Prevention Protocols

- Implement waste management controls described in SC-34 Waste Handling and Disposal.

- Develop clear protocols and lines of communication for effectively prohibiting non-stormwater discharges, especially those that are not classified as hazardous. These are often not responded to as effectively as they need to be.

- Stencil or demarcate storm drains, where applicable, to prevent illegal disposal of pollutants. Storm drain inlets should have messages such as "Dump No Waste Drains to Stream" or similar stenciled or demarcated next to them to warn against ignorant or unintentional dumping of pollutants into the storm drainage system.

- Manage and control sources of water such as hose bibs, faucets, wash racks, irrigation heads, etc. Identify hoses and faucets in the SWPPP, and post signage for appropriate use.

Non-Stormwater Discharge Investigation Protocols

Identifying the sources of non-stormwater discharges requires the Discharger to conduct an investigation of the facility at regular intervals. There are several categories of non-stormwater discharges:

- Visible, easily identifiable discharges, typically generated as surface runoff, such as uncontained surface runoff from vehicle or equipment washing; and

- Non-visible, (e.g., subsurface) discharges into the site drainage system through a variety of pathways that are not obvious.

The approach to detecting and eliminating non-stormwater discharges will vary considerably, as discussed below:

Visible and identifiable discharges

- Conduct routine inspections of the facilities and of each major activity area and identify visible evidence of unauthorized non-stormwater discharges. This may include:

  - ✓ Visual observations of actual discharges occurring;

- ✓ Evidence of surface staining, discoloring etc. that indicates that discharges have occurred;
- ✓ Pools of water in low lying areas when a rain event has not occurred; and
- ✓ Discussions with operations personnel to understand practices that may lead to unauthorized discharges.

- □ If evidence of non-stormwater discharges is discovered:
  - ✓ Document the location and circumstances using Worksheets 5 and 6 (Section 2 of the manual), including digital photos;
  - ✓ Identify and implement any quick remedy or corrective action (e.g., moving uncovered containers inside or to a proper location); and
  - ✓ Develop a plan to eliminate the discharge. Consult the appropriate activity-specific BMP Fact Sheet for alternative approaches to manage and eliminate the discharge.
- □ Consult the appropriate activity-specific BMP Fact Sheet for alternative approaches to manage and eliminate the discharge. Make sure the facility SWPPP is up-to-date and includes applicable BMPs to address the non-stormwater discharge.

Other Illegal Discharges (Non visible)

Illicit Connections

- □ Locate discharges from the industrial storm drainage system to the municipal storm drain system through review of "as-built" piping schematics.
- □ Isolate problem areas and plug illicit discharge points.
- □ Locate and evaluate discharges to the storm drain system.
- □ Visual Inspection and Inventory:
  - ✓ Inventory and inspect each discharge point during dry weather.
  - ✓ Keep in mind that drainage from a storm event can continue for a day or two following the end of a storm and groundwater may infiltrate the underground stormwater collection system.
  - ✓ Non-stormwater discharges are often intermittent and may require periodic inspections.

Review Infield Piping

- □ A review of the "as-built" piping schematic is a way to determine if there are any connections to the stormwater collection system.

- Inspect the path of loading/unloading area drain inlets and floor drains in older buildings.

- Never assume storm drains are connected to the sanitary sewer system.

Monitoring for investigation/detection of illegal discharges

- If a suspected illegal or unknown discharge is detected, monitoring of the discharge may help identify the content and/or suggest the source. This may be done with a field screening analysis, flow meter measurements, or by collecting a sample for laboratory analysis. Section 5 and Appendix D describe the necessary field equipment and procedures for field investigations.

- Investigative monitoring may be conducted over time. For example if, a discharge is intermittent, then monitoring might be conducted to determine the timing of the discharge to determine the source.

- Investigative monitoring may be conducted over a spatial area. For example, if a discharge is observed in a pipe, then monitoring might be conducted at accessible upstream locations in order to pinpoint the source of the discharge.

- Generally, investigative monitoring requiring collection of samples and submittal for lab analysis requires proper planning and specially trained staff.

Smoke Testing

Smoke testing of wastewater and stormwater collection systems is used to detect connections between the two piping systems. Smoke testing is generally performed at a downstream location and the smoke is forced upstream using blowers to create positive pressure. The advantage to smoke testing is that it can potentially identify multiple potential discharge sources at once.

- Smoke testing uses a harmless, non-toxic smoke cartridges developed specifically for this purpose.

- Smoke testing requires specialized equipment (e.g., cartridges, blowers) and is generally only appropriate for specially trained staff.

- A Standard Operating Procedure (SOP) for smoke testing is highly desirable. The SOP should address the following elements:

  - ✓ Proper planning and notification of nearby residents and emergency services is necessary since introducing smoke into the system may result in false alarms;

  - ✓ During dry weather, the stormwater collection system is filled with smoke and then traced back to sources;

- ✓ Temporary isolation of segments of pipe using sand bags is often needed to force the smoke into leaking pipes; and
- ✓ The appearance of smoke in a waste vent pipe, at a sewer manhole, or even the base of a toilet indicates that there may be a connection between the sanitary and storm water systems.

- Most municipal wastewater agencies will have necessary staff and equipment to conduct smoke testing and they should be contacted if cross connections with the sanitary sewer are suspected. See SC-44 Drainage System Maintenance for more information.

Dye Testing

- Dye testing is typically performed when there is a suspected specific pollutant source and location (i.e., leaking sanitary sewer) and there is evidence of dry weather flows in the stormwater collection system.
- Dye is released at a probable upstream source location, either the facility's sanitary or process wastewater system. The dye must be released with a sufficient volume of water to flush the system.
- Operators then visually examine the downstream discharge points from the stormwater collection system for the presence of the dye.
- Dye testing can be performed informally using commercially available products in order to conduct an initial investigation for fairly obvious cross-connections.
- More detailed dye testing should be performed by properly trained staff and follow SOPs. Specialized equipment such as fluorometers may be necessary to detect low concentrations of dye.
- Most municipal wastewater agencies will have necessary staff and equipment to conduct dye testing and they should be contacted if cross connections with the sanitary sewer are suspected.

TV Inspection of Drainage System

- Closed Circuit Television (CCTV) can be employed to visually identify illicit connections to the industrial storm drainage system. Two types of CCTV systems are available: (1) a small specially designed camera that can be manually pushed on a stiff cable through storm drains to observe the interior of the piping, or (2) a larger remote operated video camera on treads or wheels that can be guided through storm drains to view the interior of the pipe.
- CCTV systems often include a high-pressure water jet and camera on a flexible cable. The water jet cleans debris and biofilm off the inside of pipes so the camera can take video images of the pipe condition.

- CCTV units can detect large cracks and other defects such as offsets in pipe ends caused by root intrusions or shifting substrate.
- CCTV can also be used to detect dye introduced into the sanitary sewer.
- CCTV inspections require specialized equipment and properly trained staff and are generally best left to specialized contractors or municipal public works staff.

Illegal Dumping

- Substances illegally dumped on streets and into the storm drain systems and creeks may include paints, used oil and other automotive fluids, construction debris, chemicals, fresh concrete, leaves, grass clippings, and pet wastes. These wastes can cause stormwater and receiving water quality problems as well as clog the storm drain system itself.
- Establish a system for tracking incidents. The system should be designed to identify the following:
  - ✓ Illegal dumping hot spots;
  - ✓ Types and quantities (in some cases) of wastes;
  - ✓ Patterns in time of occurrence (time of day/night, month, or year);
  - ✓ Mode of dumping (abandoned containers, "midnight dumping" from moving vehicles, direct dumping of materials, accidents/spills);
  - ✓ An anonymous tip/reporting mechanism; and
  - ✓ Evidence of responsible parties (e.g., tagging, encampments, etc.).
- One of the keys to success of reducing or eliminating illegal dumping is increasing the number of people at the facility who are aware of the problem and who have the tools to at least identify the incident, if not correct it. Therefore, train field staff to recognize and report the incidents.

Once a site has been cleaned:

- Post "No Dumping" signs with a phone number for reporting dumping and disposal.
- Landscaping and beautification efforts of hot spots may also discourage future dumping, as well as provide open space and increase property values.
- Lighting or barriers may also be needed to discourage future dumping.
- See fact sheet SC-11 Spill Prevention, Control, and Cleanup.

Inspection

- Regularly inspect and clean up hot spots and other storm drainage areas where illegal dumping and disposal occurs.
- Conduct field investigations of the industrial storm drain system for potential sources of non-stormwater discharges.
- Pro-actively conduct investigations of high priority areas. Based on historical data, prioritize specific geographic areas and/or incident type for pro-active investigations.

Spill and Leak Prevention and Response

- On paved surfaces, clean up spills with as little water as possible. Use a rag for small spills, a damp mop for general cleanup, and absorbent material for larger spills. If the spilled material is hazardous, then the used cleanup materials are also hazardous and must be sent to a certified laundry (rags) or disposed of as hazardous waste.
- Never hose down or bury dry material spills. Sweep up the material and dispose of properly.
- Use adsorbent materials on small spills rather than hosing down the spill. Remove the adsorbent materials promptly and dispose of properly.
- For larger spills, a private spill cleanup company or Hazmat team may be necessary.
- See SC-11 Spill Prevention Control and Cleanup.

Employee Training Program

- Training of technical staff in identifying and documenting illegal dumping incidents is required. The frequency of training must be presented in the SWPPP, and depends on site-specific industrial materials and activities.
- Consider posting a quick reference table near storm drains to reinforce training.
- Train employees to identify non-stormwater discharges and report discharges to the appropriate departments.
- Educate employees about spill prevention and cleanup.
- Well-trained employees can reduce human errors that lead to accidental releases or spills. The employee should have the tools and knowledge to immediately begin cleaning up a spill should one occur. Employees should be familiar with the Spill Prevention Control and Countermeasure Plan. Employees should be able to identify work/jobs with high potential for spills and suggest methods to reduce possibility.
- Determine and implement appropriate outreach efforts to reduce non-permissible non-stormwater discharges.

- Conduct spill response drills annually (if no events occurred) in order to evaluate the effectiveness of the plan.
- When a responsible party is identified, educate the party on the impacts of his or her actions.

Quality Assurance and Record Keeping

Performance Evaluation

- Annually review internal investigation results; assess whether goals were met and what changes or improvements are necessary.
- Obtain feedback from personnel assigned to respond to, or inspect for, illicit connections and illegal dumping incidents.
- Develop document and data management procedures.
- A database is useful for defining and tracking the magnitude and location of the problem.
- Report prohibited non-stormwater discharges observed during the course of normal daily activities so they can be investigated, contained, and cleaned up or eliminated.
- Document that non-stormwater discharges have been eliminated by recording tests performed, methods used, dates of testing, and any on-site drainage points observed.
- Annually document and report the results of the program.
- Maintain documentation of illicit connection and illegal dumping incidents, including significant conditionally exempt discharges that are not properly managed.
- Document training activities.

Potential Limitations and Work-Arounds

Some facilities may have space constraints, limited staffing and time limitations that may preclude implementation of BMPs. Provided below are typical limitations and recommended "work-arounds."

- Many facilities do not have accurate, up-to-date 'as-built' plans or drawings which may be necessary in order to conduct non-stormwater discharge assessments.
  - ✓ Online tools such as Google Earth™ can provide an aerial view of the facility and may be useful in understanding drainage patterns and potential sources of non-stormwater discharges
  - ✓ Local municipal jurisdictions may have useful drainage systems maps.

- Video surveillance cameras are commonly used to secure the perimeter of industrial facilities against break-ins and theft. These surveillance systems may also be useful for capturing illegal dumping activities. Minor, temporary adjustments to the field of view of existing surveillance camera systems to target known or suspected problem areas may be a cost-effective way of capturing illegal dumping activities and identifying the perpetrators.

Potential Capital Facility Costs and Operation & Maintenance Requirements

Facilities

- Capital facility cost requirements may be minimal unless cross-connections to storm drains are detected.
- Indoor floor drains may require re-plumbing if cross-connections are detected.
- Leaky sanitary sewers will require repair or replacement which can have significant costs depending on the size and industrial activity at the facility.

Maintenance (including administrative and staffing)

- The primary effort is for staff time and depends on how aggressively a program is implemented.
- Costs for containment, and disposal of any leak or discharge is borne by the Discharger.
- Illicit connections can be difficult to locate especially if there is groundwater infiltration.
- Illegal dumping and illicit connection violations requires technical staff to detect and investigate them.

Supplemental Information

Permit Requirements

The IGP authorizes certain Non-Storm Water Discharges (NSWDs) provided BMPs are included in the SWPPP and implemented to:

- Reduce or prevent the contact of authorized NSWDs with materials or equipment that are potential sources of pollutants;
- Reduce, to the extent practicable, the flow or volume of authorized NSWDs;
- Ensure that authorized NSWDs do not contain quantities of pollutants that cause or contribute to an exceedance of a water quality standards (WQS); and,

- Reduce or prevent discharges of pollutants in authorized NSWDs in a manner that reflects best industry practice considering technological availability and economic practicability and achievability."

