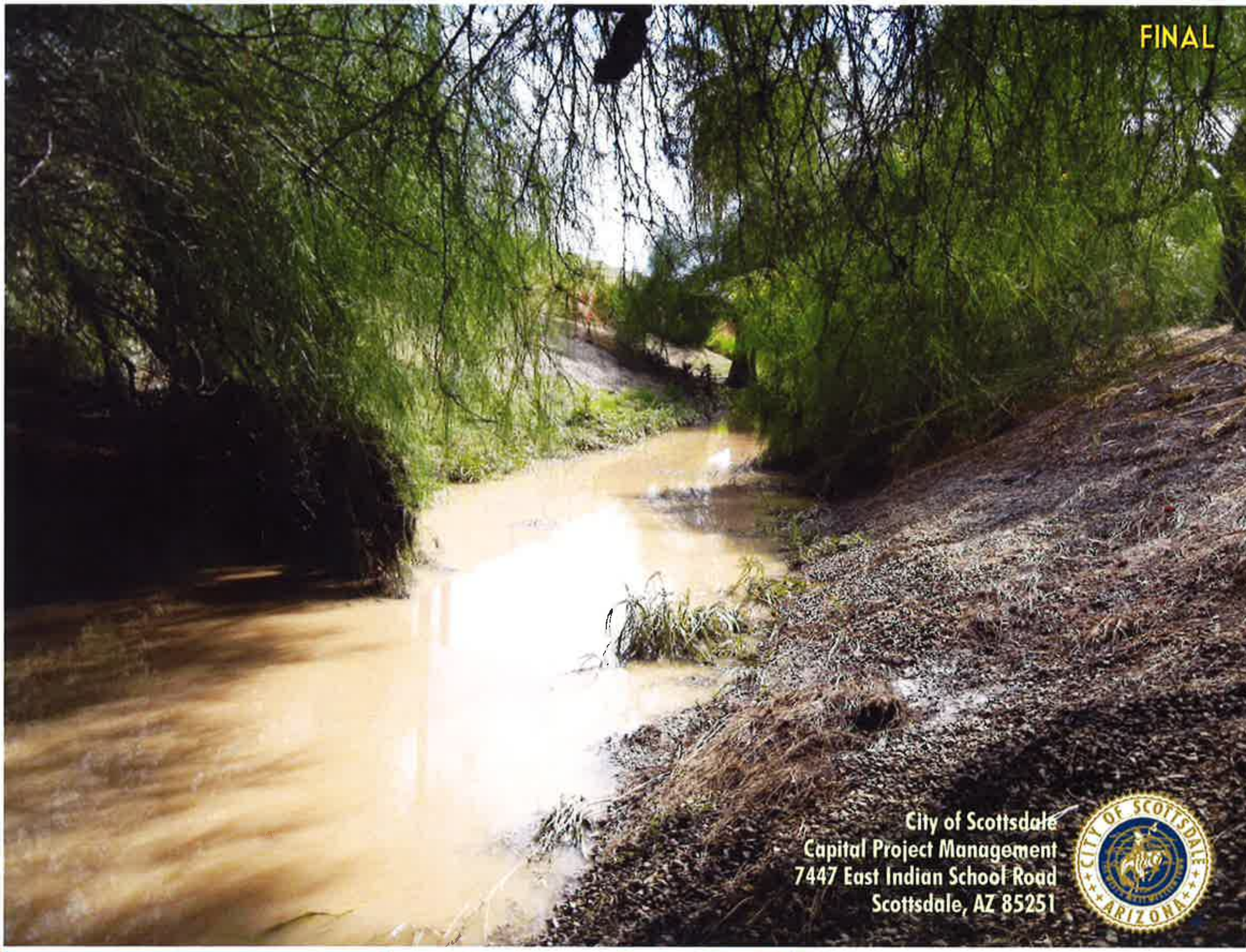
Appendix A: Granite Reef Wash Hydrology Update: Hydrologic Study Report

GRANITE REEF WASH HYDROLOGY UPDATE

HYDROLOGIC STUDY

Project No. F0201 | June 2018



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ARIZONA U.S.A.
Expires 3/31/2020

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LIST OF ABBREVIATIONS

2D .... Two-Dimensional
ARF .... Area Reduction Factor
ADMS/P .... Area Drainage Master Study / Plan
DEM .... Digital Elevation Model
DTM .... Digital Terrain Model
DXF .... Digital Interchange (or Exchange) Format
EPA .... Environmental Protection Agency
FCDMC .... Flood Control District of Maricopa County
FEMA .... Federal Emergency Management Agency
FFE .... Finished Floor Elevation
FIRM .... Flood Insurance Rate Map
GIS .... Geographic Information System
GDS .... Grid Developer System
GRW .... Granite Reef Wash
HEC .... Hydrologic Engineering Center
IA .... Initial Abstraction
InitSat .... Initial Saturation
NEXRAD .... Next Generation Weather Radar
NOAA .... National Oceanic and Atmospheric Administration
NRCS .... Natural Resources Conservation Service
RTIMP .... Percent Effective Impervious Area
S .... South
SRPMIC .... Salt River Pima-Maricopa Indian Community
SWMM .... Storm Water Management Model
TIN .... Triangulated Irregular Network
WRF .... Width Reduction Factor
WSEL .... Water Surface Elevation
XKSAT .... Hydraulic Conductivity

1.0 INTRODUCTION

1.1 Purpose

The purpose of the Granite Reef Wash Hydrology Update is to identify, quantify and document known and potential flooding hazards within the study area based on existing infrastructure. This study is meant to update the existing studies for the watershed based on current mapping and accepted two-dimensional hydrologic techniques within Maricopa County.

1.2 Authority

T.Y. Lin International (TYLIN) was authorized by the City of Scottsdale on July 1st, 2013 to begin performing professional engineering services for this project.

1.3 Location

The study area is located in the south end of the City of Scottsdale (City) and includes a portion of the Salt River Pima-Maricopa Indian Community (SRPMIC). Generally, the project watershed is bounded by the Loop 101 Pima Freeway on the east, Granite Reef Road and Hayden Road on the west, the Arizona Canal on the north and McKellips Road on the south. The study area is shown in Figure 1-1 and covers an area of approximately 6.5 square miles.

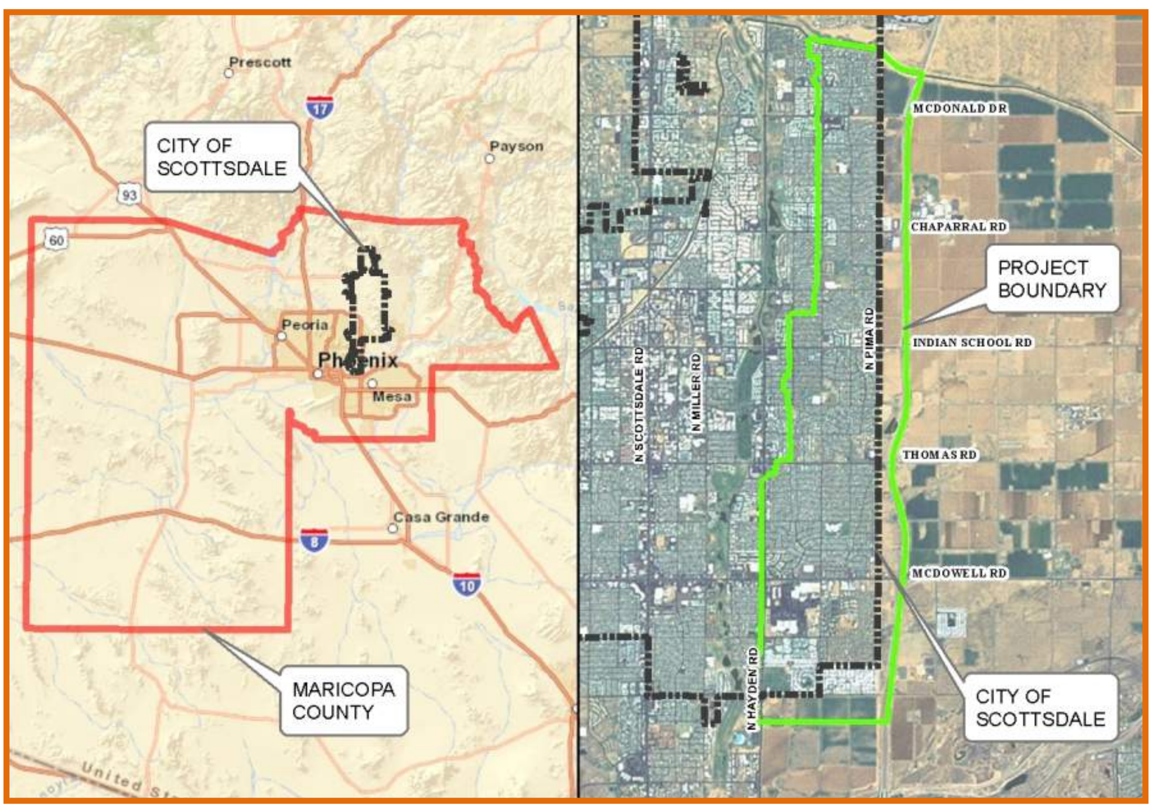


Figure 1-1 Granite Reef Wash Study Area

1.4 Survey and Mapping Information

Aerial Mapping was provided by the Flood Control District of Maricopa County (FCDMC) as part of the Lower Indian Bend Wash Area Drainage Master Study/Plan (ADMS/P). This mapping is based on aerial photography that was flown in 2007 and the topography was created with a 2-foot level of accuracy. The mapping product contained digital terrain model (DTM) data as well as a shapefile of surface features and walls.

1.5 Methodology Used for Hydrology

The scope of the study included the use of two separate hydrologic/hydraulic methods to evaluate the entire project area. The first was a FLO-2D evaluation/analysis for the overland flow in the watershed, considered to be highly urbanized in nature and requiring more detail. The second was an Environmental Protection Agency Storm Water Management Model (EPA SWMM) evaluation/analysis for the subsurface flows in the existing storm drain systems throughout the watershed. These two methods were run concurrently through the FLO-2D program to produce a single cohesive model.

2.0 BACKGROUND INFORMATION

2.1 Previous Studies

Several drainage studies have been performed within and adjacent to the Granite Reef Wash watershed area. Studies pertinent to this study include but are not limited to:

- *Granite Reef Wash Drainage Master Plan* prepared by Entellus, Inc., 2002.
- *Granite Reef Wash Drainage Study & Preliminary Design Improvements Project* prepared by Psomas, 2008.
- *Granite Reef Wash Floodplain Delineation Study* prepared by Entellus, Inc., 1997.
- *Lower Indian Bend Wash ADMS/P: Hydrology and Hydraulics Report* prepared by Gavan & Barker, Inc., 2017.

2.2 Existing Conditions

Located in the southeastern portion of the City and southwestern portions of the SRPMIC lands, the Granite Reef Wash watershed is largely hydraulically separate from the adjacent Indian Bend Wash watershed with the exception of several storm drains that divert some flows to Indian Bend Wash. All runoff generated by the watershed, with the exception of some intercepted storm drain flow, discharges directly into the Salt River at the southern extent of the watershed. Historically, the watershed used to extend further east towards the Arizona Canal but with the construction of the Loop 101 Pima Freeway, all flow east of the freeway is intercepted in a channel and diverted south to the Salt River. This has resulted in a watershed shape that is long (6 to 7 miles) but very narrow (less than 1 mile).

The current Granite Reef Wash is a combination of streets, storm drains and channels. It roughly starts at the intersection of Thomas Road and 87th Street and continues along 87th Street in a combination of storm drain and inverted crown street section.

Figure 2-1 Granite Reef Wash (87th Street)

Intersection of Thomas Rd & 87th St **87th St inverted crown section**

The wash continues along 87th Street until Coronado Road where it transitions to a channel which passes through the Scottsdale Belle Rive apartment complex.

Figure 2-2 Granite Reef Wash (Transition to Scottsdale Belle Rive)

Transition area near Coronado Road

Break in wall for incoming channel flow

Beginning of channel section

Channel behind Belle Rive apartments

The channel continues south across McDowell Road until it reaches a cul-de-sac at the north end of 84th Place. Once it reaches 84th Place, the wash converts back to a combination storm drain and inverted crown street.

Figure 2-3 Granite Reef Wash (McDowell Road to 84th Place)

Channel looking south at McDowell Rd

Channel south of McDowell Rd

Storm drain entrance at 84th Pl

84th Pl looking south

The wash along 84th Place eventually intersects Granite Reef Road and heads south to a cul-de-sac at the end of Granite Reef Road south of Roosevelt Street. At this point, Granite Reef Wash becomes a channel again and remains a channel as it leaves the City limits and enters SRPMIC lands where it eventually discharges to the Salt River.

Figure 2-4 Granite Reef Wash (Granite Reef Road to McKellips Road)

Granite Reef Rd looking north

Channel at south end of Granite Reef Rd

Channel looking south at McKellips Rd

Channel south of McKellips Rd

The Granite Reef Wash watershed is nearly fully urbanized within the City and predominately agricultural within the SRPMIC lands. On the City side of the watershed, development is largely medium density residential and includes schools, commercial and industrial. This has produced a watershed that is significantly impervious limiting the available area for infiltration. On the SRPMIC side, there are some commercial areas (Chaparral Road and Pima Road) but most of the area is agricultural and largely pervious.

Runoff within the watershed generally flows from north to south and is mostly conveyed in the streets. Since there are a significant amount of single-family residential homes, much of the rainfall falls in yards surrounded by block walls. Typical residential homes tend to drain from back to front towards the streets, but in many cases, alleys in the rear allow runoff to be released out the back of properties which is then conveyed to the adjacent streets. Many of the block walls around these homes lack scuppers/weep holes and flow can only escape through gates.

Figure 2-5a Typical Alleys with Block Walls

Within the watershed, not all walls are constructed of masonry block. Some walls are made of wood or are simply chain-link fences. These fences have little impact on the flows leaving the yards.

Figure 2-5b Alleys with Fences

Overall, the walls appear to have some impact by retaining/detaining low flows but in most cases, runoff is allowed to leave either through gates, weep holes or small scuppers.

Runoff is generally captured and conveyed in the east-west streets and is diverted to the north-south streets where flow concentrates and moves down through the watershed. To mitigate these flows, several stormwater facilities have been constructed over the years. These facilities include storm drains, culverts and channels.

Storm drains were found to be the most common stormwater facility in the watershed. Utilizing the proximity of Indian Bend Wash to the watershed, several storm drains were constructed to intercept flow along major streets and discharge into Indian Bend Wash. These streets include:

- Jackrabbit Road
- Chaparral Road/Pima Road
- Camelback Road
- Indian School Road/Pima Road
- Hayden Road

The remaining storm drains are along or discharges directly to the alignment of Granite Reef Wash. These storm drains are located in:

- 87th Street/Pima Road
- McDowell Road/Pima Road
- 84th Place/Granite Reef Road

2.3 Identified Flooding Issues

Nuisance flooding has been an ongoing issue in areas along Granite Reef Wash and in an area immediately upstream of the primary concentration point for Granite Reef Wash at Thomas Road and 87th Street. Observed issues related to flooding have been:

Figure 2-6 Flooding in the Watershed

Thomas Rd and Pima Rd (Storm Date: 8/21/12)

86th Street near Mulberry St & Angus Dr (Storm Date: 7/30/07)

Evidence of significant flow in 84th Place
(Storm Date: 8/21/12)

GRW north of McDowell Rd
(Storm Date: 8/24/06)

GRW south of McDowell Rd
(Storm Date: 8/24/06)

South end of Granite Reef Rd – Area with frequent erosion/sedimentation
(Storm Date: 8/24/06)

Many of the flooding issues appear to have been related to undersized and/or insufficient infrastructure, inefficient interception and lack of maintenance. In the past, clogging and over vegetation were some of the leading causes of flooding during storm events but in recent years, focus on maintenance and removal of some trash racks has facilitated flow through the system resulting in reduced flooding potential on adjacent properties.

Figure 2-7 Inlet Clogging and Over Vegetation

Earll Dr & Pima Frontage Rd (Storm Date: 8/21/06)

North end of 84th Place (Storm Date: 8/21/06)

Granite Reef Wash south of McDowell Rd (2014 vs. 2018)

Aside from frequent nuisance flooding, and occasional hazardous street flooding, there has been no evidence of structural flooding or any undermining of existing infrastructure. Homes, in general, appear to be elevated in areas adjacent to the primary flow corridors with no known claims of flooding since the establishment of the FEMA floodplain in the study area.

2.4 FEMA Special Flood Hazard Areas

The study area is located within two effective Flood Insurance Rate Maps (Map No. 04013C1770L & 04013C2235L). A review of these maps indicates that most of the area lies within Zone X with the exception of the area surrounding the Granite Reef Wash corridor. This area consists of Shaded Zone X and Zone AE. These zones are described as:

Zone X – *Areas determined to be outside the 0.2% annual chance floodplain.*

Shaded Zone X – *Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from the 1% annual chance flood.*

Zone AE – *Special Flood Hazard Areas (SFHAs) subject to inundation by the 1% annual chance flood; base flood elevations determined.*

See Appendix B for the FEMA FIRM map of the Zone AE area.

3.0 HYDROLOGY/HYDRAULICS

3.1 Modeling Approach

FLO-2D (Pro Model – Build No. 16.06.16) with the integrated EPA SWMM software was the two-dimensional modeling program selected to analyze the Granite Reef Wash watershed and estimate depths, discharges and flow patterning. Previous studies performed in the watershed used the HEC-1 software as the basis to estimate flows. Reviews of these studies compared with several storm events that have occurred in the watershed suggest that the HEC-1 models have been significantly overestimating flows. This led to the need to update the hydrology for the watershed using a two-dimensional analysis from which mitigation alternatives could be developed as part of a separate project.

In order to develop an acceptable FLO-2D model, the methods and procedures per FCDMC's current guidance were used. Specifically, the procedures used to develop the models for the adjacent Lower Indian Bend Wash ADMS/P were implemented in this study. For the fully documented procedures of developing the FLO-2D and EPA SWMM models, refer to Appendices C & D.

3.2 Calibration

As part of the development for the FLO-2D model, it was necessary to verify the response of the model using real historic storms. These storms were applied to the model using NEXRAD radar data adjusted to the rain gages located within the storm cell defined by the radar data. Based on the historical data recorded by the stream gage at Granite Reef Wash and McDowell Road, three storms were found to have data to calibrate the model:

- August 8, 2008
- August 22-23, 2012
- September 8, 2014

All of these events produced significant runoff as indicated by the stream gage data recorded for the storms.

After some review and testing, it was discovered that the NEXRAD data did not adequately capture the varying intensities of the summer convection storms which caused the calibration model to significantly underestimate flows during peak events. Storms with consistent rainfall intensities were found to be a more reliable source of data to calibrate. Of the three above storms, only the September 8th storm exhibited consistent rainfall intensities for extended periods of time. This was because the September storm originated from remnants of a hurricane instead of the traditional summer convection events like the August storms. As such, only the September storm was used to calibrate the model.

To verify the results of the storm event, two data sources were used: the first was the recorded flow data from the FCDMC's stream gage located along Granite Reef Wash at McDowell Road and the second was from high-water marks found in the field after the September storm event. Initially, the stream gage appeared to be an ideal data source but due to the backwater conditions produced by the downstream storm drain entrance at the north end of 84th Place, comparing flow rates was determined to not be a reliable verification metric. The gage-recorded depth, on the other hand, was found to be more suitable for comparisons since it was not skewed by the backwater effects.

The second source were measured high-water marks from the field. After the September event, the City contracted with a separate consultant to find and estimate the depth of flow at several locations throughout the watershed. The results of that task yielded two locations: one on 87th Street near Windsor Avenue and the other on 84th Place near Portland Street. When comparing to the results from FLO-2D, this data source proved to be more reliable than the stream gage and ultimately became the primary verification source for which to calibrate the model.

To adjust the FLO-2D model, only the limiting infiltration depth parameter was modified. Through a process of several model iterations, the limiting infiltration parameter was incrementally changed until the model produced a result that resembled the verification data. Once done, the new limiting infiltration parameter was applied to the final model runs for the study. Refer to Appendix C for further discussions and results of the calibration runs.

4.0 RESULTS

4.1 FLO-2D Analysis Results

As expected, most of the flow was confined to the streets as it routed through the Granite Reef Wash watershed. The following were observations of the surface flow:

- From the Arizona Canal to Chaparral Road, east-west streets capture flow and discharge to 86th Street. 86th Street is the primary conveyance corridor for this entire section of the watershed. Flow from SRPMIC collects along the Pima Road sound wall and enters the City of Scottsdale at McDonald Road and Chaparral Road.
- Between Chaparral Road and Indian School Road, there appears to be a shift of the primary flow path from 86th Street to the Pima Frontage Road. The largest shift occurs at Camelback Road where flow is diverted east towards Sells Drive which collects and conveys flow to the frontage road in an inverted crown street section. In addition to the primary flow path within the Pima Frontage Road, the alignments of 86th Street and 87th Street both convey significant flow.
- Between Indian School Road and Thomas Road, flow appears to concentrate in all of the north-south streets (Granite Reef Road, 85th Street, 86th Street, 87th Street and the Pima Frontage Road) in the north end of this section of the watershed. Then flow consolidates around Osborn Road to the alignments of 86th Street, 87th Street and the Pima Frontage Road. Eventually, all flow concentrates at Thomas Road and 87th Street which is the upper end of Granite Reef Wash.
- From Thomas Road to McKellips Road, all flow generally moves towards and concentrates in the Granite Reef Wash alignment. From there, flow remains in Granite Reef Wash and ultimately discharges to SRPMIC land south of McKellips Road.

The following table presents selected discharges throughout the watershed for each of the four modeled with this study.

Table 4-1 Selected Watershed Discharges

X-Sec No.	10-yr, 24-hr (cfs)	10-yr, 6-hr (cfs)	100-yr, 24-hr (cfs)	100-yr, 6-hr (cfs)	Location
4	43	46	86	93	McDonald Drive/86th Street
7	89	90	171	174	Jackrabbit Road/86th Street
9	65	64	115	115	Chaparral Road/86th Street
10*	27	26	79	72	Chaparral Road/Pima Road
13	21	19	37	35	Camelback Road/86th Street
14*	31	34	64	64	Camelback Road/87th Terrace
18	25	25	35	37	Indian School Road/86th Street
23*	4	4	30	32	Indian School Road/Pima Road
28	14	14	28	29	Osborn Road/86th Street

X-Sec No.	10-yr, 24-hr (cfs)	10-yr, 6-hr (cfs)	100-yr, 24-hr (cfs)	100-yr, 6-hr (cfs)	Location
30*	52	49	98	99	Osborn Road/87th Terrace
34	58	52	127	120	Thomas Road/86th Street
37*	108	94	212	208	Thomas Road/Pima Road
38*	161	145	364	351	Thomas Road/87th Street
45*	252	250	494	485	Oak Street/87th Street
54	333	317	648	624	McDowell Road/GRW
60*	363	336	684	649	Roosevelt St/Granite Reef Rd
65	361	333	566	544	McKellips Rd/GRW (Upstream)
66	246	240	286	282	McKellips Rd/GRW (Downstream)

*Includes storm drain flow

Based on the results in Table 4-1, the governing storm shifts from the 6-hour to 24-hour duration as flow moves south through the watershed. The north half of the watershed is generally the 6-hour event while the south half is the 24-hour event. With some exceptions, the shift generally occurs around Osborn Road for both the 10-year and 100-year storms.

The storm drains in Jackrabbit Road, Chaparral Road, Camelback Road and Indian School Road are shown to be very effective in diverting flow to Indian Bend Wash. In addition, the crowns of Chaparral Road and Indian School Road appear to block most of the flow from moving further south and forcing it into the storm drain inlets. The storm drains in 87th Street and 84th Place, within the Granite Reef Wash, have little effect on some of the larger flows due to their limited capacity. Table 4-2 shows the maximum discharges from the storm drain systems in the Granite Reef Watershed. Refer to Exhibit 5 in Appendix E for the storm drain locations.

Table 4-2 Storm Drain Outfall Discharges

Storm Drain	SWMM Outfall	10-yr, 24-hr (cfs)	10-yr, 6-hr (cfs)	100-yr, 24-hr (cfs)	100-yr, 6-hr (cfs)
McDonald Drive	EMDDOUTFALL	14	16	18	19
Jackrabbit Road	EJRIBWOUTFALL	78	78	157	157
Chaparral Road	ECHRIBWOUTFALL	100	97	167	168
Camelback Road	ECRIBWOUTFALL	25	25	40	41
Indian School Road	NEISRIBWOUTFALL/ SEISRIBWOUTFALL	75/83	72/85	134/143	137/148
87th Street	87STOUTFALL	76	82	71	81
Hayden Road (North)	SEMDRIBWOUTFALL	46	47	89	90
McDowell Road (West)	PJ2GRWMDR	38	33	76	70
McDowell Road (East)	PJ1GRWMDR	30	30	48	51
84th Place	GRROUTFALL	128	128	128	128
Hayden Road (South)	EMRIBWOUTFALL	25	26	44	50

A review of the depth results shows that some structures are impacted by the estimated 100-year storm. The majority of the impacted structures appear to be adjacent to the Granite Reef Wash corridor with the potential of experiencing some level of real damage. A comparison of finished floor elevations (FFE), not a part of this study, with the water surface elevation results would determine if structures are actually impacted or not.

Figure 4-1 Non-structural Property Damage

(Storm Date: 8/21/12)

Results of the FLO-2D analysis are presented in Appendix E in the following exhibits:

- **Exhibit 6** – 100-year, 24-hour results for depth, velocity and discharge
- **Exhibit 7** – 100-year, 6-hour results for depth, velocity and discharge
- **Exhibit 8** – 10-year, 24-hour results for depth, velocity and discharge
- **Exhibit 9** – 10-year, 6-hour results for depth, velocity and discharge
- **Exhibit 10** – Floodplain Cross-sections
- **Exhibit 11** – FLO-2D / FEMA Comparison

4.2 Comparison of Results

Since the previous 2008 Granite Reef Wash Drainage Study (Psomas) was a consolidation of all previous studies performed before it, there was only one HEC-1 model to compare results. Based on the locations identified in the HEC-1 model, floodplain cross-sections were placed in similar locations to directly compare results. The following represents corresponding locations captured in both models.

Table 4-3 FLO-2D Peak Discharge Comparison

X-Sec No.	Location	100-yr, 6-hr Peak (cfs)	
		TY Lin	Psomas
4	McDonald Drive/86th Street	93	283 (CG02)
5*	McDonald Drive/Pima Road	68	191 (DG06)
9	Chaparral Road/86th Street	115	751 (CF02)
10*	Chaparral Road/Pima Road	72	462 (CF07)
18	Indian School Road/86th Street	37	276 (CE02)
19	Indian School Road/87th Street	108	907 (CE03)
23*	Indian School Road/Pima Road	32	596 (CE09)
34	Thomas Road/86th Street	120	429 (CD02)
37*	Thomas Road/Pima Road	208	560 (CD09)
38*	Thomas Road/87th Street	351	1,637 (CD03)
45*	Oak Street/87th Street	485	1,752 (CC08)
54	McDowell Road/Granite Reef Wash	624	2,044 (CC03)
60*	Roosevelt Street/Granite Reef Road	649	2,092 (CB05)
65**	McKellips Road/Granite Reef Wash	544	2,207 (CB12)

*Includes storm drain flow
**Reduction in peak discharge is caused by a flow split, to the east, approximately 1300 feet downstream of Roosevelt Street at the upstream end of the existing concrete channel.

Overall, the results for the FLO-2D model are considerably lower than those estimated in the HEC-1 model from the previous study. There are several explanations for these differences:

- The FLO-2D model considers storage related to surface depressions (both retention and unintentional) and walls. The walls most likely have a metering effect on flow that slows the discharge into the streets.
- The infiltration for FLO-2D considers both rainfall and transmission losses where HEC-1 only considers rainfall.
- The SRPMIC lands were considered developed for the HEC-1 model and existing conditions for the FLO-2D model.
- HEC-1 tends to overestimate flows when using small subbasins. The HEC-1 model for this watershed used very small subbasins possibly causing the flows to be artificially high.
- The side streets along 87th Street south of Thomas Road appear to be acting as detention storage in the FLO-2D model reducing the amount of volume that can be conveyed.
- FLO-2D considers the storm drains in 87th Street, 84th Place and Granite Reef Road where the HEC-1 model does not.

5.0 REFERENCES

- Bentley Systems, Inc., *FlowMaster*, Version 8i, November 2009.
- Bentley Systems, Inc., *CulvertMaster*, Version 3.2, August 2008.
- *Design Standards & Policies Manual*, City of Scottsdale, January 2010.
- *Drainage Design Manual for Maricopa County, Arizona, Volume I – Hydrology*, Flood Control District of Maricopa County, August 2013.
- *Drainage Design Manual for Maricopa County, Arizona, Volume II – Hydraulics*, Flood Control District of Maricopa County, August 2013.
- ESRI, *ArcGIS,* Version 10.3, 2014.
- *Final Drainage Design Report – McDonald Drive – Pima Freeway - 90th Street to Indian School Road*, Alpha Engineers, Inc., January 1991.
- FLO-2D Software Inc., *FLO-2D*, Pro Model, 2017.
- *Granite Reef Wash Drainage Master Plan*, Entellus, Inc., July 2002.
- *Granite Reef Wash Drainage Study & Preliminary Design Improvements Project,* Psomas, March 2008.
- *Granite Reef Wash Floodplain Delineation Study,* Entellus, Inc., May 1997.
- *Lower Indian Bend Wash ADMS/P: Hydrology and Hydraulics Report,* Gavan & Barker, Inc., December 2017.
- Manifold Software Limited, *Manifold System*, Version 8.0, 2013.
- *Pima Freeway – 90th Street to Indian School Road – Final Drainage Report Amendment*, MK Centennial, May 1997.

APPENDIX A – Data Collection

Data Collection Log					
Item No.	Agency	Project Description	Project No.	Prepared by	Date
1	City of Scottsdale	87th Street Storm Drain (Phase II)	SD-7503	Capital Improvement Engineering	8/27/1976
2	City of Scottsdale	Traffic Bottlenecks, 85th Place Improvements, Roosevelt Street to McDowell Road	T 0703H	City of Scottsdale, Public Improvements	7/9/1992
3	City of Scottsdale	Pime Road Buffering, Thomas Road to indian School Road	S4702	BRW, Inc	2/5/1996
4	Salt River Project	Phase-2 Pipe Construction, LAT. 1.5 Arizona Canal, Sec 36, T2N, R4E	RD-11630	Water Engineering, PHX, AZ	5/1/1992
5	City of Scottsdale	Box culvert at Granite Reef Wash and McDowell Road	D-5503	Capital Engineering	7/15/1985
6	City of Scottsdale	Paving Improvement District/ 1966 Granite Reef Road (Roosevelt Street to McDowell Road)	P-6601	Williams & Ellis Consulting Engineers	4/1/1966
7	City of Scottsdale	Pima Road Buffering, Fillmore Road to McDowell Road	S4702	BRW, Inc	3/27/1996
8	City of Scottsdale	McDowell Road (Granite Reef Road to Hayden Road)		PRC Engineering	8/1/1986
9	City of Scottsdale	Granite reef wash Stabilization	F1705	Mathews Engineering and Architecture,Inc	12/16/1991
10	City of Scottsdale	Indian School Road, Drinkwater Blvd to PIMA Road	410S0308	Dibble & Associates Consulting Engineers	6/1/2006
11	City of Scottsdale	McDowell Road Street Improvements, Granite Reef to Pima Road	S1706	INCA Engineers, Inc.	3/6/1996
12	City of Scottsdale	Pime Road Buffering, Chaparral Road to McDonald Drive	S4702	BRW, Inc	5/15/1998
13	City of Scottsdale	Pime Road Buffering: Phase 1	S4703	BRW, Inc	6/17/1994
14	ADOT	Salt River Pima - Maricopa Indian community Sewer Lines 90th Street to Curry Road, Pima Freeway Loop 101, Maricopa County	RAM-600-1-346/ Tracs No. H4875 01 C	AZTEC Engineering	6/1/1998
15	City of Scottsdale	Irrigation Pipe Relocation of NE 100 +/- 18" CMP well side at "PUBELO SERENO" Lake pipe	SD-7236-6	N/A	3/26/1974
16	City of Scottsdale	PWD, Division of Enginnering	P-6821 - A, B, C, D	Subdeck Engineering CO.	5/21/1969
17	City of Scottsdale	Water System Modifications Contract No. 10, Pima Park Reservoirs and Pump Station	W - 9504	Grren & Hansen Engineers	9/20/1991
18	City of Scottsdale	Water System Modifications Contract No. 8, East Side Pipeline	W - 9502	Grren & Hansen Engineers	4/12/1991
19	City of Scottsdale	Offsite Improvement plan, Scottsdale Plams Apartments, 1221 N85th place, Scottsdale Arizona	177-DR-83	Advanced Engineering, Inc.	5/22/1984
20	City of Scottsdale	Scottsdale Trails/ Sewer and Water Plans	114-DR-83	W. N Walton & Associates, Landscape Architect/ Planner	3/8/1985
21	City of Scottsdale	PIMA Road (Thomas Road- Indian Bend Road)	P-6612	Earle V Miller Engineers	11/18/1968
22	City of Scottsdale	87th Street Storm Drain (Phase I: Channel Excavation)	SD-7503-C	Charles Bruning Company	12/5/1973
23	City of Scottsdale	Sewer Improvement District	S-7131	Hook, Rockwell & Zuendel	10/12/1972
24	ADOT	SR 101L Drainage Area Map (Princess Drive to SR 202L (RED MTN))	NON - FA/ Tracs No. H6936 01 C	AZTEC Engineering	9/1/2006
25	City of Scottsdale	Public Improvements (Large Water Meter Retrofitting)	W8590	Municipal Services Department (Capital Project Improvement)	5/1/1999
26	City of Scottsdale	Summer Field Unit 6 Paving plan	77.016	Sage Engineering corporation	11/20/1979
27	City of Scottsdale	Irvine Park Apartments (8521 E.McDowell)	N/A	Statwide Engineering Company	9/29/1983
28	City of Scottsdale	Water Plans for the trails at Scottsdale III	S-204-042-04	Wheeler.Brooks.Coffee, Inc. (WBC)	12/19/1979
29	City of Scottsdale	Water & Sewer (Quarter Section Map)	N/A	Scottsdale Geographic Information Systems	12/10/1999
30	City of Scottsdale	Roosevelt Street & Sunset Trail Paving Plans (Phase 1)	1272-4	Associated Engineers	8/25/1976
31	City of Scottsdale	Summer Field Unit 5 Paving plan	77.016	Sage Engineering corporation	11/20/1979
32	ADOT	NorthEast Outer loop (Double Tree Ranch Road)	600-1-702	The WLB group, Inc	6/26/1990
33	City of Scottsdale	Summer Field Unit 3 &4 Paving plan	WO NO: 109	VTN Engineers and Planners	9/18/1974
34	Salt River Project	Lat. 1.5 Arizona Canal - Sec 25 T2N R4E	2263	Keuffel & Esser Co., New York	3/8/1959
35	Salt River Project	Lat. 1.5 Arizona Canal - Sec 36 T2N R4E	2525	Eugene Dietzgen Co.	11/10/1959
36	Salt River Project	Lat. 1.0 Arizona Canal - Sec 25 T2N R4E	2584	Eugene Dietzgen Co.	3/23/1960
37	Salt River Project	Lat. 1.5 Arizona Canal - Sec 25 T2N R4E	2772	Eugene Dietzgen Co.	3/12/1962
38	Salt River Project	Lat. 1.0 Arizona Canal - Sec 36 T2N R4E	N/A	Eugene Dietzgen Co.	10/22/1971
39	Salt River Project	Lat. 1.5 Arizona Canal - Sec 25 T2N R4E	2-330 (TB-541)	Eugene Dietzgen Co.	1/3/1973
40	Salt River Project	Phase 2 pipe Installation (Lat. 1.5 Arizona Canal - Sec 36 T2N R4E)	RD-11630	Water Engineering, Inc	9/1/1996

APPENDIX B – FEMA Special Flood Hazard Areas

NOTES TO USERS

This map is for use in administering the Nation Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations tables in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Arizona State Plane Central zone (FIPSZONE 0202). The **horizontal datum** was NAD 83 HARN, GRS1980 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988 (NAVD 88). These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. Map users wishing to obtain flood elevations referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29) may use the following Maricopa County website application: http://www.fcd.maricopa.gov/Maps/gismaps/apps/gdacs/application/index.cfm

This web tool allows users to obtain point-specific datum conversion values by zooming in and hovering over a VERTCON checkbox on the layers menu on the left side of the screen. The VERTCON grid referenced in this web application was also used to convert existing flood elevations from NGVD 29 to NAVD 88.

To obtain current elevation, description, and/or location information for National Geodetic Survey bench marks shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242, or visit its website at http://www.ngs.noaa.gov. To obtain information about Geodetic Densification and Cadastral Survey bench marks produced by the Maricopa County Department of Transportation, please visit the Flood Control District of Maricopa County website at:
http://www.fcd.maricopa.gov/Maps/gismaps/apps/gdacs/application/index.cfm.

Base map information shown on this FIRM was derived from multiple sources. Aerial imagery was provided in digital format by the Maricopa County Department of Public Works, Flood Control District. The imagery is dated October 2009 to November 2009. Additional National Agricultural Imagery Program (NAIP) imagery was provided by the Arizona State Land Department (ALRIS) and is dated 2007. The coordinate system used for the production of the digital FIRM is State Plane Arizona Central NAD83 HARN, International Feet.

The **profile baseline** depicted on this map represents the hydraulic modeling baselines that match flood profiles in the FIS report. As a result of improved topographic data, the **profile baseline**, in some cases, may deviate significantly from the channel centerline or appear outside the SFHA.

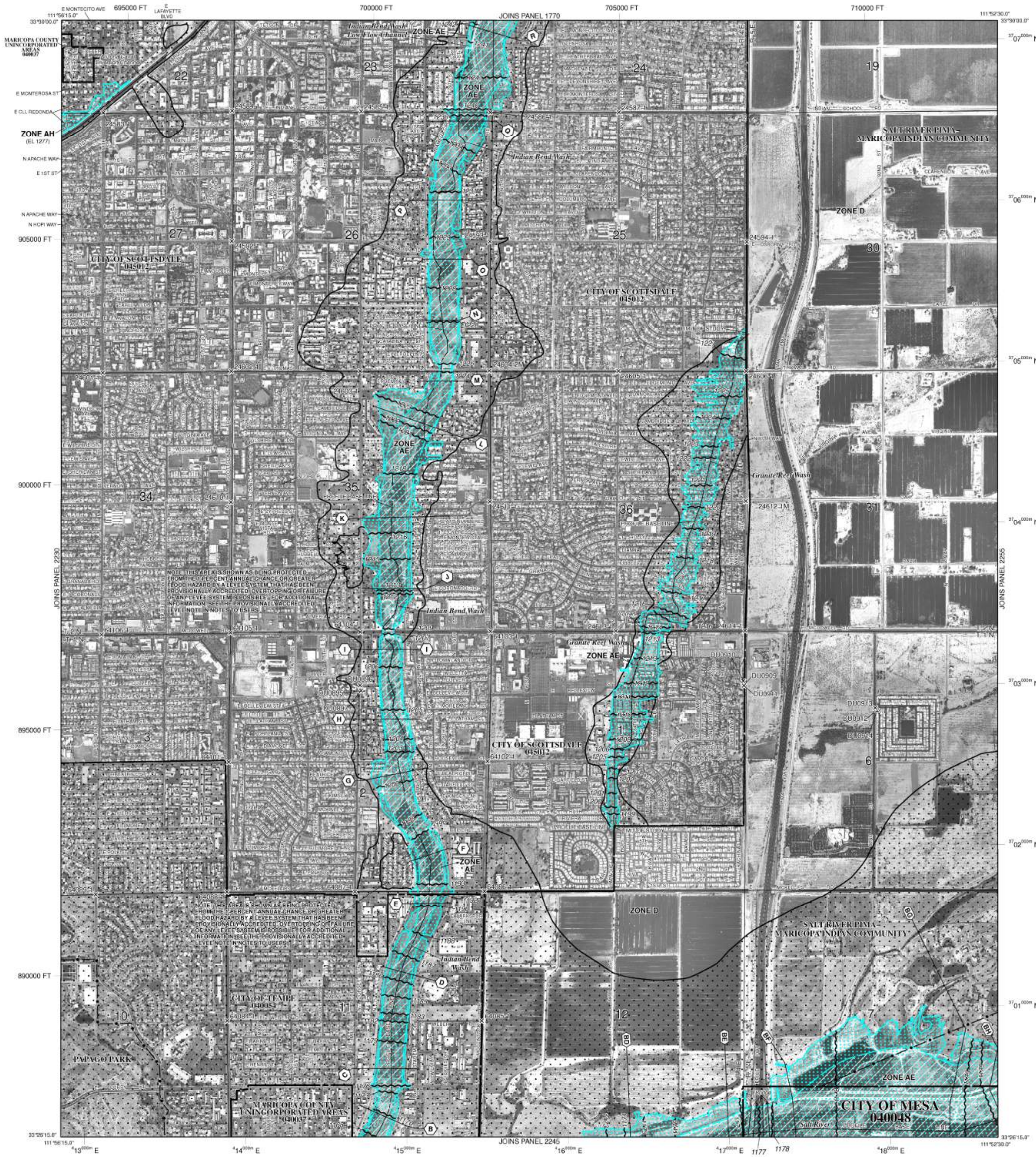
Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

For Information on available products associated with this FIRM, visit the **Map Service Center (MSC)** website at http://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, or digital versions of this map. Many of these products can be ordered or obtained directly from the website.

If you have **questions about this map,** how to order products, or the National Flood Insurance Program in general, please call the **FEMA Map Information eXchange (FMIX)** at **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/.

Provisionally Accredited Levee Notes to Users: Check with your local community to obtain more information, such as the estimated level of protection provided (which may exceed the 1-percent-annual-chance level) and Emergency Action Plan, on the levee system(s) shown as providing protection for areas on this panel. To maintain accreditation, the levee owner or community is required to submit the data and documentation necessary to comply with Section 65.10 of the NFIP regulations by June 25, 2011. If the community or owner does not provide the necessary data and documentation or if the data and documentation provided indicate the levee system does not comply with Section 65.10 requirements, FEMA will revise the flood hazard and risk information for this area to reflect de-accreditation of the levee system. To mitigate flood risk in residual risk areas, property owners and residents are encouraged to consider flood insurance and floodproofing or other protective measures. For more information on flood insurance, interested parties should visit the FEMA Website at http://www.fema.gov/business/nfip/index.shtm.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary
0.2% annual chance floodplain boundary
Floodway boundary
Zone D boundary
CBRS and OPA boundary
Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

~~ 513 ~~~~	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

(A)——(A)	Cross section line
(23)- - - -(23)	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
4275000mN	1000-meter Universal Transverse Mercator grid ticks, zone 12
6000000 M	5000-foot grid ticks: Arizona State Plane coordinate system, central zone (FIPSZONE 0202), Transverse Mercator
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
April 15, 1988
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
July 19, 2001 September 30, 2005
October 16, 2013 –to advance suffix, to add floodway, to change base flood elevations, to change floodway, to update corporate limits, to add roads and road names, to incorporate previously issued letters of map revision, to add base flood elevation, and to add special flood hazard areas.

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 1000'
500 0 1000 2000 FEET
300 0 300 600 METERS

NFIP
NATIONAL FLOOD INSURANCE PROGRAM

PANEL 2235L

FIRM
FLOOD INSURANCE RATE MAP
MARICOPA COUNTY, ARIZONA
AND INCORPORATED AREAS

PANEL 2235 OF 4425
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
MARICOPA COUNTY	040037	2235	L
MESA, CITY OF	040048	2235	L
SCOTTSDALE, CITY OF	045012	2235	L
TEMPE, CITY OF	040054	2235	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
04013C2235L

MAP REVISED
OCTOBER 16, 2013

Federal Emergency Management Agency

APPENDIX C – FLO-2D Model

APPENDIX C.1 – FLO-2D Development

C.1.0 METHODOLOGY

The two-dimensional analysis conducted for the Granite Reef Wash Hydrology Update was completed per the FCDMC's most current guidance for parameter development and modeling techniques. The current version of the FLO-2D Software (Pro Model – Build No. 16.06.16) was used for the 2D modeling. GIS platforms, ArcGIS 10.3 and Manifold System 8.0, were both utilized as preprocessors to develop the parameters for FLO-2D input files.

C.1.1 HYDROLOGY

Grid Area Boundaries

The watershed was delineated based on the most current aerial mapping and digital terrain data provided by the FCDMC. Since the study area is largely urbanized (with exception of SRPMIC lands), existing conditions are assumed to be similar to mapped conditions.

The Granite Reef Wash FLO-2D model was analyzed at a 15'x15' grid size to ensure there was enough detail to accurately represent flow patterning and discharges within the study area. A 100' buffer was added around the study area to ensure that the watershed boundaries were captured by the FLO-2D model.

Grid geometry data for the FLO-2D model area is contained within the **FPLAIN.DAT** and **CADPTS.DAT** files. Refer to electronic files included with this report.

Watershed Work Maps

Work maps for the Granite Reef Wash FLO-2D study area are included in Appendix E.1. The following maps provide the data inputs:

- **Exhibit 1: Precipitation Maps**
  - 1A: 100-yr, 24-hr Storm
  - 1B: 100-yr, 6-hr Storm
  - 1C: 10-yr, 24-hr Storm
  - 1D: 10-yr, 6-hr Storm
- **Exhibit 2: Elevations Map**
- **Exhibit 3: Land Characterization Map**
- **Exhibit 4: Soils Map**
- **Exhibit 5: Storm Drains, Hydraulic Structures and 1-D Channels Map**

Gage Data

One stream gage was located within the study area. The following gage was identified:

Table C.1-1 Stream Gage

Gage No.	Gage Type	Description	Location	Installed Date
4728	Stream	Granite Reef Wash	600 feet east of Granite Reef Road on McDowell Road	6/26/2007

The gage has a relatively short history of service with a limited record from which to calibrate the model.

Rainfall

Per the FCDMC's Drainage Design Manual, the NOAA Atlas 14, Precipitation-Frequency Atlas of the United States, Volume 1: Semiarid Southwest (Arizona, Southeast California, Nevada, New Mexico, Utah) was used to determine point depth rainfall parameters for the FLO-2D model. No other statistical parameters were used.

Four storm frequency and durations were used to analyze the study area (See Exhibits 1A through 1D, Appendix E):

Table C.1-2 Storm Event and Point Values

Storm Event	Minimum (in)	Maximum (in)
100-year, 24-hour	3.45	3.52
100-year, 6-hour	2.52	2.61
10-year, 24-hour	2.22	2.27
10-year, 6-hour	1.64	1.71

The isopluvial maps for Maricopa County indicate that rainfall is spatially varied over the study area. In the upper areas of the watersheds, rainfall depths were observed to be higher near the Arizona Canal than the areas near the Salt River. This was observed for all storm events. See Table C.1-2 above for the maximum and minimum point rainfall values for each storm event.

Each grid element was assigned a rainfall depth based on its corresponding location. FCDMC provided the appropriate ESRI ASCII Grid data file for each storm event. These data files were then used to assign each grid element, through GIS software, a rainfall depth value.

Two storm distributions, obtained from FCDMC's Drainage Design Manual, were used for this study: the 6-hour local storm and the 24-hour general storm. Both were analyzed with their respective storm frequencies to determine which will produce the greatest peak discharge. Pattern No. 1 was the only pattern applied to the study area for the 6-hour storm because, depending on where flows are estimated in the watershed, the contributing area is different. So to prevent the underestimation of peak flows, the most conservative pattern was used to temporally distribute rainfall. The SCS Type II distribution was applied to the 24-hour storms regardless of sub-watershed size. All rainfall data for the FLO-2D model is contained within the **RAIN.DAT** file.

There is no practical method to perform depth-area reduction within FLO-2D and still have meaningful results for both small and large watersheds. For this reason, the actual NOAA Atlas 14 point rainfall values were assigned to each grid element, which is accurate for small watersheds and conservative for large watersheds.

Elevations

Grid elevations were obtained from the aerial mapping that was performed as part of the FCDMC's Lower Indian Bend Wash ADMS/P. A Triangulated Irregular Network (TIN) surface was developed from this mapping capturing the limits of the study area.

Elevations were assigned to each grid element within the model to characterize the topography of the study area. Since the grid elements can only be assigned a single elevation, an average for the 15'x15' grid area was determined. Due to the process of surveying and mapping to properly account for many features in the field, excessive points are sometimes used to ensure surface elements are captured correctly. This tends to skew the results when averaging all points falling within an individual grid element taken from a Digital Terrain Model (DTM). This requires the surface to be "sampled" before assigning elevations to the grid elements.

To "sample" the surface, points were interpolated from the TIN developed for this study. A Digital Elevation Model (DEM) format (ESRI ASCII Grid) was chosen to represent the sampled surface. Guidance from the FCDMC suggested using a grid size of at least 25% of the proposed model grid size. So based on a 15'x15' grid element, a 3-foot DEM grid size was used for the sampled surface. Once completed, the DEM was overlaid with the model grid elements and the points falling within the respective grid elements were then averaged to produce the elevation for each element. See Exhibit 2 for the elevations map.

