DRAINAGE REPORT FOR MONTGOMERY AIRPORT AIR FIRE RESCUE FACILITY

For the City of San Diego

November 5, 2018
January 23, 2019
February 25, 2019
May 23, 2019
June 21, 2019
August 17, 2019
November 1, 2019
December 13, 2019

C&S ENGINEERS, INC.
2020 CAMINO DEL RIO NORTH, SUITE 1000
SAN DIEGO, CALIFORNIA 92108

Q74.001.002

KENNETH GETHERS - PROJECT ENGINEER

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OBJECTIVE

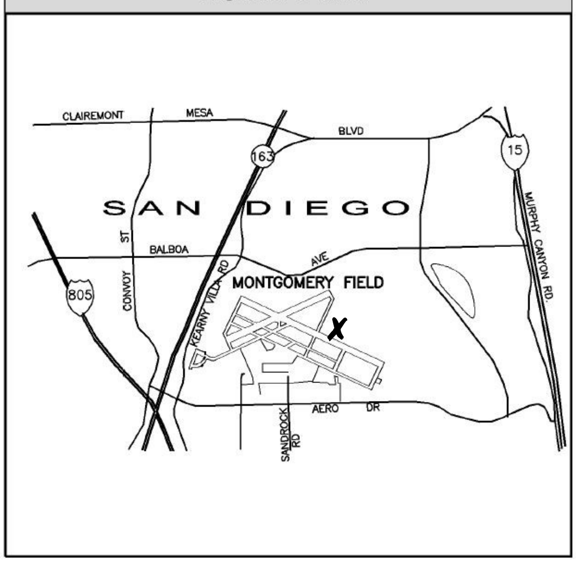
This drainage report addresses the hydrologic and hydraulic aspects of the project. Post Construction storm water issues are discussed and addressed under the "Storm Water Quality Management Plan". The report will determine Post-Construction impact to the watershed and how additional flows will be dealt with. Additionally, due to existing vernal pools in the area, the design will show how vernal pools will not be impacted by not routing post development overland runoff flows from new impervious areas into these sensitive areas.

INTRODUCTION

This drainage report shall serve to depict existing and proposed drainage patterns for the Montgomery Airport Air Fire Rescue Facility project located north of, and adjacent to, the Montgomery Airport air traffic controller's control tower.

The site is bound by Taxiway Charlie on the west, higher natural terrain grades on the south, higher natural terrain grades on the north, and a 15-ft wide asphalt paved access road on the east. The overland drainage is comprised of two drainage areas - southerly half and a northerly half. The terrain is relatively flat, with a mild grade from west to east (Taxiway Charlie to the access road). See Appendix A for a general overview of the existing site.

VICINITY MAP



The project proposes to construct two hangars for helicopters, apron areas for the helicopters, fuel tender areas, and a small maintenance facility structure. The hangars will share walls with the existing FAA facility building. The FAA facility building will be renovated to function along with the proposed improvements. See Appendix B for a general overview of the proposed site.

CONCLUSION

The table below summarize the existing flows vs. the proposed flows. The drainage boundary between Basin A and B was adjusted to treat newly created impervious areas for water quality purposes. Therefore the Post-development Q for Basin A was decreased to 2.72 CFS. Although there has been a significant increase in Q for Basin B, there will be no impact to any watersheds below our site, since all flows from Basin B will be routed and store in an underground Vault located to the northeast side of the project area, this will prevent flows from negatively impacting the vernal pools located to east of the project site. No significant impact is not anticipated because of the proposed development.

FLOWS

	C	**Tc Min**	**I In/hr**	**A (ac)**	**Q_{100} cfs**
Pre-Development					
BASIN A	0.72	10.62	3.30	1.73	4.17
BASIN B	0.62	11.25	3.23	3.20	6.49
Post-Development					
BASIN A	0.50	13.18	3.05	0.94	1.45
BASIN B	0.89	9.01	3.50	4.00	12.58

DISCUSSION

The existing site consists of impervious surfaces, such as the asphalt parking area and the building's roof top, as well as natural terrain. The runoff coefficient for the site has been developed using "The City of San Diego Drainage Design Manual" January 2017 Edition, specifically Table A-1 "Runoff Coefficient for Rational Method". Based on values shown on said table a weighted runoff coefficient was developed to accurately depict the conditions present on the site during the pre and post-development. (See Appendix C)

Per the stormwater threat assessment form DS-560, the project has been deemed a priority development project (PDP) due to large amounts of new impervious areas being proposed. Flows from Basin B will be routed, treated and stored in the proposed underground storage vault, no flows from new impervious areas and existing confluence flows are expected to leave the site via overland. Captured peak runoff volumes from the 6-hour, 100-year storm hydrograph will be pumped and hauled offsite into a nearby MS4 storm drain system.

A trench drain located on the north and west side of the building is being placed to convey the flows from the impervious areas into a modular wetland system for water quality purposed before entering the underground vault storage unit. As for the flows from the pervious areas located on the north side they will be capture by an earthen swale located on the west side on the existing access road and running in a southwesterly direction where they will capture by a catch basin that will convey them into the underground storage vault.

For compliance with the state's National Pollution Discharge Elimination System (NPDES) permit R9-2013-0001, Low Impact Development (LID) and Source Control will be implemented. For LID, due to the existing Runway 23 and Taxiway Charlie, along with the existing AC access road, the proposed hangars and apron areas are confined but will meet the minimum areas required for safe aircraft separation. And per FAA regulations, wash racks will be required for the helicopters. Wash racks will be contained and either hauled away or will be treated onsite and then hauled away. Since this hydrology study is being prepared as part of the preliminary review of the project, more information is forthcoming which will aid in the final determination on how the wash rack system will operate.

HYDROLOGIC ANALYSES

This study contains 100-year hydrologic analyses to determine the existing and proposed flows generated by the project. The City of San Diego *Drainage Design Manual, Jan. 2017 edition* criteria along with the City of San Diego Rational Method program within the *CivilDesign was utilized in calculating runoff for all basins smaller than 0.5 square miles in size.

- Drainage areas, flow lengths and elevations: For both the existing and proposed condition analyses, the grades were determined from a survey analysis prepared by the city of San Diego.

- Hydrologic soil group D was used for this study based on the requirements shown on Note 1 below Table A-1 of the City of San Diego County *Drainage Design Manual, Jan. 2017 edition.*

Due to the vernal pools and their proximity to the site, it should be noted that the access road on the east side of the site traverses the site from south to north and connects the control tower to the public road, Ponderosa Ave. More importantly, it serves as a weir for the northerly half tributary area (see Appendix B). The proposed design will continue to utilize the access road as a weir. Therefore, the overland flow will continue to concentrate west of the access road and north of the surface improvements. Additionally, an earthen swale located on the west side of the access road an running parallel to it will impede flows from leaving the site, said earthen swale will convey flows on a south westerly direction to a catch basin which will capture flows and convey them into the underground storage vault. The 6-hr. hydrograph has been developed using the CivilDesign software to determine the required storage capacity required to capture the flows. It has been determined that an underground storage vault with at storage capacity of 28,500 cubic-feet will be required said flows from Basin B.

For the southerly tributary area, there is an existing squashed corrugated metal pipe, approximately 24" in diameter that lays about one foot below the AC access road (see Appendix H). Unlike the northerly tributary area, the southerly tributary area does not pond, it continues to flow to the east via the pipe. And in consideration to the vernal pools downstream of the pipe, the proposed flows are shown to be just under the existing flows (existing = 4.17 cfs, proposed = 1.45 cfs). This equates to a discharge of 2.72 cfs lower than existing.

*CivilDesign Software uses the 2003 Darinage Design Manual, however the parameters within the software still apply to the 2017 City of San Diego Drainage Design Manual.

