PACES MILL FLOOD RISK REDUCTION

DRAFT PRELIMINARY ENGINEERING REPORT

PREPARED FOR:

CITY OF AUSTIN WATERSHED PROTECTION
WATERSHED ENGINEERING DIVISION
505 BARTON SPRINGS ROAD
AUSTIN, TX 78704

PREPARED BY

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PUBLIC PROJECT ENGINEERING
FIRM NO. 6535

APRIL 2023

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Watershed Engineering Division
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This document is released for the purpose of interim review under the authority of Alexis Woffenden, P.E. #117162 on April 7, 2023 and is not to be used for other purposes.

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1 GLOSSARY AND ACRONYMS

COA – City of Austin

DCM – Drainage Criteria Manual

ECM – Environmental Criteria Manual

FEMA – Federal Emergency Management Agency

FRR – Flood Risk Reduction

HWM – High Water Mark

KFA – K Friese + Associates

LDC- Land Development Code

LOS- Level of Service

MIPT- Mission Integration for Watershed Protection Department Capital Projects

NFIP – National Flood Insurance Program

OHWM – Ordinary High Water Mark

OPC – Opinion of Probable Cost

PER- Preliminary Engineering Report

ROW – Right of Way

TNRIS - Texas Natural Resources Information System

WOTUS – Waters of the United States

WPD – Watershed Protection Department

WSEL – Water Surface Elevation

2 EXECUTIVE SUMMARY

This PER outlines the study of flood risk reduction for the Paces Mill Tributary of Onion Creek adjacent to the Yarrabee Bend South Neighborhood. The study included creating, analyzing, and refining potential flood reduction alternatives. The PER includes the schematic design of the final recommended alternative.

The project includes updates to the effective hydrologic model to include current stormwater controls, simulations of record events in October 2015 and May 2016 as well as accounting for potential improvement at Thaxton Road. The project produced new calibrated 2D hydraulic models of the reach and proposed improvement alternatives as well as revisions to regulatory 1D simulations that align results with those produced by calibrated scenarios.

10 design alternatives and 3 buyout alternatives were analyzed in the primary analysis phase of the project. The projects were rated and ranked using a scoring matrix developed by the Watershed Protection Department (WPD) and K Friese & Associates (KFA). Of these alternatives, three physical design alternatives were carried into a secondary analysis phase. The three alternatives analyzed in the secondary analysis phase are the 100-Year Level of Service (LOS) Hybrid Channel, 100-Year LOS Engineered Channel, and the 10-Year LOS Natural Channel Alternatives. The three secondary alternatives were presented to the WPD Mission Integrated Program (MIP) for input on selection of a recommended alternative for preliminary design.

The recommended alternative for design is the 100-Year LOS Hybrid Channel. This report includes schematic drawings representative of flood risk reduction improvements in the reach, adverse impact analyses of the alternatives, and discussions of the design process tasks including anticipated permitting requirements.

3 Background

3.1 PROJECT CONTEXT

WPD is conducting this study in response to recorded flooding events on Thaxton Road and in Yarrabee Bend South Neighborhood in October 2015 and May 2016. These events each caused substantial flood damage to structures adjacent to the Paces Mill Tributary on Paces Mill Lane. This recent flooding has been a major driver in increasing the priority of the project to WPD.

The City of Austin tasked KFA with producing this PER with the primary objectives of developing an accurate assessment of possible flood risk to the residents adjacent to the tributary, and systematically developing a favorable solution to minimize that risk.

The Yarrabee Bend South Neighborhood abuts Paces Mill Tributary. The Paces Mill Tributary discharges directly into Onion Creek just north of the Yarrabee Bend South Neighborhood (Figure 1).