Elevation data for the FLO-2D model can be found in either the **FPLAIN.DAT** file or the **TOPO.DAT** file.

Roughness Coefficients

Manning's n-value were assigned to each model grid element based on the "specific" corresponding land surface character types within the project area. Land surface characterization for the model was based on specific land surface types such as desert rangeland, concrete, buildings, etc. To assign the n-values, a polygon land surface characterization shapefile was provided by the FCDMC for the study area (see Exhibit 3, Appendix E). This shapefile was then overlaid with the grid element polygons to create an area-weighted average n-value for each element. For grid elements falling on two or more polygons of different n-values, an area-weighted average value was assigned to the grid to represent the transition. The area-weighted averaging was performed using GIS software.

The following was used in this FLO-2D model:

Table C.1-3 FLO-2D Roughness Coefficients

Type	Description	n-value
Agricultural	Farm fields	0.060
Asphalt	Streets and parking lots	0.020
Buildings	Physical structures that are flow obstructions	0.024
Concrete	Sidewalks, curb, patios	0.016
Shade Structures	Parking covers and canopies	0.035
Unpaved Road	Gravel and dirt roadways and shoulders	0.026
Urban Bare Ground	Urban Bare Ground	0.035
Urban High Vegetation	Trees	0.065
Urban Low Vegetation	Lawns and low shrubs	0.045
Water	Lakes, canals and ponds	0.040

Manning's n-value data for the FLO-2D model can be found in either the **FPLAIN.DAT** file or the **MANNINGS_N.DAT** file.

Abstraction and Infiltration

The Green-Ampt method was used to estimate losses associated with initial abstraction and infiltration. Unlike HEC-1, FLO-2D considers losses through rainfall as well as transmission through the model. When compared to HEC-1, which applies losses only to rainfall, FLO-2D tends to produce higher estimates for Green-Ampt.

Data to estimate the loss was obtained from two sources:

- Natural Resources Conservation Service (NRCS) soils shapefile for the State of Arizona (April 2010)
- FCDMC's land surface characterization shapefile for the Lower Indian Bend Wash ADMS/P

The following loss parameters were obtained from the above data sources:

Table C.1-4 FLO-2D Soils Data

Map Unit No.	Description	XKSAT (in/hr)
Am	Alluvial land	1.2
23	Contine clay	0.01
22, Co	Contine clay loam	0.04

Map Unit No.	Description	XKSAT (in/hr)
57	Gilman clay loam	0.06
Gm	Gilman loam	0.25
55	Gilman loams	0.27
LaA	Laveen loam, 0 to 1 percent slopes	0.25
LaB	Laveen loam, 1 to 3 percent slopes	0.25
79	Mohall clay	0.02
77	Mohall clay loam	0.05
Mv	Mohall loam	0.25
Pm	Pimer clay loam	0.04
PnA	Pinal gravelly loam, 0 to 1 percent slopes	0.4
RiA	Rillito gravelly loam, 0 to 1 percent slopes	0.4
RiB	Rillito gravelly loam, 1 to 3 percent slopes	0.4
101	Rillito loam, 0 to 3 percent slopes	0.28
110	Suncity-Cipriano complex, 1 to 7 percent slopes	0.13
Vf	Vint loamy fine sand	1.2

Table C.1-5 FLO-2D Land Surface Characterization Data

Type	Description	IA (in)	RTIMP (%)	InitSat
Agricultural	Farm fields	0.50	0	Normal
Asphalt	Streets and parking lots	0.05	95	Normal
Buildings	Flow obstructions	0.05	95	Normal
Concrete	Sidewalks, curb, patios	0.05	98	Normal
Shade Structures	Parking covers and canopies	0.05	98	Normal
Unpaved Road	Gravel and dirt roads	0.10	50	Dry
Urban Bare Ground	Urban Bare Ground	0.20	0	Dry
Urban High Vegetation	Trees	0.10	0	Normal
Urban Low Vegetation	Lawns and low shrubs	0.10	0	Normal
Water	Lakes, canals and ponds	0.00	100	Saturated

FLO-2D requires a minimum surface detention value (TOL) to simulate surface depression storage and reduce model run times by not performing calculations at unreasonably shallow depths. This value provides some level of IA for the model. Because of this, IA in the table above must be adjusted to account for TOL. Since TOL cannot be zero, the minimum equivalent IA is 0.05 inches. TOL was then set to 0.004 (0.05 in) and 0.05 was subtracted from the above IA for each land type (except for 'Water' which remained at 0.00).

The model grid elements were overlaid with both shapefiles and assigned area-weighted average values for the loss parameters. All were area-weighted similar to the roughness coefficients with the exception of XKSAT. XKSAT was averaged by the following equation:

$$\overline{XKSAT} = 10^{\left(\frac{\sum A_i \log(XKSAT_i)}{A_{GE}}\right)}$$

Where:

$XKSAT_i$ is obtained from the NRCS shapefile
A_i is the subarea within the grid element associated with $XKSAT_i$
A_{GE} is the total grid element area

PSIF and DTHETA were determined based on Figure 4.3 in the FCDMC's Hydrology Manual using the composite XKSAT and InitSat values for each grid element. XKSAT was not adjusted for vegetation cover in accordance with FCDMC guidance for two-dimensional models.

Since infiltration in FLO-2D considers rainfall and transmission losses, excessive infiltration can occur in pervious areas of the model if the Green-Ampt parameters are not accurate. Accurate Green-Ampt parameters for specific soils are obtained through physical measurements, or model calibration to measured flow rates and volumes. When such data is not available or in the early stages of model development, FCDMC's policy is to limit the infiltration depth within the model. Following this practice, a limiting soil storage depth of 4 inches was applied to each grid. This has the effect of stopping infiltration computations when the wetting front reaches a depth of 4 inches. Modifications were applied to this variable during the calibration process to match the results with collected observed data.

Infiltration data for the FLO-2D model can be found in the **INFIL.DAT** file.

Area Reduction Factors

Area reduction factors (ARFs) reduce the available storage on a grid element. This helps characterize houses, shopping centers, office buildings or any other facility that prevents flows from occupying grid elements. ARFs were applied to the grids as a factor where 0 meant fully open while 1 meant completely blocked.

To estimate an ARF value for each grid element, the Land surface characterization shapefile (previously used for the roughness coefficient and infiltration) was used since 'Buildings' were already characterized as polygons. These building polygons were given a value of 1 and overlaid with the grid elements in GIS to produce area-weighted average values (See Exhibit 3, Appendix E).

Since FLO-2D only requires ARF values greater than zero in the **ARF.DAT** file, only grid elements with an associated ARF value greater than zero were included in the file. All other values (width reduction factors - WRFs) remained zero.

Levees

In this model, levees were used to characterize walls, specifically property, development and sound barrier walls that obstruct flow. Levee data was obtained from the FCDMC in the form of breaklines within a DXF file and converted into a GIS “wall” shapefile. This shapefile was then compared with current aerial photography to verify location and necessity. Many walls were assumed to not have any effect on drainage patterns and were removed from the shapefile. This included but was not limited to short decorative walls, trash dumpster walls and walls around pool pumps. This effort helped reduce superfluous data which improved model runtimes and efficiency.

Once the wall shapefile was revised, it was converted into a data file recognizable by the FLO-2D Grid Developer System (GDS) and imported into the program as levees. The levees were then refined further in the GDS to ensure flow was not being incorrectly trapped or blocked in the model. The levees were then saved to the **LEVEE.DAT** file created by the GDS.

As part of the verification effort, top of wall elevations were checked against the grid elevations. A substantial number of wall elevations were found to be completely erroneous leading to the elevation data to be considered unusable. To correct this, all of the levee elevations were set to the grid elevation and then raised six feet. Six feet was chosen because it represented the typical wall height in the watershed.

C.1.2 HYDRAULICS

Hydraulic Structures

For this study, hydraulic structures were used to represent both culverts and simple storm drains (one and two inlet systems). Rating tables based on depth versus discharge were developed for each hydraulic structure using Bentley’s CulvertMaster and FlowMaster programs. Each were assumed to be inlet control since the FLO-2D program already compares the upstream and downstream water surface elevations and adjusts the rating table to account for outlet conditions.

Two approaches were taken to develop the rating tables for the hydraulic structures. The first approach was the typical culvert headwall type. CulvertMaster was used to develop rating tables based on pipe size and material assuming inlet control. Once developed, the rating tables were then applied to the corresponding hydraulic structures with the same size and material.

The second approach was the street curb inlet type. This required two separate rating tables to be developed. FlowMaster was used to create the first rating table for the inlet itself and CulvertMaster was used to create the rating table for the connector pipe outlet in the catch basin. The two rating tables were then combined into a single table. The composite rating assumed the curb inlet would initially govern until the connector pipe began to restrict flow. From there, the connector pipe was assumed for the higher depths in the rating table.

In some cases, two inlets would share the same outlet. This only occurred for the inlets along McDonald Drive between 86th Street and Pima Road. Typically, the D-line function would be used to limit the flow at the outlet but it was not needed for these simple storm drains. The flow reaching these inlets was small and all of the inlets discharged to the same linear basin on the south side of McDonald Drive. It was assumed that the results would be the same regardless of whether the D-line function was used or not.

In addition, rating tables were developed for the two culvert entrances in the SWMM model. One at the north end of 84th Place and the other at the northwest corner of Roosevelt Street and 84th Street within a detention basin on General Dynamics' property. These were developed with the same process as the culverts utilizing CulvertMaster.

The culverts and simple storm drain inlets with their associated rating tables can be found in the **HYSTRUC.DAT** file. The SWMM culvert entrance rating tables are located in the **SWMMFLORT.DAT** file. Refer to Exhibit 5 for locations hydraulic structures and Appendix C.2 for the rating tables and CulvertMaster/FlowMaster output.

Storm Drains

See Appendix D.1 for discussion on SWMM model development.

C.1.3 MODEL ADJUSTMENTS

After reviewing the original sampled grid elevations for the study area, it was apparent that certain grids needed to be adjusted to provide more detail due to new development, existing channels that were not represented correctly, modification of streets to provide adequate capacity and other modifications to correctly route stormwater runoff. Grid elevations, Manning's n-values and Area Reduction Factors (ARF's) were modified and documented using a 'Tracked Changes' shapefile. The 'Tracked Changes' shapefile includes the original grid elevations, n-values and ARF values as well as the modified values. Descriptions were added to modified grids to document the changes made. The 'Tracked Changes' shapefile is provided as part of this submittal in the electronic files.

The following are significant changes made to the model:

Rainfall

When the model grid was originally developed, the approach was to model the entire Granite Reef Wash Watershed to the outfall at the Salt River. Due to limited or outdated surface date south of McKellips Road, the model was truncated to just south of McKellips Road but with enough context to not artificially impact the backwater conditions for the Granite Reef Wash culvert across McKellips Road. This created a situation where the grids in the south end of the model grid were accepting rainfall but there was no grid data to properly convert the rainfall to runoff.

It was decided to the keep the unused grids for the potential use of the model in future studies or design projects. Therefore, all of the unused grids were set to zero so no runoff would be produced, in effect, turning the grid "off." This was also applied to the grids within the right-of-way of the Loop 101 Freeway. Refer to the section below on the Loop 101 Freeway.

This approach of turning off the rainfall for the unused grids was applied to all of the model runs in this study except for the calibration run. Due to size and difficulty of modifying the calibration rainfall file (**RAINCELL.DAT**), it was decided that the initial abstraction (IA) values would be adjusted in the grids instead of modifying the rainfall. By raising the IA, the grids would capture all of the rainfall and thus prevent any runoff from the grid. To be conservative, the IA was set to 5 inches for the unused grids to ensure no runoff would be produced.

Ponded Areas

Adjustments to the grid Manning's n-values were made for the retention/detention areas in order to reduce surging within ponded areas. The following basic guidelines were used when assigning new n-vales to the retention/detention areas:

Table C.1-6 n-value Adjustments in Ponded Areas

Ponding Depth (ft)	n-value
0 to 3	No Adjustment
3 to 6	0.05
6 to 8	0.08
8 to 10	0.10
10 and up	0.20

For example, the Manning's n-value of 0.20 was applied to three grids in an offline retention basin adjacent to Granite Reef Wash (grid numbers 636258, 636670 and 637082) where significant surging was occurring. The surrounding n-values were then changed to 0.10 to also help with surging. The larger n-values stabilized the basin and eliminated the surging.

Loop 101 Freeway

The Loop 101 Freeway that borders the study area on the east was designed to convey the upstream offsite runoff, whose drainage area lies east of the freeway. The freeway was also designed to capture the onsite runoff, without water discharging to the Granite Reef Wash watershed. Therefore, to separate the freeway runoff from the Granite Reef Wash watershed, a levee was applied along the entire western right-of-way line of the Freeway. To prevent runoff from being generated on the Freeway grids, which would cause runoff to pond behind the levee, the same procedure applied south of McKellips Road was used. This consisted of setting the rainfall on the freeway grids (the grids east of the levee) to zero for the four study storms and increasing the IA to 5 inches in the calibration model.

C.1.4 MODEL CALIBRATION

As mentioned in Section 3.2, the September 8, 2014 storm was used to calibrate the FLO-2D models. To accomplish this, a calibration model was created that utilized the September 8th rainfall (RAINCELL.DAT), while keeping all the other input parameters (grid elevations, soils and land use data, levees, etc..) the same. The resulting depths of flow from the calibration model were compared to the stream gage depth in Granite Reef Wash at McDowell Road and to the high-water mark elevations obtained along 87th Street and 84th Place. Refer to Appendix C.3 for the detailed location and documentation of the September 8, 2014 storm high-water mark elevations.

Initially, the calibration model results did not compare favorably with the stream gage data or the observed high-water marks. To calibrate the model, a trial-and-success approach was used that incrementally adjusted the limiting infiltration depth and compared the model results to the observed data. This process was followed multiple times until the calibration model results compared favorably with the observed water surface elevations. Refer to Figure C.1-1 for the calculated model depth hydrograph comparison to the measured depth at the McDowell Road gage. The gage, indicated by the blue dashed line in the figure below, is located on the upstream end of the culvert crossing McDowell Road. The red line represents the difference between the X-Sec 53 (upstream of the culvert) water surface elevation and the thalweg elevation of the TIN surface at the same location.

Figure C.1-1 Stream Gage at McDowell Road and Granite Reef Wash

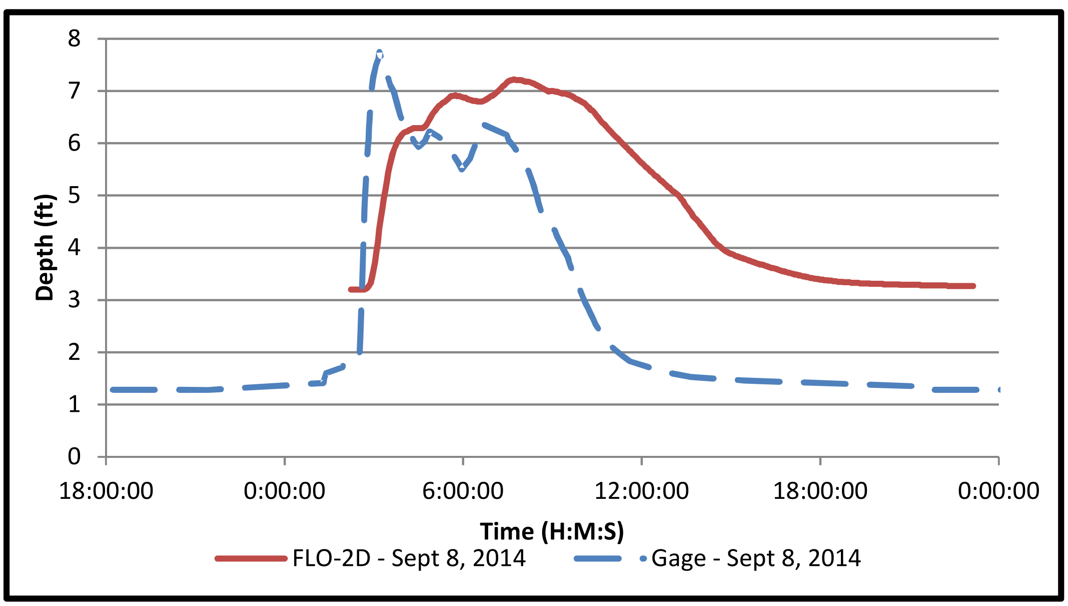


Table C.1-7 below shows a comparison of the calculated vs. observed high-water mark elevations on 87th Street and 84th Place. Refer to Exhibits 12A and 12B for the location of the high-water marks and the stream gage.

Table C.1-7 High-Water Mark Comparison

Location	Observed High-Water Mark Elevation	Calculated FLO-2D Water Surface Elevation
87th Street & Windsor Avenue	1222.24	1222.76
84th Place & Portland Street (North)	1208.26	1208.63
84th Place & Portland Street (South)	1207.61	1208.37

The calibration effort resulted in a limiting infiltration depth of 2-inches. As can be seen in the table above, a 2-inch limiting infiltration depth produced reasonable results that are 0.4 to 0.8 feet higher than the observed/measured high water elevations; indicating that the model provides a somewhat conservative prediction of flood flows. The 2-inch limiting infiltration depth was applied to all four of the study models.

APPENDIX C.2 – Hydraulic Structures

GRANITE REEF WASH

APPENDIX C.2 EXHIBIT

HYDRAULIC STRUCTURE LOCATION MAP

Hydraulic Structures

Name	Size	Inflow Grid(s)	Outflow Grid
MCDGRW	1- 12' X 8' RCB	527400	530824
SRPGRW	1- 13' X 7.5' RCB	638737	642512
MCKGRW	2 - 8' X 4' RCB	674255	677648
86THST1	6' CO, 15" SD	57389	60490
86THST2	6' CO, 15" SD	57391	60490
MCDONALD1	3' CO, 18" SD	58237	60492
MCDONALD2	3' CO, 18" SD	58243	60494
MCDONALD3	3' CO, 15" SD	58533(A), 59659(B)	60221
MCDONALD4	3' CO, 15" SD	58542	60511
MCDONALD5	3' CO, 15" SD	58283(A), 59691(B)	60534
MCDONALD6	3' CO, 15" SD	58585(A), 59430(B)	60834
MCDONALD7	3' CO, 15" SD	58606(A), 59731(B)	60574
RIVIERADR	2 - 12" SD	639149	643350
GARFIELDST1	3 - 35" x 24" CMP	605918	607978
ROOSEVELTCIR	1 - 42" x 30" CMP	627303	630622
LATHAMST	3' CO, 18" SD	595178	593519
PORTLANDST	3 - 24" CMP	596914	598976
87THPLBIKEPATH	3 - 24" CMP	635189	636834
GARFIELDST2	3' CO, 18" SD	610837	614936
AMELIAAVE	3' CO, 18" SD	264696	264348
PIMADITCH1	1 - 24" CMP	55797	56929
PIMADITCH2	1 - 24" RCP	57493	60588
PIMADITCH3	1 - 24" CMP	72774	73591
PIMADITCH4	1 - 24" RCP	105923	108091
PIMADITCH5	1 - 19" x 30" RCP	118101	119181
PIMADITCH6	1 - 24" RCP	128625	131584
PIMADITCH7	1 - 24" RCP	140999	143689
PIMADITCH8	1 - 24" RCP	150951	187284
PIMADITCH9	1 - 24" RCP	257926	261499
PIMADITCH10	1 - 18" x 40" CMP	263998	266140
PIMADITCH11	1 - 24" RCP	322883	324327
PIMADITCH12	1 - 30" CMP	332192	333960
PIMADITCH13	1 - 18" RCP	379947	414945
I3GRR84PLL*	1 - 48" RCP	557549	-
I3CP2GRR*	1 - 18" RCP	600035	-

*These are culvert entrances to the storm drain system. The rating tables for theses inlets were devloped with the hydraulic structures shown in this exhibit. The rating tables for these culvert entrances were applied to the SWMM model. Refer to Appendix D for the development of the SWMM model.

Hydraulic Structures: Rating Tables

MCDGRW (527400)		SRPGRW (638737)		MCGRW (674255)	
Depth (ft)	Discharge (cfs)	Depth (ft)	Discharge (cfs)	Depth (ft)	Discharge (cfs)
0.00	0.00	0.00	0.00	0.00	0.00
1.00	28.84	0.20	2.64	0.10	1.08
2.00	84.07	0.40	7.61	0.20	3.07
3.00	155.86	0.60	14.04	0.30	5.64
4.00	240.82	0.80	21.64	0.40	8.68
5.00	337.17	1.00	30.25	0.50	12.13
6.00	443.72	1.20	39.75	0.60	15.94
7.00	559.51	1.40	50.07	0.70	20.09
8.00	683.75	1.60	61.15	0.80	24.54
9.00	816.27	1.80	72.93	0.90	29.29
10.00	956.24	2.00	85.38	1.20	45.09
11.00	1103.38	2.20	98.47	1.40	56.82
12.00	1231.61	2.40	112.16	1.60	69.42
		2.60	126.44	1.80	82.84
		2.80	141.27	2.00	97.02
		3.00	156.64	2.20	111.93
		3.20	172.54	2.40	127.54
		3.40	188.94	2.60	143.81
		3.60	205.84	2.80	160.72
		3.80	223.23	3.00	178.24
		4.00	241.08	3.20	196.36
		4.20	259.38	3.40	215.05
		4.40	278.14	3.60	234.30
		4.60	297.33	3.80	254.10
		4.80	316.95	4.00	274.42
		5.00	336.99	4.20	295.25
		5.20	357.44	4.40	316.59
		5.40	378.29	4.60	337.75
		5.60	399.54	4.80	351.02
		5.80	421.17	5.00	363.81
		6.00	443.19	5.20	376.16
		6.20	465.56	5.40	388.12
		6.40	488.31	5.60	399.72
		6.60	511.40	5.80	410.99
		6.80	534.86	6.00	421.97
		7.00	558.68	6.20	432.66
		7.20	582.84	6.40	443.10
		7.40	607.33	6.60	453.29
		7.60	632.17	6.80	463.27
		7.80	657.33	7.00	473.03
		8.00	682.83	8.00	519.09
		9.00	815.06	9.00	561.39
		10.00	955.03	10.00	600.71
		11.00	1101.95		
		12.00	1232.18		

Hydraulic Structures: Rating Tables

86THST1 (57389) & 2 (57391)		MCDONALD1 (58237)		MCDONALD2 (58243)	
Depth (ft)	Discharge (cfs)	Depth (ft)	Discharge (cfs)	Depth (ft)	Discharge (cfs)
0.00	0.00	0.00	0.00	0.00	0.00
0.20	1.00	0.08	0.03	0.08	0.03
0.28	2.00	0.10	0.13	0.10	0.13
0.35	3.00	0.13	0.29	0.13	0.29
0.41	4.00	0.17	0.51	0.17	0.51
0.44	4.57	0.21	0.78	0.21	0.78
0.47	5.15	0.24	1.10	0.24	1.10
1.47	5.49	0.28	1.47	0.28	1.47
2.47	5.83	0.32	1.88	0.32	1.88
3.47	6.15	0.36	2.33	0.36	2.33
4.47	6.45	0.41	2.83	0.41	2.83
		0.45	3.37	0.45	3.37
		0.58	3.93	0.58	3.93
		0.75	4.53	0.75	4.53
		0.96	5.16	0.96	5.16
		1.20	5.79	1.20	5.79
		1.47	6.43	1.47	6.43
		1.76	7.05	1.76	7.05
		1.95	7.43	1.95	7.43

Hydraulic Structures: Rating Tables

MCDONALD3A (58533) & B (59659)		MCDONALD4 (58542)		MCDONALD5A (58283) & B (59691)	
Depth (ft)	Discharge (cfs)	Depth (ft)	Discharge (cfs)	Depth (ft)	Discharge (cfs)
0.00	0.00	0.00	0.00	0.00	0.00
0.08	0.03	0.08	0.03	0.08	0.03
0.10	0.13	0.10	0.13	0.10	0.13
0.13	0.29	0.13	0.29	0.13	0.29
0.17	0.51	0.17	0.51	0.17	0.51
0.21	0.78	0.21	0.78	0.21	0.78
0.24	1.10	0.24	1.10	0.24	1.10
0.28	1.47	0.28	1.47	0.28	1.47
0.32	1.88	0.32	1.88	0.32	1.88
0.36	2.33	0.36	2.33	0.36	2.33
0.41	2.83	0.41	2.83	0.41	2.83
0.45	3.37	0.45	3.37	0.45	3.37
0.58	3.93	0.58	3.93	0.58	3.93
0.75	4.53	0.75	4.53	0.75	4.53
0.96	5.16	0.96	5.16	0.96	5.16
1.20	5.79	1.20	5.79	1.20	5.79
1.47	6.43	1.47	6.43	1.47	6.43
1.76	7.05	1.76	7.05	1.76	7.05
1.95	7.43	1.95	7.43	1.95	7.43

Hydraulic Structures: Rating Tables

MCDONALD6A (58585) & B (59430)		MCDONALD7A (58606) & B (59731)		RIVIERADR (639149)	
Depth (ft)	Discharge (cfs)	Depth (ft)	Discharge (cfs)	Depth (ft)	Discharge (cfs)
0.00	0.00	0.00	0.00	0.00	0.00
0.08	0.03	0.08	0.03	0.10	0.06
0.10	0.13	0.10	0.13	0.20	0.21
0.13	0.29	0.13	0.29	0.30	0.47
0.17	0.51	0.17	0.51	0.40	0.81
0.21	0.78	0.21	0.78	0.50	1.23
0.24	1.10	0.24	1.10	0.60	1.72
0.28	1.47	0.28	1.47	0.70	2.28
0.32	1.88	0.32	1.88	0.80	2.89
0.36	2.33	0.36	2.33	0.90	3.55
0.41	2.83	0.41	2.83	1.00	4.21
0.45	3.37	0.45	3.37	1.10	4.86
0.58	3.93	0.58	3.93	1.20	5.36
0.75	4.53	0.75	4.53	1.30	5.42
0.96	5.16	0.96	5.16	1.40	5.42
1.20	5.79	1.20	5.79	1.50	5.42
1.47	6.43	1.47	6.43	1.60	5.43
1.76	7.05	1.76	7.05	1.70	5.44
1.95	7.43	1.95	7.43	1.80	5.46
				1.90	5.49
				2.00	5.52
				2.10	5.55
				2.20	5.59
				2.30	5.63
				2.40	5.67
				2.50	5.70
				2.60	5.74
				2.70	5.78
				2.80	5.82
				2.90	5.86
				3.00	5.90

Hydraulic Structures: Rating Tables

GARFIELDST1 (605918)		ROOSEVELTCIR (627303)		LATHAMST (595178)	
Depth (ft)	Discharge (cfs)	Depth (ft)	Discharge (cfs)	Depth (ft)	Discharge (cfs)
0.00	0.00	0.00	0.00	0.00	0.00
0.10	0.20	0.10	0.07	0.08	0.03
0.20	0.83	0.20	0.31	0.10	0.13
0.30	1.85	0.30	0.69	0.13	0.29
0.40	3.18	0.40	1.20	0.17	0.51
0.50	4.79	0.50	1.82	0.21	0.78
0.60	6.65	0.60	2.54	0.24	1.10
0.70	8.73	0.70	3.35	0.28	1.47
0.80	11.00	0.80	4.25	0.32	1.88
0.90	13.45	0.90	5.22	0.36	2.33
1.00	16.02	1.00	6.25	0.41	2.83
1.10	18.73	1.10	7.35	0.45	3.37
1.20	21.53	1.20	8.50	0.58	3.93
1.30	24.38	1.30	9.70	0.75	4.53
1.40	27.25	1.40	10.94	0.96	5.16
1.50	30.12	1.50	12.20	1.20	5.79
1.60	32.93	1.60	13.49	1.47	6.43
1.70	35.65	1.70	14.78	1.76	7.05
1.80	38.20	1.80	16.08	1.95	7.43
1.90	40.50	1.90	17.36		
2.00	42.43	2.00	18.62		
2.10	43.77	2.10	19.83		
2.20	44.13	2.20	20.98		
2.30	44.13	2.30	22.04		
2.40	44.13	2.40	22.97		
2.50	44.13	2.50	23.72		
2.60	44.19	2.60	24.18		
2.70	44.36	2.70	24.25		
2.80	44.53	2.80	24.25		
2.90	44.72	2.90	24.30		
3.00	44.93	3.00	24.37		

Hydraulic Structures: Rating Tables

PORTLANDST (596914)		87THPLBIKEPATH (635189)		GARFIELDST2 (610837)	
Depth (ft)	Discharge (cfs)	Depth (ft)	Discharge (cfs)	Depth (ft)	Discharge (cfs)
0.00	0.00	0.00	0.00	0.00	0.00
0.10	0.09	0.10	0.09	0.08	0.03
0.20	0.39	0.20	0.39	0.10	0.13
0.30	0.88	0.30	0.88	0.13	0.29
0.40	1.56	0.40	1.56	0.17	0.51
0.50	2.42	0.50	2.42	0.21	0.78
0.60	3.45	0.60	3.45	0.24	1.10
0.70	4.63	0.70	4.63	0.28	1.47
0.80	5.97	0.80	5.97	0.32	1.88
0.90	7.45	0.90	7.45	0.36	2.33
1.00	9.04	1.00	9.04	0.41	2.83
1.10	10.75	1.10	10.75	0.45	3.37
1.20	12.54	1.20	12.54	0.58	3.93
1.30	14.41	1.30	14.41	0.75	4.53
1.40	16.33	1.40	16.33	0.96	5.16
1.50	18.27	1.50	18.27	1.20	5.79
1.60	20.21	1.60	20.21	1.47	6.43
1.70	22.10	1.70	22.10	1.76	7.05
1.80	23.90	1.80	23.90	1.95	7.43
1.90	25.53	1.90	25.53		
2.00	26.90	2.00	26.90		
2.10	27.81	2.10	27.81		
2.20	27.96	2.20	27.96		
2.30	27.96	2.30	27.96		
2.40	28.02	2.40	28.02		
2.50	28.19	2.50	28.19		
2.60	28.37	2.60	28.37		
2.70	28.56	2.70	28.56		
2.80	28.75	2.80	28.75		
2.90	28.95	2.90	28.95		
3.00	29.15	3.00	29.15		

Hydraulic Structures: Rating Tables

AMELIAAVE (264696)		PIMADITCH1 (55797)		PIMADITCH2 (57493)	
Depth (ft)	Discharge (cfs)	Depth (ft)	Discharge (cfs)	Depth (ft)	Discharge (cfs)
0.00	0.00	0.00	0.00	0.00	0.00
0.08	0.03	0.20	0.01	0.20	0.15
0.10	0.13	0.40	0.02	0.40	0.59
0.13	0.29	0.60	0.19	0.60	1.30
0.17	0.51	0.80	0.41	0.80	2.25
0.21	0.78	1.00	0.69	1.00	3.42
0.24	1.10	1.20	1.17	1.20	4.79
0.28	1.47	1.40	1.64	1.40	6.32
0.32	1.88	1.60	2.21	1.60	7.99
0.36	2.33	1.80	2.76	1.80	9.82
0.41	2.83	2.00	3.26	2.00	11.79
0.45	3.37	2.20	3.64	2.20	13.82
0.58	3.93	2.40	4.00	2.40	15.77
0.75	4.53	2.60	4.34	2.60	17.19
0.96	5.16	2.80	4.64	2.80	17.33
1.20	5.79	3.00	4.93	3.00	17.41
1.47	6.43	3.20	5.21	3.20	17.54
1.76	7.05	3.40	5.47	3.40	17.71
1.95	7.43	3.60	5.71	3.60	17.89
		3.80	5.95	3.80	18.10
		4.00	6.18	4.00	18.31
		4.20	6.40	4.20	18.53
		4.40	6.61	4.40	18.76
		4.60	6.82	4.60	18.98
		4.80	7.02	4.80	19.20
		5.00	7.21	5.00	19.42

Hydraulic Structures: Rating Tables

PIMADITCH3 (72774)		PIMADITCH4 (105923)		PIMADITCH5 (118101)	
Depth (ft)	Discharge (cfs)	Depth (ft)	Discharge (cfs)	Depth (ft)	Discharge (cfs)
0.00	0.00	0.00	0.00	0.00	0.00
0.20	0.01	0.20	0.15	0.10	0.06
0.40	0.02	0.40	0.59	0.20	0.21
0.60	0.05	0.60	1.30	0.30	0.47
0.80	0.10	0.80	2.25	0.40	0.82
1.00	0.17	1.00	3.42	0.50	1.27
1.20	0.29	1.20	4.79	0.60	1.80
1.40	0.41	1.40	6.32	0.70	2.40
1.60	0.55	1.60	7.99	0.80	3.09
1.80	0.69	1.80	9.82	0.90	3.84
2.00	0.82	2.00	11.79	1.00	4.65
2.20	0.91	2.20	13.82	1.10	5.52
2.40	1.00	2.40	15.77	1.20	6.44
2.60	1.09	2.60	17.19	1.30	7.91
2.80	1.16	2.80	17.33	1.40	8.91
3.00	1.23	3.00	17.41	1.50	9.97
3.20	1.30	3.20	17.54	1.60	11.04
3.40	1.37	3.40	17.71	1.70	12.14
3.60	1.43	3.60	17.89	1.80	13.25
3.80	1.49	3.80	18.10	1.90	14.36
4.00	1.55	4.00	18.31	2.00	15.48
4.20	1.60	4.20	18.53	2.10	16.77
4.40	1.65	4.40	18.76	2.20	17.58
4.60	1.71	4.60	18.98	2.30	18.34
4.80	1.76	4.80	19.20	2.40	18.52
5.00	1.80	5.00	19.42	2.50	18.59
				2.60	18.69
				2.70	18.79
				2.80	18.91
				2.90	19.03
				3.00	19.16
				3.20	19.42
				3.40	19.69
				3.60	19.96
				3.80	20.22
				4.00	20.48
				4.20	20.74
				4.40	21.00
				4.60	21.26
				4.80	21.51
				5.00	21.76

Hydraulic Structures: Rating Tables

PIMADITCH6 (128625)		PIMADITCH7 (140999)		PIMADITCH8 (150951)	
Depth (ft)	Discharge (cfs)	Depth (ft)	Discharge (cfs)	Depth (ft)	Discharge (cfs)
0.00	0.00	0.00	0.00	0.00	0.00
0.10	0.04	0.20	0.15	0.20	0.15
0.20	0.15	0.40	0.59	0.40	0.59
0.30	0.34	0.60	1.30	0.60	1.30
0.40	0.59	0.80	2.25	0.80	2.25
0.50	0.91	1.00	3.42	1.00	3.42
0.60	1.30	1.20	4.79	1.20	4.79
0.70	1.75	1.40	6.32	1.40	6.32
0.80	2.25	1.60	7.99	1.60	7.99
0.90	2.81	1.80	9.82	1.80	9.82
1.00	3.42	2.00	11.79	2.00	11.79
1.10	4.08	2.20	13.82	2.20	13.82
1.20	4.79	2.40	15.77	2.40	15.77
1.30	5.54	2.60	17.19	2.60	17.19
1.40	6.32	2.80	17.33	2.80	17.33
1.50	7.14	3.00	17.41	3.00	17.41
1.60	7.99	3.20	17.54	3.20	17.54
1.70	8.87	3.40	17.71	3.40	17.71
1.80	9.82	3.60	17.89	3.60	17.89
1.90	10.80	3.80	18.10	3.80	18.10
2.00	11.79	4.00	18.31	4.00	18.31
2.20	13.82	4.20	18.53	4.20	18.53
2.40	15.77	4.40	18.76	4.40	18.76
2.60	17.19	4.60	18.98	4.60	18.98
2.80	17.33	4.80	19.20	4.80	19.20
3.00	17.41	5.00	19.42	5.00	19.42
3.20	17.54				
3.40	17.71				
3.60	17.89				
3.80	18.10				
4.00	18.31				
4.20	18.53				
4.40	18.76				
4.60	18.98				
4.80	19.20				
5.00	19.42				

Hydraulic Structures: Rating Tables

PIMADITCH9 (257926)		PIMADITCH10 (263998)		PIMADITCH11 (322883)	
Depth (ft)	Discharge (cfs)	Depth (ft)	Discharge (cfs)	Depth (ft)	Discharge (cfs)
0.00	0.00	0.00	0.00	0.00	0.00
0.10	0.04	0.20	0.28	0.20	0.01
0.20	0.15	0.40	1.06	0.40	0.02
0.30	0.34	0.60	2.22	0.60	0.19
0.40	0.59	0.80	3.67	0.80	0.41
0.50	0.91	1.00	5.34	1.00	0.69
0.60	1.30	1.20	7.18	1.20	1.17
0.70	1.75	1.40	9.08	1.40	1.64
0.80	2.25	1.60	10.98	1.60	2.21
0.90	2.81	1.80	12.73	1.80	2.76
1.00	3.42	2.00	14.14	2.00	3.26
1.10	4.08	2.20	14.71	2.20	3.64
1.20	4.79	2.40	14.71	2.40	4.00
1.30	5.54	2.60	14.73	2.60	4.34
1.40	6.32	2.80	14.84	2.80	4.64
1.50	7.14	3.00	14.98	3.00	4.93
1.60	7.99	3.20	15.12	3.20	5.21
1.70	8.87	3.40	15.28	3.40	5.47
1.80	9.82	3.60	15.44	3.60	5.71
1.90	10.80	3.80	15.61	3.80	5.95
2.00	11.79	4.00	15.78	4.00	6.18
2.10	12.81	4.20	15.96	4.20	6.40
2.20	13.82	4.40	16.13	4.40	6.61
2.30	14.82	4.60	16.31	4.60	6.82
2.40	15.77	4.80	16.49	4.80	7.02
2.50	16.62	5.00	16.67	5.00	7.21
2.60	17.19				
2.70	17.30				
2.80	17.33				
2.90	17.37				
3.00	17.41				
3.20	17.54				
3.40	17.71				
3.60	17.89				
3.80	18.10				
4.00	18.31				
4.20	18.53				
4.40	18.76				
4.60	18.98				
4.80	19.20				
5.00	19.42				

Hydraulic Structures: Rating Tables

PIMADITCH12 (332192)		PIMADITCH13 (379947)	
Depth (ft)	Discharge (cfs)	Depth (ft)	Discharge (cfs)
0.00	0.00	0.00	0.00
0.20	0.20	0.20	0.13
0.40	0.77	0.40	0.51
0.60	1.69	0.60	1.10
0.80	2.95	0.80	1.88
1.00	4.51	1.00	2.83
1.20	6.35	1.20	3.93
1.40	8.45	1.40	5.16
1.60	10.77	1.60	6.43
1.80	13.28	1.80	7.61
2.00	15.96	2.00	8.00
2.20	18.78	2.20	8.03
2.40	21.76	2.40	8.08
2.60	24.79	2.60	8.15
2.80	27.72	2.80	8.24
3.00	30.25	3.00	8.34
3.20	31.47	3.20	8.44
3.40	31.57	3.40	8.55
3.60	31.76	3.60	8.66
3.80	32.01	3.80	8.77
4.00	32.31	4.00	8.88
4.20	32.65	4.20	8.98
4.40	33.02	4.40	9.09
4.60	33.40	4.60	9.20
4.80	33.78	4.80	9.31
5.00	34.18	5.00	9.41

Hydraulic Structures: Rating Tables

I3GRR84PLL* (557549)		I3CP2GRR* (600035)	
Depth (ft)	Discharge (cfs)	Depth (ft)	Discharge (cfs)
0.00	0.00	0.00	0.00
1.00	2.67	1.00	2.82
2.00	9.69	2.00	7.59
3.00	20.20	3.00	10.40
4.00	32.89	4.00	12.74
5.00	46.44	5.00	14.78
6.00	59.62	6.00	16.59
7.00	71.21	7.00	18.23
8.00	77.87	8.00	19.75
9.00	84.00	9.00	21.15
10.00	89.71	10.00	22.47
11.00	95.08	11.00	23.72
12.00	100.16	12.00	24.90

*I3GRR84PLL and I3CP2GRR are culvert entrances for the SWMM model. The rating tables were applied to the SWMMFLORT.DAT file. Refer to Appendix D for the development of SWMM.

Culvert Analysis Report
McDowell Rd & Granite Reef Wash (MCDGRW)

Analysis Component			
Storm Event	Design	Discharge	0.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	0.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	N/A ft

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-12 x 8 ft Box	0.00 cfs	1,202.89 ft	0.00 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
McDowell Rd & Granite Reef Wash (MCDGRW)

Component:Culvert-1

Culvert Summary					
Computed Headwater Elevation	N/A	ft	Discharge	0.00	cfs
Inlet Control HW Elev.	N/A	ft	Tailwater Elevation	N/A	ft
Outlet Control HW Elev.	N/A	ft	Control Type	Inlet Control	
Headwater Depth/Height	0.00				

Grades					
Upstream Invert	1,202.89	ft	Downstream Invert	1,202.79	ft
Length	112.25	ft	Constructed Slope	0.000891	ft/ft

Hydraulic Profile					
Profile	Dry		Depth, Downstream	0.00	ft
Slope Type	Dry		Normal Depth	0.00	ft
Flow Regime	Subcritical		Critical Depth	0.00	ft
Velocity Downstream	0.00	ft/s	Critical Slope	0.000000	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	12.00	ft
Section Size	12 x 8 ft		Rise	8.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	N/A	ft	Upstream Velocity Head	0.00	ft
Ke	0.50		Entrance Loss	0.00	ft

Inlet Control Properties					
Inlet Control HW Elev.	N/A	ft	Flow Control	N/A	
Inlet Type	45° non-offset wingwall flares		Area Full	96.0	ft²
K	0.49700		HDS 5 Chart	12	
M	0.66700		HDS 5 Scale	1	
C	0.03390		Equation Form	2	
Y	0.80300				

Culvert Analysis Report
SRP well south of 84th St & Granite Reef Wash (SRPGRW)

Analysis Component			
Storm Event	Design	Discharge	0.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	0.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	N/A ft

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-12 x 8 ft Box	0.00 cfs	1,189.59 ft	0.00 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
SRP well south of 84th St & Granite Reef Wash (SRPGRW)

Component:Culvert-1

Culvert Summary

Computed Headwater Elevation	N/A ft	Discharge	0.00 cfs
Inlet Control HW Elev.	N/A ft	Tailwater Elevation	N/A ft
Outlet Control HW Elev.	N/A ft	Control Type	Inlet Control
Headwater Depth/Height	0.00		

Grades

Upstream Invert	1,189.59 ft	Downstream Invert	1,189.29 ft
Length	137.00 ft	Constructed Slope	0.002190 ft/ft

Hydraulic Profile

Profile	Dry	Depth, Downstream	0.00 ft
Slope Type	Dry	Normal Depth	0.00 ft
Flow Regime	Subcritical	Critical Depth	0.00 ft
Velocity Downstream	0.00 ft/s	Critical Slope	0.000000 ft/ft

Section

Section Shape	Box	Mannings Coefficient	0.013
Section Material	Concrete	Span	12.00 ft
Section Size	12 x 8 ft	Rise	8.00 ft
Number Sections	1		

Outlet Control Properties

Outlet Control HW Elev.	N/A ft	Upstream Velocity Head	0.00 ft
Ke	0.50	Entrance Loss	0.00 ft

Inlet Control Properties

Inlet Control HW Elev.	N/A ft	Flow Control	N/A
Inlet Type	45° non-offset wingwall flares	Area Full	96.0 ft²
K	0.49700	HDS 5 Chart	12
M	0.66700	HDS 5 Scale	1
C	0.03390	Equation Form	2
Y	0.80300		

Culvert Analysis Report
McKellips Rd & Granite Reef Wash (MCKGRW)

Analysis Component			
Storm Event	Design	Discharge	0.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	0.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	N/A ft

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	2-7 x 3 ft Box	0.00 cfs	1,184.50 ft	0.00 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
McKellips Rd & Granite Reef Wash (MCKGRW)

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	N/A ft	Discharge	0.00 cfs
Inlet Control HW Elev.	N/A ft	Tailwater Elevation	N/A ft
Outlet Control HW Elev.	N/A ft	Control Type	Inlet Control
Headwater Depth/Height	0.00		

Grades			
Upstream Invert	1,184.50 ft	Downstream Invert	1,182.40 ft
Length	120.00 ft	Constructed Slope	0.017500 ft/ft

Hydraulic Profile			
Profile	Dry	Depth, Downstream	0.00 ft
Slope Type	Dry	Normal Depth	0.00 ft
Flow Regime	Subcritical	Critical Depth	0.00 ft
Velocity Downstream	0.00 ft/s	Critical Slope	0.000000 ft/ft

Section			
Section Shape	Box	Mannings Coefficient	0.013
Section Material	Concrete	Span	7.00 ft
Section Size	7 x 3 ft	Rise	3.00 ft
Number Sections	2		

Outlet Control Properties			
Outlet Control HW Elev.	N/A ft	Upstream Velocity Head	0.00 ft
Ke	0.50	Entrance Loss	0.00 ft

Inlet Control Properties			
Inlet Control HW Elev.	N/A ft	Flow Control	N/A
Inlet Type	18.4° non-offset wingwall flares	Area Full	42.0 ft²
K	0.49500	HDS 5 Chart	12
M	0.66700	HDS 5 Scale	3
C	0.03860	Equation Form	2
Y	0.71000		

Culvert Analysis Report

McDonald Dr 15" Storm Drain (86THST1, 86THST2, MCDONALD3, MADONALD4, MCDONALD5, MCDONALD6, MCDONALD7)

Analysis Component			
Storm Event	Design	Discharge	4.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	4.00 cfs	Check Discharge	8.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	N/A ft

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-15 inch Circular	4.00 cfs	11.32 ft	4.76 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report

McDonald Dr 15" Storm Drain (86THST1, 86THST2, MCDONALD3, MADONALD4, MCDONALD5, MCDONALD6, MCDONALD7)

Component:Culvert-1

Culvert Summary

Computed Headwater Elevation	11.32	ft	Discharge	4.00	cfs
Inlet Control HW Elev.	11.26	ft	Tailwater Elevation	N/A	ft
Outlet Control HW Elev.	11.32	ft	Control Type	Outlet Control	
Headwater Depth/Height	1.05				

Grades

Upstream Invert	10.00	ft	Downstream Invert	5.00	ft
Length	1,000.00	ft	Constructed Slope	0.005000	ft/ft

Hydraulic Profile

Profile	M2		Depth, Downstream	0.81	ft
Slope Type	Mild		Normal Depth	0.91	ft
Flow Regime	Subcritical		Critical Depth	0.81	ft
Velocity Downstream	4.76	ft/s	Critical Slope	0.006782	ft/ft

Section

Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.25	ft
Section Size	15 inch		Rise	1.25	ft
Number Sections	1				

Outlet Control Properties

Outlet Control HW Elev.	11.32	ft	Upstream Velocity Head	0.27	ft
Ke	0.50		Entrance Loss	0.14	ft

Inlet Control Properties

Inlet Control HW Elev.	11.26	ft	Flow Control	N/A	
Inlet Type	Square edge w/headwall		Area Full	1.2	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Worksheet for 6' Curb Opening (86THST1, 86THST2)

Project Description

Solve For	Spread

Input Data

Discharge		4.57	ft³/s
Gutter Width		1.50	ft
Gutter Cross Slope		0.06	ft/ft
Road Cross Slope		0.02	ft/ft
Curb Opening Length		4.80	ft
Opening Height		0.42	ft
Curb Throat Type	Horizontal		
Local Depression		2.00	in
Local Depression Width		2.00	ft
Throat Incline Angle		90.00	degrees

Results

Spread	19.12	ft
Depth	0.44	ft
Gutter Depression	0.06	ft
Total Depression	0.23	ft

Messages

Notes

6' Curb Opening, considers 20% clogged length of 4.80'

Culvert Analysis Report

McDonald Dr 18" Storm Drain (MCDONALD1, MADONALD2, LATHAMST, GARFIELDST2, AMELIAAVE)

Analysis Component			
Storm Event	Design	Discharge	4.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	4.00 cfs	Check Discharge	8.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	N/A ft

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-18 inch Circular	4.00 cfs	11.21 ft	4.41 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report

McDonald Dr 18" Storm Drain (MCDONALD1, MADONALD2, LATHAMST, GARFIELDST2, AMELIAAVE)

Component:Culvert-1

Culvert Summary

Computed Headwater Elevation	11.21	ft	Discharge	4.00	cfs
Inlet Control HW Elev.	11.11	ft	Tailwater Elevation	N/A	ft
Outlet Control HW Elev.	11.21	ft	Control Type	Outlet Control	
Headwater Depth/Height	0.81				

Grades

Upstream Invert	10.00	ft	Downstream Invert	5.00	ft
Length	1,000.00	ft	Constructed Slope	0.005000	ft/ft

Hydraulic Profile

Profile	M2		Depth, Downstream	0.77	ft
Slope Type	Mild		Normal Depth	0.78	ft
Flow Regime	Subcritical		Critical Depth	0.77	ft
Velocity Downstream	4.41	ft/s	Critical Slope	0.005413	ft/ft

Section

Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.50	ft
Section Size	18 inch		Rise	1.50	ft
Number Sections	1				

Outlet Control Properties

Outlet Control HW Elev.	11.21	ft	Upstream Velocity Head	0.28	ft
Ke	0.50		Entrance Loss	0.14	ft

Inlet Control Properties

Inlet Control HW Elev.	11.11	ft	Flow Control	N/A	
Inlet Type	Square edge w/headwall		Area Full	1.8	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Worksheet for 3' Curb Opening (MCDONALD1 - 7, LATHAMST, GARFIELDST2, AMELIAAVE)

Project Description

Solve For	Spread	

Input Data

Discharge	7.43	ft^3/s
Gutter Width	1.50	ft
Gutter Cross Slope	0.06	ft/ft
Road Cross Slope	0.02	ft/ft
Curb Opening Length	2.40	ft
Opening Height	0.42	ft
Curb Throat Type	Horizontal	
Local Depression	2.00	in
Local Depression Width	2.00	ft
Throat Incline Angle	90.00	degrees

Results

Spread	94.57	ft
Depth	1.95	ft
Gutter Depression	0.06	ft
Total Depression	0.23	ft

Messages

Notes

3' Curb Opening, considers 20% clogged length of 2.40'

Ignored grate and slotted portions of combination inlets.

