City of Aztec
Storm Drainage Master Plan
and
Preliminary Engineering Report

Submitted on: June 27, 2024
Submitted to: Public Works Director
City of Aztec, NM

TIMOTHY DENNIS OSTING
NEW MEXICO
28718
PROFESSIONAL ENGINEER
06/27/2024

Prepared by:
Tim Osting, PE[1,2], CFM   Mike Vielleux, PE[2]
Justin Baker, PE[2], CFM   Jeff Irvin, PE[2]

AquaStrategies

13341 W US Hwy 290, Bldg. 2
Austin, TX 78737

[1] Licensed in New Mexico
[2] Licensed in other states

TABLE OF CONTENTS

1 Study Background and Purpose

This City of Aztec has experienced significant flooding and erosion due to monsoon rainfall events. The erosion of upstream areas contributes to high sediment loads transmitted to flatter downstream areas where sediment is deposited causing more flooding and high maintenance costs. The objective of this work will be to systematically evaluate and prioritize problem areas based on flood risk in a way to differentiate between nuisance and high-risk events.

The City of Aztec has identified numerous drainage issues in its jurisdictional area as shown on the Stormwater Problem Areas map developed by the City of Aztec in March 2023. This map is located in Appendix A – Stormwater Problem Areas Map at the end of this report. **Figure 1** and **Figure 2** below are examples of problem areas associated with the Blanco Arroyo where it crosses Blanco Street between N. Rio Grande and Creekside Village Ct. This is near site number 23 on the Stormwater Problem Areas map in Appendix A. That drainage pathway overflows at times at multiple points upstream and downstream of this area as a result of several compounding factors.

Figure 1. Culvert and drainage near Blanco Street and Creekside Village, looking southeast, 2023.

Figure 2. Same location as Figure 1, looking northwest, 2023.

Aqua Strategies was contracted to deliver to the City a Storm Drainage Master Plan describing a holistic drainage master planning approach conducted at a watershed scale. The project is also to result in a Preliminary Engineering Report (PER) that identifies and recommends one or more regional solutions in areas where localized point improvements are not capable of fully alleviating issues. The following sections of this report describe the data gathered for this project, the prioritization process, a detailed hydrology modeling approach, and evaluation of flood reducing alternatives. The PER including 30% design concept construction plans (Appendix O) has been developed to cover a regional alternative in the Blanco Arroyo watershed.

2 Storm Drainage Masterplan - Data Gathering

Existing reports, information, and data were compiled from readily available sources such as the City of Aztec, San Juan County, the state of New Mexico, FEMA, USGS, NOAA, and other databases. This information and data along with anecdotal information gathered from several meetings with City staff are described in the following sections.

2.1 Previous Studies

The City of Aztec staff provided ASI with three previous study reports completed in 2017 by AECOM. The documents are titled as follows:

1) Hampton Arroyo Master Drainage Report, Hydrologic and Hydraulic Analysis, City of Aztec, San Juan County, New Mexico. AECOM June 2017.
2) Blanco Arroyo, Flood Hazard Assessment and Mitigation Alternatives Report, City of Aztec, San Juan, New Mexico. AECOM June 2017.
3) Kokopelli Subdivision, Flood Hazard Assessment and Mitigation Alternatives Report, City of Aztec, San Juan, New Mexico. AECOM June 2017

Information from these three previous studies were used to inform the modeling and guide the alternative selection as described in Section 4 below.

2.2 FEMA Studies

2.2.1 FEMA Effective Study

The FEMA Flood Insurance Study (FIS) report was obtained and reviewed for this project.[3] This report provides details on the history of flooding in the community, as well as on hydrologic and hydraulic modeling methods used to produce the effective FEMA floodplain maps, which were reviewed and used as a reference for this project. The spatial data underlying the effective floodplain map for the area were also downloaded in shapefile format from FEMA's Map Service Center (MSC).[4] The regulatory floodplain currently regulated by the City became effective in August 2010. However, the effective FEMA floodplains available for the City do not provide enough streamline coverage and are not detailed enough for the purposes of the current study.

2.2.2 Base Level Engineering Study

A 2018 hydrologic and hydraulic study by Earth Data Analysis Center (EDAC) and ESP Associates, Inc. was obtained and reviewed.[5] The study made use of a 2-dimensional (HEC-RAS) model covering the entire Animas watershed, including the City of Aztec. The resulting floodplain data, based on a 50-ft resolution terrain were also reviewed. The data available from this effort are not detailed enough for the purposes of the current study.

2.3 Rain and Stream Gage Data

Historic data from rain and stream gages were analyzed to identify recent storm events (i.e., recent enough to likely be within the memory of current city staff) that were of significant size to provide some experience as to the ability of current stormwater infrastructure to effectively manage floods.

To identify dates of likely flooding associated with local rainfall over the watersheds of the arroyos upstream of the City of Aztec, Aqua Strategies investigated hydrology data:

- Local and regional rain gages were identified; these are shown in the figure in Appendix B and listed in **Table 1** below.
- Dates of extreme daily rainfall were identified for the most local rain gage (Aztec Ruins) and sorted by depth (see **Table 2**). The date with the highest recorded daily rainfall (2.67 inches) was August 27, 2015.
- Per the current National Oceanic and Atmospheric Administration (NOAA) Precipitation Atlas 14, the 1% Annual Chance (100-year return period) 24-hour hour storm has a rainfall depth of 2.62 inches. The estimated return period for the August 27, 2015 storm was 116 years (see **Table 3**)
- Radar precipitation images were reviewed for the August 27, 2015 event, and the storm was found to be largely concentrated over Hampton., Estes, and Blanco Arroyos.

Staff within the City of Aztec were identified who were present during the August 27, 2015, extreme event. Experience and issues associated with that event within the affected arroyos became the basis for discussion for flood mitigation alternatives developed for that part of the city (see Section 2.7 below).

[3] FEMA. Flood Insurance Study Number 35045CV000A. San Juan County, New Mexico, And Incorporated Areas. August 5, 2010.

[4] https://msc.fema.gov/portal/advanceSearch

[5] FEMA. Base Level Engineering for Animas Watershed, New Mexico. Base Level Engineering Technical Support Data Notebook. June 29, 2018.

Table 1. Rain Gages Near the City of Aztec

STATION_ID	STATION NAME	BEGIN_DATE	END_DATE
GHCND: USC00290692	AZTEC RUINS NATIONAL MONUMENT, NM US	12/31/1894	8/30/2023
GHCND: USW00023090	FARMINGTON FOUR CORNERS REGIONAL AIRPORT, NM US	12/31/1947	10/12/2023
GHCND: USC00296061	NAVAJO DAM, NM US	5/31/1963	10/12/2023

Table 2. Aztec Ruins National Monument gage - daily precipitation

No.	Year	Date	Daily Precip. (in)
0	2015	2015-08-27	2.67
1	1911	1911-10-05	1.85
2	1929	1929-08-11	1.82
3	2002	2002-09-11	1.63
4	1949	1949-08-03	1.55
5	2013	2013-07-24	1.5
6	1970	1970-09-06	1.44
7	1899	1899-08-02	1.42
8	1947	1947-08-22	1.4
9	1976	1976-09-27	1.4
10	1937	1937-07-10	1.39
11	1915	1915-09-25	1.39
12	1953	1953-10-20	1.38
13	1997	1997-08-04	1.37
14	2013	2013-09-13	1.35
15	1955	1955-08-13	1.34
16	1952	1952-04-28	1.33
17	1933	1933-07-07	1.32
18	1929	1929-08-03	1.3

Table 3. Maximum Daily Rainfall Aztec Ruins Gage

Year	Date	Daily Precip. (in)	NOAA Atlas 14 Return Period
2015	2015-08-27	2.67	116.7
1911	1911-10-05	1.85	16.0
1929	1929-08-11	1.82	14.7

To identify dates of major flooding associated with the Animas River, USGS gages on the Animas River were identified (see **Table 4**). The daily flow record was reviewed of USGS stream gage 09364500 Animas River at Farmington, NM (in operation since 1911). The more local gage (09364010, Animas River Below Aztec, NM) has been in operation less than 20 years, missing gaging the largest 17 floods in the Farmington gage historical record. Historical storms and flooding are discussed below.

Table 4. USGS Gaging Station Near the City of Aztec

STATION_ID	STATION NAME	BEGIN_DATE	END_DATE
09364010	Animas River Below Aztec, NM	2005	Current
09364500	Animas River at Farmington, NM	1911	Current

2.4 GIS Information

Spatial data from several sources were obtained for use in this project, listed below:

1. **City-wide problem areas.** Areas of concern were digitized based on a map provided by the City of Aztec.
2. **City of Aztec GIS Data.** Several shapefiles were obtained from the City, including:
   - Arroyos
   - Detention ponds
   - Irrigation ditches
   - Storm drains
   - Channels
3. **LiDAR-derived Elevation Data.** Digital Elevation Model (DEM) raster tiles covering the project site and surrounding area were downloaded from the USGS LiDAR Explorer Map.[6]
4. **San Juan County Parcel Data.** Parcel data were obtained from the San Juan County website,[7] and were used to identify the approximate parcel boundaries.
5. **FEMA Effective floodplain data.** The spatial data underlying the effective FEMA floodplain map for the City of Aztec were downloaded in shapefile format from FEMA's Map Service Center (MSC).[8]
6. **FEMA Base Level Engineering (BLE) floodplain data.** The spatial data associated with the 2018 BLE study were obtained from the Estimated Base Flood Elevation Viewer.[9]
7. **Stream centerlines.** Streamline data from the Effective FEMA GIS data were used for this project.
8. **Road centerlines.** A shapefile was obtained from the San Juan County website.
9. **Building Footprints.** An existing structure shapefile for New Mexico was obtained from the Microsoft Maps open building footprints dataset and clipped to the study area extent.[10] This shapefile shows very good agreement with recent aerial imagery.

2.5 Watershed Delineation

Initial watershed boundaries were developed from the USGS Watershed Boundary Dataset (WDB) for this study.[11] However, to prioritize areas based on flood risk, smaller subwatersheds were delineated as part of this study based on topographic data derived from aerial Light Detection and Ranging (LiDAR) data. The most recent available LiDAR-derived digital elevation model (DEM) tiles for the study area (USGS Animas, 2014) were obtained from the USGS LiDAR Explorer Map,[12] and these were mosaicked

[6] https://apps.nationalmap.gov/lidar-explorer/
[7] https://data-sjcounty.opendata.arcgis.com/datasets/6c90180473684bc588b0b2f83682f0e2_0/explore?location=36.496330%2C-108.241551%2C9.66
[8] https://msc.fema.gov/portal/home
[9] https://webapps.usgs.gov/infrm/estbfe/
[10] https://github.com/microsoft/USBuildingFootprints/tree/master
[11] The following Hydrologic Unit Code Number 12 (HUC 12) watersheds 140801041004 and 140801041005 cover the study area.
[12] https://apps.nationalmap.gov/lidar-explorer/

together into a single 1-meter resolution bare earth terrain in a GIS environment.[13] Watersheds were then automatically delineated in GIS, and then manually adjusted as necessary. All delineated watersheds are shown on the map in **Appendix C**.

2.6 Historic Storm Investigation

2.6.1 Local Flood Sources

To assist in determining the best approach for subsequent watershed prioritization and modeling, a more detailed historical storm investigation was undertaken to estimate the feasibility of hydrologic model calibration. The large August 2015 event discussed above was selected, as this was a larger than 1% Annual Exceedance Probability (AEP) (100-year) storm event, and radar data covering this time period are available. The radar-based precipitation time-series dataset was obtained in gridded format from NOAA (NOAA Atlas 14, Volume 1, Version and extracted from the NOAA Precipitation Frequency Data Server) and 15-minute rainfall was spatially averaged across the Blanco, Hampton, and Estes Arroyo watersheds (the watersheds with the highest event rain totals) for the duration of the storm event. A single time step of this dataset is shown in **Appendix D**. This exercise demonstrated the feasibility of using historical radar-derived data to calibrate a hydrologic model. Per discussions with city staff recalled levels of flooding for this event, anecdotes identify areas of flooding and locations of post-flood debris cleanup, though no records are available associated with known terrain, structure elevations or flood peak elevation. Without sufficient data to calibrate the model predictions, the historic event was not modeled. The value of this exercise is that it demonstrated the feasibility of future model calibration and the importance of future post-flood data collection of high water marks. The anecdotal information related to observed spatial extent of the 2015 flooding did correspond well to the predicted 100 year (1%) storm model predictions which was of similar rainfall magnitude.

2.6.2 Animas River Flooding

Peak discharges within the Animas River recorded at USGS Gage 09364500, in Farmington, NM, were also investigated. Annual flow events on the Animas River are generally associated with May-June snowmelt in the Colorado portion of the watershed, as shown by the hydrograph for the peak 2005 flood in **Figure 3**. Daily variations in flow are associated with diurnal temperature variations in the mountains affecting increased melt during the daytime sunshine. The peak flow within the Farmington gage historic record was a June 29, 1927 event with an estimated peak flow of 25,000 cfs (see **Table 5**). On June 28, 1927, 2.68 inches fell on Durango, CO, in a day, during a period when the temperature at night rose 15 degrees. These conditions indicate a rain-on-wet snow event. Note the second highest flood (12,800 cfs) is roughly half the peak 25,000 cfs flood. Also note, recent memory does not include any of the historic major river floods, as the largest peak flow between 1986-2016 (8,940 cfs) occurred in 2005, which ranked 18th in the full period of record (~20% AEP or 5-year flood). For reference, the 1% AEP flood estimated in the Flood Insurance Study[14] is 21,500 cfs.

Table 5. Animas River Farmington USGS gage Peak Flows

Date	Flow (cfs)
6/29/1927	25000
5/14/1941	12800
5/22/1920	11300

[13] QGIS was used or all GIS processes described in this memo: https://qgis.org/en/site/
[14] FEMA. Flood Insurance Study Number 35045CV000A. San Juan County, New Mexico, And Incorporated Areas. August 5, 2010.

Date	Flow (cfs)
f8/22/1947	11200
6/19/1949	11200
6/14/1921	11000
9/7/1970	10900
10/20/1972	10500
7/27/1957	10400
10/11/1916	10000
6/11/1952	9880
6/10/1922	9600
6/2/1914	9500
6/16/1935	9350
6/10/1985	9120
5/20/1948	9010
5/28/1958	9000
5/25/2005	8940

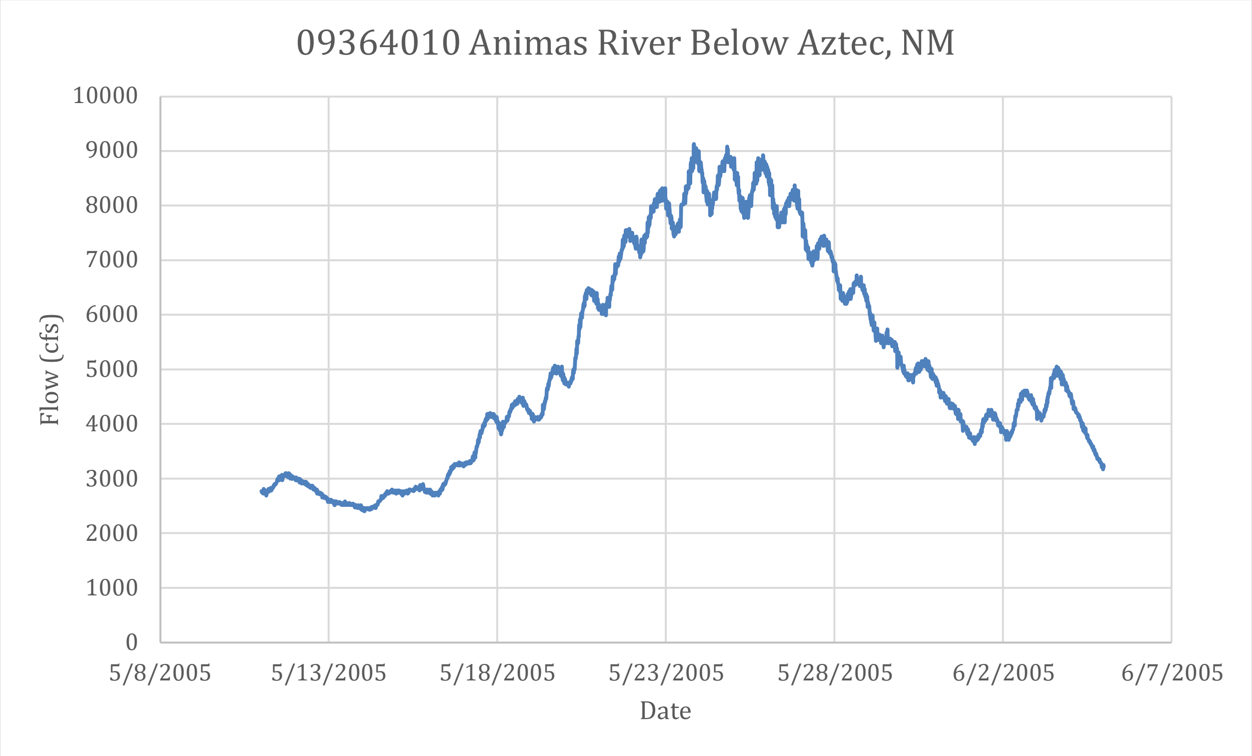


Figure 3. USGS Gage 09364010 - Animas River Below Aztec, NM - 5/11/2005 to 6/4/2005

The conclusions from this review of the historic record are: a future flood on the Animas River is potentially much higher than floods experienced in recent memory. Such a flood will be associated with a particular combination of factors within the Colorado portion of the watershed: high snow pack, the rapid rise in spring temperature, and a large rainfall event.