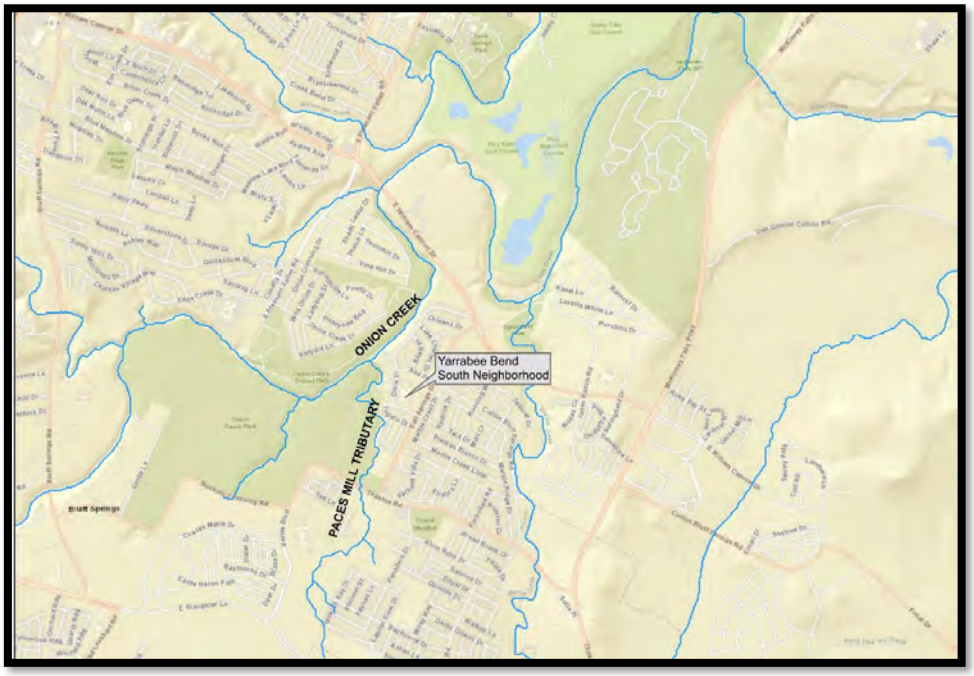


Figure 1. Yarrabee Bend South Neighborhood Location Map

3.2 PROJECT APPROACH

This preliminary engineering study was scoped to take meaningful, available data and supplement it wherever necessary to assess flood risk, progressively develop and refine a set of possible flood risk reduction solutions for the reach, and ultimately arrive at a single recommended alternative that could be completely developed in design and construction phases of the project. Each major component and its relevance is briefly discussed in this section, and in more detail in following sections.

3.2.1 Data Collection

Data collection for the project primarily included gathering regulatory models for the hydrology and hydraulics of the reach, highwater marks from historic storm events, and finished floor elevations of existing structures within the floodplain. Survey information was gathered primarily to update the hydrologic model with components constructed after the model's creation, and to provide high quality input for the hydraulic model of the reach. A geological reconnaissance was conducted of the existing channel to determine stability of the channel within the study area and to assist in the Erosion Hazard Zone analysis.

3.2.2 Hydrologic Modeling

The hydrologic model was updated primarily to include a regional pond built on Vertex Boulevard and to update to Atlas 14 meteorology. The RainVieux Radar Data from the October 2015 and May 2016 events were utilized to develop hydrologic models of these events. The runoff from these hydrologic models were utilized to calibrate the hydraulic models. Thaxton Road improvements were included in the proposed conditions model to assess the potential hydrologic impact of flood reduction improvements at Thaxton Road.

3.2.3 Hydraulic Modeling

Hydraulic modeling was performed for these major components:

3.2.3.1 Thaxton Road Flood Improvements

Thaxton Road is just upstream of the flooded homes on Paces Mill Lane and is a known low water crossing. While flood risk at Thaxton Road is of little effect on the flooding that occurs at Paces Mill Lane, development of improvement alternatives is desired by the city and is included in this report. Expected improvements to conveyance at Thaxton Road has the potential to marginally increase flows within the downstream reach and adjacent to the neighborhood. Potential hydrologic impacts due to improvements at Thaxton Road are accounted for in reach improvement alternatives.

3.2.3.2 Hydraulic Model Creation and Calibration

Flooding in the Paces Mill tributary is widespread, and in areas, there are numerous obstacles and irregularities. Because of this lack of uniformity, the reach and proposed improvements were evaluated using a 2D model.

Two major flood events occurred in October 2015 and May 2016. From these events, WPD gathered information about high water marks. RainVieux Radar Data provided information about the rainfall intensities including their distributions. These data sets were used to adjust the hydraulic model and provided confidence in the model output.

3.2.3.3 Primary Analysis

There were numerous unique alternatives developed that could reduce flood risk in the Paces Mill Tributary, all of which with different costs, benefits, and drawbacks. These many alternatives were compared utilizing a scoring matrix and three of the best scoring alternatives were advanced to the secondary analysis phase.

3.2.3.4 Secondary Analysis

The secondary analysis includes further refinement of the three selected alternatives from the primary analysis phase. These three alternatives were evaluated in both 2D and 1D model environments for the purposes of enumerating impacts of project implementation. These impact analyses included flood storage, flow, inundation and velocity analyses that demonstrate compliance with impact guidelines and potential risks associated with implementing the proposed improvements.

3.2.4 Final Alternative Selection and Preliminary Plan Development

The Hybrid Channel design was selected for the preliminary design. The preliminary design incorporated channel protection and erosion controls into the design from the Secondary Analysis. The Engineer's Opinion of Cost was updated to include the permanent erosion controls.

4 DRAINAGE POLICY AND DESIGN CRITERIA

The underlying themes that drive drainage and design criteria and will ultimately govern the ability to implement a project such as this, are generally common. These themes include desire to reduce flood risk to persons and property, to provide standards to analyze the benefits of creek before and after any potential improvements, and to assure that any improvements will provide benefit to the community without increased flood risk.

The City of Austin Drainage Criteria Manual (DCM) provides drainage policy and hydraulic design criteria for channels. The City of Austin Environmental Criteria Manual (ECM) provides floodplain modification requirements for channel improvements to preserve the natural character of the waterway, prevent degradation of water quality, and promote the stability of the waterway.

The DCM does have drainage criteria for channels; however, the majority of major waterways in the city are natural and have varying levels of service from a capacity standpoint, channel design criteria is much less prescriptive than it is for other drainage infrastructure. Thus, the DCM should primarily be held as a drainage policy document for this project. Policy should be extracted from Section 1 of the DCM and WPD's No Adverse Impacts Guidelines. These documents generally outline that projects should not adversely affect other persons or property and that flood risk up to the 100-year frequency should be contained inside of public ROW or easements. The design should meet requirements outlined in Section 6 of the DCM for open channel design.

The ECM sets forth the methodology for assessment of floodplains which provides baseline design criteria for restoration or mitigation of any channel. This project, being necessary for public safety, requires one-to-one restoration/mitigation and should include a net ecological uplift.