Culvert Analysis Report
Riviera Drive 2-12" Storm Drain (RIVIERADR)

Analysis Component			
Storm Event	Design	Discharge	4.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	4.00 cfs	Check Discharge	8.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	N/A ft

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	2-12 inch Circular	4.00 cfs	10.97 ft	4.04 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
Riviera Drive 2-12" Storm Drain (RIVIERADR)

Component:Culvert-1

Culvert Summary

Computed Headwater Elevation	10.97 ft	Discharge	4.00 cfs
Inlet Control HW Elev.	10.92 ft	Tailwater Elevation	N/A ft
Outlet Control HW Elev.	10.97 ft	Control Type	Outlet Control
Headwater Depth/Height	0.97		

Grades

Upstream Invert	10.00 ft	Downstream Invert	5.00 ft
Length	1,000.00 ft	Constructed Slope	0.005000 ft/ft

Hydraulic Profile

Profile	M2	Depth, Downstream	0.60 ft
Slope Type	Mild	Normal Depth	0.67 ft
Flow Regime	Subcritical	Critical Depth	0.60 ft
Velocity Downstream	4.04 ft/s	Critical Slope	0.006859 ft/ft

Section

Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	1.00 ft
Section Size	12 inch	Rise	1.00 ft
Number Sections	2		

Outlet Control Properties

Outlet Control HW Elev.	10.97 ft	Upstream Velocity Head	0.20 ft
Ke	0.50	Entrance Loss	0.10 ft

Inlet Control Properties

Inlet Control HW Elev.	10.92 ft	Flow Control	N/A
Inlet Type	Square edge w/headwall	Area Full	1.6 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Culvert Analysis Report
3-35x24" Arch CMP (GARFIELDST1)

Analysis Component			
Storm Event	Design	Discharge	4.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	4.00 cfs	Check Discharge	8.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	N/A ft

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	3-35 x 24 inch Arch	4.00 cfs	10.45 ft	2.56 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
3-35x24" Arch CMP (GARFIELDST1)

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	10.45 ft	Discharge	4.00 cfs
Inlet Control HW Elev.	10.37 ft	Tailwater Elevation	N/A ft
Outlet Control HW Elev.	10.45 ft	Control Type	Outlet Control
Headwater Depth/Height	0.23		

Grades			
Upstream Invert	10.00 ft	Downstream Invert	5.00 ft
Length	1,000.00 ft	Constructed Slope	0.005000 ft/ft

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.27 ft
Slope Type	Mild	Normal Depth	0.37 ft
Flow Regime	Subcritical	Critical Depth	0.27 ft
Velocity Downstream	2.56 ft/s	Critical Slope	0.016853 ft/ft

Section			
Section Shape	Arch	Mannings Coefficient	0.025
Section Material	Steel and Aluminum Var CR	Span	2.92 ft
Section Size	35 x 24 inch	Rise	2.00 ft
Number Sections	3		

Outlet Control Properties			
Outlet Control HW Elev.	10.45 ft	Upstream Velocity Head	0.05 ft
Ke	0.90	Entrance Loss	0.04 ft

Inlet Control Properties			
Inlet Control HW Elev.	10.37 ft	Flow Control	N/A
Inlet Type	Thin wall projecting	Area Full	13.5 ft²
K	0.03400	HDS 5 Chart	34
M	1.50000	HDS 5 Scale	3
C	0.04960	Equation Form	1
Y	0.57000		

Culvert Analysis Report
Roosevelt Circle 1-42x30" CMP (ROOSEVELTCIR)

Analysis Component			
Storm Event	Design	Discharge	4.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	4.00 cfs	Check Discharge	8.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	N/A ft

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-42 x 29 inch Arch	4.00 cfs	10.77 ft	3.39 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
Roosevelt Circle 1-42x30" CMP (ROOSEVELTCIR)

Component:Culvert-1

Culvert Summary

Computed Headwater Elevation	10.77 ft	Discharge	4.00 cfs
Inlet Control HW Elev.	10.65 ft	Tailwater Elevation	N/A ft
Outlet Control HW Elev.	10.77 ft	Control Type	Outlet Control
Headwater Depth/Height	0.32		

Grades

Upstream Invert	10.00 ft	Downstream Invert	5.00 ft
Length	1,000.00 ft	Constructed Slope	0.005000 ft/ft

Hydraulic Profile

Profile	M2	Depth, Downstream	0.46 ft
Slope Type	Mild	Normal Depth	0.61 ft
Flow Regime	Subcritical	Critical Depth	0.46 ft
Velocity Downstream	3.39 ft/s	Critical Slope	0.014516 ft/ft

Section

Section Shape	Arch	Mannings Coefficient	0.025
Section Material	Steel and Aluminum Var CR	Span	3.50 ft
Section Size	42 x 29 inch	Rise	2.42 ft
Number Sections	1		

Outlet Control Properties

Outlet Control HW Elev.	10.77 ft	Upstream Velocity Head	0.09 ft
Ke	0.90	Entrance Loss	0.08 ft

Inlet Control Properties

Inlet Control HW Elev.	10.65 ft	Flow Control	N/A
Inlet Type	Thin wall projecting	Area Full	6.5 ft²
K	0.03400	HDS 5 Chart	34
M	1.50000	HDS 5 Scale	3
C	0.04960	Equation Form	1
Y	0.57000		

Culvert Analysis Report
Portland Street Basin Entrance 3-24" CMP (PORTLANDST)

Analysis Component			
Storm Event	Design	Discharge	4.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	4.00 cfs	Check Discharge	8.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	N/A ft

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	3-24 inch Circular	4.00 cfs	10.65 ft	2.99 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
Portland Street Basin Entrance 3-24" CMP (PORTLANDST)

Component:Culvert-1

Culvert Summary

Computed Headwater Elevation	10.65	ft	Discharge	4.00	cfs
Inlet Control HW Elev.	10.54	ft	Tailwater Elevation	N/A	ft
Outlet Control HW Elev.	10.65	ft	Control Type	Outlet Control	
Headwater Depth/Height	0.32				

Grades

Upstream Invert	10.00	ft	Downstream Invert	5.00	ft
Length	1,000.00	ft	Constructed Slope	0.005000	ft/ft

Hydraulic Profile

Profile	M2		Depth, Downstream	0.40	ft
Slope Type	Mild		Normal Depth	0.53	ft
Flow Regime	Subcritical		Critical Depth	0.40	ft
Velocity Downstream	2.99	ft/s	Critical Slope	0.015629	ft/ft

Section

Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	3				

Outlet Control Properties

Outlet Control HW Elev.	10.65	ft	Upstream Velocity Head	0.06	ft
Ke	0.90		Entrance Loss	0.06	ft

Inlet Control Properties

Inlet Control HW Elev.	10.54	ft	Flow Control	N/A	
Inlet Type	Projecting		Area Full	9.4	ft²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Analysis Report
87th Place Bike Path 3-24" CMP (87THPLBIKEPATH)

Analysis Component			
Storm Event	Design	Discharge	4.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	4.00 cfs	Check Discharge	8.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	N/A ft

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	3-24 inch Circular	4.00 cfs	10.65 ft	2.99 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
87th Place Bike Path 3-24" CMP (87THPLBIKEPATH)

Component:Culvert-1

Culvert Summary					
Computed Headwater Elevation	10.65	ft	Discharge	4.00	cfs
Inlet Control HW Elev.	10.54	ft	Tailwater Elevation	N/A	ft
Outlet Control HW Elev.	10.65	ft	Control Type	Outlet Control	
Headwater Depth/Height	0.32				

Grades					
Upstream Invert	10.00	ft	Downstream Invert	5.00	ft
Length	1,000.00	ft	Constructed Slope	0.005000	ft/ft

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.40	ft
Slope Type	Mild		Normal Depth	0.53	ft
Flow Regime	Subcritical		Critical Depth	0.40	ft
Velocity Downstream	2.99	ft/s	Critical Slope	0.015629	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	3				

Outlet Control Properties					
Outlet Control HW Elev.	10.65	ft	Upstream Velocity Head	0.06	ft
Ke	0.90		Entrance Loss	0.06	ft

Inlet Control Properties					
Inlet Control HW Elev.	10.54	ft	Flow Control	N/A	
Inlet Type	Projecting		Area Full	9.4	ft²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Analysis Report
24"CMP (PIMADITCH1, PIMADITCH3)

Analysis Component			
Storm Event	Design	Discharge	4.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	4.00 cfs	Check Discharge	8.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	N/A ft

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-24 inch Circular	4.00 cfs	12.40 ft	4.07 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
24"CMP (PIMADITCH1, PIMADITCH3)

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	12.40 ft	Discharge	4.00 cfs
Inlet Control HW Elev.	11.02 ft	Tailwater Elevation	N/A ft
Outlet Control HW Elev.	12.40 ft	Control Type	Outlet Control
Headwater Depth/Height	1.20		

Grades			
Upstream Invert	10.00 ft	Downstream Invert	5.00 ft
Length	1,000.00 ft	Constructed Slope	0.000000 ft/ft

Hydraulic Profile			
Profile	CompositeH2PressureProfile	Depth, Downstream	0.70 ft
Slope Type	Horizontal	Normal Depth	N/A ft
Flow Regime	Subcritical	Critical Depth	0.70 ft
Velocity Downstream	4.07 ft/s	Critical Slope	0.015291 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	12.40 ft	Upstream Velocity Head	0.03 ft
Ke	0.90	Entrance Loss	0.02 ft

Inlet Control Properties			
Inlet Control HW Elev.	11.02 ft	Flow Control	N/A
Inlet Type	Projecting	Area Full	3.1 ft²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report

24" RCP (PIMADITCH2, PIMADITCH4, PIMADITCH6, PIMADITCH7, PIMADITCH8, PIMADITCH9, PIMADITCH11)

Analysis Component			
Storm Event	Design	Discharge	4.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	4.00 cfs	Check Discharge	8.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	N/A ft

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-24 inch Circular	4.00 cfs	11.09 ft	4.23 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report

24" RCP (PIMADITCH2, PIMADITCH4, PIMADITCH6, PIMADITCH7, PIMADITCH8, PIMADITCH9, PIMADITCH11)

Component:Culvert-1

Culvert Summary

Computed Headwater Elevation	11.09	ft	Discharge	4.00	cfs
Inlet Control HW Elev.	10.97	ft	Tailwater Elevation	N/A	ft
Outlet Control HW Elev.	11.09	ft	Control Type	Entrance Control	
Headwater Depth/Height	0.54				

Grades

Upstream Invert	10.00	ft	Downstream Invert	5.00	ft
Length	1,000.00	ft	Constructed Slope	0.005000	ft/ft

Hydraulic Profile

Profile	S2		Depth, Downstream	0.68	ft
Slope Type	Steep		Normal Depth	0.68	ft
Flow Regime	Supercritical		Critical Depth	0.70	ft
Velocity Downstream	4.23	ft/s	Critical Slope	0.004486	ft/ft

Section

Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	1				

Outlet Control Properties

Outlet Control HW Elev.	11.09	ft	Upstream Velocity Head	0.26	ft
Ke	0.50		Entrance Loss	0.13	ft

Inlet Control Properties

Inlet Control HW Elev.	10.97	ft	Flow Control	N/A	
Inlet Type	Square edge w/headwall		Area Full	3.1	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Analysis Report
19"x30" Elliptical RCP (PIMADITCH5)

Analysis Component			
Storm Event	Design	Discharge	4.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	4.00 cfs	Check Discharge	8.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	N/A ft

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-19x30 inch Horiz Ellipse	4.00 cfs	10.92 ft	4.02 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
19"x30" Elliptical RCP (PIMADITCH5)

Component:Culvert-1

Culvert Summary

Computed Headwater Elevation	10.92 ft	Discharge	4.00 cfs
Inlet Control HW Elev.	10.82 ft	Tailwater Elevation	N/A ft
Outlet Control HW Elev.	10.92 ft	Control Type	Entrance Control
Headwater Depth/Height	0.57		

Grades

Upstream Invert	10.00 ft	Downstream Invert	5.00 ft
Length	1,000.00 ft	Constructed Slope	0.005000 ft/ft

Hydraulic Profile

Profile	S2	Depth, Downstream	0.56 ft
Slope Type	Steep	Normal Depth	0.56 ft
Flow Regime	Supercritical	Critical Depth	0.59 ft
Velocity Downstream	4.02 ft/s	Critical Slope	0.004101 ft/ft

Section

Section Shape	Horizontal Ellipse	Mannings Coefficient	0.013
Section Material	Concrete	Span	2.52 ft
Section Size	19x30 inch	Rise	1.60 ft
Number Sections	1		

Outlet Control Properties

Outlet Control HW Elev.	10.92 ft	Upstream Velocity Head	0.22 ft
Ke	0.50	Entrance Loss	0.11 ft

Inlet Control Properties

Inlet Control HW Elev.	10.82 ft	Flow Control	N/A
Inlet Type	Square edge with headwall (horizontal ellipse)	Area Full	3.3 ft²
K	0.01000	HDS 5 Chart	29
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Culvert Analysis Report
18"x40" Arch CMP (PIMADITCH10)

Analysis Component			
Storm Event	Design	Discharge	4.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	4.00 cfs	Check Discharge	8.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	N/A ft

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-35 x 24 inch Arch	4.00 cfs	10.84 ft	3.56 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
18"x40" Arch CMP (PIMADITCH10)

Component:Culvert-1

Culvert Summary						
Computed Headwater Elevation	10.84	ft	Discharge	4.00	cfs
Inlet Control HW Elev.	10.72	ft	Tailwater Elevation	N/A	ft
Outlet Control HW Elev.	10.84	ft	Control Type	Outlet Control	
Headwater Depth/Height	0.42				

Grades					
Upstream Invert	10.00	ft	Downstream Invert	5.00	ft
Length	1,000.00	ft	Constructed Slope	0.005000	ft/ft

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.49	ft
Slope Type	Mild		Normal Depth	0.66	ft
Flow Regime	Subcritical		Critical Depth	0.49	ft
Velocity Downstream	3.56	ft/s	Critical Slope	0.014815	ft/ft

Section					
Section Shape	Arch		Mannings Coefficient	0.025	
Section Material	Steel and Aluminum Var CR		Span	2.92	ft
Section Size	35 x 24 inch		Rise	2.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	10.84	ft	Upstream Velocity Head	0.09	ft
Ke	0.90		Entrance Loss	0.09	ft

Inlet Control Properties					
Inlet Control HW Elev.	10.72	ft	Flow Control	N/A	
Inlet Type	Thin wall projecting		Area Full	4.5	ft²
K	0.03400		HDS 5 Chart	34	
M	1.50000		HDS 5 Scale	3	
C	0.04960		Equation Form	1	
Y	0.57000				

Culvert Analysis Report
30" RCP (PIMADITCH12)

Analysis Component			
Storm Event	Design	Discharge	4.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	4.00 cfs	Check Discharge	8.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	N/A ft

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-30 inch Circular	4.00 cfs	10.94 ft	4.15 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
30" RCP (PIMADITCH12)

Component:Culvert-1

Culvert Summary

Computed Headwater Elevation	10.94 ft	Discharge	4.00 cfs
Inlet Control HW Elev.	10.89 ft	Tailwater Elevation	N/A ft
Outlet Control HW Elev.	10.94 ft	Control Type	Entrance Control
Headwater Depth/Height	0.38		

Grades

Upstream Invert	10.00 ft	Downstream Invert	5.00 ft
Length	1,000.00 ft	Constructed Slope	0.005000 ft/ft

Hydraulic Profile

Profile	S2	Depth, Downstream	0.63 ft
Slope Type	Steep	Normal Depth	0.63 ft
Flow Regime	Supercritical	Critical Depth	0.66 ft
Velocity Downstream	4.15 ft/s	Critical Slope	0.004152 ft/ft

Section

Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	2.50 ft
Section Size	30 inch	Rise	2.50 ft
Number Sections	1		

Outlet Control Properties

Outlet Control HW Elev.	10.94 ft	Upstream Velocity Head	0.23 ft
Ke	0.20	Entrance Loss	0.05 ft

Inlet Control Properties

Inlet Control HW Elev.	10.89 ft	Flow Control	N/A
Inlet Type	Groove end projecting	Area Full	4.9 ft²
K	0.00450	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	3
C	0.03170	Equation Form	1
Y	0.69000		

Culvert Analysis Report
18" RCP (PIMADITCH13)

Analysis Component			
Storm Event	Design	Discharge	4.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	4.00 cfs	Check Discharge	8.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	N/A ft

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-18 inch Circular	4.00 cfs	11.21 ft	4.41 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
18" RCP (PIMADITCH13)

Component:Culvert-1

Culvert Summary

Computed Headwater Elevation	11.21	ft	Discharge	4.00	cfs
Inlet Control HW Elev.	11.11	ft	Tailwater Elevation	N/A	ft
Outlet Control HW Elev.	11.21	ft	Control Type	Outlet Control	
Headwater Depth/Height	0.81				

Grades

Upstream Invert	10.00	ft	Downstream Invert	5.00	ft
Length	1,000.00	ft	Constructed Slope	0.005000	ft/ft

Hydraulic Profile

Profile	M2		Depth, Downstream	0.77	ft
Slope Type	Mild		Normal Depth	0.78	ft
Flow Regime	Subcritical		Critical Depth	0.77	ft
Velocity Downstream	4.41	ft/s	Critical Slope	0.005413	ft/ft

Section

Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.50	ft
Section Size	18 inch		Rise	1.50	ft
Number Sections	1				

Outlet Control Properties

Outlet Control HW Elev.	11.21	ft	Upstream Velocity Head	0.28	ft
Ke	0.50		Entrance Loss	0.14	ft

Inlet Control Properties

Inlet Control HW Elev.	11.11	ft	Flow Control	N/A	
Inlet Type	Square edge w/headwall		Area Full	1.8	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Analysis Report
84th Pl Storm Drain (I3GRR84PLL)

Analysis Component			
Storm Event	Design	Discharge	0.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	0.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	N/A ft

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-48 inch Circular	0.00 cfs	1,200.53 ft	0.00 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
84th Pl Storm Drain (I3GRR84PLL)

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	N/A ft	Discharge	0.00 cfs
Inlet Control HW Elev.	N/A ft	Tailwater Elevation	N/A ft
Outlet Control HW Elev.	N/A ft	Control Type	Inlet Control
Headwater Depth/Height	0.00		

Grades			
Upstream Invert	1,200.53 ft	Downstream Invert	1,190.02 ft
Length	3,030.00 ft	Constructed Slope	0.396215 ft/ft

Hydraulic Profile			
Profile	Dry	Depth, Downstream	0.00 ft
Slope Type	Dry	Normal Depth	0.00 ft
Flow Regime	Subcritical	Critical Depth	0.00 ft
Velocity Downstream	0.00 ft/s	Critical Slope	0.000000 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	4.00 ft
Section Size	48 inch	Rise	4.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	N/A ft	Upstream Velocity Head	0.00 ft
Ke	0.50	Entrance Loss	0.00 ft

Inlet Control Properties			
Inlet Control HW Elev.	N/A ft	Flow Control	N/A
Inlet Type	Square edge w/headwall	Area Full	12.6 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Culvert Analysis Report
General Dynamics Basin Outfall (I3CP2GRR)

Analysis Component			
Storm Event	Design	Discharge	0.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	0.00 cfs	Check Discharge	0.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	N/A ft

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-18 inch Circular	0.00 cfs	1,199.21 ft	0.00 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
General Dynamics Basin Outfall (I3CP2GRR)

Component:Culvert-1

Culvert Summary					
Computed Headwater Elevation	N/A	ft	Discharge	0.00	cfs
Inlet Control HW Elev.	N/A	ft	Tailwater Elevation	N/A	ft
Outlet Control HW Elev.	N/A	ft	Control Type	Inlet Control	
Headwater Depth/Height	0.00				

Grades					
Upstream Invert	1,199.21	ft	Downstream Invert	1,198.96	ft
Length	109.00	ft	Constructed Slope	0.002294	ft/ft

Hydraulic Profile					
Profile	Dry		Depth, Downstream	0.00	ft
Slope Type	Dry		Normal Depth	0.00	ft
Flow Regime	Subcritical		Critical Depth	0.00	ft
Velocity Downstream	0.00	ft/s	Critical Slope	0.000000	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.50	ft
Section Size	18 inch		Rise	1.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	N/A	ft	Upstream Velocity Head	0.00	ft
Ke	0.50		Entrance Loss	0.00	ft

Inlet Control Properties					
Inlet Control HW Elev.	N/A	ft	Flow Control	N/A	
Inlet Type	Square edge w/headwall		Area Full	1.8	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

APPENDIX C.3 – High-Water Marks from the September 8, 2014 Storm

PLAN VIEW

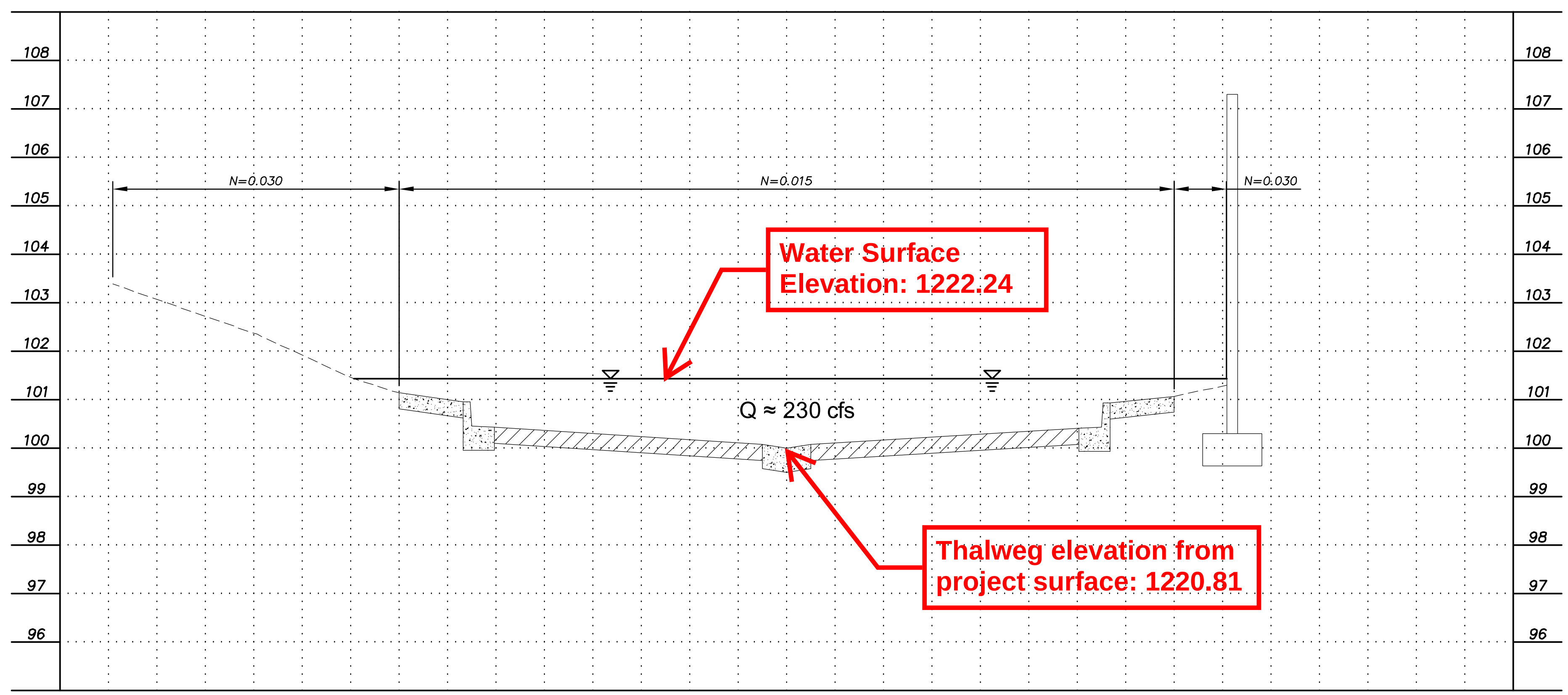
SCALE: H:1"=200'

Channel Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. — Wednesday, Jan 7 2015

87th Street and Windsor Avenue

User-defined		Highlighted	
Invert Elev (ft)	= 100.00	Depth (ft)	= 1.43
Slope (%)	= 0.28	Q (cfs)	= 233.11
N-Value	= 0.017	Area (sqft)	= 51.53
		Velocity (ft/s)	= 4.52
Calculations		Wetted Perim (ft)	= 54.58
Compute by:	Known Depth	Crit Depth, Yc (ft)	= 1.30
Known Depth (ft)	= 1.43	Top Width (ft)	= 53.45
		EGL (ft)	= 1.75



CROSS SECTION

LOOKING DOWNSTREAM
SCALE: H:1"=10'
V:1"=3.33'

Gavan & Barker Inc.

Gavan & Barker, Inc.
3030 N. Central Ave.
Suite 1530
Phoenix, Arizona 85012
Phone: 602-200-0031
Fax: 602-200-0032

Civil Engineering
Landscape Architecture

Project :

GRANITE REEF WATERSHED
SEPTEMBER 8TH 2014 STORM PEAK DISCHARGE ESTIMATE
CITY OF SCOTTSDALE

Submittal :

G&B No.	1316
Issue Date:	1/15
Drawn By:	OK
Checked By:	MTG

Sheet Title :

87TH ST. & WINDSOR AVE.

Sheet Number:

1

PLAN VIEW
SCALE: H:1"=200'

Channel Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. — Wednesday, Jan 7 2015

84th Place and Portland Street (North)

User-defined

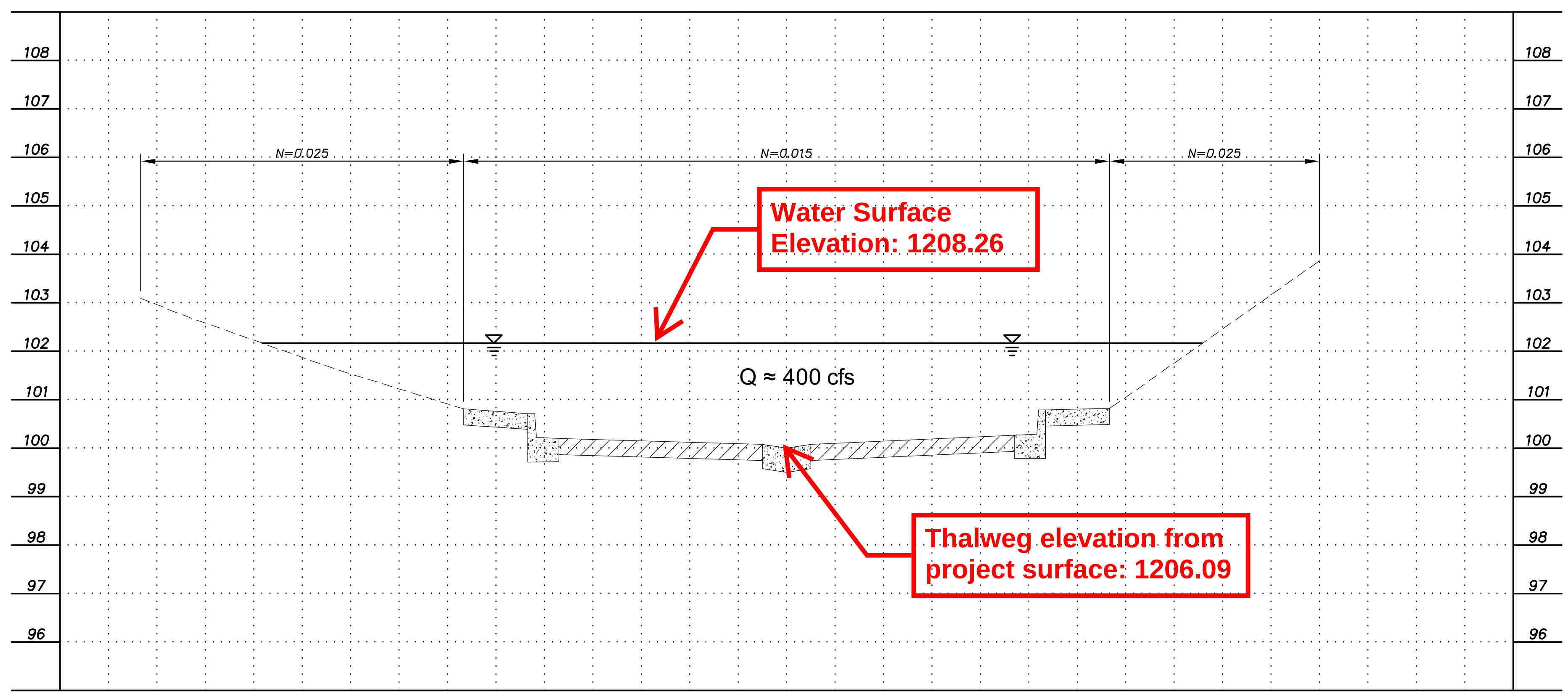
Invert Elev (ft)	=	100.00
Slope (%)	=	0.18
N-Value	=	0.018

Calculations

Compute by:		Known Depth
Known Depth (ft)	=	2.17

Highlighted

Depth (ft)	=	2.17
Q (cfs)	=	395.86
Area (sqft)	=	88.39
Velocity (ft/s)	=	4.48
Wetted Perim (ft)	=	59.32
Crit Depth, Yc (ft)	=	1.73
Top Width (ft)	=	58.25
EGL (ft)	=	2.48



NORTH CROSS SECTION
LOOKING DOWNSTREAM
SCALE: H:1"=10'
V:1"=3.33'

Gavan & Barker Inc.
Gavan & Barker, Inc.
3030 N. Central Ave.
Suite 1530
Phoenix, Arizona 85012
Phone: 602-200-0031
Fax: 602-200-0032
Civil Engineering
Landscape Architecture

Project :

GRANITE REEF WATERSHED
SEPTEMBER 8TH 2014 STORM
PEAK DISCHARGE ESTIMATE
CITY OF SCOTTSDALE

Submittal :

G&B No.	1316
Issue Date:	1/15
Drawn By:	OK
Checked By:	MTG

Sheet Title :
84TH PL. & PORTLAND ST. (NORTH)

Sheet Number:
2

Gavan & Barker Inc.
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Landscape Architecture

Project :

GRANITE REEF WATERSHED
SEPTEMBER 8TH 2014 STORM PEAK DISCHARGE ESTIMATE
CITY OF SCOTTSDALE

PLAN VIEW
SCALE: H:1"=200'

Channel Report

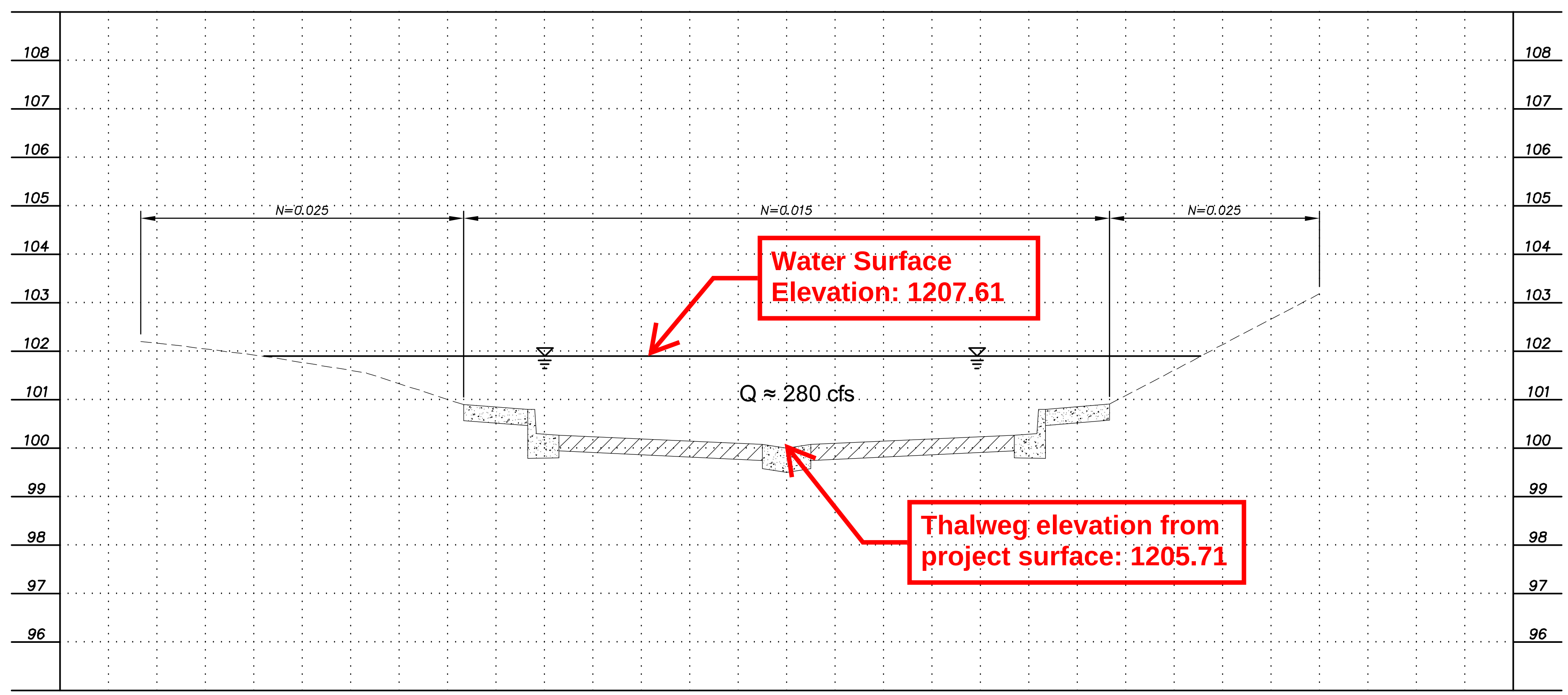
Hydraflow Express Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. Wednesday, Jan 7 2015

84th Place and Portland Street (South)

User-defined
Invert Elev (ft) = 100.00
Slope (%) = 0.18
N-Value = 0.018

Calculations
Compute by: Known Depth
Known Depth (ft) = 1.90

Highlighted
Depth (ft) = 1.90
Q (cfs) = 279.66
Area (sqft) = 71.58
Velocity (ft/s) = 3.91
Wetted Perim (ft) = 59.10
Crit Depth, Yc (ft) = 1.48
Top Width (ft) = 58.12
EGL (ft) = 2.14



SOUTH CROSS SECTION
LOOKING DOWNSTREAM
SCALE: H:1"=10'
V:1"=3.33'

Submittal :
G&B No. 1316
Issue Date: 1/15
Drawn By: OK
Checked By: MTG

Sheet Title :
84TH PL. & PORTLAND ST. (SOUTH)

Sheet Number:
3
3 of 3

APPENDIX D – EPA Storm Water Management Model (EPA SWMM)

APPENDIX D.1 – EPA SWMM Development

D.1.0 METHODOLGY

The storm drain analysis conducted for the Granite Reef Wash Hydrology Update was completed per FLO-2D's most current guidance for parameter development and modeling techniques. This ensured the storm drain model would effectively operate within the FLO-2D software. The current version of the FLO-2D Software interfaced with the Environmental Protection Agency's (EPA) Storm Water Management Model (SWMM) software was used for the storm drain modeling. The software programs, ArcGIS 10.3 and inpPINS, were both utilized as preprocessors to develop the parameters for the model and convert them into the SWMM input file.

D.1.1 HYDROLOGY

Since the SWMM software interfaces with the FLO-2D model, hydrology is handled within FLO-2D and then flow is transferred to specified SWMM inlet locations. These inlet locations are listed in the **SWMMFLO.DAT** file. This file defined the inlet geometry based on five types: (1) curb opening inlet at grade, (2) curb opening inlet in sag, (3) grate inlet, (4) user-defined and (5) manhole. For this project, curb opening inlets at grade, grate inlets and manholes were primarily used to intercept surface flows with the exception of two culvert entrances along Granite Reef Wash and the outfall for the General Dynamics complex. In the case of combination inlets, grates were ignored and only the curb opening portion of the inlet was used. This was due to the simplicity of the model inputs as well as the inefficiency (high clogging potential) of grates when compared to curb openings.

A clogging factor was applied to the inlets based on the FCDMC's Hydraulics Design Manual. For curb openings, it was assumed to be 0.80 while grates were assumed to be 0.50 after the factors of 0.7 and 0.85 were applied for the clear area and perimeter, respectively. This was done by reducing the area and perimeter of the inlets in the SWMMFLO.DAT file. For the user-defined inlets, no clogging factors were applied since no grates were used on the culvert entrances.

FLO-2D calculated inflow for each inlet based on the depth of the corresponding grid element as well as SWMM's ability to accept flow. In some cases, the pressure head in the SWMM model prevented flow from entering the inlet and even returned flow back to FLO-2D. Other than FLO-2D model, no other hydrology was applied to the SWMM model.

D.1.2 HYDRAULICS

In order to develop the SWMM model, shapefiles were first developed to define the locations of the inlets, manholes/junctions, pipes/conduits and outfalls. Using as-builts and existing GIS layers, the attributes were populated with the physical storm drain characteristics such as inverts, pipe sizes, depths, etc. To help facilitate the development, existing SWMM-ready storm drain shapefiles were obtained from the adjacent Lower Indian Bend Wash study where there was overlap between the two models. The remaining data related to Granite Reef Wash was added to these files to establish the shapefiles for this study. Refer to Exhibit 5 in Appendix E.1 for location and size of the storm drains.

Once complete, the shapefiles were converted into a SWMM input file through a program called inpPINS. The FLO-2D GDS would then take the SWMM file and interface the models by spatially matching the SWMM inlets with the corresponding FLO-2D grid elements. This is defined by the **SWMMFLO.DAT** file. A secondary file was created for the 'Type 4' culvert entrances which uses rating tables similar to the hydraulic structures. And like the hydraulic structures, Bentley's CulvertMaster program was used to establish the rating tables assuming inlet control. These rating tables are defined in the **SWMMFLORT.DAT** file.

The last step was to define whether the SWMM outfalls would return to the grid or be removed from the system. Most storm drains within this watershed north of Thomas Road and along Hayden Road intercepted and conveyed flows to Indian Bend Wash. The remaining storm drains discharged into Granite Reef Wash. These outfalls and their corresponding grid elements are defined in the **SWMMOUTF.DAT** file with a switch: '0' flow leaves the system through SWMM and '1' flow is returned to the FLO-2D grid.

Inlet/Grid Adjustments

In some cases, the inlets in the SWMM input file did not correspond to the correct grid elements in FLO-2D for the models to work properly. It was necessary to adjust these inlets to their appropriate grids. SWMM inlet locations were moved to an adjacent grid which better represented the actual roadway inlet location because the inlet was initially located at a high point (top of sidewalk or adjacent landscaping area with a higher grid elevation) and was not accurately capturing stormwater runoff.

Minor Loss Coefficients

The storm drain minor loss coefficients used for the SWMM model were from the FCDMC's Hydraulics Manual (August 2013), Chapter 4. Bend losses were applied to inlets, manholes and outfalls. For inlets at the beginning of a pipe, an entry loss coefficient of 1.2 was applied. Inlets along the storm drain that connected pipes were treated as manholes. As such, these inlets and manholes were subject to bend losses based on the deflection angle of the connecting pipes.

Depending on the incoming angle of deflection, the bend loss coefficient varied between 0 and 90 degrees. The bend losses were based on the 'Curved or Deflector' manhole curve in Figure 4.10 from the Hydraulics Manual. Small connector pipes discharging to manholes were assumed to be negligible and not accounted for in the bend loss coefficient. Larger laterals (3 feet and larger) were evaluated on a case by case basis to determine the appropriate bend loss coefficient to apply. The following table describes the bend loss coefficients used based on the ranges of deflection angles. Additional notes are provided in Appendix D.2.

Table D.1-1 Bend Loss Coefficients

Angle of Deflection	Bend Loss Coefficient
0° - 15°	0.05
15° - 30°	0.16
30° - 45°	0.28
45° - 60°	0.48
60°- 75°	0.72
75° - 90°	1.02

Outfalls and small laterals discharging to larger storm drains were assigned an exit loss coefficient of 1.0. Loss coefficients at pipe junctions were assumed to be negligible regardless of the deflection angle.

D.1.3 ISSUES ENCOUNTERED DURING THE STUDY

Surging/Oscillations

Some minor oscillations were observed in the results when the HGL rose (or fell) too fast between the soffit of the storm drain and the rim elevation of the inlet or manhole. These oscillations appeared to have little to no impact on the peak results and were assumed to be negligible. No oscillations were observed below the soffit of pipe or above the rim elevation.

Flow in the Streets

Due to how the FLO-2D grids averaged elevations, much of the street flow conveyance was eliminated and was not characterized well in the model. This was determined to be an issue for the SWMM inlets since they operated on the depth from the corresponding grids. To improve this, all streets, with the exception of the inverted crown streets, were depressed 4-inches. This helped to bring more flow into the streets as well as provide the inlets with more realistic depths on the grid.

FLO-2D Grid and SWMM Inlet Elevations

FLO-2D adjusted the grid elevations to match the associated SWMM rim elevation. A summary of the adjustments was provided in the **FPRIMELEV.OUT** file. Since many of the grid adjustments were found to adversely affect the results, the SWMM inlet maximum depths were modified to prevent these undesirable adjustments. Street inlets were adjusted to their corresponding grid elements and then depressed additional 2-inches. This in turn depressed those grids 2-inches through the model's adjustments giving the inlets a total of 6-inches when considering the 4-inches the streets were depressed by to improve flow. Inlets outside the streets were adjusted to the grid elevation.

SWMM Warning Messages

Within the **STORMDRAIN_ERROR.CHK** and **SWMM.RPT** output files, warning messages appeared in the current run. These were checked at the specific junctions and storm drain conduits to see if they were being represented accurately.

D.1.4 CURB HIGH CAPACITY COMPARISONS

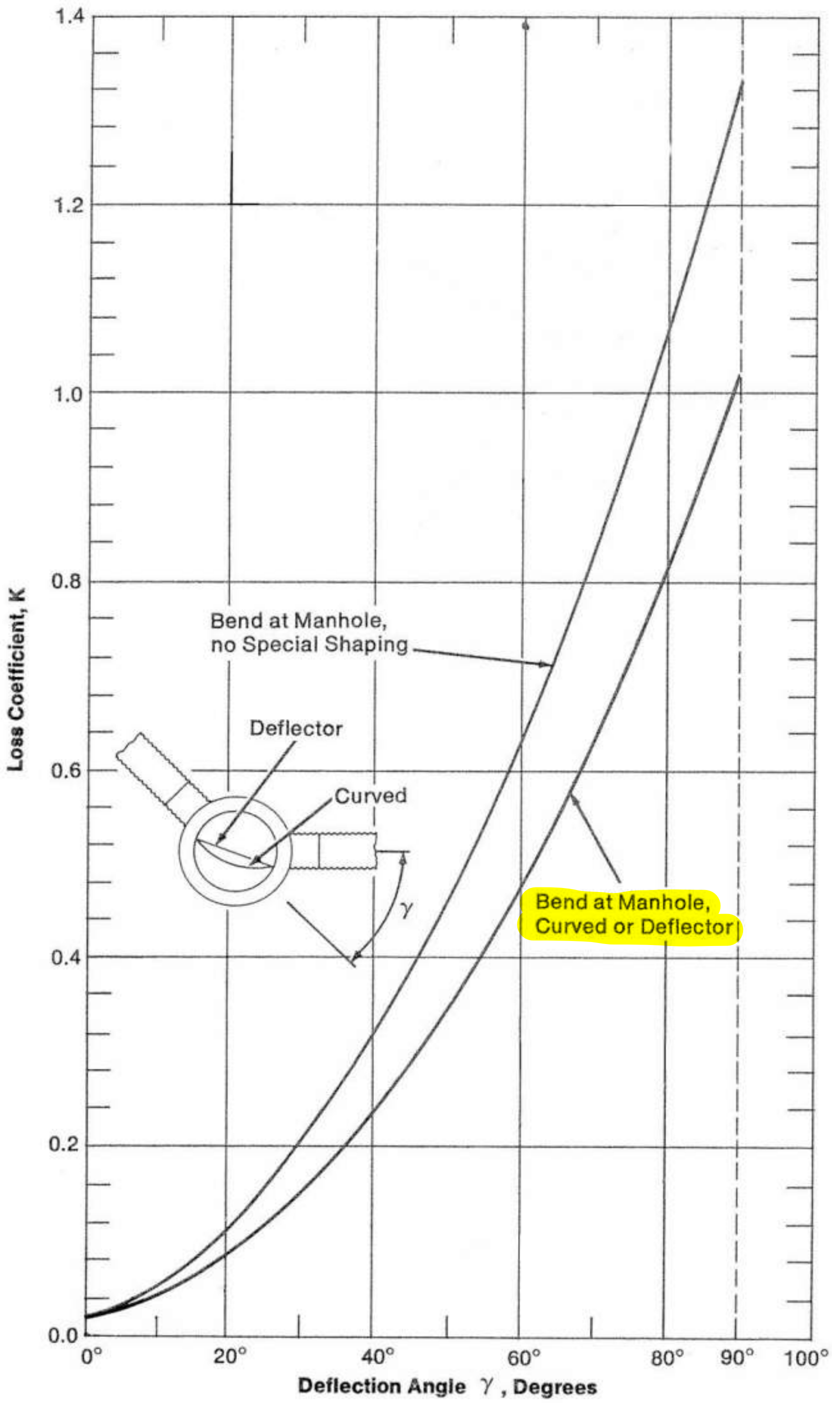
For most inlets, the curb high capacity was assumed to be approximately 6-inches of depth. Culvert type inlets assumed the soffit of the pipe. The capacity rates were then compared to the actual interception rates for the inlets from each of the model runs. The actual interception rates were obtained from inlet connector pipes since these governed the interception capacities See Appendix D.4 for the inlet comparisons. The purpose for the comparisons was to verify the reasonableness of the inlet flows in the model.

The results of the models showed the patterning of flow was not uniform with the inlets which created significant variations between curb high and actual interception. In the 100-year event, most inlets were generally below with some above the calculated curb height interception rate while the 10-year event was generally at or below the interception rate which is consistent with the expected response of the storm drain system. For the inlets that received significant flow, the depths were higher than the curb height resulting in higher interception rates.

In general, with some exceptions, the interception results appear very reasonable when compared with the other FLO-2D results. In the 100-year event, the majority of the flow is intercepted by the east-west storm drains that outlet into Indian Bend Wash and there is still capacity in some of the main lines. In several cases for the 10-year event, the interception rate nearly matches the curb high capacity that it was designed for.

