
# Drainage Reports

# DRAINAGE REPORT

## Phoenix Herpetogical Society

Within A Portion of the:
SEC. 35, T5N, R4E
Of the Gila & Salt River Base and Meridian,
Carefree, Arizona

Job Number: 16-163

Case # 10-UP-2018

***Prepared for:***
***Kurt Jones***
***Tiffany & Bosco***
***2525 E. Camelback II***
***Phoenix, AZ 85016***


Exp. 06-30-22

***Prepared by:***
***GRAHAM SURVEYING & ENGINEERING, INC.***
***Post Office Box 1240***
***Carefree, Arizona 85377***
***Office (480) 488-4393***
***NWYLLIE@GRAHAMSANDE.COM***

***May 24, 2019***

# TABLE OF CONTENTS



# FIGURES



# APPENDICES

# 1.0 Introduction

## 1.1 SCOPE

This project is to permit existing improvements on the subject parcel. Provided herein are offsite and onsite hydrologic and hydraulic analyses/designs.

This report does not include ground water hydrology or hydrogeology. Any issues that arise must be addressed by an engineering firm or an engineer whose specialty covers ground water issues. Graham Surveying & Engineering, Inc. will be held harmless for any damages as a result of ground water issues.

## 1.2 SITE DESCRIPTION

The lot is located on the east side of 78$^{th}$ St., approximately ½ mile east of the intersection of Scottsdale Rd. and Dynamite Blvd. (See figure 1). The project is within a portion of Section 35, Township 5 North, Range 4 East of the Gila & Salt River Base and Meridian, Maricopa County, Arizona. This project gross area is 2.10.

The site has been developed with several buildings and reptile pens and storage areas. The terrain generally flat and evenly falls to the southwest at close to a 2 percent slope (see figure 2).

# 2.0 Existing Conditions

A small wash meanders from east to west along the north property boundary. This wash converges with a large wash and enters the project near the west quarter of the north property boundary. The flow runs south along an exiting sitewall to bisect the west property boundary on exit.

# 3.0 Hydrology

The project is part of the Pinnacle Peak West Area Master Drainage Study (PPWAMDS) area. The study divides the area into 20'x20' squares. The model reports a peak flowrate, water surface elevation, and direction of dominate flow for each square. Adjacent squares where summed to quantify 100-year flowrates (See figure 3). The results were multiplied by a factor of 1.3 to account for the unpredictable nature of upstream flowsplits in an alluvial fan. See table 1 below for the results.

Table 1: 100-year flowrates

| PPWAMDS Flowrate (CFS) | Design Flowrate (CFS) |
|---|---|
| 13 | 16.9 |
| 80 | 104 |
| 52 | 67.6 |
| 45 | 58.5 |
| 16 | 20.8 |
| 18 | 23.4 |

# 4.0 Hydraulics

## 4.1 Existing Pipes

A flowrate of 20.8 CFS wash meets the south 1/3 of the east property boundary flowing to the southwest. Two existing 12" corrugated plastic pipes (CPP) are intended to convey this flow onto the site. The upstream side of the pipe daylights through a 24" tall masonry wall with corral fencing on top. The top 2 courses of block will be removed for 6 L.F. to allow stormwater to overtop the wall onto the site. The software HY-8 was used to model the hydraulics of the pipes. Entering the design flowrate of 20.8 CFS and the physical properties of the crossing yields a headwater elevation. The design flowrate is conveyed onsite with a headwater elevation of 2156.19' (See Appendix A3). The flow is contained within the wash banks, therefore after the new improvements this lot will not have a negative drainage impact on the adjacent lot.

The downstream grades with be lowered to the existing downstream invert. Grades will fall to 3 existing 12" CCP pipes which will discharge the flow near the midpoint of the south property boundary. The hydraulics of the system was modeled in similar fashion as the 2 12" CCP. The pipes will convey the design flow with a headwater elevation of 2155.04 (See Appendix A13).

### 4.2 Large Wash

A large wash with a design flowrate of 104 CFS clips the northwest corner of the lot flowing to the southwest. Gabion baskets have been installed along the east bank to combat erosion and maintain the historical bank. The hectically topography contours measured in 2007 have been overlaid onto the existing conditions map (See Figure 5). The existing improvements are similar to the historic conditions, therefore new improvements do not have a negative drainage impact on the adjacent lot.

# 5.0 Stormwater Storage

A requirement of this project is to provide stormwater storage for any increase runoff generated from any development after the initial house. Much of the newer development will not increase runoff.

- Structures labeled as sheds are tortoise shelters with no footings. They have wooden walls with no floor, therefore the water will percolate into the soil under the roof.
- The structure labeled storage container is elevated above natural ground, allowing water to percolate into the soil underneath.
- Improved walkways are made of wood and elevated above natural grade allowing for water to percolate into the ground beneath.
- All reptile ponds are equipped with floater switches that maintain the water surface 6" below the top of pond elevation. With a 100-year 2 hour precipitation value of 2.58" each pond provides more then double the required storage volume. The water will be disposed of through evaporation.

The existing improvements that increase runoff were delineated (See Figure 5). Required storage calculations were found by applying the following equation:

$V_{(req)}=\Delta C(P/12)A$
$V_{(req)}$=required storage volume
$\Delta C$=Increase in Runoff Coefficient (0.95 for impervious & 0.50 for natural desert)
P=Rainfall depth for the 100-year 2-hour storm event (2.58 for lot location)
A=Area of improvements

$V_{(req)}=(0.95-0.50)*(2.58/12)*(2{,}062.9)= 199.59$ C.F.

$V_{(req)}$=199.59 cubic feet

The following table 2 is a summary of storage calculations.

Table 2: Stormwater Storage

| Area Description | Runoff Areas (SF) | Delta Runoff Coefficient (C) | Storage Volume Required (CU. FT.) |
|---|---|---|---|
| Gift Shop | 357.22 | 0.45 | 34.56 |
| Garage Concrete | 802.17 | 0.45 | 77.61 |
| walk in refrigerator & Concrete | 242.95 | 0.45 | 23.51 |
| Wood Shed | 230.95 | 0.45 | 22.34 |
| Storage Building | 353.51 | 0.45 | 34.20 |
| Pool Equip Pads | 76.10 | 0.45 | 7.36 |
| | | TOTAL: | 199.59 |

Two retention areas will compensate for the increased runoff of the new development. Basin #1 is at the southwest corner of the project. A new berm will create a 6" deep retention basin that is sized to capture all of the increased runoff expect for the pool equipment pads. The additional runoff will be held within the voids of existing river rock around the pool equipment pads. See Appendix C for volume calculations.

# 6.0 Flood Zone Information & Finished Floors

The site is located within the unshaded Zone X of FEMA FIRM Panel 1310 of 4425, Community No. 040126 on Map Number 04013C1310 L, revised October 16, 2013. Areas within the unshaded Zone X are classified by FEMA as "Areas outside of the 0.2% annual chance flood." Existing livable finished floor elevations are currently or will be elevated to 1' above the highest adjacent grade. Livable finished floor elevations are safe from inundation by the 100-year peak rainfall event if constructed in accordance with the accompanying Civil Grading and Drainage Plan.

# 7.0 Conclusion

- All finished floor elevations are safe from inundation by the 100-year peak rainfall event if constructed in accordance with the accompanying Civil Grading and Drainage Plan.
- This drainage report and accompanying Civil Grading and Drainage plan was made to comply with the City of Scottsdale & Maricopa County Design Standards and Policies.
- Retention basins will offset the negative impacts of new development.
- This project does not create a negative drainage impact on adjacent parcels.

# 8.0 References

Design Standards & Policies Manual, City of Scottsdale, January 2018

Drainage Design Manual for Maricopa County, Arizona, Volume I Hydrology

Drainage Design Manual for Maricopa County, Arizona, Volume II Hydraulics

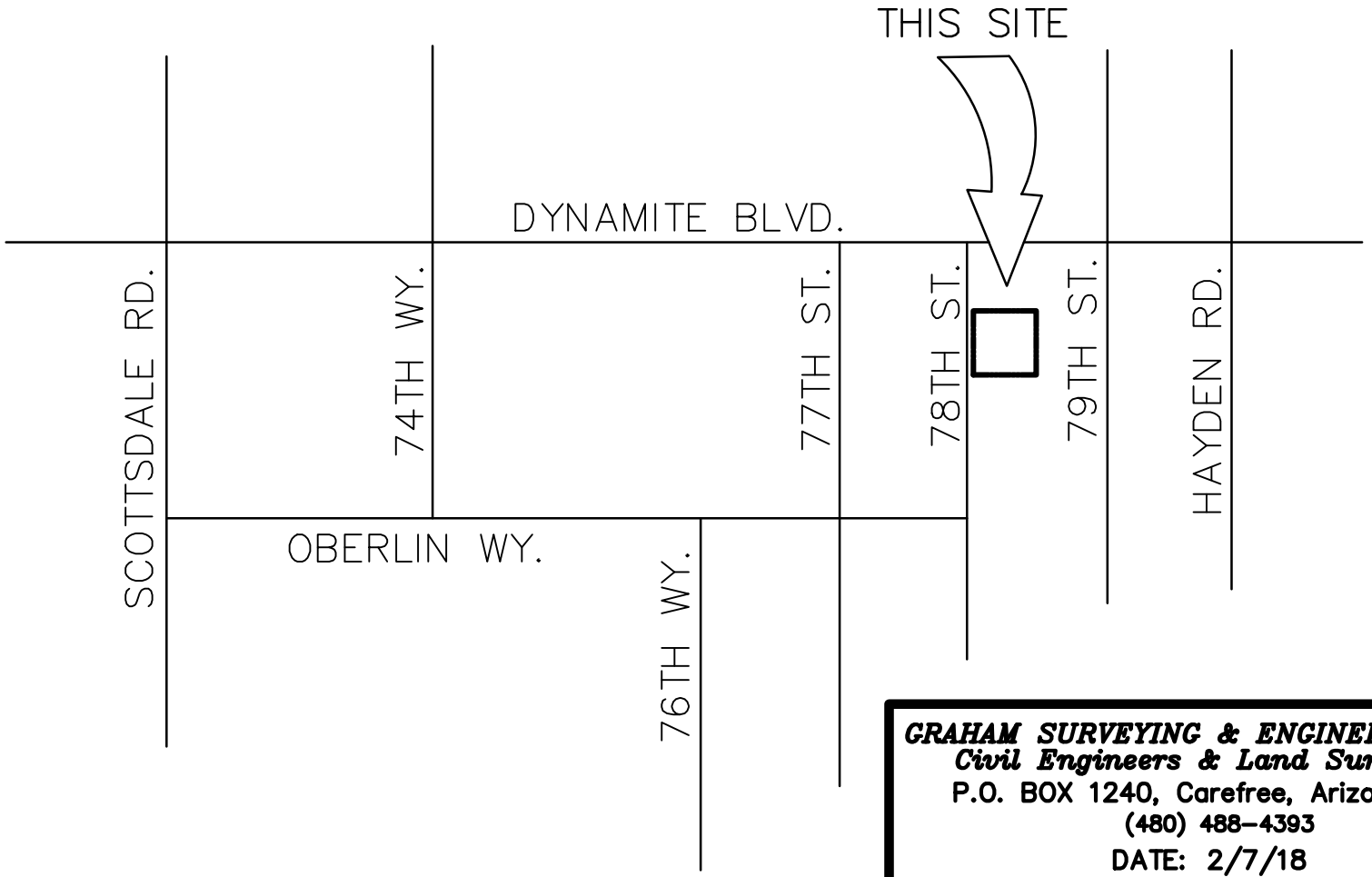
Flood Control District of Maricopa County Storm Water Management System (DDMS) ST.APP, Version 4.8.0, Copyright KVL Consultants Inc.