FEMA does have the permitting authority over mapped floodplains including Paces Mill Tributary. FEMA is tasked with assuring that floodplain alteration is compliant with the NFIP regulations, and has set forth modeling standards for evaluation and analysis of floodplains.

The US Army Corp of Engineers (COE) has permitting authority over Waters of the U.S. (WOTUS) and wetlands from the Clean Water Act. Their permitting authority has a focus on maintaining the ecological merits of waterways primarily or improving those merits.

5 DATA COLLECTION

5.1 FEMA

FEMA plays multiple roles in floodplain projects. FEMA creates and publishes floodplain mappings of creek and river flood risk for regulatory, informatory, emergency, and insurance purposes. The Paces Mill tributary has a mapped regulatory floodplain. The FEMA hydrologic and hydraulic models are available in the FloodPro model repository. The City of Austin regulatory models were used as baseline for modeling tasks in this preliminary study.

5.2 HYDROLOGIC DATA

Hydrologic data for the project was gathered primarily from three primary sources: The COA FloodPro model repository, survey data, and RainVieux radar data for record rainfall events.

- Onion Creek Regulatory Model: The City of Austin Onion Creek Hydrologic model was used as a baseline for analysis of the basin.
- Survey Data: Survey data was incorporated into the hydrologic model. An element was added to represent the regional pond on Vertex Boulevard.
- RainVieux Radar Data: This radar rain intensity data was provided by WPD and incorporated into simulations of record rainfall events for the October 2015 and May 2016 storms.

5.3 HYDRAULIC DATA

Hydraulic data for the project was gathered primarily from four primary sources: The COA FloodPro model repository, open source planimetric and elevation data, survey data for updating the hydrologic network, and measurements taken by WPD of high-water marks.

- Paces Mill Regulatory Model: This hydraulic model from the COA FloodPro repository included baseline input used primarily for Thaxton Road improvements.
- Planimetric and Elevation Data: This data gathered from the COA and TNRIS were key components of the 2D models created in this study. Elevation data from 2017 LiDAR provides coverage for any area not surveyed. Planimetric data serves primarily to designate roughness values in the 2D model.
- Survey Data: Survey data was gathered for the project reach and is the primary source of elevation data for the project.
- COA HWM Data: WPD gathered high water mark data from affected homes after the October 2015 and May 2016 record events.

5.4 ENVIRONMENTAL DATA

Environmental data about the reach was gathered by HDR from both desktop and in field surveys of the project reach. HDR performed a visual assessment of the existing stream, conducted stream pebble counts, and photographed the channel within the project area.

6 EXISTING HYDROLOGIC MODEL DEVELOPMENT METHODOLOGY

This section identifies parameterization methods used in both the effective model and this study. For this study, a copy of the effective model was truncated to only include the Paces Mill Tributary and the following parameters were evaluated.

- Meteorology: *Updated from using old COA criteria to the COA Atlas 14 rainfall*
- Basin Delineation: *No Revisions*
- Basin Transform Parameters: *No Revisions*
- Basin Loss Parameters: *Revert Initial Abstraction values to default.*
- Reach Routing: *No revisions for Thaxton Road culvert improvements design. For Paces Mill Tributary channel improvements, the reach routing storage-discharge curve for reach RLOCR350A will be adjusted based on removal of Thaxton Road crossing to mimic highest loss of reach storage due to improving Thaxton Road culvert system.*
- Reservoir Routing: *Add Vertex Pond*
- Record Event Recreation

The following subsections address modifications to specific model parameters in more depth.

6.1 METEOROLOGY

Meteorological events are provided within the HEC-HMS model to simulate the 500-, 100-, 50-, 25-, 10-, 5-, and 2-year frequency storm events. These rainfall depths are derived from the City of Austin Drainage Criteria Manual's recommended depth-frequency distributions for South Austin based on NOAA Atlas 14. Design storm depth-duration-frequency data is tabulated in Table 1 :

Table 1- Depth-Duration-Frequency values

Table 2-1A, Depth-Duration-Frequency Values (Zone 1)

Duration	Depth of Precipitation (Inches) by Recurrence Interval							
	2-yr.	5-yr.	10-yr.	25-yr.	50-yr.	100-yr.	200-yr.	500-yr.
5-min.	0.53	0.67	0.80	0.98	1.12	1.28	1.45	1.68
15-min.	1.06	1.35	1.60	1.96	2.24	2.54	2.87	3.34
30-min.	1.49	1.90	2.25	2.75	3.13	3.54	4.01	4.69
1-hr.	1.96	2.51	2.99	3.66	4.19	4.77	5.45	6.45
2-hr.	2.42	3.15	3.82	4.81	5.63	6.57	7.65	9.27
3-hr.	2.70	3.54	4.34	5.55	6.60	7.81	9.21	11.31
6-hr.	3.17	4.20	5.21	6.78	8.17	9.79	11.65	14.48
12-hr.	3.64	4.84	6.02	7.85	9.47	11.37	13.58	16.94
24-hr.	4.14	5.51	6.84	8.90	10.69	12.80	15.27	19.05

6.2 BASIN DELINEATION

For this study, no significant revision was performed from the delineation provided in the regulatory model. For the calibrated storm events, the effective model's basins were divided to match the rainfall grid provided by Rainvieux. The division of the basins did not impact the flows. Values presented in Table 2 reflects the drainage areas of the updated and effective hydrologic models.