2.7 Anecdotal Information and Staff Interviews

City of Aztec staff from the Public Works Department, GIS, and other departments were queried to better understand the effects of recent events.

Ms. Yvonne Multine (Public Works Superintendent) had several observations of the 2015 Event:

- Creekside Village had significant flooding and erosion, especially at Blanco Road and Creekside Village.
- A large amount of sand washed down the length of the arroyo which took a week to remove with all the public works department equipment including additional help from the parks department.
- Sandbags were required along the east side of Main Street specifically in the alley behind Rubia's Restaurant where Chaco Street Crosses Main Street.
- Several roads were closed until sand could be removed.
- The arroyo was widened after this event.

Ms. Multine commented that a more recent storm caused similar issues to the 2015 event. However, the 2015 event was the worst in recent memory because the debris and sediment material that accumulated after the storm was soupy and in large quantities.
Ms. Laurie Martinez (GIS Technician) had additional observations of the 2015 event:

- The trailer court near Blanco Arroyo at Ford Street was stranded because the road was washed out.
- One house was flooded in this same area.
- Flooded across Rio Grande Street.
- The water was over the road along Rio Grande Avenue and Blanco Street because the culvert pipes were too small to handle the volume of water.
- The backyard fences are against the arroyo so access is a problem and full of trash and tree roots, shopping carts.
- It is common for stormwater to overflow and enter the irrigation ditch systems. The irrigation ditch overflowed by the High School. There are emergency dump gates located at several locations along the irrigation ditches however, there is no clear authority of how the dump gates are operated.
- The City was originally designed so that all streets drain into the irrigation ditches.

January 10, 2024 Phone Call with San Juan County

- Mike Mestas the San Juan County emergency manager and Michele Truby-Tillen the county Floodplain Manager provided the following information regarding riverine flooding:
- To their knowledge there was no flooding in the City along the Animas River
- There is no overbank flooding during spring runoff and even the 0.2% AEP (500-Year) flood.
- The county has an emergency management plan that is based on the flow at the at the Aztec gage reaching 8,000 cfs. The county also monitors gages upstream at Cedar Hill, Durango, and Silverton.
- The county works with NOAA, the National Weather Service, and other jurisdictions such as the City of Durango during emergency events.

This information was taken into account during the prioritization phase of this work.

3 Storm Drainage Masterplan - Prioritization Scheme

3.1 Background

ASI and the City of Aztec staff developed a prioritization scheme for the numbered watersheds shown in **Appendix C** – Delineated Watersheds. This scheme is based on the local knowledge of many staff members from recent flooding events as described in the previous section of this report. Several factors were presented during this process such as reduced flooding of real property and major arterial roadways, reduced maintenance, reduced erosion and sedimentation, reduced impact on irrigation infrastructure, and potential permitting difficulty. The following sections contain the results of this process.

3.2 Known Problem Areas

The City of Aztec provided ASI with a stormwater problem area map in PDF format. Appendix A contains this map georeferenced with the watersheds described in Section 2. The numbering on the map corresponds to the priority order of each sub-watershed based on the prioritization scheme. The highest-priority watersheds were on the east side of the city: Hampton Arroyo, Blanco Arroyo, Williams Arroyo, and WS4 between Hampton and Blanco Arroyos. On the west side of the City, the highest ranking watersheds were Estes Arroyo WS5, and WS6 the North Oliver area. WS6 was ranked high but City staff revealed that work is in-progress in this area to alleviate flooding along North Oliver Street and at the water treatment plant.

3.3 Prioritization Results

Table 6. Watershed Ranking contains the results of the watershed ranking based on input from City staff. The first column in the table includes the watershed number in order of rank, as shown on the map in **Appendix C** – Delineated Watersheds. The second column contains the common name of the watershed. Scores were given to the first 7 watersheds as these areas by far have the most problem areas. The remaining number of watersheds were ranked based on the number of structures in the 1% AEP (100-year) floodplain. Those that had no structures in the floodplain, or were dominated by Animas River riverine floodplain, were ranked last.

Table 6. Watershed Ranking

				Count			RANKING								
Watershed	**Name**	**Area (acres)**	**All Buildings**	**FEMA 100-yr Buildings**	**BLE 100-yr Buildings**	**City of Aztec Problem Area**	**Dam Safety**	**Reduce Flooding of Real Property**	**Reduce the Risk of Debris Flow**	**Reduce Flooding Major Arterial Roadways**	**Reduce Maintenance**	**Reduce Impact on Irrigation Infrastructure**	**Reduce Nuisance Flooding**	**Permit Complexity or ROW**	**Score**
WS1	Hampton Arroyo	2,933	327	1	0	11, 12, 15, 16, 17, 18, 19, 27, 29	0	3	3	3	2	2		1	14
WS2	Blanco Arroyo	682	158	49	10	Local - 21, 22, 23, 24, 25, 26	0	3	3		3		3	1	13
WS3	Williams Arroyo	3,578	413	1	6	6, 7, 8*	0	3	3	1	3	1			11
WS4		246	452	2	5	13, 14, 20	0	3			3		3	1	10
WS5	Estes Arroyo	8,085	738	36	9	Local - 5	0	1	3	3	3			1	11
WS6	North Oliver	556	730	4	9	Local - 1, 2, Riverine - 3, 4	0	3					2	1	6
WS7		457	453	18	10	8*, 9, 10, 28	0	3			2		3	1	9
WS8		702	358	27	31		0								0
WS9		961	341	7	47		0								0
WS10	Knickerbocker Canyon	3,045	150	15	2		0								0
WS11	Bohanan Canyon	3,474	62	4	1		0								0
WS12	Kochis Arroyo	1,897	149	3	2		0								0
WS13	Farmers Arroyo	954	15	0	1		0								0
WS14	Ruins	491	279	0	0		0								0
WS15		409	201	0	0		0								0
WS16	Knickerbocker Canyon Trib 2	1,464	73	0	0		0								0
WS17	Animas River Trib 14	990	47	0	0		0								0
WS18	Jones Arroyo	1,445	39	0	0		0								0
WS19	Knickerbocker Canyon Trib 1	1,654	32	0	0		0								0
WS20		1,828	2	0	0		0								0
WS21		295	184	93	100	Riverine	0								0
WS22		554	152	64	57	Riverine	0								0
WS23		257	91	53	52	Riverine	0								0
WS24		566	94	17	20	Riverine	0								0
WS25		330	0	0	0		0								0
WS26		44	0	0	0		0								0

4 Storm Drainage Masterplan – Regional 2D HEC-RAS Modeling

4.1 Background

Based on the outcome of the problem area prioritization, the focus of the watershed flood modeling would be on the east side of the city encompassing Hampton and Blanco Arroyos. HEC-RAS version 6.4.1 was used to model the entire combined Hampton and Blanco Arroyos, including the smaller watershed numbered WS4, WS5, and WS8 situated along the Animas River as shown on the map in Appendix C – Delineated Watersheds.

4.2 Model Parameters

This section documents the data that was collected and used during the modeling. All data described in the following subsections was reviewed for reasonability and applicability before being used in the modeling efforts.

4.2.1 Coordinate System

The coordinate system used for the project is North American Datum of 1983 (NAD83) State Plane, New Mexico West, FIPS 3003, US Survey Feet 'NAD_1983_StatePlane_New_Mexico_West_FIPS_3003.' The vertical datum for the study is the North American Vertical Datum of 1988 (NAVD88). All results will be projected into these horizontal and vertical datums.

4.2.2 Terrain

The most recent available LiDAR-derived digital elevation model (DEM) tiles for the study area (USGS Animas, 2014) were obtained from the USGS LiDAR Explorer Map,[15] and these were mosaicked together into a single 1-meter resolution bare earth terrain in a GIS environment.[16]

4.2.3 Land Cover and Impervious Cover

The U.S. Geological Survey (USGS), in partnership with several federal agencies, has developed and released seven National Land Cover Database (NLCD)[17] products including impervious surface for the contiguous United States. These products provide spatially explicit and reliable information on the Nation's land cover and land cover change. The most recent version was released in 2021 and forms the basis for land use in this modeling task. The NLCD 2021 was collected and used as the base land cover for the study area. See the Land Cover Map in **Appendix D** for an overview of land use for the study area. The 2021 NLCD Impervious Cover dataset[18] was also collected and used as a base impervious cover for the study area (MRCL, 2021). See the Impervious Cover map in **Appendix D** for an overview of impervious cover in the study area.

---

[15] https://apps.nationalmap.gov/lidar-explorer/
[16] QGIS was used or all GIS processes described in this memo: https://qgis.org/en/site/
[17] National Land Cover Database (NLCD) 2021 Land Cover Conterminous United States, U.S. Geological Survey, Sioux Falls, SD. June 30, 2023; https://www.mrlc.gov/data
[18] National Land Cover Database (NLCD) 2021 Impervious Surface Conterminous United States, U.S. Geological Survey, Sioux Falls, SD. June 30, 2023; https://www.mrlc.gov/data

4.2.4 Soils Data

Soils information was downloaded from the U.S. Department of Agriculture, Natural Resources Conservation Soil Survey Geographic (SSURGO) Database[19]. This data set is a digital soil survey and generally is the most detailed level of soil geographic data developed by the National Cooperative Soil Survey. The information was prepared by digitizing maps, by compiling information onto a planimetric correct base and digitizing, or by revising digitized maps using remotely sensed and other information. This data set consists of georeferenced digital map data and computerized attribute data. The map data are in a soil survey area extent format and include a detailed, field-verified inventory of soils and miscellaneous areas that normally occur in a repeatable pattern on the landscape and that can be cartographically shown at the scale mapped. The specific area used was for San Juan County, New Mexico, East Part. Hydrologic soils groups as defined by this dataset will be utilized to determine soil infiltration parameters. See the Soils Map in **Appendix D** for SSURGO hydrologic soil groups for the study area.

4.2.5 Infiltration

Hydrologic losses were implemented in HEC-RAS through gridded infiltration using the Green and Ampt hydrologic loss method. HEC-RAS applies infiltration rates based on a spatially varied soils layer. The parameters needed for this loss method include the initial content, saturated content, hydraulic conductivity, suction, residual water content, pore size distribution index, and percent impervious cover. Values for each Green and Ampt parameter were applied to the HEC-RAS model according to hydrologic soil group data obtained from the SSURGO soils database. Base Green and Ampt parameter values are shown in **Table 7.** Green-Ampt Loss Parameters*. This table also lists recommended initial estimates and ranges of acceptable parameter values for each HSG. The final selected values should be supported by calibration results. For initial content, the recommended values correspond to the field capacity (i.e., 2 to 3 days after rain or irrigation). Acceptable values range from the residual water content, or wilting point (i.e., very dry conditions), to the saturated content from total porosity.[20]

*Table 7. Green-Ampt Loss Parameters**

Hydrologic Soil Group	Initial Content	Saturated Content	Suction (in)	Hydraulic Conductivity (in/hr)
A	0.05 (0.02 – 0.44)	0.44	2	0.35 (0.30 – 0.45)
B	0.10 (0.04 – 0.45)	0.45	4	0.20 (0.15 – 0.30)
C	0.20 (0.07 – 0.46)	0.46	8	0.08 (0.05 – 0.15)
D	0.30 (0.09 – 0.47)	0.47	12	0.02 (0.00 – 0.05)

* Table lists recommended initial estimate, followed by range of acceptable values. Final selected values should be supported by calibration. Values sourced from *HEC-HMS Technical Reference Manual, which cites SCS (1986)*; Skaggs and Khaleel (1982)[21]; and Rawls, Brakensiek, and Miller (1982); and from Rawls, Brakensiek, and Miller (1983)[22].

[19] Soil Survey Geographic (SSURGO) Database; San Juan County, New Mexico, Eastern Part (NM618) U.S. Department of Agriculture, Natural Resources Conservation Service, Fort Worth, Texas. Sept. 11, 2021; https://websoilsurvey.sc.egov.usda.gov/

[20] Rawls, W.J., Brakensiek, D.L., Saxton, K.E. 1982. Estimation of soil water properties. Trans. ASAE 25:1316-1320.

[21] Skaggs, R.W. and Khaleel, R. (1982) Hydrologic Modeling of Small Watersheds. In: Haan, C.T., Johnson, H.P. and Brakenstek, D.L., Eds., An ASAE Monograph Number 5 in a Series, American Society of Agricultural Engineers, USA.

[22] Rawls, W.J., Brakensiek, D.L., & Miller, N.L. 1983. Green – Ampt Infiltration Parameters from Soils Data. Journal of Hydraulic Engineering, 109, 62-70.

4.2.6 Precipitation

Frequency event precipitation data used in the modeling consisted of NOAA Atlas 14 precipitation frequency estimates for the following 24-hour duration Annual Exceedance Probability (AEP) events:

- 10% AEP, 24-hour (10-year, 24-hour)
- 4% AEP, 24-hour (25-year, 24-hour)
- 1% AEP, 24-hour (100-year, 24-hour)

These rainfall depths were distributed in time according to the New Mexico State Highway and Transportation Department (Now NMDOT) Hydrology Manual Volume 1[23].

Table 8. Frequency Specific Distribution

DURATION (hours)	Cumulative Depth (%)		
	10-YEAR	25-YEAR	100-YEAR
0	0	0	0
0.25	0.018	0.016	0.01
0.5	0.036	0.032	0.02
0.75	0.055	0.048	0.03
1	0.085	0.075	0.054
1.25	0.101	0.089	0.066
1.5	0.112	0.096	0.07
1.75	0.13	0.114	0.087
2	0.147	0.132	0.105
2.5	0.201	0.187	0.165
3	0.539	0.538	0.536
3.5	0.655	0.66	0.665
4	0.709	0.715	0.726
5	0.727	0.733	0.743
6	0.744	0.751	0.761
7	0.756	0.758	0.765
8	0.771	0.772	0.777
9	0.802	0.799	0.801
10	0.82	0.815	0.811
11	0.838	0.831	0.821
12	0.856	0.847	0.831
14	0.88	0.872	0.859
16	0.904	0.898	0.887
18	0.928	0.923	0.915
20	0.952	0.949	0.944
22	0.976	0.974	0.972
24	1	1	1

4.3 Model Development

This section describes the development of the 2D HEC-RAS model that encompasses the highest priority watershed areas described in section 3.

[23] New Mexico State Highway and Transportation Department, Drainage Manual Volume 1, Hydrology, December 1995

4.3.1 Model Extents

Hampton and Blanco Arroyo's were combined into the same model by combining the sub-watersheds described in section 0 along with WS4, WS4, and WS8. This area encompasses most of the City east of the Animas River, and extends eastward to the upgradient end of each watershed. This modeled area encompasses all the areas identified in the AECOM studies.

4.3.2 2D Mesh Development

The terrain datasets described in Section 2.2 were used to create a 1m x 1m composite terrain for the hydraulic model, and the 2D mesh was developed to accurately capture significant features of the terrain. The base 2D mesh uses 50' x 50' cells. Breaklines were developed to capture features like streams, channel banks, roads, and levees or ditches. Stream centerline breaklines were typically utilized to define channels, with cell sizes ranging from 10' – 20.' Where applicable, stream breaklines utilize near repeats to capture channel banks. Roadways, levees, and other breaklines also use cell sizes that range from 10 – 50'. **Figure 4** presents an example of the 2D mesh near Aztec High School where Blanco Arroyo crosses the L. Animas Ditch. Note the higher density of cells surrounding the arroyo and the ditch. The figure also shows the detail of the underlying terrain as described in **Section 4.2.2**.