APPENDIX A

CIVILDESIGN CALCULATIONS

PRE-DEVELOPMENT

PRE-DEVELOPMENT HYDROLOGY EXHIBIT
AIR FIRE RESCUE FACILITY

DATE: 12/13/19

DRAWING:
SHEET 1 OF 1

SAVE DATE: 12/13/2019 ~ PLOT DATE: 12/13/2019 ~ FILE NAME: F:\Project\274 - City of San Diego\274001002- Air Fire Rescue Facility\Planning-Study\Reports\Phase 2 Reports\18301Phase 2 CAD Files\HYDROLOGY\183.01_PreDevelopment.dwg

```
                 San Diego County Rational Hydrology Program

      CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2003 Version
6.3

      Rational method hydrology  program based on
      San Diego County Flood Control Division 1985 hydrology manual
            Rational Hydrology Study        Date: 12/13/19
      -----------------------------------------------------------------
------
      Montgomery Air Fire Rescue Facility
      Pre-Development Condition
      100 Year Storm Event

      -----------------------------------------------------------------
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       *********   Hydrology Study Control Information **********

      -----------------------------------------------------------------
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      Program License Serial Number 5017

      -----------------------------------------------------------------
------
      Rational hydrology study storm event year is   100.0
      English (in-lb) input data Units used
      English (in) rainfall data used

      Standard intensity of Appendix I-B used for year and
      Elevation 0 - 1500 feet
      Factor (to multiply * intensity)  =  1.000
      Only used if inside City of San Diego
      San Diego hydrology manual 'C' values used
      Runoff coefficients by rational method


      +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
++++
      Process from Point/Station        5.000 to Point/Station
10.000
      **** INITIAL AREA EVALUATION ****
      _________________________________________________________________
____
      User specified 'C' value of 0.720 given for subarea
      Initial subarea flow distance  =  100.000(Ft.)
      Highest elevation =  425.400(Ft.)
      Lowest elevation =  424.700(Ft.)
      Elevation difference =    0.700(Ft.)
      Time of concentration calculated by the urban
      areas overland flow method (App X-C) =     7.70 min.
      TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
      TC = [1.8*(1.1-0.7200)*( 100.000^.5)/( 0.700^(1/3)]=   7.70
      Rainfall intensity (I) =      3.711(In/Hr) for a   100.0 year
storm
      Effective runoff coefficient used for area (Q=KCIA) is C = 0.720
      Subarea runoff =      0.508(CFS)
      Total initial stream area =       0.190(Ac.)
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     Process from Point/Station      10.000 to Point/Station
15.000
     **** IMPROVED CHANNEL TRAVEL TIME ****
     ___________________________________________________________________
____
     Upstream point elevation =   424.700(Ft.)
     Downstream point elevation =   417.500(Ft.)
     Channel length thru subarea  =   387.000(Ft.)
     Channel base width      =    0.000(Ft.)
     Slope or 'Z' of left channel bank =  16.000
     Slope or 'Z' of right channel bank =  16.000
     Estimated mean flow rate at midpoint of channel =      2.565(CFS)
     Manning's 'N'    = 0.025
     Maximum depth of channel  =    0.250(Ft.)
     Flow(q) thru subarea =      2.565(CFS)
     Depth of flow =   0.269(Ft.), Average velocity =   2.225(Ft/s)
     !!Warning: Water is above left or right bank elevations
     Channel flow top width =    8.000(Ft.)
     Flow Velocity =    2.23(Ft/s)
     Travel time  =    2.90 min.
     Time of concentration =   10.60 min.
     Critical depth =      0.271(Ft.)
     ERROR - Channel depth exceeds maximum allowable depth
      Adding area flow to channel
     User specified 'C' value of 0.720 given for subarea
     Rainfall intensity =      3.304(In/Hr) for a   100.0 year storm
     Runoff coefficient used for sub-area, Rational method,Q=KCIA, C =
0.720
     Subarea runoff =      3.663(CFS) for    1.540(Ac.)
     Total runoff =      4.171(CFS)      Total area =       1.73(Ac.)


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     Process from Point/Station       15.000 to Point/Station
20.000
     **** CONFLUENCE OF MAIN STREAMS ****
     ___________________________________________________________________
____
     The following data inside Main Stream is listed:
     In Main Stream number: 1
     Stream flow area =      1.730(Ac.)
     Runoff from this stream =      4.171(CFS)
     Time of concentration =   10.60 min.
     Rainfall intensity =     3.304(In/Hr)
     Summary of stream data:

     Stream   Flow rate      TC            Rainfall Intensity
      No.       (CFS)       (min)                 (In/Hr)


     1        4.171     10.60              3.304
     Qmax(1) =
              1.000 *    1.000 *     4.171) + =       4.171

     Total of 1 main streams to confluence:
     Flow rates before confluence point:
            4.171
```

```
Maximum flow rates at confluence using above data:
        4.171
Area of streams before confluence:
        1.730


Results of confluence:
Total flow rate =      4.171(CFS)
Time of concentration =    10.602 min.
Effective stream area after confluence  =      1.730(Ac.)
End of computations, total study area =           1.730 (Ac.)
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Process from Point/Station       20.000 to Point/Station       25.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
User specified 'C' value of 0.620 given for subarea
Initial subarea flow distance  =  100.000(Ft.)
Highest elevation =  424.900(Ft.)
Lowest elevation =  422.600(Ft.)
Elevation difference =    2.300(Ft.)
Time of concentration calculated by the urban
areas overland flow method (App X-C) =     6.55 min.
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.6200)*( 100.000^.5)/( 2.300^(1/3)]=   6.55
Rainfall intensity (I) =      3.946(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.620
Subarea runoff =      0.391(CFS)
Total initial stream area =        0.160(Ac.)


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Process from Point/Station       25.000 to Point/Station       30.000
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________
Upstream point elevation =   422.600(Ft.)
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Downstream point elevation =   419.900(Ft.)
Channel length thru subarea  =   443.000(Ft.)
Channel base width      =    3.000(Ft.)
Slope or 'Z' of left channel bank =  16.000
Slope or 'Z' of right channel bank =  16.000
Estimated mean flow rate at midpoint of channel =      4.110(CFS)
Manning's 'N'    = 0.025
Maximum depth of channel  =    0.350(Ft.)
Flow(q) thru subarea =      4.110(CFS)
Depth of flow =   0.321(Ft.), Average velocity =   1.570(Ft/s)
Channel flow top width =   13.288(Ft.)
Flow Velocity =    1.57(Ft/s)
Travel time  =    4.70 min.
Time of concentration =   11.25 min.
Critical depth =      0.254(Ft.)
 Adding area flow to channel
User specified 'C' value of 0.620 given for subarea
Rainfall intensity =      3.233(In/Hr) for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.620
Subarea runoff =      6.094(CFS) for    3.040(Ac.)
Total runoff =      6.486(CFS)  Total area =       3.20(Ac.)


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Process from Point/Station      30.000 to Point/Station      30.000
**** CONFLUENCE OF MAIN STREAMS ****
______________________________________________________________________
The following data inside Main Stream is listed:
In Main Stream number: 1
Stream flow area =      3.200(Ac.)
Runoff from this stream =      6.486(CFS)
Time of concentration =   11.25 min.
Rainfall intensity =     3.233(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                 (In/Hr)


1        6.486     11.25                 3.233
Qmax(1) =
           1.000 *    1.000 *     6.486) + =       6.486

Total of 1 main streams to confluence:
Flow rates before confluence point:
       6.486
Maximum flow rates at confluence using above data:
        6.486
```

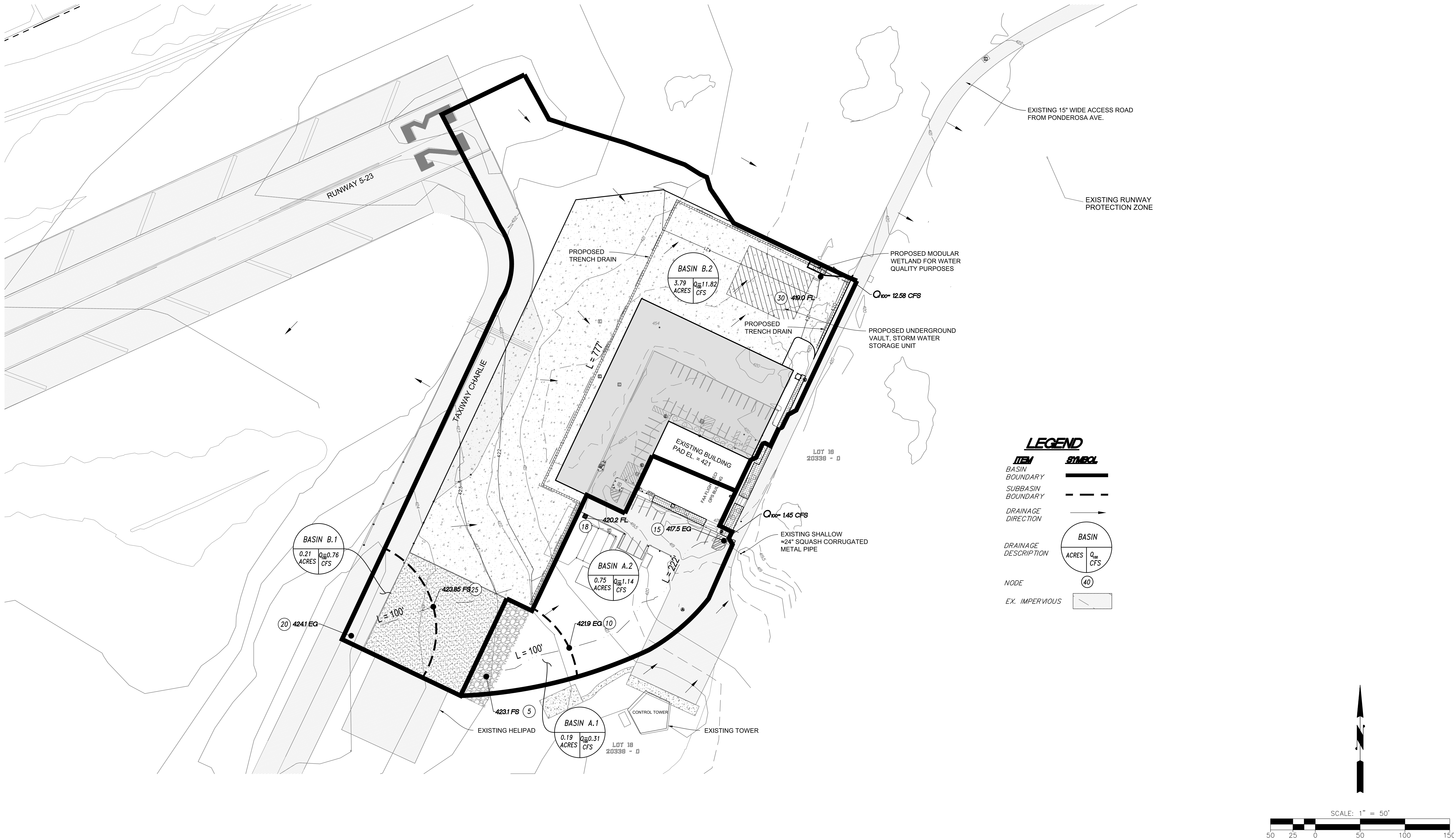
```
Area of streams before confluence:
        3.200


Results of confluence:
Total flow rate =      6.486(CFS)
Time of concentration =    11.249 min.
Effective stream area after confluence  =      3.200(Ac.)
End of computations, total study area =           3.200 (Ac.)
```

APPENDIX B

CIVILDESIGN CALCULATIONS

POST-DEVELOPMENT



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POST-DEVELOPMENT HYDROLOGY EXHIBIT
AIR FIRE RESCUE FACILITY

DATE: 10/31/19

DRAWING:

SHEET 1 OF 1

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                San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2003 Version 6.3

Rational method hydrology  program based on
San Diego County Flood Control Division 1985 hydrology manual
        Rational Hydrology Study        Date: 10/31/19
------------------------------------------------------------------------
Montgomery Air Fire Rescue Facility
Post Development Condition
100 Year Storm Event


------------------------------------------------------------------------
 *********   Hydrology Study Control Information **********

------------------------------------------------------------------------


Program License Serial Number 5017

------------------------------------------------------------------------
Rational hydrology study storm event year is   100.0
English (in-lb) input data Units used
English (in) rainfall data used

Standard intensity of Appendix I-B used for year and
Elevation 0 - 1500 feet
Factor (to multiply * intensity)  =  1.000
Only used if inside City of San Diego
San Diego hydrology manual 'C' values used
Runoff coefficients by rational method

BASIN A
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        5.000 to Point/Station       10.000
**** INITIAL AREA EVALUATION ****
A.1______________________________________________________________________
User specified 'C' value of 0.500 given for subarea
Initial subarea flow distance  =  100.000(Ft.)
Highest elevation =  422.800(Ft.)
Lowest elevation =  421.900(Ft.)
Elevation difference =    0.900(Ft.)
Time of concentration calculated by the urban
areas overland flow method (App X-C) =    11.19 min.
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.5000)*( 100.000^.5)/( 0.900^(1/3)]=  11.19
```

Rainfall intensity (I) =   3.240(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.500
Subarea runoff =   0.308(CFS)
Total initial stream area =   0.190(Ac.)

++
Process from Point/Station   10.000 to Point/Station   15.000
**** IMPROVED CHANNEL TRAVEL TIME ****
A.2____
Upstream point elevation =   421.900(Ft.)
Downstream point elevation =   417.500(Ft.)
Channel length thru subarea =   222.000(Ft.)
Channel base width   =   1.500(Ft.)
Slope or 'Z' of left channel bank = 10.000
Slope or 'Z' of right channel bank = 10.000
Estimated mean flow rate at midpoint of channel =   0.915(CFS)
Manning's 'N'   = 0.025
Maximum depth of channel =   0.350(Ft.)
Flow(q) thru subarea =   0.915(CFS)
Depth of flow =   0.159(Ft.), Average velocity =   1.859(Ft/s)
Channel flow top width =   4.684(Ft.)
Flow Velocity =   1.86(Ft/s)
Travel time =   1.99 min.
Time of concentration =   13.18 min.
Critical depth =   0.160(Ft.)
Adding area flow to channel
User specified 'C' value of 0.500 given for subarea
Rainfall intensity =   3.051(In/Hr) for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.500
Subarea runoff =   1.144(CFS) for   0.750(Ac.)
Total runoff =   1.452(CFS) Total area =   0.94(Ac.)

++
Process from Point/Station   15.000 to Point/Station   15.000
**** CONFLUENCE OF MAIN STREAMS ****
____
The following data inside Main Stream is listed:
In Main Stream number: 1
Stream flow area =   0.940(Ac.)
Runoff from this stream =   1.452(CFS)
Time of concentration =   13.18 min.
Rainfall intensity =   3.051(In/Hr)
Summary of stream data:

Stream   Flow rate   TC   Rainfall Intensity
No.   (CFS)   (min)   (In/Hr)