Figure 2. Paces Mill Subbasin Boundaries (shown in blue) and Rainviex Grid (shown in red)

Table 2. Areas of Updated and Effective Paces Mill Subbasins

Basin	Area (sq mi)
LOCR320	0.358723
LOCR330	0.332783
LOCR340C	0.022825
LOCR340A	0.178911
LOCR340B	0.120515
LOCR350A	0.172401
LOCR350B	0.09827
LOCR350C	0.097361

6.3 BASIN LOSS PARAMETERS

Initial abstraction values were adjusted based on discussions with the city. The initial abstraction values developed for the Onion Creek model reflected losses within the Onion Creek basin due to karst features which are not believed to be present in the Paces Mill Tributary. Based on this discussion, set initial abstraction values were removed from the model and the default internal calculation within the program for SCS Method was utilized.

Table 3 provides curve numbers and percent impervious cover utilized in the hydrologic analysis. These values are unchanged from those provided in the regulatory model.

Table 3. Curve Numbers and Percent Impervious for Existing and Ultimate Conditions

Existing Conditions Hydrology			Ultimate Conditions Hydrology		
Basin	**Curve Number**	**Impervious (%)**	**Basin**	**Curve Number**	**Impervious (%)**
LOCR320	81	13.6	LOCR320	81	57.8
LOCR330	84	12.5	LOCR330	84	55.6
LOCR340C	78	25.2	LOCR340C	78	25.2
LOCR340A	81	52.2	LOCR340A	81	55.3
LOCR340B	79	53.6	LOCR340B	79	53.6
LOCR350A	73	36.5	LOCR350A	73	42.7
LOCR350B	67	34.4	LOCR350B	67	38.3
LOCR350C	65	36.7	LOCR350C	65	36.7

6.4 REACH ROUTING / ELEMENT CONFIGURATION

No revisions to reach routing was made to the Thaxton Road culvert improvements hydraulic model. For the Paces Mill Tributary channel improvements hydraulic model, the storage-discharge curve for reach RLOCR350A was adjusted based on removal of Thaxton Road crossing to mimic highest possible loss of reach storage due to improving Thaxton Road culvert system.

Table 4 provides the reach RLOCR350A storage-discharge rating curve for existing conditions and the possible loss of storage for Thaxton Road culvert improvements.

Table 4. Reach RLOCR350A Storage-Discharge Rating Curves for Existing and Improved Thaxton Road

Thaxton Existing		Thaxton Improved	
Reach RLOCR350A		**Reach RLOCR350A**	
Storage (ac-ft)	**Discharge (cfs)**	**Storage (ac-ft)**	**Discharge (cfs)**
1.58	30	1.6	30
2.31	50	2.35	50
3.98	110	4.07	110
6.67	220	6.66	220
14.89	550	13.11	550
22.09	1090	21.85	1090
37.8	2720	35.43	2720
42.1	3260	39.99	3260
45.62	3810	42.92	3810
52.38	4770	49.77	4770
59.64	6100	57.48	6100
63.22	6700	61.31	6700

6.5 RESERVOIR ROUTING

The recently constructed (approximately 2014) regional pond behind Blazier Elementary School on Vertex Boulevard (Vertex Pond) was added to the hydrologic model to simulate storage at the location. This pond is included in all basin models. Based upon aerial imagery, the pond was constructed prior to the calibration storm events in 2015 and 2016.

Figure 3. Vertex Pond Location Map

6.5.1 Vertex Pond Elevation Storage

The rating curve for the Vertex pond water surface elevation to storage data was developed based upon the project's survey of the Vertex pond. This rating curve is provided in Table 5.

Table 5. Vertex Pond Rating Curve

WSEl (ft)	Storage (ac-ft)
564.56	0
565	3.02
566	13.54
567	29.04
568	47.52
569	68.07
570	90.1
571	113.39
572	137.65
573	162.86
574	189.23
575	216.51
576	244.1

6.5.2 Vertex Pond Storage Discharge

The Vertex Pond is located at the downstream end of the basin LOCR320 in the hydrologic model. The pond abuts the Paces Mill Tributary and is separated from the tributary by an earthen embankment that parallels the tributary. This pond was built to serve recent development in the basin as stormwater and water quality management. Standing water visible in aerial imagery is located at wet pond locations which will stack runoff for attenuation purposes. The pond has two 12-inch PVC pipes which serves the primary outlet for water quality control. The spillway serves as the flood control structure (weir) and is a concrete riprap lined trapezoidal notch in the earthen embankment. The weir has an approximate bottom width of 52 feet, an opening top width of approximately 88 feet, and a length of approximately 40 feet. The weir is approximately a foot and a half above the flowline of the pond and appears to match the channel bottom elevation at the downstream side.

The function of the weir is highly sensitive to tailwater conditions (flow depth in the tributary). A 2D simulation of this confluence was created to develop an elevation-discharge relationship for the weir to be used in the hydrologic analysis.

The 2D simulation was performed in HEC RAS using the Ultimate Conditions 500-year storm event at the confluence of the Vertex Pond and the receiving channel. This model provided the highest expected inflows to the Vertex Pond and receiving channel (junction JLOCR340C). This analysis relies on the assumption that basins LOCR320 and LOCR330 will experience identical rainfall which appear appropriate since the basins are relatively small and adjacent to one another.

A time series tables of the pond outlet was created with consideration to tailwater conditions. Two time series data sets were created from the model results: one for discharge through the primary spillway of the Vertex pond, and another for pond WSEL. The spillway discharge and pond WSEL were combined to create an Elevation-Discharge Time Series (1-minute increments) shown in Figure 4.