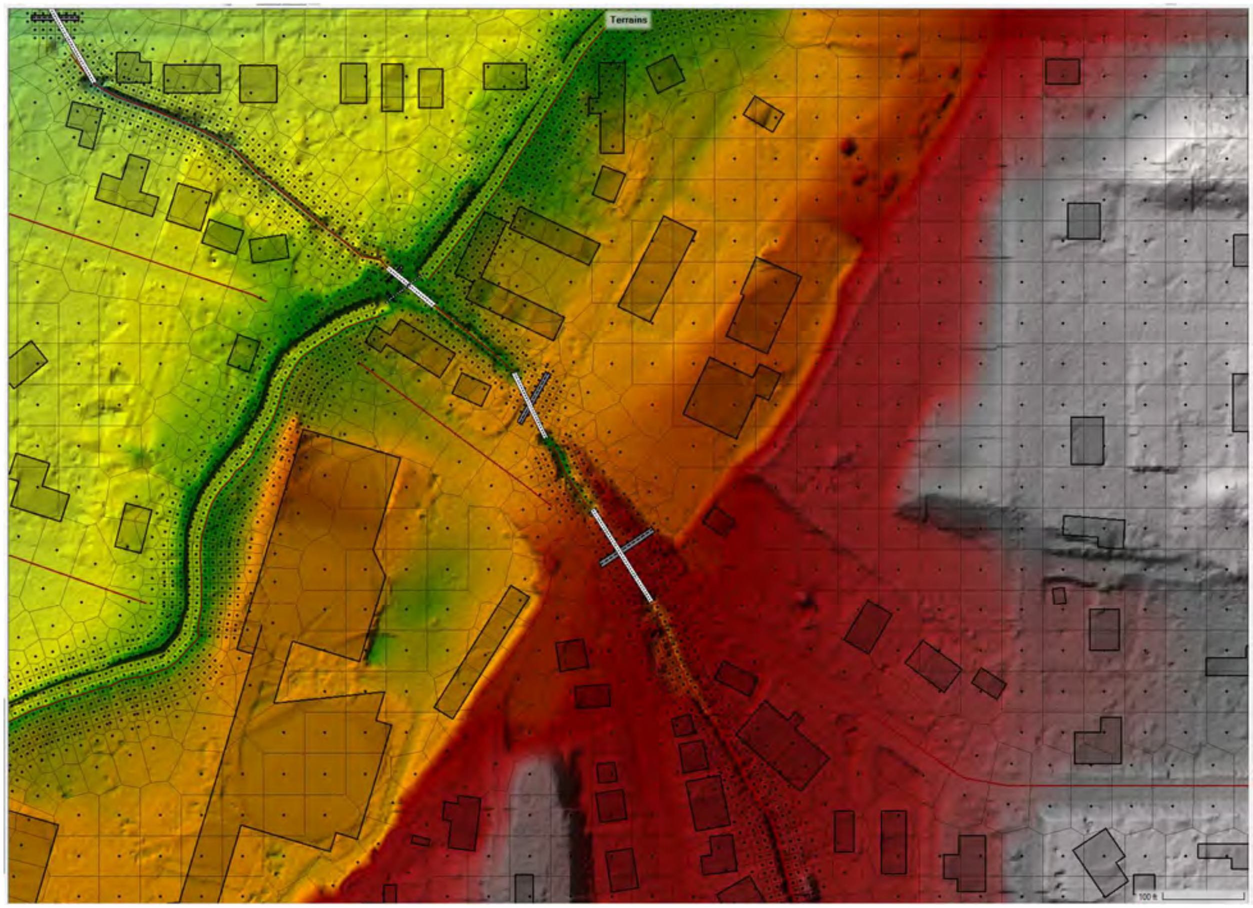


Figure 4. HEC-RAS 2D Mesh - Blanco Arroyo and L. Animas Ditch

4.3.3 Manning's Roughness

Manning's roughness values were assigned to each NLCD land cover classification from the data described in **Section 4.2.3**. Manual overrides were also developed for channels via a channel classification region and building footprints. Channel roughness was given a value of 0.035 and the buildings were assigned a value of 10. **Table 9** shows the Manning's roughness values used in the HEC-RAS model.

Table 9. Manning's Roughness Values

NLCD ID and Naming Convention		
ID	Name	Manning's N
0	NoData	0.035
52	Shrub-Scrub	0.08
21	Developed, Open Space	0.04
22	Developed, Low Intensity	0.08
90	Woody Wetlands	0.07
23	Developed, Medium Intensity	0.12
11	Open Water	0.035
81	Pasture-Hay	0.045
95	Emergent Herbaceous Wetlands	0.05
24	Developed, High Intensity	0.15
42	Evergreen Forest	0.15
71	Grassland-Herbaceous	0.04
82	Cultivated Crops	0.05
31	Barren Land Rock-Sand-Clay	0.03
1	Bldg Footprint	10
2	Estes Arroyo	0.035
3	Kochis Arroyo	0.035
4	Hampton Arroyo	0.035
5	Williams Arroyo	0.035
6	Blanco Arroyo	0.035
7	Knowlton Arroyo	0.035

4.3.4 Hydraulic Features

This section summarizes the hydraulic features included in the model. The HEC-RAS model contains 20 culverts modeled as SA/2D connections. The existing culverts on Blanco Arroyo were based on the information in the AECOM report, with several culverts updated to match current conditions according to field observations conducted as part of this study. The existing culverts include information on the material type, shape, number of barrels, and max barrel width. Vertical information was not available so the inlet and outlet inverts are estimated based on the terrain described in **Section 4.2.2**. Four of the culverts that were inserted in the model represent irrigation siphons. The location of the siphons was based on observations of the satellite imagery and the terrain. The size of the siphons was estimated as there was no data readily available.

The outlets in the proposed detention ponds were also modeled as culverts. The proposed culvert barrel size and dam height were chosen by making several interative model runs until the height of the dam and outlet could contain the 4% AEP (25-year) storm within the detention pond while reducing downstream flows.

There were many smaller culverts observed in the satellite imagery, mainly along Navajo Dam Road. At locations where culverts were evident, these minor structures were modeled as terrain modifications. During early model development, areas where ponding occurred were identified and the terrain was modified to allow hydraulic connection.

4.3.5 Boundary Conditions

The model contains eight external boundary condition lines. These lines are located at the downstream end of each watershed and correspond to where each arroyo or ditch enters the Animas River. All eight are considered normal depth boundaries representing a typical non-flood Animas River flow condition since flooding and high water on the Animas River was not the focus of this effort.

4.4 Model Scenarios

The HEC-RAS model as described above was run for the 10% AEP, 4% AEP, and 1% AEP rainfall events described in Section 4.2.6.

4.4.1 10% AEP Results

The 10% AEP (10-year) design storm was simulated with the HEC-RAS model as described in the previous sections. The output maps focused on Blanco Arroyo are provided in **Appendix E** – HEC-RAS Output Blanco Arroyo 10% AEP, while the output maps showing Hampton Arroyo are provided in **Appendix H** - HEC-RAS Output Hampton Arroyo 10% AEP.

4.4.2 4% AEP Results

The 4% AEP (25-year) design storm was simulated with the HEC-RAS model as described in the previous sections. The output maps focused on Blanco Arroyo are provided in **Appendix F** – HEC-RAS Output Blanco Arroyo 4% AEP, while the output maps showing Hampton Arroyo are provided in **Appendix I** - HEC-RAS Output Hampton Arroyo 4% AEP.

4.4.3 1% AEP Results

The 1% AEP (100-year) design storm was simulated with the HEC-RAS model as described in the previous sections. The output maps focused on Blanco Arroyo are provided in **Appendix G** - HEC-RAS Output Blanco Arroyo 1% AEP, while the output maps showing Hampton Arroyo are provided in **Appendix J** - HEC-RAS Output Hampton Arroyo 1% AEP.

4.5 Results and Summary

As can be seen in the results maps shown in Appendix G - HEC-RAS Output Blanco Arroyo 1% AEP and Appendix J - HEC-RAS Output Hampton Arroyo 1% AEP, 51 structures have been removed from the 1% AEP (100-year) floodplain. The structures are outlined in green in the drawings. Table 10 contains the total number of structures removed from the floodplain for each model scenario.

Table 10. Structures Removed from Flooding Based on Proposed Alternatives.

	Number of inundated structures			Area (acres)		
	Exist	Proposed	Difference (Structures Removed)	Exist	Proposed	Difference
1%, 100yr	674	623	51	404	368	36
4%, 25yr	579	504	75	317	291	26
10%, 10yr	512	447	65	266	249	17

The depth of flooding has been reduced at several key locations. One example is in the parking lot at the Aztec High School. The point where the depth for each design storm is shown in Figure 5 while the reduction for the 1% and 4% AEP model results are shown in Figure 6.

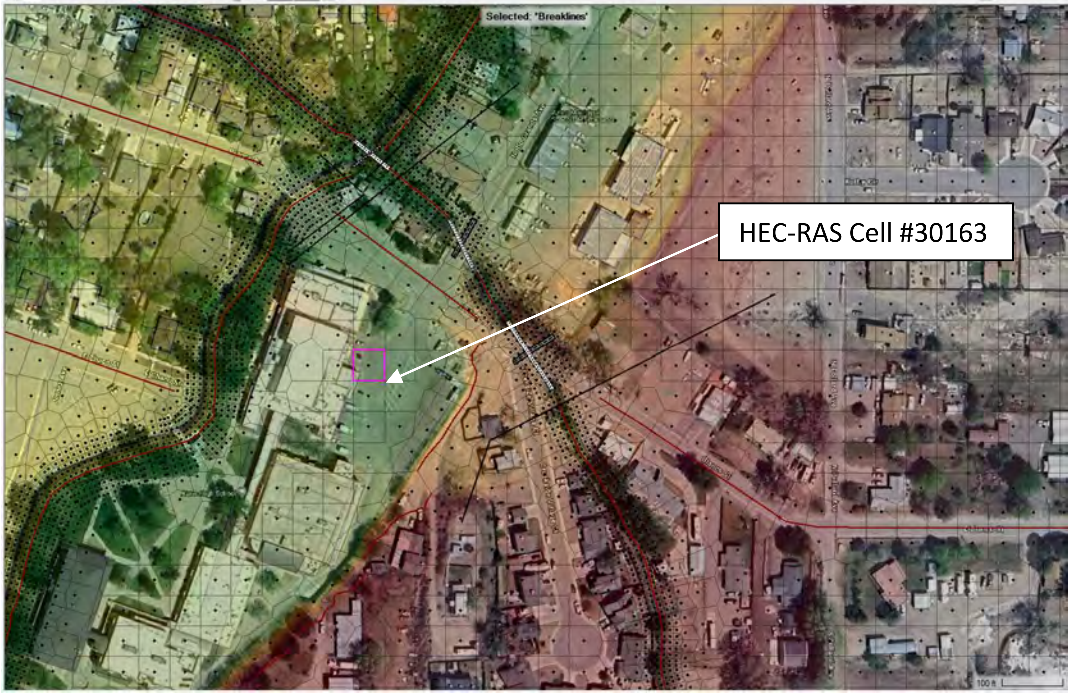


Figure 5. HEC-RAS Depth Plot Location - Aztec High School

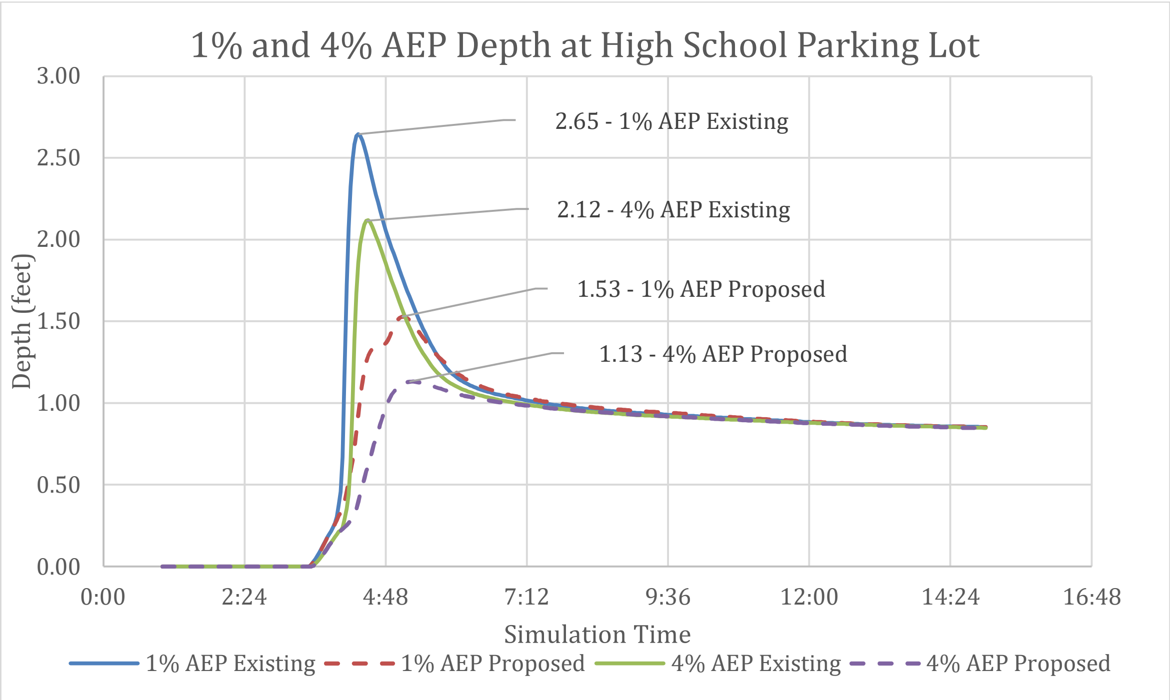


Figure 6. HEC-RAS Depth Plots - Aztec High School Parking Lot

Another location is in the Creekside Village cul-de-sac shown in Figure 7 while the reduction for the 1% and 4% AEP model results are shown in Figure 8.

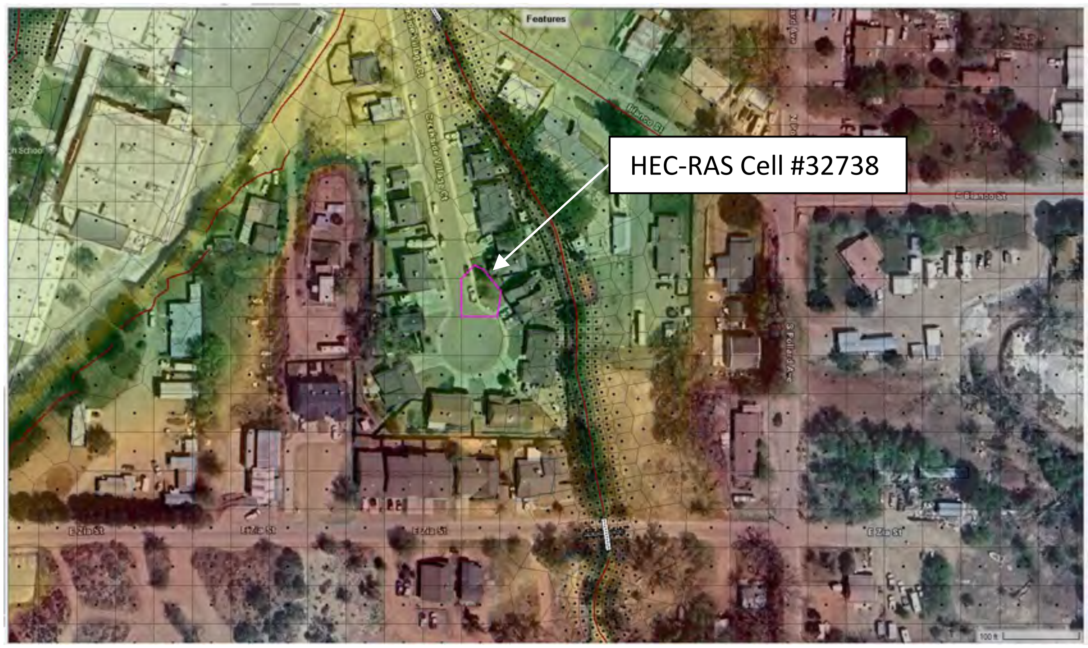


Figure 7. HEC-RAS Depth Plot Location – Creekside Village

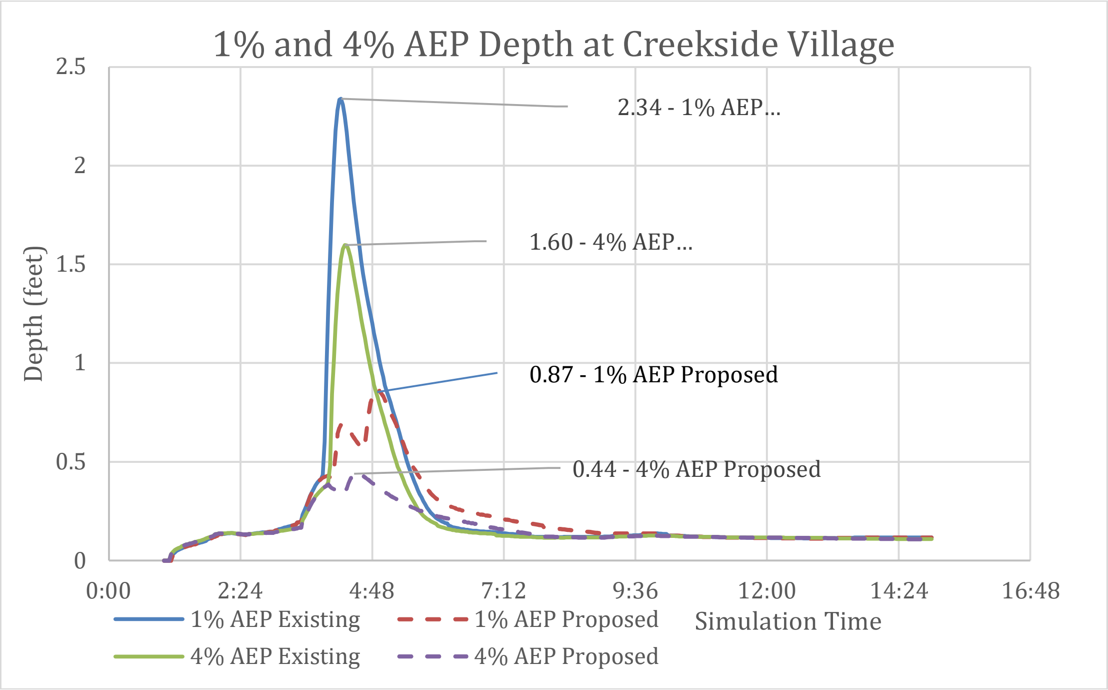


Figure 8. HEC-RAS Depth Plots - Creekside Village

A third location is near the corner of Pollard Avenue and Ford Street. The point where the depth for each design storm is shown in Figure 9 while the reduction for the 1% and 4% AEP model results are shown in Figure 10.