```
1        1.452     13.18                 3.051
Qmax(1) =
           1.000 *    1.000 *     1.452) + =       1.452

Total of 1 main streams to confluence:
Flow rates before confluence point:
       1.452
Maximum flow rates at confluence using above data:
        1.452
Area of streams before confluence:
        0.940


Results of confluence:
Total flow rate =      1.452(CFS)
Time of concentration =    13.176 min.
Effective stream area after confluence  =      0.940(Ac.)
End of computations, total study area =           0.940 (Ac.)

BASIN B
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       20.000 to Point/Station       25.000
**** INITIAL AREA EVALUATION ****
B.1__________________________________________________________________________
User specified 'C' value of 0.890 given for subarea
Initial subarea flow distance  =  100.000(Ft.)
Highest elevation =  424.100(Ft.)
Lowest elevation =  423.850(Ft.)
Elevation difference =    0.250(Ft.)
Time of concentration calculated by the urban
areas overland flow method (App X-C) =     6.00 min.
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.8900)*( 100.000^.5)/( 0.250^(1/3)]=   6.00
Rainfall intensity (I) =      4.081(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.890
Subarea runoff =      0.763(CFS)
Total initial stream area =       0.210(Ac.)


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Process from Point/Station       25.000 to Point/Station       30.000
**** IMPROVED CHANNEL TRAVEL TIME ****
B.2__________________________________________________________________________
Upstream point elevation =   423.850(Ft.)
Downstream point elevation =   419.000(Ft.)
Channel length thru subarea  =   777.000(Ft.)
```

```
Channel base width      =    1.500(Ft.)
Slope or 'Z' of left channel bank =   2.000
Slope or 'Z' of right channel bank =   2.000
Estimated mean flow rate at midpoint of channel =      7.645(CFS)
Manning's 'N'    = 0.015
Maximum depth of channel  =    0.750(Ft.)
Flow(q) thru subarea =      7.645(CFS)
Depth of flow =   0.639(Ft.), Average velocity =   4.302(Ft/s)
Channel flow top width =    4.058(Ft.)
Flow Velocity =    4.30(Ft/s)
Travel time  =    3.01 min.
Time of concentration =    9.01 min.
Critical depth =      0.688(Ft.)
 Adding area flow to channel
User specified 'C' value of 0.890 given for subarea
Rainfall intensity =      3.504(In/Hr) for a   100.0 year storm
Runoff coefficient used for sub-area, Rational method,Q=KCIA, C = 0.890
Subarea runoff =     11.819(CFS) for    3.790(Ac.)
Total runoff =     12.582(CFS)  Total area =       4.00(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       30.000 to Point/Station       30.000
**** CONFLUENCE OF MAIN STREAMS ****
______________________________________________________________________
The following data inside Main Stream is listed:
In Main Stream number: 1
Stream flow area =      4.000(Ac.)
Runoff from this stream =     12.582(CFS)
Time of concentration =    9.01 min.
Rainfall intensity =     3.504(In/Hr)
Summary of stream data:

Stream   Flow rate      TC             Rainfall Intensity
 No.       (CFS)       (min)                  (In/Hr)


1       12.582      9.01                 3.504
Qmax(1) =
           1.000 *    1.000 *    12.582) + =      12.582

Total of 1 main streams to confluence:
Flow rates before confluence point:
      12.582
Maximum flow rates at confluence using above data:
       12.582
Area of streams before confluence:
        4.000
```

```
Results of confluence:
Total flow rate =     12.582(CFS)
Time of concentration =     9.010 min.
Effective stream area after confluence  =      4.000(Ac.)
End of computations, total study area =           4.000 (Ac.)
```

```
              San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2003 Version 6.3

Rational method hydrology  program based on
San Diego County Flood Control Division 1985 hydrology manual
        Rational Hydrology Study        Date: 11/04/19
------------------------------------------------------------------------
Airport 6-hr Unit Hyd




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 *********   Hydrology Study Control Information **********

------------------------------------------------------------------------


Program License Serial Number 5017

------------------------------------------------------------------------
Rational hydrology study storm event year is   100.0
English (in-lb) input data Units used
English (in) rainfall data used

Standard intensity of Appendix I-B used for year and
Elevation 0 - 1500 feet
Factor (to multiply * intensity)  =  1.000
Only used if inside City of San Diego
San Diego hydrology manual 'C' values used
Runoff coefficients by rational method


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       30.000 to Point/Station       30.000
**** USER DEFINED FLOW INFORMATION AT A POINT ****
______________________________________________________________________
User specified 'C' value of 0.890 given for subarea
Rainfall intensity (I) =      3.504(In/Hr) for a   100.0 year storm
User specified values are as follows:
TC =   9.01 min.  Rain intensity =       3.50(In/Hr)
Total area =        4.000(Ac.)  Total runoff =    12.582(CFS)

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```

```
Process from Point/Station       30.000 to Point/Station       30.000
**** PRINT CURRENT HYDROGRAPH ****
______________________________________________________________________
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
                   P R I N T   O F   S T O R M
                R u n o f f      H y d r o g r a p h
                                                               -------

   1-OK; 2-Change this entry; 3-Use another option] >
[ Allowable values:        1.0000  to        3.0000 ]-------------------
Time(h+m) Volume(Ac.Ft)   Q(CFS)  0        3.1       6.3       9.4      12.6
-----------------------------------------------------------------------
0+15       0.0000      0.00  Q         |         |         |         |
0+30       0.0085      0.41  VQ        |         |         |         |
0+45       0.0174      0.43   Q        |         |         |         |
1+ 0       0.0265      0.44  |Q        |         |         |         |
1+15       0.0362      0.47  |QV       |         |         |         |
1+30       0.0463      0.49  |QV       |         |         |         |
1+45       0.0570      0.52  |Q V      |         |         |         |
2+ 0       0.0682      0.54  |Q  V     |         |         |         |
2+15       0.0804      0.59  |Q  V     |         |         |         |
2+30       0.0931      0.62  |Q   V    |         |         |         |
2+45       0.1072      0.68  | Q   V   |         |         |         |
3+ 0       0.1222      0.72  | Q    V  |         |         |         |
3+15       0.1394      0.83  | Q     V |         |         |         |
3+30       0.1580      0.90  | Q      V|         |         |         |
3+45       0.1807      1.10  |  Q      V         |         |         |
4+ 0       0.2066      1.25  |  Q        V       |         |         |
4+15       0.2447      1.84  |    Q    |   V     |         |         |
4+30       0.2983      2.60  |       Q |      V  |         |         |
4+45       0.5582     12.58  |         |                     V       Q
5+ 0       0.5887      1.48  |   Q     |         |         |   V     |
5+15       0.6091      0.99  |  Q      |         |         |    V    |
5+30       0.6251      0.77  | Q       |         |         |     V   |
5+45       0.6385      0.65  | Q       |         |         |      V  |
6+ 0       0.6501      0.56  |Q        |         |         |       V |
-----------------------------------------------------------------------
```

0.6501 Ac. ft * 43,560 = **28,318.4 cubic feet**

Note:

6-hr Unit Hydrograph only being provided to determine total volume needed for the vault, routing is not being performed since flows are being contained and hauled off-site after rain event. Per the 6-hr Unit Hydrograph the total volume is 28,318.4 cubic feet, an underground vault L = 95' x W = 60' x D = 5' will be required which will have a capacity of 28,500 cubic feet.

APPENDIX C

WEIGHTED RUNOFF COEFFICIENT TABLES

Pre-Project Drainage

Basin ID	Total Area (ac)	Pervious Area - Soil Type D (sq-ft)	Impervious Area - Soil Type D (sq-ft)	% Impervious	% Pervious	Sub-Basin Weighted Runoff Coeff. C:	Basin Weighted Runoff Coeff. C:
A.1	0.19	0	8276	100%	0%	0.95	0.72
A.2	1.54	37852	29230	44%	56%	0.70	
B.1	0.16	3507	3463	50%	50%	0.72	0.62
B.2	3.04	99812	32610	25%	75%	0.61	
Total	4.93		73579				

* Runoff Coefficient Table	
Soil Type	D
Impervious	0.95
Pervious	0.50

Industrial (per Table A.1 of drainage manual)

Post-Project Drainage

Basin ID	Total Area (ac)	Pervious Area - Soil Type D (sq-ft)	Impervious Area - Soil Type D (sq-ft)	% Impervious	% Pervious	Weighted Runoff Coef C:	Basin Weighted Runoff Coeff. C:
A.1	0.19	8307	0	0%	100%	0.50	0.50
A2	0.75	16966	15867.1	49%	52%	0.72	
B.1	0.21	0	9115.3	100%	0%	0.95	0.89
B.2	3.79	21714	143295.3	87%	13%	0.89	
Total	4.93		168277.7				

APPENDIX D

CITY OF SAN DIEGO FIGURES & TABLES

Appendix A

Rational Method and Modified Rational Method

A.1. Rational Method (RM)

The Rational Method (RM) is a mathematical formula used to determine the maximum runoff rate from a given rainfall. It has particular application in urban storm drainage where it is used to estimate peak runoff rates from small urban and rural watersheds for the design of storm drains and drainage structures. The RM is recommended for analyzing the runoff response from drainage areas for watersheds less than 0.5 square miles. It should not be used in instances where there is a junction of independent drainage systems or for drainage areas greater than approximately 0.5 square mile in size. In these instances, the Modified Rational Method (MRM) should be used for junctions of independent drainage systems in watersheds up to approximately 1 square mile in size (see Section A.2); or the NRCS Hydrologic Method should be used for watersheds greater than approximately 1 square mile in size (see Appendix B).