References and Resources

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Spill Prevention, Control & Cleanup SC-11

Description

Many activities that occur at an industrial or commercial site have the potential to cause accidental spills. Preparation for accidental spills, with proper training and reporting systems implemented, can minimize the discharge of pollutants to the environment.

Spills and leaks are one of the largest contributors of stormwater pollutants. Spill prevention and control plans are applicable to any site at which hazardous materials are stored or used. An effective plan should have spill prevention and response procedures that identify hazardous material storage areas, specify material handling procedures, describe spill response procedures, and provide locations of spill clean-up equipment and materials. The plan should take steps to identify and characterize potential spills, eliminate and reduce spill potential, respond to spills when they occur in an effort to prevent pollutants from entering the stormwater drainage system, and train personnel to prevent and control future spills. An adequate supply of spill clean-up materials must be maintained onsite.

Objectives
■ *Cover*
■ *Contain*
■ *Educate*
■ *Reduce/Minimize*
■ *Product Substitution*

Targeted Constituents	
Sediment	
Nutrients	
Trash	
Metals	✓
Bacteria	
Oil and Grease	✓
Organics	✓

Minimum BMPs Covered	
Good Housekeeping	
Preventative Maintenance	
Spill and Leak Prevention and Response	✓
Material Handling & Waste Management	
Erosion and Sediment Controls	
Employee Training Program	✓
Quality Assurance Record Keeping	✓

Approach

General Pollution Prevention Protocols

- ☐ Develop procedures to prevent/mitigate spills to storm drain systems.
- ☐ Develop and standardize reporting procedures, containment, storage, and disposal activities, documentation, and follow-up procedures.
- ☐ Establish procedures and/or controls to minimize spills and leaks. The procedures should address:
  - ✓ Description of the facility, owner and address, activities, chemicals, and quantities present;

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- ✓ Facility map of the locations of industrial materials;
- ✓ Notification and evacuation procedures;
- ✓ Cleanup instructions;
- ✓ Identification of responsible departments; and
- ✓ Identify key spill response personnel.

- ☐ Recycle, reclaim, or reuse materials whenever possible. This will reduce the amount of process materials that are brought into the facility.

Spill and Leak Prevention and Response

Spill Prevention

- ☐ Develop procedures to prevent/mitigate spills to storm drain systems. Develop and standardize reporting procedures, containment, storage, and disposal activities, documentation, and follow-up procedures.

- ☐ If illegal dumping is observed at the facility:

  - ✓ Post "No Dumping" signs with a phone number for reporting illegal dumping and disposal. Signs should also indicate fines and penalties applicable for illegal dumping.
  - ✓ Landscaping and beautification efforts may also discourage illegal dumping.
  - ✓ Bright lighting and/or entrance barriers may also be needed to discourage illegal dumping.

- ☐ Store and contain liquid materials in such a manner that if the container is ruptured, the contents will not discharge, flow, or be washed into the storm drainage system, surface waters, or groundwater.

- ☐ If the liquid is oil, gas, or other material that separates from and floats on water, install a spill control device (such as a tee section) in the catch basins that collects runoff from the storage tank area.

Preventative Maintenance

- ☐ Place drip pans or absorbent materials beneath all mounted taps, and at all potential drip and spill locations during filling and unloading of tanks. Any collected liquids or soiled absorbent materials must be reused/recycled or properly disposed.

- ☐ Store and maintain appropriate spill cleanup materials in a location known to all near the tank storage area; and ensure that employees are familiar with the site's spill control plan and/or proper spill cleanup procedures.

- ☐ Sweep and clean the storage area monthly if it is paved, *do not hose down the area to a storm drain.*

- ☐ Check tanks (and any containment sumps) daily for leaks and spills. Replace tanks that are leaking, corroded, or otherwise deteriorating with tanks in good condition. Collect all spilled liquids and properly dispose of them.

- ☐ Label all containers according to their contents (e.g., solvent, gasoline).

- ☐ Label hazardous substances regarding the potential hazard (corrosive, radioactive, flammable, explosive, poisonous).

- ☐ Prominently display required labels on transported hazardous and toxic materials (per US DOT regulations).

- ☐ Identify key spill response personnel.

Spill Response

- ☐ Clean up leaks and spills immediately.

- ☐ Place a stockpile of spill cleanup materials where it will be readily accessible (e.g., near storage and maintenance areas).

- ☐ On paved surfaces, clean up spills with as little water as possible.

  - ✓ Use a rag for small spills, a damp mop for general cleanup, and absorbent material for larger spills.

  - ✓ If the spilled material is hazardous, then the used cleanup materials are also hazardous and must be sent to a certified laundry (rags) or disposed of as hazardous waste.

  - ✓ If possible use physical methods for the cleanup of dry chemicals (e.g., brooms, shovels, sweepers, or vacuums).

- ☐ Never hose down or bury dry material spills. Sweep up the material and dispose of properly.

- ☐ Chemical cleanups of material can be achieved with the use of adsorbents, gels, and foams. Use adsorbent materials on small spills rather than hosing down the spill. Remove the adsorbent materials promptly and dispose of properly.

- ☐ For larger spills, a private spill cleanup company or Hazmat team may be necessary.

Reporting

- Report spills that pose an immediate threat to human health or the environment to the Regional Water Quality Control Board or local authority as location regulations dictate.
- Federal regulations require that any oil spill into a water body or onto an adjoining shoreline be reported to the National Response Center (NRC) at 800-424-8802 (24 hour).
- Report spills to 911 for dispatch and clean-up assistance when needed. Do not contact fire agencies directly.
- Establish a system for tracking incidents. The system should be designed to identify the following:
  - ✓ Types and quantities (in some cases) of wastes;
  - ✓ Patterns in time of occurrence (time of day/night, month, or year);
  - ✓ Mode of dumping (abandoned containers, "midnight dumping" from moving vehicles, direct dumping of materials, accidents/spills);
  - ✓ Clean-up procedures; and
  - ✓ Responsible parties.

Employee Training Program

- Educate employees about spill prevention and cleanup.
- Well-trained employees can reduce human errors that lead to accidental releases or spills:
  - ✓ The employee should have the tools and knowledge to immediately begin cleaning up a spill should one occur; and
  - ✓ Employees should be familiar with the Spill Prevention Control and Countermeasure Plan.
- Employees should be educated about aboveground storage tank requirements. Employees responsible for aboveground storage tanks and liquid transfers should be thoroughly familiar with the Spill Prevention Control and Countermeasure Plan and the plan should be readily available.
- Train employees to recognize and report illegal dumping incidents.

Other Considerations (Limitations and Regulations)

- State regulations exist for facilities with a storage capacity of 10,000 gallons or more of petroleum to prepare a Spill Prevention Control and Countermeasure (SPCC) Plan (Health & Safety Code Chapter 6.67).
- State regulations also exist for storage of hazardous materials (Health & Safety Code Chapter 6.95), including the preparation of area and business plans for emergency response to the releases or threatened releases.
- Consider requiring smaller secondary containment areas (less than 200 sq. ft.) to be connected to the sanitary sewer, prohibiting any hard connections to the storm drain.

Requirements

Costs (including capital and operation & maintenance)

- Will vary depending on the size of the facility and the necessary controls.
- Prevention of leaks and spills is inexpensive. Treatment and/or disposal of contaminated soil or water can be quite expensive.

Maintenance (including administrative and staffing)

- Develop spill prevention and control plan, provide and document training, conduct inspections of material storage areas, and supply spill kits.
- Extra time is needed to properly handle and dispose of spills, which results in increased labor costs.

Supplemental Information

Further Detail of the BMP

Reporting

Record keeping and internal reporting represent good operating practices because they can increase the efficiency of the facility and the effectiveness of BMPs. A good record keeping system helps the facility minimize incident recurrence, correctly respond with appropriate cleanup activities, and comply with legal requirements. A record keeping and reporting system should be set up for documenting spills, leaks, and other discharges, including discharges of hazardous substances in reportable quantities. Incident records describe the quality and quantity of non-stormwater discharges to the storm sewer. These records should contain the following information:

- Date and time of the incident;
- Weather conditions;
- Duration of the spill/leak/discharge;

- Cause of the spill/leak/discharge;
- Response procedures implemented;
- Persons notified; and
- Environmental problems associated with the spill/leak/discharge.

Separate record keeping systems should be established to document housekeeping and preventive maintenance inspections, and training activities. All housekeeping and preventive maintenance inspections should be documented. Inspection documentation should contain the following information:

- Date and time the inspection was performed;
- Name of the inspector;
- Items inspected;
- Problems noted;
- Corrective action required; and
- Date corrective action was taken.

Other means to document and record inspection results are field notes, timed and dated photographs, videotapes, and drawings and maps.

Aboveground Tank Leak and Spill Control

Accidental releases of materials from aboveground liquid storage tanks present the potential for contaminating stormwater with many different pollutants. Materials spilled, leaked, or lost from tanks may accumulate in soils or on impervious surfaces and be carried away by stormwater runoff.

The most common causes of unintentional releases are:

- Installation problems;
- Failure of piping systems (pipes, pumps, flanges, couplings, hoses, and valves);
- External corrosion and structural failure;
- Spills and overfills due to operator error; and
- Leaks during pumping of liquids or gases from truck or rail car to a storage tank or vice versa.

Storage of reactive, ignitable, or flammable liquids should comply with the Uniform Fire Code and the National Electric Code. Practices listed below should be employed to enhance the code requirements:

- Tanks should be placed in a designated area.
- Tanks located in areas where firearms are discharged should be encapsulated in concrete or the equivalent.
- Designated areas should be impervious and paved with Portland cement concrete, free of cracks and gaps, in order to contain leaks and spills.
- Liquid materials should be stored in UL approved double walled tanks or surrounded by a curb or dike to provide the volume to contain 10 percent of the volume of all of the containers or 110 percent of the volume of the largest container, whichever is greater. The area inside the curb should slope to a drain.
- For used oil or dangerous waste, a dead-end sump should be installed in the drain.
- All other liquids should be drained to the sanitary sewer if available. The drain must have a positive control such as a lock, valve, or plug to prevent release of contaminated liquids.
- Accumulated stormwater in petroleum storage areas should be passed through an oil/water separator.

Maintenance is critical to preventing leaks and spills. Conduct routine inspections and:

- Check for external corrosion and structural failure.
- Check for spills and overfills due to operator error.
- Check for failure of piping system (pipes, pumps, flanges, coupling, hoses, and valves).
- Check for leaks or spills during pumping of liquids or gases from truck or rail car to a storage facility or vice versa.
- Visually inspect new tank or container installation for loose fittings, poor welding, and improper or poorly fitted gaskets.
- Inspect tank foundations, connections, coatings, and tank walls and piping system. Look for corrosion, leaks, cracks, scratches, and other physical damage that may weaken the tank or container system.
- Frequently relocate accumulated stormwater during the wet season.

- Periodically conduct integrity testing by a qualified professional.

Vehicle Leak and Spill Control

Major spills on roadways and other public areas are generally handled by highly trained Hazmat teams from local fire departments or environmental health departments. The measures listed below pertain to leaks and smaller spills at vehicle maintenance shops.

In addition to implementing the spill prevention, control, and clean up practices above, use the following measures related to specific activities:

Vehicle and Equipment Maintenance

- Perform all vehicle fluid removal or changing inside or under cover to prevent the run-on of stormwater and the runoff of spills.
- Regularly inspect vehicles and equipment for leaks, and repair immediately.
- Check incoming vehicles and equipment (including delivery trucks, and employee and subcontractor vehicles) for leaking oil and fluids. Do not allow leaking vehicles or equipment onsite.
- Always use secondary containment, such as a drain pan or drop cloth, to catch spills or leaks when removing or changing fluids.
- Immediately drain all fluids from wrecked vehicles.
- Store wrecked vehicles or damaged equipment under cover.
- Place drip pans or absorbent materials under heavy equipment when not in use.
- Use absorbent materials on small spills rather than hosing down the spill.
- Remove the adsorbent materials promptly and dispose of properly.
- Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around.
- Oil filters disposed of in trashcans or dumpsters can leak oil and contaminate stormwater. Place the oil filter in a funnel over a waste oil recycling drum to drain excess oil before disposal. Oil filters can also be recycled. Ask your oil supplier or recycler about recycling oil filters.
- Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries, even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

Vehicle and Equipment Fueling

- Design the fueling area to prevent the run-on of stormwater and the runoff of spills:

  Cover fueling area if possible.

  Use a perimeter drain or slope pavement inward with drainage to a sump.

  Pave fueling area with concrete rather than asphalt.