Hydraulic Toolbox 4.2, Federal Highway Administration, April 15, 2014

# FIGURES

# FIGURE 1
# VICINITY MAP

**28011 N 78TH ST**
**SCOTTSDALE, AZ. 85266**




***GRAHAM SURVEYING & ENGINEERING INC.***
***Civil Engineers & Land Surveyors***
P.O. BOX 1240, Carefree, Arizona 85377
(480) 488-4393

DATE: 2/7/18
JOB # 16-163

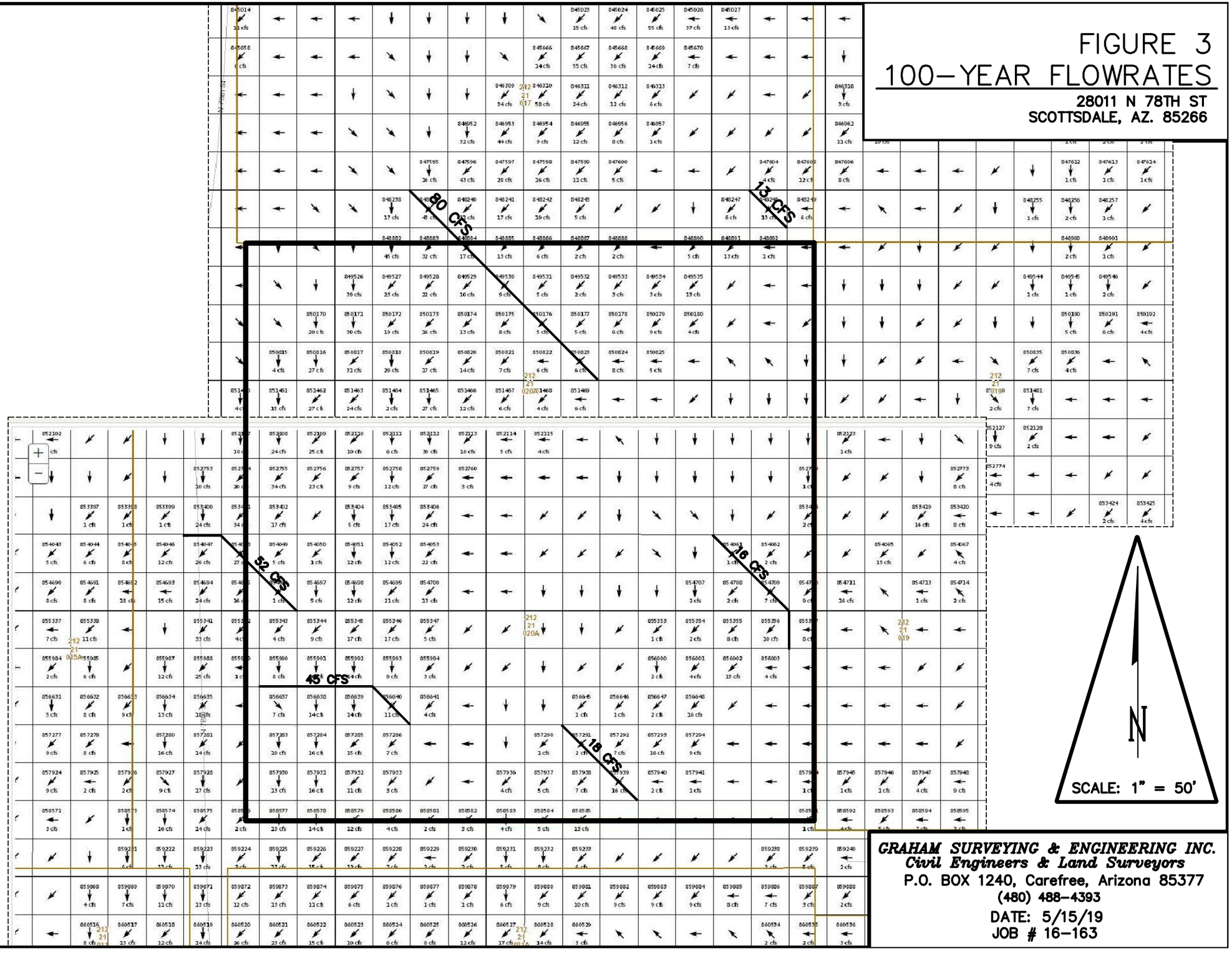
# AERIAL PHOTOGRAPH

FIGURE 2


1/26/2018 3:27:59 PM

# FIGURE 3
# 100–YEAR FLOWRATES

**28011 N 78TH ST**
**SCOTTSDALE, AZ. 85266**





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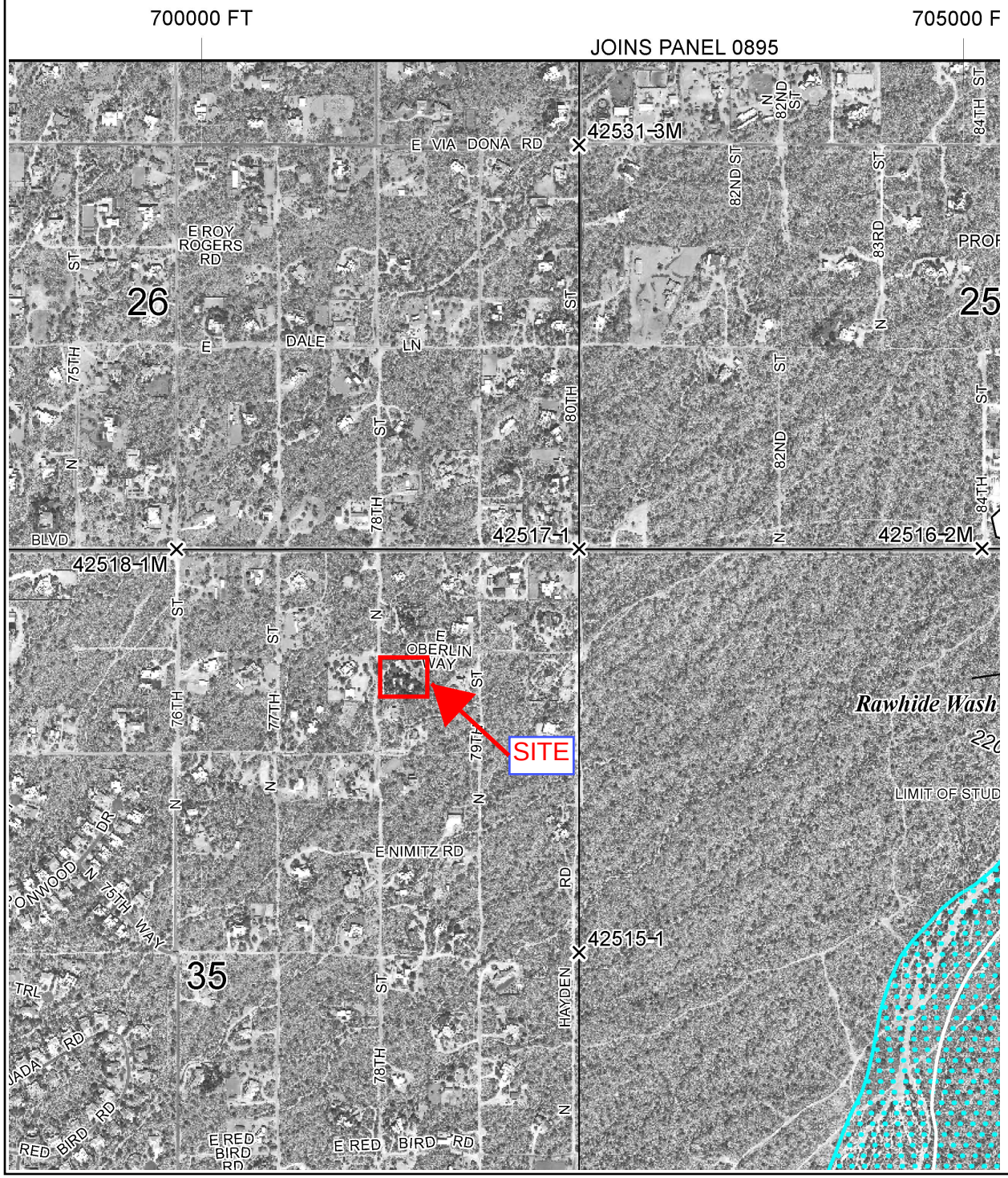
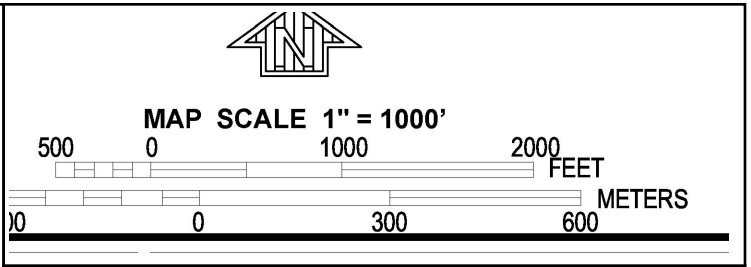
DATE: 5/15/19
JOB # 16–163