A.1.1. Rational Method Formula

The RM formula estimates the peak rate of runoff at any location in a watershed as a function of the drainage area (A), runoff coefficient (C), and rainfall intensity (I) for a duration equal to the time of concentration (T_c), which is the time required for water to flow from the most remote point of the basin to the location being analyzed. The RM formula is expressed in Equation A-1.

Equation A-1. RM Formula Expression

$$Q = C\ I\ A$$

where:

Q	=	peak discharge, in cubic feet per second (cfs)
C	=	runoff coefficient expressed as that percentage of rainfall which becomes surface runoff (no units); Refer to Appendix A.1.2
I	=	average rainfall intensity for a storm duration equal to the time of concetrnatation (T_c) of the contributing draiange area, in inches per hour; Refer to Appendix A.1.3 and Appendix A.1.4
A	=	drainage area contributing to the design location, in acres

Combining the units for the expression CIA yields:

$$\left(\frac{1\,\text{acre}\times\text{inch}}{\text{hour}}\right)\left(\frac{43{,}560\ \text{ft}^2}{\text{acre}}\right)\left(\frac{1\,\text{foot}}{12\,\text{inches}}\right)\left(\frac{1\,\text{hour}}{3{,}600\,\text{seconds}}\right) \Rightarrow 1.008\,\text{cfs}$$

For practical purposes, the unit conversion coefficient difference of 0.8% can be ignored.

The RM formula is based on the assumption that for constant rainfall intensity, the peak discharge rate at a point will occur when the raindrop that falls at the most upstream point in the tributary drainage basin arrives at the point of interest.

Unlike the MRM (discussed in Appendix A.2) or the NRCS hydrologic method (discussed in Appendix B), the RM does not create hydrographs and therefore does not add separate subarea hydrographs at collection points. Instead, the RM develops peak discharges in the main line by increasing the T_c as flow travels downstream.

Characteristics of, or assumptions inherent to, the RM are listed below:

1. The discharge resulting from any I is maximum when the I lasts as long as or longer than the T_c.
2. The storm frequency of peak discharges is the same as that of I for the given T_c.
3. The fraction of rainfall that becomes runoff (or the runoff coefficient, C) is independent of I or precipitation zone number (PZN) condition (PZN Condition is discussed in the NRCS method).
4. The peak rate of runoff is the only information produced by using the RM.

A.1.2. Runoff Coefficient

The runoff coefficients are based on land use (see Table A–1). Soil type "D" is used throughout the City of San Diego for storm drain conveyance design. An appropriate runoff coefficient (C) for each type of land use in the subarea should be selected from this table and multiplied by the percentage of the total area (A) included in that class. The sum of the products for all land uses is the weighted runoff coefficient (Σ[CA]). Good engineering judgment should be used when applying the values presented in Table A–1, as adjustments to these values may be appropriate based on site-specific characteristics.

Table A-1. Runoff Coefficients for Rational Method

Land Use	Runoff Coefficient (C)
	Soil Type (1)
Residential:	
Single Family	0.55
Multi-Units	0.70
Mobile Homes	0.65
Rural (lots greater than ½ acre)	0.45
Commercial (2)	
80% Impervious	0.85
Industrial (2)	
90% Impervious	0.95

Note:
(1) Type D soil to be used for all areas.
(2) Where actual conditions deviate significantly from the tabulated imperviousness values of 80% or 90%, the values given for coefficient C, may be revised by multiplying 80% or 90% by the ratio of actual imperviousness to the tabulated imperviousness. However, in case shall the final coefficient be less than 0.50. For example: Consider commercial property on D soil.

Actual imperviousness = 50%
Tabulated imperviousness = 80%
Revised C = (50/80) x 0.85 = 0.53

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

A.1.3. Rainfall Intensity

The rainfall intensity (I) is the rainfall in inches per hour (in/hr.) for a duration equal to the T_C for a selected storm frequency. Once a particular storm frequency has been selected for design and a T_C calculated for the drainage area, the rainfall intensity can be determined from the Intensity-Duration-Frequency Design Chart (Figure A-1).

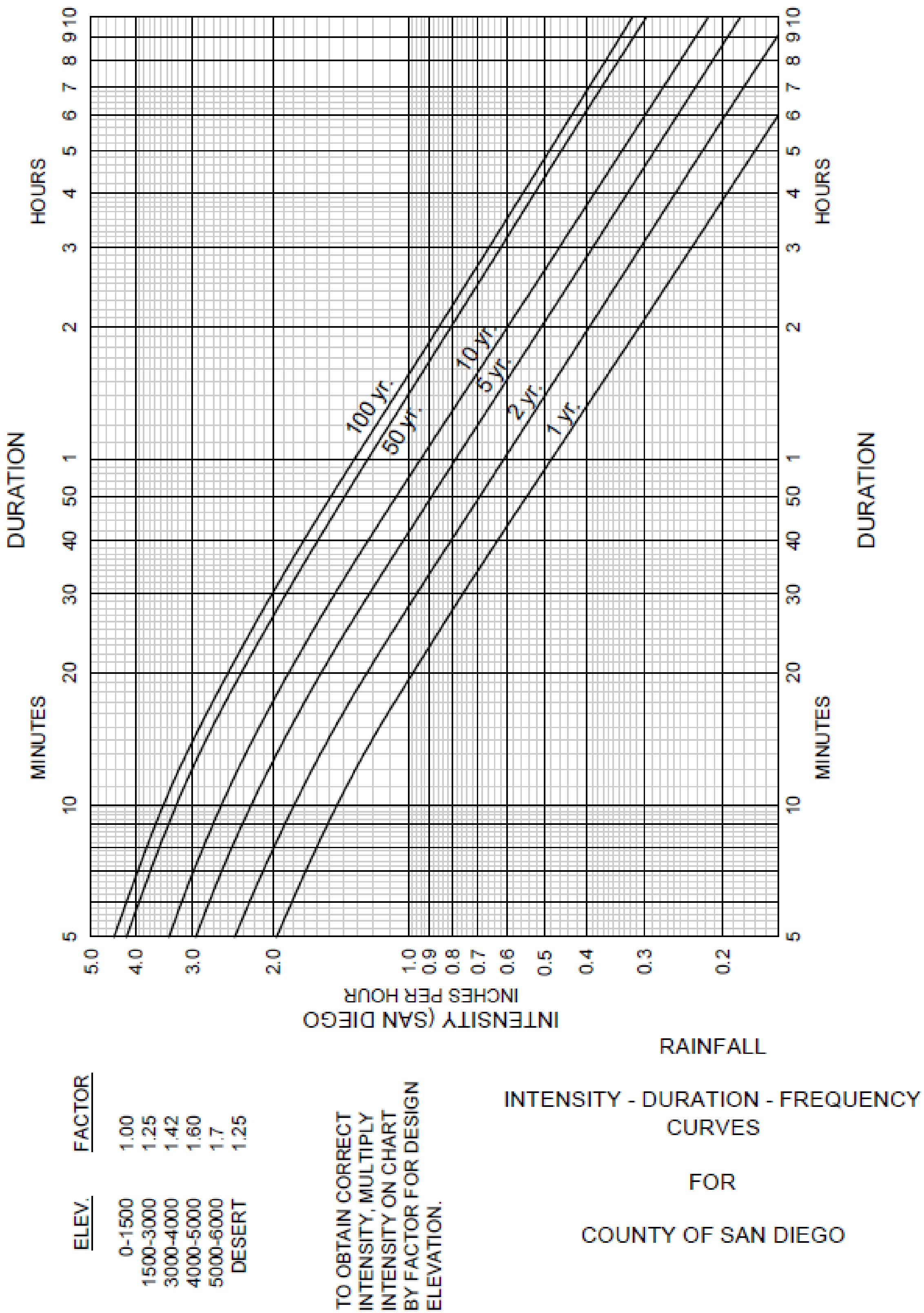


Figure A-1. Intensity-Duration-Frequency Design Chart

A.1.4. Time of Concentration

The Time of Concentration (T_c) is the time required for runoff to flow from the most remote part of the watershed to the outlet point under consideration.

Methods of calculation differ for natural watersheds (non-urbanized) and for urban drainage systems. Also, when designing storm drain systems, the designer must consider the possibility that an existing natural watershed may become urbanized during the useful life of the storm drain system. Future land uses must be used for Tc and runoff calculations, and can be determined from the Community Plans.

a. Natural watersheds: Obtain Tc from Figures A.2 and A.3

b. Urban drainage systems: In the case of urban drainage systems, the time of concentration at any point within the drainage area is given by:

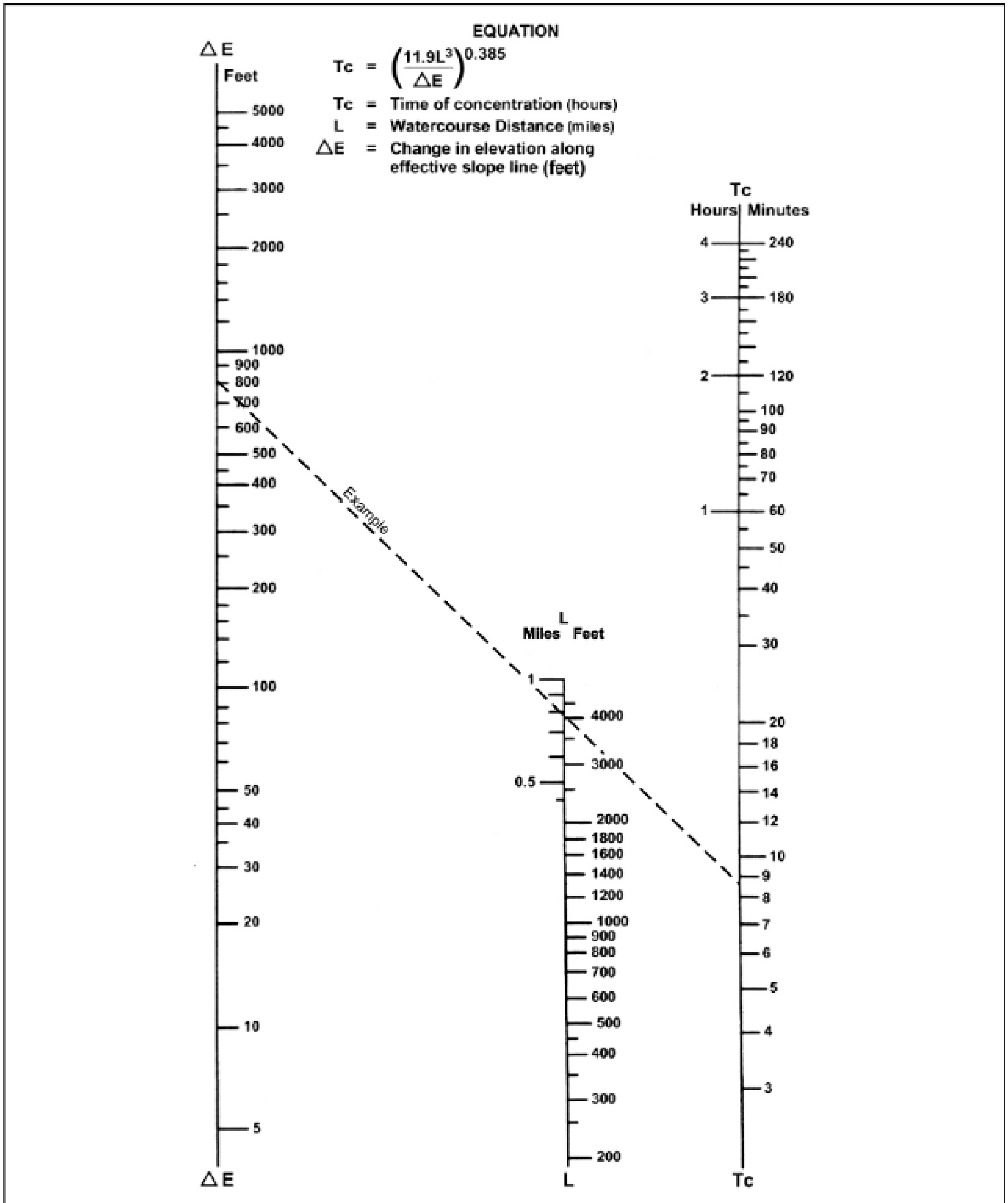
   $T_c = T_i + T_t$ where

   T_i is the inlet time or the time required for the storm water to flow to the first inlet in the system. It is the sum of time in overland flow across lots and in the street gutter.