- If dead-end sump is not used to collect spills, install an oil/water separator.
- Install vapor recovery nozzles to help control drips as well as air pollution.
- Discourage "topping-off" of fuel tanks.
- Use secondary containment when transferring fuel from the tank truck to the fuel tank.
- Use absorbent materials on small spills and general cleaning rather than hosing down the area. Remove the absorbent materials promptly.
- Carry out all Federal and State requirements regarding underground storage tanks, or install above ground tanks.
- Do not use mobile fueling of mobile industrial equipment around the facility; rather, transport the equipment to designated fueling areas.
- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Train employees in proper fueling and cleanup procedures.

Industrial Spill Prevention Response

For the purposes of developing a spill prevention and response program to meet the stormwater regulations, facility managers should use information provided in this fact sheet and the spill prevention/response portions of the fact sheets in this handbook, for specific activities.

The program should:

- Integrate with existing emergency response/hazardous materials programs (e.g., Fire Department).
- Develop procedures to prevent/mitigate spills to storm drain systems.
- Identify responsible departments.

- Develop and standardize reporting procedures, containment, storage, and disposal activities, documentation, and follow-up procedures.
- Address spills at municipal facilities, as well as public areas.
- Provide training concerning spill prevention, response and cleanup to all appropriate personnel.

References and Resources

California's Nonpoint Source Program Plan. http://www.swrcb.ca.gov/nps/index.html.

Clark County Storm Water Pollution Control Manual. Available online at: http://www.co.clark.wa.us/pubworks/bmpman.pdf.

King County Storm Water Pollution Control Manual. Available online at: http://dnr.metrokc.gov/wlr/dss/spcm.htm.

Orange County Stormwater Program, Best Management Practices for Industrial/Commercial Business Activities. Available online at: http://ocwatersheds.com/documents/bmp/industrialcommercialbusinessesactivities

Santa Clara Valley Urban Runoff Pollution Prevention Program. http://www.scvurppp.org.

The Stormwater Managers Resource Center. http://www.stormwatercenter.net/.

Outdoor Loading/Unloading SC-30

Description

The loading/unloading of materials usually takes place outside on docks or terminals; therefore, materials spilled, leaked, or lost during loading/unloading may collect in the soil or on other surfaces and have the potential to be carried away by wind, stormwater runoff or when the area is cleaned. Additionally, rainfall may wash pollutants from machinery used to unload or move materials. Implementation of the following protocols will prevent or reduce the discharge of pollutants to stormwater from outdoor loading/unloading of materials.

Approach

Reduce potential for pollutant discharge through source control pollution prevention and BMP implementation. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

General Pollution Prevention Protocols

- Park tank trucks or delivery vehicles in designated areas so that spills or leaks can be contained.
- Limit exposure of material to rainfall whenever possible.
- Prevent stormwater run-on.
- Check equipment regularly for leaks.

Good Housekeeping

- Develop an operations plan that describes procedures for loading and/or unloading.
- Conduct loading and unloading in dry weather if possible.

Objectives
■ *Cover*
■ *Contain*
■ *Educate*
■ *Reduce/Minimize*
■ *Product Substitution*

Targeted Constituents	
Sediment	✓
Nutrients	✓
Trash	
Metals	✓
Bacteria	
Oil and Grease	✓
Organics	✓

Minimum BMPs Covered	
Good Housekeeping	✓
Preventative Maintenance	
Spill and Leak Prevention and Response	✓
Material Handling & Waste Management	✓
Erosion and Sediment Controls	
Employee Training Program	✓
Quality Assurance Record Keeping	✓

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- Cover designated loading/unloading areas to reduce exposure of materials to rain.
- Consider placing a seal or door skirt between delivery vehicles and building to prevent exposure to rain.
- Design loading/unloading area to prevent stormwater run-on, which would include grading or berming the area, and position roof downspouts so they direct stormwater away from the loading/unloading areas.
- Have employees load and unload all materials and equipment in covered areas such as building overhangs at loading docks if feasible.
- Load/unload only at designated loading areas.
- Use drip pans underneath hose and pipe connections and other leak-prone spots during liquid transfer operations, and when making and breaking connections. Several drip pans should be stored in a covered location near the liquid transfer area so that they are always available, yet protected from precipitation when not in use. Drip pans can be made specifically for railroad tracks. Drip pans must be cleaned periodically, and drip collected materials must be disposed of properly.
- Pave loading areas with concrete instead of asphalt.
- Avoid placing storm drains inlets in the area.
- Grade and/or berm the loading/unloading area with drainage to sump; regularly remove materials accumulated in sump.

Spill Response and Prevention Procedures

- Keep your spill prevention and control plan up-to-date or have an emergency spill cleanup plan readily available, as applicable.
- Contain leaks during transfer.
- Store and maintain appropriate spill cleanup materials in a location that is readily accessible and known to all employees.
- Ensure that employees are familiar with the site's spill control plan and proper spill cleanup procedures.
- Use drip pans or comparable devices when transferring oils, solvents, and paints.

Material Handling and Waste Management

- Spot clean leaks and drips routinely to prevent runoff of spillage.
- Do not pour liquid wastes into floor drains, sinks, outdoor storm drain inlets, or other storm drains or sewer connections.

- Do not put used or leftover cleaning solutions, solvents, and automotive fluids in the storm drain or sanitary sewer.
- Collect leaking or dripping fluids in drip pans or containers. Fluids are easier to recycle if kept separate.
- Promptly transfer used fluids to the proper waste or recycling drums. Do not leave drip pans or other open containers lying around.
- Minimize the possibility of stormwater pollution from outside waste receptacles by doing at least one of the following:
  - ✓ Use only watertight waste receptacle(s) and keep the lid(s) closed.
  - ✓ Grade and pave the waste receptacle area to prevent run-on of stormwater.
  - ✓ Install a roof over the waste receptacle area.
  - ✓ Install a low containment berm around the waste receptacle area.
  - ✓ Use and maintain drip pans under waste receptacles.
- Post "no littering" signs.
- Perform work area clean-up and dry sweep after daily operations.

Employee Training Program

- Train employees (e.g., fork lift operators) and contractors on proper spill containment and cleanup.
- Have employees trained in spill containment and cleanup present during loading/unloading.
- Train employees in proper handling techniques during liquid transfers to avoid spills.
- Make sure forklift operators are properly trained on loading and unloading procedures.

Quality Assurance and Record Keeping

- Keep accurate maintenance logs that document activities performed, quantities of materials removed, and improvement actions.
- Keep accurate logs of spill response actions that document what was spilled, how it was cleaned up, and how the waste was disposed.
- Establish procedures to complete logs and file them in the central office.
- Keep accurate logs of daily clean-up operations.

Potential Limitations and Work-Arounds

Some facilities may have space constraints, limited staffing and time limitations that may preclude implementation of BMPs. Provided below are typical limitations and recommended "work-arounds."

- Space and time limitations may preclude all transfers from being performed indoors or under cover.
  - ✓ Designate specific areas for outdoor loading and unloading.
  - ✓ Require employees to understand and follow spill and leak prevention BMPs.
- It may not be possible to conduct transfers only during dry weather.
  - ✓ Limit materials and equipment rainfall exposure to all extents practicable.
  - ✓ Require employees to understand and follow spill and leak prevention BMPs.

Potential Capital Facility Costs and Operation & Maintenance Requirements

Facilities

Many facilities will already have indoor or covered areas where loading/unloading takes place and will require no additional capital expenditures.

If outdoor activities are required, construction of berms or other means to retain spills and leaks may require appropriate constructed systems for containment. These containment areas may require significant new capital investment.

Capital investments will likely be required at some sites if adequate cover and containment facilities do not exist and can vary significantly depending upon site conditions.

Maintenance

Most of the operations and maintenance activities associated with implementing this BMP are integrally linked to routine operations as previously described. Therefore additional O&M is not required.

- Conduct regular inspections and make repairs and improvements as necessary.
- Check loading and unloading equipment regularly for leaks.
- Conduct regular broom dry-sweeping of area. Do not wash with water.

Supplemental Information

Loading and Unloading of Liquids

- Loading or unloading of liquids should occur in the manufacturing building so that any spills that are not completely retained can be discharged to the sanitary sewer,

treatment plant, or treated in a manner consistent with local sewer authorities and permit requirements.

- For loading and unloading tank trucks to above and below ground storage tanks, the following procedures should be used:
  - ✓ The area where the transfer takes place should be paved. If the liquid is reactive with the asphalt, Portland cement should be used to pave the area.
  - ✓ The transfer area should be designed to prevent run-on of stormwater from adjacent areas. Sloping the pad and using a curb, like a speed bump, around the uphill side of the transfer area should reduce run-on.
  - ✓ The transfer area should be designed to prevent runoff of spilled liquids from the area. Sloping the area to a drain should prevent runoff. The drain should be connected to a dead-end sump or to the sanitary sewer. A positive control valve should be installed on the drain.
- For transfer from rail cars to storage tanks that must occur outside, use the following procedures:
  - ✓ Drip pans should be placed at locations where spillage may occur, such as hose connections, hose reels, and filler nozzles. Use drip pans when making and breaking connections.
  - ✓ Drip pan systems should be installed between the rails to collect spillage from tank cars.

References and Resources

Minnesota Pollution Control Agency, *Industrial Stormwater Best Management Practices Guidebook BMP 26 Fueling and Liquid Loading/Unloading Operations*. Available online at: http://www.pca.state.mn.us/index.php/view-document.html?gid=10557.

New Jersey Department of Environmental Protection, 2013. *Basic Industrial Stormwater General Permit Guidance Document NJPDES General Permit No NJ0088315*. Available online at: http://www.nj.gov/dep/dwq/pdf/5G2_guidance_color.pdf.

Orange County Stormwater Program, Best Management Practices for Industrial/Commercial Business Activities. Available online at: http://ocwatersheds.com/documents/bmp/industrialcommercialbusinessesactivities.

Oregon Department of Environmental Quality, 2013. *Industrial Stormwater Best Management Practices Manual- BMP 26 Fueling and Liquid Loading/Unloading Operations*. Available online at: http://www.deq.state.or.us/wq/wqpermit/docs/IndBMP021413.pdf.

Sacramento Stormwater Management Program, *Best Management Practices for Industrial Storm Water Pollution Control*. Available online at: http://www.msa.saccounty.net/sactostormwater/documents/guides/industrial-BMP-manual.pdf.

Sacramento County Environmental Management Stormwater Program: *Best Management Practices*. Available online at: http://www.emd.saccounty.net/EnvHealth/Stormwater/Stormwater-BMPs.html.

Santa Clara Valley Urban Runoff Pollution Prevention Program. http://www.scvurppp-w2k.com/.

US EPA. National Pollutant Discharge Elimination System – Industrial Fact Sheet Series for Activities Covered by EPA's Multi Sector General Permit. Available online at: http://cfpub.epa.gov/npdes/stormwater/swsectors.cfm.

Outdoor Equipment Operations SC-32

Description

Outside process equipment operations and maintenance can contaminate stormwater runoff. Activities, such as grinding, painting, coating, sanding, degreasing or parts cleaning, landfills and waste piles, and solid waste treatment and disposal are examples of process operations that can lead to contamination of stormwater runoff. The targeted constituents will vary for each site depending on the operation being performed.

Approach

Implement source control BMPs to limit exposure of outdoor equipment to direct precipitation and stormwater run-on. Refer to SC-22 Vehicle and Equipment Repair for additional information.

General Pollution Prevention Protocols

- ☐ Perform the activity during dry periods whenever possible.
- ☐ Install secondary containment measures where leaks and spills may occur.
- ☐ Use non-toxic chemicals for maintenance and minimize or eliminate the use of solvents.
- ☐ Connect process equipment area to public sanitary sewer or facility wastewater treatment system when possible. Some jurisdictions require that secondary containment areas be connected to the sanitary sewer, prohibiting any hard connections to the storm drain.

Good Housekeeping

- ☐ Manage materials and waste properly (see Material Handling and Waste Management) to reduce adverse impacts on stormwater quality.

Objectives
■ Cover
■ *Contain*
■ *Educate*
■ *Reduce/Minimize*

Targeted Constituents	
Sediment	✓
Nutrients	✓
Trash	✓
Metals	✓
Bacteria	✓
Oil and Grease	✓
Organics	✓

Minimum BMPs Covered	
Good Housekeeping	✓
Preventative Maintenance	✓
Spill and Leak Prevention and Response	✓
Material Handling & Waste Management	✓
Erosion and Sediment Controls	
Employee Training Program	✓
Quality Assurance Record Keeping	✓

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- Cover the work area with a permanent roof if possible.
- Use drop cloths for sanding and painting operations.
- Use a vacuum for fine particle clean-up in pavement cracks and crevices.
- Minimize contact of stormwater with outside process equipment operations through berming and drainage routing (run-on prevention).
- "Spot clean" leaks and drips routinely. Leaks are not cleaned up until the absorbent is picked up and disposed of properly.
- Paint signs on storm drain inlets to indicate that they are not to receive liquid or solid wastes.
- Use roll down or permanent walls when windy/breezy to prevent wind transport of particulates/pollutants.