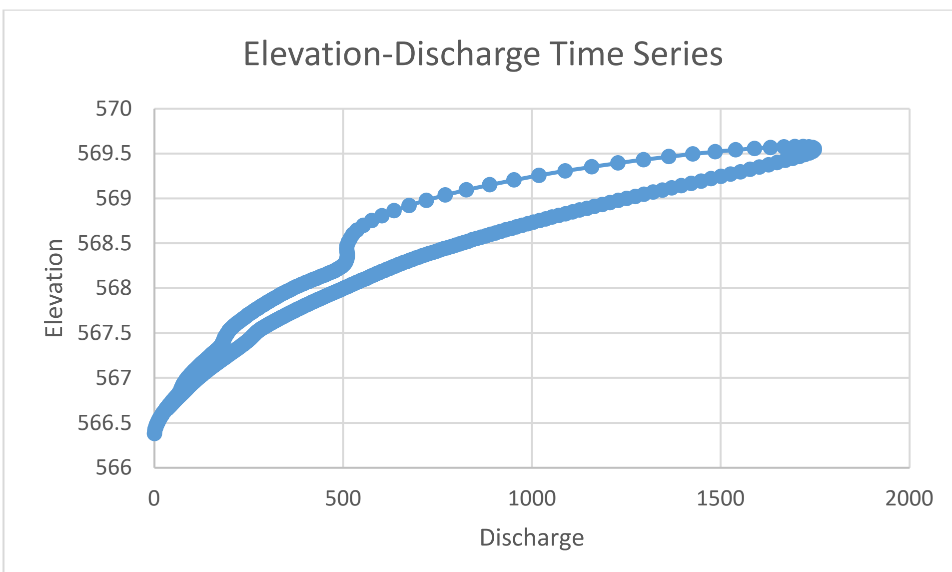


Figure 4. Elevation-Discharge Time Series for Vertex Pond

The Vertex Pond Storage-Discharge table was based upon the pond terrain and the Elevation-Discharge table shown above. The values chosen from the elevation discharge curve are from the ascending (lower) limb of the graph. Table 6 provides the storage-discharge table.

Table 6. Storage-Discharge Values for Vertex Pond

Elevation (ft)	Storage (ac-ft)	Discharge (cfs)
564.56	0.00	0.00
565	3.02	1.00*
566	13.54	2.00*
567	29.04	88.14
568	47.52	368.41
569	68.07	770.49
569.55	80.30	1748.47
571	113.39	4394.87

Value is interpolated

The maximum discharge in the Elevation-Discharge time series was 1748.47cfs at an elevation of 569.55ft. To create a discharge for the highest storage value, it was extrapolated by extending the elevation-discharge curve for higher discharges to determine the discharge at elevation 571-ft. Discharge values marked with an asterisk are added to maintain monotonic increase in rating curve values before the weir is engaged.

6.6 RECORD EVENT RECREATION

A truncated copy of the effective HEC-HMS model was used for this analysis. Within this model, all of the basins were divided based upon the grids associated with the recorded gridded radar rainfall measurements. Measured rainfall is applied to each subbasin component based upon the location of the rainfall measurement.

6.7 RAINFALL GAUGES / METEOROLOGY

Historical rainfall was provided by the City for two events; the Halloween (October 30th) 2015 storm (Figure 6) and the May 26th, 2016 storm (Figure 5). Rainfall data was collected using radar and is presented in time series data based on a spatial grid of 1 kilometer by 1 kilometer provided by Rainvieux. The time series in Figure 5 and Figure 6 were provided.