NATIONAL FLOOD INSURANCE PROGRAM

# FIRM

## FLOOD INSURANCE RATE MAP

## MARICOPA COUNTY, ARIZONA

## AND INCORPORATED AREAS

**PANEL 1310 OF 4425**

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

| COMMUNITY | NUMBER | PANEL | SUFFIX |
|---|---|---|---|
| MARICOPA COUNTY | 040037 | 1310 | L |
| PHOENIX, CITY OF | 040051 | 1310 | L |
| SCOTTSDALE, CITY OF | 045012 | 1310 | L |

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

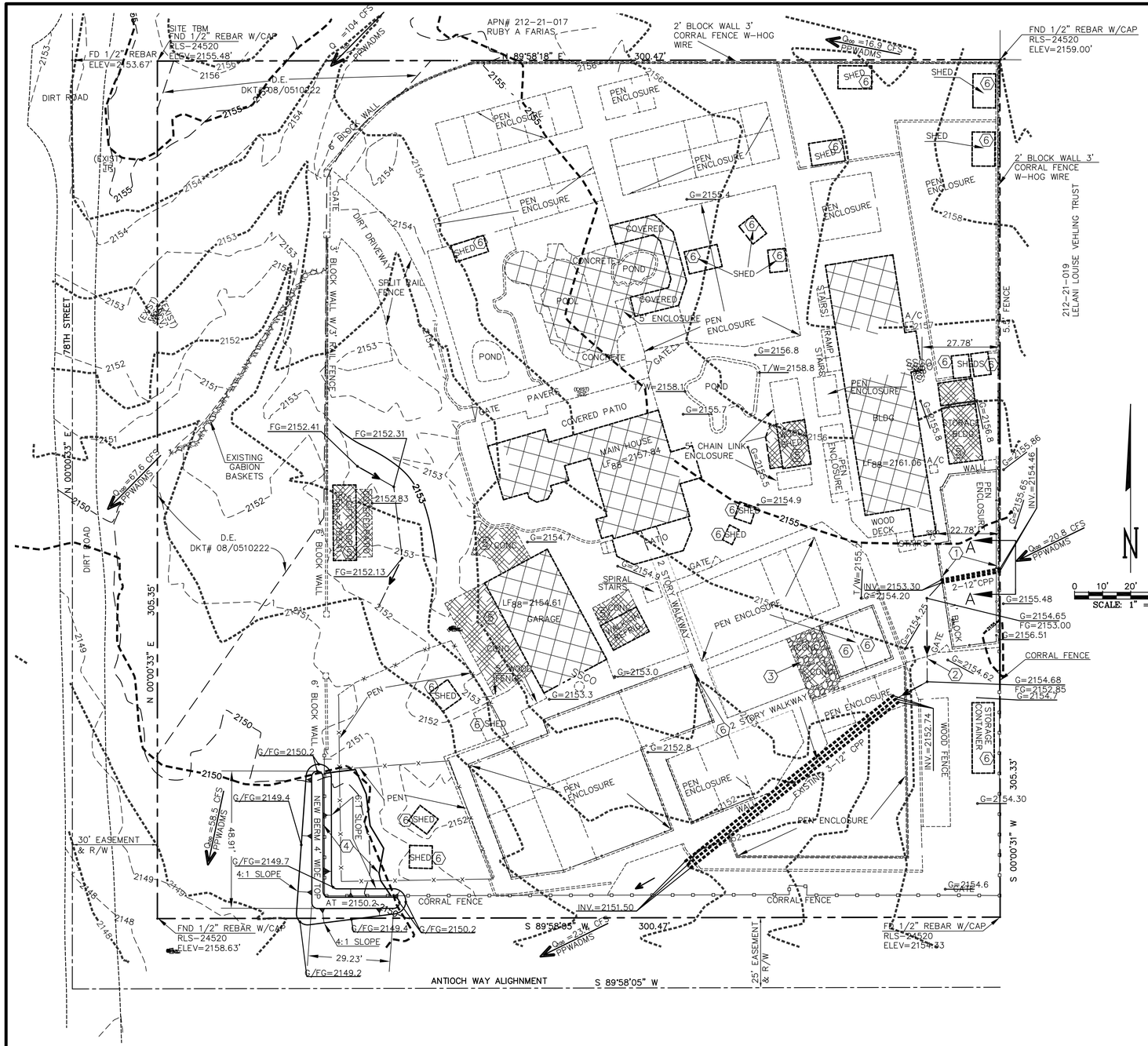
**MAP NUMBER**
**04013C1310L**

**MAP REVISED**
**OCTOBER 16, 2013**

Federal Emergency Management Agency

# FIGURE 5

## DEVELOPMENT PLAN




## LEGEND:

| | |
|---|---|
| CCP | CORRUGATED PLASTIC PIPE |
| (X) | CONSTRUCTION NOTE |
| CFS | CUBIC FEET PER SECOND |
| | DIRECTION OF DRAINAGE |
| 00 | EXISTING CONTOUR |
| G | EXISTING GRADE ELEVATION |
| FG | FINISHED GRADE ELEVATION |
| | HISTORIC CONTOURS SURVEYED DECEMBER 2007 |
| | HISTORIC IMPERVIOUS AREA |
| 00 | PROPOSED CONTOUR |
| | PROPOSED FLOWLINE |
| | EXISTING IMPERVIOUS AREA ADDED |

## CONSTRUCTION NOTES:

1. REMOVE 6 L.F. OF EXISTING BLOCK WALL ABOVE EXISTING PIPES. SEE SECTION A–A FOR DETAILS.
2. GRADE A TRIANGULAR SWALE WITH 6(H):1(V) SIDE SLOPES AND FLOWLINE GRADES PER SPOT ELEVATIONS.
3. RETENTION BASIN #2. 162 C.F. OF 4" DIAMETER RIVER STONE. USING A VOID RATIO OF 40 PERCENT THIS AREA PROVIDES 64.8 C.F. OF STORAGE VOLUME. VOLUME REQUIRED IS 7.36 C.F.
4. RETENTION BASIN #1. 4' WIDE BERM IS CONSTRUCTED ON EXISTING GRADE. COMPACT IN 6" LIFTS TO 95 PERCENT PROCTOR DENSITY. WILL PROVIDE A STORAGE VOLUME OF 195.75 C.F. SEE BASIN PROPERTIES ON THIS SHEET.
5. IMPROVED IMPERVIOUS AREA THAT CONTRIBUTES TO RETENTION BASIN #1 VOLUME REQUIRED.
6. IMPROVED IMPERVIOUS AREA THAT ALLOWS FOR STORMWATER PERCOLATION OR STORAGE.
   - SHEDS ARE TORTOISE SHELTERS WITH NO FOOTINGS THEY HAVE WOODEN WALLS AND NO FLOOR.
   - STORAGE CONTAINER IS ELEVATED 3" ABOVE EXISTING GRADE.
   - IMPROVED WALKWAYS ARE MADE OF WOOD AND ELEVATED ABOVE THE EXISTING GRADE.
   - SEASONAL SHADES ARE MADE OF MESH ALLOWING STORMWATER TO PASS THROUGH TO EXISTING GRADE.
   - ALL REPTILE PONDS ARE EQUIPPED WITH FLOATER SWITCHES THAT MAINTAIN THE WATER SURFACE 6" BELOW THE TOP OF POND. WITH A 2 HOUR 100-YEAR PRECIPITATION VALUE OF 2.58" PONDS PROVIDE DOUBLE THE REQUIRED STORAGE.

## STORMWATER STORAGE:

$V_{req}$=required retention volume (C.F.)
ΔC=Difference of PRE VS. POST Runoff Coefficient
0.95 for Impervious material (i.e. concrete & roof) (POST)
0.50 for natural desert (PRE)
ΔC= 0.95–0.50=0.45
P=Rainfall depth for the NOAA14 100–year 2–hour storm event(in per hour)
2.58 in./hr. for lot location
A=Runoff areas (S.F.)

$V_{req}$=ΔC(P/12)A

Basin #1
$V_{req}$=0.45(2.58/12)1,987
$V_{req}$=193 C.F.

Basin #2
$V_{req}$=0.45(2.58/12)76.1
$V_{req}$=7.4 C.F.