Preventative Maintenance

- Design outdoor equipment areas to prevent stormwater runoff and spills. Use a perimeter drain or slope pavement inward with drainage to sump.
- Dry clean the work area regularly. Do not wash outdoor equipment with water if there is a direct connection to the storm drain.
- Pave area with concrete rather than asphalt.
- Inspect outdoor equipment regularly for leaks or spills. Also check for structural failure, spills and overfills due to operator error, and/or failure of piping system.
- Inspect and clean, if necessary, storm drain inlets and catch basins within the outdoor equipment area before October 1 each year.

Spill Response and Prevention Procedures

- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Have employees trained in emergency spill cleanup procedures present when dangerous waste, liquid chemicals, or other wastes are delivered.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- Prevent operator errors by using engineering safe guards and thus reducing accidental releases of pollutant.

Material Handling and Waste Management

- Do not pour liquid wastes into floor drains, sinks, outdoor storm drain inlets, or other storm drain or sewer connections.
- Collect leaking or dripping fluids in drip pans or containers. Fluids are easier to recycle if kept separate.
- Promptly transfer used fluids to the proper waste or recycling drums. Do not leave drip pans or other open containers lying around.
- Minimize the possibility of stormwater pollution from outside waste receptacles by doing at least one of the following:
  - ✓ Use only watertight waste receptacle(s) and keep the lid(s) closed.
  - ✓ Grade and pave the waste receptacle area to prevent run-on of stormwater.
  - ✓ Install a roof over the waste receptacle area.

Employee Training Program

- Educate employees about pollution prevention measures and goals.
- Train employees on proper equipment operation and maintenance procedures.
- Train all employees upon hiring and annually thereafter on proper methods for handling and disposing of waste. Ensure that all employees understand stormwater discharge prohibitions, wastewater discharge requirements, and these best management practices.
- Use a training log or similar method to document training.
- Ensure that employees are familiar with the site's spill control plan and/or proper spill cleanup procedures.

Quality Assurance and Record Keeping

- Keep accurate maintenance logs that document minimum BMP activities performed for outdoor equipment, types and quantities of materials removed and disposed of, and any improvement actions.
- Keep accurate logs of spill response actions that document what was spilled, how it was cleaned up, and how the waste was disposed.
- Establish procedures to complete logs and file them in the central office.

Potential Limitations and Work-Arounds

Some facilities may have space constraints, limited staffing and time limitations that may preclude implementation of BMPs. Provided below are typical limitations and recommended "work-arounds."

- Providing cover over outdoor equipment may be impractical or cost-prohibitive.
  - ✓ Operate outdoor equipment only during periods of dry weather.
- Regular operations and time limitations may require outdoor activities during wet weather.
  - ✓ Designate specific areas for outdoor activities.
  - ✓ Allow time for work area clean-up after each shift.
  - ✓ Require employees to understand and follow preventive maintenance and spill and leak prevention BMPs.
  - ✓ Design and install secondary containment and good housekeeping BMPs for outdoor equipment area.
- Storage sheds often must meet building and fire code requirements.

Potential Capital Facility Costs and Operation & Maintenance Requirements

Facilities

- Many facilities will already have indoor covered areas where vehicle and equipment repairs take place and will require no additional capital expenditures.
- If outdoor activities are required, construction of berms or other means to retain spills and leaks may require appropriate constructed systems for containment. These containment areas may require significant new capital investment.
- Capital investments will likely be required at some sites if adequate cover and containment facilities do not exist and can vary significantly depending upon site conditions.

Maintenance

- Most of the operations and maintenance activities associated with implementing this BMP are integrally linked to routine operations as previously described. Therefore additional O&M is not required.
- For facilities responsible for pre-treating their wastewater prior to discharging, the proper functioning of structural treatment system is an important maintenance consideration.
- Routine cleanout of oil and grease is required for the devices to maintain their effectiveness, usually at least once a month. During periods of heavy rainfall, cleanout is required more often to ensure pollutants are not washed through the trap. Sediment removal is also required on a regular basis to keep the device working efficiently.

References and Resources

Minnesota Pollution Control Agency. *Industrial Stormwater Best Management Practices Guidebook BMP 26 Fueling and Liquid Loading/Unloading Operations*. Available online at: http://www.pca.state.mn.us/index.php/view-document.html?gid=10557.

New Jersey Department of Environmental Protection, 2013. *Basic Industrial Stormwater General Permit Guidance Document NJPDES General Permit No NJ0088315*. Available online at: http://www.nj.gov/dep/dwq/pdf/5G2_guidance_color.pdf.

Orange County Stormwater Program, Best Management Practices for Industrial/Commercial Business Activities. Available online at: http://ocwatersheds.com/documents/bmp/industrialcommercialbusinessesactivities.

Oregon Department of Environmental Quality, *Industrial Stormwater Best Management Practices Manual- BMP 26 Fueling and Liquid Loading/Unloading Operations*, February 2013. Available online at: http://www.deq.state.or.us/wq/wqpermit/docs/IndBMP021413.pdf.

Sacramento Stormwater Management Program. *Best Management Practices for Industrial Storm Water Pollution Control*. Available online at: http://www.msa.saccounty.net/sactostormwater/documents/guides/industrial-BMP-manual.pdf.

Sacramento County Environmental Management Stormwater Program: Best Management Practices. Available online at: http://www.emd.saccounty.net/EnvHealth/Stormwater/Stormwater-BMPs.html.

Santa Clara Valley Urban Runoff Pollution Prevention Program. http://www.scvurppp-w2k.com/

US EPA. National Pollutant Discharge Elimination System – Industrial Fact Sheet Series for Activities Covered by EPA's Multi Sector General Permit. Available online at: http://cfpub.epa.gov/npdes/stormwater/swsectors.cfm.

Waste Handling & Disposal SC-34

Description

Improper storage and handling of solid wastes can allow toxic compounds, oils and greases, heavy metals, nutrients, suspended solids, and other pollutants to enter stormwater runoff. The discharge of pollutants to stormwater from waste handling and disposal can be prevented and reduced by tracking waste generation, storage, and disposal; reducing waste generation and disposal through source reduction, reuse, and recycling; and preventing run-on and runoff.

Approach

Reduce potential for pollutant discharge through source control pollution prevention and BMP implementation. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

General Pollution Prevention Protocols

- ☐ Accomplish reduction in the amount of waste generated using the following source controls:
  - ✓ Production planning and sequencing;
  - ✓ Process or equipment modification;
  - ✓ Raw material substitution or elimination;
  - ✓ Loss prevention and housekeeping;
  - ✓ Waste segregation and separation; and
  - ✓ Close loop recycling.
- ☐ Establish a material tracking system to increase awareness about material usage. This may reduce spills and minimize contamination, thus reducing the amount of waste produced.
- ☐ Recycle materials whenever possible.

Objectives
■ *Cover*
■ *Contain*
■ *Educate*
■ *Reduce/Minimize*
■ *Product Substitution*

Targeted Constituents	
Sediment	
Nutrients	
Trash	
Metals	✓
Bacteria	✓
Oil and Grease	✓
Organics	✓

Minimum BMPs Covered	
Good Housekeeping	✓
Preventative Maintenance	✓
Spill and Leak Prevention and Response	✓
Material Handling & Waste Management	✓
Erosion and Sediment Controls	
Employee Training Program	✓
Quality Assurance Record Keeping	✓

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- Use the entire product before disposing of the container.
- To the extent possible, store wastes under cover or indoors after ensuring all safety concerns such as fire hazard and ventilation are addressed.
- Provide containers for each waste stream at each work station. Allow time after shift to clean area.

Good Housekeeping

- Cover storage containers with leak proof lids or some other means. If waste is not in containers, cover all waste piles (plastic tarps are acceptable coverage) and prevent stormwater run-on and runoff with a berm. The waste containers or piles must be covered except when in use.
- Use drip pans or absorbent materials whenever grease containers are emptied by vacuum trucks or other means. Grease cannot be left on the ground. Collected grease must be properly disposed of as garbage.
- Dispose of rinse and wash water from cleaning waste containers into a sanitary sewer if allowed by the local sewer authority. Do not discharge wash water to the street or storm drain. Clean in a designated wash area that drains to a clarifier.
- Transfer waste from damaged containers into safe containers.
- Take special care when loading or unloading wastes to minimize losses. Loading systems can be used to minimize spills and fugitive emission losses such as dust or mist. Vacuum transfer systems can minimize waste loss.
- Keep the waste management area clean at all times by sweeping and cleaning up spills immediately.
- Use dry methods when possible (e.g., sweeping, use of absorbents) when cleaning around restaurant/food handling dumpster areas. If water must be used after sweeping/using absorbents, collect water and discharge through grease interceptor to the sewer.
- Stencil or demarcate storm drains on the facility's property with prohibitive message regarding waste disposal.
- Cover waste piles with temporary covering material such as reinforced tarpaulin, polyethylene, polyurethane, polypropylene or hypalon.
- If possible, move the activity indoor after ensuring all safety concerns such as fire hazard and ventilation are addressed.

Preventative Maintenance

- Prevent stormwater run-on from entering the waste management area by enclosing the area or building a berm around the area.
- Prevent waste materials from directly contacting rain.

- Cover waste piles with temporary covering material such as reinforced tarpaulin, polyethylene, polyurethane, polypropylene or hypalon.
- Cover the area with a permanent roof if feasible.
- Cover dumpsters to prevent rain from washing waste out of holes or cracks in the bottom of the dumpster.
- Check waste containers weekly for leaks and to ensure that lids are on tightly. Replace any that are leaking, corroded, or otherwise deteriorating.
- Sweep and clean the waste management area regularly. Use dry methods when possible (e.g., sweeping, vacuuming, use of absorbents) when cleaning around restaurant/food handling dumpster areas. If water must be used after sweeping/using absorbents, collect water and discharge through grease interceptor to the sewer.
- Inspect and replace faulty pumps or hoses regularly to minimize the potential of releases and spills.
- Repair leaking equipment including valves, lines, seals, or pumps promptly.

Spill Response and Prevention Procedures

- Keep your spill prevention and plan up-to-date.
- Have an emergency plan, equipment and trained personnel ready at all times to deal immediately with major spills.
- Collect all spilled liquids and properly dispose of them.
- Store and maintain appropriate spill cleanup materials in a location known to all near the designated wash area.
- Ensure that vehicles transporting waste have spill prevention equipment that can prevent spills during transport. Spill prevention equipment includes:
  - ✓ Vehicles equipped with baffles for liquid waste; and
  - ✓ Trucks with sealed gates and spill guards for solid waste.

Material Handling and Waste Management

Litter Control

- Post "No Littering" signs and enforce anti-litter laws.
- Provide a sufficient number of litter receptacles for the facility.
- Clean out and cover litter receptacles frequently to prevent spillage.

Waste Collection

- Keep waste collection areas clean.

- Inspect solid waste containers for structural damage regularly. Repair or replace damaged containers as necessary.
- Secure solid waste containers; containers must be closed tightly when not in use.
- Do not fill waste containers with washout water or any other liquid.
- Ensure that only appropriate solid wastes are added to the solid waste container. Certain wastes such as hazardous wastes, appliances, fluorescent lamps, pesticides, etc., may not be disposed of in solid waste containers (see chemical/ hazardous waste collection section below).
- Do not mix wastes; this can cause chemical reactions, make recycling impossible, and complicate disposal. Affix labels to all waste containers.

Chemical/Hazardous Wastes

- Select designated hazardous waste collection areas on-site.
- Store hazardous materials and wastes in covered containers and protect them from vandalism.
- Place hazardous waste containers in secondary containment.
- Make sure that hazardous waste is collected, removed, and disposed of only at authorized disposal areas.
- Hazardous waste cannot be reused or recycled; it must be disposed of by a licensed hazardous waste hauler.

Employee Training Program

- Educate employees about pollution prevention measures and goals.
- Train employees how to properly handle and dispose of waste using the source control BMPs described above.
- Train employees and subcontractors in proper hazardous waste management.
- Use a training log or similar method to document training.
- Ensure that employees are familiar with the site's spill control plan and/or proper spill cleanup procedures.

Quality Assurance and Record Keeping

- Keep accurate maintenance logs that document minimum BMP activities performed for waste handling and disposal, types and quantities of waste disposed of, and any improvement actions.
- Keep accurate logs of spill response actions that document what was spilled, how it was cleaned up, and how the waste was disposed.

- Establish procedures to complete logs and file them in the central office.

Potential Capital Facility Costs and Operation & Maintenance Requirements

Facilities

- Capital costs will vary substantially depending on the size of the facility and the types of waste handled. Significant capital costs may be associated with reducing wastes by modifying processes or implementing closed-loop recycling.
- Many facilities will already have indoor covered areas where waste materials will be stored and will require no additional capital expenditures for providing cover.
- If outdoor storage of wastes is required, construction of berms or other means to prevent stormwater run-on and runoff may require appropriate constructed systems for containment.
- Capital investments will likely be required at some sites if adequate cover and containment facilities do not exist and can vary significantly depending upon site conditions.