   T_t is the travel time or the time required for the storm water to flow in the storm drain from the most upstream inlet to the point in question.

   Travel Time, T_t is computed by dividing the length of storm drain by the computed flow velocity. Since the velocity normally changes at each inlet because of changes in flow rate or slope, total travel time must be computed as the sum of the travel times for each section of the storm drain.

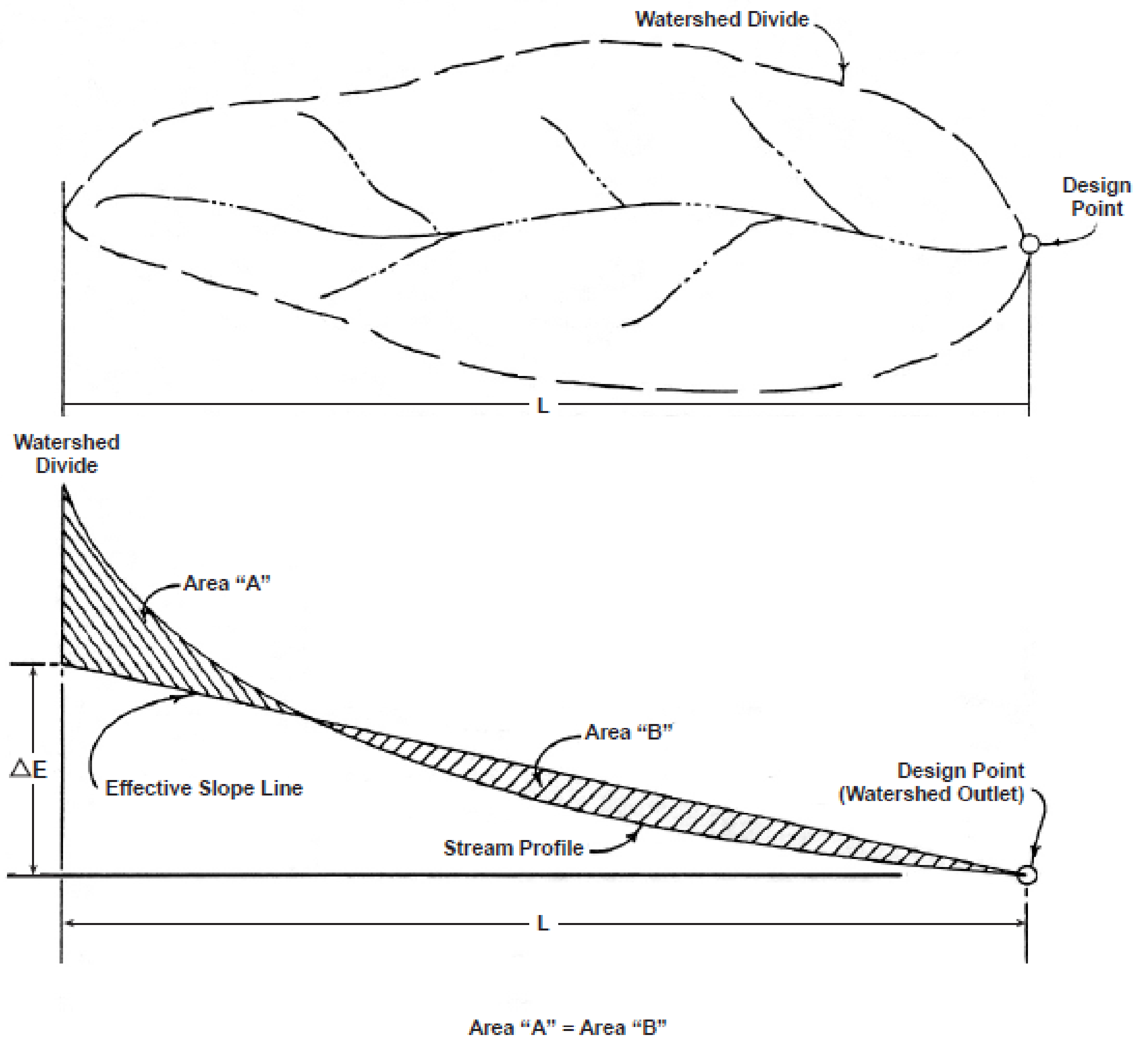
   The overland flow component of inlet time, T_i, may be estimated by the use of the chart shown in Figure A-4. Use Figure A-5 to estimate time of travel for street gutter flow.



SOURCE: California Division of Highways (1941) and Kirpich (1940)

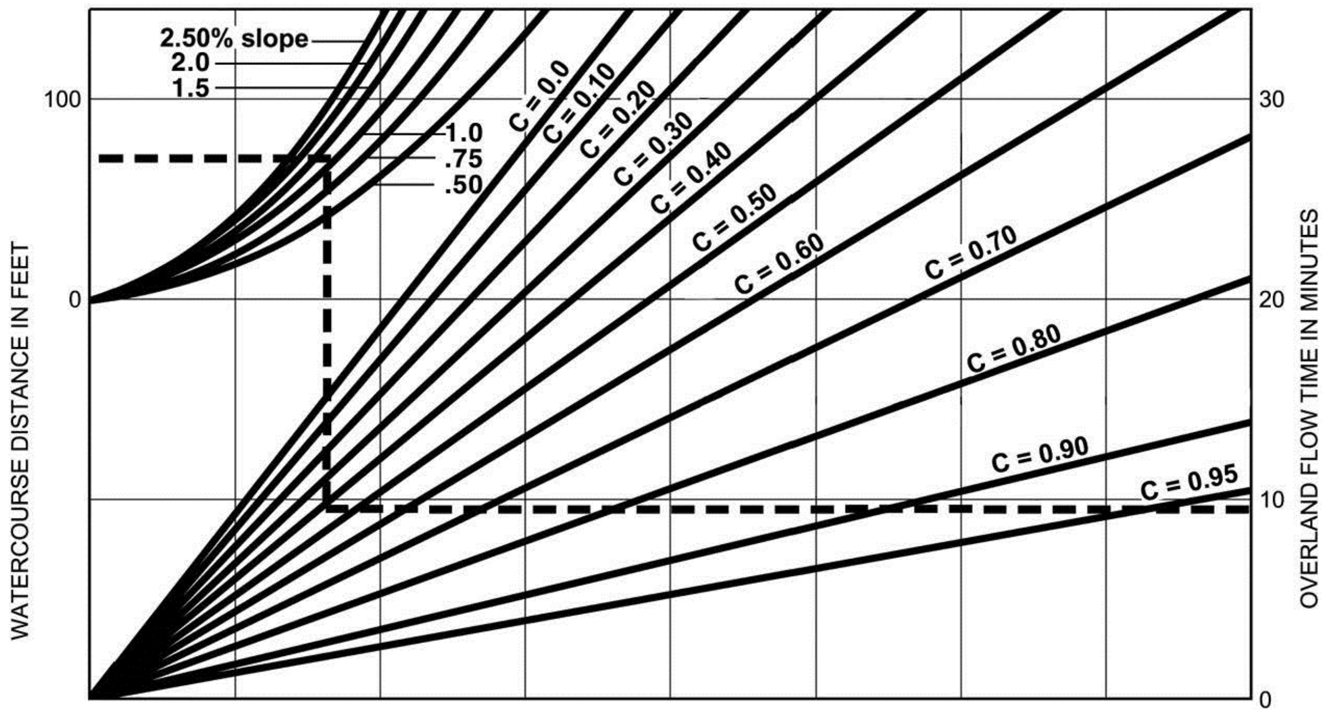
Figure A-2. Nomograph for Determination of T_c for Natural Watersheds

Note: Add ten minutes to the computed time of concentration from Figure A-2.



SOURCE: California Division of Highways (1941) and Kirpich (1940)

Figure A-3. Computation of Effective Slope for Natural Watersheds



EXAMPLE:

Given: Watercourse Distance (D) = 70 Feet
Slope (s) = 1.3%
Runoff Coefficient (C) = 0.41
Overland Flow Time (T) = 9.5 Minutes

$$T = \frac{1.8\,(1.1 - C)\sqrt{D}}{\sqrt[3]{s}}$$

SOURCE: Airport Drainage, Federal Aviation Administration, 1965

Figure A-4. Rational Formula – Overland Time of Flow Nomograph

<u>Note</u>: Use formula for watercourse distances in excess of 100 feet.