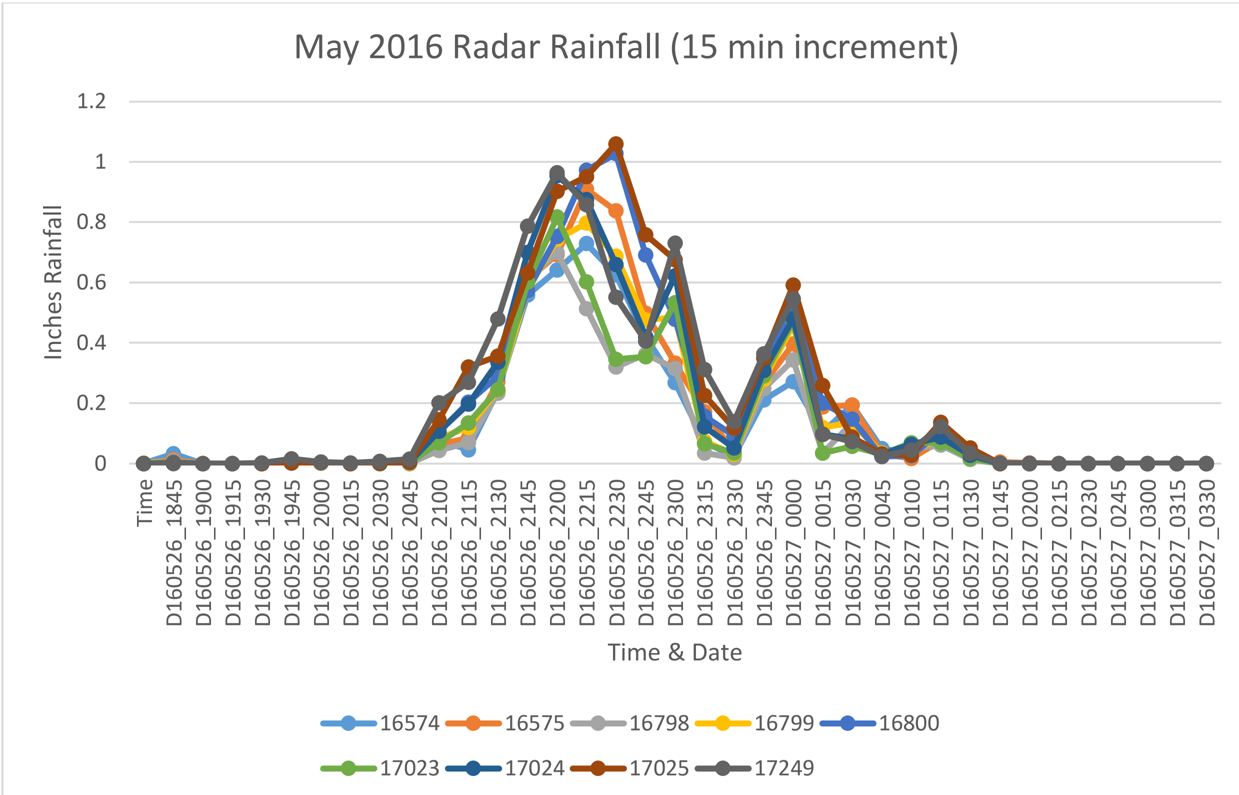


Figure 5. May 26th, 2016 Radar Rainfall Time Series

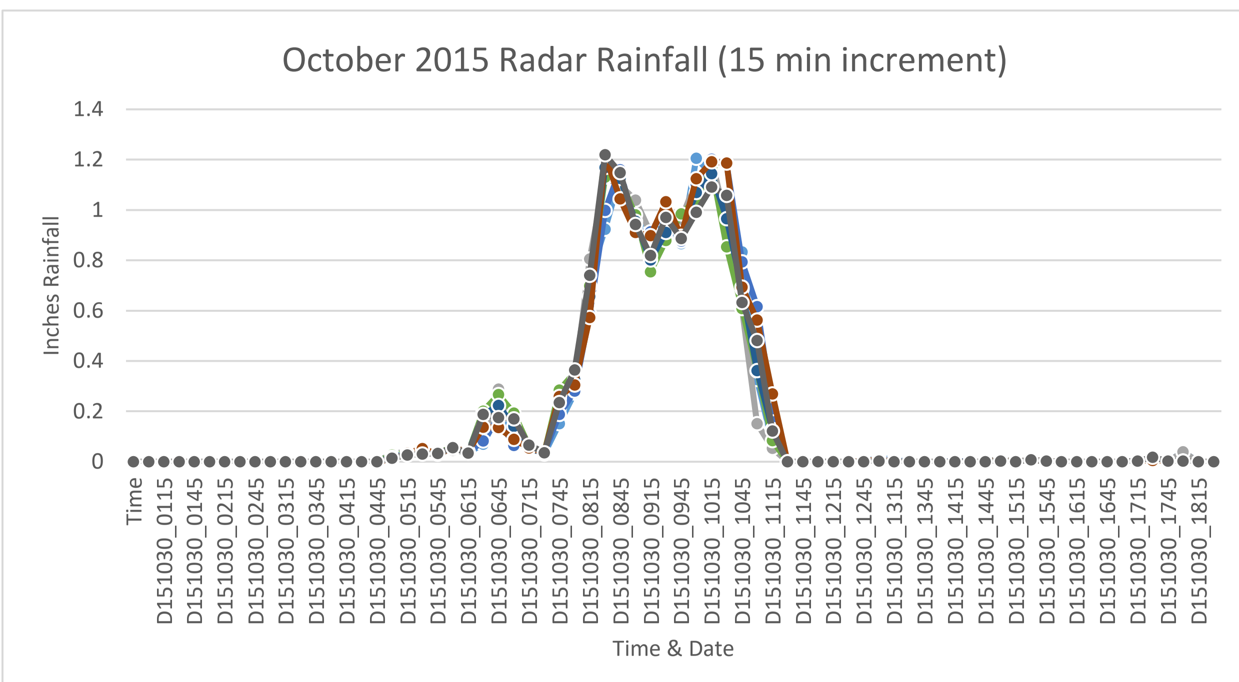


Figure 6. October 30th, 2015 Radar Rainfall Time Series

There is noticeably more spatial variation of rainfall in the May event while the October storm produced rather consistent rainfall throughout the observed event.

Storm gauge data was input into HEC-HMS using the time series provided for each storm event and applied to each subbasin.

6.8 BASIN DELINEATION

None of subbasins in the Paces Mill Tributary hydrologic model fell completely within one of the rainfall grids provided with the rainfall data (see Figure 2). Hydrologic subbasin elements were divided by rainfall data grid and given a suffix corresponding to the rainfall grid which the portion of subbasin falls into. In the process of dividing the subbasins in the model, only the subbasin area was adjusted. Subbasin subcomponents have no changes in model connectivity, or changes to subbasin loss or transformation parameters. Table 7 outlines each subbasin subcomponent and provides its partial area.