## BASIN PROPERTIES

BASIN #1:
VOL. REQUIRED=193 C.F.
VOL PROVIDED=196 C.F.
BOTTOM=2149.7'
TOP=2150.2
DEPTH=6"

BASIN #2:
VOL. REQUIRED=7.4 C.F.
VOL PROVIDED=64.8 C.F.
BOTTOM=NA
TOP=2154.00
DEPTH=NA

## SITE ADDRESS:

28011 N 78TH ST.
SCOTTSDALE, AZ. 85266

## ASSESSORS PCL. NO.:

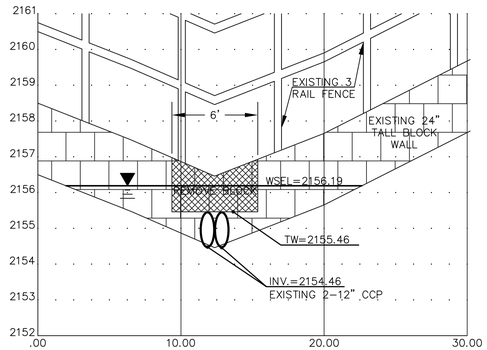
212–21–020A

## C.O.S. QUARTER SECTION NO.:

50–46

## DATE:

| | | |
|---|---|---|
| PHASE 1 | 5/15/18 | MP |
| ---- | ---- | ---- |
| ---- | ---- | ---- |
| ---- | ---- | ---- |




## SECTION A–A

SCALE: VERT. 1"=2'
HORIZ. 1"=5'

## BENCHMARK:

COS BRASS CAP FLUSH, EASTERLY OF 2, LOCATED AT THE INTERSECTION OF PINNACLE VISTA DR. AND 76TH ST.
ELEVATION=2097.75' (NAVD88)

## T.B.M.:

FD ½" REBAR AT THE NORTHWEST PROPERTY CORNER
ELEVATION=2155.48' (NAVD88)

## BENCHMARK CERTIFICATION:

I HEREBY CERTIFY THAT ALL ELEVATIONS REPRESENTED ON THIS PLAN ARE BASED ON THE ELEVATION DATUM FOR THE CITY OF SCOTTSDALE BENCHMARK.


*GRAHAM SURVEYING & ENGINEERING, INC.*
*Civil Engineers & Land Surveyors*
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JOB #16–163

# HY-8 Culvert Analysis Report

**Crossing Discharge Data**

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0 cfs

Design Flow: 20.8 cfs

Maximum Flow: 40 cfs

**Table 1 - Summary of Culvert Flows at Crossing: @ EAST PROP.**

| Headwater Elevation (ft) | Total Discharge (cfs) | EXIST. 2 12" CCP Discharge (cfs) | Roadway Discharge (cfs) | Iterations |
|---|---|---|---|---|
| 2154.46 | 0.00 | 0.00 | 0.00 | 1 |
| 2155.34 | 4.00 | 4.00 | 0.00 | 1 |
| 2155.68 | 8.00 | 6.01 | 1.98 | 7 |
| 2155.87 | 12.00 | 6.94 | 5.03 | 5 |
| 2156.02 | 16.00 | 7.64 | 8.34 | 5 |
| 2156.16 | 20.00 | 8.21 | 11.78 | 5 |
| 2156.19 | 20.80 | 8.31 | 12.46 | 3 |
| 2156.40 | 28.00 | 9.11 | 18.87 | 4 |
| 2156.51 | 32.00 | 9.49 | 22.50 | 4 |
| 2156.61 | 36.00 | 9.83 | 26.15 | 3 |
| 2156.71 | 40.00 | 10.15 | 29.84 | 3 |
| 2155.46 | 4.74 | 4.74 | 0.00 | Overtopping |

**Rating Curve Plot for Crossing: @ EAST PROP.**

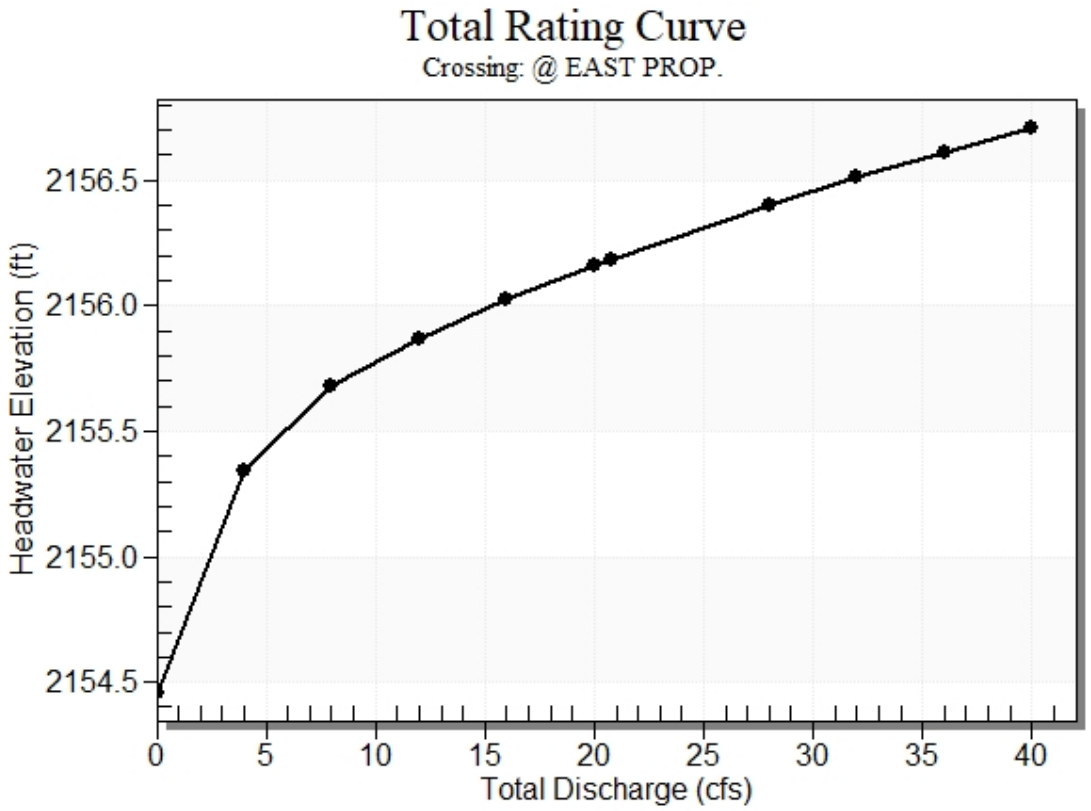


**Table 2 - Culvert Summary Table: EXIST. 2 12" CCP**

| Total Discharge (cfs) | Culvert Discharge (cfs) | Headwater Elevation (ft) | Inlet Control Depth (ft) | Outlet Control Depth (ft) | Flow Type | Normal Depth (ft) | Critical Depth (ft) | Outlet Depth (ft) | Tailwater Depth (ft) | Outlet Velocity (ft/s) | Tailwater Velocity (ft/s) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0.00 | 2154.46 | 0.000 | 0.000 | 0-NF | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 4.00 | 4.00 | 2155.34 | 0.881 | 0.0* | 1-S2n | 0.452 | 0.598 | 0.452 | 0.499 | 5.610 | 2.680 |
| 8.00 | 6.01 | 2155.68 | 1.220 | 0.429 | 5-S2n | 0.579 | 0.741 | 0.579 | 0.647 | 6.180 | 3.188 |
| 12.00 | 6.94 | 2155.87 | 1.406 | 0.867 | 5-S2n | 0.638 | 0.793 | 0.657 | 0.753 | 6.153 | 3.528 |
| 16.00 | 7.64 | 2156.02 | 1.562 | 1.124 | 5-S2n | 0.684 | 0.828 | 0.704 | 0.839 | 6.272 | 3.791 |
| 20.00 | 8.21 | 2156.16 | 1.700 | 1.283 | 5-S2n | 0.725 | 0.854 | 0.725 | 0.912 | 6.540 | 4.008 |
| 20.80 | 8.31 | 2156.19 | 1.725 | 1.336 | 5-S2n | 0.732 | 0.859 | 0.732 | 0.925 | 6.545 | 4.048 |
| 28.00 | 9.11 | 2156.40 | 1.942 | 1.784 | 7-M2t | 1.000 | 0.890 | 0.985 | 1.035 | 5.820 | 4.360 |
| 32.00 | 9.49 | 2156.51 | 2.051 | 1.991 | 4-FFf | 1.000 | 0.903 | 1.000 | 1.088 | 6.043 | 4.508 |
| 36.00 | 9.83 | 2156.61 | 2.153 | 2.194 | 4-FFf | 1.000 | 0.912 | 1.000 | 1.137 | 6.259 | 4.643 |
| 40.00 | 10.15 | 2156.71 | 2.251 | 2.388 | 4-FFf | 1.000 | 0.920 | 1.000 | 1.183 | 6.460 | 4.766 |

* Full Flow Headwater elevation is below inlet invert.