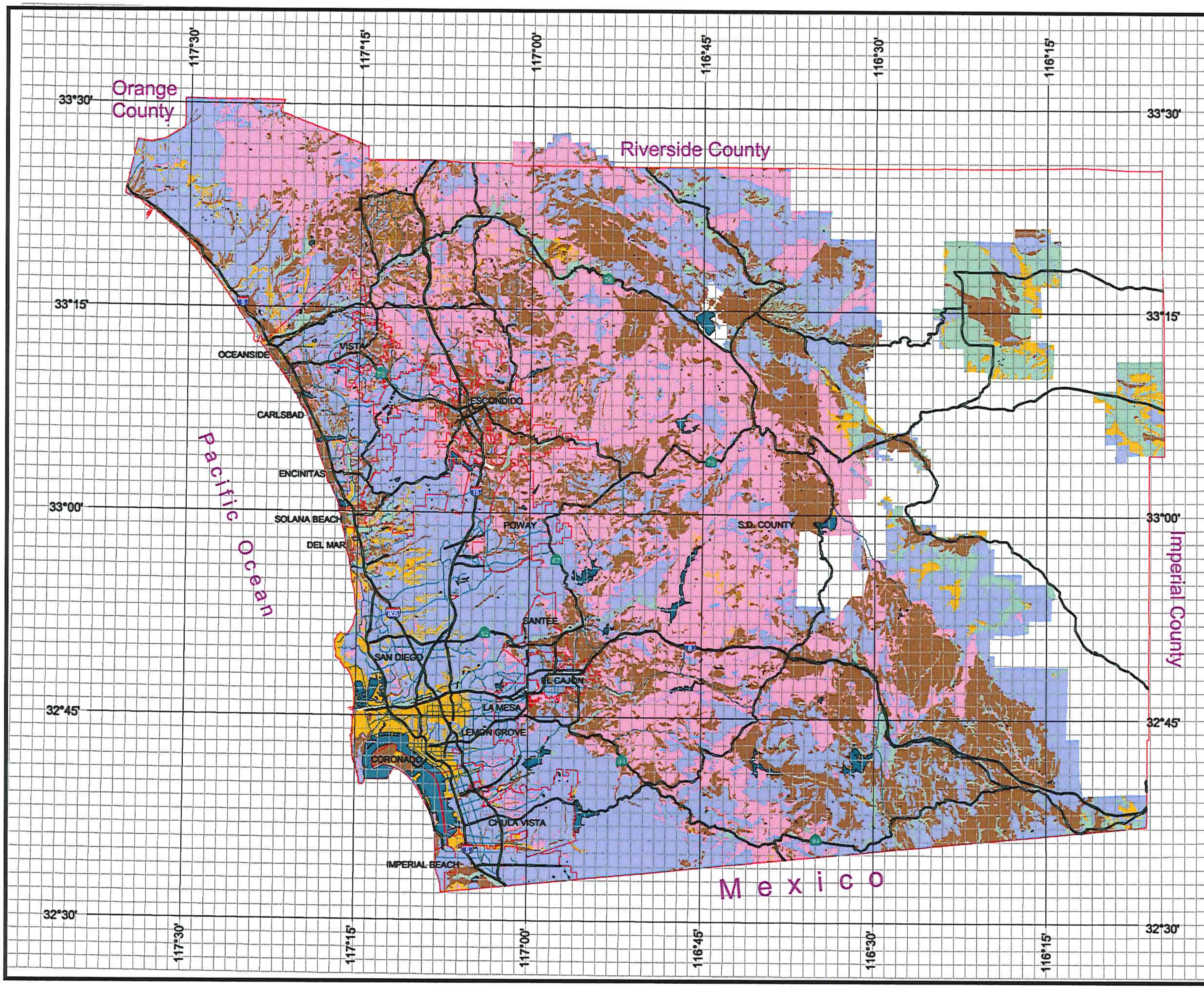
APPENDIX E

COUNTY COUNTY OF SAN DIEGO SOILS

HYDROLOGIC GROUPS

County of San Diego Hydrology Manual

Soil Hydrologic Groups



Legend

Soil Groups

- Group A
- Group B
- Group C
- Group D
- Undetermined
- Data Unavailable

DPW GIS
Department of Public Works
Geographic Information Services

SanGIS
We Have San Diego Covered!

N S E W

3 0 3 Miles

APPENDIX F

CITY OF SAN DIEGO RAINFALL ISOPLUVIALS MAPS

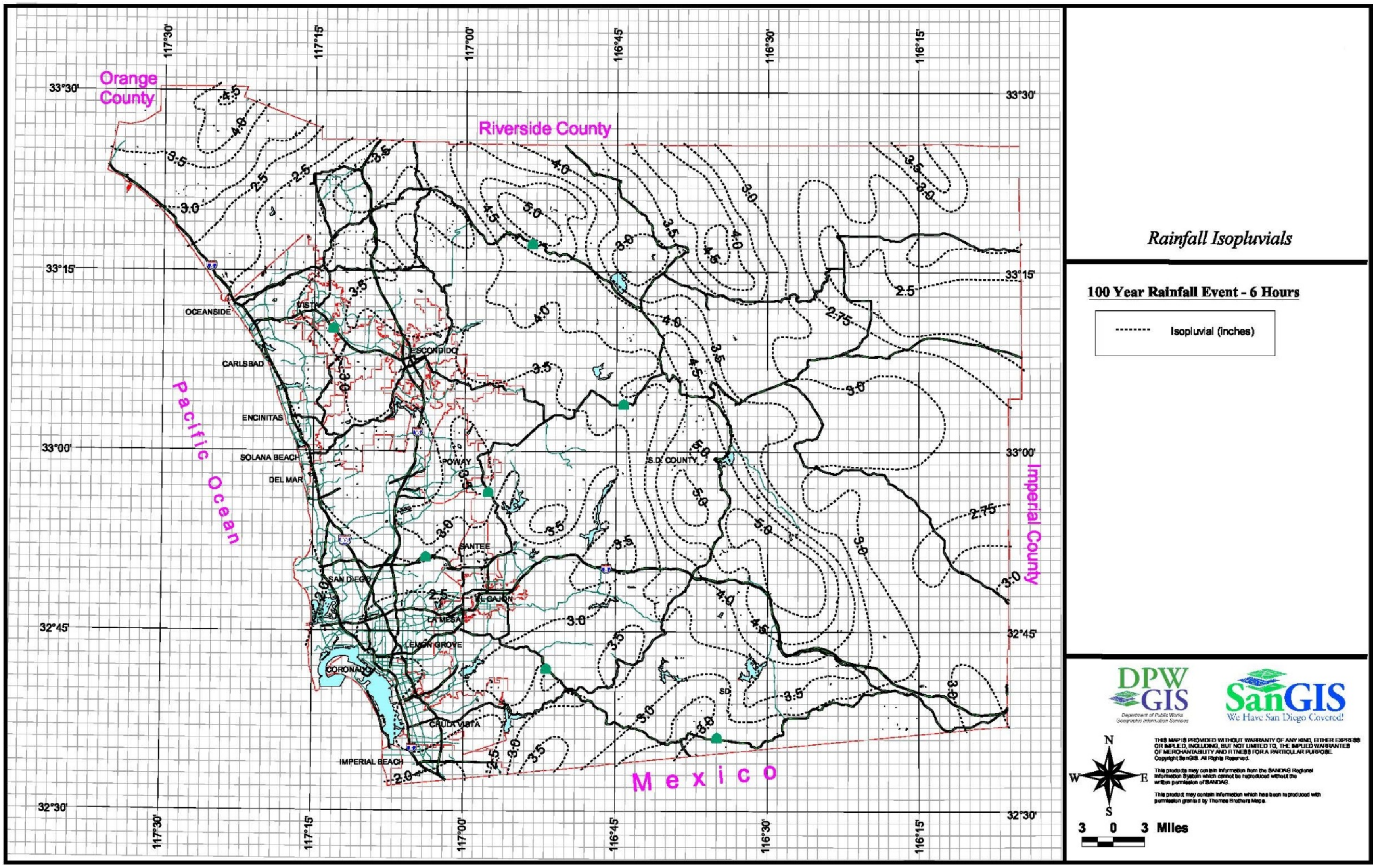


Figure B-2. 100-Year 6-Hour Isopluvials.

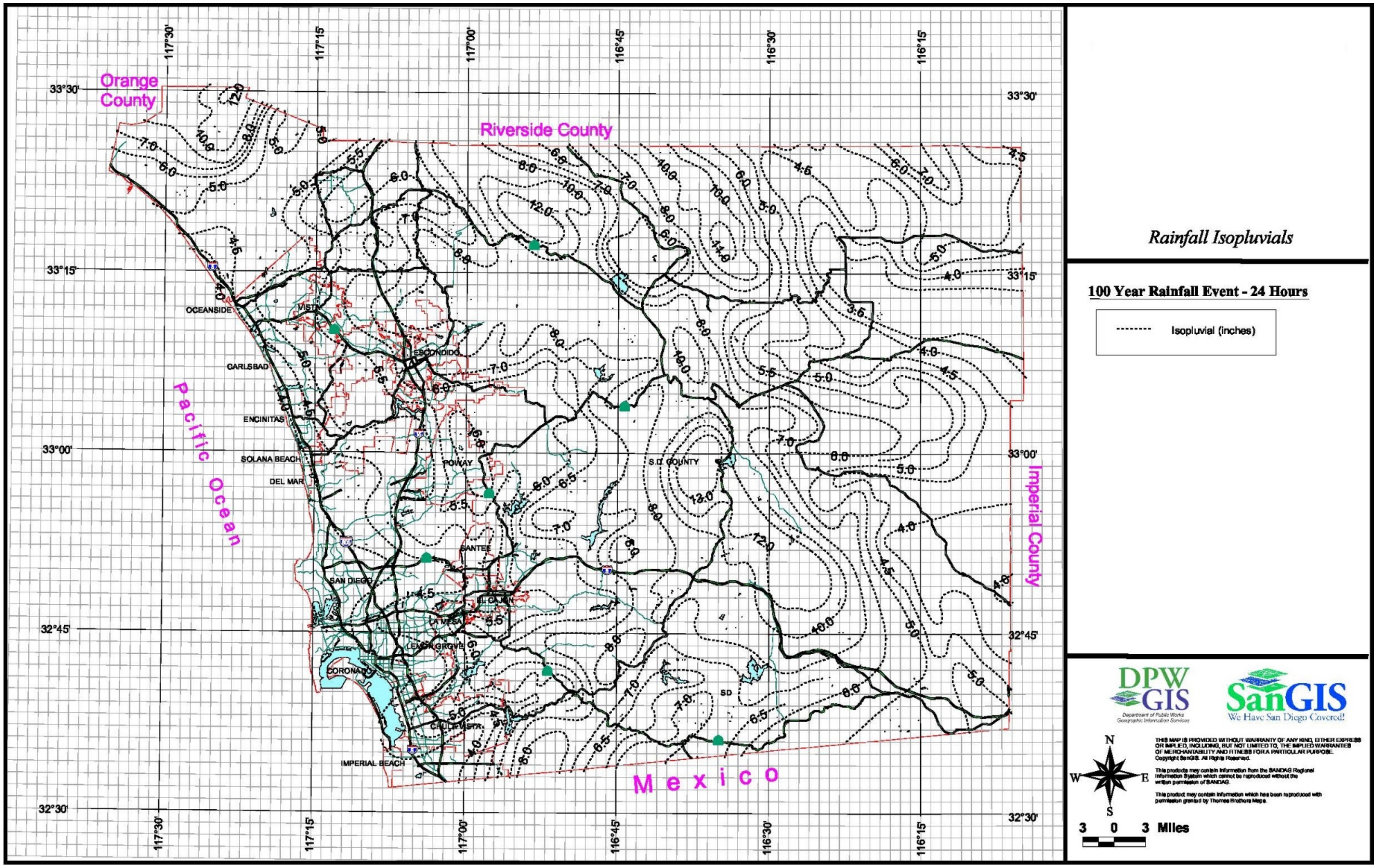


Figure B-3. 100-Year 24-Hour Isopluvials

APPENDIX G

STORM WATER REQUIREMENTS APPLICABILITY

CHECKLIST (DS-560)

City of San Diego
Development Services
1222 First Ave., MS-302
San Diego, CA 92101
(619) 446-5000

Storm Water Requirements Applicability Checklist

FORM
DS-560
November 2018

Project Address:	Project Number:

SECTION 1. Construction Storm Water BMP Requirements:

All construction sites are required to implement construction BMPs in accordance with the performance standards in the Storm Water Standards Manual. Some sites are additionally required to obtain coverage under the State Construction General Permit (CGP)[1], which is administered by the State Regional Water Quality Control Board.