APPENDIX D.2 – Additional SWMM Data

FIGURE 4.10
BEND LOSS COEFFICIENT
(MODIFIED FROM AISI, 1990)



APPENDIX D.3 – Storm Main Profiles

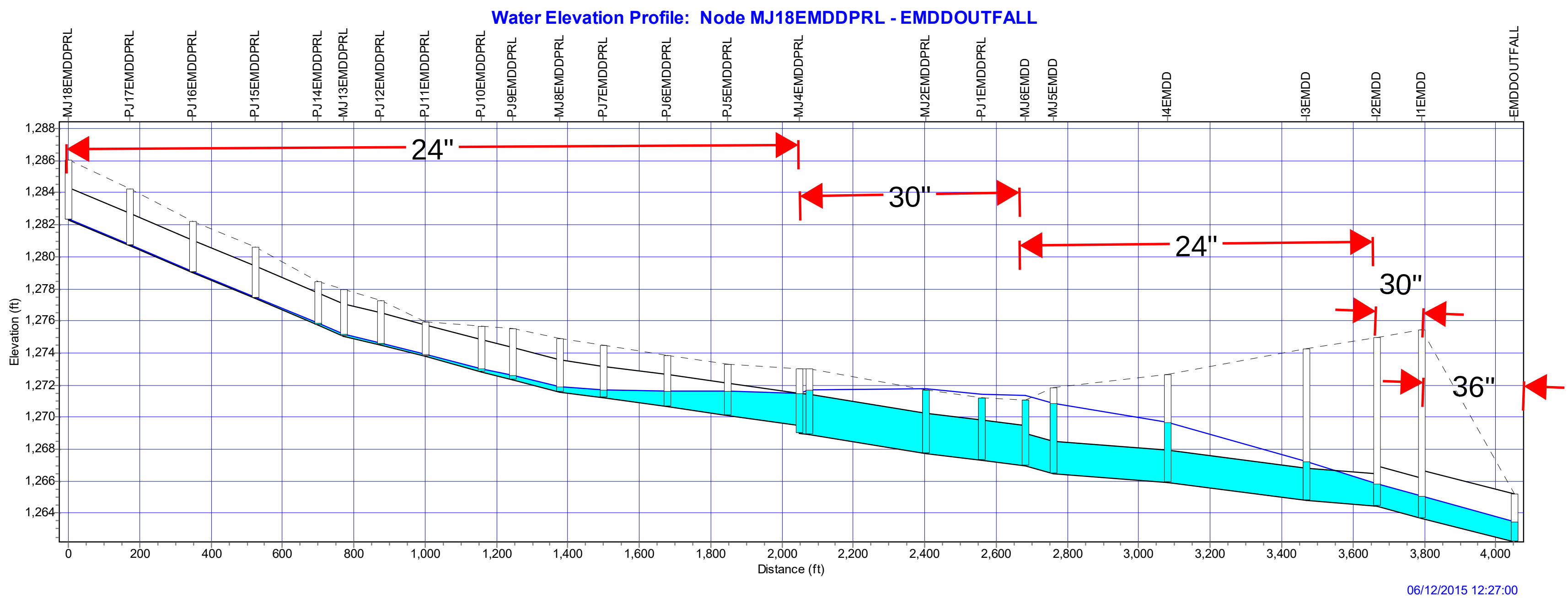
GRANITE REEF WASH
APPENDIX D.3 EXHIBIT
STORM DRAIN LOCATION MAP
CITY OF SCOTTSDALE ARIZONA
0 1,000 2,000 Feet
T·Y·LIN INTERNATIONAL
engineers| planners| scientists
Legend
Outfalls
Manholes
Inlets
Combination
Curb Opening
Grate
Storm Mains
12" (Circular)
15" (Circular)
18" (Circular)
19" x 30" (Elliptical)
21" (Circular)
24" (Circular)
30" (Circular)
36" (Circular)
42" (Circular)
3.5 ft x 3 ft (Box)
48" (Circular)
4.21 ft x 3 ft (Box)
54" (Circular)
60" (Circular)
66" (Circular)
72" (Circular)
84" (Circular)
FLO-2D Boundary
SCOTTSDALE RD
LOWER INDIAN BEND WASH
HAYDEN RD
GRANITE REEF RD
PIMA RD
SR101L
AZ CANAL
MCDONALD RD
JACKRABBIT RD
CHAPARRAL RD
CAMELBACK RD
INDIAN SCHOOL RD
OSBORN RD
THOMAS RD
OAK ST
MCDOWELL RD
ROOSEVELT ST
MCKELLIPS RD
MCCLINTOCK DR
MILLER RD
PIMA / MCDONALD STORM DRAIN
JACKRABBIT STORM DRAIN
PIMA / CHAPARRAL STORM DRAIN
CAMELBACK STORM DRAIN
NORTH INDIAN SCHOOL STORM DRAIN
PIMA / SOUTH INDIAN SCHOOL STORM DRAIN
PIMA / 87TH STREET STORM DRAIN
NORTH HAYDEN STORM DRAIN
WEST MCDOWELL STORM DRAIN
EAST MCDOWELL STORM DRAIN
84TH PLACE STORM DRAIN
SOUTH HAYDEN STORM DRAIN
Pipe to ADOT Channel
EMDDOUTFALL
Salt River Pima-Maricopa Indian Community (SRPMIC)
SAGUARO HIGH SCHOOL
MOHAVE MIDDLE SCHOOL
SCOTTSDALE COMMUNITY COLLEGE
WALMART
NAVAJO ELEMENTARY SCHOOL
PIMA ELEMENTARY SCHOOL
HOHOKAM ELEMENTARY SCHOOL
APACHE ELEMENTARY SCHOOL
GENERAL DYNAMICS
GREEN ACRES MEMORIAL PARK
GRANITE REEF WASH

Profile:

100 YEAR - 24 HOUR

Pima/McDonald Storm Drain

INP file created on 6/12/2015 3:34:06 PM by rkraft with inpPINS version 0.0.2.0



Outfall Max Flow= 18 cfs

Profile:

100 YEAR - 24 HOUR

Jackrabbit Storm Drain

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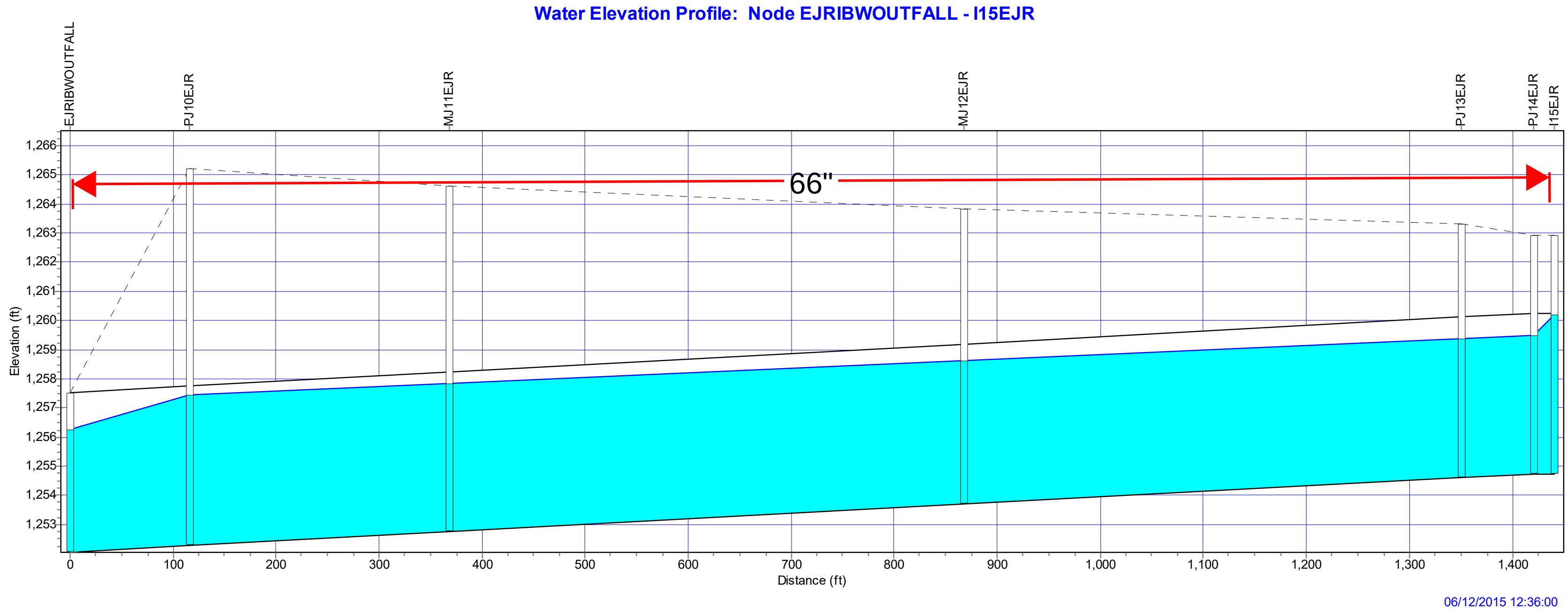

Outfall Max Flow= 157 cfs

Profile:

100 YEAR - 24 HOUR

Pima/Chaparral Storm Drain

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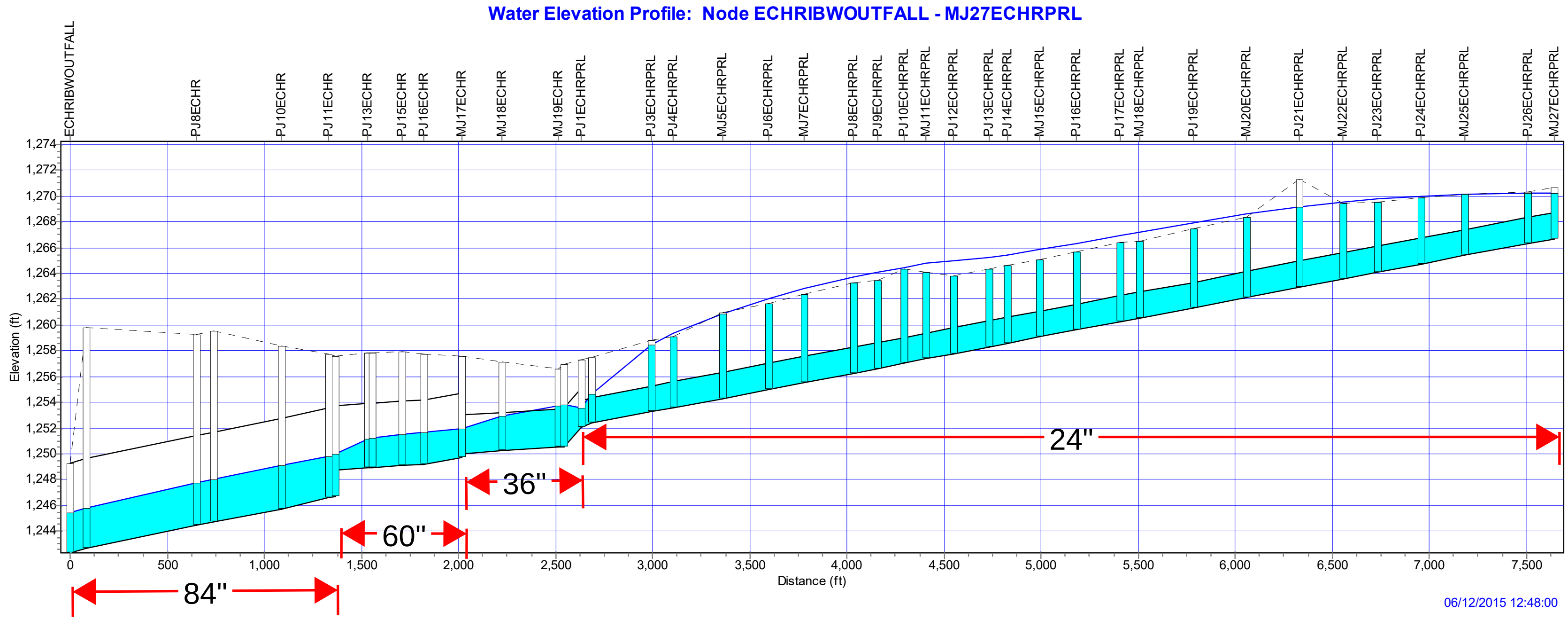

Outfall Max Flow= 167 cfs

Profile:

100 YEAR - 24 HOUR

Camelback Storm Drain

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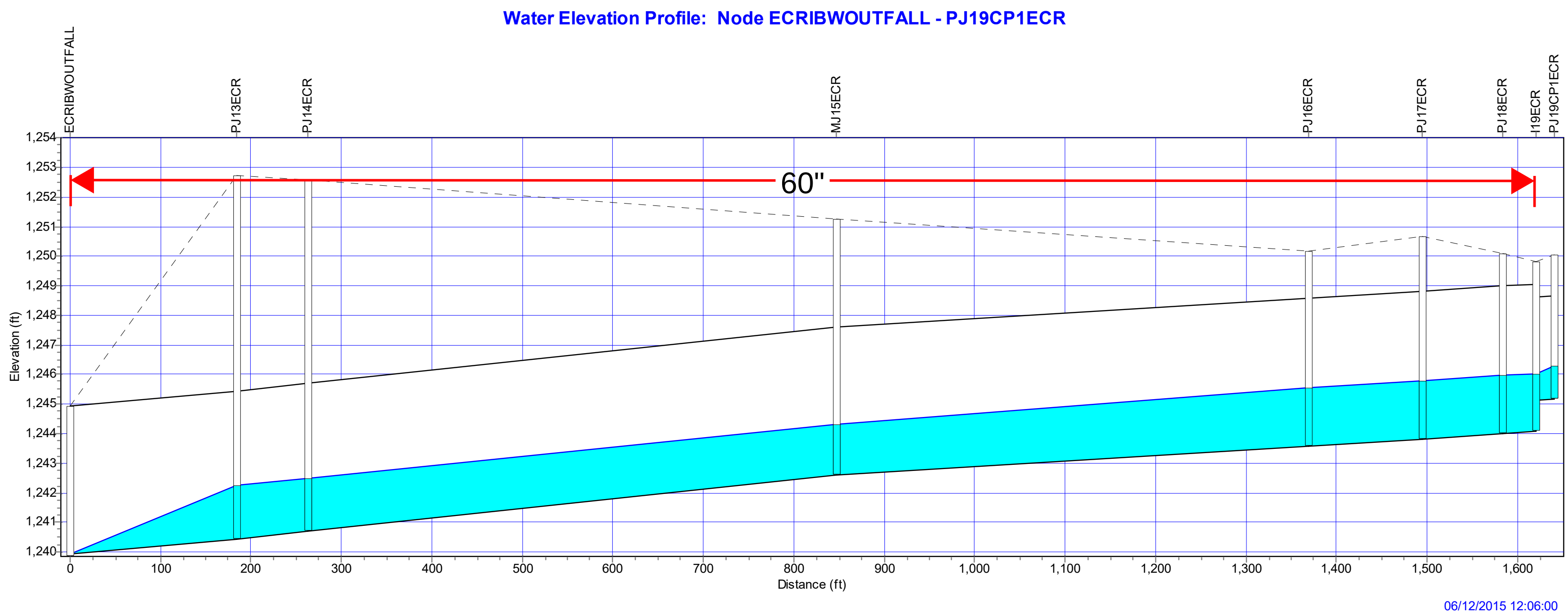

Outfall Max Flow= 40 cfs

Profile:

100 YEAR - 24 HOUR

Pima / South Indian School Storm Drain

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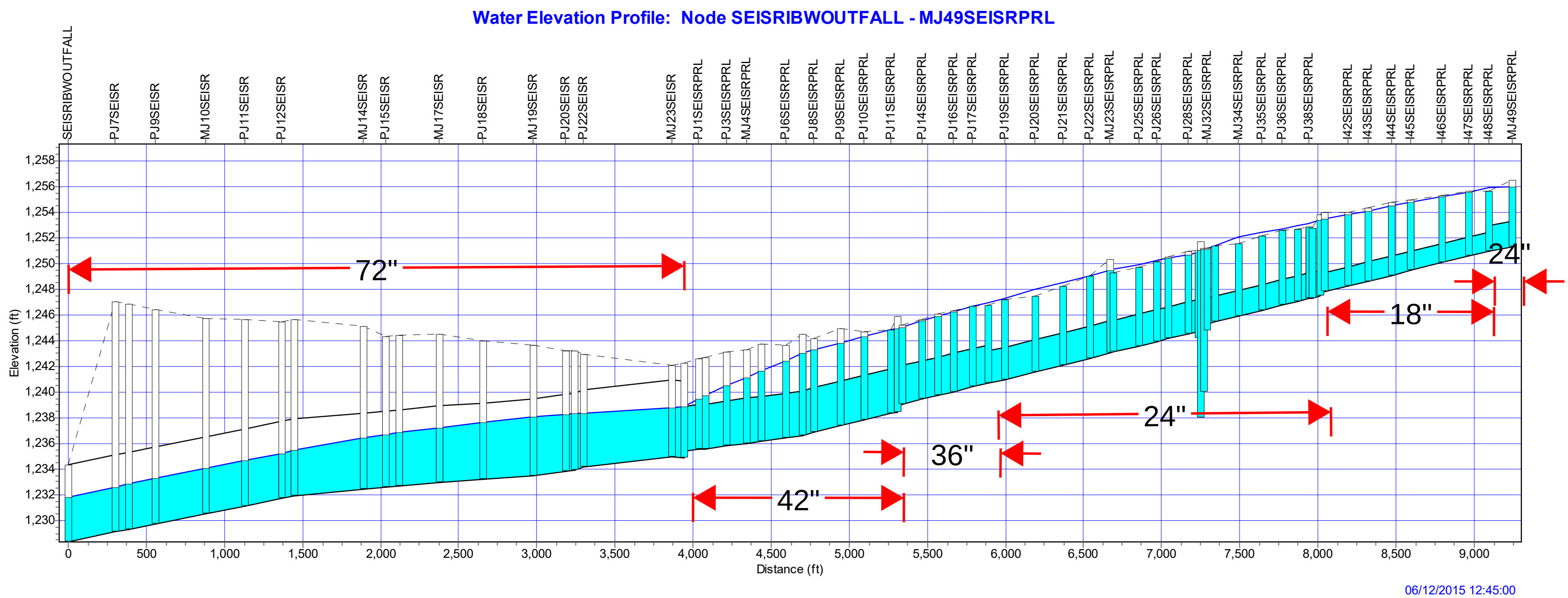

Outfall Max Flow= 143 cfs

Profile:

100 YEAR - 24 HOUR

North Indian School Storm Drain

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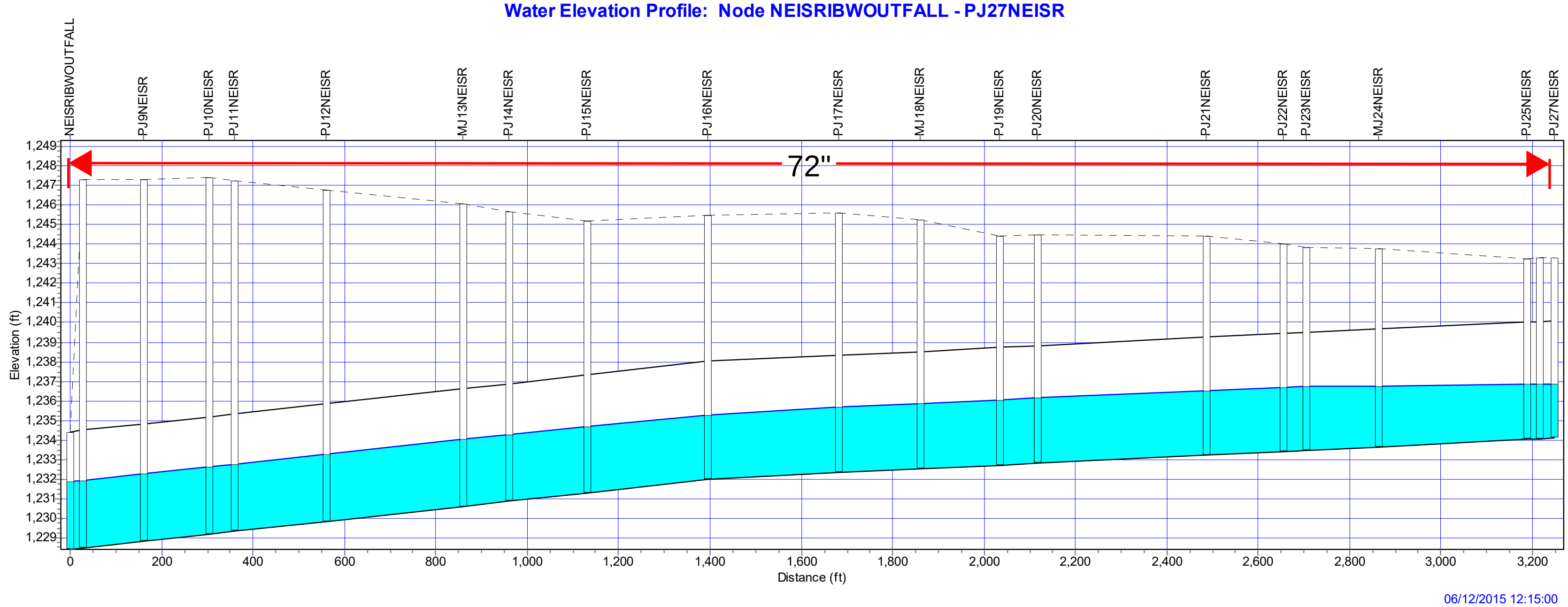

Outfall Max Flow= 134 cfs

Profile:

100 YEAR - 24 HOUR

Pima / 87th Street Storm Drain

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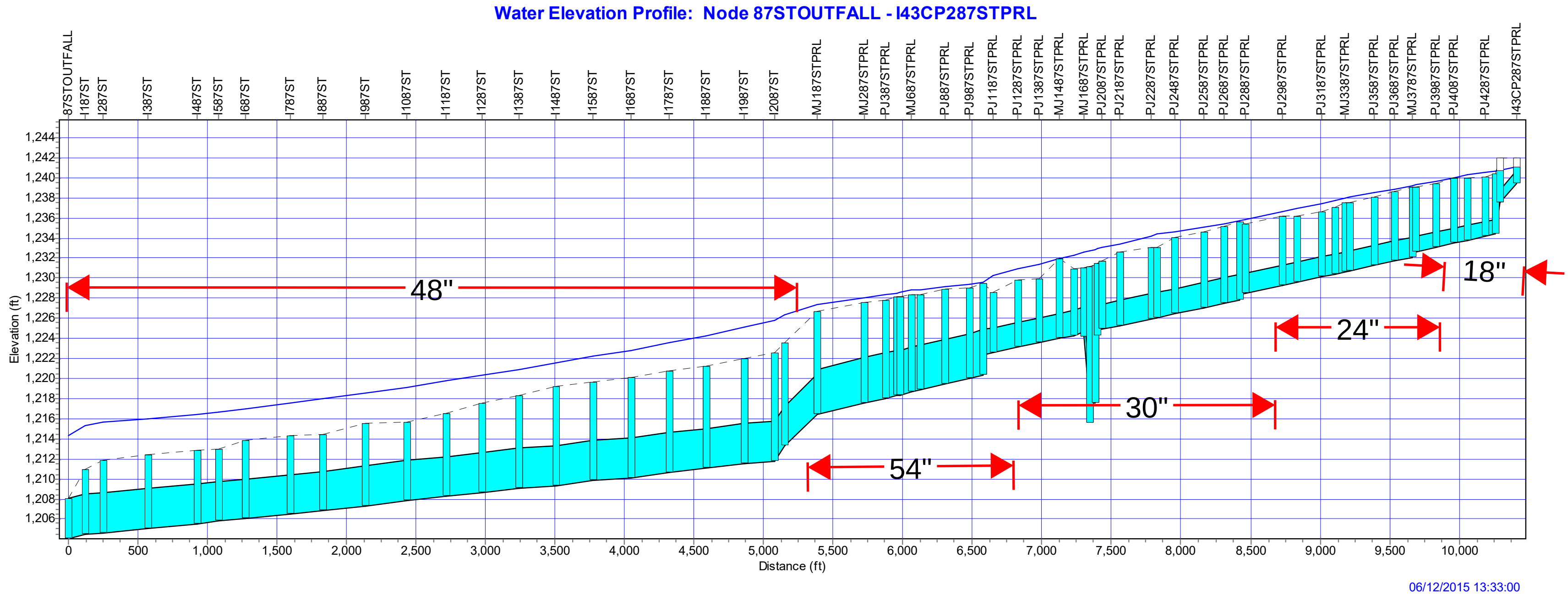

Outfall Max Flow= 71 cfs

Profile:

100 YEAR - 24 HOUR

East McDowell Storm Drain

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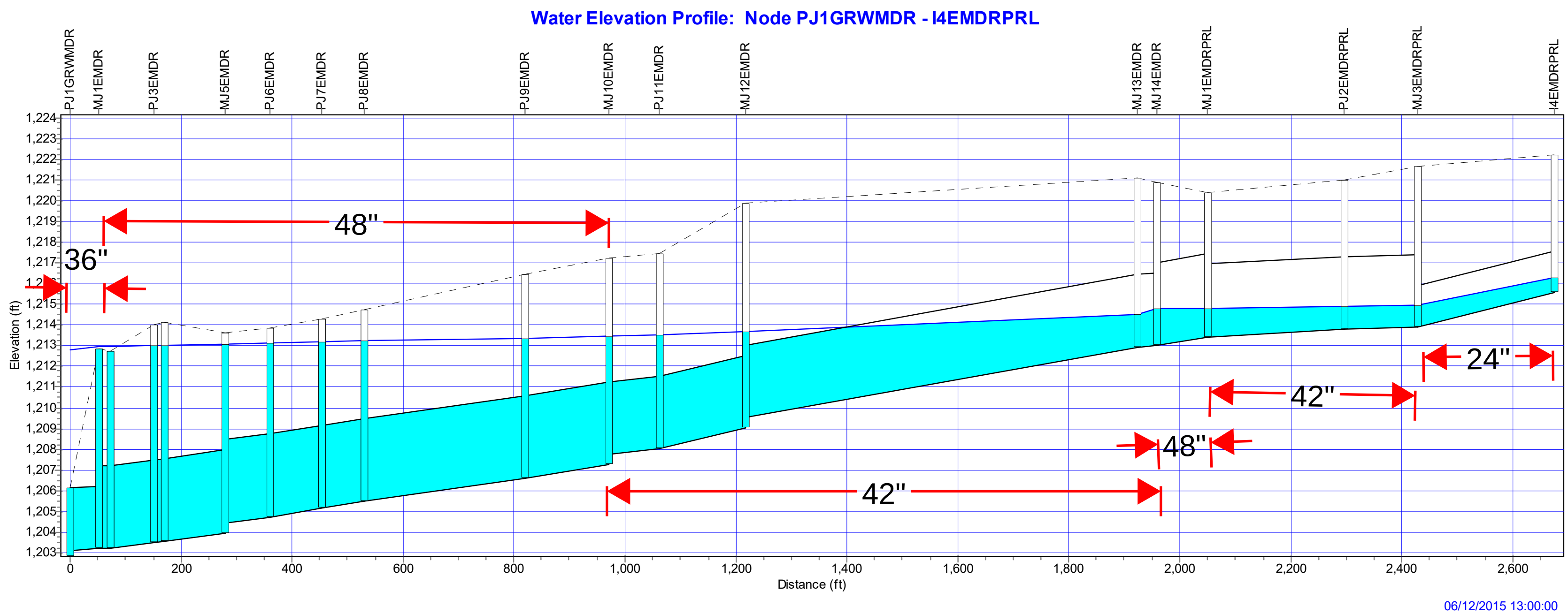

Outfall Max Flow= 48 cfs

Profile:

100 YEAR - 24 HOUR

West McDowell Storm Drain

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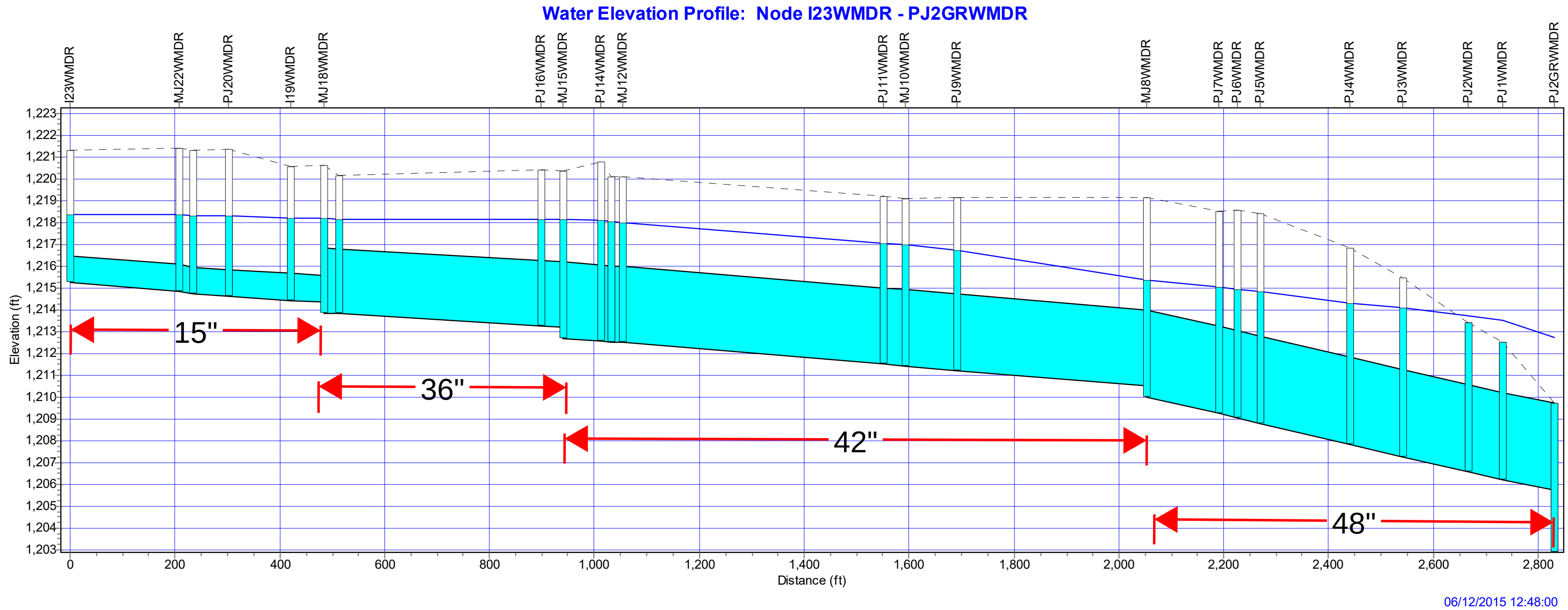

Outfall Max Flow= 76 cfs

Profile:

100 YEAR - 24 HOUR

North Hayden Storm Drain

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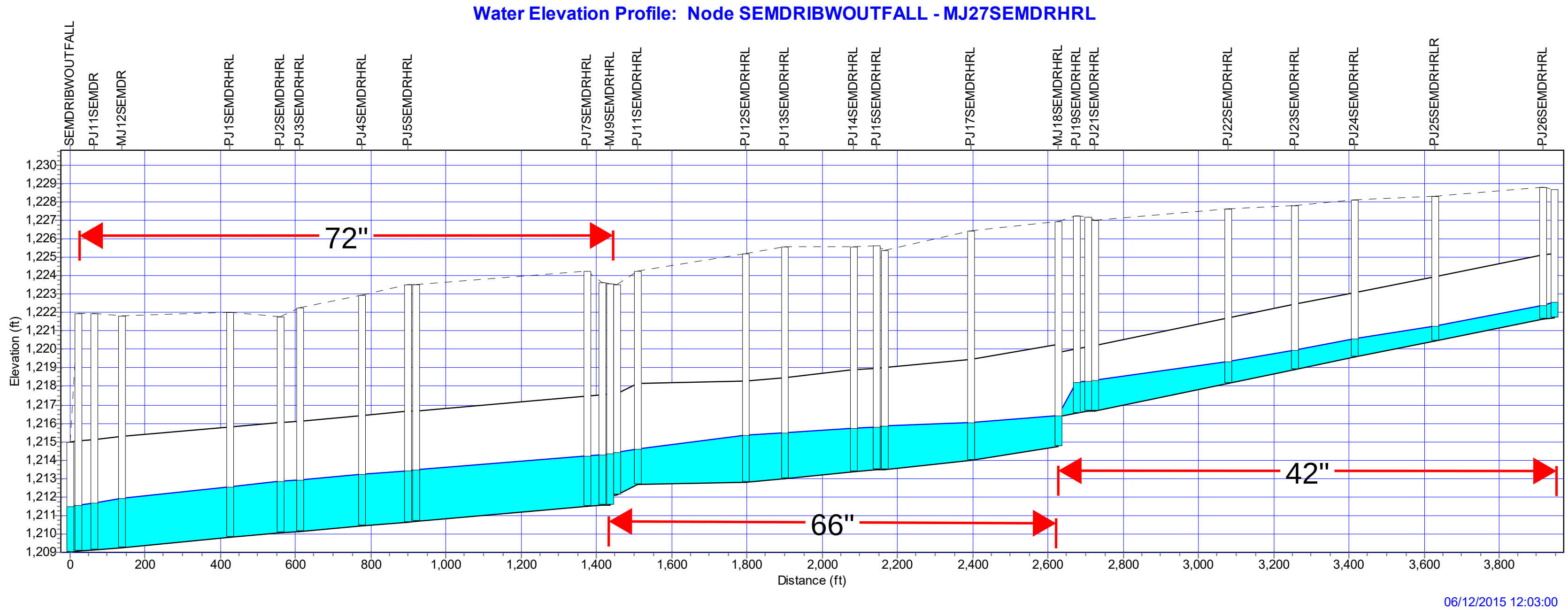

Outfall Max Flow= 89 cfs

Profile:

100 YEAR - 24 HOUR

84th Place Storm Drain

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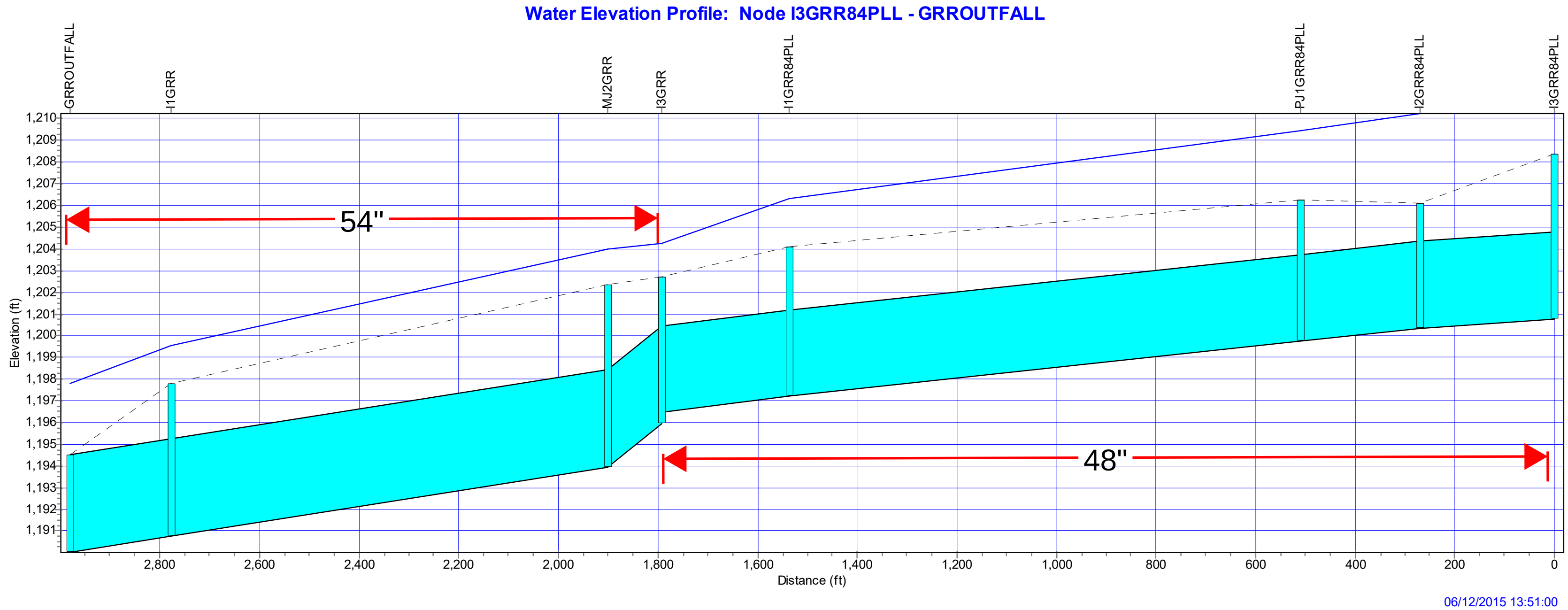

Outfall Max Flow= 128 cfs

Profile:

100 YEAR - 24 HOUR

South Hayden Storm Drain

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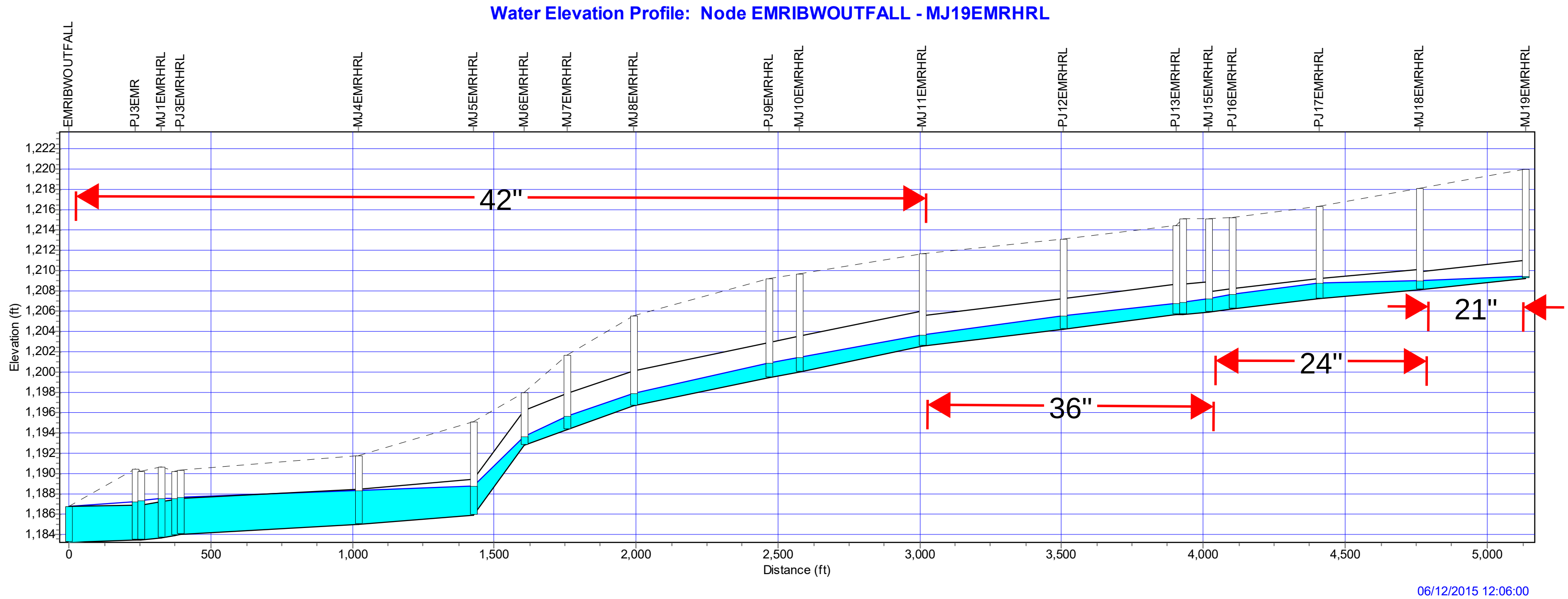

Outfall Max Flow= 44 cfs

Profile:

100 YEAR - 6 HOUR

Pima/McDonald Storm Drain

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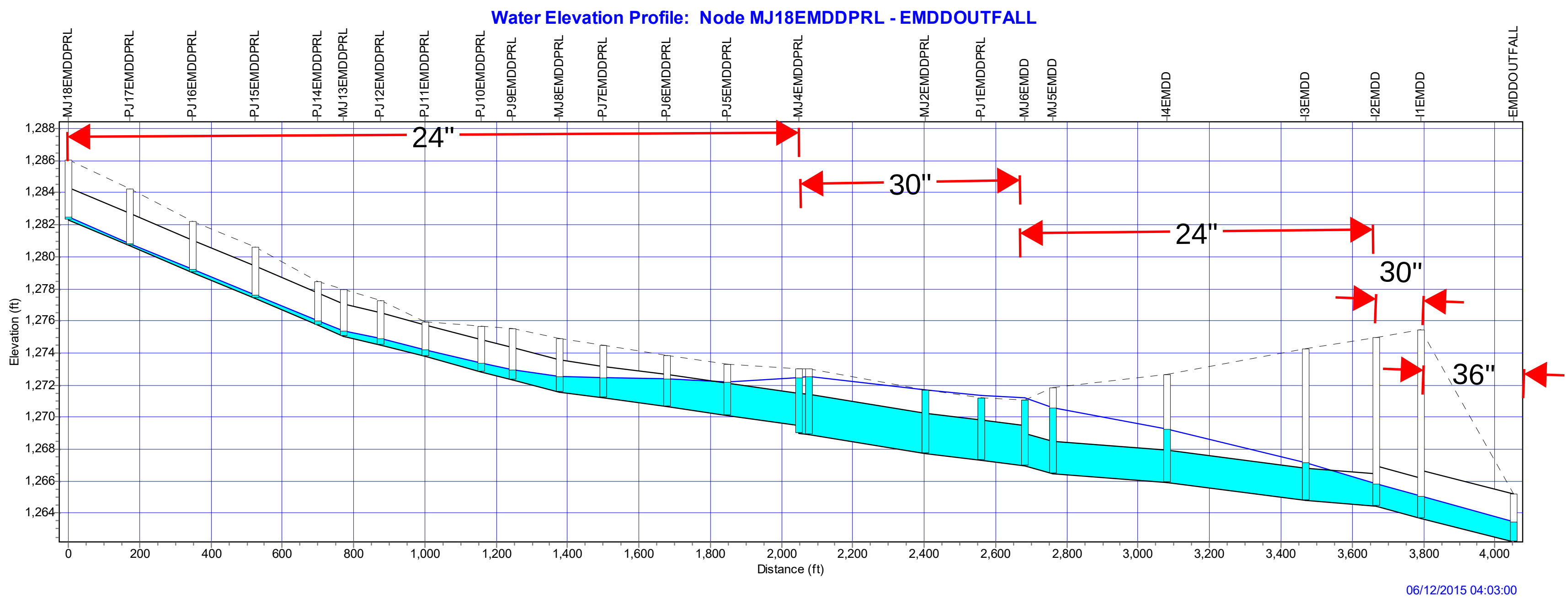

Outfall Max Flow= 19 cfs

Profile:

100 YEAR - 6 HOUR

Jackrabbit Storm Drain

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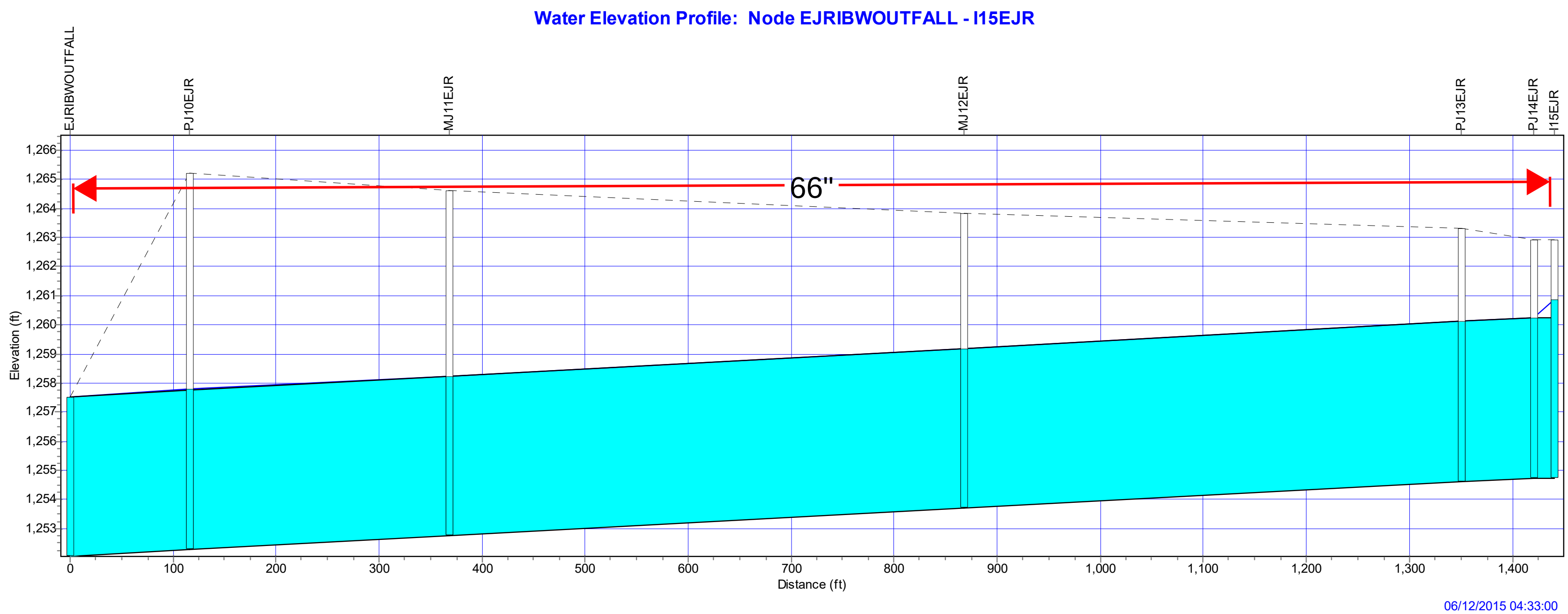

Outfall Max Flow= 157 cfs

Profile:

100 YEAR - 6 HOUR

Pima/Chaparral Storm Drain

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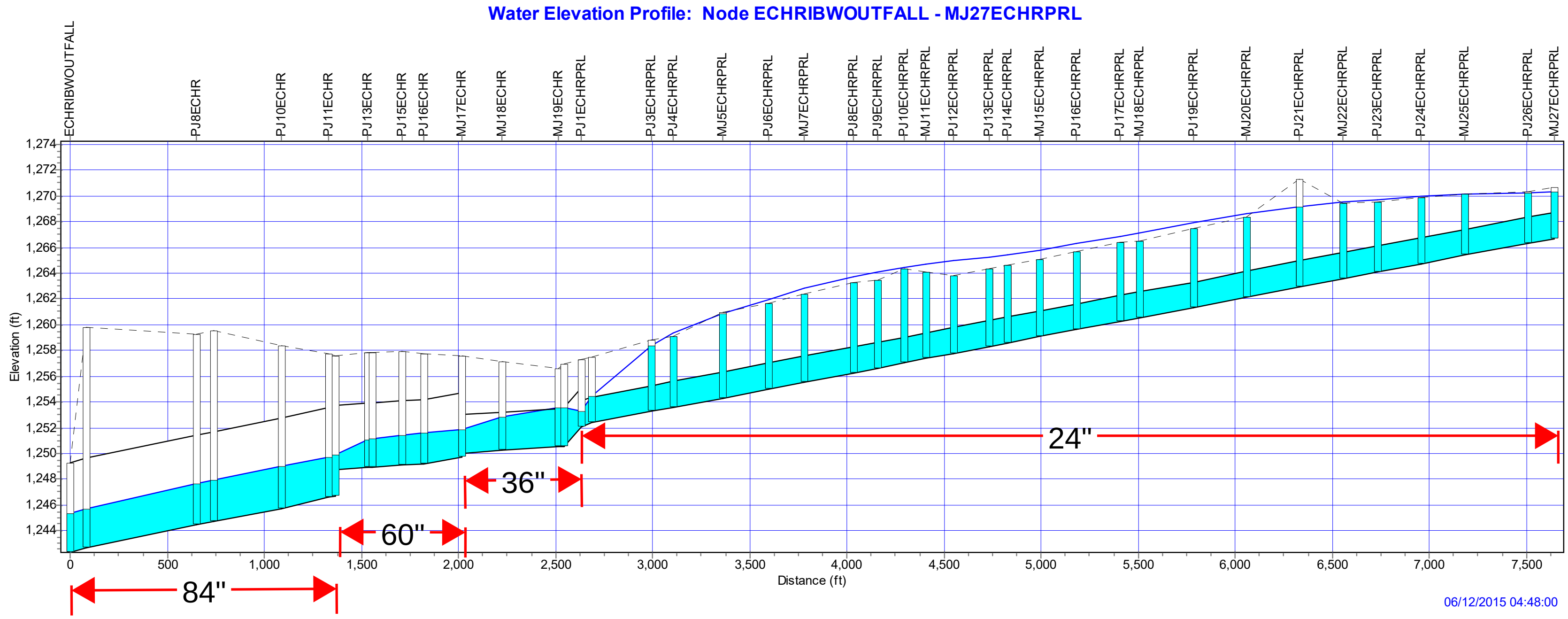

Outfall Max Flow= 168 cfs

Profile:

100 YEAR - 6 HOUR

Camelback Storm Drain

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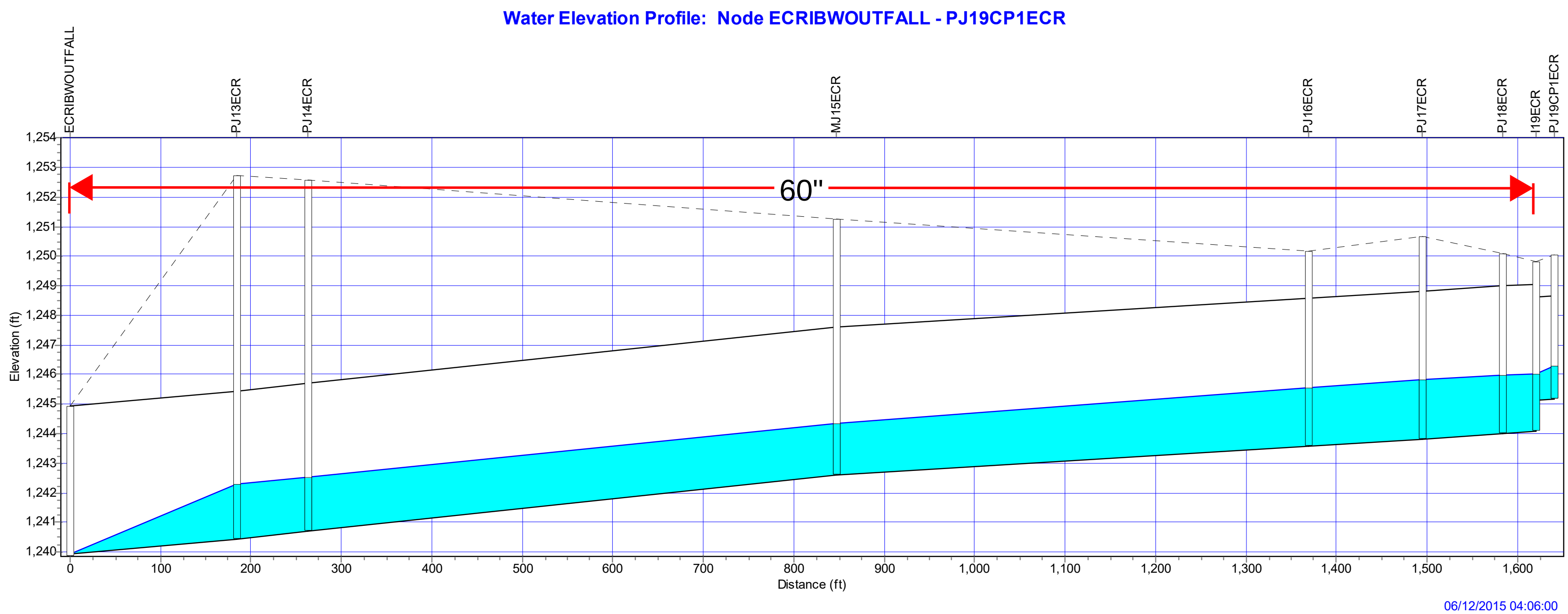

Outfall Max Flow= 41 cfs

Profile:

100 YEAR - 6 HOUR

Pima / South Indian School Storm Drain

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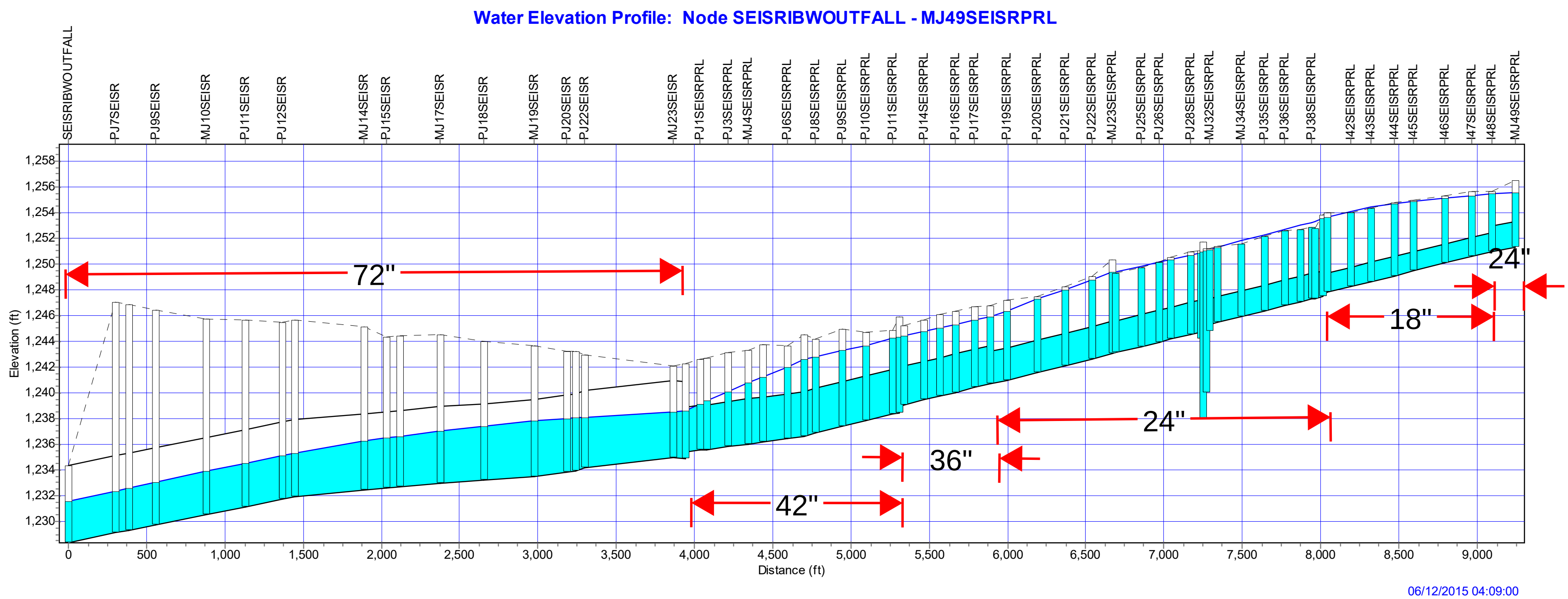

Outfall Max Flow= 148 cfs

Profile:

100 YEAR - 6 HOUR

North Indian School Storm Drain

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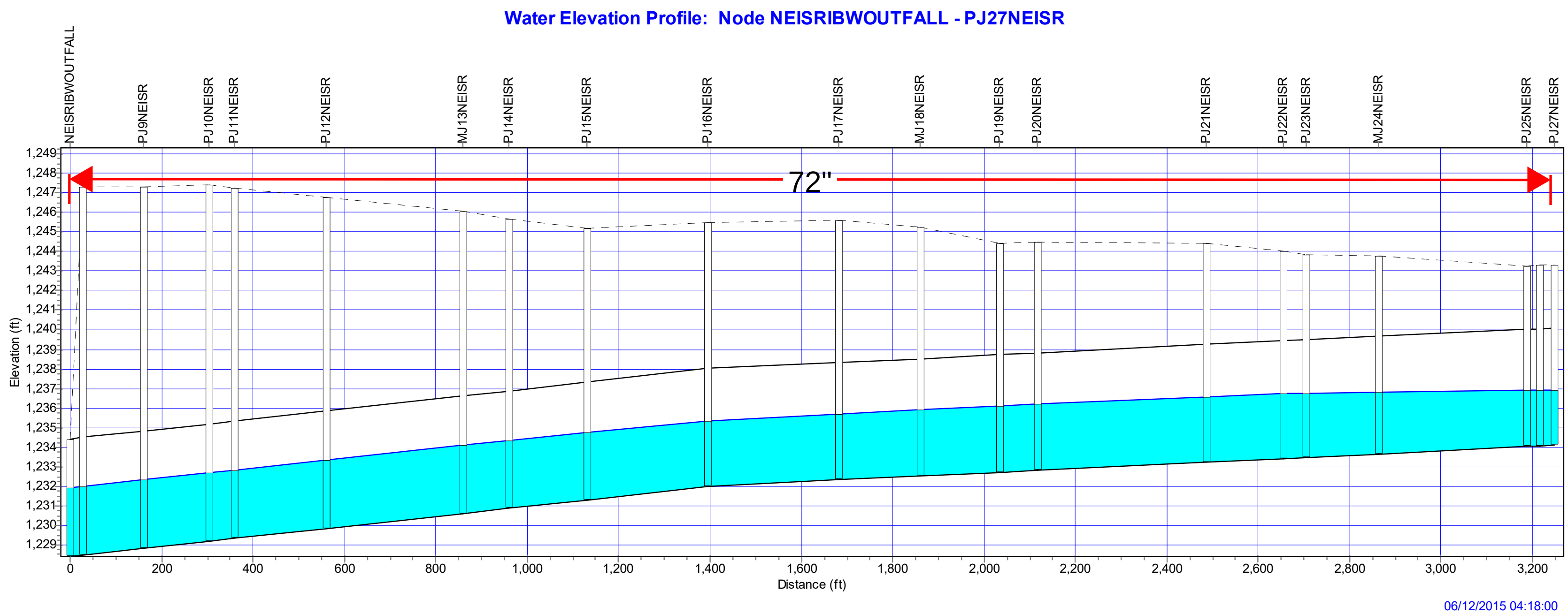

Outfall Max Flow= 137 cfs

Profile:

100 YEAR - 6 HOUR

Pima / 87th Street Storm Drain

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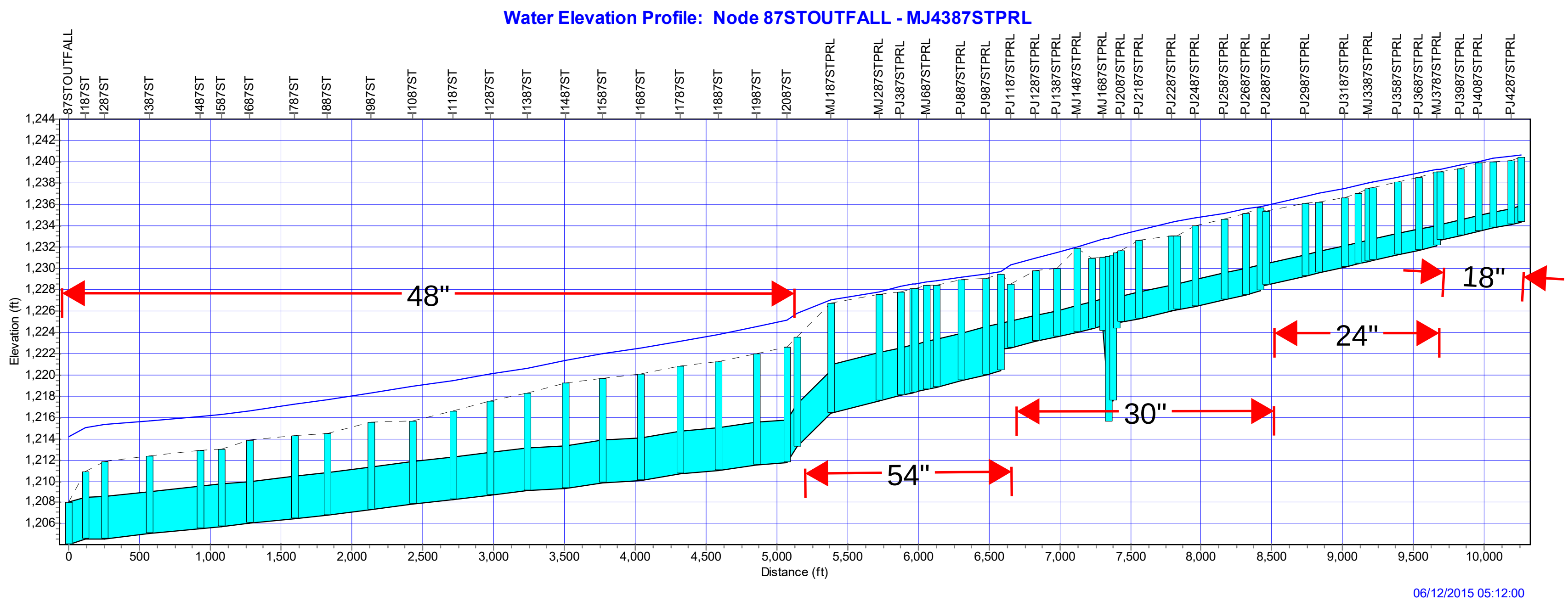

Outfall Max Flow= 81 cfs

Profile:

100 YEAR - 6 HOUR

East McDowell Storm Drain

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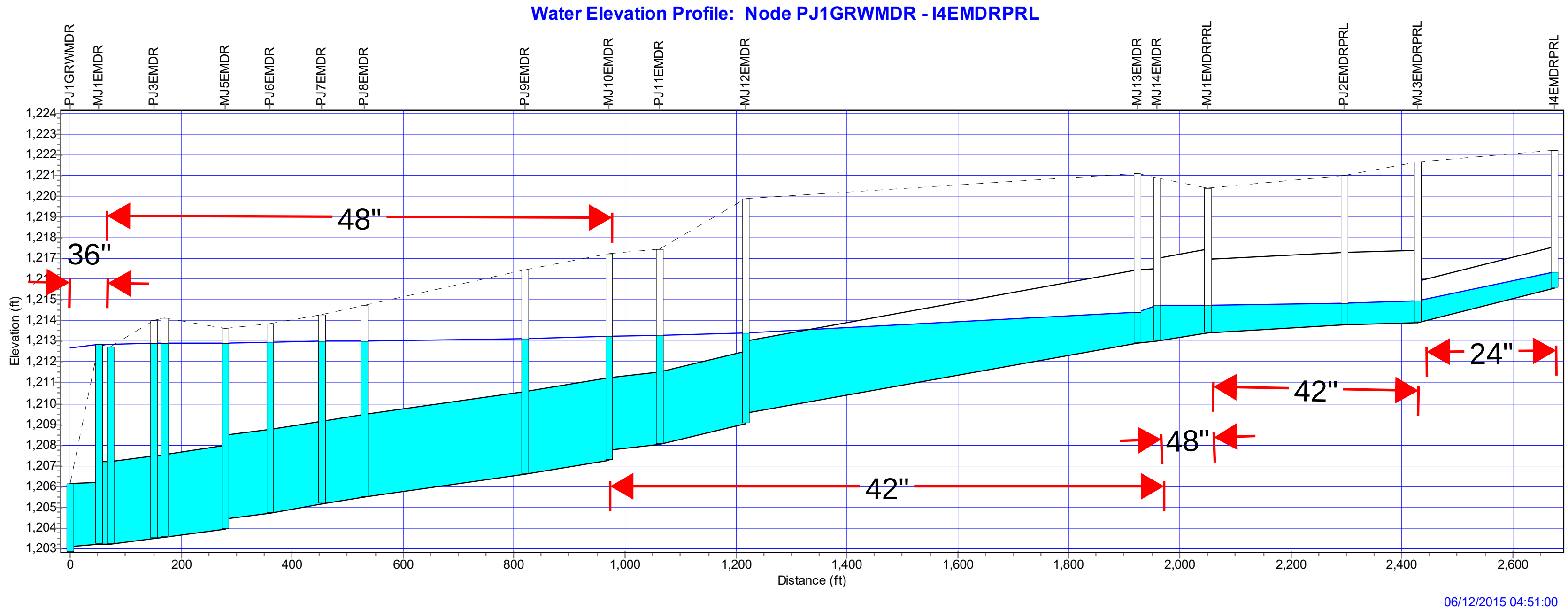

Outfall Max Flow= 51 cfs

Profile:

100 YEAR - 6 HOUR

West McDowell Storm Drain

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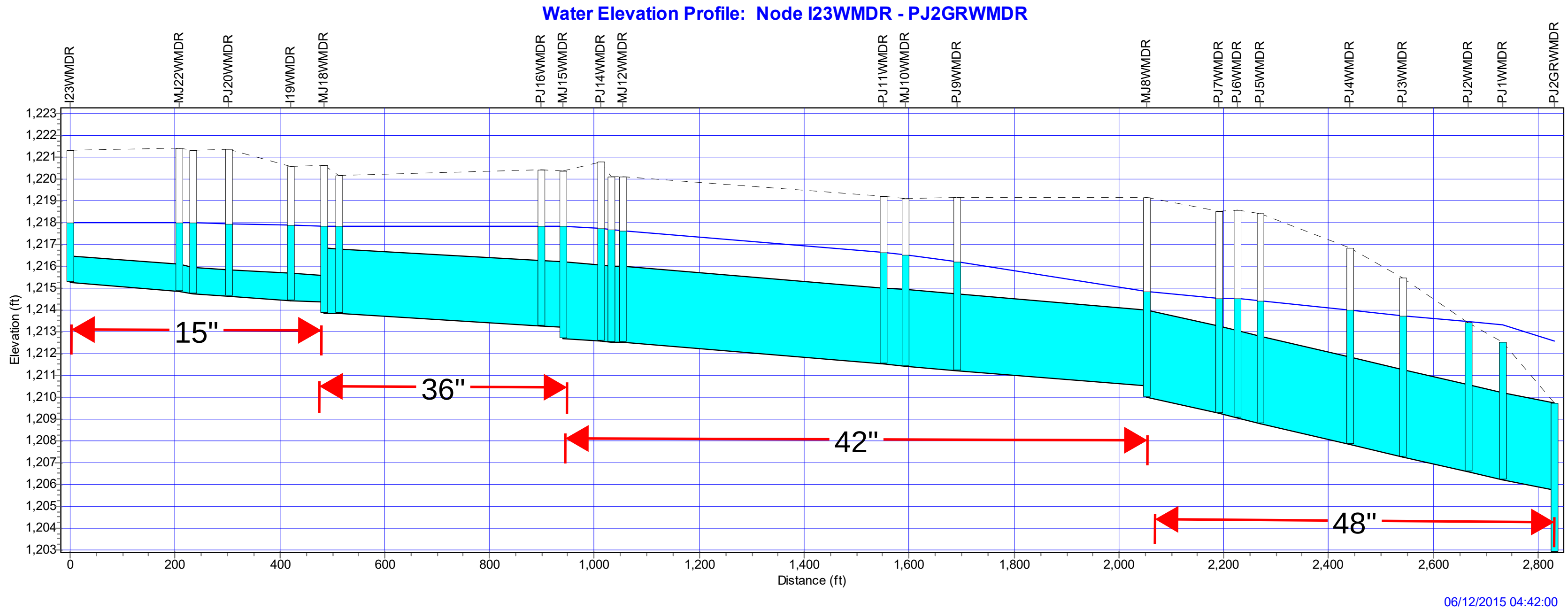

Outfall Max Flow= 70 cfs

Profile:

100 YEAR - 6 HOUR

North Hayden Storm Drain

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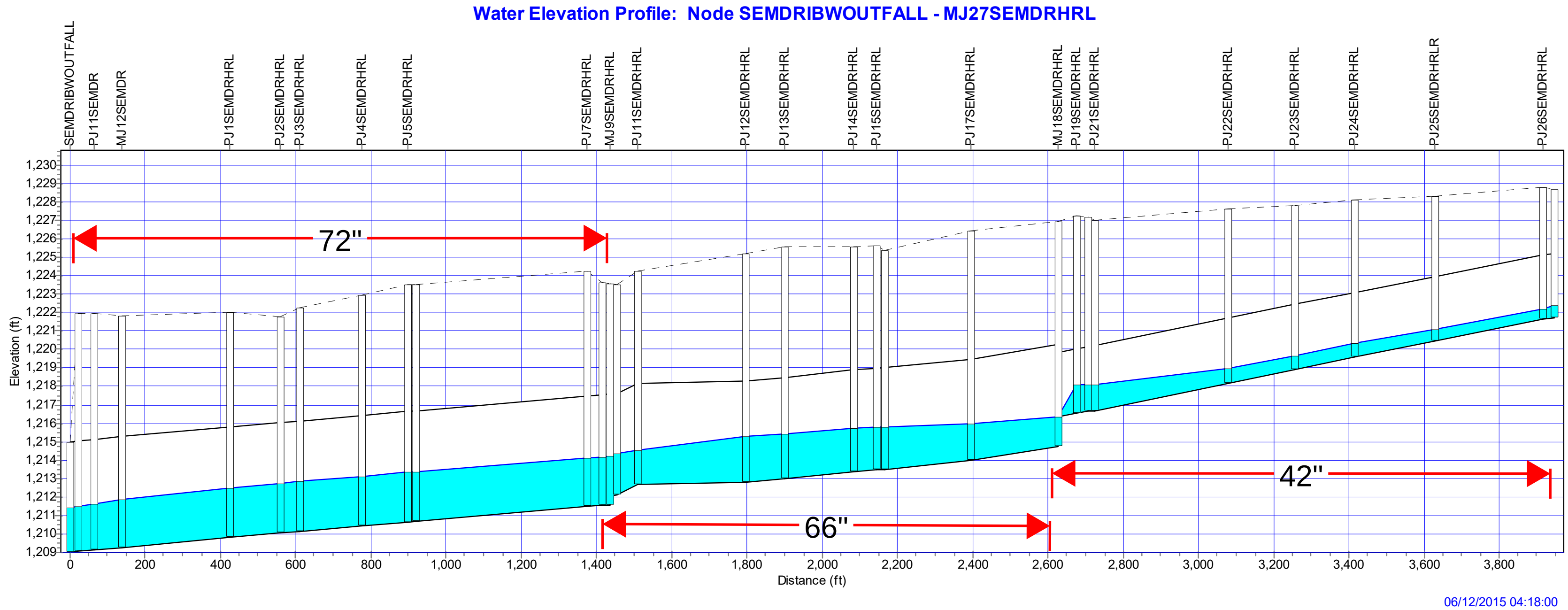

Outfall Max Flow= 90 cfs

Profile:

100 YEAR - 6 HOUR

84th Place Storm Drain

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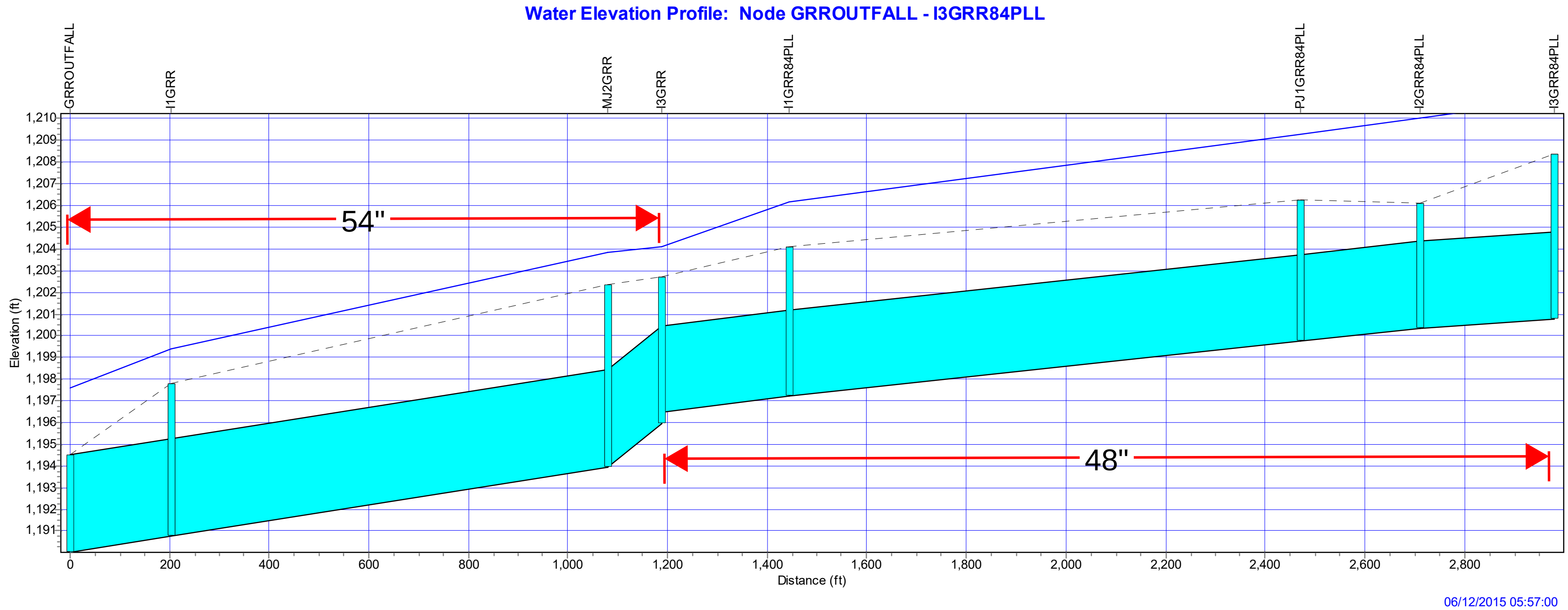

Outfall Max Flow= 128 cfs

Profile:

100 YEAR - 6 HOUR

South Hayden Storm Drain

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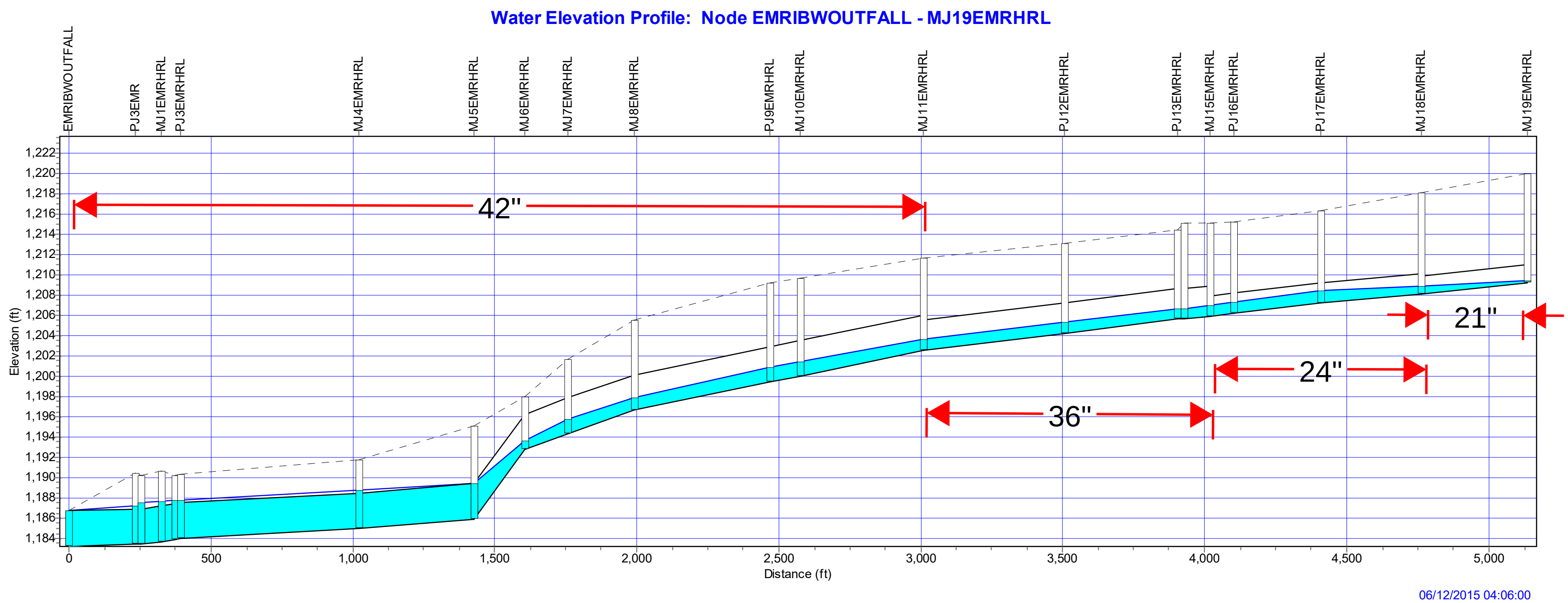

Outfall Max Flow= 50 cfs

Profile:

10 YEAR - 24 HOUR

Pima/McDonald Storm Drain

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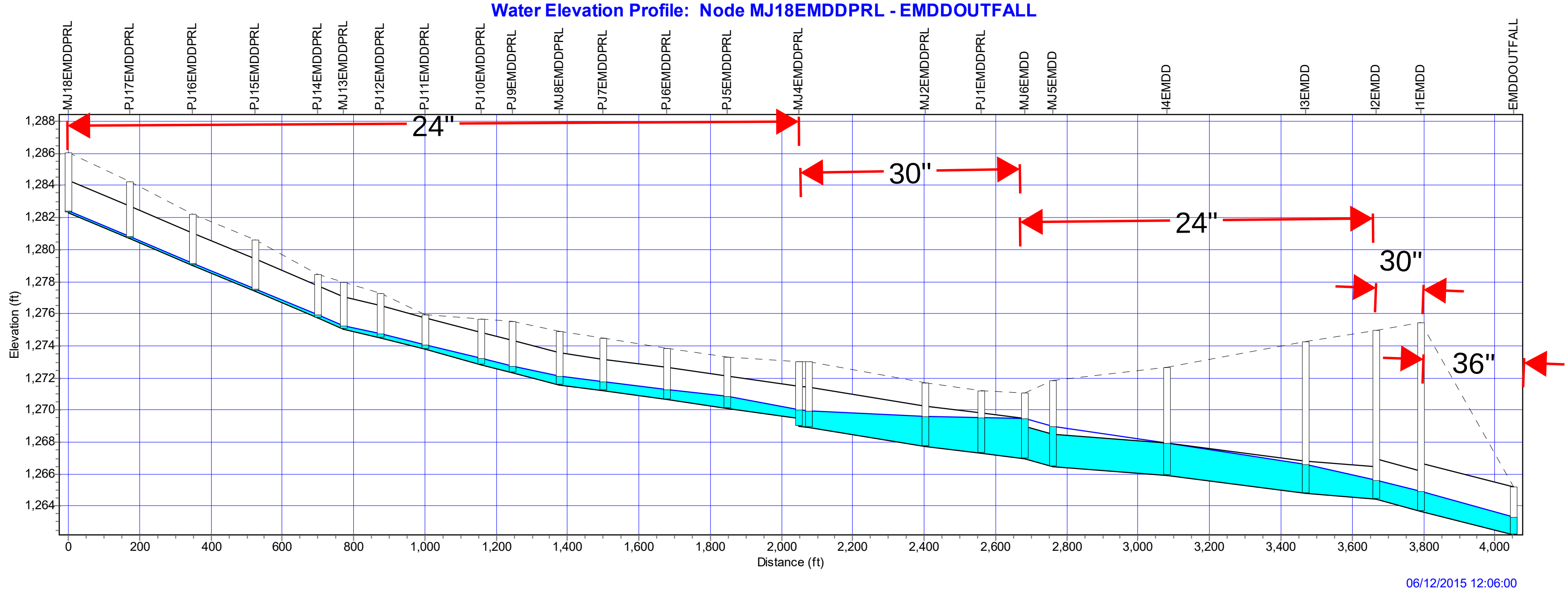

Outfall Max Flow= 14 cfs

Profile:

10 YEAR - 24 HOUR

Jackrabbit Storm Drain

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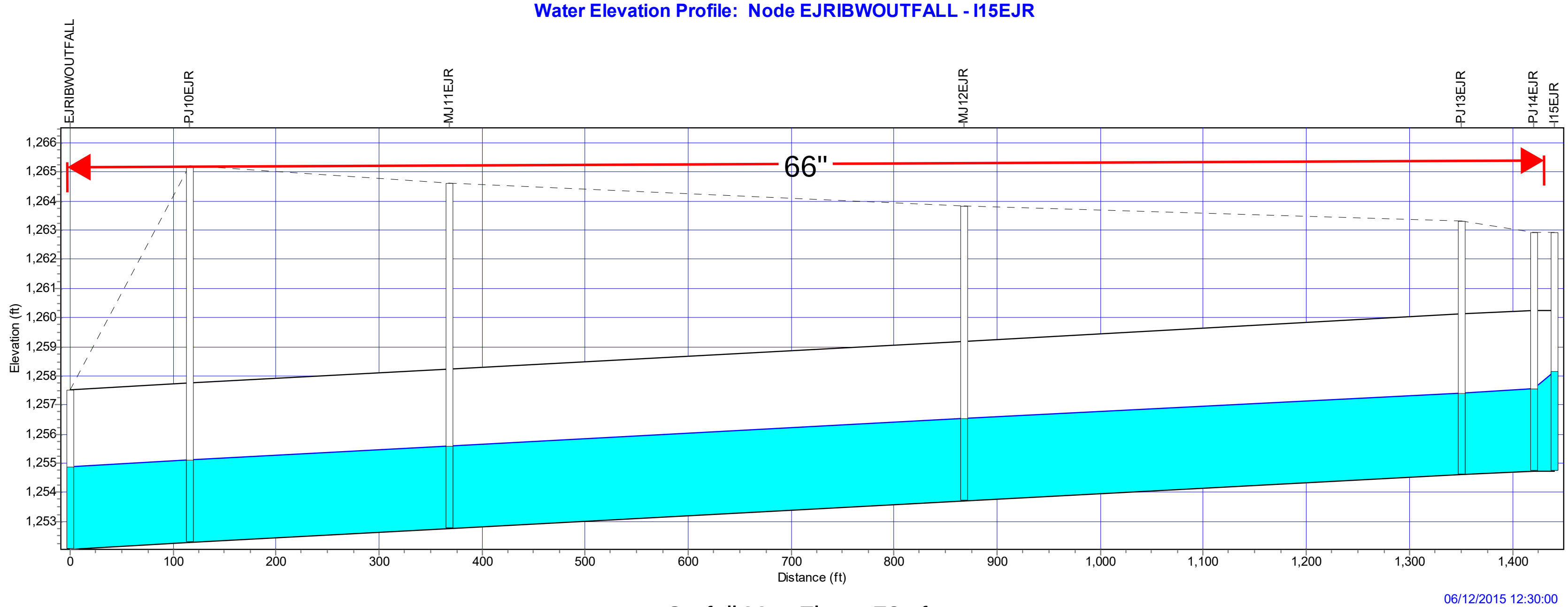


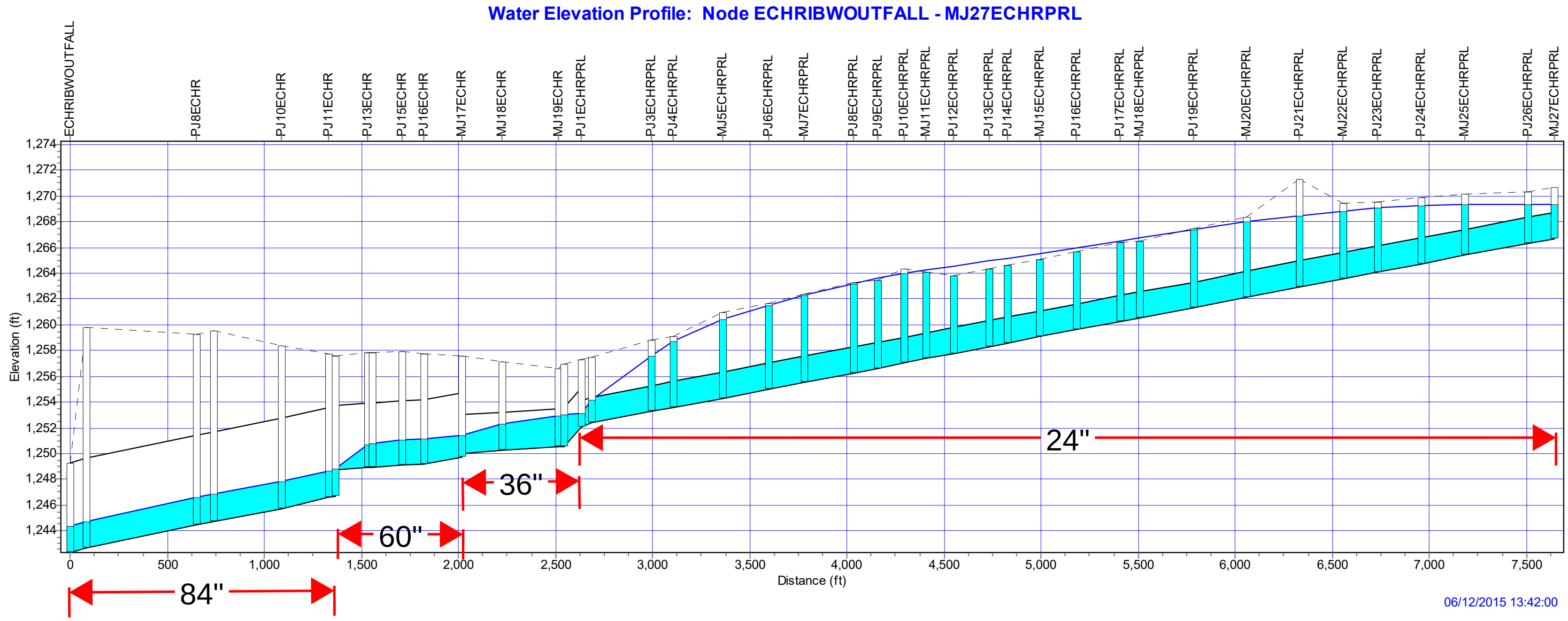
Outfall Max Flow= 78 cfs

Profile:

10 YEAR - 24 HOUR

Pima/Chaparral Storm Drain

INP file created on 6/12/2015 3:34:06 PM by rkraft with inpPINS version 0.0.2.0



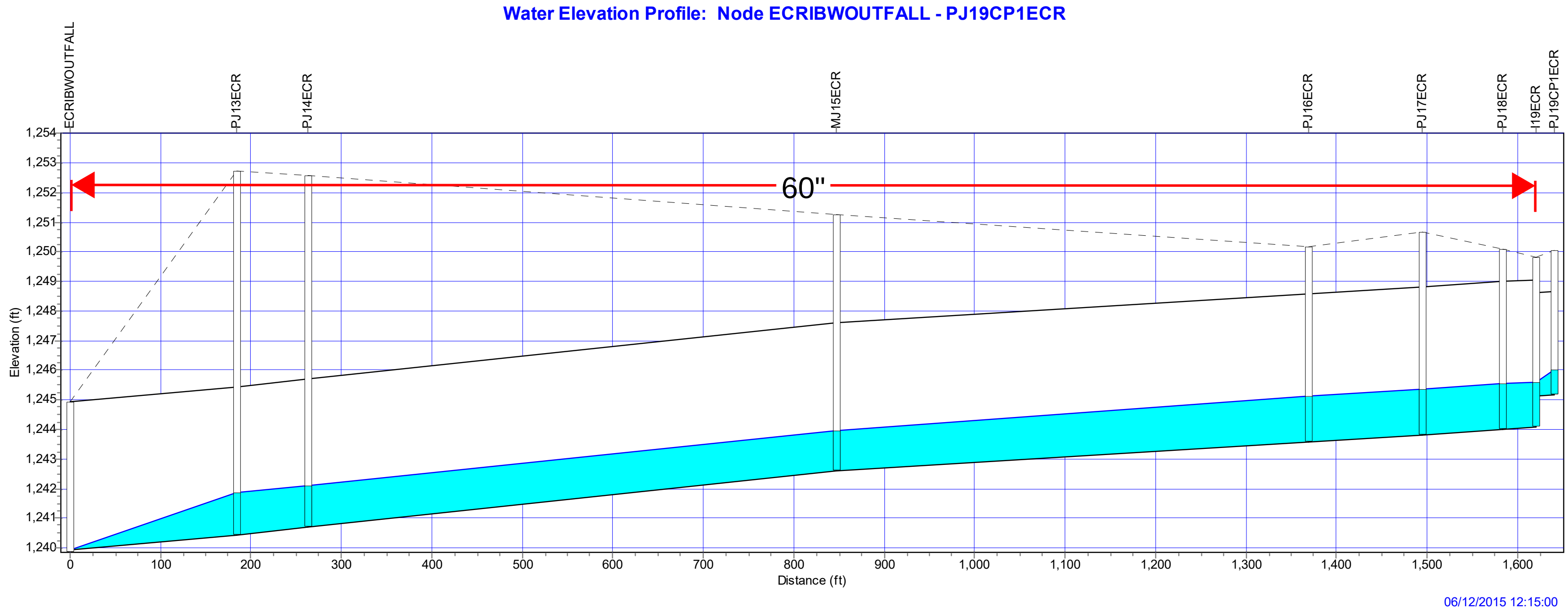
Outfall Max Flow= 100 cfs

Profile:

10 YEAR - 24 HOUR

Camelback Storm Drain

INP file created on 6/12/2015 3:34:06 PM by rkraft with inpPINS version 0.0.2.0



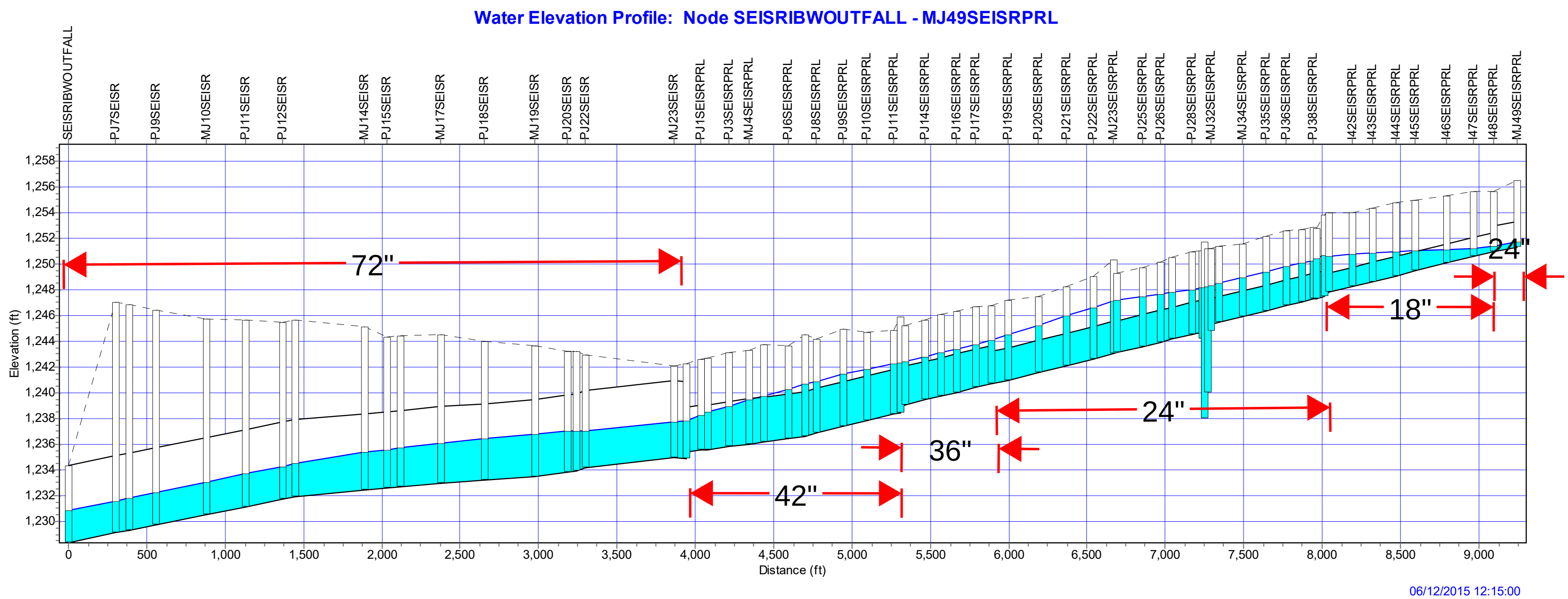
Outfall Max Flow= 25 cfs

Profile:

10 YEAR - 24 HOUR

Pima / South Indian School Storm Drain

INP file created on 6/12/2015 3:34:06 PM by rkraft with inpPINS version 0.0.2.0



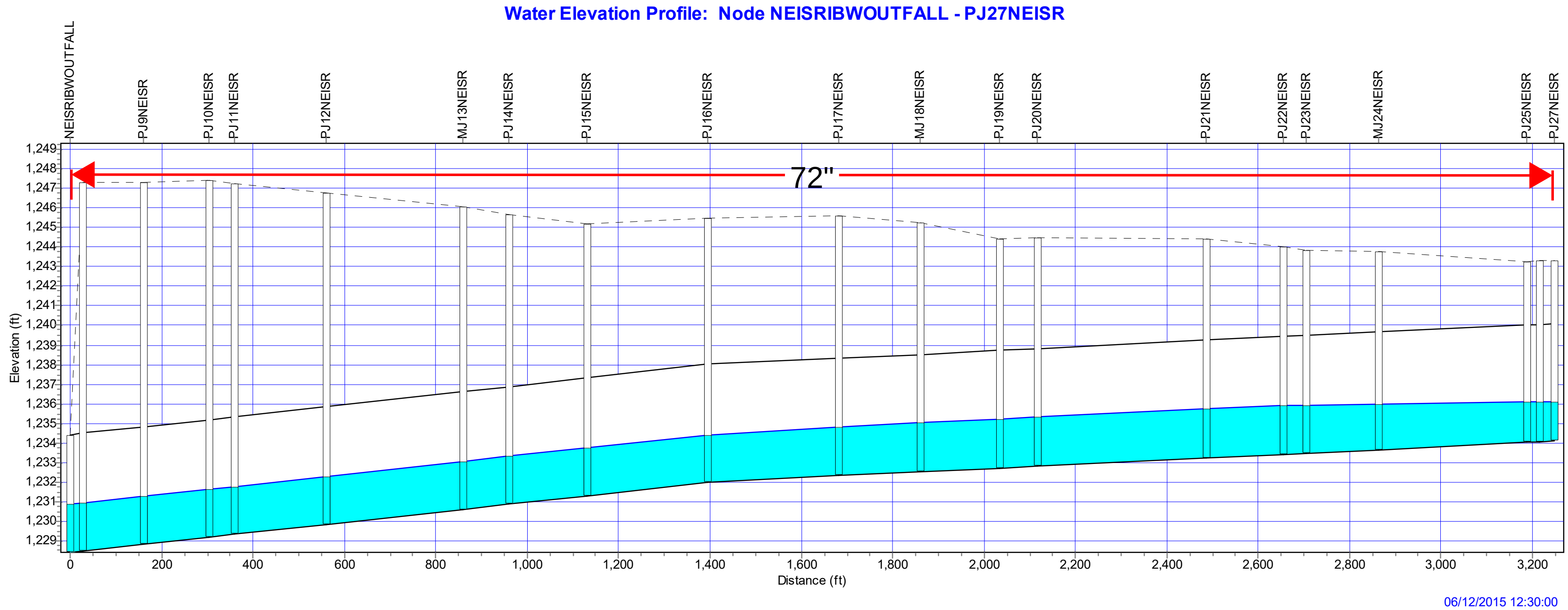
Outfall Max Flow= 83 cfs

Profile:

10 YEAR - 24 HOUR

North Indian School Storm Drain

INP file created on 6/12/2015 3:34:06 PM by rkraft with inpPINS version 0.0.2.0



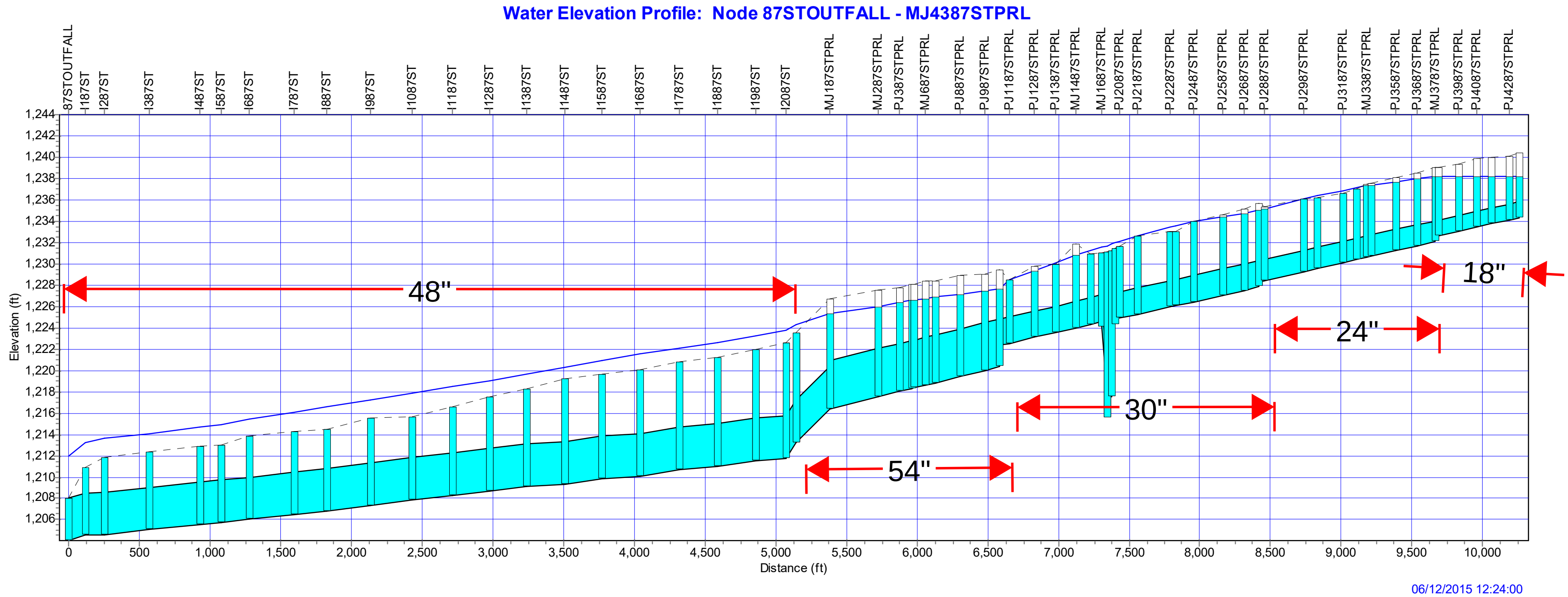
Outfall Max Flow= 75 cfs

Profile:

10 YEAR - 24 HOUR

Pima / 87th Street Storm Drain

INP file created on 6/12/2015 3:34:06 PM by rkraft with inpPINS version 0.0.2.0



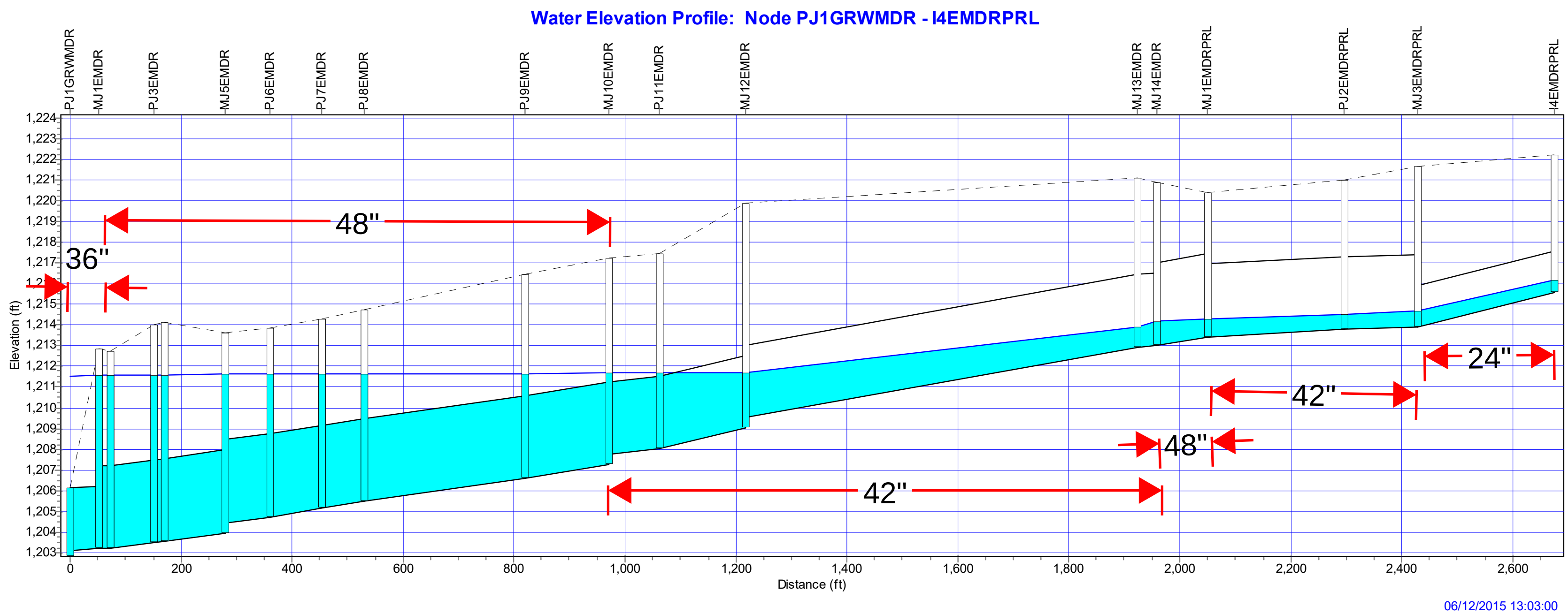
Outfall Max Flow= 76 cfs

Profile:

10 YEAR - 24 HOUR

East McDowell Storm Drain

INP file created on 6/12/2015 3:34:06 PM by rkraft with inpPINS version 0.0.2.0



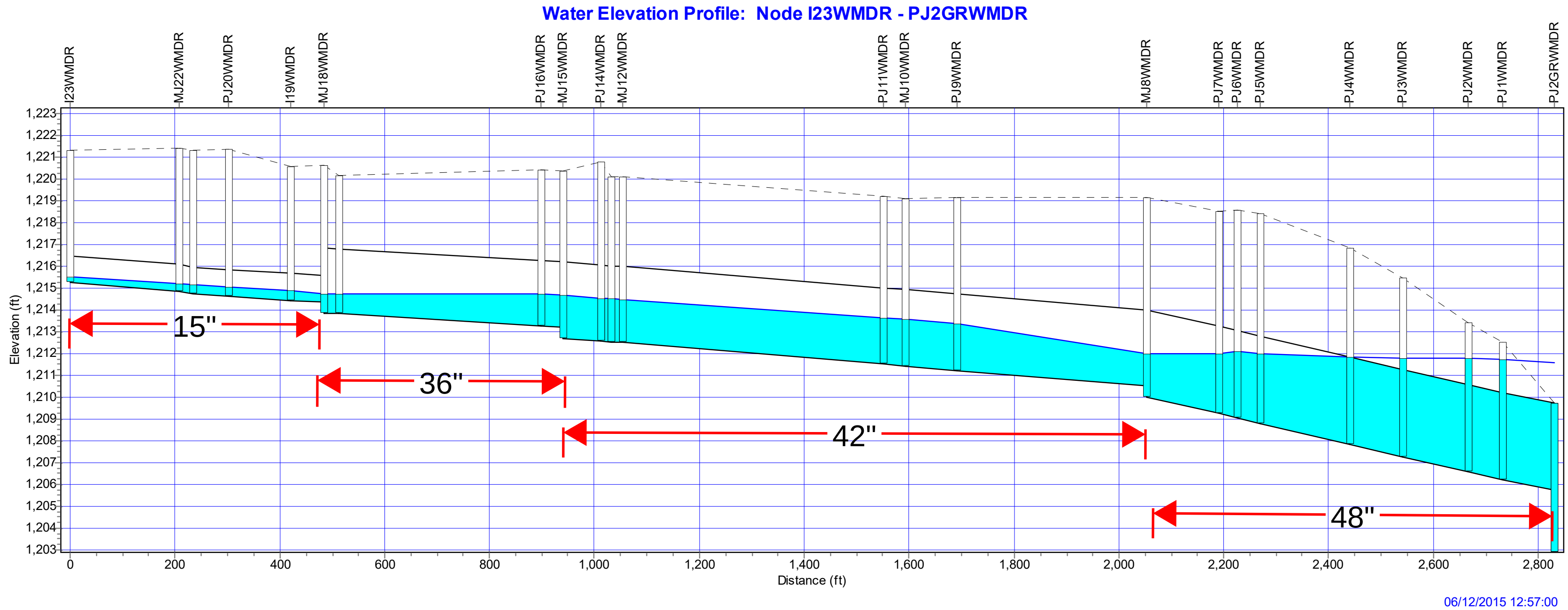
Outfall Max Flow= 30 cfs

Profile:

10 YEAR - 24 HOUR

West McDowell Storm Drain

INP file created on 6/12/2015 3:34:06 PM by rkraft with inpPINS version 0.0.2.0



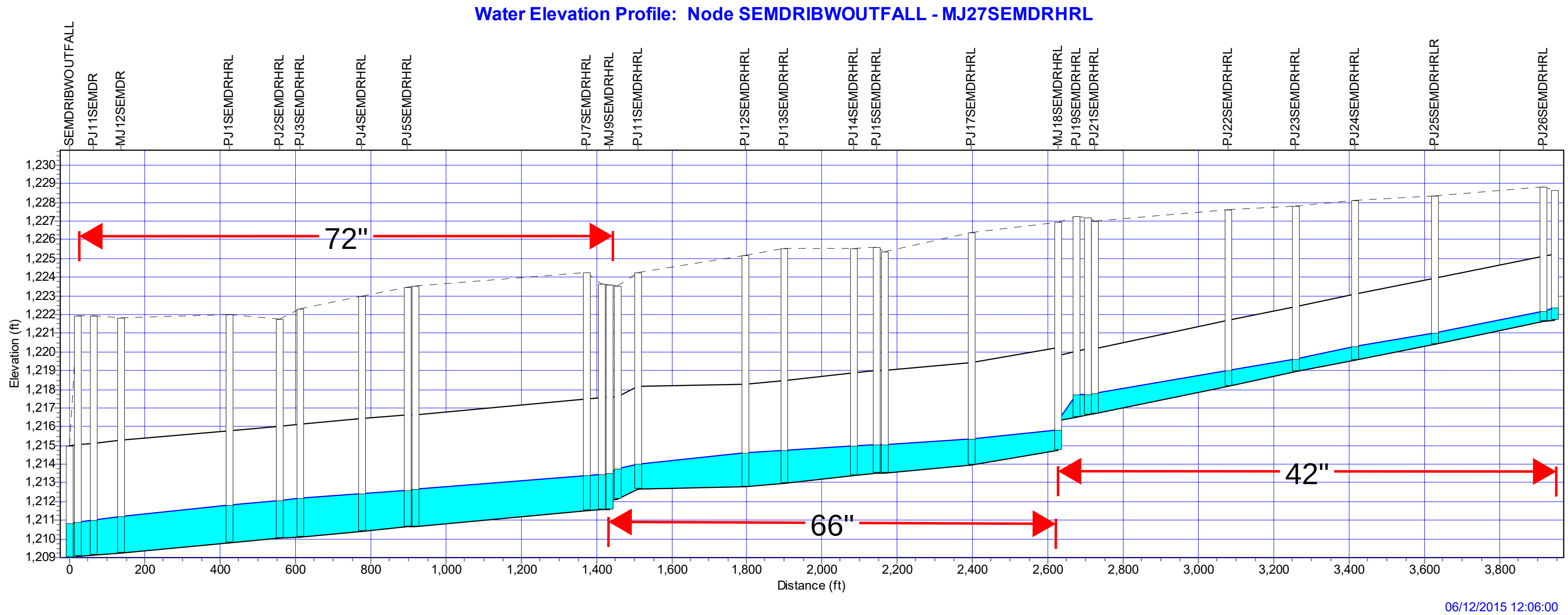
Outfall Max Flow= 38 cfs

Profile:

10 YEAR - 24 HOUR

North Hayden Storm Drain

INP file created on 6/12/2015 3:34:06 PM by rkraft with inpPINS version 0.0.2.0



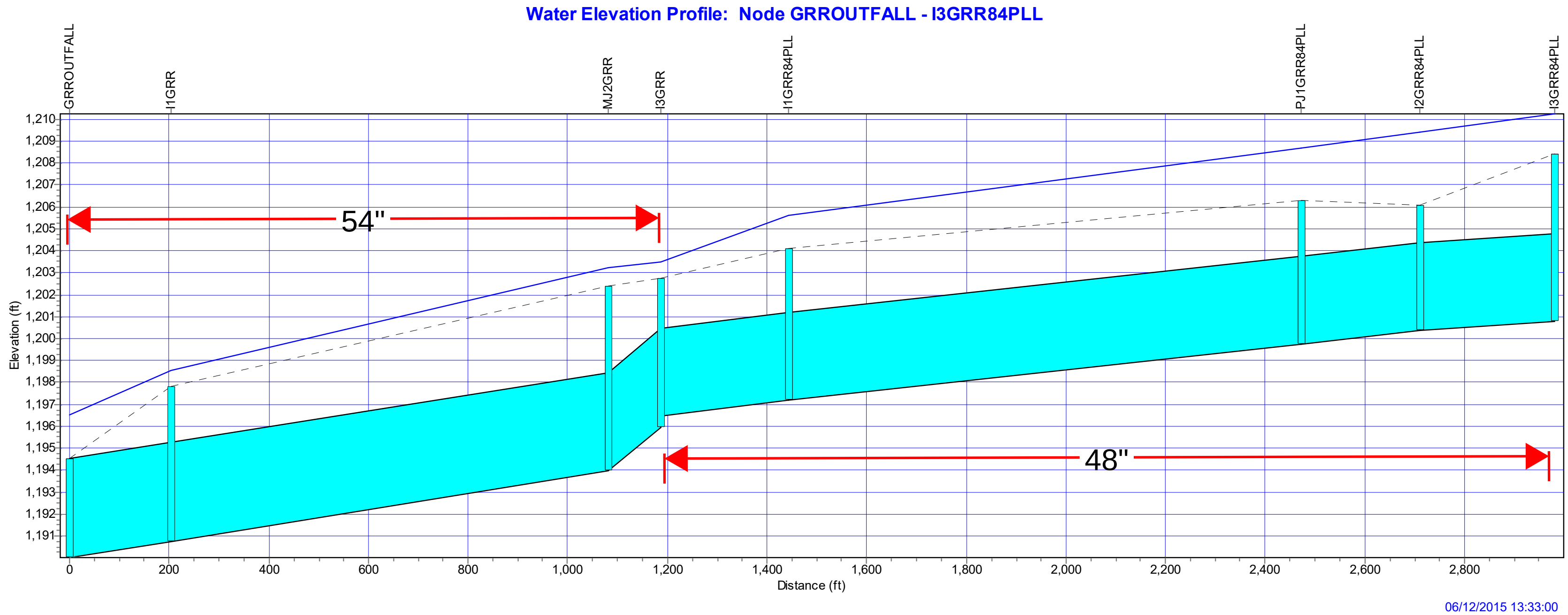
Outfall Max Flow= 46 cfs

Profile:

10 YEAR - 24 HOUR

84th Place Storm Drain

INP file created on 6/12/2015 3:34:06 PM by rkraft with inpPINS version 0.0.2.0



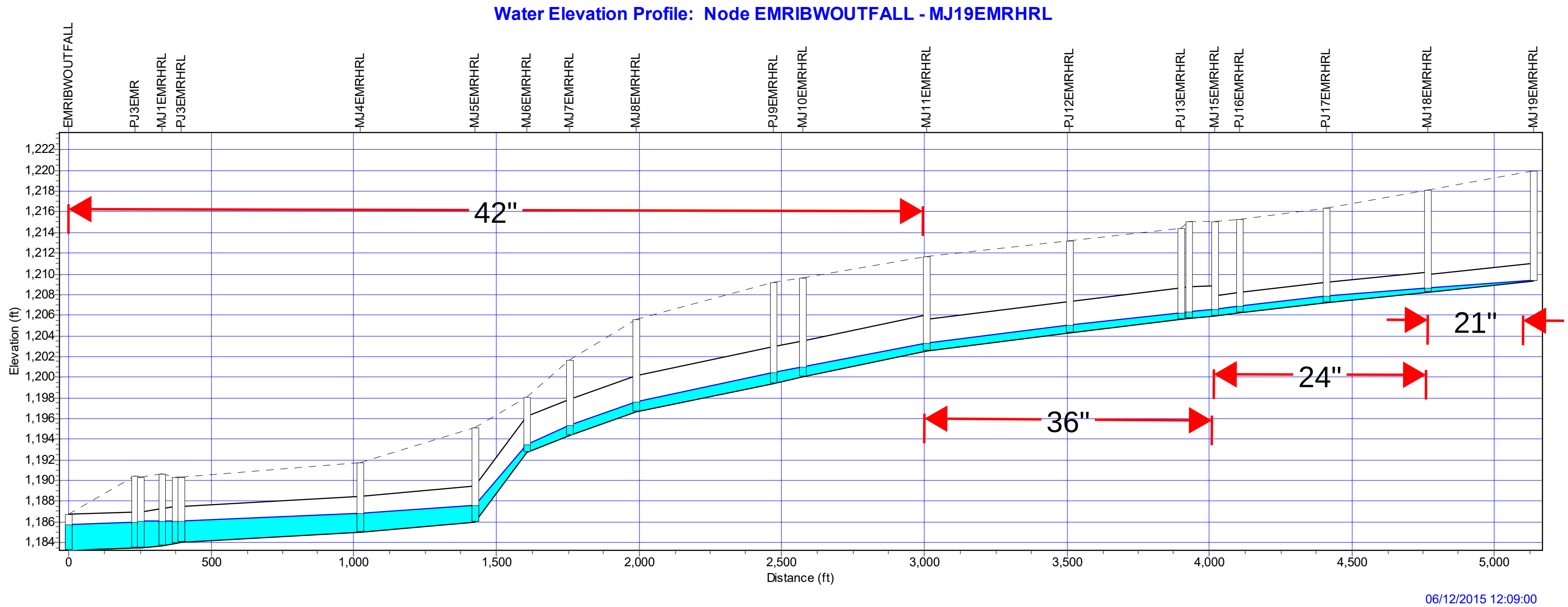
Outfall Max Flow= 128 cfs

Profile:

10 YEAR - 24 HOUR

South Hayden Storm Drain

INP file created on 6/12/2015 3:34:06 PM by rkraft with inpPINS version 0.0.2.0



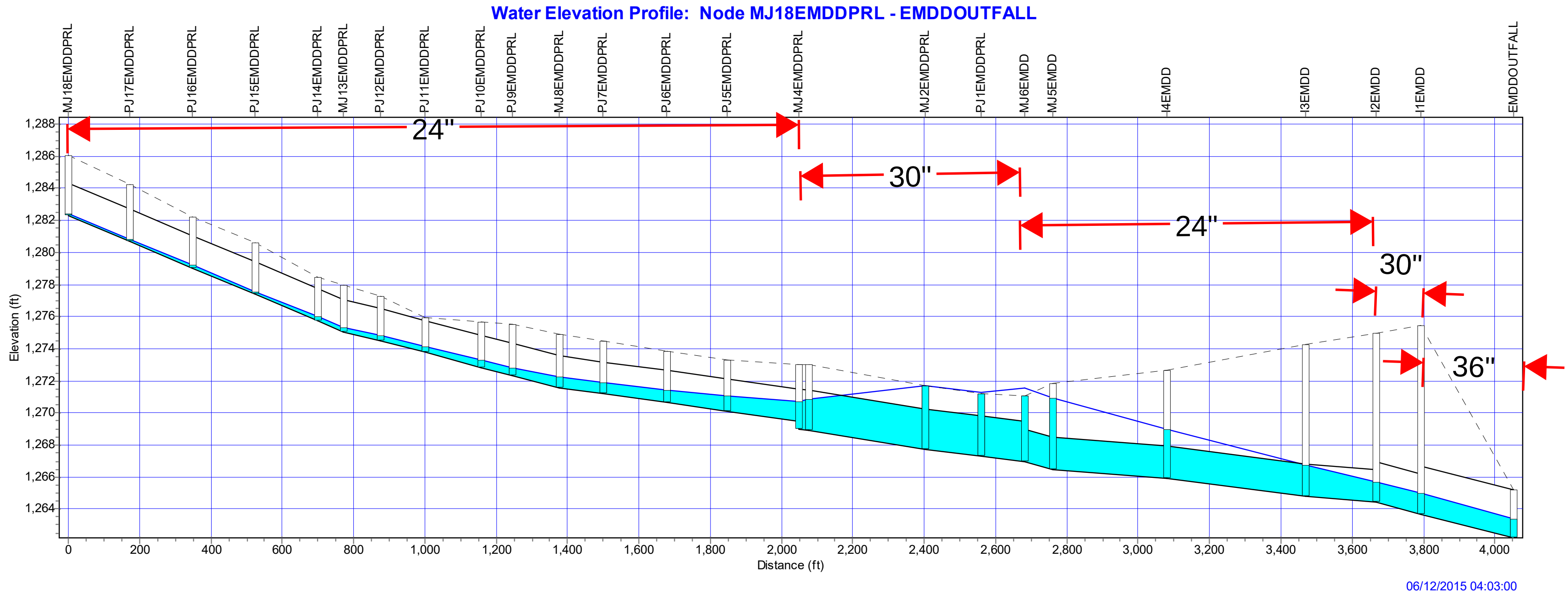
Outfall Max Flow= 25 cfs

Profile:

10 YEAR - 6 HOUR

Pima/McDonald Storm Drain

INP file created on 6/12/2015 3:34:06 PM by rkraft with inpPINS version 0.0.2.0



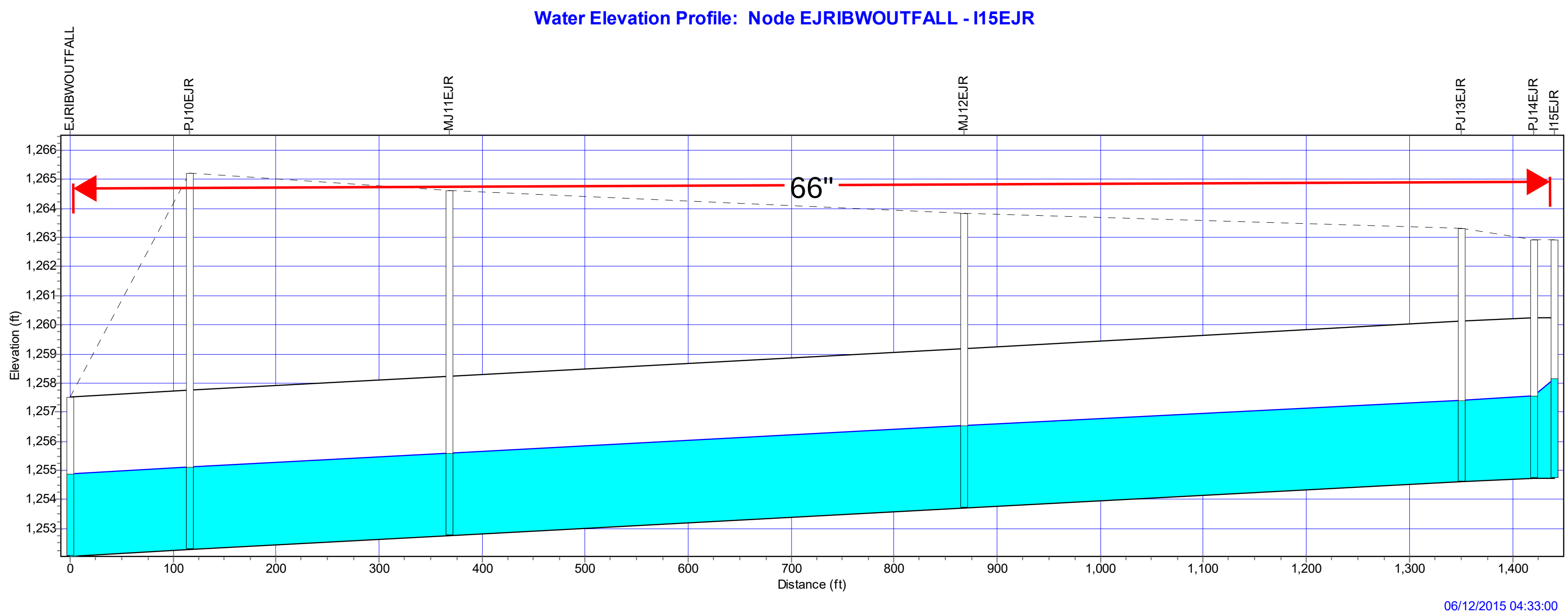
Outfall Max Flow= 16 cfs

Profile:

10 YEAR - 6 HOUR

Jackrabbit Storm Drain

INP file created on 6/12/2015 3:34:06 PM by rkraft with inpPINS version 0.0.2.0



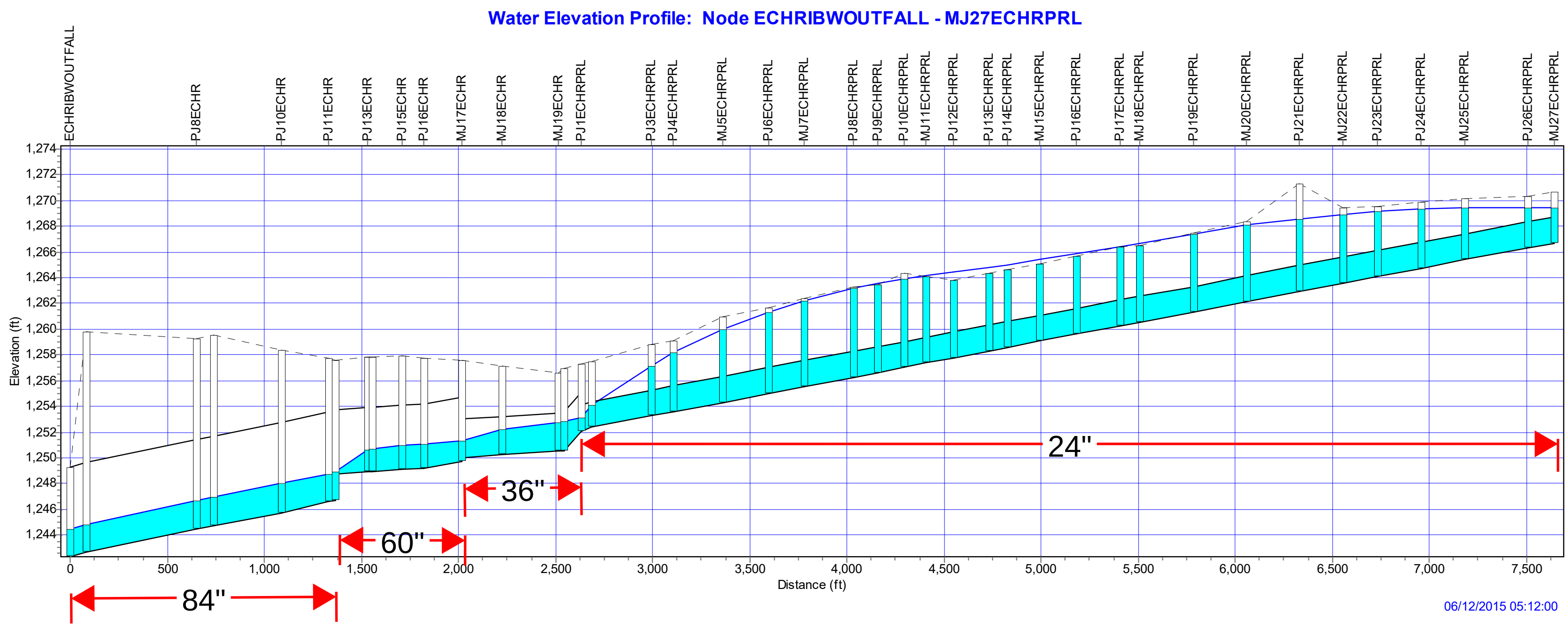
Outfall Max Flow= 78 cfs

Profile:

10 YEAR - 6 HOUR

Pima/Chaparral Storm Drain

INP file created on 6/12/2015 3:34:06 PM by rkraft with inpPINS version 0.0.2.0



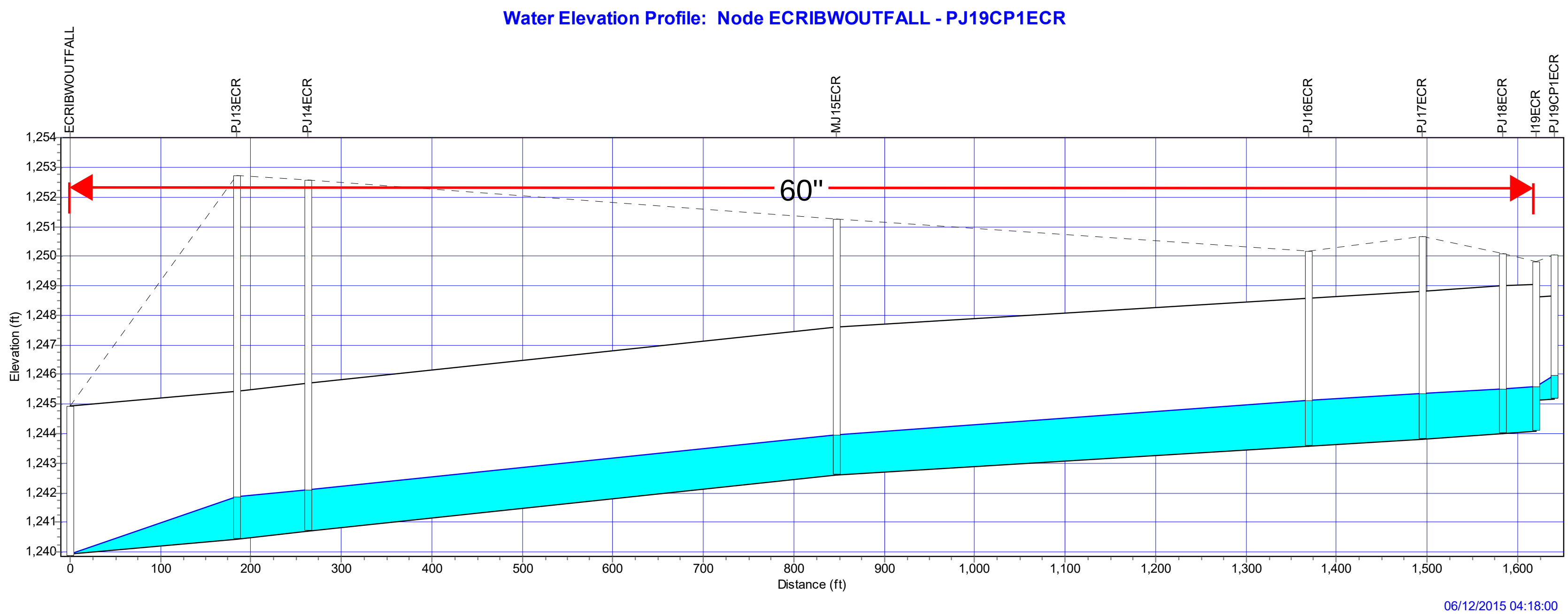
Outfall Max Flow= 97 cfs

Profile:

10 YEAR - 6 HOUR

Camelback Storm Drain

INP file created on 6/12/2015 3:34:06 PM by rkraft with inpPINS version 0.0.2.0



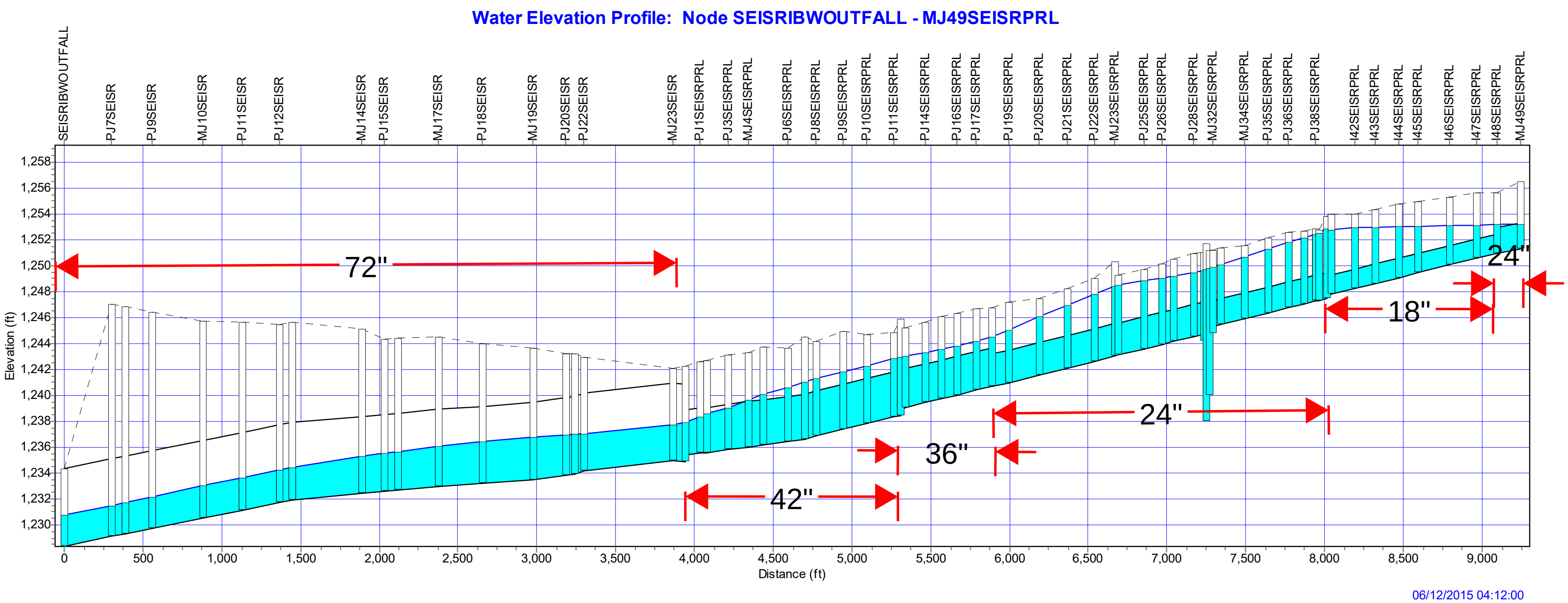
Outfall Max Flow= 25 cfs

Profile:

10 YEAR - 6 HOUR

Pima / South Indian School Storm Drain

INP file created on 6/12/2015 3:34:06 PM by rkraft with inpPINS version 0.0.2.0



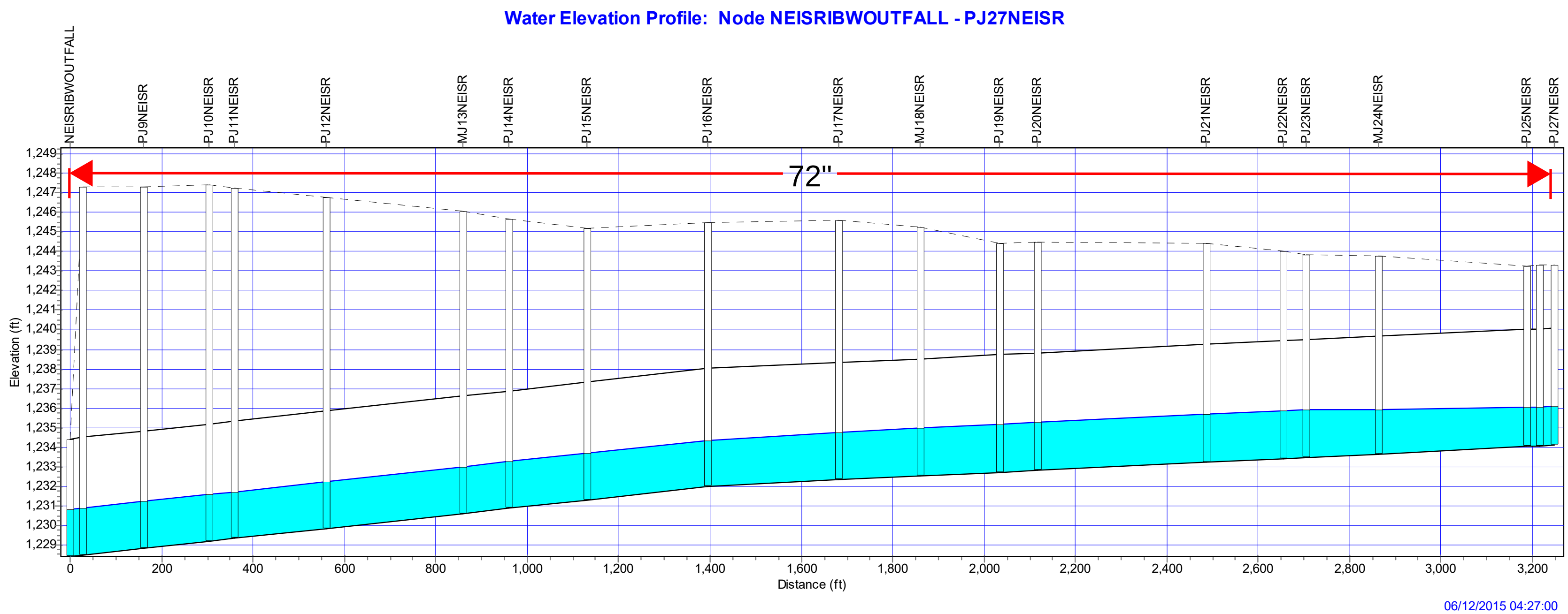
Outfall Max Flow= 85 cfs

Profile:

10 YEAR - 6 HOUR

North Indian School Storm Drain

INP file created on 6/12/2015 3:34:06 PM by rkraft with inpPINS version 0.0.2.0



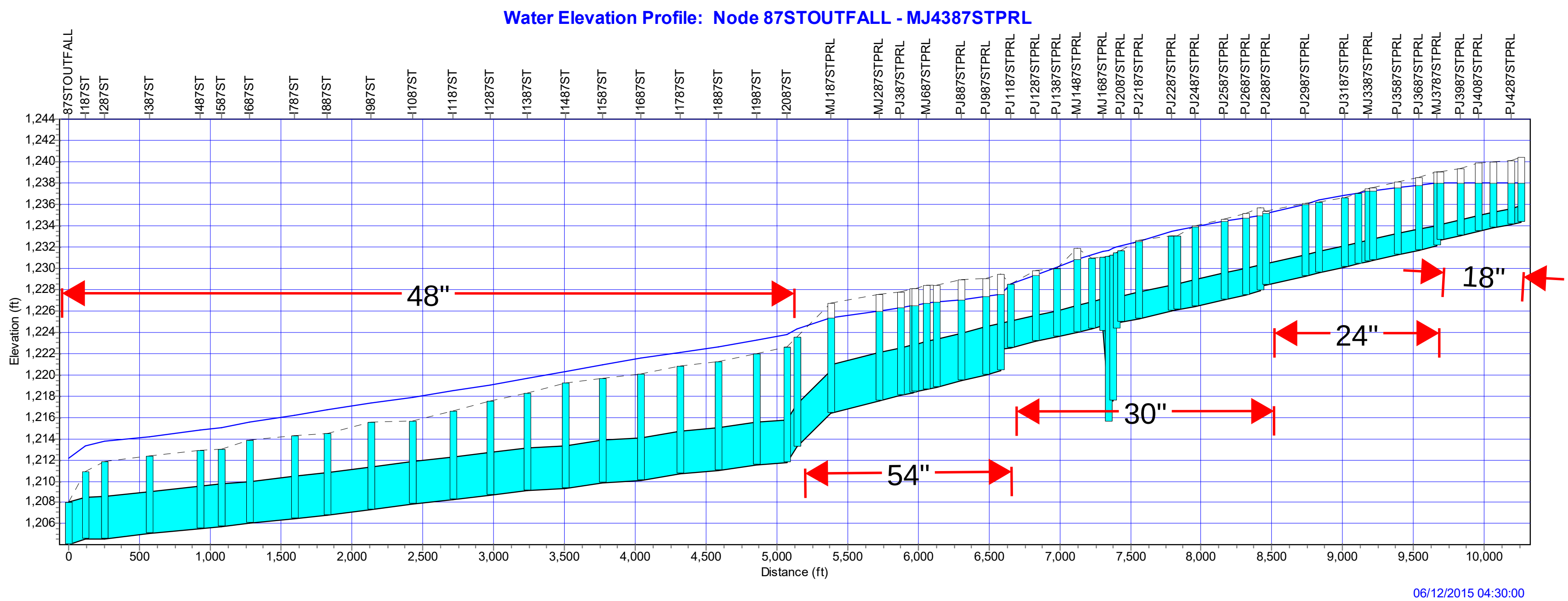
Outfall Max Flow= 72 cfs

Profile:

10 YEAR - 6 HOUR

Pima / 87th Street Storm Drain

INP file created on 6/12/2015 3:34:06 PM by rkraft with inpPINS version 0.0.2.0



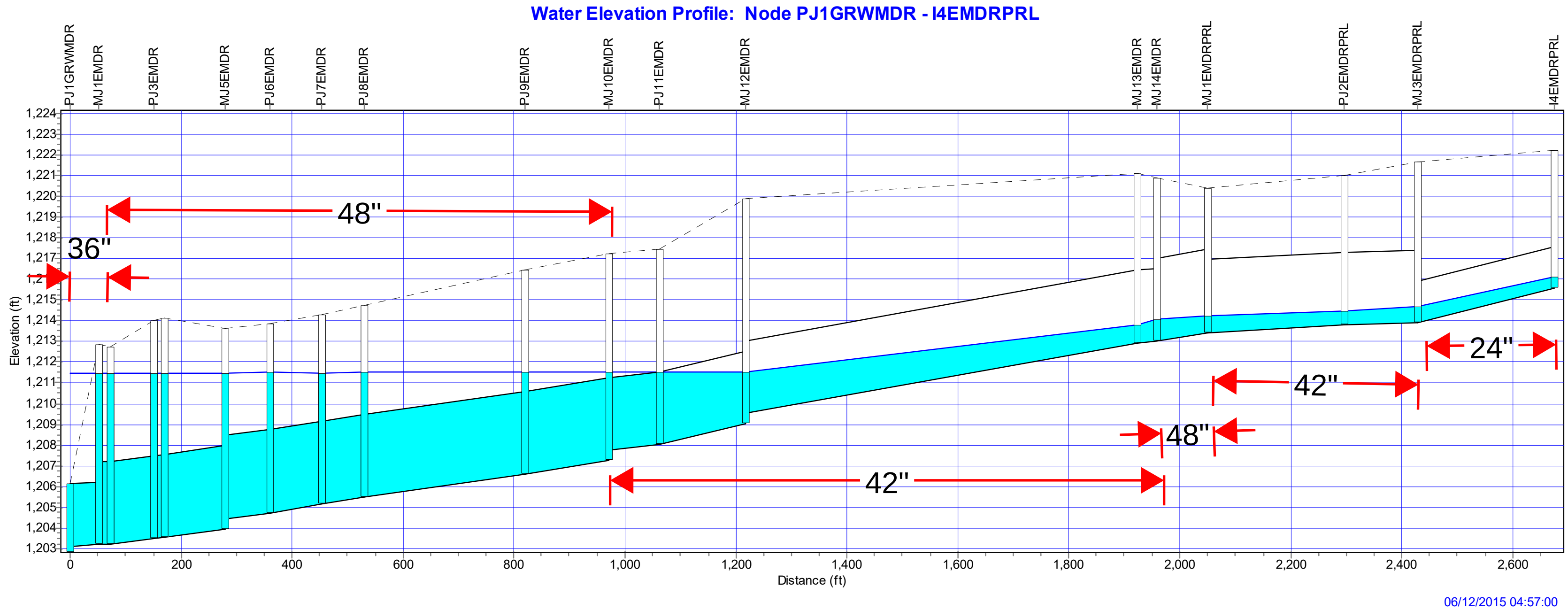
Outfall Max Flow= 82 cfs

Profile:

10 YEAR - 6 HOUR

East McDowell Storm Drain

INP file created on 6/12/2015 3:34:06 PM by rkraft with inpPINS version 0.0.2.0



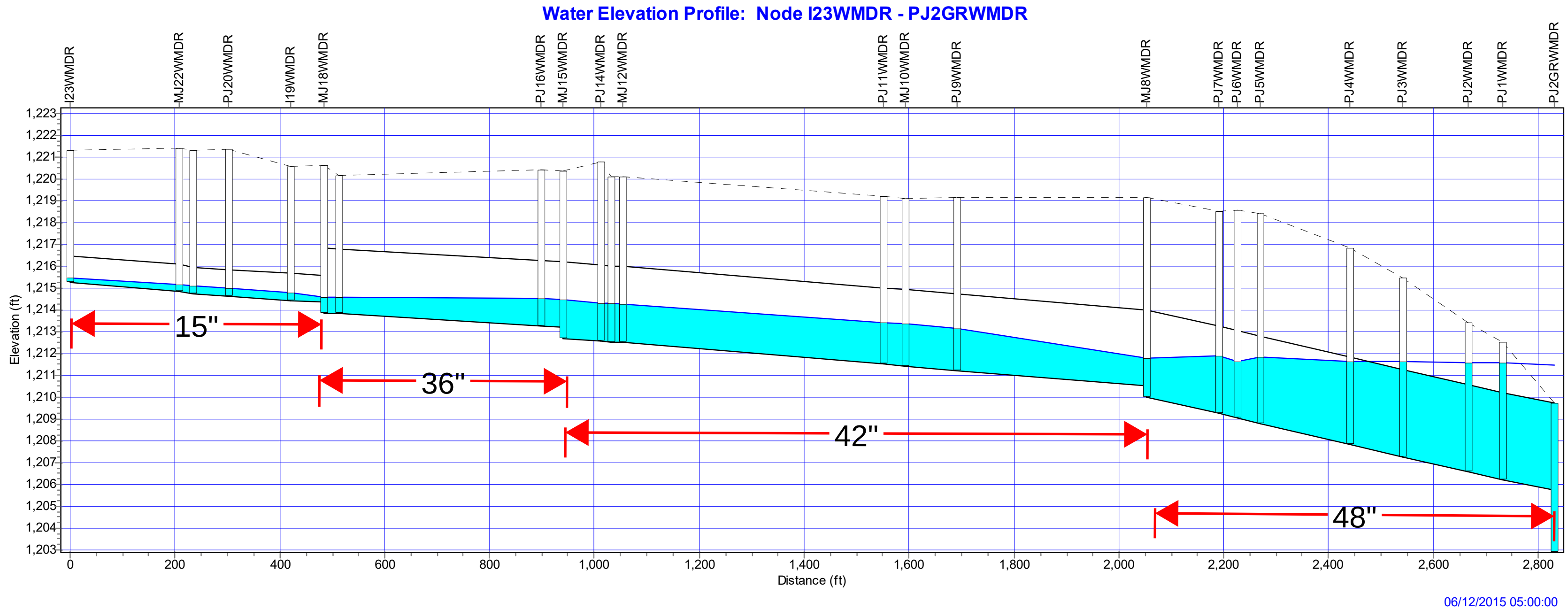
Outfall Max Flow= 30 cfs

Profile:

10 YEAR - 6 HOUR

West McDowell Storm Drain

INP file created on 6/12/2015 3:34:06 PM by rkraft with inpPINS version 0.0.2.0



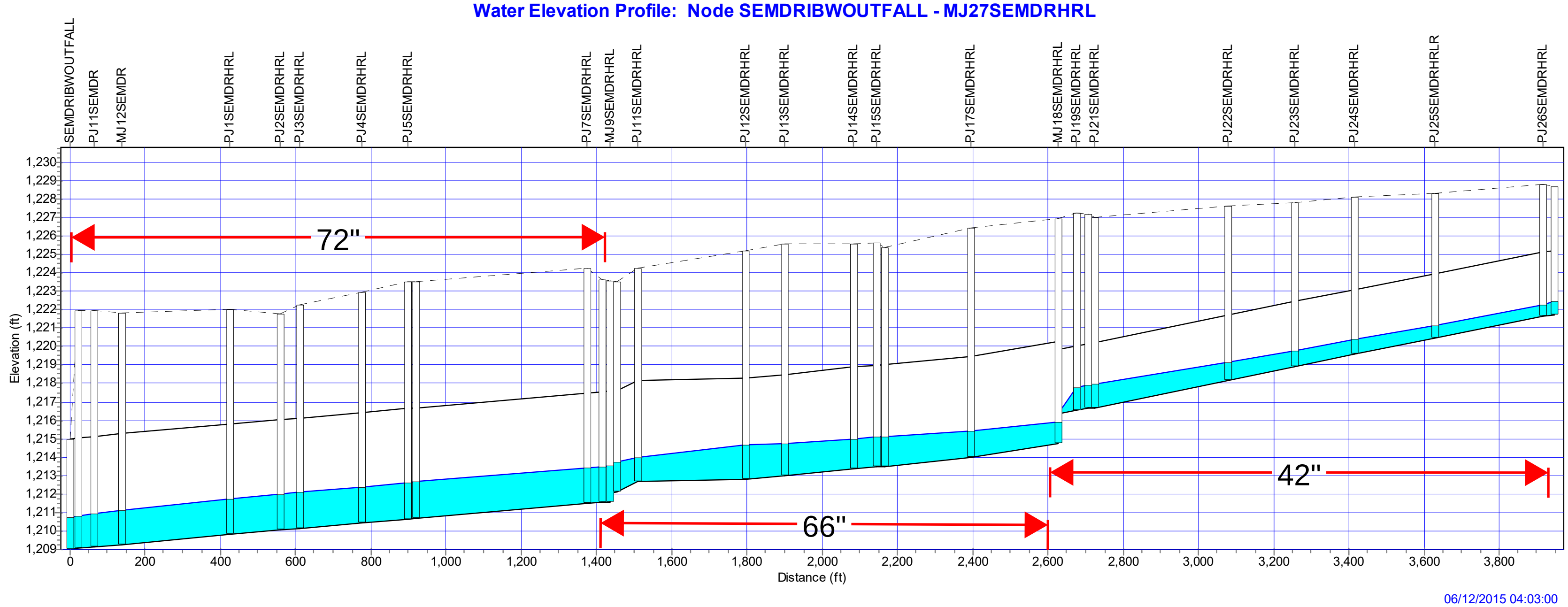
Outfall Max Flow= 33 cfs

Profile:

10 YEAR - 6 HOUR

North Hayden Storm Drain

INP file created on 6/12/2015 3:34:06 PM by rkraft with inpPINS version 0.0.2.0



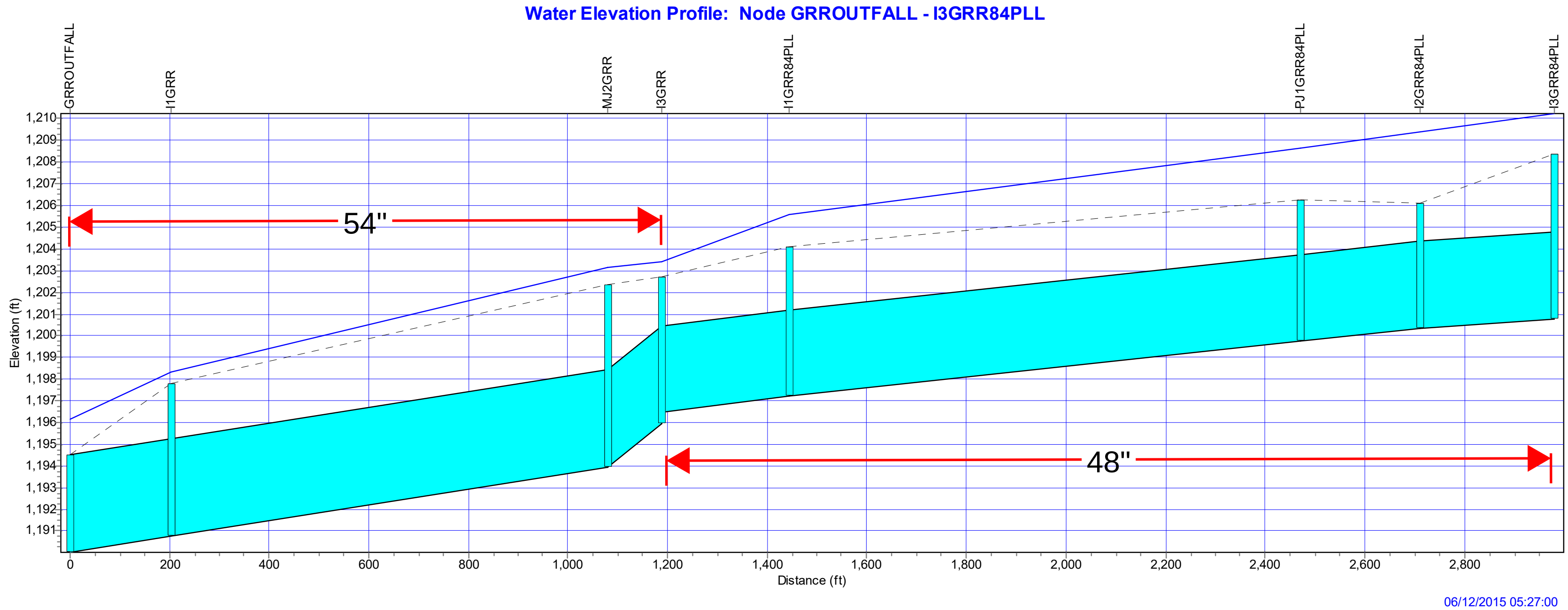
Outfall Max Flow= 47 cfs

Profile:

10 YEAR - 6 HOUR

84th Place Storm Drain

INP file created on 6/12/2015 3:34:06 PM by rkraft with inpPINS version 0.0.2.0



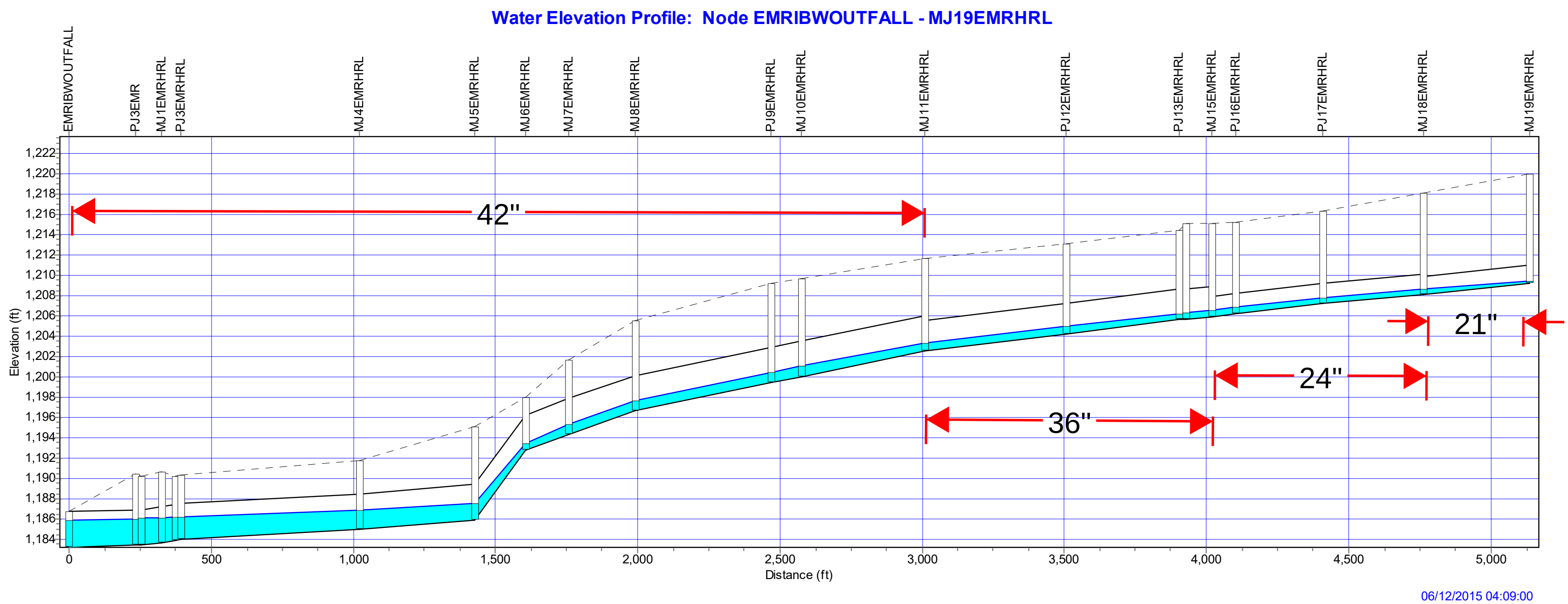
Outfall Max Flow= 128 cfs

Profile:

10 YEAR - 6 HOUR

South Hayden Storm Drain

INP file created on 6/12/2015 3:34:06 PM by rkraft with inpPINS version 0.0.2.0



Outfall Max Flow= 26 cfs

APPENDIX D.4 – Curb High Capacity Comparisons

Pima/McDonald Storm Drain

Inlet Name	Curb High / Soffit High Interception	FLO-2D/SWMM Model Interception			
		100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*	*(cfs)*
I18CP1EMDDPRL	2.6	0.3	0.3	0.2	0.2
I17CP1EMDDPRL	7.8	0.0	0.0	0.0	0.0
I16CP1EMDDPRL	7.8	0.1	0.1	0.0	0.0
I15CP1EMDDPRL	7.8	0.1	0.1	0.0	0.0
I14CP1EMDDPRL	7.8	0.5	0.6	0.3	0.4
I12CP1EMDDPRL	2.6	0.6	0.7	0.4	0.5
I11CP1EMDDPRL	2.6	0.4	0.5	0.3	0.3
I10CP1EMDDPRL	7.8	0.9	1.1	0.5	0.6
I9CP1EMDDPRL	2.6	0.6	0.6	0.4	0.5
I8CP1EMDDPRL	2.6	0.9	1.0	0.6	0.6
I7CP1EMDDPRL	2.6	0.8	1.0	0.5	0.6
I6CP1EMDDPRL	7.8	1.0	1.3	0.6	0.7
I5CP1EMDDPRL	7.8	1.6	1.8	1.0	1.2
I4CP1EMDDPRL	7.8	1.5	1.9	0.8	1.0
I3CP1EMDDPRL	3.4	8.8	9.2	5.6	6.2
I1CP3EMDDPRL	7.0	1.9	2.3	1.3	1.5
I1CP2EMDDPRL	7.0	0.0	0.0	0.0	0.0
I1CP1EMDDPRL	7.8	8.3	11.0	2.9	5.1
I5CP2EMDD	4.6	0.4	0.4	0.0	0.0
I5CP1EMDD	4.6	0.3	0.3	0.0	0.0
I4CP1EMDD	5.2	2.4	2.3	0.1	0.1
I3CP1EMDD	5.2	0.4	0.5	0.3	0.4
I2CP1EMDD	5.2	0.2	0.2	0.1	0.1
I1CP1EMDD	5.2	0.0	0.0	0.0	0.0

Conduit Name	FLO-2D/SWMM Model Interception			
	100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*
C18CP1EMDDPRL	0.3	0.3	0.2	0.2
C18EMDDPRL	0.3	0.3	0.2	0.2
C17CP1EMDDPRL	0.0	0.0	0.0	0.0
C17EMDDPRL	0.3	0.4	0.2	0.3
C16CP1EMDDPRL	0.1	0.1	0.0	0.0
C16EMDDPRL	0.4	0.4	0.3	0.3
C15CP1EMDDPRL	0.1	0.1	0.0	0.0
C15EMDDPRL	0.4	0.5	0.3	0.3
C14CP1EMDDPRL	0.5	0.6	0.3	0.4
C14EMDDPRL	0.9	1.1	0.6	0.7
C13EMDDPRL	0.9	1.1	0.6	0.7
C12CP1EMDDPRL	0.6	0.7	0.4	0.5
C12EMDDPRL	1.4	1.7	1.0	1.2
C11CP1EMDDPRL	0.4	0.5	0.3	0.3
C11EMDDPRL	1.9	2.2	1.3	1.5
C10CP1EMDDPRL	0.9	1.0	0.5	0.6
C10EMDDPRL	2.7	3.2	1.8	2.1
C9CP1EMDDPRL	0.6	0.6	0.4	0.5
C9EMDDPRL	3.3	3.9	2.2	2.5
C8CP1EMDDPRL	0.9	1.0	0.6	0.6
C8EMDDPRL	4.1	4.7	2.7	3.1
C7CP1EMDDPRL	0.8	1.0	0.5	0.6
C7EMDDPRL	4.8	5.7	3.2	3.7
C6CP1EMDDPRL	1.0	1.3	0.6	0.7
C6EMDDPRL	5.9	7.2	3.7	4.3
C5CP1EMDDPRL	1.6	2.2	1.0	1.2
C5EMDDPRL	7.6	8.7	4.7	5.6
C4CP1EMDDPRL	4.1	3.0	0.8	1.5
C4EMDDPRL	12.0	12.8	5.4	11.2
C3CP1EMDDPRL	8.9	9.4	5.6	6.8

Conduit Name	FLO-2D/SWMM Model Interception			
	100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*
C3EMDDPRL	15.7	16.8	11.0	16.4
C2EMDDPRL	22.0	21.7	9.9	21.8
C1CP3EMDDPRL	2.0	2.3	1.2	2.3
C1CP2EMDDPRL	3.0	2.7	1.1	4.5
C1CP1EMDDPRL	12.2	12.9	3.9	13.6
C1EMDDPRL	20.6	18.1	13.0	19.2
C6EMDD	17.5	16.7	12.8	18.0
C5CP2EMDD	5.1	3.7	0.3	5.9
C5CP1EMDD	3.6	2.8	0.2	3.2
C5EMDD	15.1	15.1	12.8	15.5
C4CP1EMDD	2.6	2.8	0.1	1.2
C4EMDD	17.8	17.6	13.7	16.3
C3CP1EMDD	2.2	1.8	0.2	1.9
C3EMDD	18.0	18.0	14.3	16.7
C2CP1EMDD	0.8	0.6	0.1	0.6
C2EMDD	18.4	18.8	14.4	16.5
C1CP1EMDD	0.3	0.3	0.1	0.2
C1EMDD	18.3	18.8	14.4	16.1

Jackrabbit Storm Drain

Inlet Name	Curb High / Soffit High Interception	FLO-2D/SWMM Model Interception			
		100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*	*(cfs)*
I15CP2EJR	17.9	29.1	29.4	15.2	15.2
I15EJR	20.7	89.8	92.2	48.3	48.1
I15CP1EJR	17.9	28.2	28.3	12.3	12.3
I10CP2EJR	5.2	0.1	0.2	0.1	0.1
I10CP1EJR	5.2	3.8	4.0	3.5	3.6

Conduit Name	FLO-2D/SWMM Model Interception			
	100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*
C15CP2EJR	29.1	30.1	15.2	15.2
C15CP1EJR	25.5	26.8	12.3	12.3
C15EJR	144.3	148.1	75.7	75.4
C14EJR	144.3	148.1	75.7	75.4
C13EJR	144.3	148.0	75.7	75.4
C12EJR	144.3	148.3	75.7	75.4
C11EJR	144.5	149.4	75.7	75.4
C10CP2EJR	0.1	0.2	0.1	0.1
C10CP1EJR	4.0	4.1	3.5	3.7
C10EJR	157.1	157.1	78.3	77.9

Pima / Chaparral Storm Drain

Inlet Name	Curb High / Soffit High Interception	FLO-2D/SWMM Model Interception			
		100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*	*(cfs)*
I27CP1ECHRPRL	2.6	2.2	2.3	0.6	0.7
I26CP1ECHRPRL	5.2	6.2	5.5	2.5	2.2
I25CP1ECHRPRL	2.6	4.2	3.2	2.4	2.2
I24CP1ECHRPRL	2.6	4.9	4.9	4.2	4.1
I23CP1ECHRPRL	2.6	4.5	4.3	2.2	2.0
I22CP1ECHRPRL	2.6	2.1	1.9	1.3	1.1
I21CP1ECHRPRL	2.6	0.8	0.7	0.7	0.8
I20CP1ECHRPRL	2.6	2.8	2.0	1.3	1.4
I19CP1ECHRPRL	2.6	2.7	2.7	1.3	1.2
I18CP1ECHRPRL	5.2	9.7	9.6	3.1	2.6
I17CP1ECHRPRL	2.6	4.6	4.6	1.3	0.4
I16CP1ECHRPRL	2.6	4.6	4.5	1.5	1.5
I15CP1ECHRPRL	2.6	5.1	5.1	2.4	2.1
I14CP1ECHRPRL	2.6	5.3	5.2	2.8	2.5
I13CP1ECHRPRL	2.6	5.3	5.1	2.0	1.9
I12CP1ECHRPRL	2.6	6.2	6.1	5.0	4.8
I11CP1ECHRPRL	2.6	1.1	2.1	2.1	2.1
I10CP1ECHRPRL	2.6	1.3	1.4	1.4	1.1
I9CP1ECHRPRL	2.6	0.9	0.9	1.0	1.0
I8CP1ECHRPRL	2.6	1.3	1.7	1.8	1.8
I7CP1ECHRPRL	2.6	1.8	1.8	2.0	1.9
I6CP1ECHRPRL	2.6	1.8	1.8	1.9	1.9
I5CP1ECHRPRL	2.6	2.8	3.0	2.3	2.1
I4CP1ECHRPRL	5.2	5.0	5.3	4.7	4.0
I3CP2ECHRPRL	5.2	2.4	2.6	1.3	1.3
I3CP1ECHRPRL	5.2	4.5	4.2	1.6	0.9
I3CP1ECHRPRL	5.2	4.5	4.2	1.6	0.9
I20CP1ECHR	2.9	4.7	3.3	0.2	0.3
I20CP2ECHR	5.9	1.2	1.3	0.6	0.6
I19CP2ECHR	5.9	2.5	2.8	1.3	1.5

Inlet Name	Curb High / Soffit High Interception	FLO-2D/SWMM Model Interception			
		100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*	*(cfs)*
I19CP1ECHR	5.9	3.2	3.6	1.9	2.1
I18CP2ECHR	5.9	5.8	6.5	3.2	3.8
I18CP1ECHR	2.9	2.9	3.2	2.0	2.2
I17CP1ECHR	26.0	7.5	7.5	4.4	4.3
I16CP2ECHR	5.9	5.0	5.5	3.2	3.5
I16CP1ECHR	2.9	0.9	1.1	0.6	0.7
I15CP1ECHR	8.4	1.2	1.5	0.5	0.5
I14CP2ECHR	2.9	2.6	3.0	1.8	2.0
I14CP1ECHR	2.9	1.7	2.1	1.0	1.2
I13CP1ECHR	2.9	1.3	1.6	0.7	0.9
I12CP3ECHR	15.3	29.8	29.8	27.8	27.7
I12CP2ECHR	20.3	47.5	47.4	21.8	21.0
I12CP4ECHR	15.3	24.6	24.6	13.0	12.8
I11CP2ECHR	5.9	9.3	9.3	3.8	3.7
I11CP1ECHR	2.9	2.4	2.8	1.5	1.8
I10CP2ECHR	2.9	0.2	0.2	0.1	0.1
I10CP1ECHR	2.9	0.5	0.6	0.3	0.4
I9CP1ECHR	7.9	12.6	13.9	7.4	7.6
I8CP2ECHR	5.9	4.7	5.2	3.1	3.6
I8CP1ECHR	2.9	4.9	5.2	3.0	3.5
I7CP3ECHR	17.4	1.1	1.2	0.7	0.9
I7CP2ECHR	17.4	3.5	4.0	2.2	2.5

Conduit Name	FLO-2D/SWMM Model Interception			
	100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*
C27CP1ECHRPRL	10.51	10.7	10.4	1.3
C27ECHRPRL	14.26	12.4	8.4	4.5
C26CP1ECHRPRL	8.27	7.9	6.7	3.7
C26ECHRPRL	14.84	11.8	10.8	11.0
C25CP1ECHRPRL	17.9	18.2	18.2	18.1
C25ECHRPRL	14.07	10.8	9.2	9.7
C24CP1ECHRPRL	12.25	14.7	12.8	8.1
C24ECHRPRL	10.81	10.7	8.6	8.6
C23CP1ECHRPRL	8.55	15.2	17.0	17.5
C23ECHRPRL	13.87	11.9	15.4	16.4
C22CP1ECHRPRL	14.59	19.5	21.4	21.6
C22ECHRPRL	13.33	11.8	11.2	12.9
C21CP1ECHRPRL	15.68	16.8	15.7	13.9
C21ECHRPRL	12.09	14.0	11.0	10.4
C20CP1ECHRPRL	11.89	22.6	21.9	22.2
C20ECHRPRL	13.04	13.2	13.4	15.9
C19CP1ECHRPRL	12.17	10.2	10.6	13.5
C19ECHRPRL	13.28	13.4	12.7	12.1
C18CP1ECHRPRL	20.78	20.7	18.4	18.2
C18ECHRPRL	12.62	20.8	17.4	16.9
C17CP1ECHRPRL	11.7	12.8	5.9	7.7
C17ECHRPRL	12.08	12.2	12.9	12.4
C16CP1ECHRPRL	13.88	15.0	3.9	4.5
C16ECHRPRL	13.92	12.2	13.5	13.2
C15CP1ECHRPRL	22.06	21.6	4.7	4.6
C15ECHRPRL	14.63	17.6	14.0	13.7
C14CP1ECHRPRL	7.04	10.0	3.8	4.1
C14ECHRPRL	13.28	14.6	15.6	14.3
C13CP1ECHRPRL	7.43	9.1	4.1	4.4
C13ECHRPRL	13.6	14.3	15.3	14.5

Pima / Chaparral Storm Drain Continued

Conduit Name	FLO-2D/SWMM Model Interception			
	100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*
C12CP1ECHRPRL	16.71	14.5	3.1	3.8
C12ECHRPRL	14.03	15.2	15.7	15.2
C11CP1ECHRPRL	21.28	22.2	3.0	2.3
C11ECHRPRL	21.34	17.9	16.3	15.9
C10CP1ECHRPRL	9.23	5.8	2.6	1.6
C10ECHRPRL	15.11	14.9	16.4	15.9
C9CP1ECHRPRL	9.22	10.0	1.5	1.4
C9ECHRPRL	13.07	14.6	15.8	16.0
C8CP1ECHRPRL	12.64	12.7	2.5	2.4
C8ECHRPRL	14.02	15.1	14.7	14.8
C7CP1ECHRPRL	10.16	10.1	3.5	3.6
C7ECHRPRL	17.95	18.2	16.2	16.3
C6CP1ECHRPRL	7.35	6.2	5.0	5.0
C6ECHRPRL	17.72	18.6	17.7	17.8
C5CP1ECHRPRL	5.64	5.3	13.4	14.1
C5ECHRPRL	19.54	20.1	25.8	25.4
C4CP1ECHRPRL	5.27	5.1	7.0	6.9
C4ECHRPRL	23.14	23.6	24.9	25.4
C3CP2ECHRPRL	2.88	2.7	1.3	1.3
C3CP1ECHRPRL	6.14	5.9	1.9	2.0
C3ECHRPRL	26.35	26.3	24.8	23.6
C2ECHRPRL	26.32	26.3	24.8	23.9
C1CP1ECHRPRL	1.2	1.2	0.4	0.3
C1ECHRPRL	27.33	27.6	25.1	24.0
C20CP1ECHR	5.27	3.6	0.5	0.5
C20CP2ECHR	1.49	2.7	1.2	0.8
C20ECHR	32.57	32.9	27.2	25.4
C19CP2ECHR	2.44	2.8	1.3	1.5
C19CP1ECHR	5.54	6.2	3.2	3.5
C19ECHR	35.33	33.5	26.0	24.1

Conduit Name	FLO-2D/SWMM Model Interception			
	100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*
C18CP2ECHR	5.75	6.5	3.2	3.8
C18CP1ECHR	2.87	3.2	2.0	2.2
C18ECHR	38.5	37.7	26.6	24.5
C17CP1ECHR	7.53	7.5	4.4	4.3
C17ECHR	46.04	43.5	30.3	28.0
C16CP2ECHR	4.96	5.5	3.2	3.5
C16CP1ECHR	0.92	1.1	0.6	0.7
C16ECHR	48.27	48.3	30.7	28.3
C15CP1ECHR	1.23	1.5	0.5	0.5
C15ECHR	49.12	49.4	30.7	28.4
C14CP2ECHR	2.58	3.0	1.8	2.0
C14CP1ECHR	4.21	5.0	2.8	3.2
C14ECHR	52.79	53.8	30.9	28.6
C13CP1ECHR	1.32	1.6	0.7	0.9
C13ECHR	53.67	54.9	31.0	29.1
C12CP3ECHR	29.83	29.7	27.8	27.7
C12CP4ECHR	24.63	24.6	13.0	12.8
C12CP2ECHR	101.56	101.5	62.5	61.5
C12CP1ECHR	101.56	101.5	62.5	61.5
C12ECHR	150.47	145.8	90.6	87.9
C11CP2ECHR	8.32	8.2	3.8	3.7
C11CP1ECHR	2.35	2.8	1.5	1.8
C11ECHR	158.95	153.4	94.5	91.7
C10CP2ECHR	0.17	0.2	0.1	0.1
C10CP1ECHR	0.51	0.6	0.3	0.4
C10ECHR	159.09	153.5	94.6	91.7
C9CP1ECHR	12.54	13.9	7.4	7.6
C9ECHR	164.37	160.3	98.8	96.2
C8CP2ECHR	4.66	5.2	3.1	3.6
C8CP1ECHR	4.87	5.2	3.0	3.5
C8ECHR	165.97	165.9	99.6	96.9
C7CP3ECHR	1.05	1.2	0.7	0.9
C7CP2ECHR	4.58	5.2	3.0	3.4
C7CP1ECHR	4.58	5.2	3.0	3.4
C7ECHR	166.8	168.4	100.3	97.5

Camelback Storm Drain

Inlet Name	Curb High / Soffit High Interception	FLO-2D/SWMM Model Interception			
		100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*	*(cfs)*
I19CP3ECR	17.8	14.8	14.1	8.8	8.1
I19ECR	5.5	15.7	16.4	11.3	11.3
I18CP2ECR	17.8	9.9	9.5	6.5	6.1
I14CP1ECR	7.0	2.5	2.8	1.9	1.9
I13CP1ECR	3.5	1.4	1.6	0.8	0.9

Conduit Name	FLO-2D/SWMM Model Interception			
	100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*
C19CP3ECR	14.8	14.1	8.8	8.1
C19CP2ECR	14.8	14.1	8.8	8.1
C19CP1ECR	14.8	14.1	8.8	8.1
C18CP2ECR	9.9	9.5	6.5	6.1
C18CP1ECR	9.9	9.5	6.5	6.1
C18ECR	38.2	38.8	23.9	23.8
C17ECR	38.2	38.8	23.9	23.8
C16ECR	38.2	38.8	23.9	23.7
C15ECR	38.2	38.7	23.9	23.7
C14CP1ECR	2.5	2.8	1.9	1.9
C14ECR	39.6	40.5	24.8	24.7
C13CP1ECR	1.4	1.6	0.8	0.9
C13ECR	40.4	41.4	25.0	25.0

North Indian School Road

Inlet Name	Curb High / Soffit High Interception	FLO-2D/SWMM Model Interception			
		100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*	*(cfs)*
I27CP3NEISR	17.4	31.7	32.2	27.6	27.5
I26CP3NEISR	17.4	8.5	8.9	1.0	0.9
I23CP4NEISR	8.4	8.4	8.5	7.4	7.4
I23CP3NEISR	17.4	27.6	27.6	15.6	15.6
I21CP3NEISR	26.1	14.3	11.9	6.3	7.2
I17CP1NEISR	5.4	3.6	4.1	2.1	2.5
I16CP5NEISR	3.6	5.5	5.6	2.4	2.2
I16CP4NEISR	11.3	13.9	17.9	8.1	7.9
I16CP3NEISR	11.3	17.9	17.9	8.2	8.0
I14CP2NEISR	7.8	5.4	5.5	2.7	2.3
I14CP1NEISR	7.8	4.8	4.9	2.3	1.9
I8CP2NEISR	7.8	3.9	4.7	1.9	2.2
I8CP1NEISR	13.1	0.7	0.8	0.4	0.4

Conduit Name	FLO-2D/SWMM Model Interception			
	100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*
C27CP3NEISR	31.7	32.2	25.5	24.3
C27CP2NEISR	31.7	32.2	25.5	24.3
C27CP1NEISR	31.7	32.2	25.5	24.3
C27NEISR	31.7	32.2	25.5	24.3
C26CP3NEISR	8.5	8.9	1.0	0.9
C26CP2NEISR	8.5	8.9	1.0	2.0
C26CP1NEISR	8.5	8.9	1.0	2.5
C26NEISR	40.2	41.2	26.4	25.2
C25NEISR	40.4	41.4	26.3	25.2
C24NEISR	40.7	41.7	26.3	25.3
C23CP4NEISR	8.4	8.5	7.4	7.4
C23CP3NEISR	33.7	35.4	22.9	23.0
C23CP2NEISR	33.7	35.4	23.0	23.0
C23CP1NEISR	33.7	35.4	22.9	23.0
C23NEISR	72.6	74.4	48.3	47.3
C22NEISR	72.6	74.4	48.4	47.3
C21CP3NEISR	14.3	11.9	6.3	7.2
C21CP2NEISR	14.3	11.9	6.3	7.2
C21CP1NEISR	14.3	11.9	6.3	7.2
C21NEISR	84.1	84.8	52.2	50.5
C20NEISR	83.5	84.7	52.1	50.5
C19NEISR	83.4	84.7	52.1	50.5
C18NEISR	83.2	84.6	52.1	50.5
C17CP1NEISR	3.6	4.1	2.1	2.5
C17NEISR	86.5	88.3	52.5	50.8
C16CP5NEISR	5.5	5.6	2.4	2.2
C16CP4NEISR	19.4	20.7	10.5	10.0
C16CP2NEISR	0.2	0.3	0.0	0.0
C16CP3NEISR	17.9	17.9	8.2	8.0
C16CP1NEISR	37.2	38.5	18.7	18.0

Conduit Name	FLO-2D/SWMM Model Interception			
	100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*
C16NEISR	123.6	126.6	71.1	68.7
C15NEISR	123.7	126.7	71.1	68.7
C14CP2NEISR	5.4	5.5	2.7	2.3
C14CP1NEISR	10.1	10.4	5.0	4.2
C14NEISR	132.0	135.3	74.2	71.6
C13NEISR	132.0	135.4	74.2	71.6
C12NEISR	132.0	135.4	74.2	71.6
C11NEISR	132.0	135.4	74.2	71.6
C10NEISR	132.0	135.4	74.2	71.6
C9NEISR	132.1	135.4	74.2	71.6
C8CP2NEISR	3.9	4.7	1.9	2.2
C8CP1NEISR	4.6	5.5	2.2	2.6
C8NEISR	133.7	137.1	74.7	72.0

Pima / South Indian School Storm Drain

Inlet Name	Curb High / Soffit High Interception	FLO-2D/SWMM Model Interception			
		100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
I49CP1SEISRPRL	4.6	4.8	5.8	2.9	3.5
I48SEISRPRL	5.2	1.6	1.6	0.1	0.3
I47SEISRPRL	2.6	0.4	0.4	0.2	0.3
I46SEISRPRL	2.6	0.6	0.6	0.3	0.4
I45SEISRPRL	2.6	0.7	0.8	0.5	0.6
I44SEISRPRL	2.6	0.6	0.7	0.3	0.4
I43SEISRPRL	5.2	0.5	0.7	0.4	0.4
I42SEISRPRL	2.6	0.6	0.7	0.4	0.5
I41SEISRPRL	5.2	0.1	0.1	0.0	0.0
I40CP1SEISRPRL	20.0	8.5	8.6	7.6	8.3
I39SEISRPRL	7.0	4.9	6.0	3.2	3.6
I38CP1SEISRPRL	2.6	0.2	0.2	0.1	0.1
I37CP1SEISRPRL	5.2	0.2	0.2	0.1	0.1
I36CP1SEISRPRL	5.2	0.3	0.4	0.2	0.3
I35CP1SEISRPRL	5.2	0.2	0.2	0.1	0.1
I34CP1SEISRPRL	5.2	0.6	0.6	0.3	0.4
I33CP1SEISRPRL	5.2	0.3	0.4	0.2	0.3
I29CP1SEISRPRL	20.0	7.7	8.7	5.7	5.8
I28CP1SEISRPRL	5.2	0.3	0.4	0.2	0.3
I27CP1SEISRPRL	2.6	0.6	0.7	0.4	0.4
I26CP1SEISRPRL	2.6	0.2	0.3	0.1	0.2
I25CP1SEISRPRL	2.6	0.2	0.3	0.2	0.2
I24CP1SEISRPRL	5.2	0.2	0.3	0.1	0.1
I23CP1SEISRPRL	20.0	10.7	11.0	9.1	9.8
I22CP1SEISRPRL	5.2	0.4	0.5	0.2	0.2
I21CP1SEISRPRL	5.2	0.5	0.6	0.3	0.4
I20CP1SEISRPRL	5.2	1.2	1.4	0.7	0.8
I19CP1SEISRPRL	5.2	0.6	0.6	0.4	0.4
I18CP1SEISRPRL	27.0	10.4	10.6	10.3	10.5
I17CP1SEISRPRL	5.2	1.0	1.1	0.5	0.7

Inlet Name	Curb High / Soffit High Interception	FLO-2D/SWMM Model Interception			
		100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
I16CP1SEISRPRL	2.6	2.3	0.7	0.4	0.4
I15CP1SEISRPRL	2.6	3.0	1.8	0.3	0.3
I14CP1SEISRPRL	2.6	1.8	0.5	0.3	0.4
I13CP1SEISRPRL	2.6	0.3	0.4	0.2	0.2
I12CP1SEISRPRL	11.3	19.6	20.6	20.5	21.6
I11CP1SEISRPRL	2.6	0.2	0.3	0.2	0.2
I10CP1SEISRPRL	5.2	0.1	0.2	0.1	0.1
I9CP1SEISRPRL	5.2	0.9	1.1	0.6	0.7
I8CP1SEISRPRL	5.2	0.1	0.1	0.0	0.1
I7CP1SEISRPRL	11.3	17.9	18.6	6.5	6.9
I6CP1SEISRPRL	5.2	0.0	0.0	0.0	0.0
I5CP1SEISRPRL	2.6	0.1	0.2	0.0	0.0
I3CP1SEISRPRL	5.2	1.6	1.8	0.9	0.8
I1CP1SEISRPRL	5.2	8.3	8.6	1.3	1.4
I24CP1SEISR	5.2	10.1	10.4	4.3	4.3
I23CP1SEISR	5.2	12.4	12.7	3.8	3.6
I22CP3SEISR	20.0	32.0	32.1	14.9	14.9
I20CP1SEISR	7.8	9.1	12.4	0.9	1.0
I18CP1SEISR	7.8	1.9	2.3	1.2	1.3
I16CP1SEISR	7.8	1.7	1.8	0.6	0.7
I15CP1SEISR	7.8	3.3	3.3	0.9	0.8
I12CP2SEISR	5.2	1.3	1.3	0.4	0.4
I12CP1SEISR	6.3	2.1	2.2	0.4	0.4
I11CP1SEISR	11.3	0.1	0.1	0.0	0.0
I9CP1SEISR	7.8	0.0	0.0	0.0	0.0
I7CP1SEISR	7.8	0.1	0.1	0.1	0.1

Pima / South Indian School Storm Drain Continued

Conduit Name	FLO-2D/SWMM Model Interception			
	100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*
C49CP1SEISRPRL	9.7	10.0	2.9	3.4
C49SEISRPRL	10.3	10.9	2.9	3.4
C48SEISRPRL	4.9	5.0	3.0	3.7
C47SEISRPRL	5.1	5.1	3.2	3.9
C46SEISRPRL	5.0	5.1	3.4	4.2
C45SEISRPRL	5.1	5.1	3.9	4.4
C44SEISRPRL	5.5	5.4	4.0	4.4
C43SEISRPRL	5.6	5.6	3.9	4.4
C42SEISRPRL	6.1	6.3	4.1	4.8
C41SEISRPRL	6.2	6.4	4.0	4.8
C40CP1SEISRPRL	10.0	9.5	8.5	8.3
C40SEISRPRL	12.6	14.2	11.1	11.8
C39SEISRPRL	17.4	18.9	14.3	15.1
C38CP1SEISRPRL	4.7	2.0	0.2	1.2
C38SEISRPRL	15.8	17.2	14.4	15.2
C37CP1SEISRPRL	4.7	1.3	0.4	0.9
C37SEISRPRL	15.9	16.7	14.3	15.2
C36CP1SEISRPRL	3.7	2.1	0.3	0.5
C36SEISRPRL	16.3	16.8	14.2	15.4
C35CP1SEISRPRL	4.1	3.1	0.6	0.3
C35SEISRPRL	16.4	17.0	14.1	15.5
C34CP1SEISRPRL	7.7	1.3	0.5	0.5
C34SEISRPRL	18.4	17.5	14.1	15.4
C33CP1SEISRPRL	5.1	1.9	0.2	1.0
C33SEISRPRL	18.1	18.0	13.8	15.1
C32SEISRPRL	18.1	17.8	13.7	15.1
C31SEISRPRL	18.1	17.8	13.7	15.1
C30SEISRPRL	18.1	17.8	13.7	15.1
C29CP1SEISRPRL	8.9	9.2	5.9	6.0
C29SEISRPRL	24.7	24.3	19.2	20.5

Conduit Name	FLO-2D/SWMM Model Interception			
	100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*
C28CP1SEISRPRL	2.8	2.2	0.2	0.4
C28SEISRPRL	25.5	22.3	18.9	20.5
C27CP1SEISRPRL	2.6	1.4	0.4	0.4
C27SEISRPRL	26.1	22.7	19.1	20.7
C26CP1SEISRPRL	3.4	1.1	0.1	0.3
C26SEISRPRL	24.2	22.8	19.1	20.7
C25CP1SEISRPRL	2.8	0.9	0.2	0.3
C25SEISRPRL	25.4	23.1	19.2	20.7
C24CP1SEISRPRL	2.5	0.9	0.4	0.6
C24SEISRPRL	25.8	23.3	19.3	20.8
C23CP1SEISRPRL	10.6	11.0	9.1	9.8
C23SEISRPRL	33.0	31.7	28.4	30.3
C22CP1SEISRPRL	2.2	0.7	0.4	0.4
C22SEISRPRL	32.9	32.0	28.5	30.4
C21CP1SEISRPRL	1.8	0.9	0.3	0.6
C21SEISRPRL	33.1	32.7	28.7	30.5
C20CP1SEISRPRL	3.4	2.1	0.7	0.8
C20SEISRPRL	34.1	34.0	29.0	30.8
C19CP1SEISRPRL	4.3	1.2	0.4	0.7
C19SEISRPRL	34.6	34.6	29.2	31.0
C18CP1SEISRPRL	9.1	9.1	9.6	9.6
C18SEISRPRL	51.5	42.6	37.8	39.6
C17CP1SEISRPRL	6.3	2.0	0.5	0.8
C17SEISRPRL	46.7	43.2	38.0	39.7
C16CP1SEISRPRL	5.0	1.1	0.5	1.1
C16SEISRPRL	44.5	43.5	37.9	39.8
C15CP1SEISRPRL	4.5	1.8	0.3	1.0
C15SEISRPRL	43.1	43.5	37.9	39.8
C14CP1SEISRPRL	3.0	1.0	0.3	1.2
C14SEISRPRL	43.4	42.9	37.9	39.8

Pima / South Indian School Storm Drain Continued

Conduit Name	FLO-2D/SWMM Model Interception			
	100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*
C13CP1SEISRPRL	2.3	0.7	0.2	1.0
C13SEISRPRL	43.2	42.5	37.9	39.6
C12CP1SEISRPRL	19.3	20.5	20.5	21.8
C12SEISRPRL	57.9	57.3	54.1	56.3
C11CP1SEISRPRL	2.4	0.7	0.2	0.3
C11SEISRPRL	57.9	57.3	54.1	56.3
C10CP1SEISRPRL	1.1	0.8	0.1	0.1
C10SEISRPRL	58.0	57.3	54.1	56.3
C9CP1SEISRPRL	1.2	1.3	0.6	0.7
C9SEISRPRL	58.5	57.3	54.5	56.7
C8CP1SEISRPRL	0.8	1.8	0.0	0.1
C8SEISRPRL	58.7	57.3	54.5	56.7
C7CP1SEISRPRL	16.5	18.3	6.5	6.9
C7SEISRPRL	72.6	71.4	59.2	61.4
C6CP1SEISRPRL	1.1	1.9	0.0	0.0
C6SEISRPRL	72.6	71.4	59.2	61.4
C5CP1SEISRPRL	0.7	0.8	0.0	0.0
C5SEISRPRL	72.6	71.4	59.6	61.5
C4SEISRPRL	72.6	71.4	59.6	61.6
C3CP1SEISRPRL	1.6	1.8	0.9	0.8
C3SEISRPRL	73.5	72.5	59.3	61.9
C2SEISRPRL	73.5	72.5	59.1	61.9
C1CP1SEISRPRL	8.3	8.6	1.3	1.4
C1SEISRPRL	80.9	79.4	60.2	63.0
C24CP1SEISR	10.1	10.4	4.3	4.3
C24SEISR	91.0	89.8	64.4	66.9
C23CP1SEISR	12.4	12.7	3.8	3.6
C23SEISR	103.7	103.2	66.9	70.2
C22CP3SEISR	34.3	33.5	14.9	14.9
C22CP2SEISR	34.3	33.5	14.9	14.9

Conduit Name	FLO-2D/SWMM Model Interception			
	100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*
C22CP1SEISR	34.3	33.5	14.9	14.9
C22SEISR	130.1	133.5	81.3	84.1
C21SEISR	130.1	133.5	81.3	84.1
C20CP1SEISR	9.1	10.6	0.9	1.0
C20SEISR	138.8	143.2	81.5	84.2
C19SEISR	138.6	143.1	81.5	84.2
C18CP1SEISR	1.9	2.3	1.2	1.3
C18SEISR	138.8	143.3	81.7	84.4
C17SEISR	138.8	143.3	81.6	84.4
C16CP1SEISR	1.7	1.8	0.6	0.7
C16SEISR	139.2	143.6	81.8	84.6
C15CP1SEISR	3.3	3.3	0.9	0.8
C15SEISR	140.4	144.8	82.4	85.2
C14SEISR	140.4	144.8	82.4	85.2
C13SEISR	140.4	144.8	82.4	85.2
C12CP2SEISR	1.3	1.3	0.4	0.4
C12CP1SEISR	3.4	3.5	0.7	0.9
C12SEISR	143.2	147.6	82.7	85.3
C11CP1SEISR	0.1	0.1	0.0	0.0
C11SEISR	143.2	147.6	82.7	85.3
C10SEISR	143.2	147.6	82.7	85.3
C9CP1SEISR	0.0	0.0	0.0	0.0
C9SEISR	143.2	147.6	82.7	85.3
C8SEISR	143.2	147.6	82.7	85.3
C7CP1SEISR	0.1	0.1	0.1	0.1
C7SEISR	143.2	147.6	82.7	85.3

North Hayden Storm Drain

Inlet Name	Curb High / Soffit High Interception	FLO-2D/SWMM Model Interception			
		100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*	*(cfs)*
I27CP3SEMDRHRL	2.6	1.2	1.3	0.9	1.0
I27CP2SEMDRHRL	13.1	5.2	5.7	3.3	3.6
I27CP1SEMDRHRL	5.4	0.7	0.9	0.3	0.3
I26CP1SEMDRHRL	13.1	0.1	0.1	0.0	0.1
I25CP1SEMDRHRLR	13.1	2.1	2.6	1.3	1.6
I24CP1SEMDRHRL	13.1	3.8	4.4	2.4	2.9
I23CP1SEMDRHRL	5.2	0.4	0.4	0.2	0.3
I22CP2SEMDRHRL	3.4	2.4	2.8	1.6	1.8
I22CP1SEMDRHRL	13.1	2.4	3.0	1.3	1.6
I21CP2SEMDRHRL	5.4	1.8	2.2	1.2	1.4
I21CP1SEMDRHRL	13.1	3.9	3.7	1.6	1.8
I20CP1SEMDRHRL	5.2	1.7	2.0	1.1	1.2
I19CP1SEMDRHRL	13.1	14.3	14.1	6.6	6.2
I18CP1SEMDRHRL	13.1	5.0	4.9	1.4	1.1
I17CP1SEMDRHRL	2.6	5.5	5.5	5.0	5.0
I16CP1SEMDRHRL	8.7	6.3	5.8	2.8	1.9
I15CP1SEMDRHRL	2.6	4.2	4.1	1.7	1.9
I14CP1SEMDRHRL	5.2	9.1	9.0	5.9	5.1
I13CP1SEMDRHRL	2.6	2.2	2.0	1.0	0.8
I12CP1SEMDRHRL	2.6	0.7	0.8	0.5	0.5
I11CP1SEMDRHRL	8.7	5.4	5.7	3.4	3.4
I10CP1SEMDRHRL	8.7	7.6	8.3	4.0	4.2
I8CP2SEMDRHRL	8.7	9.9	13.7	4.2	4.6
I7CP1SEMDRHRL	2.6	0.9	1.0	0.7	0.7
I6CP1SEMDRHRL	2.6	1.3	1.4	0.9	0.9
I5CP1SEMDRHRL	2.6	1.6	1.8	1.2	1.3
I3CP1SEMDRHRL	2.6	4.3	4.3	2.6	2.6
I2CP1SEMDRHRL	2.6	2.3	2.3	1.4	1.4
I11CP1SEMDR	8.7	2.0	2.0	0.9	1.0

Conduit Name	FLO-2D/SWMM Model Interception			
	100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*
C27CP3SEMDRHRL	1.2	1.3	0.9	1.0
C27CP2SEMDRHRL	6.3	7.0	4.2	4.6
C27CP1SEMDRHRL	7.0	7.9	4.4	4.9
C27SEMDRHRL	7.0	7.9	4.4	4.9
C26CP1SEMDRHRL	0.1	0.1	0.0	0.1
C26SEMDRHRL	7.1	8.0	4.4	4.9
C25CP1SEMDRHRLR	2.1	2.6	1.3	1.6
C25SEMDRHRLR	9.1	10.5	5.6	6.4
C24CP1SEMDRHRL	3.8	4.4	2.4	2.9
C24SEMDRHRL	12.8	14.7	8.0	9.2
C23CP1SEMDRHRL	0.4	0.4	0.2	0.3
C23SEMDRHRL	13.1	15.1	8.2	9.4
C22CP2SEMDRHRL	2.4	2.8	1.6	1.8
C22CP1SEMDRHRL	4.8	5.8	2.9	3.5
C22SEMDRHRL	17.7	20.6	10.9	12.6
C21CP2SEMDRHRL	1.8	2.2	1.2	1.4
C21CP1SEMDRHRL	4.8	5.7	2.7	3.2
C21SEMDRHRL	22.3	26.2	13.5	15.8
C20CP1SEMDRHRL	1.7	2.0	1.1	1.2
C20SEMDRHRL	23.9	28.0	14.5	16.9
C19CP1SEMDRHRL	14.3	14.1	6.6	6.2
C19SEMDRHRL	31.8	34.4	19.0	19.0
C18CP1SEMDRHRL	5.0	4.9	1.4	1.1
C18SEMDRHRL	33.8	35.5	19.4	19.4
C17CP1SEMDRHRL	5.5	5.5	5.0	5.0
C17SEMDRHRL	38.7	39.9	22.1	22.2
C16CP1SEMDRHRL	6.3	5.8	2.8	1.9
C16SEMDRHRL	42.7	42.9	22.3	22.2
C15CP1SEMDRHRL	4.2	4.1	1.7	1.9

Conduit Name	FLO-2D/SWMM Model Interception			
	100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*
C15SEMDRHRL	45.9	45.2	23.9	24.0
C14CP1SEMDRHRL	9.1	9.0	5.9	5.1
C14SEMDRHRL	54.9	52.5	27.3	27.2
C13CP1SEMDRHRL	2.2	2.0	1.0	0.8
C13SEMDRHRL	56.8	54.2	27.8	27.6
C12CP1SEMDRHRL	0.7	0.8	0.5	0.5
C12SEMDRHRL	57.4	54.5	28.3	28.1
C11CP1SEMDRHRL	5.4	5.7	3.4	3.4
C11SEMDRHRL	62.2	58.9	31.6	31.5
C10CP1SEMDRHRL	7.6	8.3	4.0	4.2
C10SEMDRHRL	67.9	67.0	35.6	35.7
C9SEMDRHRL	67.9	67.0	35.6	35.7
C8CP2SEMDRHRL	9.9	11.7	4.2	4.6
C8SEMDRHRL	77.6	78.2	39.6	40.2
C7CP1SEMDRHRL	0.9	1.0	0.7	0.7
C7SEMDRHRL	78.4	79.1	40.2	40.9
C6CP1SEMDRHRL	1.3	1.4	0.9	0.9
C6SEMDRHRL	79.4	80.2	40.9	41.6
C5CP1SEMDRHRL	1.6	1.8	1.2	1.3
C5SEMDRHRL	80.7	81.8	42.0	42.7
C4SEMDRHRL	80.8	81.8	41.9	42.7
C3CP1SEMDRHRL	4.3	4.3	2.6	2.6
C3SEMDRHRL	85.0	86.0	44.4	45.1
C2CP1SEMDRHRL	2.3	2.3	1.4	1.4
C2SEMDRHRL	87.3	88.3	45.8	46.3
C1SEMDRHRL	87.3	88.4	45.8	46.4
C12SEMDR	87.3	88.4	45.8	46.4
C11CP1SEMDR	2.0	2.0	0.9	1.0
C11SEMDR	88.6	89.7	46.1	46.7
C10SEMDR	88.6	89.7	46.1	46.7

87th Street Storm Drain (Granite Reef Wash)

Inlet Name	Curb High / Soffit High Interception	FLO-2D/SWMM Model Interception			
		100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*	*(cfs)*
I43CP287STPRL	5.2	2.7	2.0	0.1	0.2
I43CP187STPRL	5.2	0.1	0.2	0.1	0.1
I42CP187STPRL	5.2	0.6	0.5	0.3	0.3
I41CP187STPRL	2.6	0.4	0.4	0.3	0.3
I40CP187STPRL	2.6	0.4	0.5	0.3	0.3
I39CP187STPRL	2.6	0.3	0.4	0.2	0.2
I38CP187STPRL	2.6	0.2	0.2	0.1	0.1
I37CP187STPRL	20.0	10.2	12.1	10.8	11.8
I36CP187STPRL	5.2	0.8	0.9	0.5	0.5
I35CP187STPRL	5.2	0.3	0.4	0.2	0.2
I34CP187STPRL	5.2	0.5	0.6	0.3	0.4
I33CP187STPRL	13.1	4.6	6.8	5.4	6.4
I32CP187STPRL	2.6	0.3	0.3	0.2	0.3
I31CP187STPRL	2.6	0.3	0.2	0.1	0.1
I30CP187STPRL	5.2	0.3	0.3	0.2	0.2
I29CP187STPRL	2.6	0.4	0.5	0.3	0.3
I28CP187STPRL	2.6	0.2	0.3	0.2	0.2
I27CP187STPRL	20.0	10.9	12.3	10.3	11.8
I26CP187STPRL	5.2	0.0	0.0	0.0	0.0
I25CP187STPRL	5.2	0.3	0.4	0.2	0.3
I24CP187STPRL	5.2	0.7	0.8	0.5	0.6
I23CP187STPRL	20.0	13.7	13.0	13.8	14.2
I22CP187STPRL	5.2	0.0	0.0	0.0	0.0
I21CP187STPRL	5.2	0.2	0.2	0.1	0.1
I20CP187STPRL	2.6	0.4	0.4	0.2	0.2
I15CP187STPRL	5.2	0.4	0.4	0.2	0.2
I14CP187STPRL	7.0	16.3	16.2	7.1	7.4
I13CP187STPRL	5.2	0.2	0.2	0.1	0.2
I12CP187STPRL	5.2	0.1	0.1	0.0	0.1
I11CP187STPRL	5.2	0.0	0.0	0.0	0.0