**********

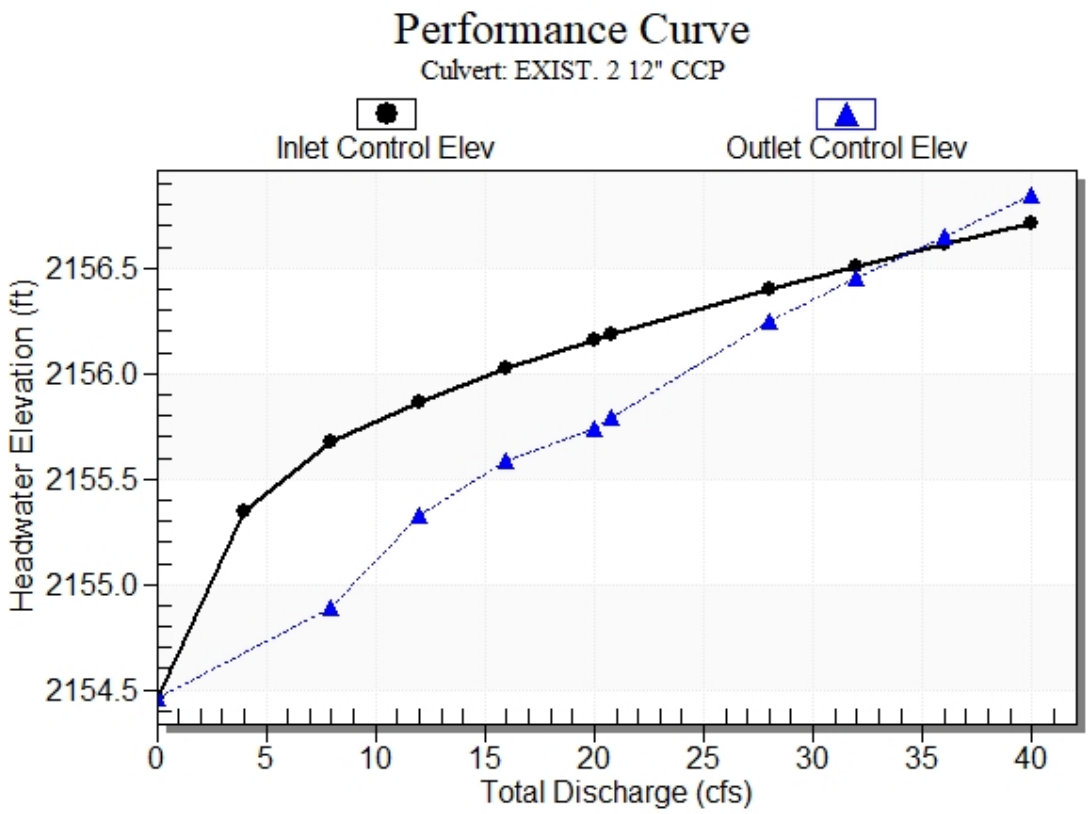
Straight Culvert

Inlet Elevation (invert): 2154.46 ft, Outlet Elevation (invert): 2153.30 ft

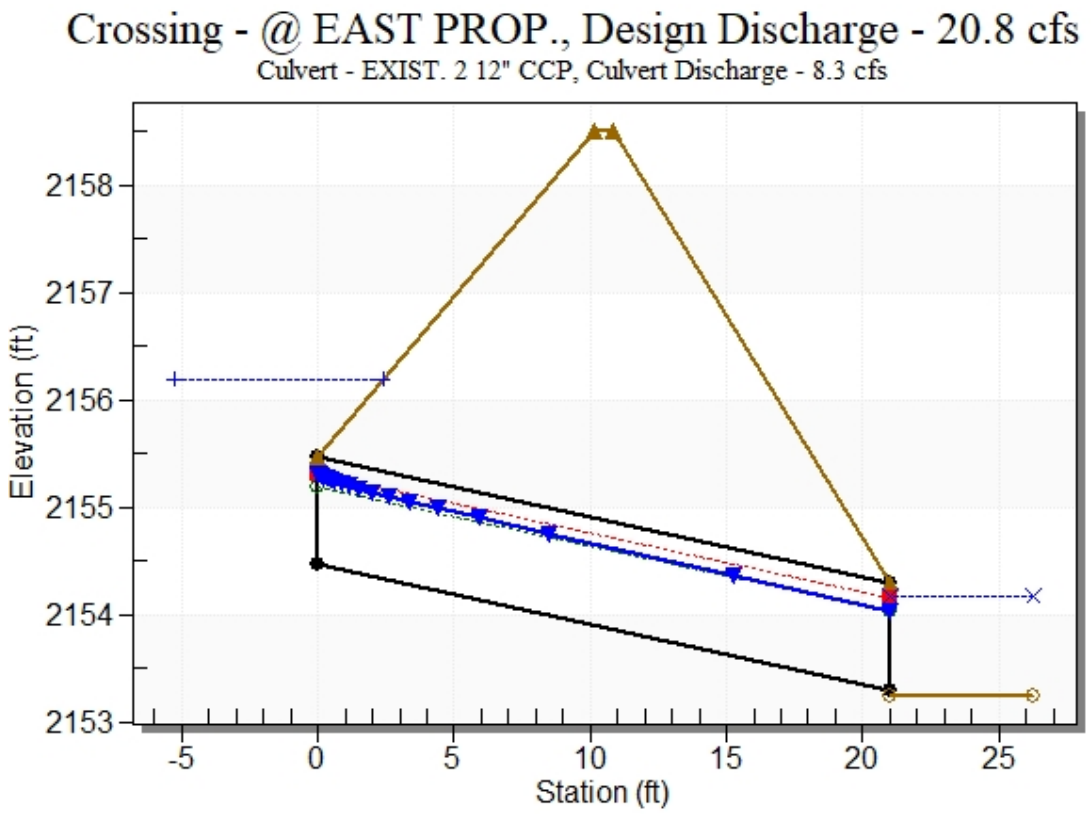
Culvert Length: 21.03 ft, Culvert Slope: 0.0552

**********

**Culvert Performance Curve Plot: EXIST. 2 12" CCP**



**Water Surface Profile Plot for Culvert: EXIST. 2 12" CCP**




**Site Data - EXIST. 2 12" CCP**

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 2154.46 ft

Outlet Station: 21.00 ft

Outlet Elevation: 2153.30 ft

Number of Barrels: 2

**Culvert Data Summary - EXIST. 2 12" CCP**

Barrel Shape: Circular

Barrel Diameter: 1.00 ft

Barrel Material: Corrugated PE

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

**Crossing Front View (Roadway Profile): @ EAST PROP.**

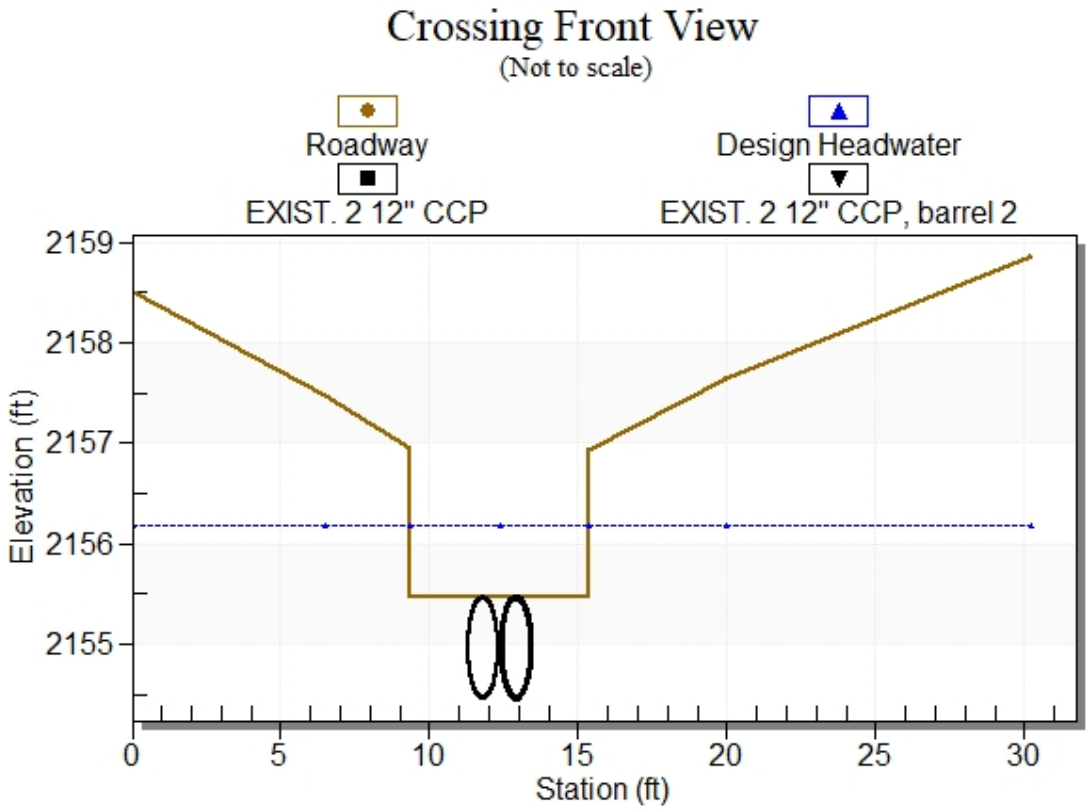


**Table 3 - Downstream Channel Rating Curve (Crossing: @ EAST PROP.)**

| Flow (cfs) | Water Surface Elev (ft) | Depth (ft) | Velocity (ft/s) | Shear (psf) | Froude Number |
|---|---|---|---|---|---|
| 0.00 | 2153.25 | 0.00 | 0.00 | 0.00 | 0.00 |
| 4.00 | 2153.75 | 0.50 | 2.68 | 0.59 | 0.95 |
| 8.00 | 2153.90 | 0.65 | 3.19 | 0.77 | 0.99 |
| 12.00 | 2154.00 | 0.75 | 3.53 | 0.89 | 1.01 |
| 16.00 | 2154.09 | 0.84 | 3.79 | 0.99 | 1.03 |
| 20.00 | 2154.16 | 0.91 | 4.01 | 1.08 | 1.05 |
| 20.80 | 2154.18 | 0.93 | 4.05 | 1.10 | 1.05 |
| 28.00 | 2154.28 | 1.03 | 4.36 | 1.23 | 1.07 |
| 32.00 | 2154.34 | 1.09 | 4.51 | 1.29 | 1.08 |
| 36.00 | 2154.39 | 1.14 | 4.64 | 1.35 | 1.09 |
| 40.00 | 2154.43 | 1.18 | 4.77 | 1.40 | 1.09 |

**Tailwater Channel Data - @ EAST PROP.**

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 6.00 (_:1)

Channel Slope: 0.0190

Channel Manning's n: 0.0300

Channel Invert Elevation: 2153.25 ft

**Roadway Data for Crossing: @ EAST PROP.**

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Irregular Roadway Cross-Section:

| Coord No. | Station (ft) | Elevation (ft) |
|---|---|---|
| 0 | 0.00 | 2158.51 |
| 1 | 6.47 | 2157.48 |
| 2 | 9.34 | 2156.96 |
| 3 | 9.35 | 2155.46 |
| 4 | 12.36 | 2155.46 |
| 5 | 15.35 | 2155.46 |
| 6 | 15.36 | 2156.93 |
| 7 | 19.96 | 2157.65 |
| 8 | 30.21 | 2158.86 |