Maintenance

- Check waste containers weekly for leaks and to ensure that lids are on tightly. Replace any that are leaking, corroded, or otherwise deteriorating.
- Sweep and clean the waste management area regularly. Use dry methods when possible (e.g., sweeping, use of absorbents) when cleaning around restaurant/food handling dumpster areas. If water must be used after sweeping/using absorbents, collect water and discharge through grease interceptor to the sewer.
- Inspect and replace faulty pumps or hoses regularly to minimize the potential of releases and spills.
- Repair leaking equipment including valves, lines, seals, or pumps promptly.

References and Resources

Minnesota Pollution Control Agency, *Industrial Stormwater Best Management Practices Guidebook*. Available online at: http://www.pca.state.mn.us/index.php/view-document.html?gid=10557.

New Jersey Department of Environmental Protection, 2013. *Basic Industrial Stormwater General Permit Guidance Document NJPDES General Permit No NJ0088315,* Revised. Available online at: http://www.nj.gov/dep/dwq/pdf/5G2_guidance_color.pdf.

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Sacramento County Environmental Management Stormwater Program: Best Management Practices. Available online at: http://www.emd.saccounty.net/EnvHealth/Stormwater/Stormwater-BMPs.html.

Santa Clara Valley Urban Runoff Pollution Prevention Program. http://www.scvurppp-w2k.com/

US EPA. National Pollutant Discharge Elimination System – Industrial Fact Sheet Series for Activities Covered by EPA's Multi Sector General Permit. Available online at: http://cfpub.epa.gov/npdes/stormwater/swsectors.cfm.

Safer Alternative Products SC-35

Description

Promote the use of less harmful products and products that contain little or no TMDL and 303(d) list pollutants. Alternatives exist for most product classes including chemical fertilizers, pesticides, cleaning solutions, janitorial chemicals, automotive and paint products, and consumables (batteries, fluorescent lamps).

Approach

Pattern a new program after the many established programs around the state and country. Integrate this best management practice as much as possible with existing programs at your facility.

Develop a comprehensive program based on:

- The "Precautionary Principle," which is an alternative to the "Risk Assessment" model that says it's acceptable to use a potentially harmful product until physical evidence of its harmful effects are established and deemed too costly from an environmental or public health perspective. For instance, a risk assessment approach might say it's acceptable to use a pesticide until there is direct proof of an environmental impact. The Precautionary Principle approach is used to evaluate whether a given product is safe, whether it is really necessary, and whether alternative products would perform just as well.
- Environmentally Preferable Purchasing Program to minimize the purchase of products containing hazardous ingredients used in the facility's custodial services, fleet maintenance, and facility maintenance in favor of using alternate products that pose less risk to employees and to the environment.
- Integrated Pest Management (IPM) or Less-Toxic Pesticide Program, which uses a pest management approach that minimizes the use of toxic chemicals and gets rid of pests

Objectives
■ *Educate*
■ *Reduce/Minimize*
■ *Product Substitution*

Targeted Constituents	
Sediment	
Nutrients	✓
Trash	
Metals	✓
Bacteria	
Oil and Grease	✓
Organics	✓

Minimum BMPs Covered	
Good Housekeeping	
Preventative Maintenance	
Spill and Leak Prevention and Response	
Material Handling & Waste Management	
Erosion and Sediment Controls	
Employee Training Program	✓
Quality Assurance Record Keeping	

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by methods that pose a lower risk to employees, the public, and the environment.

- Energy Efficiency Program including no-cost and low-cost energy conservation and efficiency actions that can reduce both energy consumption and electricity bills, along with long-term energy efficiency investments.

Consider the following mechanisms for developing and implementing a comprehensive program:

- Policies
- Procedures
  - ✓ Standard operating procedures (SOPs);
  - ✓ Purchasing guidelines and procedures; and
  - ✓ Bid packages (services and supplies).
- Materials
  - ✓ Preferred or approved product and supplier lists;
  - ✓ Product and supplier evaluation criteria;
  - ✓ Training sessions and manuals; and
  - ✓ Fact sheets for employees.

Implement this BMP in conjunction with the Vehicle and Equipment Management fact sheets (SC-20 – SC-22) and SC-41 Building and Grounds Maintenance.

Employee Training Program

- Employees who handle potentially harmful materials should be trained in the use of safer alternatives.
- Purchasing departments should be trained on safer alternative products and encouraged to procure less hazardous materials and products that contain little or no harmful substances or TMDL pollutants.
- Employees and contractors / service providers can both be educated about safer alternatives by using information developed by a number of organizations including the references and resources provided in this fact sheet.

Potential Limitations and Work-Arounds

Some facilities may have space constraints, limited staffing and time limitations that may preclude implementation of BMPs. Provided below are typical limitations and recommended "work-arounds"

- Alternative products may not be available, suitable, or effective in every case.

- ✓ Minimize use of hazardous/harmful products if no alternative product is available.

Regulatory Considerations

This BMP has no regulatory requirements unless local/municipal ordinance applies. Existing regulations already encourage facilities to reduce the use of hazardous materials through incentives such as reduced:

- Specialized equipment storage and handling requirements;
- Storm water runoff sampling requirements;
- Training and licensing requirements; and
- Record keeping and reporting requirements.

Cost Considerations

- The primary cost is for staff time to: 1) develop new policies and procedures and 2) educate purchasing departments and employees who handle potentially harmful materials about the availability, procurement, and use of safer alternatives.
- Some alternative products may be slightly more expensive than conventional products.

Supplemental Information

The following discussion provides some general information on safer alternatives. More specific information on particular hazardous materials and the available alternatives may be found in the references and resources listed below.

- Automotive products – Less toxic alternatives are not available for many automotive products, especially engine fluids. But there are alternatives to grease lubricants, car polishes, degreasers, and windshield washer solution. Refined motor oil is also available.
- Vehicle/Trailer lubrication – Fifth wheel bearings on trucks require routine lubrication. Adhesive lubricants are available to replace typical chassis grease.
- Cleaners – Vegetables-based or citrus-based soaps are available to replace petroleum-based soaps/detergents.
- Paint products – Water-based paints, wood preservatives, stains, and finishes with low VOC content are available.
- Pesticides – Specific alternative products or methods exist to control most insects, fungi, and weeds.
- Chemical Fertilizers – Compost and soil amendments are natural alternatives.
- Consumables – Manufacturers have either reduced or are in the process of reducing the amount of heavy metals in consumables such as batteries and fluorescent lamps.

All fluorescent lamps contain mercury, however low-mercury containing lamps are now available from most hardware and lighting stores. Fluorescent lamps are also more energy efficient than the average incandescent lamp.

- Janitorial chemicals – Even biodegradable soap can harm fish and wildlife before it biodegrades. Biodegradable does not mean non-toxic. Safer products and procedures are available for floor stripping and cleaning, as well as carpet, glass, metal, and restroom cleaning and disinfecting. Use paper products with post-consumer recycled content and implement electric had dryers.

Examples

There are a number of business and trade associations, and communities with effective programs. Some of the more prominent are listed below in the references and resources section.

References and Resources

Note: Many of these references provide alternative products for materials that typically are used inside and disposed to the sanitary sewer as well as alternatives to products that usually end up in the storm drain.

General Sustainable Practices and Pollution Prevention Including Pollutant-Specific Information

California Department of Toxic Substances Control, http://www.dtsc.ca.gov/PollutionPrevention/GreenTechnology/Index.cfm.

CalRecycle, http://www.calrecycle.ca.gov/Business/Regulated.htm.

City of Santa Monica Office of Sustainability and Environment, http://www.smgov.net/departments/ose/.

City of Palo Alto, http:// www.city.palo-alto.ca.us/cleanbay.

City and County of San Francisco, Department of the Environment, http://www.sfenvironment.org/toxics-health/greener-business-practices.

Green Business Program, http://www.greenbiz.ca.gov/GRlocal.html .

Product Stewardship Institute, http://www.productstewardship.us/index.cfm.

Sacramento Clean Water Business Partners. http://www.sacstormwater.org/CleanWaterBusinessPartners/CleanWaterBusinessPartners.html.

USEPA. National Pollutant Discharge Elimination System (NPDES) Stormwater Discharges From Industrial Facilities, http://cfpub.epa.gov/npdes/stormwater/indust.cfm.

USEPA Region IX Pollution Prevention Program, http://www.epa.gov/region9/waste/p2/business.html.

Western Sustainability and Pollution Prevention Network, http://wsppn.org/.

Metals (mercury, copper)

National Electrical Manufacturers Association – Environmental Stewardship, http://www.nema.org/Policy/Environmental-Stewardship/pages/default.aspx.

Sustainable Conservation, http://www.suscon.org.

Auto Recycling Project

Brake Pad Partnership

Pesticides and Chemical Fertilizers

Bio-Integral Resource Center, http://www.birc.org.

California Department of Pesticide Regulation, http://www.cdpr.ca.gov/dprprograms.htm.

University of California Statewide IPM Program, http://www.ipm.ucdavis.edu/default.html.

Dioxins

Bay Area Dioxins Project, http://www.abag.ca.gov/bayarea/dioxin/project_materials.htm.

Building & Grounds Maintenance SC-41

Description

Stormwater runoff from building and grounds maintenance activities can be contaminated with toxic hydrocarbons in solvents, fertilizers and pesticides, suspended solids, heavy metals, abnormal pH, and oils and greases. Utilizing the protocols in this fact sheet will prevent or reduce the discharge of pollutants to stormwater from building and grounds maintenance activities by washing and cleaning up with as little water as possible, following good landscape management practices, preventing and cleaning up spills immediately, keeping debris from entering the storm drains, and maintaining the stormwater collection system.

Approach

Reduce potential for pollutant discharge through source control pollution prevention and BMP implementation. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

General Pollution Prevention Protocols

- ☐ Switch to non-toxic chemicals for maintenance to the maximum extent possible.
- ☐ Choose cleaning agents that can be recycled.
- ☐ Encourage proper lawn management and landscaping, including use of native vegetation.
- ☐ Encourage use of Integrated Pest Management techniques for pest control.
- ☐ Encourage proper onsite recycling of yard trimmings.
- ☐ Recycle residual paints, solvents, lumber, and other material as much as possible.

Objectives
■ *Cover*
■ *Contain*
■ *Educate*
■ *Reduce/Minimize*
■ *Product Substitution*

Targeted Constituents	
Sediment	✓
Nutrients	✓
Trash	
Metals	✓
Bacteria	✓
Oil and Grease	
Organics	

Minimum BMPs Covered	
Good Housekeeping	✓
Preventative Maintenance	
Spill and Leak Prevention and Response	✓
Material Handling & Waste Management	✓
Erosion and Sediment Controls	
Employee Training Program	✓
Quality Assurance Record Keeping	✓

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- Clean work areas at the end of each work shift using dry cleaning methods such as sweeping and vacuuming.

Good Housekeeping

Pressure Washing of Buildings, Rooftops, and Other Large Objects

- In situations where soaps or detergents are used and the surrounding area is paved, pressure washers must use a water collection device that enables collection of wash water and associated solids. A sump pump, wet vacuum or similarly effective device must be used to collect the runoff and loose materials. The collected runoff and solids must be disposed of properly.

- If soaps or detergents are not used, and the surrounding area is paved, wash runoff does not have to be collected but must be screened. Pressure washers must use filter fabric or some other type of screen on the ground and/or in the catch basin to trap the particles in wash water runoff.

- If you are pressure washing on a grassed area (with or without soap), runoff must be dispersed as sheet flow as much as possible, rather than as a concentrated stream. The wash runoff must remain on the grass and not drain to pavement.

Landscaping Activities

- Dispose of grass clippings, leaves, sticks, or other collected vegetation as garbage, or by composting. Do not dispose of collected vegetation into waterways or storm drainage systems.

- Use mulch or other erosion control measures on exposed soils. See also SC-40, Contaminated and Erodible Areas, for more information.

Building Repair, Remodeling, and Construction

- Do not dump any toxic substance or liquid waste on the pavement, the ground, or toward a storm drain.

- Use ground or drop cloths underneath outdoor painting, scraping, and sandblasting work, and properly dispose of collected material daily.

- Use a ground cloth or oversized tub for activities such as paint mixing and tool cleaning.

- Clean paintbrushes and tools covered with water-based paints in sinks connected to sanitary sewers or in portable containers that can be dumped into a sanitary sewer drain. Brushes and tools covered with non-water-based paints, finishes, or other materials must be cleaned in a manner that enables collection of used solvents (e.g., paint thinner, turpentine, etc.) for recycling or proper disposal.

- Use a storm drain cover, filter fabric, or similarly effective runoff control mechanism if dust, grit, wash water, or other pollutants may escape the work area and enter a catch basin. This is particularly necessary on rainy days. The containment device(s) must be in place at the beginning of the work day, and accumulated dirty runoff and

solids must be collected and disposed of before removing the containment device(s) at the end of the work day.