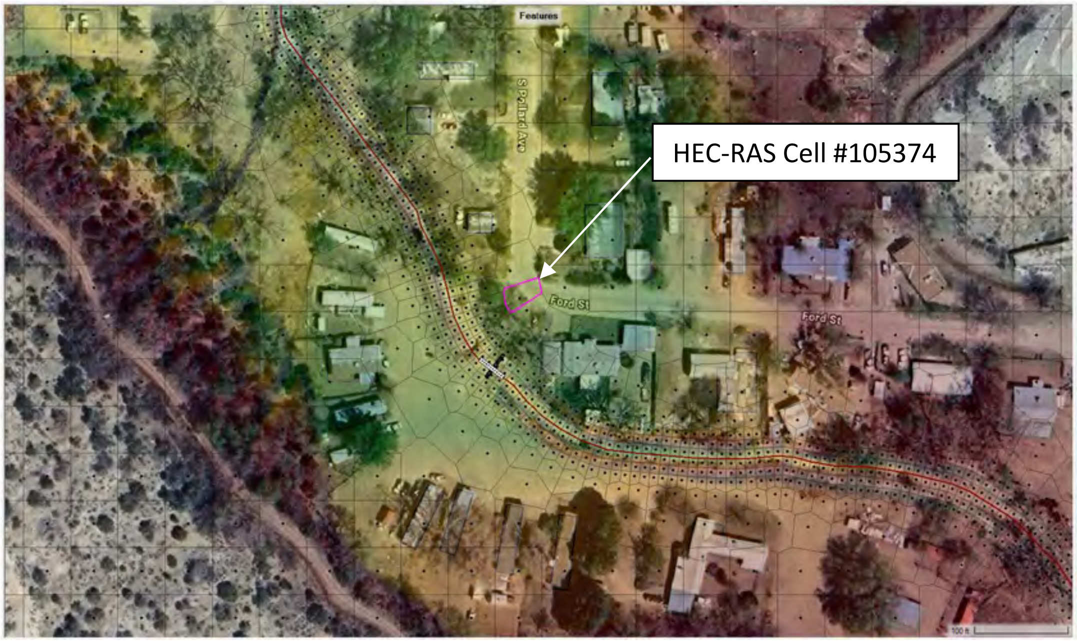


Figure 9. HEC-RAS Depth Plot Location – Pollard Ave. @ Ford St.

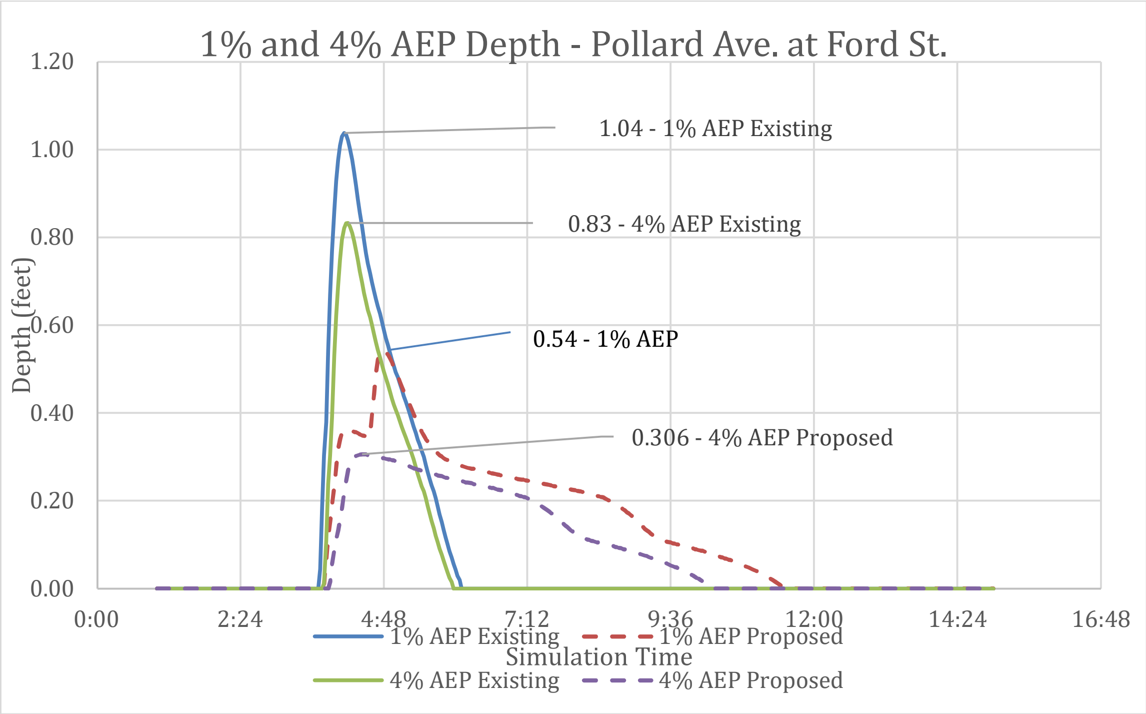


Figure 10. HEC-RAS Depth Plots - Pollard Ave. @ Ford St.

Flows at the eleven locations along Blanco Arroyo identified in the AECOM study were also calculated for each design storm using a profile line in RASmapper. Table 11 shows the computed flows from 2D HEC-RAS for the 4% AEP storm as compared to the culvert capacitates calculated by AECOM.

Table 11. Flows at Culvert Crossing on Blanco Arroyo for 2D HEC-RAS model for existing and proposed conditions.

No.	Location	Type	Existing Structure Size AECOM	Existing Culvert Capacity (cfs) AECOM	AECOM Proposed Structure	April 23, 2024 Field Visit ASI	HEC-RAS 2D Existing Q_{25yr} (cfs)	HEC-RAS 2D Alt 5 Q_{25yr} (cfs)	% Reduction
1	Aztec Rd. (4 lanes)	C[1]	14.5 ft x 6.6 ft Concrete box	981	N/A	same	111	81	27%
2	N. Ash Ave.	C	60 in CMP - Circular	157	81"x59" Steel/Aluminum Arch	84" x 52" CMAP	110	80	27%
3	N. Main Ave. (Hwy 550)	C	2 - 10 ft x 4 ft Concrete Box	725	N/A	same	190	97	49%
4	N. Church Ave.	B[2]		356	N/A	Terrain mod.	175	97	45%
5	N. Mesa Verde Ave.	C	2 - 9.25 ft x 6 ft Concrete Box	1000	N/A	same	192	105	45%
6	Lovers Ln.	C	60 in Concrete Circular	143	81"x59" Steel/Aluminum Arch	80" CMP	167	103	38%
7	Dirt access parallel to E. Blanco St.	C	60 in CMP Circular	131	81"x59" Steel/Aluminum Arch	same	467	163	65%

8	N. Rio Grande Ave.	C	60 in CMP Circular	154	81"x59" Steel/Aluminum Arch	72" x 60" CMAP	470	162	66%
9	E. Blanco & Creekside Village	C	72 in Concrete Circular	220	N/A	same	525	172	67%
10	E. Zia St.	C	84 in CMP Circular	334	N/A	86" CMP Circular	481	172	64%
11	Dirt access @ Ford St.	C	3 - 24 in CMP Circular	43	3-36" Circular CMP	64" Concrete Circular	411	84	80%

1 - C = Culvert

2 - B = Bridge

AECOM Recommended resizing

Not resized

The flow hydrograph for the 4% AEP existing and proposed alternatives models at the Dirt Access at Ford Street (No. 11 in Table 11) are shown on Figure 11. Figure 12 is the same events for the most downstream crossing at Aztec Boulevard (No. 1 in Table 11). The remain flow hydrographs for the 4% AEP rainfall event are included in **Appendix K** – Hydrographs for 4% AEP at Culvert Crossings. The hydrographs for the 1% AEP events are included in **Appendix L** - Hydrographs for 1% AEP at Culvert Crossings.

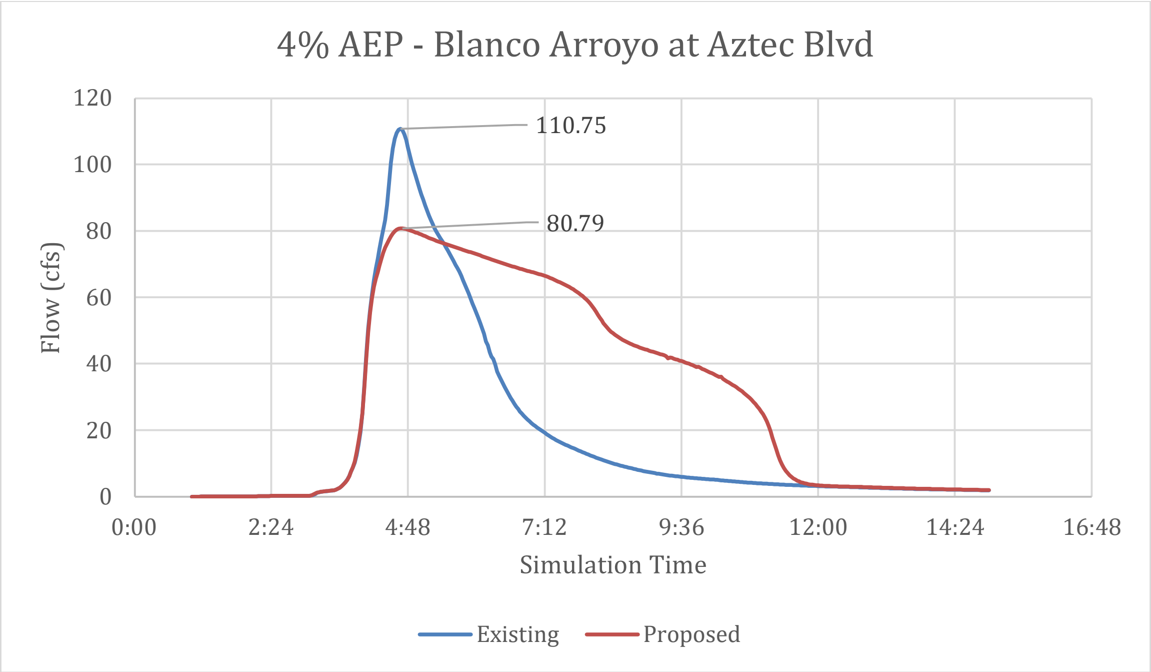


Figure 11. 4% AEP Flow Hydrograph - Blanco Arroyo at Aztec Boulevard

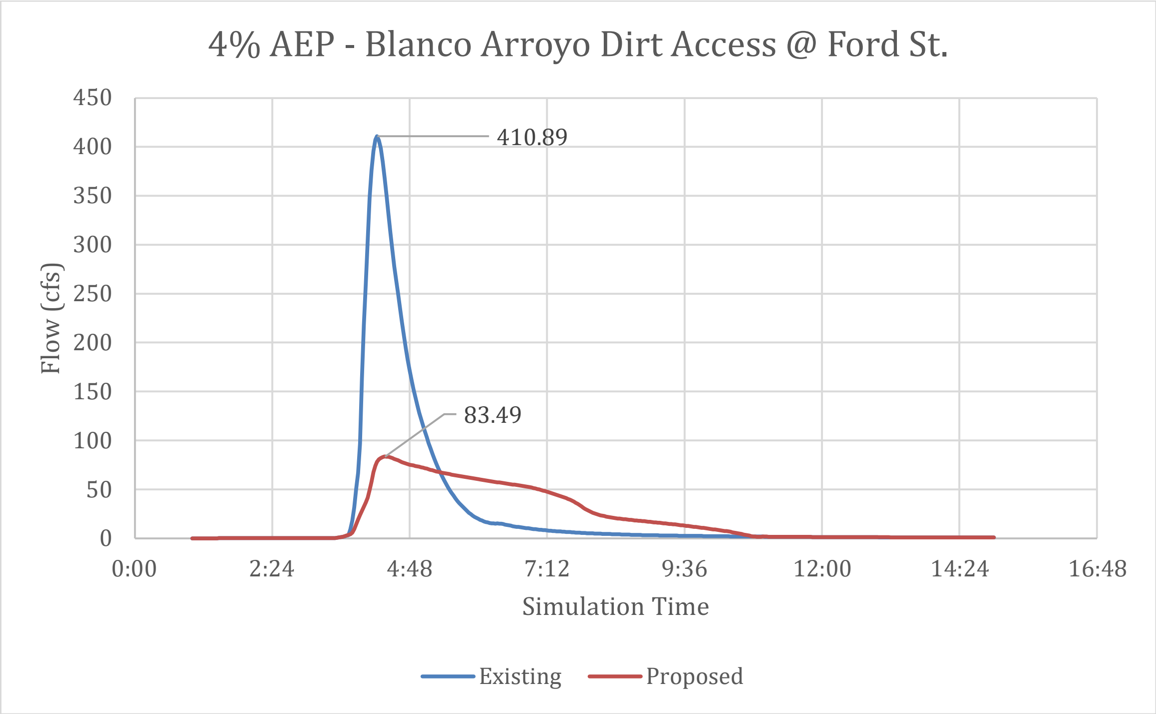


Figure 12. 4% AEP Flow Hydrograph - Blanco Arroyo at the Dirt Access at Ford Street

5 Regional Alternatives - Preliminary Cost Estimates

Local and regional alternatives to mitigate flooding were identified (see mapping in Appendix M) and modeled. To prioritize the alternatives on a cost and benefit basis, preliminary costs were estimated and the value of benefit to infrastructure was estimated. The cost to benefit ratio was calculated, and additional factors were considered to recommend best value alternatives.

The alternatives identified for this cost benefit analysis are compiled from chapter 4 alternatives and other alternatives identified in prior work. The alternatives for each watershed are as follows:

Blanco Arroyo

1. No Action – continuation of current conditions; not further assessed.
2. Improve Channel 5000 linear feet – Recognizing that the Blanco Arroyo is undersized from the southeast side of town at Blanco Street and all the way downstream to West Aztec Blvd/NM516, this alternative would be to increase the capacity of the channel by widening the channel. This alternatives was not modeled. This alternative would impact approximately 27 properties currently lying along the arroyo's banks.
3. Replace 60" CMP culvert at Siphon – The culvert located north of Aztec High School and Blanco Street, between Rio Grande Avenue and Lovers Lane is recommended to be increased to a size consistent with the upstream and downstream culverts, 84-inch x 52-inch Corrugated Metal Arch Pipe (CMAP). Increasing the size of this pipe will reduce flow constriction and reduce upstream headwater flooding. This pipe is adjacent to an irrigation canal siphon for Lower Animas Ditch.
4. Blanco Arroyo Detention 1 – This alternative is for regional detention upstream of Ford Street on Blanco Arroyo is described in Section 4 and Appendices M and O.
5. Blanco Arroyo Detention 2 – This alternative is for regional detention upstream of Ford Street on a tributary to Blanco Arroyo is described in Section 4 and Appendices M and O.
6. Combined Blanco Detention 1 plus Detention 2 plus replace the 60" Culvert – This alternative is a combined alternatives that includes alternatives 3+4+5.

Hampton Arroyo

11. No Action – continuation of current conditions; not further assessed.
12. Hampton Detention 1 – Local detention on unnamed tributary north of Sabena Road and Navajo Dam Road as shown in Appendix M. This alternative is intended to reduce local flooding near Sabena and Sagebrush Roads.
13. Hampton Detention 2 – Regional detention located on the mainstem of Hampton Arroyo as shown in Appendix M. The main purpose of this alternative is to reduce channel velocities and erosion potential in Hampton Arroyo downstream of US 550. This is intended to help arrest the ongoing erosion, channel downcutting, and channel widening that threatens adjacent infrastructure including Sabena Street, Martinez Street, a wastewater force main, the McCoy Avenue bridge, and McCoy Avenue Elementary School.
14. Grade Control – This is a different strategy to achieve a similar goal as alternative 13, to arrest erosion, downcutting, and widening in Hampton Arroyo downstream of US550. This strategy involves installation of grade control structures in the channel under current flow and velocity conditions, without reducing flow or velocity.
15. Kokopelli Subdivision measures – These are the measures recommended by AECOM in their 2017 reports. These measures remain recommended, and were not further assessed except for the diversion bypass channel.