Table 7. Subareas for Each Subbasin Subcomponent

Element	Area (sq mi)
LOCR330_17024	0.27
LOCR330_17025	0.05
LOCR330_17249	0.01
LOCR330_16799	0.00
LOCR340C_16799	0.02
LOCR340C_16800	0.00
LOCR320_16799	0.23
LOCR320_17024	0.07
LOCR320_16798	0.04
LOCR320_10723	0.02
LOCR340a_17025	0.10
LOCR340A_16800	0.08
LOCR340B_16800	0.07
LOCR340B_16799	0.04
LOCR340b_17024	0.01
LOCR340B_17025	0.00
LOCR350A_16800	0.10
LOCR350A_16799	0.05
LOCR350A_16574	0.01
LOCR350B_16575	0.05
LOCR350B_16574	0.03
LOCR350B_16800	0.02
LOCR350B_16799	0.00
LOCR350C_16575	0.07
LOCR350C_16574	0.03

6.9 SENSITIVITY TEST

A sensitivity test of the 100-year meteorological event was simulated in the Paces Mill basin model (undivided) as well as the gridded version (divided). The results are tabulated in Table 8.

Table 8. Results of Paces Mill Basin Model Sensitivity Test for the 100-year Meteorological Event

Element	Q Trunc (cfs)	Q Gridded (cfs)	Change (cfs)	Change%
JLOCR320_340C	2357.3	2359.6	2.3	0.10
JLOCR330	1222.8	1223.7	0.9	0.07
JLOCR340A	991.2	992.3	1.1	0.11
JLOCR340B	1025.6	1027	1.4	0.14
JLOCR340B_340C	3224.8	3227.9	3.1	0.10
JLOCR340C	1222.4	1223.3	0.9	0.07
JLOCR350A	3642.2	3645.7	3.5	0.10
JLOCR350B	3658	3661.5	3.5	0.10
JLOCR350C	3688.8	3692.1	3.3	0.09

Division of the subbasins within the basin model had little impact on the results of the simulation and the basin does not appear to be sensitive to dividing subbasins into smaller basins.

7 EXISTING HYDRAULIC MODEL METHODOLOGY

This section identifies the methods used to develop the 2D hydraulic model for this study. The effective hydraulic 1D model was used for the Thaxton Road culvert improvements analysis. The following subsections address each of the 2D hydraulic model parameters in more depth.

- Model Terrain
- Model Boundary Conditions
- Model Calibration and Roughness

7.1 MODEL TERRAIN

The terrain used in the development of both the 2D hydraulic and revisions or additions to the 1D hydraulic model comes from two primary sources. The majority of the terrain model is based on an on-the-ground survey performed by Zamora Surveying (see Figure 7 below). The survey was supplemented with City of Austin 2017 LiDAR data to give a complete representation of the terrain for the model.

Figure 7. Survey Limits

7.1.1 1D Model Geometry

The one-dimensional model used for analysis and design at the Thaxton Road low water crossing is primarily sourced from the effective model. KFA made several changes to model geometry to best represent proposed improvements to the crossings.

- RS 4533; Downstream Reach Lengths Adjusted to account for addition of XS 4464.
- RS 4464: Added cross section at limits of grading changes. Roughness values were chosen to align with those of adjacent cross sections.
- RS 4448: Adjusted cross section geometry and to approximate grading adjacent to proposed culvert improvements. Ineffective flow areas and bank stations adjusted based on grading. Downstream Reach Lengths adjusted.
- RS 4418: Geometry and conveyance adjusted to reflect proposed drainage / roadway improvements.
- RS 4383: Added cross section to approximate grading adjacent to proposed culvert improvements.

7.2 2D BOUNDARY CONDITIONS

There are multiple boundary conditions applied to this model, including both internal boundary conditions for flow input as well as external boundary conditions for tailwater and flow leaving the model. Figure 8 itemizes each boundary condition used in the existing conditions hydraulic 2D model.

Figure 8. Hydraulic 2D Model Boundary Conditions

7.2.1 Internal Boundary Conditions

There are three internal boundary conditions used in the hydraulic model. A direct runoff hydrograph sourced from the HEC-HMS model is associated with each internal boundary condition. Boundary condition 'Thaxton Road' represents flow leaving Thaxton Road (Junction JLOCR350A). Boundary conditions LOCR350B and LOCR350C each represent subbasin flow for the similarly named subbasins in the hydrologic model.

7.2.2 External Boundary Conditions

The project area of the Paces Mill Tributary is near the lower end of the tributary's basin and near its confluence with Onion Creek. For this reason, Onion Creek's water surface elevation has potential to significantly impact the Paces Mill Tributary's water surface elevation near the confluence. However, due to the size of the Paces Mill Tributary watershed in comparison to the Onion Creek watershed, the peak of the runoff from a storm event is not likely to occur coincidentally for the two watersheds. The selections of the tailwater boundary conditions were based on Table 7-3 from the HEC-22 document provided in Table 9.

Table 9. Frequencies for Coincidental Occurrence taken from Table 7-3 of HEC-22.

Table 7-3. Frequencies for Coincidental Occurrence.