- If you need to de-water an excavation site, you may need to filter the water before discharging to a catch basin or off-site. If directed off-site, you should direct the water through hay bales and filter fabric or use other sediment filters or traps.
- Store toxic material under cover during precipitation events and when not in use. A cover would include tarps or other temporary cover material.

Mowing, Trimming, and Planting

- Dispose of leaves, sticks, or other collected vegetation as garbage, by composting or at a permitted landfill. Do not dispose of collected vegetation into waterways or storm drainage systems.
- Use mulch or other erosion control measures when soils are exposed.
- Place temporarily stockpiled material away from watercourses and drain inlets, and berm or cover stockpiles to prevent material releases to the storm drain system.
- Consider an alternative approach when bailing out muddy water: do not put it in the storm drain; pour over landscaped areas.
- Use hand weeding where practical.

Fertilizer and Pesticide Management

- Do not use pesticides if rain is expected.
- Do not mix or prepare pesticides for application near storm drains.
- Use the minimum amount needed for the job.
- Calibrate fertilizer distributors to avoid excessive application.
- Employ techniques to minimize off-target application (e.g., spray drift) of pesticides, including consideration of alternative application techniques.
- Apply pesticides only when wind speeds are low.
- Fertilizers should be worked into the soil rather than dumped or broadcast onto the surface.
- Irrigate slowly to prevent runoff and then only as much as is needed.
- Clean pavement and sidewalk if fertilizer is spilled on these surfaces before applying irrigation water.

Inspection

- Inspect irrigation system periodically to ensure that the right amount of water is being applied and that excessive runoff is not occurring. Minimize excess watering and repair leaks in the irrigation system as soon as they are observed.

Building & Grounds Maintenance SC-41

Spill Response and Prevention Procedures

- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Place a stockpile of spill cleanup materials, such as brooms, dustpans, and vacuum sweepers (if desired) near the storage area where it will be readily accessible.
- Have employees trained in spill containment and cleanup present during the loading/unloading of dangerous wastes, liquid chemicals, or other materials.
- Familiarize employees with the Spill Prevention Control and Countermeasure Plan.
- Clean up spills immediately.

Material Handling and Waste Management

- Follow all federal, state, and local laws and regulations governing the use, storage, and disposal of fertilizers and pesticides and training of applicators and pest control advisors.
- Use less toxic pesticides that will do the job when applicable. Avoid use of copper-based pesticides if possible.
- Dispose of empty pesticide containers according to the instructions on the container label.
- Use up the pesticides. Rinse containers, and use rinse water as product. Dispose of unused pesticide as hazardous waste.
- Implement storage requirements for pesticide products with guidance from the local fire department and County Agricultural Commissioner. Provide secondary containment for pesticides.

Employee Training Program

- Educate and train employees on pesticide use and in pesticide application techniques to prevent pollution.
- Train employees and contractors in proper techniques for spill containment and cleanup.
- Be sure the frequency of training takes into account the complexity of the operations and the needs of individual staff.

Quality Assurance and Record Keeping

- Keep accurate logs that document maintenance activities performed and minimum BMP measures implemented.
- Keep accurate logs of spill response actions that document what was spilled, how it was cleaned up, and how the waste was disposed.
- Establish procedures to complete logs and file them in the central office.

Potential Capital Facility Costs and Operation & Maintenance Requirements

Facilities

- Additional capital costs are not anticipated for building and grounds maintenance. Implementation of the minimum BMPs described above should be conducted as part of regular site operations.

Maintenance

- Maintenance activities for the BMPs described above will be minimal, and no additional cost is anticipated.

Supplemental Information

Fire Sprinkler Line Flushing

Site fire sprinkler line flushing may be a source of non-stormwater runoff pollution. The water entering the system is usually potable water, though in some areas it may be non-potable reclaimed wastewater. There are subsequent factors that may drastically reduce the quality of the water in such systems. Black iron pipe is usually used since it is cheaper than potable piping, but it is subject to rusting and results in lower quality water. Initially, the black iron pipe has an oil coating to protect it from rusting between manufacture and installation; this will contaminate the water from the first flush but not from subsequent flushes. Nitrates, poly-phosphates and other corrosion inhibitors, as well as fire suppressants and antifreeze may be added to the sprinkler water system. Water generally remains in the sprinkler system a long time (typically a year) and between flushes may accumulate iron, manganese, lead, copper, nickel, and zinc. The water generally becomes anoxic and contains living and dead bacteria and breakdown products from chlorination. This may result in a significant BOD problem and the water often smells. Consequently dispose fire sprinkler line flush water into the sanitary sewer. Do not allow discharge to storm drain or infiltration due to potential high levels of pollutants in fire sprinkler line water.

References and Resources

City of Seattle, Seattle Public Utilities Department of Planning and Development, 2009. *Stormwater Manual Vol. 1 Source Control Technical Requirements Manual.*

Kennedy/Jenks Consultants, 2007. *The Truckee Meadows Industrial and Commercial Storm Water Best Management Practices Handbook*. Available online at: http://www.cityofsparks.us/sites/default/files/assets/documents/env-control/construction/TM-I-C_BMP_Handbook_2-07-final.pdf.

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Sacramento Stormwater Management Program. *Best Management Practices for Industrial Storm Water Pollution Control*. Available online at:

http://www.msa.saccounty.net/sactostormwater/documents/guides/industrial-BMP-manual.pdf.

US EPA, 1997. *Best Management Practices Handbook for Hazardous Waste Containers*. Available online at: http://www.epa.gov/region6/6en/h/handbk4.pdf.

Ventura Countywide Stormwater Management Program Clean Business Fact Sheets. Available online at: http://www.vcstormwater.org/documents/programs_business/building.pdf.

Building Repair and Construction SC-42

Description

Site modifications are common, particularly at large industrial sites. The activity may vary from minor and normal building repair to major remodeling, or the construction of new facilities. These activities can generate pollutants including solvents, paints, paint and varnish removers, finishing residues, spent thinners, soap cleaners, kerosene, asphalt and concrete materials, adhesive residues, and old asbestos installation. Protocols in this fact sheet are intended to prevent or reduce the discharge of pollutants to stormwater from building repair, remodeling, and minor construction by using soil erosion controls, enclosing or covering building material storage areas, using good housekeeping practices, using safer alternative products, and training employees.

This fact sheet is intended to be used for minor repairs and construction. If major construction is required, the guidelines in the Construction BMP Handbook should be followed.

Approach

The BMP approach is to reduce potential for pollutant discharges through source control pollution prevention and BMP implementation. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

General Pollution Prevention Protocols

- ☐ Recycle residual paints, solvents, lumber, and other materials to the maximum extent practicable.
- ☐ Avoid outdoor repairs and construction during periods of wet weather.
- ☐ Use safer alternative products to the maximum extent practicable. See also SC-35 Safer Alternative Products for more information.

Objectives
■ *Cover*
■ *Contain*
■ *Educate*
■ *Reduce/Minimize*
■ *Product Substitution*

Targeted Constituents	
Sediment	✓
Nutrients	
Trash	✓
Metals	✓
Bacteria	
Oil and Grease	✓
Organics	✓

Minimum BMPs Covered	
Good Housekeeping	✓
Preventative Maintenance	
Spill and Leak Prevention and Response	✓
Material Handling & Waste Management	✓
Erosion and Sediment Controls	✓
Employee Training Program	✓
Quality Assurance Record Keeping	✓

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- Buy recycled products to the maximum extent practicable.
- Inform on-site contractors of company policy on these matters and include appropriate provisions in their contract to ensure certain proper housekeeping and disposal practices are implemented.
- Make sure that nearby storm drains are well marked to minimize the chance of inadvertent disposal of residual paints and other liquids.

Good Housekeeping

Repair & Remodeling

- Keep the work site clean and orderly. Remove debris in a timely fashion. Sweep and vacuum the area regularly to remove sediments and small debris.
- Cover raw materials of particular concern that must be left outside, particularly during the rainy season. See also SC-33 Outdoor Storage of Raw Materials for more information.
- Use equipment and tools such as bag sanders to reduce accumulation of debris.
- Limit/prohibit work on windy days; implement roll-down walls or other measures to reduce wind transport of pollutants.
- Do not dump waste liquids down the storm drain.
- Dispose of wash water, sweepings, and sediments properly.
- Store liquid materials properly that are normally used in repair and remodeling such as paints and solvents. See also SC-31 Outdoor Liquid Container Storage for more information.
- Sweep out rain gutters or wash the gutter and trap the particles at the outlet of the downspout. A sock or geofabric placed over the outlet may effectively trap the materials. If the downspout is tight lined, place a temporary plug at the first convenient point in the storm drain and pump out the water with a vactor truck, and clean the catch basin sump where you placed the plug.
- Clean the storm drain system in the immediate vicinity of the construction activity after it is completed. See also SC-44 Drainage System Maintenance for more information.

Painting

- Enclose painting operations consistent with local air quality regulations and OSHA.
- Local air pollution regulations may, in many areas of the state, specify painting procedures which if properly carried out are usually sufficient to protect water quality.
- Develop paint handling procedures for proper use, storage, and disposal of paints.

- Transport paint and materials to and from job sites in containers with secure lids and tied down to the transport vehicle.
- Test and inspect spray equipment prior to starting to paint. Tighten all hoses and connections and do not overfill paint containers.
- Mix paint indoors before using so that any spill will not be exposed to rain. Do so even during dry weather because cleanup of a spill will never be 100 percent effective.
- Transfer and load paint and hot thermoplastic away from storm drain inlets.
- Do not transfer or load paint near storm drain inlets.
- Plug nearby storm drain inlets prior to starting painting and remove plugs when job is complete when there is risk of a spill reaching storm drains.
- Cover nearby storm drain inlets prior to starting work if sand blasting is used to remove paint.
- Use a ground cloth to collect the chips if painting requires scraping or sand blasting of the existing surface. Dispose of the residue properly.
- Cover or enclose painting operations properly to avoid drift.
- Clean the application equipment in a sink that is connected to the sanitary sewer if using water based paints.
- Capture all cleanup-water and dispose of properly.
- Dispose of paints containing lead or tributyl tin and considered a hazardous waste properly.
- Store leftover paints if they are to be kept for the next job properly, or dispose properly.
- Recycle paint when possible. Dispose of paint at an appropriate household hazardous waste facility.

Spill Response and Prevention Procedures

- Keep your spill prevention and control plan up-to-date.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- Clean up spills immediately.
- Excavate and remove the contaminated (stained) soil if a spill occurs on dirt.

Material Handling and Waste Management

- Post “No Littering” signs and enforce anti-litter laws.

- Provide a sufficient number of litter receptacles for the facility.
- Clean out and cover litter receptacles frequently to prevent spillage.
- Keep waste collection areas clean.
- Inspect solid waste containers for structural damage regularly. Repair or replace damaged containers as necessary.
- Secure solid waste containers; containers must be closed tightly when not in use.
- Do not fill waste containers with washout water or any other liquid.
- Ensure that only appropriate solid wastes are added to the solid waste container. Certain wastes such as hazardous wastes, appliances, fluorescent lamps, pesticides, etc., may not be disposed of in solid waste containers (see chemical/ hazardous waste collection section below).
- Do not mix wastes; this can cause chemical reactions, make recycling impossible, and complicate disposal. Affix labels to all waste containers.
- Make sure that hazardous waste is collected, removed, and disposed of properly. See also SC-34, Waste Handling and Disposal for more information.

Sediment and Erosion Controls

- Limit disturbance to bare soils and preserve natural vegetation whenever possible. See also EC-2, Preservation of Existing Vegetation, in the Construction BMP Handbook.
- Stabilize loose soils by re-vegetating whenever possible. See also EC-4 Hydroseeding, in the Construction BMP Handbook.
- Utilize non-vegetative stabilization methods for areas prone to erosion where vegetative options are not feasible. Examples include:
  - ✓ Areas of vehicular or pedestrian traffic such as roads or paths;
  - ✓ Arid environments where vegetation would not provide timely ground coverage, or would require excessive irrigation;
  - ✓ Rocky substrate, infertile or droughty soils where vegetation would be difficult to establish; and
  - ✓ Areas where vegetation will not grow adequately within the construction time frame.

  There are several non-vegetative stabilization methods and selection should be based on site-specific conditions. See also EC-16 Non-Vegetative Stabilization, in the Construction BMP Handbook.

- Utilize chemical stabilization when needed. See also EC-5 Soil Binders, in the Construction BMP Handbook.
- Use geosynthetic membranes to control erosion if feasible. See also EC-7 Geotextiles and Mats, in the Construction BMP Handbook.
- Stabilize all roadways, entrances, and exits to sufficiently control discharges of erodible materials from discharging or being tracked off the site. See also TC 1-3 Tracking Control, in the Construction BMP Handbook.
- Refer to the supplemental information provided below for projects that involve more extensive soil disturbance activities.