16. Kokopelli – diversion bypass channel – This alternative was identified in AECOM's 2017 report for Kokopelli Subdivision.

Construction cost estimates are based on preliminary quantity and 2023/2024 unit costs (Appendix N). Because of the concept level stage of design, and because of recent construction cost fluctuations and escalations, a 30% contingency was estimated and applied to the total cost. The fee for design, permitting, and associated investigations leading to final construction plans is estimated at 20% of construction cost. The total estimated cost is the sum of these three items (Table 12).

Table 12. Preliminary Estimate of Costs for Alternatives

	Aqua Strategies Inc. City of Aztec Drainage Masterplanning Alternatives - Preliminary Estimate of Costs				6/25/2024
Alternative	**Estimated Total Cost**	**20% Estimated Fee for Design (shovel ready with permits)**	**30% Contingency**	**Estimated Construction Cost**	***2.5% Estimated Fee for PER only for Planning and initiate Permitting***
BLANCO ARROYO					
1. No Action					
2. Improve Channel 5000 linear feet	**$ 1,734,967**	$ 231,328.89	$ 346,993.33	$ 1,156,644.44	*$ 28,916.11*
3. Replace 60" CMP Culvert at siphon	**$ 112,500**	$ 15,000.00	$ 22,500.00	$ 75,000.00	*$ 1,875.00*
4. Blanco Detention 1	**$ 1,437,750**	$ 191,700.00	$ 287,550.00	$ 958,500.00	*$ 23,962.50*
5. Blanco Detention 2	**$ 1,398,240**	$ 186,432.00	$ 279,648.00	$ 932,160.00	*$ 23,304.00*
6. Blanco Det 1 + Det 2 + Culvert (3+4+5)	**$ 2,948,490**	$ 393,132.00	$ 589,698.00	$ 1,965,660.00	*$ 49,141.50*
HAMPTON ARROYO					
11. No Action					
12. Hampton Detention 1	**$ 641,250**	$ 85,500.00	$ 128,250.00	$ 427,500.00	*$ 10,687.50*
13. Hampton Detention 2	**$ 6,862,200**	$ 914,960.00	$ 1,372,440.00	$ 4,574,800.00	*$ 114,370.00*
14. Grade Control - erosion mitigation	**$ 1,125,000**	$ 150,000.00	$ 225,000.00	$ 750,000.00	*$ 18,750.00*
15. Kokopelli subdivision measures	n/a				
16. Kokopelli - diversion bypass channel	n/a	$ 40,000.00			*$ 15,000.00*

The fee for a Preliminary Engineering Report (PER) is included in Table 12. This is a lesser fee option that may be chosen to be conducted first before the shovel ready design option. The PER, after completed, would contribute to the 20% design as a "head start" but would not result in final construction plans and permits.

The benefits of each alternative was estimated using the number of structures removed from the floodplain, and a gross assumption that removing the property from the floodplain has a value of $175,000. A ratio of cost / benefit was calculated quantitatively, and then a priority was assigned qualitatively based upon maximized benefit and minimized disturbance of number of properties.

Right of way (ROW) or property purchase costs are included within the Construction Cost. However, ROW costs are highly variable and are recommended to be further evaluated.

For Blanco Arroyo, the Alternative 6 is the recommended alternative (Table 13) that has the best overall benefit for the most properties. This alternative to introduce regional detention and retrofit the existing 60" CMP culvert should be pursued. Preliminary construction plans have been developed for the regional detention ponds associated with Alternative 6 and are presented in Appendix O.

For Hampton Arroyo, Alternative 14 to construct grade control structures is the recommended alternative (Table 13) to protect the channel downstream of US550, instead of regional detention. Alterative 16 is also recommended to address localized flooding in the Kokopelli subdivision.

Table 13. Evaluation and summary of alternatives.

Alternative	Estimated Benefit (structures removed from FP at $175k/structure)	Cost/ Benefit	Priority	Note
BLANCO ARROYO				
1. No Action				
2. Improve Channel 5000 linear feet	40	0.25	5	Assumes minimal disturbance of channel-adjacent properties
3. Replace 60" CMP Culvert at siphon	< 5	0.13	2	Assumes adjacent siphon will not affect design and costs
4. Blanco Detention 1	< 20	0.41	4	Limited downstream flow attenuation
5. Blanco Detention 2	< 20	0.40	3	Limited downstream flow attenuation
6. Blanco Det 1 + Det 2 + Culvert (3+4+5)	60	0.28	**1, Recommended**	Combined flow attenuation maximizes benefit
HAMPTON ARROYO				
11. No Action				
12. Hampton Detention 1	3	1.22	2	
13. Hampton Detention 2	downstream of US550	0.75	3	Protect: Sabena St, Martinez Ln, Elementary School, WW force main
14. Grade Control - erosion mitigation	same	0.12	**1, Recommended**	Five grade control structures to mitigate erosion by reducing channel velocity and arresting downcutting/degradation
15. Kokopelli subdivision measures	n/a	n/a	**Recommended**	Not assessed (n/a); no changes from 2017 AECOM recommendations
16. Kokopelli - diversion bypass channel	n/a	n/a	**Recommended**	Not assessed (n/a); no changes from 2017 AECOM recommendations

6 Storm Drainage Masterplan - Recommendations

Priority flood improvement projects are recommended to be pursued as a result of this report:

- **Blanco Arroyo**
  - Blanco Arroyo regional detention Alternative 6
    - Schematic 30% plans attached as Appendix O for regional detention (Alternatives 4+5)
    - Blanco Arroyo 60" culvert replacement is recommended (Alternative 5)
  - Refine estimate of ROW and property costs
  - Refine materials take off estimates and advance preliminary design concepts
- **Hampton Arroyo**
  - Assess grade control structures to arrest erosion and degradation in Hampton Arroyo downstream of US550 (Alternative 14)
  - Kokopelli Subdivision - Assess local runoff bypass channel around the subdivision (Alternative 16), and continue to address localized interior improvements

In addition, the following recommendations are made to continue assessing items identified within the Storm Water Master Plan:

- **Priority watersheds:**
  - Williams Arroyo – Evaluate upstream portions of the watershed, and determine whether all problem area items located near the downstream are sufficiently addressed
  - Estes Arroyo – Evaluate whether regional alternatives or local alternatives are most beneficial to alleviate issues just north of W. Aztec Blvd, near Heiland Road and N Light Plant Road.
  - Continue evaluating priority watersheds or point problems.
- **City-wide projects**
  - Continue to maintain close coordination with San Juan County on Hazard Mitigation Planning
    - Determine whether an update is needed for Animas River Flood Forecasting and Early Warning based on current-day conditions and evolving use of the new Durango Radar
  - Identify local flood forecast early warning
    - Based upon Precipitation Forecasting – new Durango Radar

The presentation slide deck associated with the City Workshop on stormwater conducted on June 11, 2024, is attached as Appendix P.

7 Appendix A – Stormwater Problem Areas Map

Stormwater Problem Areas Map
Developed by the City of Aztec
March 2023

8 Appendix B – Rain and Stream Gages Map

Local and Regional Rain Gages and Stream Gages Map

9 Appendix C – Delineated Watersheds

Delineated Watersheds

10 Appendix D – HEC-RAS Model Data

1 – NLCD Land Use
2 - Impervious Cover
3 - SSURGO Soils
4 - Manning's N Values

11 Appendix E – HEC-RAS Output Blanco Arroyo 10% AEP

12 Appendix F – HEC-RAS Output Blanco Arroyo 4% AEP

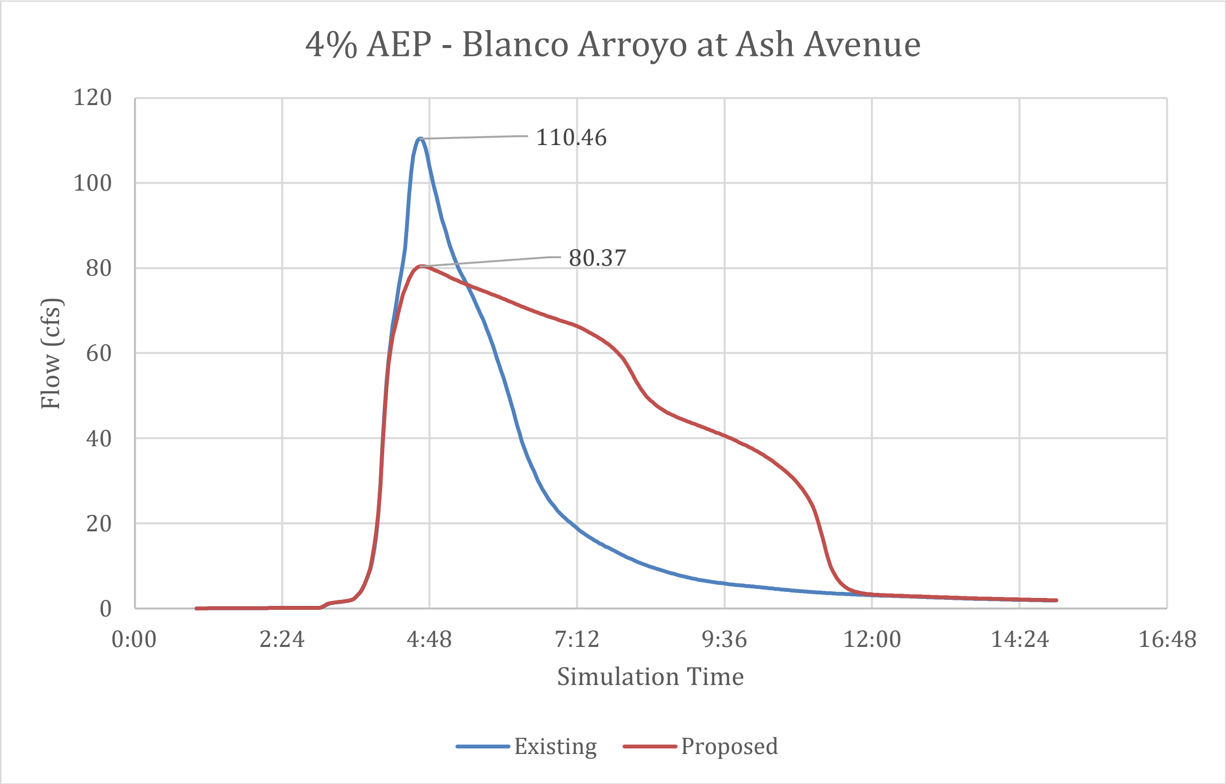
13 Appendix G - HEC-RAS Output Blanco Arroyo 1% AEP

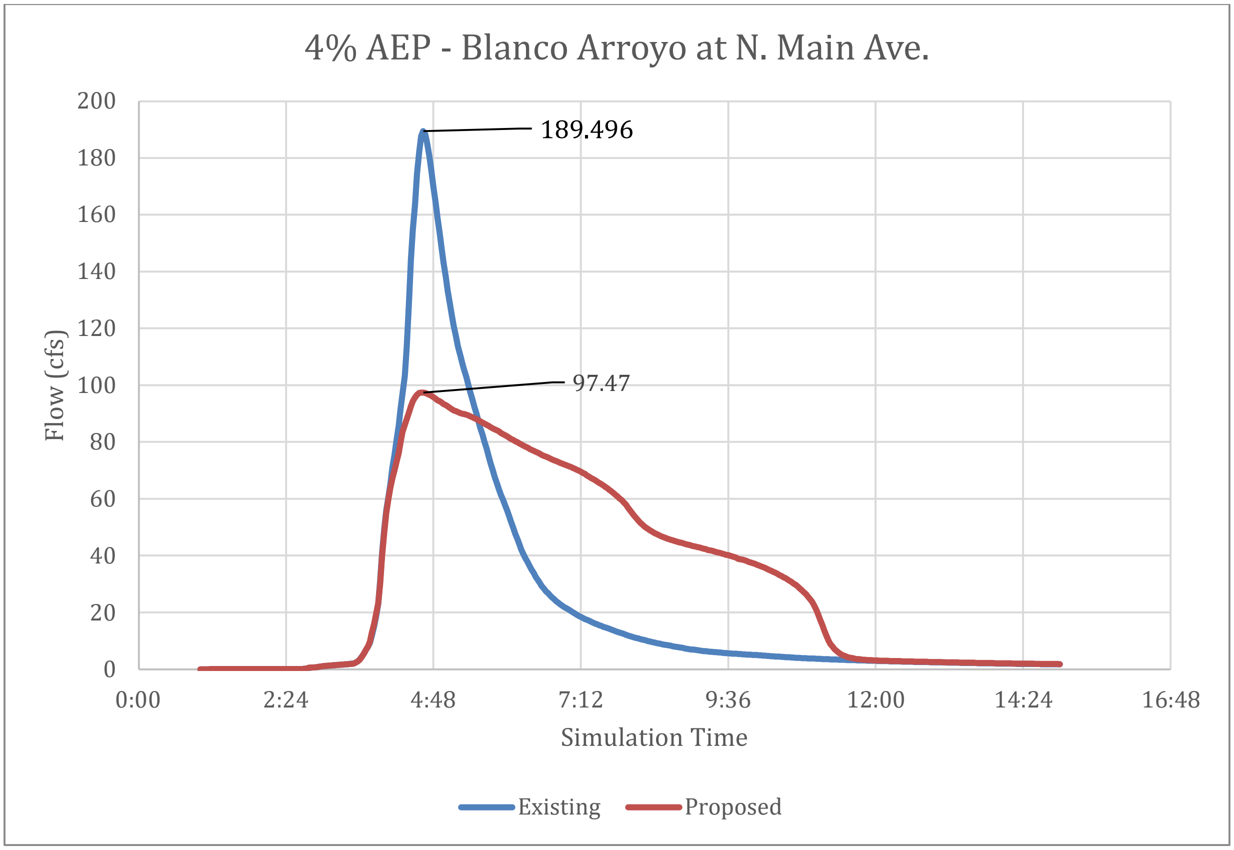
14 Appendix H - HEC-RAS Output Hampton Arroyo 10% AEP

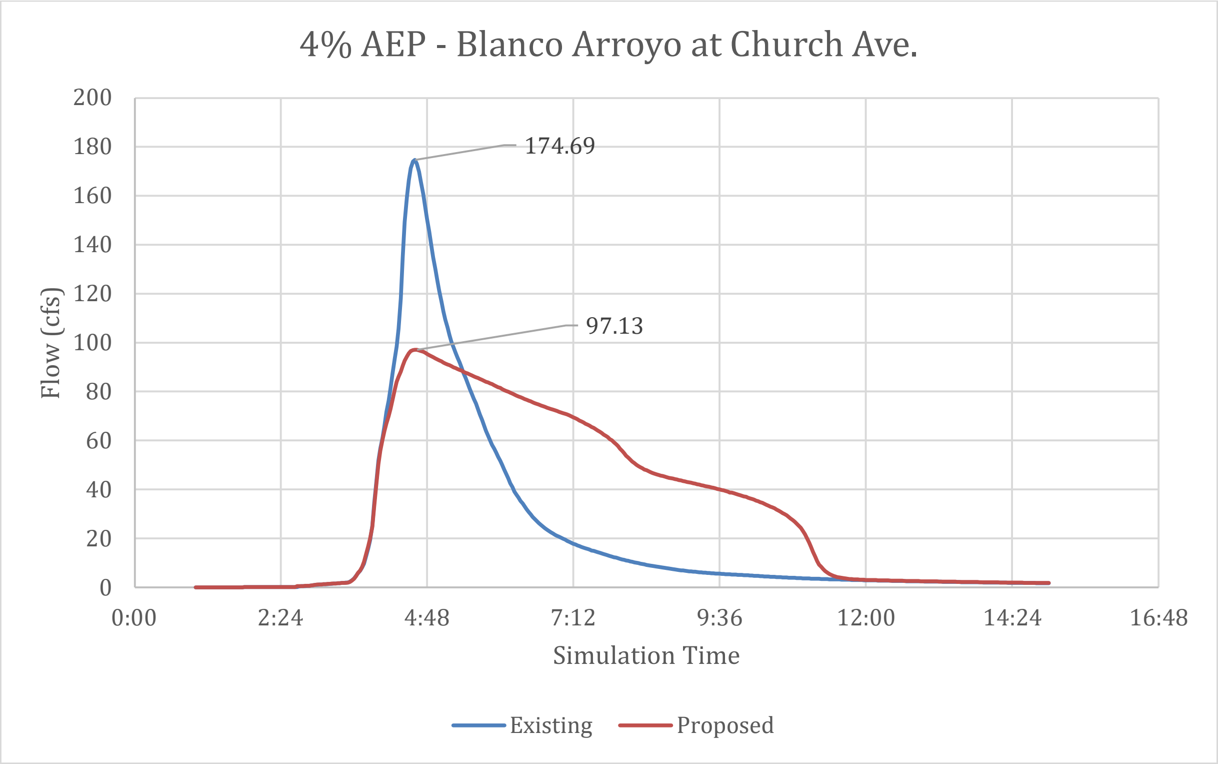
15 Appendix I - HEC-RAS Output Hampton Arroyo 4% AEP