For all projects complete PART A: If project is required to submit a SWPPP or WPCP, continue to PART B.

PART A: Determine Construction Phase Storm Water Requirements.

1. Is the project subject to California's statewide General NPDES permit for Storm Water Discharges Associated with Construction Activities, also known as the State Construction General Permit (CGP)? (Typically projects with land disturbance greater than or equal to 1 acre.)

☒ Yes; SWPPP required, skip questions 2-4 ☐ No; next question

2. Does the project propose construction or demolition activity, including but not limited to, clearing, grading, grubbing, excavation, or any other activity resulting in ground disturbance and/or contact with storm water?

☐ Yes; WPCP required, skip questions 3-4 ☒ No; next question

3. Does the project propose routine maintenance to maintain original line and grade, hydraulic capacity, or original purpose of the facility? (Projects such as pipeline/utility replacement)

☐ Yes; WPCP required, skip question 4 ☒ No; next question

4. Does the project only include the following Permit types listed below?

- Electrical Permit, Fire Alarm Permit, Fire Sprinkler Permit, Plumbing Permit, Sign Permit, Mechanical Permit, Spa Permit.
- Individual Right of Way Permits that exclusively include only ONE of the following activities: water service, sewer lateral, or utility service.
- Right of Way Permits with a project footprint less than 150 linear feet that exclusively include only ONE of the following activities: curb ramp, sidewalk and driveway apron replacement, pot holing, curb and gutter replacement, and retaining wall encroachments.

☒ Yes; no document required

Check one of the boxes below, and continue to PART B:

☒ If you checked "Yes" for question 1, **a SWPPP is REQUIRED. Continue to PART B**

☐ If you checked "No" for question 1, and checked "Yes" for question 2 or 3, **a WPCP is REQUIRED.** If the project proposes less than 5,000 square feet of ground disturbance AND has less than a 5-foot elevation change over the entire project area, a Minor WPCP may be required instead. **Continue to PART B.**

☐ If you checked "No" for all questions 1-3, and checked "Yes" for question 4 PART B **does not apply and no document is required. Continue to Section 2.**

1. More information on the City's construction BMP requirements as well as CGP requirements can be found at: www.sandiego.gov/stormwater/regulations/index.shtml

PART B: Determine Construction Site Priority

This prioritization must be completed within this form, noted on the plans, and included in the SWPPP or WPCP. The city reserves the right to adjust the priority of projects both before and after construction. Construction projects are assigned an inspection frequency based on if the project has a "high threat to water quality." The City has aligned the local definition of "high threat to water quality" to the risk determination approach of the State Construction General Permit (CGP). The CGP determines risk level based on project specific sediment risk and receiving water risk. Additional inspection is required for projects within the Areas of Special Biological Significance (ASBS) watershed. **NOTE:** The construction priority does **NOT** change construction BMP requirements that apply to projects; rather, it determines the frequency of inspections that will be conducted by city staff.

Complete PART B and continued to Section 2

1. ☐ **ASBS**

a. Projects located in the ASBS watershed.

2. ☐ **High Priority**

a. Projects that qualify as Risk Level 2 or Risk Level 3 per the Construction General Permit (CGP) and not located in the ASBS watershed.

b. Projects that qualify as LUP Type 2 or LUP Type 3 per the CGP and not located in the ASBS watershed.

3. ☒ **Medium Priority**

a. Projects that are not located in an ASBS watershed or designated as a High priority site.

b. Projects that qualify as Risk Level 1 or LUP Type 1 per the CGP and not located in an ASBS watershed.

c. WPCP projects (>5,000sf of ground disturbance) located within the Los Penasquitos watershed management area.

4. ☐ **Low Priority**

a. Projects not subject to a Medium or High site priority designation and are not located in an ASBS watershed.

SECTION 2. Permanent Storm Water BMP Requirements.

Additional information for determining the requirements is found in the Storm Water Standards Manual.

PART C: Determine if Not Subject to Permanent Storm Water Requirements.

Projects that are considered maintenance, or otherwise not categorized as "new development projects" or "redevelopment projects" according to the Storm Water Standards Manual are not subject to Permanent Storm Water BMPs.

If "yes" is checked for any number in Part C, proceed to Part F and check "Not Subject to Permanent Storm Water BMP Requirements".

If "no" is checked for all of the numbers in Part C continue to Part D.

1.	Does the project only include interior remodels and/or is the project entirely within an existing enclosed structure and does not have the potential to contact storm water?	☐ Yes ☒ No
2.	Does the project only include the construction of overhead or underground utilities without creating new impervious surfaces?	☐ Yes ☒ No
3.	Does the project fall under routine maintenance? Examples include, but are not limited to: roof or exterior structure surface replacement, resurfacing or reconfiguring surface parking lots or existing roadways without expanding the impervious footprint, and routine replacement of damaged pavement (grinding, overlay, and pothole repair).	☐ Yes ☒ No

Clear Page 2

PART D: PDP Exempt Requirements.

PDP Exempt projects are required to implement site design and source control BMPs.

If "yes" was checked for any questions in Part D, continue to Part F and check the box labeled "PDP Exempt."

If "no" was checked for all questions in Part D, continue to Part E.

1. **Does the project ONLY include new or retrofit sidewalks, bicycle lanes, or trails that:**
   - **Are designed and constructed to direct storm water runoff to adjacent vegetated areas, or other non-erodible permeable areas? Or;**
   - **Are designed and constructed to be hydraulically disconnected from paved streets and roads? Or;**
   - **Are designed and constructed with permeable pavements or surfaces in accordance with the Green Streets guidance in the City's Storm Water Standards manual?**

   ☐ Yes; PDP exempt requirements apply ☒ No; next question

2. Does the project ONLY include retrofitting or redeveloping existing paved alleys, streets or roads designed and constructed in accordance with the Green Streets guidance in the City's Storm Water Standards Manual?

   ☐ Yes; PDP exempt requirements apply ☒ No; project not exempt.

PART E: Determine if Project is a Priority Development Project (PDP).
Projects that match one of the definitions below are subject to additional requirements including preparation of a Storm Water Quality Management Plan (SWQMP).

If "yes" is checked for any number in PART E, continue to PART F and check the box labeled "Priority Development Project".

If "no" is checked for every number in PART E, continue to PART F and check the box labeled "Standard Development Project".

1.	**New Development that creates 10,000 square feet or more of impervious surfaces collectively over the project site.** This includes commercial, industrial, residential, mixed-use, and public development projects on public or private land.	☐ Yes ☒ No
2.	**Redevelopment project that creates and/or replaces 5,000 square feet or more of impervious surfaces on an existing site of 10,000 square feet or more of impervious surfaces.** This includes commercial, industrial, residential, mixed-use, and public development projects on public or private land.	☒ Yes ☐ No
3.	**New development or redevelopment of a restaurant.** Facilities that sell prepared foods and drinks for consumption, including stationary lunch counters and refreshment stands selling prepared foods and drinks for immediate consumption (SIC 5812), and where the land development creates and/or replace 5,000 square feet or more of impervious surface.	☐ Yes ☒ No
4.	**New development or redevelopment on a hillside.** The project creates and/or replaces 5,000 square feet or more of impervious surface (collectively over the project site) and where the development will grade on any natural slope that is twenty-five percent or greater.	☐ Yes ☒ No
5.	**New development or redevelopment of a parking lot that creates and/or replaces 5,000 square feet or more of impervious surface (collectively over the project site).**	☐ Yes ☒ No
6.	**New development or redevelopment of streets, roads, highways, freeways, and driveways.** The project creates and/or replaces 5,000 square feet or more of impervious surface (collectively over the project site).	☐ Yes ☒ No

Clear Page 3

7.	**New development or redevelopment discharging directly to an Environmentally Sensitive Area.** The project creates and/or replaces 2,500 square feet of impervious surface (collectively over project site), and discharges directly to an Environmentally Sensitive Area (ESA). "Discharging directly to" includes flow that is conveyed overland a distance of 200 feet or less from the project to the ESA, or conveyed in a pipe or open channel any distance as an isolated flow from the project to the ESA (i.e. not commingled with flows from adjacent lands).	☐ Yes ☒ No
8.	**New development or redevelopment projects of a retail gasoline outlet (RGO) that create and/or replaces 5,000 square feet of impervious surface.** The development project meets the following criteria: (a) 5,000 square feet or more or (b) has a projected Average Daily Traffic (ADT) of 100 or more vehicles per day.	☐ Yes ☒ No
9.	**New development or redevelopment projects of an automotive repair shops that creates and/or replaces 5,000 square feet or more of impervious surfaces.** Development projects categorized in any one of Standard Industrial Classification (SIC) codes 5013, 5014, 5541, 7532-7534, or 7536-7539.	☐ Yes ☒ No
10.	**Other Pollutant Generating Project.** The project is not covered in the categories above, results in the disturbance of one or more acres of land and is expected to generate pollutants post construction, such as fertilizers and pesticides. This does not include projects creating less than 5,000 sf of impervious surface and where added landscaping does not require regular use of pesticides and fertilizers, such as slope stabilization using native plants. Calculation of the square footage of impervious surface need not include linear pathways that are for infrequent vehicle use, such as emergency maintenance access or bicycle pedestrian use, if they are built with pervious surfaces of if they sheet flow to surrounding pervious surfaces.	☐ Yes ☒ No

PART F: Select the appropriate category based on the outcomes of PART C through PART E.