Roadway Surface: Paved

Roadway Top Width: 0.67 ft

**Crossing Discharge Data**

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0 cfs

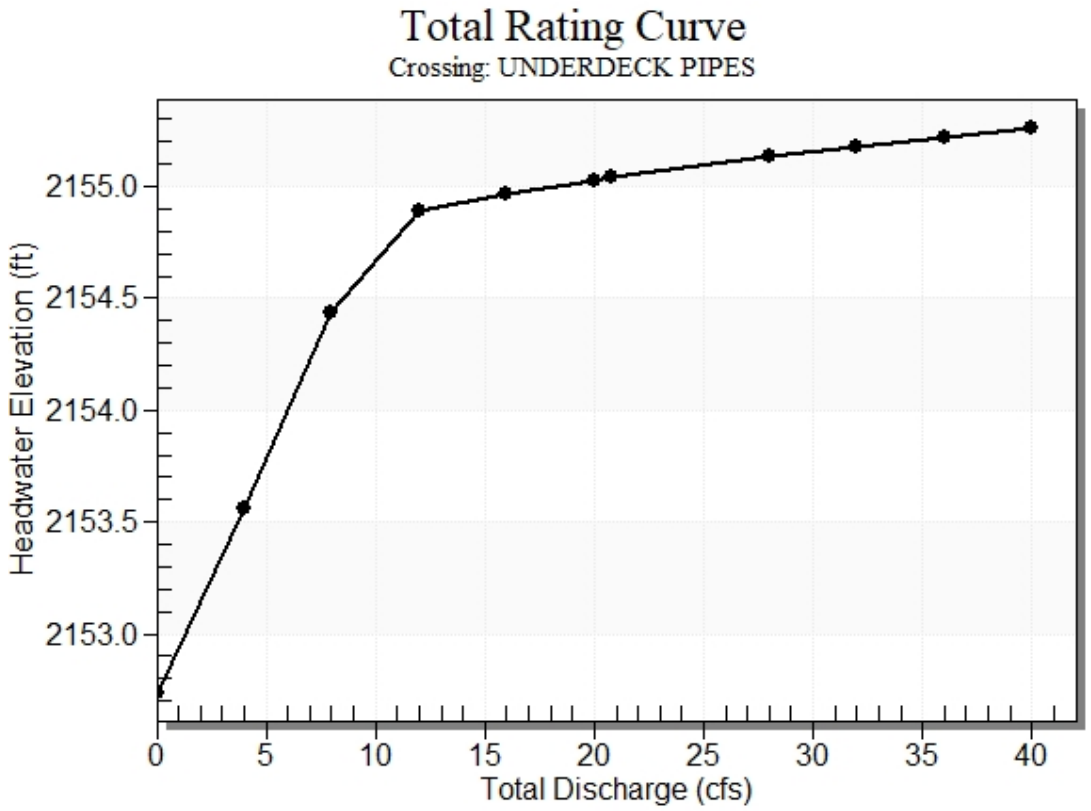
Design Flow: 20.8 cfs

Maximum Flow: 40 cfs

**Table 4 - Summary of Culvert Flows at Crossing: UNDERDECK PIPES**

| Headwater Elevation (ft) | Total Discharge (cfs) | 3-12" CCP Discharge (cfs) | Roadway Discharge (cfs) | Iterations |
|---|---|---|---|---|
| 2152.74 | 0.00 | 0.00 | 0.00 | 1 |
| 2153.56 | 4.00 | 4.00 | 0.00 | 1 |
| 2154.44 | 8.00 | 8.00 | 0.00 | 1 |
| 2154.89 | 12.00 | 8.73 | 3.22 | 12 |
| 2154.97 | 16.00 | 8.85 | 7.11 | 5 |
| 2155.03 | 20.00 | 8.94 | 11.00 | 4 |
| 2155.04 | 20.80 | 8.97 | 11.79 | 3 |
| 2155.13 | 28.00 | 9.11 | 18.87 | 4 |
| 2155.18 | 32.00 | 9.19 | 22.78 | 3 |
| 2155.22 | 36.00 | 9.25 | 26.74 | 3 |
| 2155.27 | 40.00 | 9.32 | 30.67 | 3 |
| 2154.78 | 8.56 | 8.56 | 0.00 | Overtopping |

**Rating Curve Plot for Crossing: UNDERDECK PIPES**



## Table 5 - Culvert Summary Table: 3-12" CCP

| Total Discharge (cfs) | Culvert Discharge (cfs) | Headwater Elevation (ft) | Inlet Control Depth (ft) | Outlet Control Depth (ft) | Flow Type | Normal Depth (ft) | Critical Depth (ft) | Outlet Depth (ft) | Tailwater Depth (ft) | Outlet Velocity (ft/s) | Tailwater Velocity (ft/s) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0.00 | 2152.74 | 0.000 | 0.000 | 0-NF | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 4.00 | 4.00 | 2153.56 | 0.755 | 0.819 | 2-M2c | 0.546 | 0.488 | 0.488 | 0.379 | 3.501 | 1.721 |
| 8.00 | 8.00 | 2154.44 | 1.268 | 1.695 | 7-M2c | 1.000 | 0.698 | 0.698 | 0.559 | 4.557 | 2.145 |
| 12.00 | 8.73 | 2154.89 | 1.381 | 2.150 | 7-M2c | 1.000 | 0.729 | 0.729 | 0.697 | 4.744 | 2.426 |
| 16.00 | 8.85 | 2154.97 | 1.401 | 2.225 | 7-M2c | 1.000 | 0.734 | 0.734 | 0.814 | 4.778 | 2.640 |
| 20.00 | 8.94 | 2155.03 | 1.416 | 2.287 | 7-M2c | 1.000 | 0.737 | 0.737 | 0.916 | 4.801 | 2.817 |
| 20.80 | 8.97 | 2155.04 | 1.420 | 2.298 | 7-M2c | 1.000 | 0.739 | 0.739 | 0.935 | 4.808 | 2.848 |
| 28.00 | 9.11 | 2155.13 | 1.445 | 2.392 | 7-M2c | 1.000 | 0.744 | 0.744 | 1.092 | 4.846 | 3.099 |
| 32.00 | 9.19 | 2155.18 | 1.457 | 2.438 | 7-M2c | 1.000 | 0.747 | 0.747 | 1.169 | 4.865 | 3.216 |
| 36.00 | 9.25 | 2155.22 | 1.468 | 2.483 | 7-M2c | 1.000 | 0.750 | 0.750 | 1.242 | 4.883 | 3.323 |
| 40.00 | 9.32 | 2155.27 | 1.479 | 2.525 | 7-M2c | 1.000 | 0.752 | 0.752 | 1.310 | 4.899 | 3.421 |