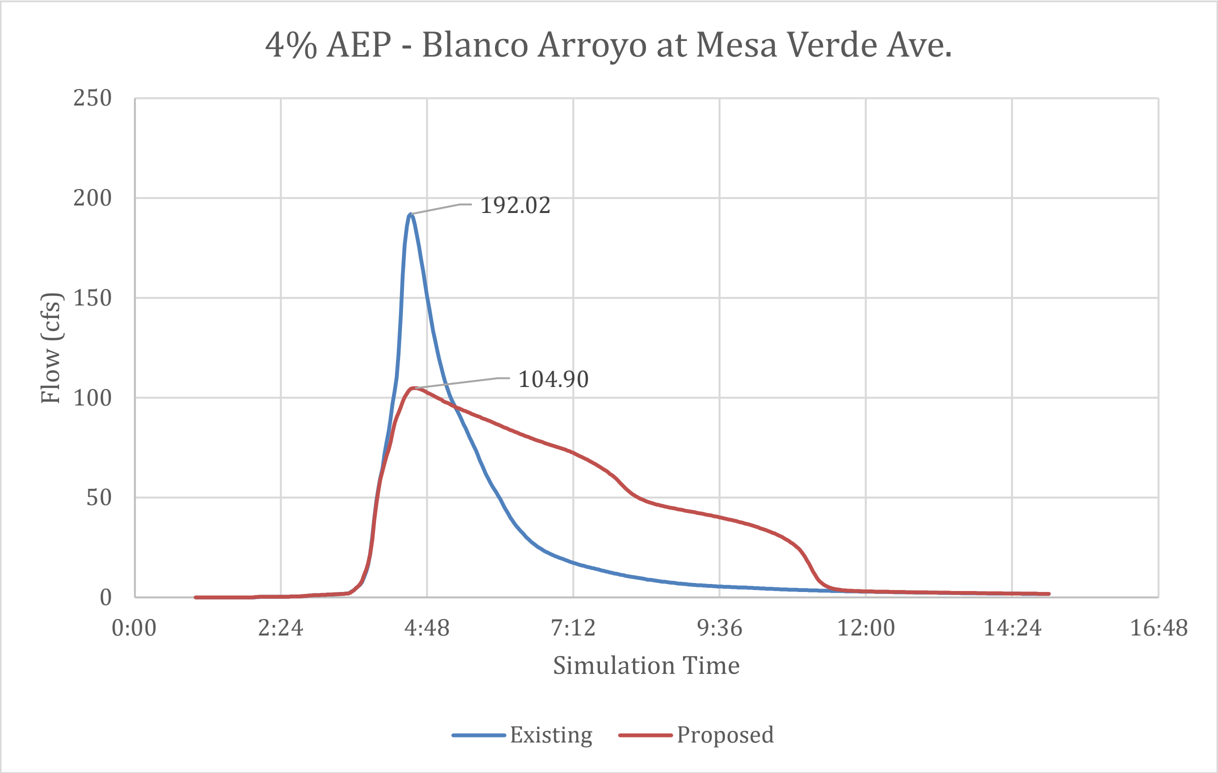
16 Appendix J - HEC-RAS Output Hampton Arroyo 1% AEP

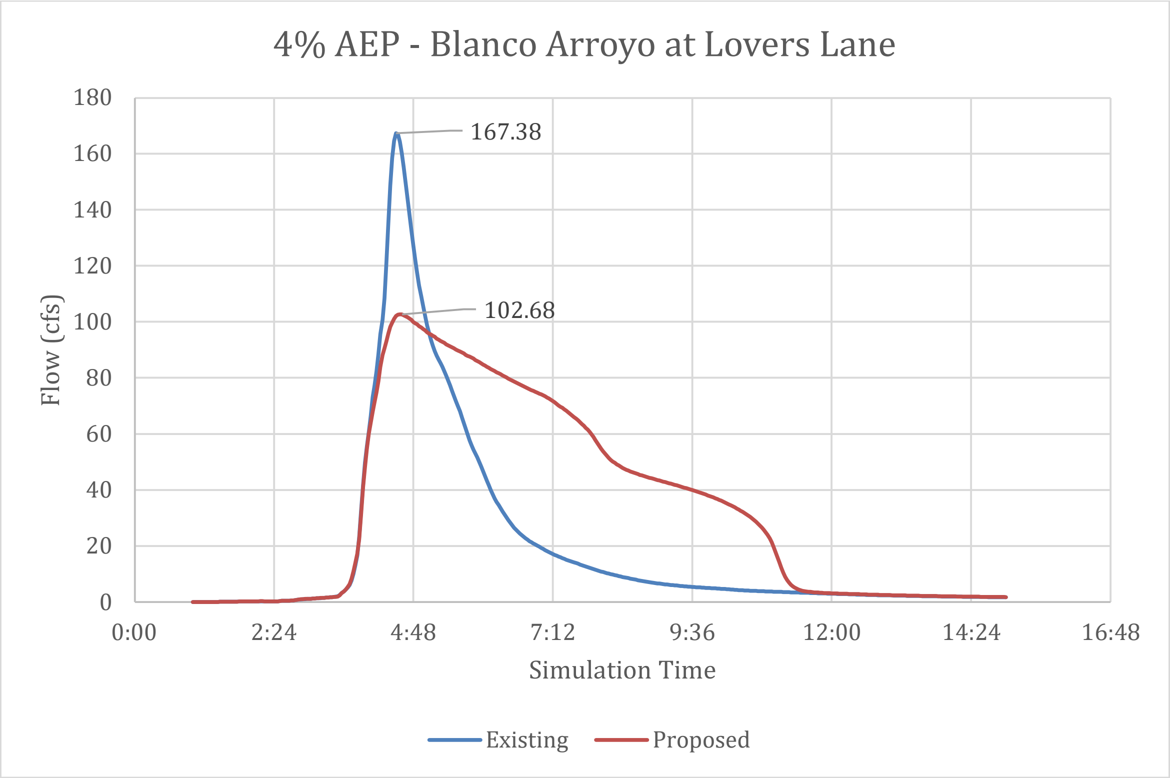
17 Appendix K – Hydrographs for 4% AEP at Culvert Crossings

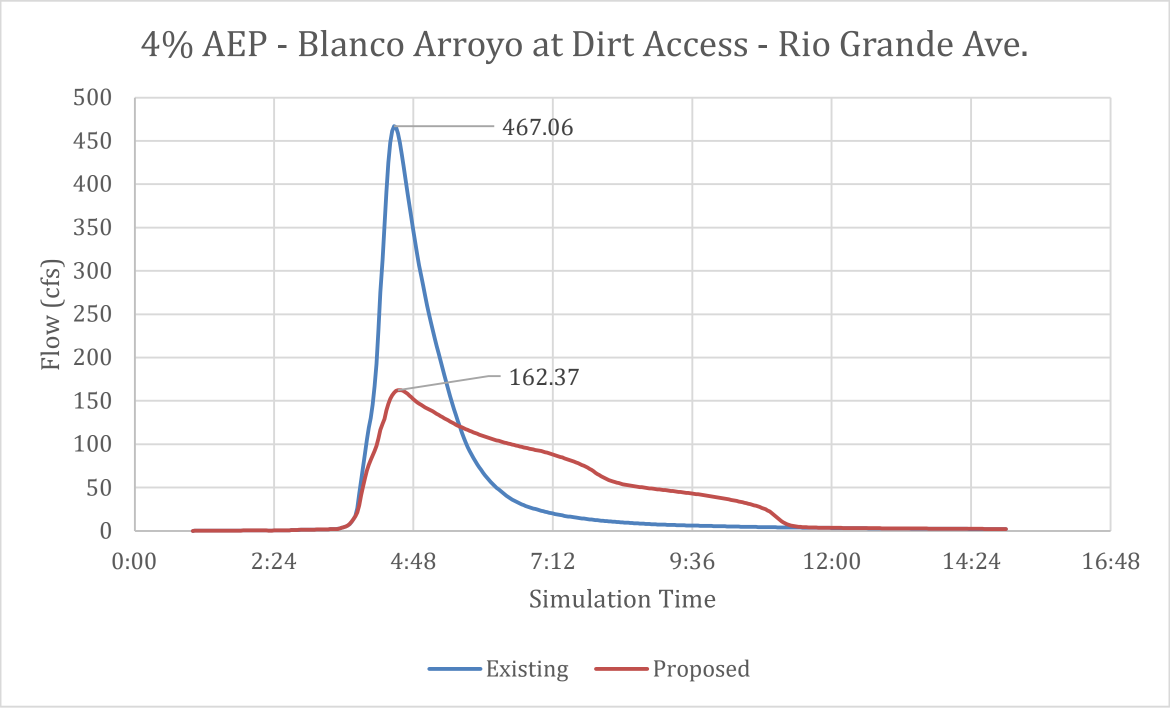

4% AEP - Blanco Arroyo at Ash Avenue
110.46
80.37
Flow (cfs)
Simulation Time
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
Existing
Proposed

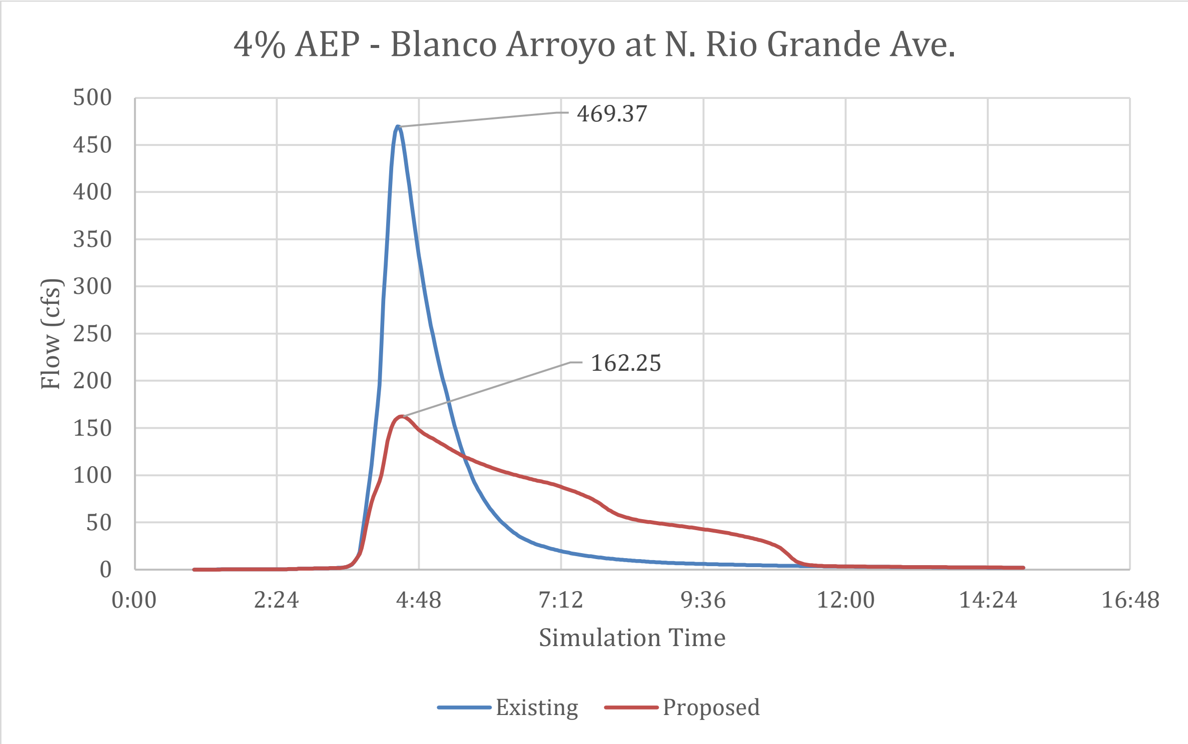

4% AEP - Blanco Arroyo at N. Main Ave.
189.496
97.47
Flow (cfs)
Simulation Time
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
Existing
Proposed

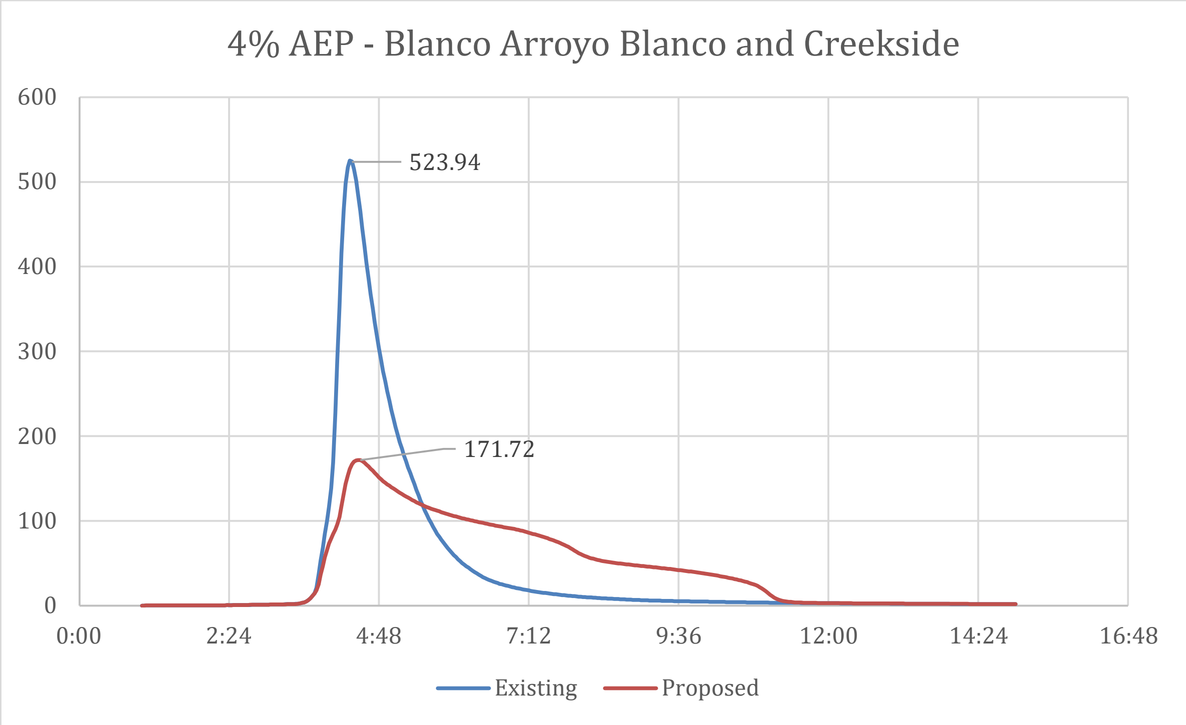

4% AEP - Blanco Arroyo at Church Ave.
174.69
97.13
Flow (cfs)
200
180
160
140
120
100
80
60
40
20
0
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
Simulation Time
Existing
Proposed

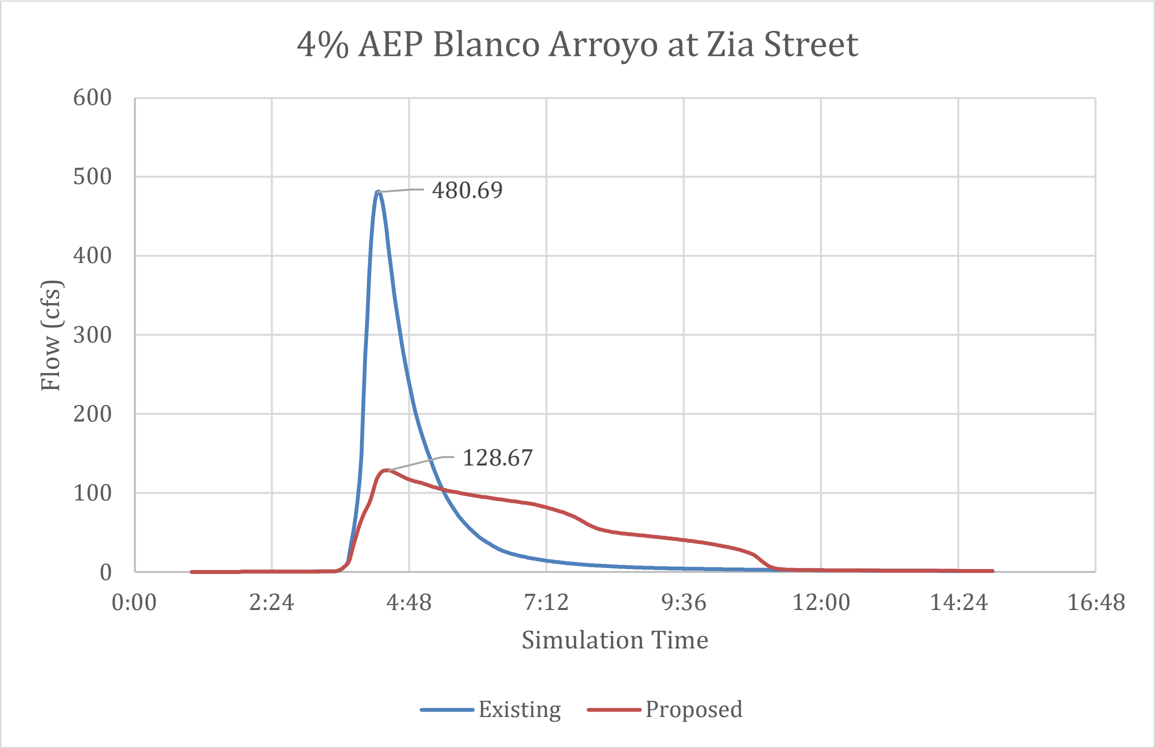

4% AEP - Blanco Arroyo at Mesa Verde Ave.
192.02
104.90
Flow (cfs)
250
200
150
100
50
0
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
Simulation Time
Existing
Proposed