Employee Training Program

- Educate employees about pollution prevention measures and goals.
- Train employees how to properly implement the source control BMPs described above. Detailed information for Sediment and Erosion Control BMPs is provided in the Construction BMP Handbook.
- Proper education of off-site contractors is often overlooked. The conscientious efforts of well trained employees can be lost by unknowing off-site contractors, so make sure they are well informed about pollutant source control responsibilities.
- Use a training log or similar method to document training.

Quality Assurance and Record Keeping

- Keep accurate maintenance logs that document minimum BMP activities performed for building repair and construction, types and quantities of waste disposed of, and any improvement actions.
- Keep accurate logs of spill response actions that document what was spilled, how it was cleaned up, and how the waste was disposed.
- Establish procedures to complete logs and file them in the central office.

Potential Limitations and Work-Arounds

Some facilities may have space constraints, limited staffing and time limitations that may preclude implementation of BMPs. Provided below are typical limitations and recommended "work-arounds."

- This BMP is for minor construction only. The State's General Construction Activity Stormwater Permit has more extensive requirements for larger projects that would disturb one or more acres of surface.
  - ✓ Refer to the companion "Construction Best Management Practice Handbook" which contains specific guidance and best management practices for larger-scale projects.

- Time constraints may require some outdoor repairs and construction during wet weather.
  - ✓ Require employees to understand and follow good housekeeping and spill and leak prevention BMPs.
  - ✓ Inspect sediment and erosion control BMPs daily during periods of wet weather and repair or improve BMP implementation as necessary.
- Hazardous waste that cannot be reused or recycled must be disposed of by a licensed hazardous waste hauler.
  - ✓ Minimize use of hazardous materials to the maximum extent practicable.
- Be certain that actions to help stormwater quality are consistent with Cal- and Fed-OSHA and air quality regulations.
- Prices for recycled/safer alternative materials and fluids may be higher than those of conventional materials.

Potential Capital Facility Costs and Operation & Maintenance Requirements

Facilities

- Limited capital investments may be required at some sites if adequate cover and containment facilities do not exist for construction materials and wastes.
- Purchase and installation of erosion and sediment controls, if needed will require additional capital investments, and this amount will vary depending on site characteristics and the types of BMPs being implemented.
- Minimize costs by maintaining existing vegetation and limiting construction operations on bare soils.

Maintenance

- The erosion and sediment control BMPs described above require periodic inspection and maintenance to remain effective. The cost of these actions will vary depending on site characteristics and the types of BMPs being implemented.
- Irrigation costs may be required to establish and maintain vegetation.

Supplemental Information

Soil/Erosion Control

If the work involves exposing large areas of soil, employ the appropriate soil erosion and control techniques. See the Construction Best Management Practice Handbook. If old buildings are being torn down and not replaced in the near future, stabilize the site using measures described in SC-40 Contaminated or Erodible Areas.

Building Repair and Construction SC-42

If a building is to be placed over an open area with a storm drainage system, make sure the storm inlets within the building are covered or removed, or the storm line is connected to the sanitary sewer. If because of the remodeling a new drainage system is to be installed or the existing system is to be modified, consider installing catch basins as they serve as effective "in-line" treatment devices. Include in the catch basin a "turn-down" elbow or similar device to trap floatables.

References and Resources

City of Seattle, Seattle Public Utilities Department of Planning and Development, 2009. *Stormwater Manual Vol. 1 Source Control Technical Requirements Manual*.

California Stormwater Quality Association, 2012. *Construction Stormwater Best Management Practice Handbook*. Available at http://www.casqa.org.

Kennedy/Jenks Consultants, 2007. *The Truckee Meadows Industrial and Commercial Storm Water Best Management Practices Handbook*. Available online at: http://www.cityofsparks.us/sites/default/files/assets/documents/env-control/construction/TM-I-C_BMP_Handbook_2-07-final.pdf.

Sacramento Stormwater Management Program. *Best Management Practices for Industrial Storm Water Pollution Control*. Available online at: http://www.msa.saccounty.net/sactostormwater/documents/guides/industrial-BMP-manual.pdf.

US EPA. *Construction Site Stormwater Runoff Control*. Available online at: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=min_measure&min_measure_id=4.

Parking Area Maintenance SC-43

Description

Parking lots can contribute a number of substances, such as trash, suspended solids, hydrocarbons, oil and grease, and heavy metals that can enter receiving waters through stormwater runoff or non-stormwater discharges. The protocols in this fact sheet are intended to prevent or reduce the discharge of pollutants from parking areas and include using good housekeeping practices, following appropriate cleaning BMPs, and training employees.

BMPs for other outdoor areas on site (loading/unloading, material storage, and equipment operations) are described in SC-30 through SC-33.

Approach

The goal of this program is to ensure stormwater pollution prevention practices are considered when conducting activities on or around parking areas to reduce potential for pollutant discharge to receiving waters. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

General Pollution Prevention Protocols

- Encourage advanced designs and maintenance strategies for impervious parking lots. Refer to the treatment control BMP fact sheets in this manual for additional information.
- Keep accurate maintenance logs to evaluate BMP implementation.

Good Housekeeping

- Keep all parking areas clean and orderly. Remove debris, litter, and sediments in a timely fashion.
- Post "No Littering" signs and enforce anti-litter laws.

Objectives
Cover
Contain
Educate
Reduce/Minimize
Product Substitution

Targeted Constituents	
Sediment	✓
Nutrients	
Trash	✓
Metals	✓
Bacteria	
Oil and Grease	✓
Organics	✓

Minimum BMPs Covered	
Good Housekeeping	✓
Preventative Maintenance	✓
Spill and Leak Prevention and Response	✓
Material Handling & Waste Management	
Erosion and Sediment Controls	
Employee Training Program	✓
Quality Assurance Record Keeping	✓

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- ☐ Provide an adequate number of litter receptacles.
- ☐ Clean out and cover litter receptacles frequently to prevent spillage.

Preventative Maintenance

Inspection

Have designated personnel conduct inspections of parking facilities and stormwater conveyance systems associated with parking facilities on a regular basis.

- ☐ Inspect cleaning equipment/sweepers for leaks on a regular basis.

Surface Cleaning

- ☐ Use dry cleaning methods (e.g., sweeping, vacuuming) to prevent the discharge of pollutants into the stormwater conveyance system if possible.
- ☐ Establish frequency of public parking lot sweeping based on usage and field observations of waste accumulation.
- ☐ Sweep all parking lots at least once before the onset of the wet season.
- ☐ Dispose of parking lot sweeping debris and dirt at a landfill.
- ☐ Follow the procedures below if water is used to clean surfaces:
  - ✓ Block the storm drain or contain runoff.
  - ✓ Collect and pump wash water to the sanitary sewer or discharge to a pervious surface. Do not allow wash water to enter storm drains.
- ☐ Follow the procedures below when cleaning heavy oily deposits:
  - ✓ Clean oily spots with absorbent materials.
  - ✓ Use a screen or filter fabric over inlet, then wash surfaces.
  - ✓ Do not allow discharges to the storm drain.
  - ✓ Vacuum/pump discharges to a tank or discharge to sanitary sewer.
  - ✓ Dispose of spilled materials and absorbents appropriately.

Surface Repair

- ☐ Check local ordinance for SUSMP/LID ordinance.
- ☐ Preheat, transfer or load hot bituminous material away from storm drain inlets.
- ☐ Apply concrete, asphalt, and seal coat during dry weather to prevent contamination from contacting stormwater runoff.
- ☐ Cover and seal nearby storm drain inlets where applicable (with waterproof material or mesh) and manholes before applying seal coat, slurry seal, etc. Leave covers in

place until job is complete and all water from emulsified oil sealants has drained or evaporated. Clean any debris from these covered manholes and drains for proper disposal.

- Use only as much water as necessary for dust control during sweeping to avoid runoff.
- Catch drips from paving equipment that is not in use with pans or absorbent material placed under the machines. Dispose of collected material and absorbents properly.

Spill Response and Prevention Procedures

- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Place a stockpile of spill cleanup materials where it will be readily accessible or at a central location.
- Clean up fluid spills immediately with absorbent rags or material.
- Dispose of spilled material and absorbents properly.

Employee Training Program

- Provide regular training to field employees and/or contractors regarding cleaning of paved areas and proper operation of equipment.
- Train employees and contractors in proper techniques for spill containment and cleanup.
- Use a training log or similar method to document training.

Quality Assurance and Record Keeping

- Keep accurate maintenance logs that document minimum BMP activities performed for parking area maintenance, types and quantities of waste disposed of, and any improvement actions.
- Keep accurate logs of spill response actions that document what was spilled, how it was cleaned up, and how the waste was disposed.
- Establish procedures to complete logs and file them in the central office.

Potential Capital Facility Costs and Operation & Maintenance Requirements

Facilities

- Capital investments may be required at some sites to purchase sweeping equipment, train sweeper operators, install oil/water/sand separators, or implement advanced BMPs. These costs can vary significantly depending upon site conditions and the amount of BMPs required.

Maintenance

- Sweep and clean parking lots regularly to minimize pollutant transport into storm drains from stormwater runoff.
- Clean out oil/water/sand separators regularly, especially after heavy storms.
- Maintain advanced BMPs such as vegetated swales, infiltration trenches, or detention basins as appropriate. Refer to the treatment control fact sheets for more information.

Supplemental Information

Advanced BMPs

Some parking areas may require advanced BMPs to further reduce pollutants in stormwater runoff, and a few examples are listed below. Refer to the Treatment Control Fact Sheets and the New Development and Redevelopment Manual for more information.

- When possible, direct sheet runoff to flow into biofilters (vegetated strip and swale) and/or infiltration devices.
- Utilize sand filters or oleophilic collectors for oily waste in low quantities.
- Arrange rooftop drains to prevent drainage directly onto paved surfaces.
- Design lot to include semi-permeable hardscape.

References and Resources

City of Seattle, Seattle Public Utilities Department of Planning and Development, 2009. *Stormwater Manual Vol. 1 Source Control Technical Requirements Manual.*

California Stormwater Quality Association, 2003. *New Development and Redevelopment Stormwater Best Management Practice Handbook*. Available online at: https://www.casqa.org/resources/bmp-handbooks/new-development-redevelopment-bmp-handbook.

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Orange County Stormwater Program, Best Management Practices for Industrial/Commercial Business Activities. Available online at: http://ocwatersheds.com/documents/bmp/industrialcommercialbusinessesactivities.

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The Storm Water Managers Resource Center, http://www.stormwatercenter.net.

US EPA. *Post-Construction Stormwater Management in New Development and Redevelopment*. BMP Fact Sheets. Available online at: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=min_measure&min_measure_id=5.

Drainage System Maintenance SC-44

Description

As a consequence of its function, the stormwater drainage facilities on site convey stormwater that may contain certain pollutants either to the offsite conveyance system that collects and transports urban runoff and stormwater, or directly to receiving waters. The protocols in this fact sheet are intended to reduce pollutants leaving the site to the offsite drainage infrastructure or to receiving waters through proper on-site conveyance system operation and maintenance. The targeted constituents will vary depending on site characteristics and operations.

Approach

Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

General Pollution Prevention Protocols

- ☐ Maintain catch basins, stormwater inlets, and other stormwater conveyance structures on a regular basis to remove pollutants, reduce high pollutant concentrations during the first flush of storms, prevent clogging of the downstream conveyance system, restore catch basins' sediment trapping capacity, and ensure the system functions properly hydraulically to avoid flooding.
- ☐ Develop and follow a site specific drainage system maintenance plan that describes maintenance locations, methods, required equipment, water sources, sediment collection areas, disposal requirements, and any other pertinent information.

Good Housekeeping

Illicit Connections and Discharges

- ☐ Look for evidence of illegal discharges or illicit connections during routine maintenance of conveyance system and drainage structures:

Objectives
■ *Cover*
■ *Contain*
■ *Educate*
■ *Reduce/Minimize*

Targeted Constituents	
Sediment	✓
Nutrients	✓
Trash	✓
Metals	✓
Bacteria	✓
Oil and Grease	✓
Organics	✓

Minimum BMPs Covered	
Good Housekeeping	✓
Preventative Maintenance	✓
Spill and Leak Prevention and Response	✓
Material Handling & Waste Management	
Erosion and Sediment Controls	
Employee Training Program	✓
Quality Assurance Record Keeping	✓

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- ✓ Identify evidence of spills such as paints, discoloring, odors, etc.
- ✓ Record locations of apparent illegal discharges/illicit connections.
- ✓ Track flows back to potential discharges and conduct aboveground inspections. This can be done through visual inspection of upgradient manholes or alternate techniques including zinc chloride smoke testing, fluorometric dye testing, physical inspection testing, or television camera inspection.
- ✓ Eliminate the discharge once the origin of flow is established.