**********

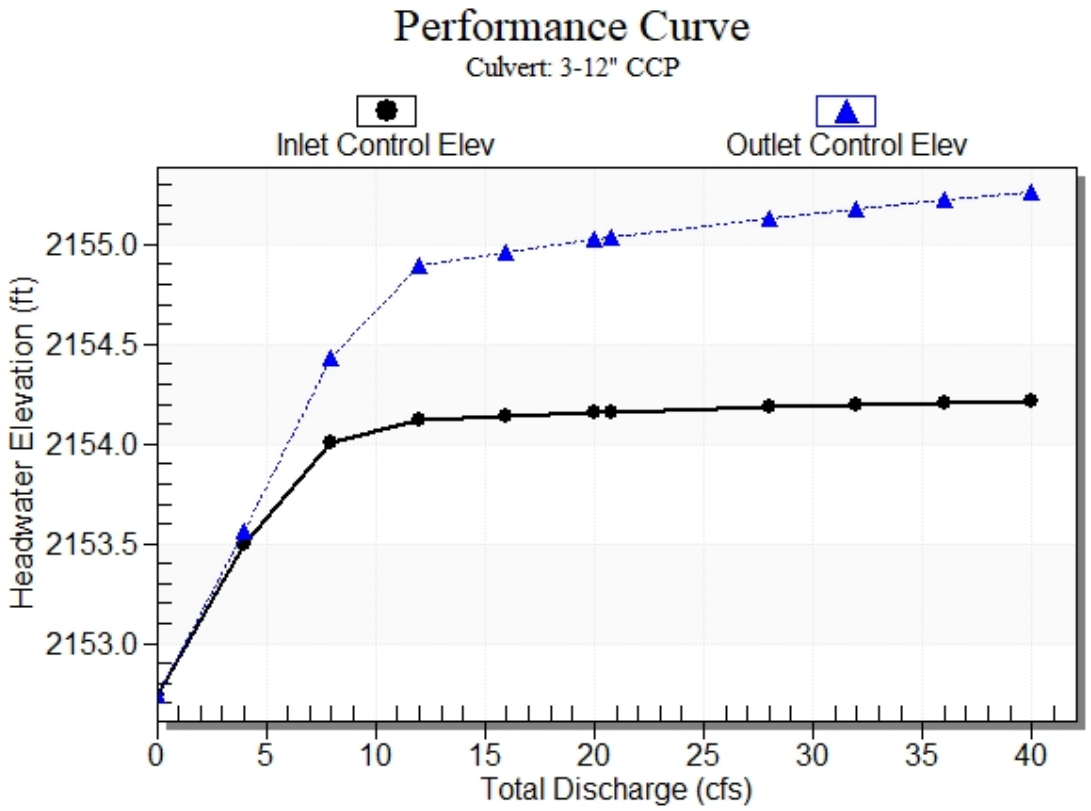
Straight Culvert

Inlet Elevation (invert): 2152.74 ft, Outlet Elevation (invert): 2151.50 ft

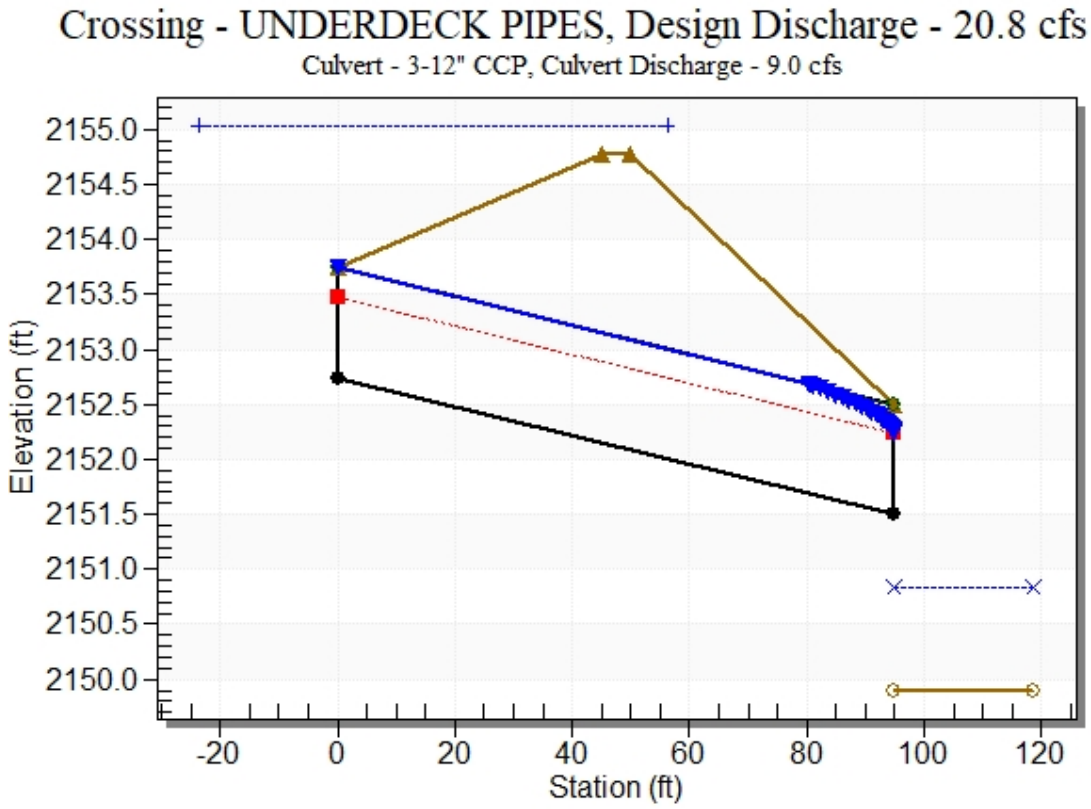
Culvert Length: 95.01 ft, Culvert Slope: 0.0131

**********

**Culvert Performance Curve Plot: 3-12" CCP**



**Water Surface Profile Plot for Culvert: 3-12" CCP**




**Site Data - 3-12" CCP**

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 2152.74 ft

Outlet Station: 95.00 ft

Outlet Elevation: 2151.50 ft

Number of Barrels: 3

**Culvert Data Summary - 3-12" CCP**

Barrel Shape: Circular

Barrel Diameter: 1.00 ft

Barrel Material: Corrugated PE

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting

Inlet Depression: None

**Table 6 - Downstream Channel Rating Curve (Crossing: UNDERDECK PIPES)**

| Flow (cfs) | Water Surface Elev (ft) | Depth (ft) | Velocity (ft/s) | Shear (psf) | Froude Number |
|---|---|---|---|---|---|
| 0.00 | 2149.90 | 0.00 | 0.00 | 0.00 | 0.00 |
| 4.00 | 2150.28 | 0.38 | 1.72 | 0.45 | 0.54 |
| 8.00 | 2150.46 | 0.56 | 2.15 | 0.66 | 0.57 |
| 12.00 | 2150.60 | 0.70 | 2.43 | 0.83 | 0.58 |
| 16.00 | 2150.71 | 0.81 | 2.64 | 0.97 | 0.59 |
| 20.00 | 2150.82 | 0.92 | 2.82 | 1.09 | 0.60 |
| 20.80 | 2150.84 | 0.94 | 2.85 | 1.11 | 0.61 |
| 28.00 | 2150.99 | 1.09 | 3.10 | 1.29 | 0.62 |
| 32.00 | 2151.07 | 1.17 | 3.22 | 1.39 | 0.62 |
| 36.00 | 2151.14 | 1.24 | 3.32 | 1.47 | 0.63 |
| 40.00 | 2151.21 | 1.31 | 3.42 | 1.55 | 0.63 |

**Tailwater Channel Data - UNDERDECK PIPES**

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 5.00 ft

Side Slope (H:V): 3.00 (_:1)

Channel Slope: 0.0190

Channel Manning's n: 0.0550

Channel Invert Elevation: 2149.90 ft

**Roadway Data for Crossing: UNDERDECK PIPES**

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 30.00 ft

Crest Elevation: 2154.78 ft

Roadway Surface: Paved

Roadway Top Width: 5.00 ft

**NOAA Atlas 14, Volume 1, Version 5**
**Location name: Scottsdale, Arizona, USA***
**Latitude: 33.7399°, Longitude: -111.9123°**
**Elevation: 2152.71 ft****
* source: ESRI Maps
** source: USGS

**POINT PRECIPITATION FREQUENCY ESTIMATES**

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

## PF tabular

**PDS-based point 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 | **0.222** (0.184-0.272) | **0.289** (0.242-0.354) | **0.390** (0.322-0.476) | **0.467** (0.384-0.568) | **0.570** (0.462-0.691) | **0.649** (0.520-0.782) | **0.729** (0.575-0.876) | **0.811** (0.631-0.974) | **0.921** (0.699-1.11) | **1.01** (0.749-1.22) |
| 10-min | **0.338** (0.281-0.413) | **0.440** (0.368-0.539) | **0.594** (0.491-0.725) | **0.711** (0.585-0.865) | **0.868** (0.704-1.05) | **0.988** (0.792-1.19) | **1.11** (0.876-1.33) | **1.24** (0.960-1.48) | **1.40** (1.06-1.69) | **1.53** (1.14-1.85) |
| 15-min | **0.419** (0.348-0.512) | **0.545** (0.456-0.668) | **0.736** (0.608-0.899) | **0.881** (0.725-1.07) | **1.08** (0.872-1.30) | **1.23** (0.981-1.48) | **1.38** (1.09-1.65) | **1.53** (1.19-1.84) | **1.74** (1.32-2.09) | **1.90** (1.41-2.29) |
| 30-min | **0.564** (0.469-0.690) | **0.734** (0.614-0.900) | **0.991** (0.820-1.21) | **1.19** (0.976-1.44) | **1.45** (1.18-1.76) | **1.65** (1.32-1.99) | **1.85** (1.46-2.23) | **2.06** (1.60-2.48) | **2.34** (1.78-2.81) | **2.56** (1.90-3.09) |
| 60-min | **0.698** (0.580-0.854) | **0.909** (0.760-1.11) | **1.23** (1.01-1.50) | **1.47** (1.21-1.79) | **1.79** (1.45-2.17) | **2.04** (1.64-2.46) | **2.29** (1.81-2.76) | **2.55** (1.98-3.06) | **2.90** (2.20-3.48) | **3.17** (2.35-3.82) |
| 2-hr | **0.810** (0.684-0.970) | **1.05** (0.882-1.26) | **1.39** (1.17-1.66) | **1.65** (1.38-1.97) | **2.01** (1.66-2.39) | **2.29** (1.86-2.71) | **2.58** (2.06-3.04) | **2.86** (2.26-3.38) | **3.25** (2.51-3.85) | **3.56** (2.69-4.23) |
| 3-hr | **0.872** (0.736-1.06) | **1.11** (0.946-1.36) | **1.45** (1.23-1.76) | **1.72** (1.44-2.08) | **2.10** (1.73-2.52) | **2.40** (1.95-2.87) | **2.71** (2.17-3.24) | **3.04** (2.39-3.62) | **3.49** (2.68-4.16) | **3.86** (2.89-4.61) |
| 6-hr | **1.04** (0.900-1.22) | **1.31** (1.14-1.54) | **1.67** (1.44-1.95) | **1.95** (1.67-2.28) | **2.35** (1.98-2.72) | **2.65** (2.21-3.07) | **2.97** (2.44-3.44) | **3.30** (2.66-3.83) | **3.74** (2.94-4.34) | **4.09** (3.15-4.75) |
| 12-hr | **1.22** (1.06-1.42) | **1.54** (1.34-1.79) | **1.93** (1.68-2.24) | **2.25** (1.93-2.60) | **2.67** (2.27-3.08) | **3.00** (2.52-3.45) | **3.33** (2.77-3.84) | **3.67** (3.02-4.23) | **4.12** (3.31-4.77) | **4.47** (3.52-5.21) |
| 24-hr | **1.43** (1.26-1.64) | **1.82** (1.60-2.09) | **2.37** (2.08-2.71) | **2.81** (2.45-3.21) | **3.43** (2.97-3.93) | **3.93** (3.36-4.51) | **4.47** (3.76-5.15) | **5.03** (4.17-5.83) | **5.82** (4.71-6.83) | **6.46** (5.14-7.66) |
| 2-day | **1.61** (1.41-1.85) | **2.05** (1.79-2.36) | **2.70** (2.35-3.09) | **3.22** (2.79-3.69) | **3.96** (3.40-4.53) | **4.55** (3.86-5.23) | **5.18** (4.34-5.98) | **5.84** (4.83-6.80) | **6.77** (5.48-7.97) | **7.52** (5.98-8.95) |
| 3-day | **1.71** (1.50-1.96) | **2.18** (1.91-2.50) | **2.89** (2.53-3.30) | **3.47** (3.02-3.95) | **4.29** (3.70-4.90) | **4.97** (4.24-5.69) | **5.69** (4.79-6.56) | **6.46** (5.36-7.52) | **7.56** (6.14-8.89) | **8.46** (6.75-10.1) |
| 4-day | **1.80** (1.59-2.06) | **2.31** (2.04-2.64) | **3.08** (2.71-3.50) | **3.71** (3.25-4.21) | **4.63** (4.01-5.26) | **5.38** (4.61-6.15) | **6.20** (5.24-7.14) | **7.08** (5.89-8.23) | **8.35** (6.80-9.82) | **9.40** (7.51-11.2) |
| 7-day | **2.07** (1.81-2.38) | **2.65** (2.32-3.03) | **3.53** (3.09-4.04) | **4.27** (3.71-4.88) | **5.33** (4.58-6.10) | **6.22** (5.29-7.15) | **7.18** (6.02-8.31) | **8.22** (6.80-9.63) | **9.73** (7.87-11.5) | **11.0** (8.71-13.2) |
| 10-day | **2.26** (1.99-2.59) | **2.90** (2.55-3.32) | **3.87** (3.38-4.41) | **4.66** (4.05-5.30) | **5.80** (5.00-6.61) | **6.74** (5.75-7.72) | **7.76** (6.54-8.95) | **8.86** (7.36-10.3) | **10.4** (8.48-12.4) | **11.8** (9.36-14.1) |
| 20-day | **2.87** (2.53-3.27) | **3.69** (3.25-4.20) | **4.89** (4.29-5.56) | **5.83** (5.09-6.62) | **7.13** (6.18-8.12) | **8.16** (7.01-9.32) | **9.24** (7.86-10.6) | **10.4** (8.73-12.0) | **11.9** (9.87-14.0) | **13.2** (10.7-15.7) |
| 30-day | **3.40** (2.98-3.87) | **4.38** (3.85-4.98) | **5.80** (5.08-6.58) | **6.90** (6.03-7.81) | **8.40** (7.29-9.54) | **9.59** (8.25-10.9) | **10.8** (9.23-12.4) | **12.1** (10.2-13.9) | **13.8** (11.5-16.1) | **15.2** (12.5-17.9) |
| 45-day | **4.03** (3.56-4.58) | **5.20** (4.59-5.90) | **6.88** (6.06-7.79) | **8.17** (7.17-9.25) | **9.92** (8.64-11.3) | **11.3** (9.75-12.9) | **12.7** (10.9-14.5) | **14.1** (12.0-16.3) | **16.1** (13.5-18.9) | **17.7** (14.6-20.9) |
| 60-day | **4.50** (3.97-5.09) | **5.80** (5.13-6.56) | **7.65** (6.76-8.64) | **9.04** (7.95-10.2) | **10.9** (9.51-12.3) | **12.3** (10.7-14.0) | **13.8** (11.8-15.7) | **15.2** (13.0-17.5) | **17.2** (14.5-20.1) | **18.8** (15.6-22.2) |