4% AEP - Blanco Arroyo at Lovers Lane
167.38
102.68
180
160
140
120
100
80
60
40
20
0
Flow (cfs)
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
Simulation Time
Existing
Proposed

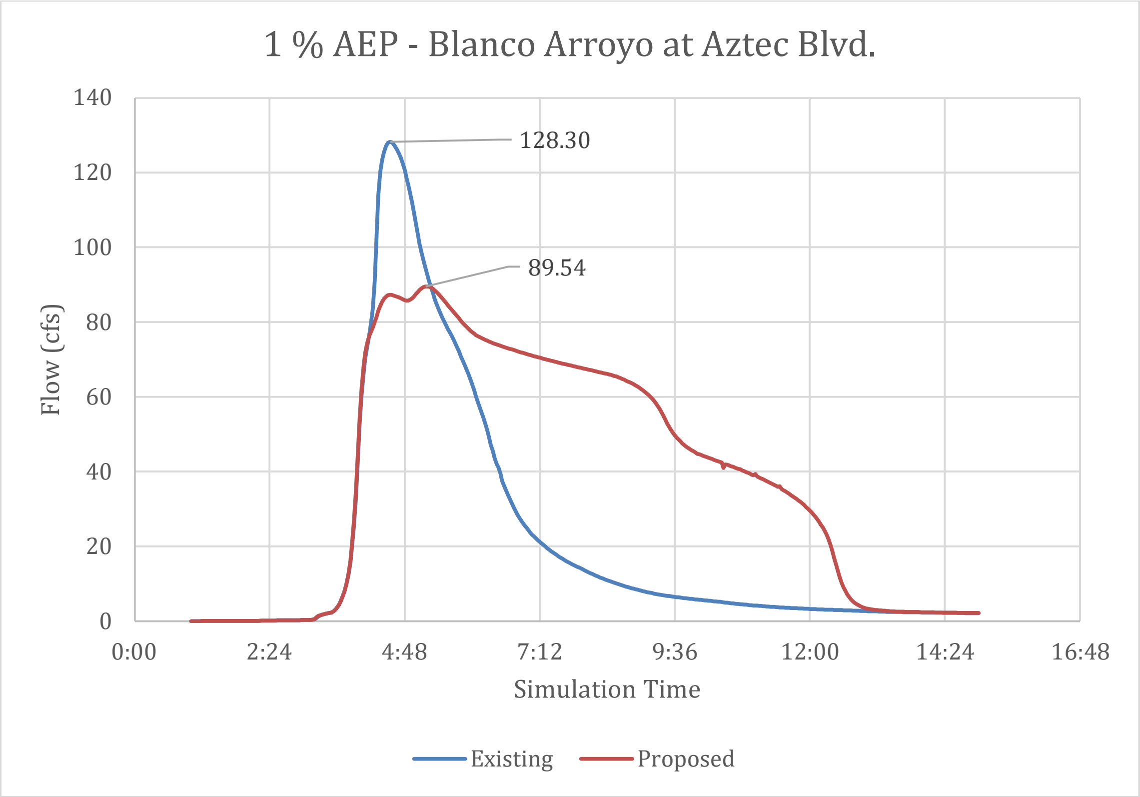

4% AEP - Blanco Arroyo at Dirt Access - Rio Grande Ave.
467.06
162.37
500
450
400
350
300
250
200
150
100
50
0
Flow (cfs)
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
Simulation Time
Existing
Proposed


4% AEP - Blanco Arroyo at N. Rio Grande Ave.
469.37
162.25
Flow (cfs)
500
450
400
350
300
250
200
150
100
50
0
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
Simulation Time
Existing
Proposed

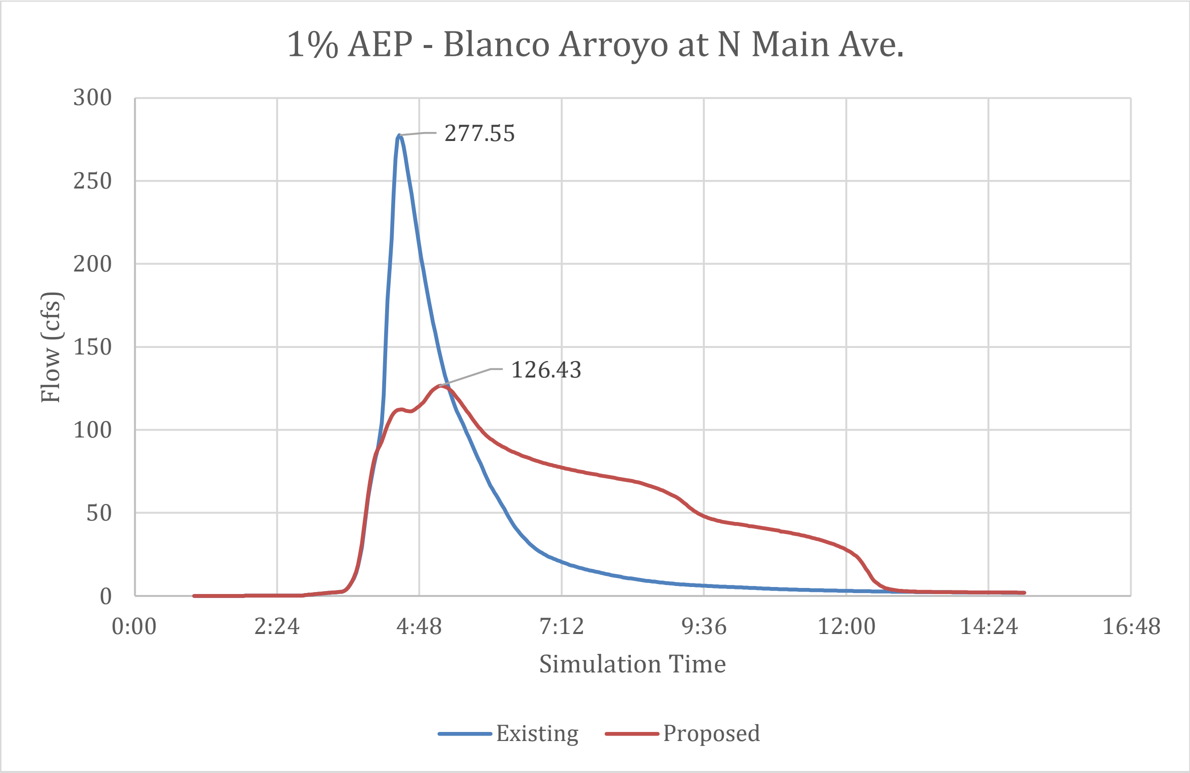

4% AEP - Blanco Arroyo Blanco and Creekside
523.94
171.72
600
500
400
300
200
100
0
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
Existing
Proposed

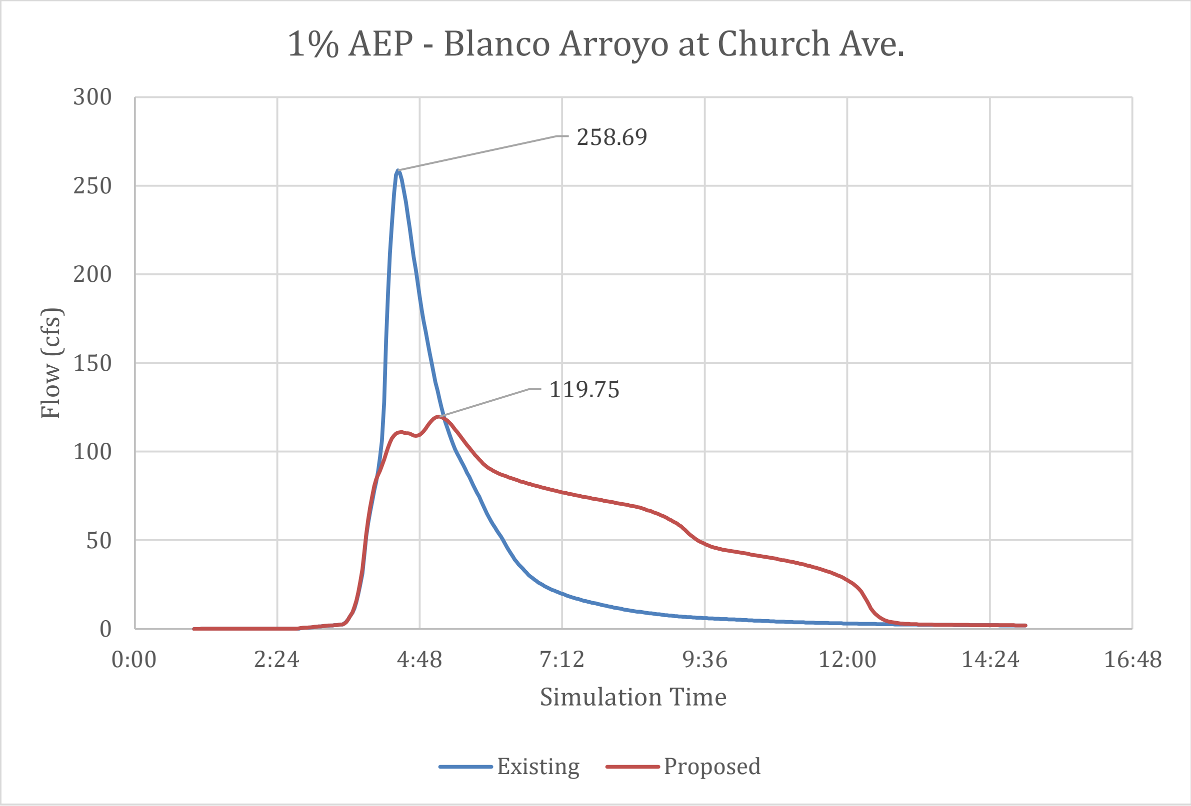

4% AEP Blanco Arroyo at Zia Street
600
500
400
300
200
100
0
Flow (cfs)
480.69
128.67
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
Simulation Time
Existing
Proposed

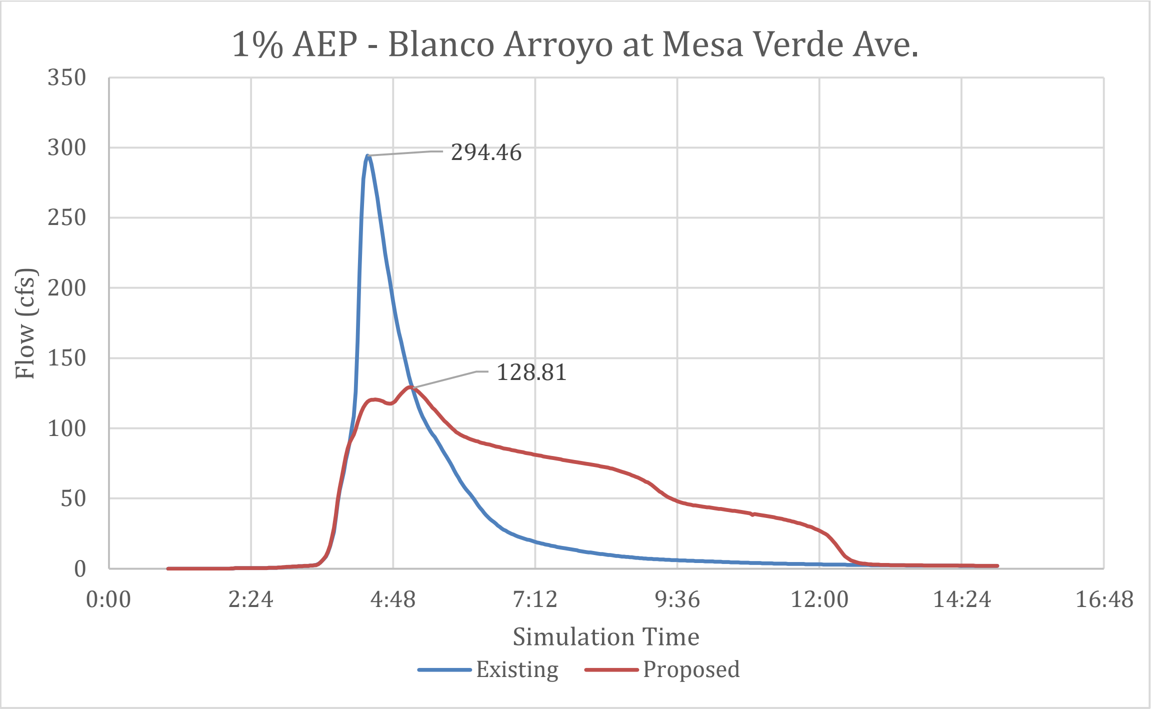
18 Appendix L - Hydrographs for 1% AEP at Culvert Crossings

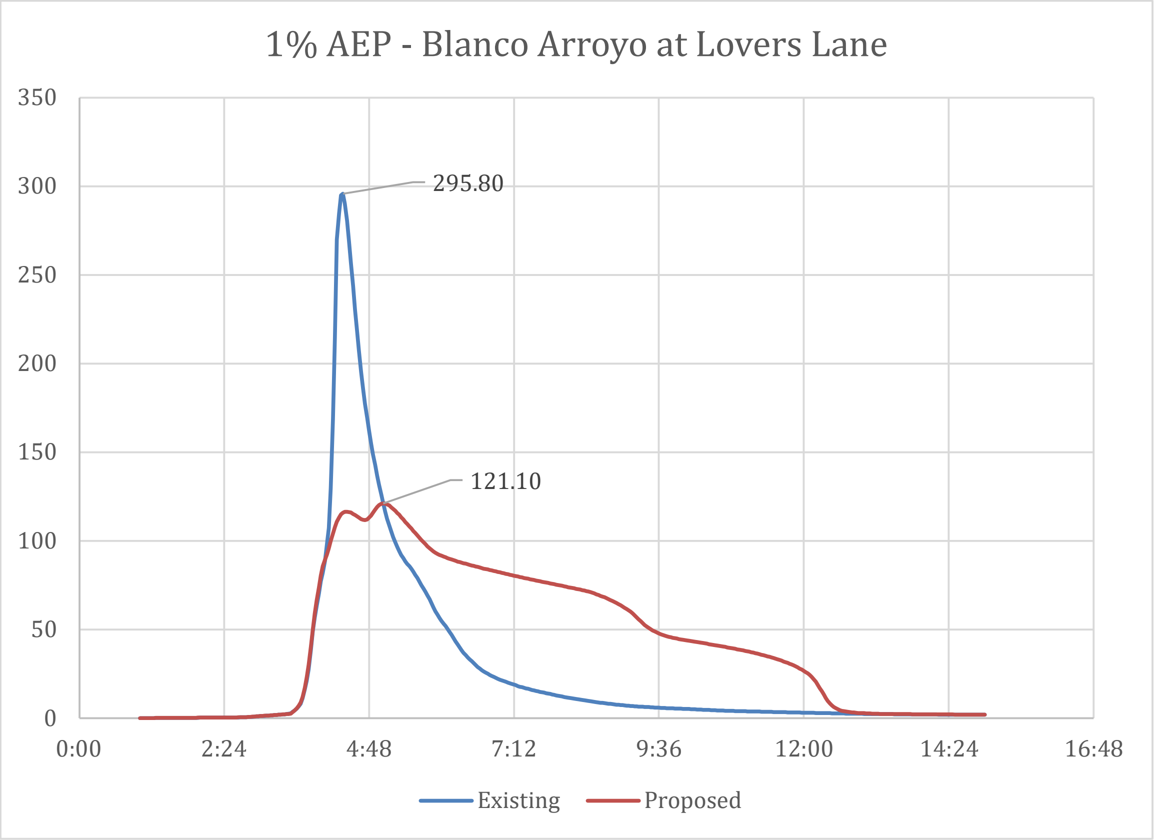

1 % AEP - Blanco Arroyo at Aztec Blvd.
140
120
100
80
60
40
20
0
Flow (cfs)
128.30
89.54
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
Simulation Time
Existing
Proposed