- ☐ Stencil or demarcate storm drains, where applicable, to prevent illegal disposal of pollutants. Storm drain inlets should have messages such as "Dump No Waste Drains to Stream" or similar stenciled next to them to warn against ignorant or intentional dumping of pollutants into the storm drainage system.
- ☐ Refer to fact sheet SC-10 Non-Stormwater Discharges for additional information.

Illegal Dumping

- ☐ Inspect and clean up hot spots and other storm drainage areas regularly where illegal dumping and disposal occurs.
- ☐ Establish a system for tracking incidents. The system should be designed to identify the following:
  - ✓ Illegal dumping hot spots;
  - ✓ Types and quantities (in some cases) of wastes;
  - ✓ Patterns in time of occurrence (time of day/night, month, or year);
  - ✓ Mode of dumping (abandoned containers, "midnight dumping" from moving vehicles, direct dumping of materials, accidents/spills); and
  - ✓ Responsible parties.
- ☐ Post "No Dumping" signs in problem areas with a phone number for reporting dumping and disposal. Signs should also indicate fines and penalties for illegal dumping.
- ☐ Refer to fact sheet SC-10 Non-Stormwater Discharges for additional information.

Preventative Maintenance

Catch Basins/Inlet Structures

- ☐ Staff should regularly inspect facilities to ensure compliance with the following:
  - ✓ Immediate repair of any deterioration threatening structural integrity.
  - ✓ Cleaning before the sump is 40% full. Catch basins should be cleaned as frequently as needed to meet this standard.

- Clean catch basins, storm drain inlets, and other conveyance structures before the wet season to remove sediments and debris accumulated during the summer.
- Conduct inspections more frequently during the wet season for problem areas where sediment or trash accumulates more often. Prioritize storm drain inlets; clean and repair as needed.
- Keep accurate logs of the number of catch basins cleaned.
- Store wastes collected from cleaning activities of the drainage system in appropriate containers or temporary storage sites in a manner that prevents discharge to the storm drain.
- Dewater the wastes if necessary with outflow into the sanitary sewer if permitted. Water should be treated with an appropriate filtering device prior to discharge to the sanitary sewer. If discharge to the sanitary sewer is not allowed, water should be pumped or vacuumed to a tank and properly disposed. Do not dewater near a storm drain or stream.

Storm Drain Conveyance System

- Locate reaches of storm drain with deposit problems and develop a flushing schedule that keeps the pipe clear of excessive buildup.
- Collect and pump flushed effluent to the sanitary sewer for treatment whenever possible.

Pump Stations

- Clean all storm drain pump stations prior to the wet season to remove silt and trash.
- Do not allow discharge to reach the storm drain system when cleaning a storm drain pump station or other facility.
- Conduct routine maintenance at each pump station.
- Inspect, clean, and repair as necessary all outlet structures prior to the wet season.

Open Channel

- Modify storm channel characteristics to improve channel hydraulics, increase pollutant removals, and enhance channel/creek aesthetic and habitat value.
- Conduct channel modification/improvement in accordance with existing laws. Any person, government agency, or public utility proposing an activity that will change the natural state of any river, stream, or lake in California, must enter into a Steam or Lake Alteration Agreement with the Department of Fish and Wildlife. The developer-applicant should also contact local governments (city, county, special districts), other state agencies (SWRCB, RWQCB, Department of Forestry, Department of Water Resources), and Army Corps of Engineers and USFWS.

Spill Response and Prevention Procedures

- Keep your spill prevention control plan up-to-date.

- Investigate all reports of spills, leaks, and/or illegal dumping promptly.
- Place a stockpile of spill cleanup materials where it will be readily accessible or at a central location.
- Clean up all spills and leaks using "dry" methods (with absorbent materials and/or rags) or dig up, remove, and properly dispose of contaminated soil.

Employee Training Program

- Educate employees about pollution prevention measures and goals.
- Train employees how to properly handle and dispose of waste using the source control BMPs described above.
- Train employees and subcontractors in proper hazardous waste management.
- Use a training log or similar method to document training.
- Ensure that employees are familiar with the site's spill control plan and/or proper spill cleanup procedures.
- Have staff involved in detection and removal of illicit connections trained in the following:
  - ✓ OSHA-required Health and Safety Training (29 CFR 1910.120) plus annual refresher training (as needed).
  - ✓ OSHA Confined Space Entry training (Cal-OSHA Confined Space, Title 8 and Federal OSHA 29 CFR 1910.146).
  - ✓ Procedural training (field screening, sampling, smoke/dye testing, TV inspection).

Quality Assurance and Record Keeping

- Keep accurate maintenance logs that document minimum BMP activities performed for drainage system maintenance, types and quantities of waste disposed of, and any improvement actions.
- Keep accurate logs of spill response actions that document what was spilled, how it was cleaned up, and how the waste was disposed.
- Keep accurate logs of illicit connections, illicit discharges, and illegal dumping into the storm drain system including how wastes were cleaned up and disposed.
- Establish procedures to complete logs and file them in the central office.

Potential Limitations and Work-Arounds

Provided below are typical limitations and recommended "work-arounds" for drainage system maintenance:

- Clean-up activities may create a slight disturbance for local aquatic species. Access to items and material on private property may be limited. Trade-offs may exist between channel hydraulics and water quality/riparian habitat. If storm channels or basins are recognized as wetlands, many activities, including maintenance, may be subject to regulation and permitting.

  - ✓ Perform all maintenance onsite and do not flush accumulated material downstream to private property or riparian habitats.

- Storm drain flushing is most effective in small diameter pipes (36-inch diameter pipe or less, depending on water supply and sediment collection capacity). Other considerations associated with storm drain flushing may include the availability of a water source, finding a downstream area to collect sediments, and liquid/sediment disposal.

  - ✓ Develop and follow a site specific drainage system maintenance plan that describes maintenance locations, methods, required equipment, water sources, sediment collection areas, disposal requirements, and any other pertinent information.

- Regulations may include adoption of substantial penalties for illegal dumping and disposal.

  - ✓ Do not dump illegal materials anywhere onsite.

  - ✓ Identify illicit connections, illicit discharge, and illegal dumping.

  - ✓ Cleanup spills immediately and properly dispose of wastes.

- Local municipal codes may include sections prohibiting discharge of soil, debris, refuse, hazardous wastes, and other pollutants into the sanitary sewer system.

  - ✓ Collect all materials and pollutants accumulated in drainage system and dispose of according to local regulations.

  - ✓ Install debris excluders in areas with a trash TMDL.

Potential Capital Facility Costs and Operation & Maintenance Requirements

Facilities

- Capital costs will vary substantially depending on the size of the facility and characteristics of the drainage system. Significant capital costs may be associated with purchasing water trucks, vacuum trucks, and any other necessary cleaning equipment or improving the drainage infrastructure to reduce the potential .

- Developing and implementing a site specific drainage system maintenance plan will require additional capital if a similar program is not already in place.

Maintenance

- Two-person teams may be required to clean catch basins with vactor trucks.
- Teams of at least two people plus administrative personnel are required to identify illicit discharges, depending on the complexity of the storm sewer system.
- Arrangements must be made for proper disposal of collected wastes.
- Technical staff are required to detect and investigate illegal dumping violations.
- Methods used for illicit connection detection (smoke testing, dye testing, visual inspection, and flow monitoring) can be costly and time-consuming. Site-specific factors, such as the level of impervious area, the density and ages of buildings, and type of land use will determine the level of investigation necessary.

Supplemental Information

Storm Drain Flushing

Flushing is a common maintenance activity used to improve pipe hydraulics and to remove pollutants in storm drainage systems. Flushing may be designed to hydraulically convey accumulated material to strategic locations, such as an open channel, another point where flushing will be initiated, or the sanitary sewer and the treatment facilities, thus preventing re-suspension and overflow of a portion of the solids during storm events. Flushing prevents "plug flow" discharges of concentrated pollutant loadings and sediments. Deposits can hinder the designed conveyance capacity of the storm drain system and potentially cause backwater conditions in severe cases of clogging.

Storm drain flushing usually takes place along segments of pipe with grades that are too flat to maintain adequate velocity to keep particles in suspension. An upstream manhole is selected to place an inflatable device that temporarily plugs the pipe. Further upstream, water is pumped into the line to create a flushing wave. When the upstream reach of pipe is sufficiently full to cause a flushing wave, the inflated device is rapidly deflated with the assistance of a vacuum pump, thereby releasing the backed up water and resulting in the cleaning of the storm drain segment.

To further reduce impacts of stormwater pollution, a second inflatable device placed well downstream may be used to recollect the water after the force of the flushing wave has dissipated. A pump may then be used to transfer the water and accumulated material to the sanitary sewer for treatment. In some cases, an interceptor structure may be more practical or required to recollect the flushed waters.

It has been found that cleansing efficiency of periodic flush waves is dependent upon flush volume, flush discharge rate, sewer slope, sewer length, sewer flow rate, sewer diameter, and population density. As a rule of thumb, the length of line to be flushed should not exceed 700 feet. At this maximum recommended length, the percent removal efficiency ranges between 65-75% for organics and 55-65% for dry weather grit/inorganic material. The percent removal efficiency drops rapidly beyond that. Water is commonly supplied by a water truck, but fire hydrants can also supply water. To make the best use of water, it is recommended that reclaimed water be used if allowed or that fire hydrant line flushing coincide with storm sewer flushing.

References and Resources

City of Seattle, Seattle Public Utilities Department of Planning and Development, 2009. *Stormwater Manual Vol. 1 Source Control Technical Requirements Manual*.

Knox County Tennessee *Stormwater Management Manual* Chapter 5 Drainage System Maintenance, 2008. Available online at: http://www.knoxcounty.org/stormwater/manual/Volume%201/knoxco_swmm_v1_chap5_jan2008.pdf.

US EPA. Storm Drain System Cleaning, 2012. Available online at: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=102.

Efficient Irrigation SD-12

Design Objectives

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

Description

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

Approach

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

Suitable Applications

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

Design Considerations

Designing New Installations

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

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

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

Redeveloping Existing Installations

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

Other Resources

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

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

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

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

Storm Drain Signage SD-13

Design Objectives

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

Description

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

Approach

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

Suitable Applications

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

Design Considerations

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

Designing New Installations

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

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

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

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

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

Redeveloping Existing Installations

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

Additional Information

Maintenance Considerations

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

Placement

- Signage on top of curbs tends to weather and fade.

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

Supplemental Information

Examples

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

Other Resources

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

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

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

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

Maintenance Bays & Docks SD-31

Design Objectives

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

Description

Several measures can be taken to prevent operations at maintenance bays and loading docks from contributing a variety of toxic compounds, oil and grease, heavy metals, nutrients, suspended solids, and other pollutants to the stormwater conveyance system.

Approach

In designs for maintenance bays and loading docks, containment is encouraged. Preventative measures include overflow containment structures and dead-end sumps. However, in the case of loading docks from grocery stores and warehouse/distribution centers, engineered infiltration systems may be considered.

Suitable Applications

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

Design Considerations

Design requirements for vehicle maintenance and repair are governed by Building and Fire Codes, and by current local agency ordinances, and zoning requirements. The design criteria described in this fact sheet are meant to enhance and be consistent with these code requirements.

Designing New Installations

Designs of maintenance bays should consider the following:

- Repair/maintenance bays and vehicle parts with fluids should be indoors; or designed to preclude urban run-on and runoff.
- Repair/maintenance floor areas should be paved with Portland cement concrete (or equivalent smooth impervious surface).

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- Repair/maintenance bays should be designed to capture all wash water leaks and spills. Provide impermeable berms, drop inlets, trench catch basins, or overflow containment structures around repair bays to prevent spilled materials and wash-down waters form entering the storm drain system. Connect drains to a sump for collection and disposal. Direct connection of the repair/maintenance bays to the storm drain system is prohibited. If required by local jurisdiction, obtain an Industrial Waste Discharge Permit.

- Other features may be comparable and equally effective.

The following designs of loading/unloading dock areas should be considered:

- Loading dock areas should be covered, or drainage should be designed to preclude urban run-on and runoff.

- Direct connections into storm drains from depressed loading docks (truck wells) are prohibited.

- Below-grade loading docks from grocery stores and warehouse/distribution centers of fresh food items should drain through water quality inlets, or to an engineered infiltration system, or an equally effective alternative. Pre-treatment may also be required.

- Other features may be comparable and equally effective.

Redeveloping Existing Installations

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

Additional Information

Stormwater and non-stormwater will accumulate in containment areas and sumps with impervious surfaces. Contaminated accumulated water must be disposed of in accordance with applicable laws and cannot be discharged directly to the storm drain or sanitary sewer system without the appropriate permit.

Other Resources

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

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

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

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

Trash Storage Areas SD-32

Description

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

Approach

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

Design Objectives

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

Suitable Applications

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

Design Considerations

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

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

Designing New Installations

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

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

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

Redeveloping Existing Installations

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

Additional Information

Maintenance Considerations

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

Other Resources

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

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

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

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

Section 6.4

Attachment F
Infiltration Report
(PENDING)