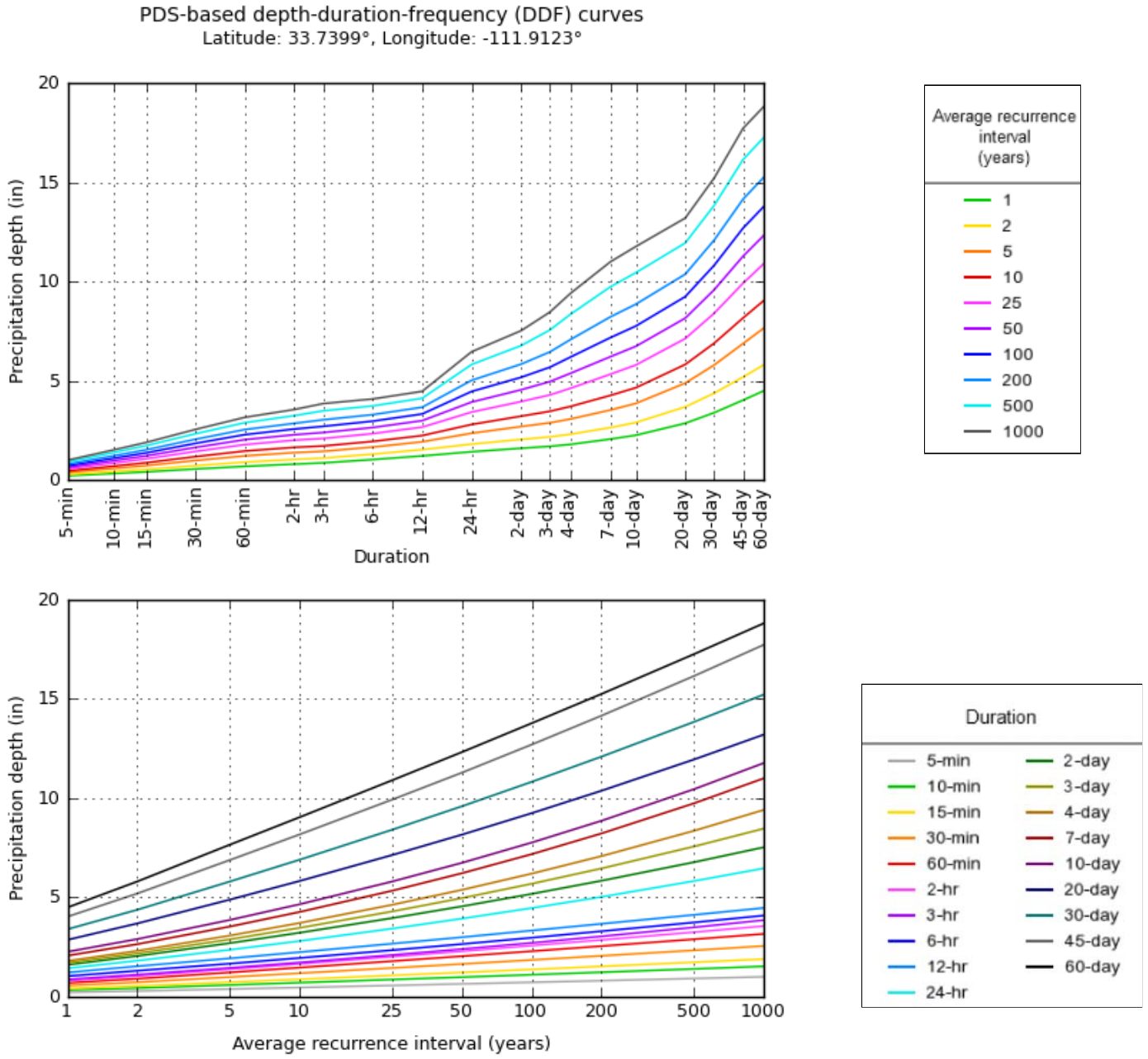
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

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.

Back to Top

## PF graphical




NOAA Atlas 14, Volume 1, Version 5

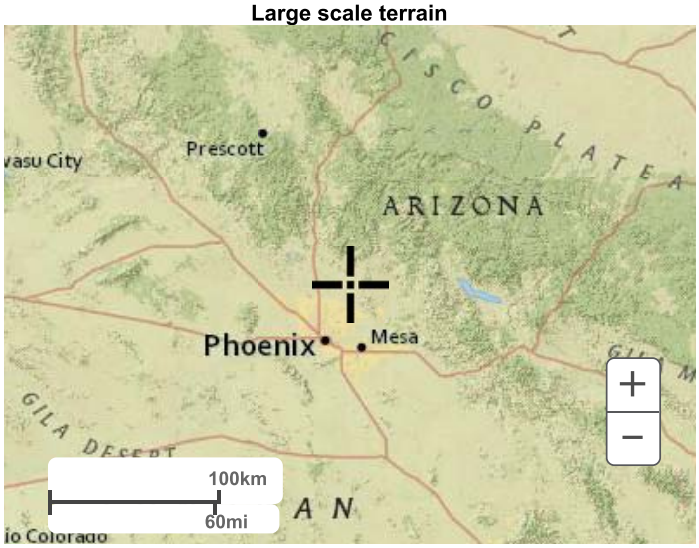
Created (GMT): Wed May 22 20:30:45 2019

Back to Top

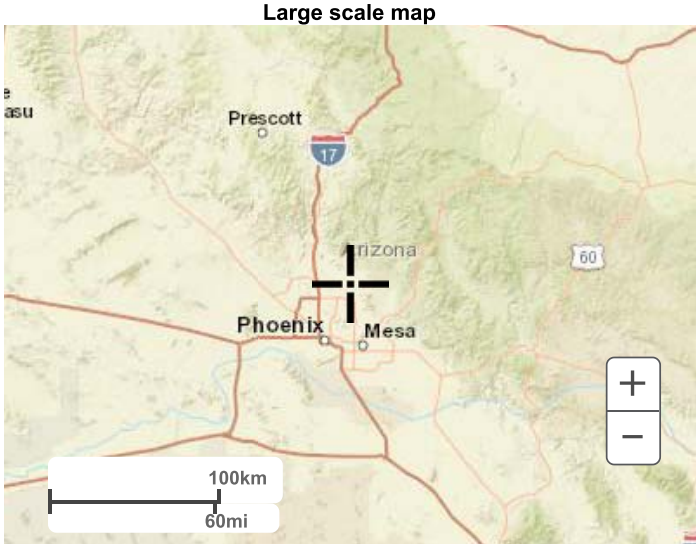
## Maps & aerials

**Small scale terrain**

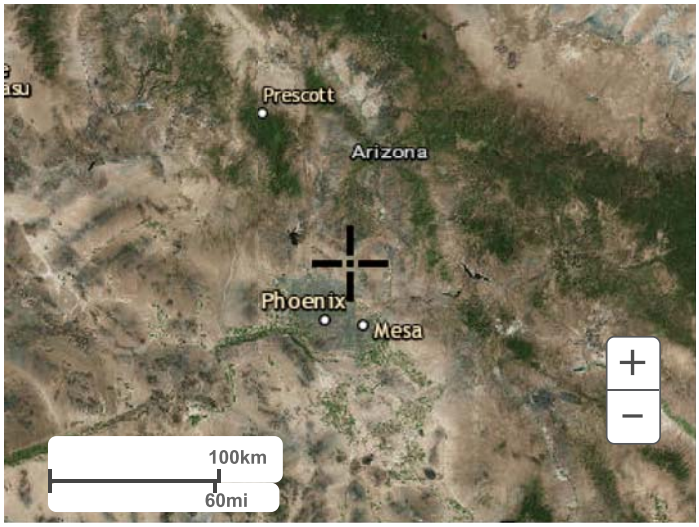

**Large scale terrain**




**Large scale map**




**Large scale aerial**




Back to Top

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US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

Basin Volume Using the Slice Method

Basin 1

| Elevation | SLICE AREA (Square Feet) | Depth (feet) | Volume per foot (Cubic Feet) | Cumulative Volume (Cubic Feet) |
|---|---|---|---|---|
| 2149.7 | 0 | 0 | 0.00 | 0.00 |
| 2150.2 | 783 | 0.5 | 195.75 | 195.75 |
| | | | | |