1.	The project is **NOT SUBJECT TO PERMANENT STORM WATER REQUIREMENTS**.	☐
2.	The project is a **STANDARD DEVELOPMENT PROJECT**. Site design and source control BMP requirements apply. See the Storm Water Standards Manual for guidance.	☐
3.	The project is **PDP EXEMPT**. Site design and source control BMP requirements apply. See the Storm Water Standards Manual for guidance.	☐
4.	The project is a **PRIORITY DEVELOPMENT PROJECT**. Site design, source control, and structural pollutant control BMP requirements apply. See the Storm Water Standards Manual for guidance on determining if project requires a hydromodification plan management	☒

Kenneth Gethers	Project Engineer
Name of Owner or Agent *(Please Print)*	Title
	12/13/2019
Signature	Date

Clear Page 4

Clear Form

Bio Clean
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Oceanside, CA 92058
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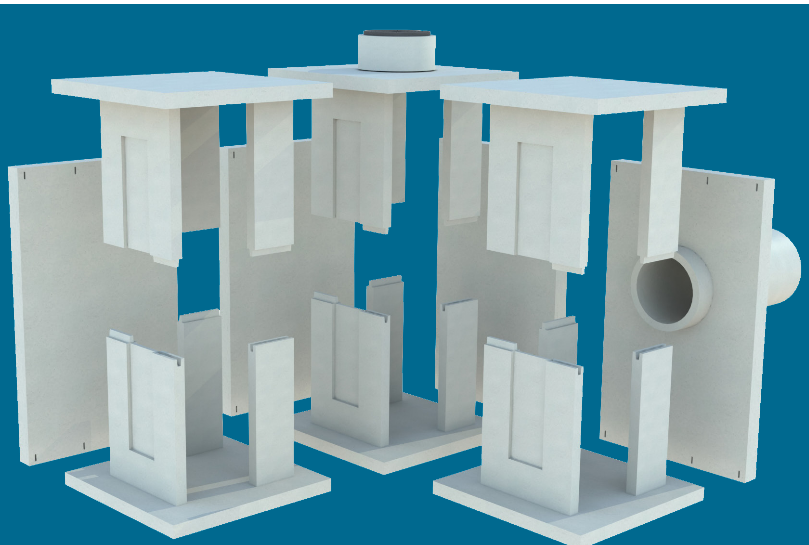
F 760.433.3176
bioclean_info@forterrabp.com
www.biocleanenvironmental.com

Since 1999, Bio Clean™ Environmental has been committed to providing a cleaner environment for generations to come by being the leader in stormwater technologies, solutions, research and customer care.

Ready to Talk About Your Project?
Call 760.433.7640
or email us at bioclean_info@forterrabp.com

Bio Clean's Stormwater Management Solutions

Biofiltration *Media Filters* *Separator Products* *Trash Screens*
Specialty Filters *Catch Basin Filters* *Detention, Retention and Infiltration*



UrbanPond Installation

Each module is 8 ft wide by 8 ft long (O.D.) which is the maximum width allowable on a flatbed truck without the requirement of a pilot car.

This size maximizes the space on each truck load. A 10 ft Double UrbanPond module (two pieces) weighs only 17,000 lbs total or only 8,500 lbs per piece.

At least 4 individual pieces can be delivered on a single truckload to reduce shipping costs and minimize crane requirements during install.

Most units can be installed using a simple backhoe due to low weights.

UrbanPond can be easily maintained from finished surface with a standard vacuum truck. Access points are provided, strategically, throughout the assembly for easy maintenance.

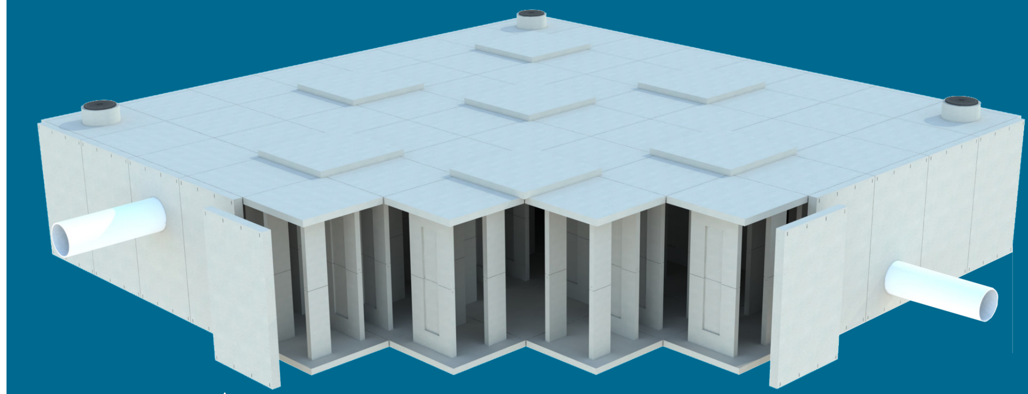
Go to biocleanenvironmental.com for complete information on UrbanPond sizing, installation, and maintenance details.

UrbanPond Maintenance

UrbanPond is designed to be easily accessed and maintained from finished surface via access ports.

Modules can be modified to act as clear wells or pre-treatment chambers for capturing trash, debris and sediment to isolate maintenance requirements to only a select few modules.

Designed with multiple access points for easy maintenance. Standard manholes, hinged manholes and other access hatches are available.



STORMWATER DETENTION SOLUTIONS

UrbanPond™

A Breakthrough System for Managing Stormwater Runoff

DETENTION

Bio Clean's UrbanPond (UP) is a technological breakthrough in underground stormwater management.

Its unique square tessellation assembly provides superior strength and material efficiency over traditional rectangular modules. Each module utilizes an offset 3 legged design with two narrow legs running parallel and one wider leg running perpendicular. This unique geometry allows for maximum strength and minimum material usage. The standard design is rated for HS-20 tandem axle live loading.

UrbanPond has high void percentages to maximize stormwater volume and its robust precast form allows systems to be buried deeper without the need for specialized backfill, increased wall thicknesses or extra rebar reinforcement.

UrbanPond is engineered specifically for:

- Detention - with controlled discharge utilizing built-in outlet orifice structures
- Retention - for long term retention of runoff on site to meet strict stormwater requirements
- Harvesting - self-contained treatment, recycling and pumping of runoff for irrigation and grey water needs
- Infiltration - capture and infiltration of runoff back into underlying native soils for recharge needs
- Treatment - utilize as an underground extended detention basin or pond for advanced treatment of stormwater - integrates well with treatment train components (bio filtration, separation, etc.)
- Flood Control - control of peak storm events to minimize downstream flooding and erosion
- Low Impact Development - maximize land use with underground storage - construct an urban infill without a pond at grade

Bio Clean
A Forterra Company

UrbanPond Configurations

UrbanPond is a modular precast concrete structure which can be assembled from 1 to several hundred modules in various shapes and configurations to meet site specific constraints and volume requirements.

Each UrbanPond module is 8 ft wide x 8 ft long (O.D.) - specifically designed to fit on a standard flatbed truck.

UrbanPond can be configured in a combination of modules from as low as 2 ft to as high as 14 ft inside height.

Single UrbanPond

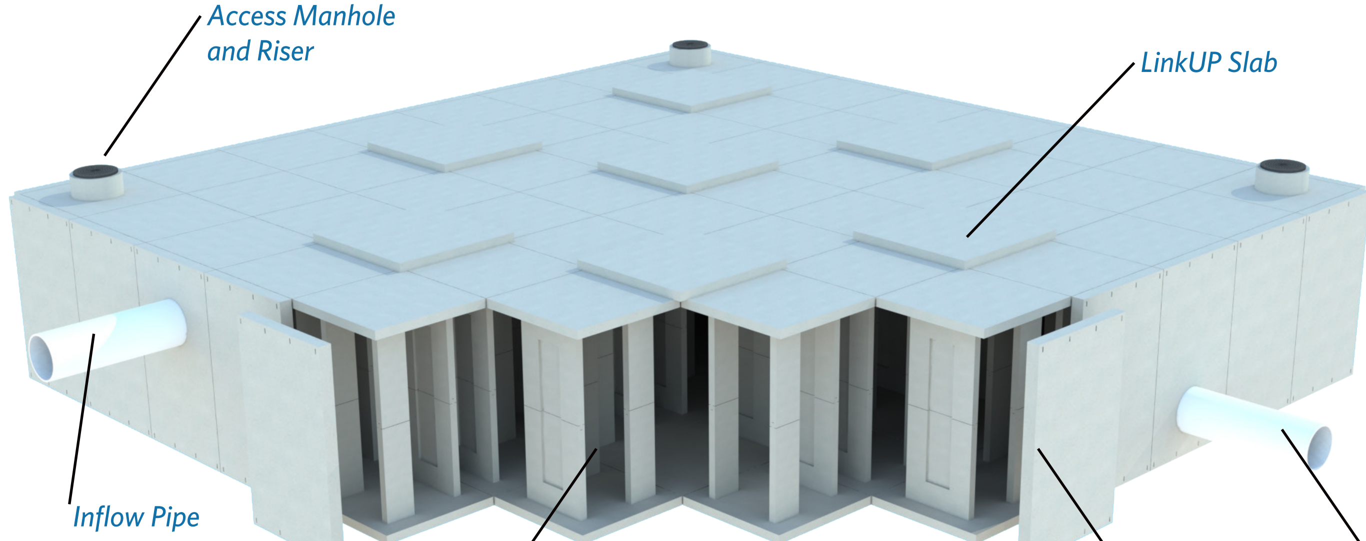
The Bio Clean Single UrbanPond module is available in heights from 2 ft to 7 ft

Double UrbanPond

The Bio Clean Double UrbanPond module is available in heights from 4 ft to 14 ft

UrbanPond Advantages

- The square tessellation provides superior strength and load capacity.
- Designed to exceed H20 loading requirements.
- Can be installed deeper without the need to increase wall thickness or add additional rebar.
- Higher void percentages and increased material efficiency for best in class cost per cubic foot storage.
- Lighter weight means it's easier to install.
- Every module drains down fully.
- In 9-module arrays, a linkUP slab allows us to eliminate a module, further decreasing cost and installation time.



LinkUP Slabs span the open cavities in a 9-module array.

Sidewalls easily attach using standard wedge anchors and bolts.

UrbanPond Assembly

The UrbanPond is based on a square tessellation. A tessellation is created when a shape is repeated over and over again covering a plane without any gaps or overlaps. Because of the self-supporting characteristic of tessellated shaped structures, Bio Clean has been able to further reduce material usage and costs up to 20% without sacrificing structural strength.

As shown in the image to the right the offset leg configuration of the modules creates a very open and channel-less internal space.

Each module offers access walkways of greater than 3 ft in each module and between modules for easy inspection and maintenance.

View looking down with top slabs removed

UrbanPond Sizing

UrbanPond is available from heights of 2 ft (I.D.) to up to 14 ft. Single UrbanPond modules are available up to 7 ft height and the Double UrbanPond modules up to 14 ft.

The system's internal offset leg configuration provides channel-less water distribution for stormwater entering and exiting the system.

Single UrbanPond (2–7 ft); *Double UrbanPond* (7–14 ft)

I.D. Module Height (ft)	Module Storage Capacity (cu ft)
2	119
3	179
4	237
5	298
6	358
7	419
8	479
9	540
10	600
11	661
12	721
13	782
14	842