Inlet Name	Curb High / Soffit High Interception	FLO-2D/SWMM Model Interception			
		100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*	*(cfs)*
I10CP187STPRL	13.0	56.6	51.8	53.3	51.0
I9CP187STPRL	5.2	4.3	4.3	0.1	0.1
I8CP187STPRL	5.2	4.3	4.2	0.2	0.3
I7CP187STPRL	5.2	2.3	2.3	0.0	0.1
I6CP187STPRL	2.6	3.0	2.1	1.1	0.2
I5CP287STPRL	8.7	7.0	8.7	3.7	4.3
I5CP387STPRL	8.7	9.6	10.2	5.8	6.5
I4CP187STPRL	2.6	3.1	2.1	2.1	1.7
I3CP187STPRL	2.6	1.7	1.7	1.0	0.7
I4CP187STTRL	17.4	4.2	4.2	3.9	4.2
I487STTRL	17.4	4.7	4.7	3.8	3.9
I387STTRL	17.4	29.6	20.5	9.7	9.0
I1CP187STTRL	3.4	3.9	3.6	1.8	2.0
I2087ST	7.5	23.4	20.9	16.5	16.5
I1987ST	6.4	14.8	14.4	14.6	10.3
I1887ST	6.5	15.0	14.7	11.0	13.5
I1787ST	6.5	14.6	14.0	14.6	10.4
I1687ST	6.5	15.0	14.4	11.2	13.5
I1587ST	6.5	14.6	14.2	12.4	14.6
I1487ST	6.5	13.9	13.7	10.2	9.7
I1387ST	6.5	14.4	14.6	14.6	14.6
I1287ST	6.5	15.0	14.5	11.5	11.5
I1187ST	6.5	16.2	15.8	13.0	14.0
I1087ST	6.5	16.9	16.5	13.8	14.3
I987ST	6.5	15.7	15.3	12.4	12.3
I887ST	6.5	16.7	16.4	14.5	13.7
I787ST	6.5	16.1	15.7	12.9	12.8
I687ST	6.5	14.9	14.9	11.9	11.9
I587ST	6.5	16.2	16.1	13.2	13.1
I487ST	6.5	16.3	16.1	13.0	12.9
I387ST	6.5	16.3	16.1	12.6	12.5
I287ST	6.5	17.2	17.0	13.2	13.0
I187ST	6.5	19.2	18.7	15.4	15.2

Note:
1) 87th Street is an inverted crown roadway.
curb high capacities are not applicable.
2) Grate inlets on 87th Street are not active
in the SWMM model

87th Street Storm Drain (Granite Reef Wash) Continued

Conduit Name	FLO-2D/SWMM Model Interception			
	100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*
C43CP287STPRL	2.7	2.3	1.4	1.2
C43CP187STPRL	10.0	10.3	10.0	10.2
C4387STPRL	11.3	12.0	11.0	11.9
C42CP187STPRL	4.7	6.3	4.9	4.8
C4287STPRL	18.0	18.5	18.1	18.3
C41CP187STPRL	12.2	11.2	12.1	11.3
C4187STPRL	7.5	9.6	7.6	9.3
C40CP187STPRL	6.1	4.6	7.3	4.5
C4087STPRL	8.1	12.5	10.5	12.5
C39CP187STPRL	4.0	7.2	5.4	6.7
C3987STPRL	12.1	14.0	13.6	14.1
C38CP187STPRL	5.3	6.3	5.6	5.4
C3887STPRL	37.5	29.2	36.0	32.6
C37CP187STPRL	18.4	13.3	16.0	16.0
C3787STPRL	13.8	12.1	10.7	10.8
C36CP187STPRL	5.4	4.9	4.0	4.5
C3687STPRL	19.5	12.2	12.2	11.2
C35CP187STPRL	8.1	4.8	4.9	4.5
C3587STPRL	18.1	11.8	11.3	11.3
C34CP187STPRL	5.9	2.9	1.8	2.0
C3487STPRL	47.0	12.1	11.6	11.6
C33CP187STPRL	14.5	9.6	10.0	9.8
C3387STPRL	13.7	16.0	13.8	14.4
C32CP187STPRL	3.1	2.5	2.4	2.0
C3287STPRL	13.0	15.8	13.7	14.2
C31CP187STPRL	3.0	3.8	3.2	3.6
C3187STPRL	12.7	14.3	13.3	13.6
C30CP187STPRL	9.1	5.8	5.4	5.5
C3087STPRL	20.3	13.9	13.6	13.7
C29CP187STPRL	6.7	4.7	6.0	6.3

Conduit Name	FLO-2D/SWMM Model Interception			
	100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*
C2987STPRL	13.6	14.2	13.7	13.8
C28CP187STPRL	5.1	4.7	2.9	1.8
C2887STPRL	16.8	34.5	13.8	13.9
C27CP187STPRL	20.7	22.5	17.0	13.5
C2787STPRL	21.6	27.7	21.8	22.3
C26CP187STPRL	2.8	2.9	4.1	1.0
C2687STPRL	21.2	22.1	21.3	21.9
C25CP187STPRL	2.3	3.2	2.4	1.2
C2587STPRL	21.3	22.6	21.4	22.0
C24CP187STPRL	1.5	2.0	0.9	1.5
C2487STPRL	22.0	23.3	22.0	22.8
C23CP187STPRL	13.7	15.6	13.9	14.4
C2387STPRL	29.0	28.8	28.8	28.5
C22CP187STPRL	1.0	1.1	0.8	0.5
C2287STPRL	26.7	27.6	28.4	28.2
C21CP187STPRL	0.5	0.5	0.5	0.8
C2187STPRL	26.5	27.5	28.3	27.9
C20CP187STPRL	0.6	0.7	1.0	0.9
C2087STPRL	26.7	27.6	28.4	28.3
C1987STPRL	26.7	27.6	28.3	28.3
C1887STPRL	26.4	27.6	28.3	28.3
C1787STPRL	27.7	27.6	28.3	28.3
C1687STPRL	27.6	27.6	28.3	28.2
C15CP187STPRL	1.0	0.7	1.2	1.4
C1587STPRL	26.8	27.7	28.4	29.0
C14CP187STPRL	7.6	7.5	7.3	7.5
C1487STPRL	31.9	35.1	34.2	35.5
C13CP187STPRL	1.1	1.2	1.6	1.6
C1387STPRL	32.0	35.2	34.3	35.7
C12CP187STPRL	0.7	1.8	2.1	2.0

87th Street Storm Drain (Granite Reef Wash) Continued

Conduit Name	FLO-2D/SWMM Model Interception			
	100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*
C1287STPRL	32.1	35.3	34.3	35.8
C11CP187STPRL	1.0	2.4	2.2	2.1
C1187STPRL	32.1	35.6	34.3	44.7
C10CP187STPRL	56.4	52.8	53.1	109.2
C1087STPRL	81.5	91.0	80.2	89.0
C9CP187STPRL	4.3	4.3	1.7	2.4
C987STPRL	83.6	83.4	80.2	85.1
C8CP187STPRL	4.3	9.5	2.7	7.0
C887STPRL	87.5	84.6	80.2	92.0
C7CP187STPRL	2.3	6.9	6.9	12.3
C987STPRL	83.6	83.4	80.2	85.1
C6CP187STPRL	3.0	6.6	5.7	7.4
C887STPRL	87.5	84.6	80.2	92.0
C5CP187STPRL	16.5	18.6	9.4	11.0
C787STPRL	89.7	177.7	182.4	111.5
C4CP187STPRL	3.0	10.6	10.9	15.0
C687STPRL	91.7	163.3	161.7	79.3
C3CP187STPRL	1.6	8.6	6.7	6.8
C587STPRL	99.8	145.8	145.8	86.4
C487STPRL	101.5	133.3	131.1	83.8
C387STPRL	102.3	130.4	126.9	83.9
C287STPRL	102.3	106.0	90.1	84.1
C187STPRL	102.3	108.0	90.1	84.1
C2187ST	85.4	99.6	92.2	87.9
C2087ST	80.9	82.1	85.6	82.7
C1987ST	77.7	77.6	79.9	78.5
C1887ST	75.3	74.7	76.8	75.9
C1787ST	73.3	72.6	74.6	74.0
C1687ST	71.6	70.9	72.7	72.2
C1587ST	72.2	71.8	71.9	71.6

Conduit Name	FLO-2D/SWMM Model Interception			
	100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*
C1487ST	75.5	74.9	75.4	75.2
C1387ST	67.7	68.3	68.3	67.9
C1287ST	69.0	69.4	69.4	69.0
C1187ST	69.2	69.4	69.2	69.1
C1087ST	66.5	68.3	68.4	68.3
C987ST	67.5	69.3	69.4	69.4
C887ST	66.4	66.5	65.5	65.5
C787ST	67.9	68.0	66.4	66.3
C687ST	63.3	63.4	66.2	66.2
C587ST	63.3	62.5	62.8	62.3
C487ST	63.4	62.7	63.0	62.5
C387ST	63.4	63.0	63.1	65.1
C287ST	66.6	69.9	67.0	73.4
C187ST	71.5	81.1	75.9	82.2

West McDowell Storm Drain

Inlet Name	Curb High / Soffit High Interception	FLO-2D/SWMM Model Interception			
		100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*	*(cfs)*
I15CP1WMDR	5.5	0.9	1.1	0.7	0.8
I15CP2WMDR	11.3	18.1	18.5	10.3	9.0
I15CP3WMDR	11.3	9.1	9.1	5.3	3.7
I14CP1WMDR	11.3	11.1	11.4	1.5	1.0
I13CP1WMDR	5.5	0.5	0.7	0.3	0.4
I13CP1WMDR	5.5	0.5	0.7	0.3	0.4
I11CP1WMDR	5.5	1.6	1.9	1.1	1.3
I10CP1WMDR	3.8	10.4	10.4	4.4	3.3
I9CP1WMDR	5.2	9.1	8.2	4.4	4.7
I8CP1WMDR	2.6	1.6	1.8	1.1	1.2
I8CP2WMDR	2.6	4.7	4.6	2.9	4.1
I7CP1WMDR	2.6	1.2	1.2	0.5	0.6
I6CP1WMDR	13.1	3.8	4.0	0.4	0.5
I5CP1WMDR	8.7	8.4	7.9	4.6	5.3
I4CP1WMDR	8.7	0.0	0.0	0.0	0.0
I3CP1WMDR	8.7	0.0	0.0	0.0	0.0
I2CP1WMDR	8.7	0.0	0.0	0.0	0.0
I1CP1WMDR	8.7	5.4	4.0	1.0	1.2

Conduit Name	FLO-2D/SWMM Model Interception			
	100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*
C15CP1WMDR	0.9	1.1	0.7	0.8
C15CP2WMDR	25.1	25.8	15.5	12.7
C15CP3WMDR	10.4	10.0	5.3	3.7
C17WMDR	14.0	13.5	5.3	5.6
C14CP1WMDR	11.4	11.4	1.5	1.0
C16WMDR	20.3	22.9	14.2	13.3
C13CP1WMDR	0.7	0.7	0.3	0.4
C15WMDR	39.7	37.6	25.1	21.6
C14WMDR	48.4	46.8	26.7	22.5
C11CP1WMDR	1.6	1.9	1.1	1.3
C13WMDR	48.4	46.9	26.7	22.6
C12WMDR	48.4	46.7	26.7	22.6
C10CP1WMDR	10.5	10.7	4.4	3.3
C11WMDR	49.1	47.1	26.8	22.6
C10WMDR	58.1	56.8	31.1	25.9
C9CP1WMDR	9.1	8.3	4.4	4.7
C9WMDR	64.3	62.0	33.5	28.0
C8CP1WMDR	1.6	1.8	1.0	1.2
C8CP2WMDR	5.2	5.1	3.0	3.3
C8WMDR	69.0	65.5	36.6	31.7
C7CP1WMDR	1.8	1.2	0.5	0.6
C7WMDR	69.5	65.8	55.2	57.2
C6CP1WMDR	3.8	4.0	0.4	0.5
C6WMDR	71.6	65.9	53.5	51.5
C5CP1WMDR	8.4	8.0	4.6	5.3
C5WMDR	77.6	71.1	40.3	39.5
C4CP1WMDR	0.8	0.7	0.4	0.6
C4WMDR	77.6	71.1	38.5	34.1
C3CP1WMDR	0.7	0.6	1.1	1.1
C3WMDR	77.6	71.1	38.3	32.6
C2CP1WMDR	0.9	0.8	0.6	1.7
C2WMDR	77.5	71.3	38.4	32.7
C1CP1WMDR	3.4	2.2	1.0	1.3
C1WMDR	76.0	70.5	38.5	32.7

East McDowell Storm Drain

Inlet Name	Curb High / Soffit High Interception	FLO-2D/SWMM Model Interception			
		100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*	*(cfs)*
I4CP2EMDRPRL	3.4	4.4	4.7	2.9	3.2
I4CP1EMDRPRL	3.4	5.1	5.6	2.6	3.0
I3CP1EMDRPRL	5.2	0.4	0.4	0.1	0.2
I2CP1EMDRPRL	5.2	1.0	0.8	0.3	0.2
I1CP1EMDRPRL	5.2	9.8	9.6	5.3	4.3
I13CP2EMDR	8.7	13.8	9.4	2.4	2.0
I13CP1EMDR	8.7	1.4	1.6	0.9	1.1
I12CP1EMDR	8.7	2.3	2.6	1.5	1.6
I11CP5EMDR	4.6	9.6	10.1	7.1	7.6
I11CP1EMDR	8.7	3.1	3.2	1.1	1.2
I10CP1EMDR	7.8	0.3	0.4	0.2	0.2
I9CP1EMDR	8.7	0.4	0.5	0.3	0.4
I8CP1EMDR	8.7	3.5	3.5	1.3	1.1
I7CP1EMDR	7.8	2.0	2.3	1.5	1.7
I6CP1EMDR	8.7	1.0	1.0	0.5	0.5
I5CP4EMDR	2.6	5.9	5.6	2.9	3.0
I5CP3EMDR	8.7	18.4	17.6	4.2	4.8
I5CP1EMDR	7.8	3.3	3.6	1.6	2.0
I4CP1EMDR	5.2	2.8	3.0	0.5	0.6
I3CP1EMDR	5.2	3.6	3.8	0.7	0.9

Conduit Name	FLO-2D/SWMM Model Interception			
	100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*
C5EMDRPRL	2.2	2.0	0.8	1.0
C4CP2EMDRPRL	4.4	4.7	2.9	3.2
C4EMDRPRL	14.4	13.6	6.8	7.7
C3CP1EMDRPRL	0.4	0.4	0.1	0.2
C3EMDRPRL	14.8	14.0	6.9	7.7
C2CP1EMDRPRL	1.0	0.8	0.3	0.2
C2EMDRPRL	15.4	14.5	6.9	7.7
C1CP1EMDRPRL	9.8	9.6	5.3	4.3
C1EMDRPRL	24.5	23.3	10.8	11.5
C13CP2EMDR	13.0	9.4	2.4	2.0
C13CP1EMDR	1.4	1.6	0.9	1.1
C14EMDR	24.5	23.3	10.8	11.5
C12CP1EMDR	2.3	2.6	1.5	1.6
C13EMDR	33.4	30.2	13.0	14.0
C11CP1EMDR	10.7	11.8	7.5	7.7
C12EMDR	34.3	31.2	15.4	16.6
C10CP1EMDR	0.8	1.2	0.2	0.4
C11CP5EMDR	9.5	9.9	7.0	7.5
C11CP4EMDR	9.1	9.3	6.8	7.2
C11CP3EMDR	8.5	8.8	6.7	7.0
C11CP2EMDR	8.2	8.7	6.7	7.0
C11CP1EMDR	10.7	11.8	7.5	7.7
C11EMDR	37.6	35.4	22.7	24.2
C9CP1EMDR	0.4	0.5	0.3	0.4
C10EMDR	37.7	35.4	22.2	23.5
C8CP1EMDR	3.5	3.6	1.3	1.1
C9EMDR	37.7	35.5	20.2	21.2
C7CP1EMDR	2.4	2.4	1.5	1.7
C8EMDR	39.5	37.5	20.9	22.4
C6CP1EMDR	1.0	1.1	0.6	0.5

Conduit Name	FLO-2D/SWMM Model Interception			
	100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*
C7EMDR	40.3	39.0	21.9	21.6
C5CP1EMDR	3.3	3.7	1.6	2.0
C6EMDR	41.3	40.0	22.4	21.9
C4CP1EMDR	2.9	3.1	0.5	0.6
C5CP4EMDR	2.8	3.5	2.9	3.0
C5CP3EMDR	3.9	5.1	4.3	4.8
C5CP2EMDR	6.6	8.3	7.1	7.8
C5CP1EMDR	3.3	3.7	1.6	2.0
C5EMDR	44.7	46.7	29.6	29.5
C3CP1EMDR	3.6	3.9	0.9	1.1
C4EMDR	45.4	47.5	29.8	29.7
C3EMDR	47.7	50.2	30.2	30.2
C2EMDR	48.4	51.0	30.4	30.4
C1EMDR	48.5	51.0	30.4	30.4

South Hayden Storm Drain

Inlet Name	Curb High / Soffit High Interception	FLO-2D/SWMM Model Interception			
		100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*	*(cfs)*
I15CP3EMRHRL	7.8	0.7	0.8	0.4	0.5
I15CP2EMRHRL	2.6	0.3	0.3	0.2	0.2
I15CP1EMRHRL	2.6	0.5	0.6	0.3	0.3
I12CP1EMRHRL	2.6	0.0	0.0	0.0	0.0
I12CP2EMRHRL	2.6	1.9	1.9	1.3	1.3
I11CP1EMRHRL	11.3	2.1	2.5	1.4	1.6
I11CP2EMRHRL	11.3	4.0	4.3	2.6	2.7
I10CP3EMRHRL	5.4	8.0	8.9	5.6	6.1
I9CP2EMRHRL	7.8	0.9	1.1	0.6	0.7
I9CP1EMRHRL	2.6	0.0	0.0	0.0	0.0
I8CP2EMRHRL	7.8	1.0	1.3	0.5	0.5
I8CP1EMRHRL	2.6	0.0	0.0	0.0	0.0
I7CP1EMRHR	17.4	4.4	4.9	2.4	2.4
I5CP2EMRHRL	17.4	3.8	4.2	2.3	2.2
I5CP1EMRHRL	2.6	1.5	1.6	0.8	0.8
I4CP1EMRHRL	2.6	0.0	0.0	0.0	0.0
I2CP2EMRHRL	5.2	0.4	0.5	0.2	0.3
I2CP1EMRHRL	4.5	5.2	6.2	2.8	3.6
I1CP4EMRHRL	3.6	2.5	3.1	1.5	1.9
I1CP3EMRHRL	7.8	2.8	3.3	1.7	2.1
I1CP1EMRHRL	4.5	3.2	3.7	1.7	2.1
I3CP1EMR	5.2	0.7	0.8	0.4	0.5

Conduit Name	FLO-2D/SWMM Model Interception			
	100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*
C15CP3EMRHRL	0.7	0.8	0.4	0.4
C15CP2EMRHRL	0.9	1.1	0.5	0.6
C15CP1EMRHRL	0.5	0.6	0.3	0.3
C15EMRHRL	14.3	12.6	5.2	5.7
C14EMRHRL	14.3	12.6	5.2	5.6
C13EMRHRL	14.3	12.6	5.2	5.6
C12CP1EMRHRL	0.0	0.0	0.0	0.0
C12CP2EMRHRL	1.8	1.9	1.2	1.3
C12EMRHRL	15.6	13.8	6.3	6.8
C11CP1EMRHRL	2.1	2.5	1.4	1.6
C11CP2EMRHRL	4.0	4.3	2.6	2.7
C11EMRHRL	19.5	17.8	10.0	10.7
C10CP3EMRHRL	8.0	8.9	5.6	6.1
C10CP2EMRHRL	8.0	8.9	5.6	6.1
C10CP1EMRHRL	8.0	8.9	5.6	6.1
C10EMRHRL	26.7	26.7	15.5	16.6
C9CP2EMRHRL	0.9	1.1	0.6	0.7
C9CP1EMRHRL	0.0	0.0	0.0	0.0
C9EMRHRL	27.3	27.6	16.0	17.2
C8CP2EMRHRL	1.0	1.3	0.5	0.5
C8CP1EMRHRL	0.0	0.0	0.0	0.0
C8EMRHRL	28.0	28.9	16.4	17.6
C7CP1EMRHRL	4.4	4.9	2.4	2.3
C7EMRHRL	32.1	33.6	18.7	19.2
C6EMRHRL	32.1	33.6	18.7	19.2
C5CP2EMRHRL	3.8	4.2	2.3	2.2
C5CP1EMRHRL	1.5	1.6	0.8	0.8
C5EMRHRL	37.3	39.6	21.5	21.4
C4CP1EMRHRL	0.0	0.4	0.0	0.0
C4EMRHRL	37.5	39.7	21.3	21.2

Conduit Name	FLO-2D/SWMM Model Interception			
	100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*
C3EMRHRL	37.5	39.7	21.3	21.4
C2CP2EMRHRL	1.0	1.0	0.2	0.3
C2CP1EMRHRL	5.3	6.2	2.8	3.6
C2EMRHRL	38.9	43.0	22.4	22.6
C1CP4EMRHRL	2.5	3.3	1.5	1.9
C1CP3EMRHRL	2.8	3.3	1.7	2.1
C1CP2EMRHRL	5.3	6.4	3.2	3.8
C1CP1EMRHRL	3.2	3.7	1.7	2.1
C1EMRHRL	44.0	49.2	25.1	25.8
C4EMR	44.0	49.2	25.1	25.8
C3CP1EMR	1.3	1.7	0.4	0.5
C3EMR	44.3	49.5	25.1	25.9

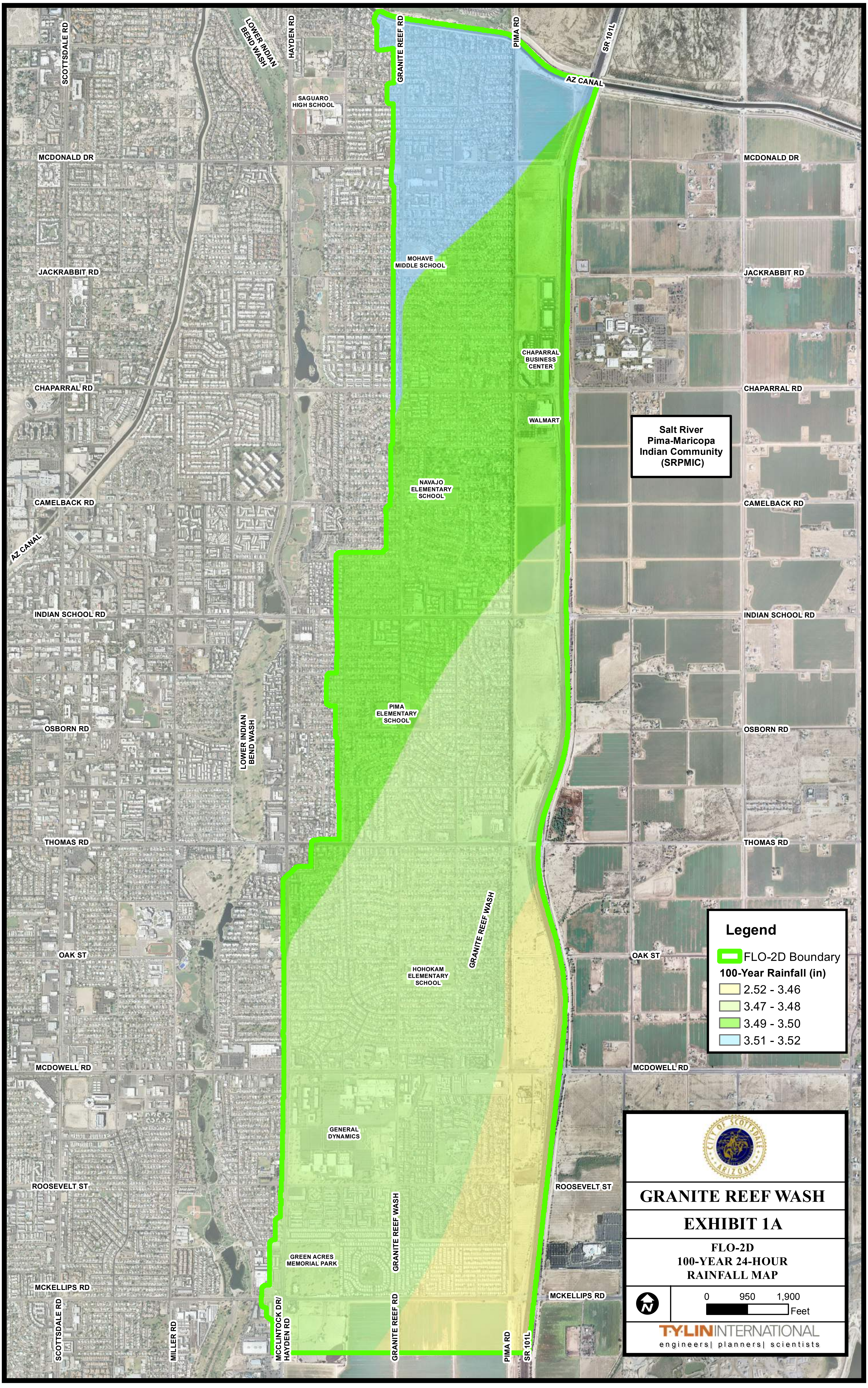
84th Street Storm Drain (Granite Reef Wash)

Inlet Name	Curb High / Soffit High Interception	FLO-2D/SWMM Model Interception			
		100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*	*(cfs)*
I3GRR84PLL	0.0	92.3	91.8	87.9	87.5
I2GRR84PLL	7.0	25.2	25.1	21.6	21.3
I1CP1GRR84PLL	4.6	18.2	18.0	17.7	17.5
I1GRR84PLL	3.8	10.2	10.4	10.4	10.4
I3CP2GRR	2.3	9.9	10.5	7.8	8.2
I3CP1GRR	6.1	12.5	12.3	8.0	8.3
I3GRR	6.1	9.1	9.8	8.7	8.6
I1GRR	7.0	18.2	18.2	18.2	18.2

Conduit Name	FLO-2D/SWMM Model Interception			
	100-yr, 24-hr	100-yr, 6-hr	10-yr, 24-hr	10-yr, 6-hr
	(cfs)	*(cfs)*	*(cfs)*	*(cfs)*
C3GRR84PLL	91.7	91.4	87.6	87.3
C2GRR84PLL	83.6	94.3	81.1	92.8
C1CP1GRR84PLL	7.9	13.9	9.0	10.1
C1GRR84PLL	82.0	85.3	82.3	85.5
C4GRR	91.8	97.1	91.6	94.9
C3CP2GRR	9.9	10.5	7.8	8.2
C3CP1GRR	17.3	20.4	21.6	21.2
C3GRR	118.7	114.8	108.1	123.5
C2GRR	107.0	106.9	107.2	107.4
C1GRR	127.5	127.5	128.3	128.3

APPENDIX E – Drainage Exhibits

APPENDIX E.1 – Input Data Exhibits



SCOTTSDALE RD
LOWER INDIAN BEND WASH
HAYDEN RD
GRANITE REEF RD
PIMA RD
SR 101L
AZ CANAL
SAGUARO HIGH SCHOOL
MCDONALD DR
JACKRABBIT RD
MOHAVE MIDDLE SCHOOL
CHAPARRAL BUSINESS CENTER
CHAPARRAL RD
WALMART
Salt River Pima-Maricopa Indian Community (SRPMIC)
NAVAJO ELEMENTARY SCHOOL
CAMELBACK RD
INDIAN SCHOOL RD
PIMA ELEMENTARY SCHOOL
OSBORN RD
THOMAS RD
GRANITE REEF WASH
OAK ST
HOHOKAM ELEMENTARY SCHOOL
MCDOWELL RD
GENERAL DYNAMICS
ROOSEVELT ST
GREEN ACRES MEMORIAL PARK
MCKELLIPS RD
MILLER RD
MCCLINTOCK DR/ HAYDEN RD
Legend
FLO-2D Boundary
100-Year Rainfall (in)
2.52 - 3.46
3.47 - 3.48
3.49 - 3.50
3.51 - 3.52
GRANITE REEF WASH
EXHIBIT 1A
FLO-2D
100-YEAR 24-HOUR
RAINFALL MAP
0
950
1,900
Feet
TY·LIN INTERNATIONAL
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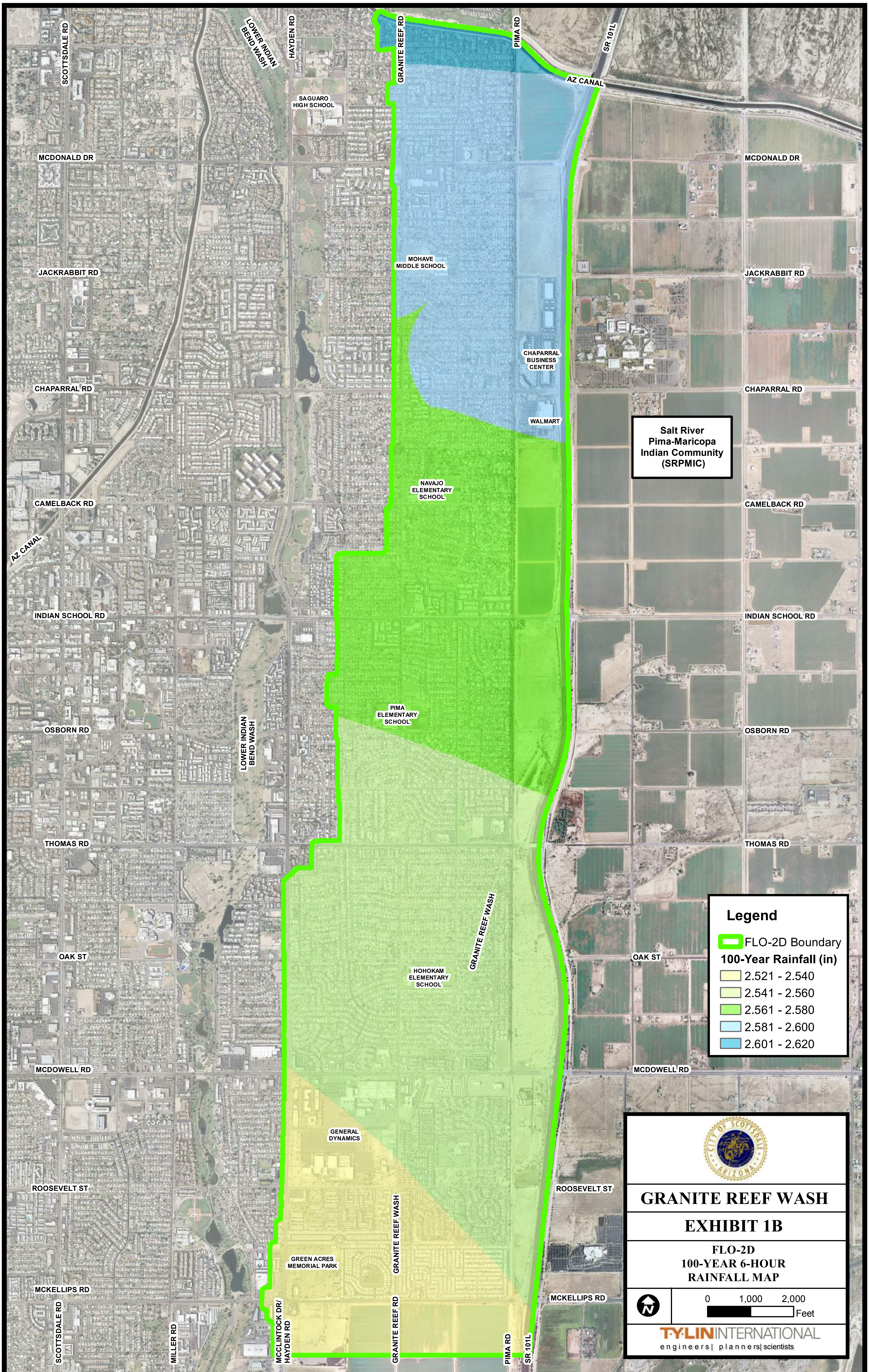

SCOTTSDALE RD
LOWER INDIAN BEND WASH
HAYDEN RD
GRANITE REEF RD
PIMA RD
SR 101L
AZ CANAL
SAGUARO HIGH SCHOOL
MCDONALD DR
MOHAVE MIDDLE SCHOOL
JACKRABBIT RD
CHAPARRAL BUSINESS CENTER
CHAPARRAL RD
WALMART
Salt River Pima-Maricopa Indian Community (SRPMIC)
NAVAJO ELEMENTARY SCHOOL
CAMELBACK RD
AZ CANAL
INDIAN SCHOOL RD
PIMA ELEMENTARY SCHOOL
OSBORN RD
THOMAS RD
GRANITE REEF WASH
HOHOKAM ELEMENTARY SCHOOL
OAK ST
MCDOWELL RD
GENERAL DYNAMICS
ROOSEVELT ST
GREEN ACRES MEMORIAL PARK
MCKELLIPS RD
MILLER RD
MCCLINTOCK DR/ HAYDEN RD
Legend
FLO-2D Boundary
100-Year Rainfall (in)
2.521 - 2.540
2.541 - 2.560
2.561 - 2.580
2.581 - 2.600
2.601 - 2.620
CITY OF SCOTTSDALE ARIZONA
GRANITE REEF WASH
EXHIBIT 1B
FLO-2D
100-YEAR 6-HOUR
RAINFALL MAP
0
1,000
2,000
Feet
TYLIN INTERNATIONAL
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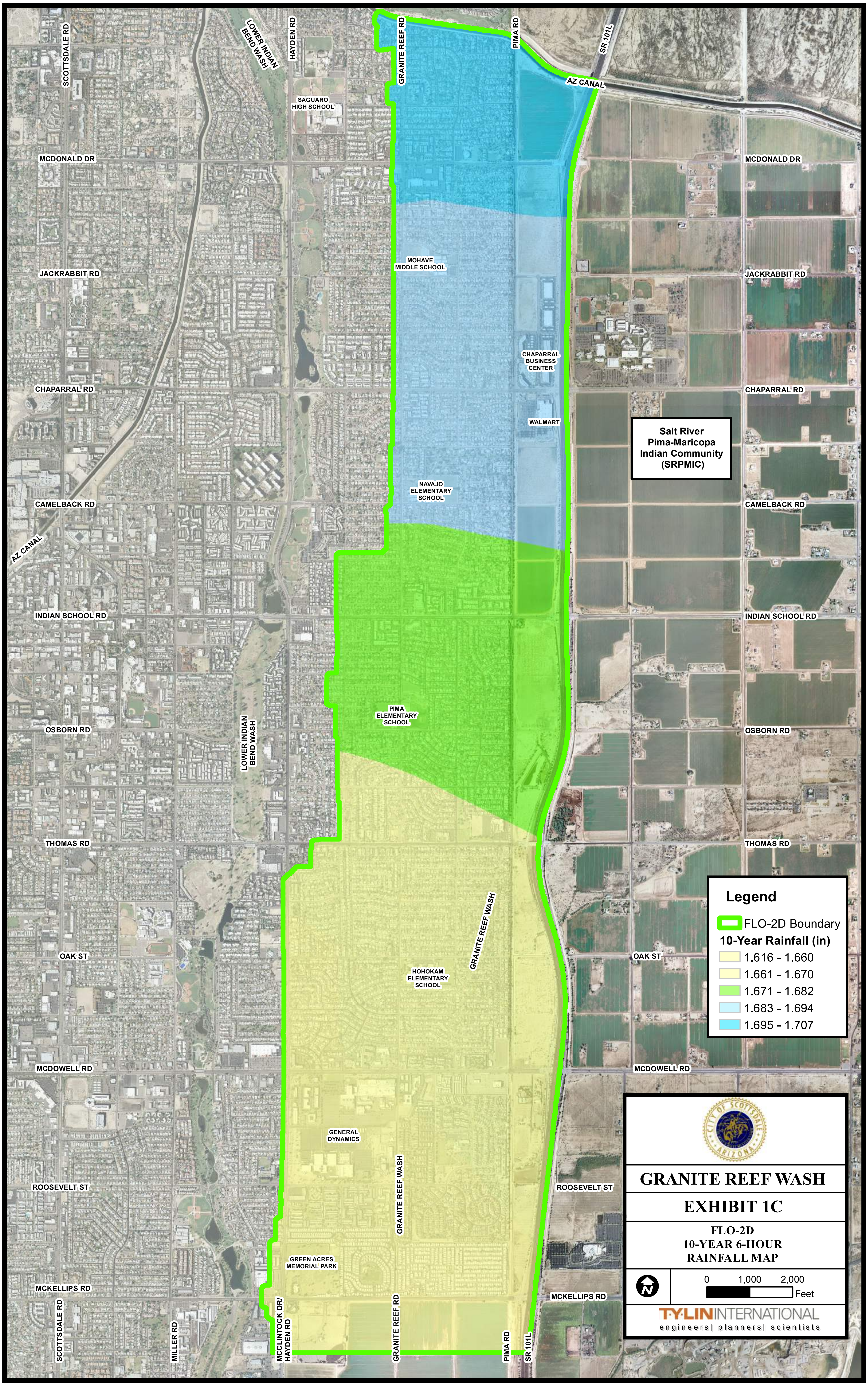

GRANITE REEF WASH

EXHIBIT 1C

FLO-2D 10-YEAR 6-HOUR RAINFALL MAP

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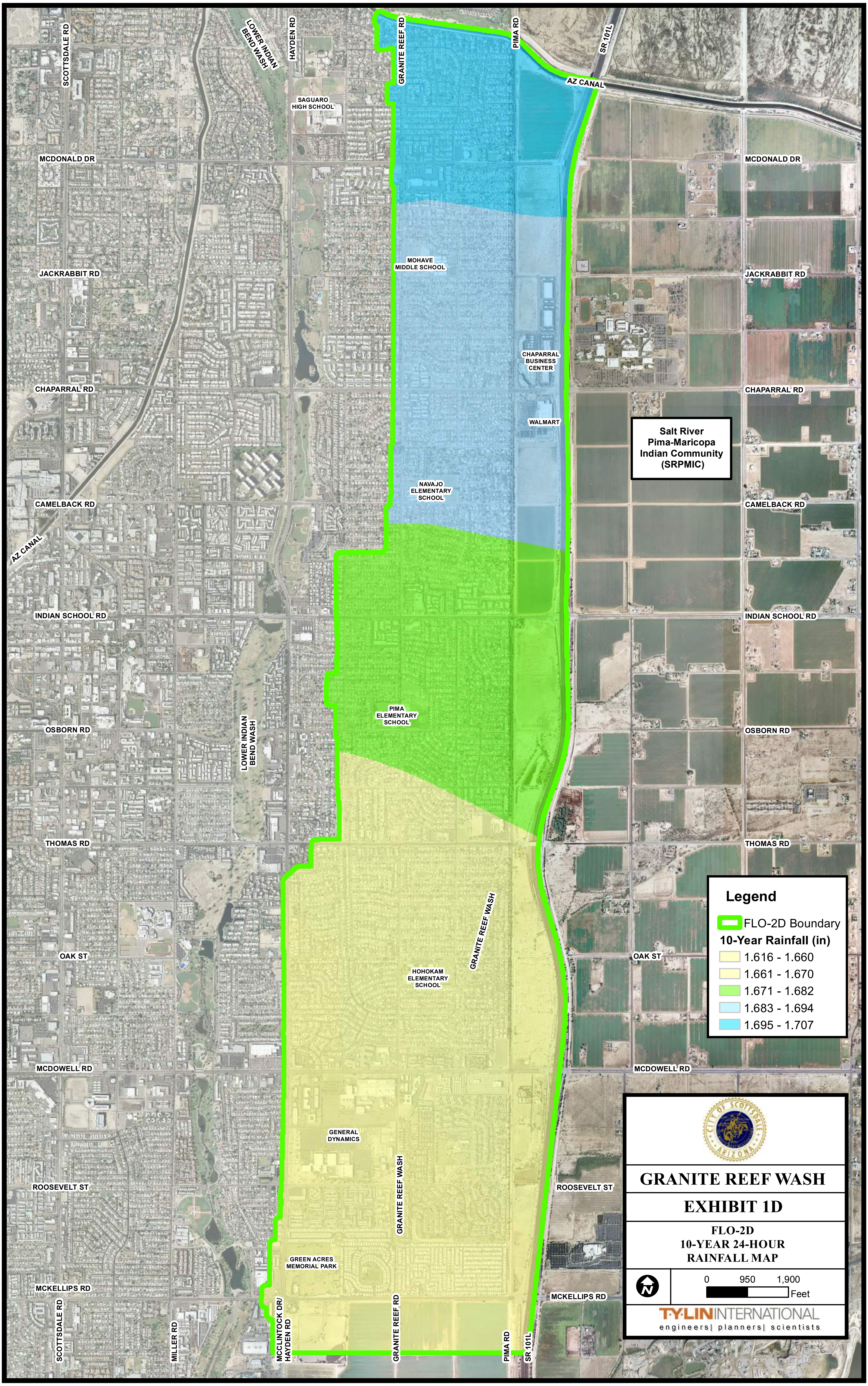

SCOTTSDALE RD
LOWER INDIAN BEND WASH
HAYDEN RD
GRANITE REEF RD
PIMA RD
SR 101L
AZ CANAL
SAGUARO HIGH SCHOOL
MCDONALD DR
JACKRABBIT RD
MOHAVE MIDDLE SCHOOL
CHAPARRAL BUSINESS CENTER
CHAPARRAL RD
WALMART
Salt River Pima-Maricopa Indian Community (SRPMIC)
NAVAJO ELEMENTARY SCHOOL
CAMELBACK RD
AZ CANAL
INDIAN SCHOOL RD
PIMA ELEMENTARY SCHOOL
OSBORN RD
LOWER INDIAN BEND WASH
THOMAS RD
GRANITE REEF WASH
OAK ST
HOHOKAM ELEMENTARY SCHOOL
MCDOWELL RD
GENERAL DYNAMICS
GRANITE REEF WASH
ROOSEVELT ST
GREEN ACRES MEMORIAL PARK
MCKELLIPS RD
SCOTTSDALE RD
MILLER RD
MCCLINTOCK DR/ HAYDEN RD
GRANITE REEF RD
PIMA RD
SR 101L
Legend
FLO-2D Boundary
10-Year Rainfall (in)
1.616 - 1.660
1.661 - 1.670
1.671 - 1.682
1.683 - 1.694
1.695 - 1.707
CITY OF SCOTTSDALE ARIZONA
GRANITE REEF WASH
EXHIBIT 1D
FLO-2D
10-YEAR 24-HOUR
RAINFALL MAP
0 950 1,900
Feet
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SCOTTSDALE RD
LOWER INDIAN BEND WASH
HAYDEN RD
GRANITE REEF RD
PIMA RD
SR 101L
AZ CANAL
SAGUARO HIGH SCHOOL
THE GARDEN CHRISTIAN CHURCH
MCDONALD DR
MOHAVE MIDDLE SCHOOL
JACKRABBIT RD
SCOTTSDALE COMMUNITY COLLEGE
CHAPARRAL BUSINESS CENTER
CHAPARRAL RD
WALMART
Salt River Pima-Maricopa Indian Community (SRPMIC)
CAMELBACK RD
NAVAJO ELEMENTARY SCHOOL
INDIAN SCHOOL RD
PIMA ELEMENTARY SCHOOL
OSBORN RD
MICROSEMI
THOMAS RD
OAK ST
GRANITE REEF WASH
HOHOKAM ELEMENTARY SCHOOL
MCDOWELL RD
GENERAL DYNAMICS
APACHE ELEMENTARY SCHOOL
ROOSEVELT ST
GREEN ACRES MEMORIAL PARK
MCKELLIPS RD
MCCLINTOCK DR/ HAYDEN RD
MILLER RD
LEGEND
FLO-2D Boundary
Elevations (Feet)
1,140 - 1,160
1,160 - 1,180
1,180 - 1,200
1,200 - 1,220
1,220 - 1,240
1,240 - 1,260
1,260 - 1,280
1,280 - 1,300
1,300 - 1,320
CITY OF SCOTTSDALE ARIZONA
GRANITE REEF WASH
EXHIBIT 2
FLO-2D
ELEVATIONS MAP
N
0 1,000 2,000
Feet
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Land Character Type	IA (inches)	RTIMP (%)	InitSat	n
Agricultural	0.50	0	Normal	0.060
Asphalt	0.05	95	Normal	0.020
Buildings	0.05	95	Normal	0.024
Concrete	0.05	98	Normal	0.016
Shade Structures	0.05	98	Normal	0.035
Unpaved road	0.10	50	Dry	0.026
Urban Bare Ground	0.20	0	Dry	0.035
Urban High Vegetation	0.10	0	Normal	0.065
Urban Low Vegetation	0.10	0	Normal	0.045
Water	0	100	Saturated	0.040

Legend
FLO-2D Boundary
Soil Data Source
RiA Rillito gravelly loam, 0 to 1 percent slopes
Am Alluvial land
23 Contine clay
22/Co Contine clay loam
57 Gilman clay loam
Gm Gilman loam
55 Gilman loams
LaA Laveen loam, 0 to 1 percent slopes
LaB Laveen loam, 1 to 3 percent slopes
79 Mohall clay
77 Mohall clay loam
Mv Mohall loam
Pm Pimer clay loam
PnA Pinal gravelly loam, 0 to 1 percent slopes
RiB Rillito gravelly loam, 1 to 3 percent slopes
101 Rillito loam, 0 to 3 percent slopes
110 Suncity-Cipriano complex, 1 to 7 percent slopes
Vf Vint loamy fine sand
CITY OF SCOTTSDALE ARIZONA
GRANITE REEF WASH
EXHIBIT 4
FLO-2D
SOILS MAP
0 1,000 2,000
Feet
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Salt River Pima-Maricopa Indian Community (SRPMIC)
SCOTTSDALE RD
HAYDEN RD
GRANITE REEF RD
PIMA RD
SR 101L
LOWER INDIAN BEND WASH
AZ CANAL
MCDONALD DR
JACKRABBIT RD
CHAPARRAL RD
CAMELBACK RD
INDIAN SCHOOL RD
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OAK ST
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MCKELLIPS RD
MILLER RD
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PIMA ELEMENTARY SCHOOL
MICROSEMI
HOHOKAM ELEMENTARY SCHOOL
GRANITE REEF WASH
GENERAL DYNAMICS
APACHE ELEMENTARY SCHOOL
GREEN ACRES MEMORIAL PARK
Salt River Pima-Maricopa Indian Community (SRPMIC)

GRANITE REEF WASH

EXHIBIT 5

FLO-2D STORM DRAINS AND HYDRAULIC STRUCTURES MAP

Hydraulic Structures

Name	Size	Inflow Grid(s)	Outflow Grid
MCDGRW	1- 12' X 8' RCB	527400	530824
SRPGRW	1- 13' X 7.5' RCB	638737	642512
MCKGRW	2 - 8' X 4' RCB	674255	677648
86THST1	6' CO, 15" SD	57389	60490
86THST2	6' CO, 15" SD	57391	60490
MCDONALD1	3' CO, 18" SD	58237	60492
MCDONALD2	3' CO, 18" SD	58243	60494
MCDONALD3	3' CO, 15" SD	58533(A), 59659(B)	60221
MCDONALD4	3' CO, 15" SD	58542	60511
MCDONALD5	3' CO, 15" SD	58283(A), 59691(B)	60534
MCDONALD6	3' CO, 15" SD	58585(A), 59430(B)	60834
MCDONALD7	3' CO, 15" SD	58606(A), 59731(B)	60574
RIVIERADR	2 - 12" SD	639149	643350
GARFIELDST1	3 - 35" x 24" CMP	605918	607978
ROOSEVELTCIR	1 - 42" x 30" CMP	627303	630622
LATHAMST	3' CO, 18" SD	595178	593519
PORTLANDST	3 - 24" CMP	596914	598976
87THPLBIKEPATH	3 - 24" CMP	635189	636834
GARFIELDST2	3' CO, 18" SD	610837	614936
AMELIAAVE	3' CO, 18" SD	264696	264348
PIMADITCH1	1 - 24" CMP	55797	56929
PIMADITCH2	1 - 24" RCP	57493	60588
PIMADITCH3	1 - 24" CMP	72774	73591
PIMADITCH4	1 - 24" RCP	105923	108091
PIMADITCH5	1 - 19" x 30" RCP	118101	119181
PIMADITCH6	1 - 24" RCP	128625	131584
PIMADITCH7	1 - 24" RCP	140999	143689
PIMADITCH8	1 - 24" RCP	150951	187284
PIMADITCH9	1 - 24" RCP	257926	261499
PIMADITCH10	1 - 18" x 40" CMP	263998	266140
PIMADITCH11	1 - 24" RCP	322883	324327
PIMADITCH12	1 - 30" CMP	332192	333960
PIMADITCH13	1 - 18" RCP	379947	414945
I3GRR84PLL*	1 - 48" RCP	557549	-
I3CP2GRR*	1 - 18" RCP	600035	-

*These are culvert entrances to the storm drain system. The rating tables for theses inlets were devloped with the hydraulic structures shown in this exhibit. The rating tables for these culvert entrances were applied to the SWMM model. Refer to Appendix D for the development of the SWMM model.

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