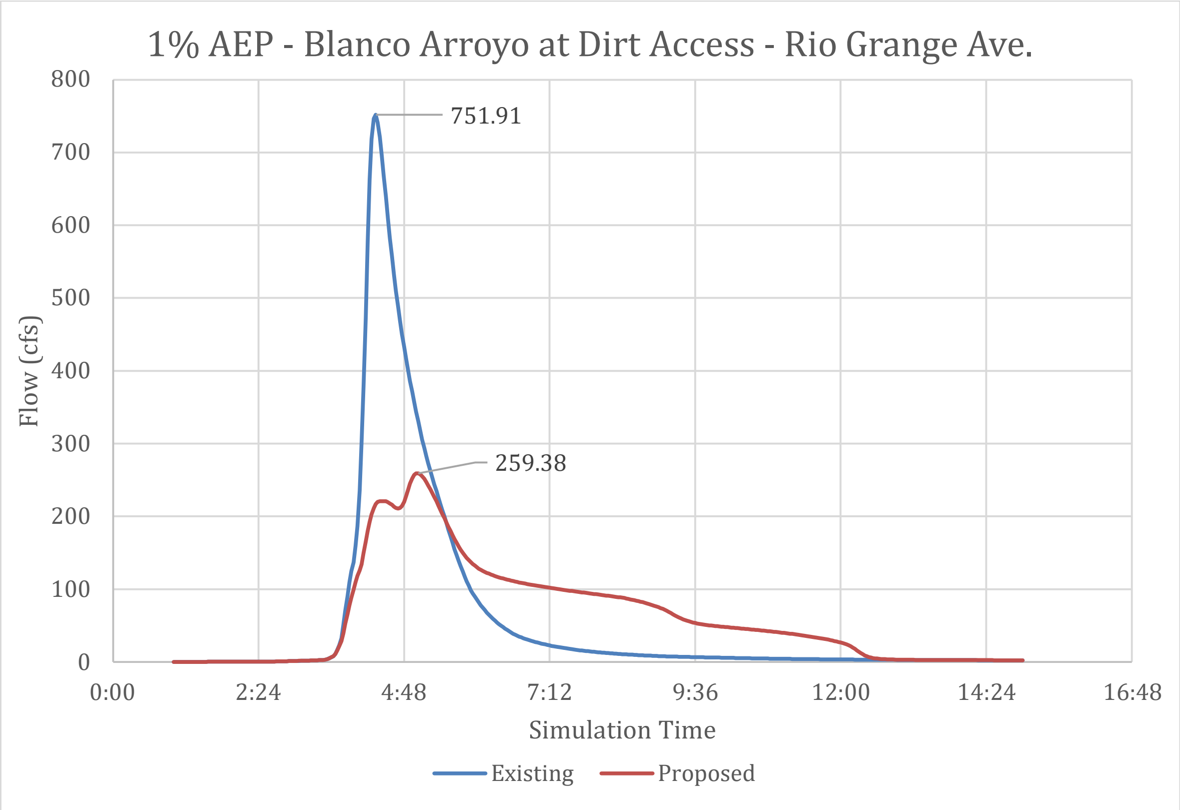

1% AEP - Blanco Arroyo at Ash Avenue
140
120
100
80
60
40
20
0
Flow (cfs)
128.93
88.84
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
Simulation Time
Existing
Proposed

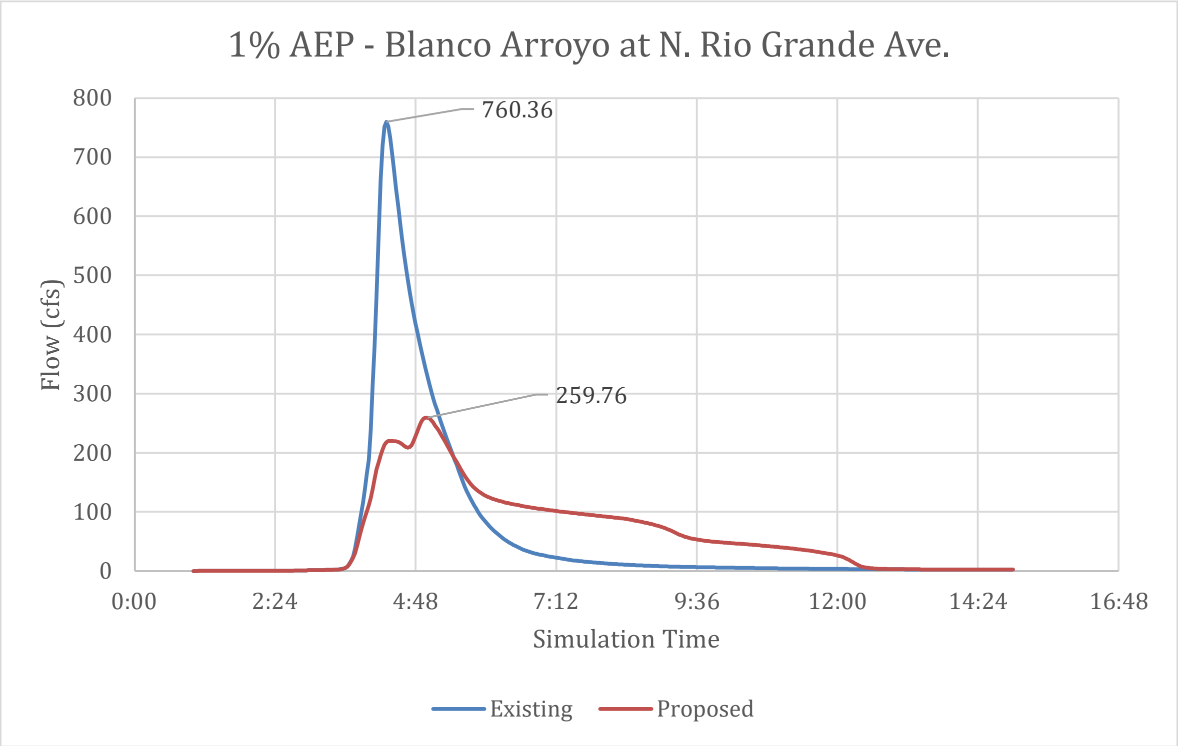

1% AEP - Blanco Arroyo at N Main Ave.
300
250
200
150
100
50
0
Flow (cfs)
277.55
126.43
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
Simulation Time
Existing
Proposed


1% AEP - Blanco Arroyo at Church Ave.
300
250
200
150
100
50
0
Flow (cfs)
258.69
119.75
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
Simulation Time
Existing
Proposed

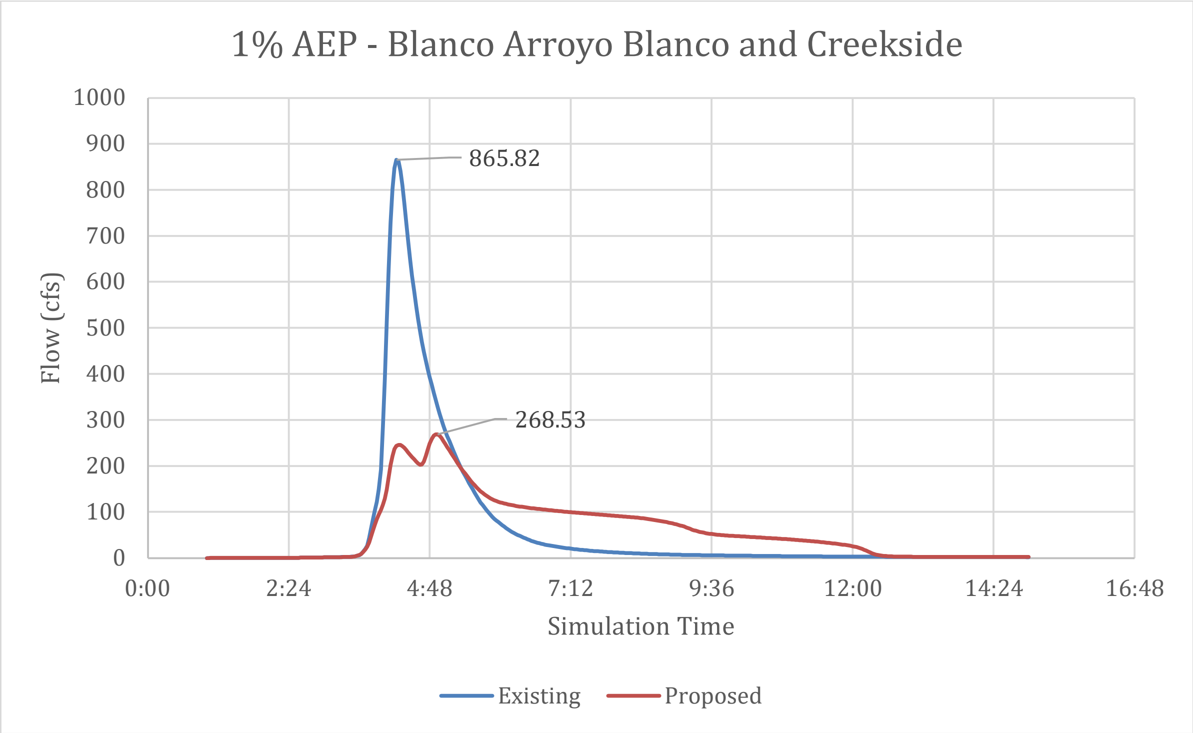

1% AEP - Blanco Arroyo at Mesa Verde Ave.
350
300
250
200
150
100
50
0
Flow (cfs)
294.46
128.81
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
Simulation Time
Existing
Proposed

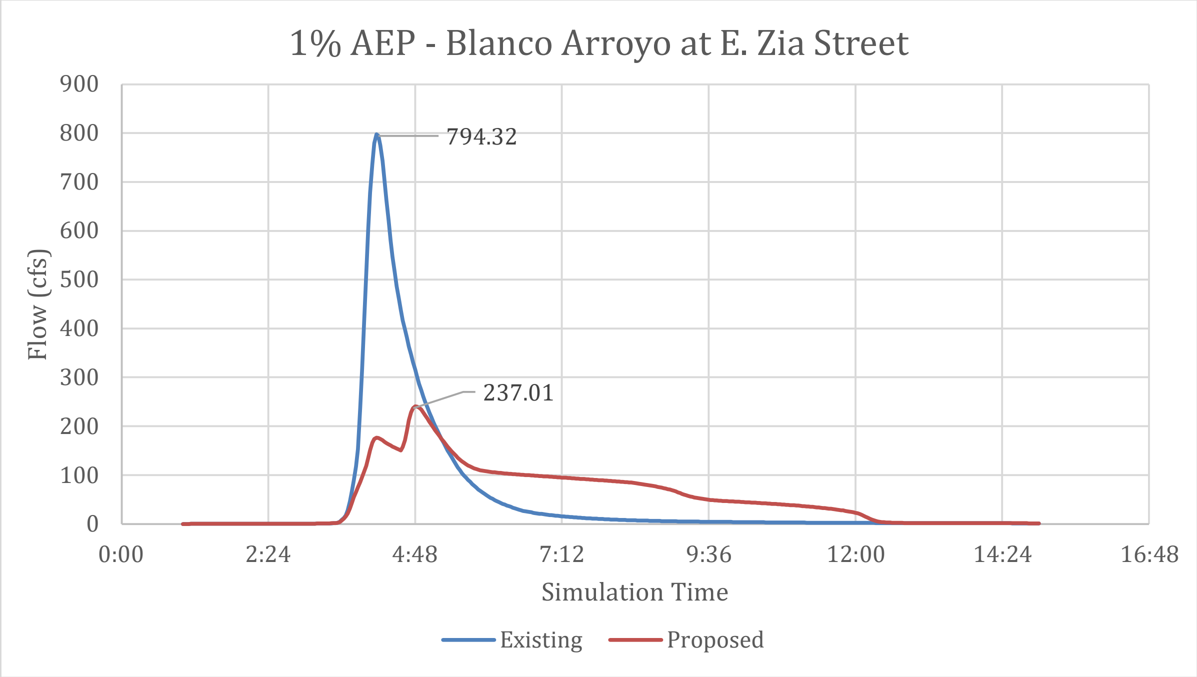

1% AEP - Blanco Arroyo at Lovers Lane
350
300
250
200
150
100
50
0
295.80
121.10
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
Existing
Proposed

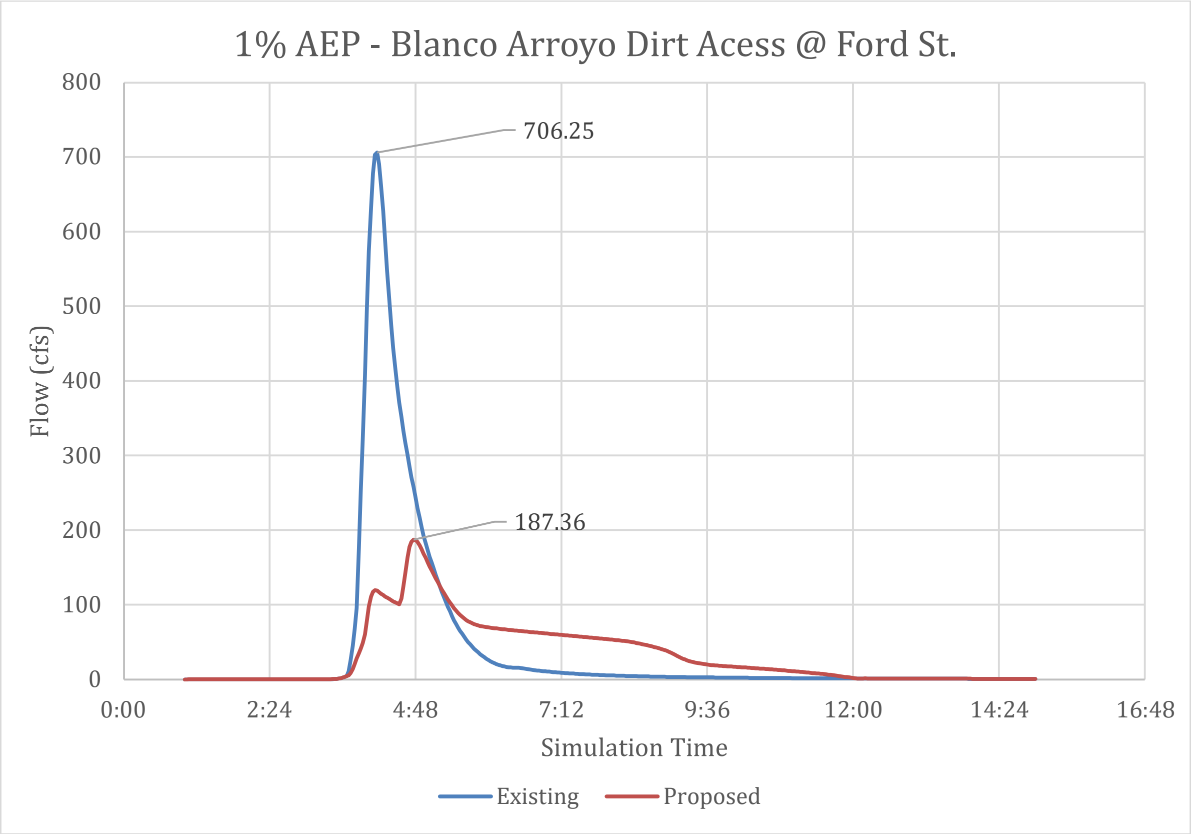

1% AEP - Blanco Arroyo at Dirt Access - Rio Grange Ave.
800
700
600
500
400
300
200
100
0
Flow (cfs)
751.91
259.38
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
Simulation Time
Existing
Proposed


1% AEP - Blanco Arroyo at N. Rio Grande Ave.
800
700
600
500
400
300
200
100
0
Flow (cfs)
760.36
259.76
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
Simulation Time
Existing
Proposed

13341 W US Hwy 290, Bldg 2
Austin TX 78737
Tel: (512) 826-2604






1% AEP - Blanco Arroyo Dirt Acess @ Ford St.
800
700
600
500
400
300
200
100
0
Flow (cfs)
706.25
187.36
0:00
2:24
4:48
7:12
9:36
12:00
14:24
16:48
Simulation Time
Existing
Proposed

19 Appendix M – Blanco and Hampton Arroyos Alternatives

M 1 – Blanco Arroyo
M 2 – Hampton Arroyo upstream of US550
M 3 – Hampton Arroyo downstream of US550

20 Appendix N – Alternatives Cost Tables

21 Appendix O – 30% Plans for Blanco Arroyo Regional Detention

30% Preliminary Construction Plans

22 Appendix P – City Council Workshop Presentation June 11, 2024