Area Ratio	Frequencies for Coincidental Occurrence			
	10-Year Design		100-Year Design	
	Main Stream	Tributary	Main Stream	Tributary
10,000 to 1	1 10	10 1	2 100	100 2
1,000 to 1	2 10	10 2	10 100	100 10
100 to 1	5 10	10 5	25 100	100 25
10 to 1	10 10	10 10	50 100	100 50
1 to 1	10 10	10 10	100 100	100 100

The Paces Mill Tributary has a total area of 1.35 square miles and the total contributing area of Onion Creek at the confluence is 284 square miles. The area ratio of 100:1 is the most appropriate representing ratio from Table 7-3. The frequency storms and the associated Onion Creek tailwater conditions are provided below:

- 5-year Onion Creek tailwater (533.85 ft)
    - 2-year design storm
    - 10-year design storm
    - May calibration storm (approximate 10-year storm)
- 25-year Onion Creek tailwater (542.8 ft)
    - 25-year design storm
    - 100-year design storm
    - October calibration storm (approximate 100-year storm)

The Onion Creek tailwater elevations for the Paces Mill Tributary model were obtained from the Onion Creek effective model at cross-section 94254. Note: These values are from the effective Onion Creek hydraulic model and do not reflect Atlas 14 rainfall rates.

7.3 MODEL CALIBRATION AND ROUGHNESS

To calibrate the hydraulic 2D model of Paces Mill Tributary, the Manning's 'n' (roughness) values were adjusted to closely match the recorded water surface elevations with the model's output of the calibrated storm's water surface elevations. Major considerations in the calibration involve both the roughness values selected and the distribution of roughness values.

7.3.1 Delineation of Roughness Boundaries

The majority of roughness values spatial distribution is based on City of Austin planimetric data. The majority of features in the 2D model are well delineated such as roads, sidewalks and other pavement, pools, and structures. Most of these features have predictable roughness value ranges which were directly assigned before the calibration process begins. Features such as roads and pavement have relatively low roughness values in the 0.03 range while a structure is represented with a high roughness value (Manning's 'n' value of 3).

The calibration effort mainly focuses on three roughness areas; the channel bottom roughness (this area is clearly less vegetated than bank and overbank areas), the channel bank and overbank roughness, and the roughness of flooded lawn areas in the project area. Because measurements of flood depths for the calibration storm are heavily clustered, there was little justification for more discrete delineation of roughness zones, especially downstream of flood measurements.

7.3.2 Calibration Observations

Adjustment of each of the three calibration roughness zones (channel bed, banks and overbanks, and lawn areas) together control the output for both calibration storms. The May event did produce substantial flooding throughout the neighborhood in the project area but had a much smaller flood footprint than the October event. The May storm event had a more significant impact on the proposed channel bed roughness values. This may be due to the May event's narrower flooding extents.

When considering both the October and May events together; the roughness values for the less vegetated channel bottom exceeded those of the vegetated banks, overbanks, and lawn areas ladened with obstructions. For this reason, the May event has been disregarded from the calibration.

Using the October storm, a combination of roughness values was chosen to simulate measured water surface elevations at the downstream end of the neighborhood area.

Lawn roughness values were selected to best simulate the observed grade line throughout the area of measurements. Table 10 provides a summary of roughness values developed based upon the calibration storms.

7.3.3 Calibration Results

Table 10 provides roughness values used for calibration.

Table 10. Calibration Roughness Values

Calibration Roughness Values	
Feature	**Roughness**
Channel (Bed)	0.08-0.12
Channel (Bank andOverbank)	0.25
Lawns	0.155
Structures	3
Decks	0.02
Streets	0.03
Driveways	0.02
Manmade Hydrography	0.015-0.025
Paved	0.023
Pools	0.02

Table 11 provides a comparison of the recorded water surface elevation for the October 2015 storm event.

Table 11. Calibration Results of the Recorded Water Surface Elevation for October 2015 Event

Calibration Results - October			
Address	**Measured WSEL (ft)**	**Simulated WSEL (ft)**	**Simulated - Measured Difference (ft)**
6207 Tupelo	552.71	553.15	0.44
6209 Tupelo	553.94	553.43	-0.51
7702 Paces Mill	554.4	553.83	-0.57
7800 Paces Mill	554.13	554.03	-0.1
7802 Paces Mill	554.08	554.16	0.08
7804 Paces Mill	554.43	554.34	-0.09
7806 Paces Mill	554.53	554.48	-0.05
7808 Paces Mill	552.52	554.6	2.08
7810 Paces Mill	554.51	554.8	0.29
7812 Paces Mill	554.61	555	0.39
7814 Paces Mill	554.89	555.31	0.42
7816 Paces Mill	555.81	555.6	-0.21
7818 Paces Mill	556.97	555.5	-1.47
7807 Paces Mill	554.88	554.56	-0.32

Table 12 provides a comparison of the recorded water surface elevation for the May 2016 storm event. It is observable that the simulation does not well approximate the storm experienced in May 2016. It is believed that some anomaly may have occurred during this event such as clogging that may have produced such high water surfaces.

Table 12. Calibration Results of the Recorded Water Surface Elevation for May 2016 Event

Calibration Results - May		
Address	**Measured WSEL (ft)**	**Simulated WSEL (ft)**
7804 Paces Mill	552.68	551.44
7806 Paces Mill	552.61	551.69
7808 Paces Mill	552.52	551.77
7810 Paces Mill	553.92	552.32
7816 Paces Mill	556.22	553.14

Images of the Paces Mill Tributary are provided below. Figure 9, Figure 10, and Figure 11 show the extensive vegetation within the channel and along its overbanks.

Figure 9. Extensive Vegetation within the Channel and along its Overbank (Paces Mill Tributary)

Figure 10. Extensive Vegetation within the Channel and along its Overbank (Paces Mill Tributary)

Figure 11. Extensive Vegetation within the Channel and along its Overbank (Paces Mill Tributary)

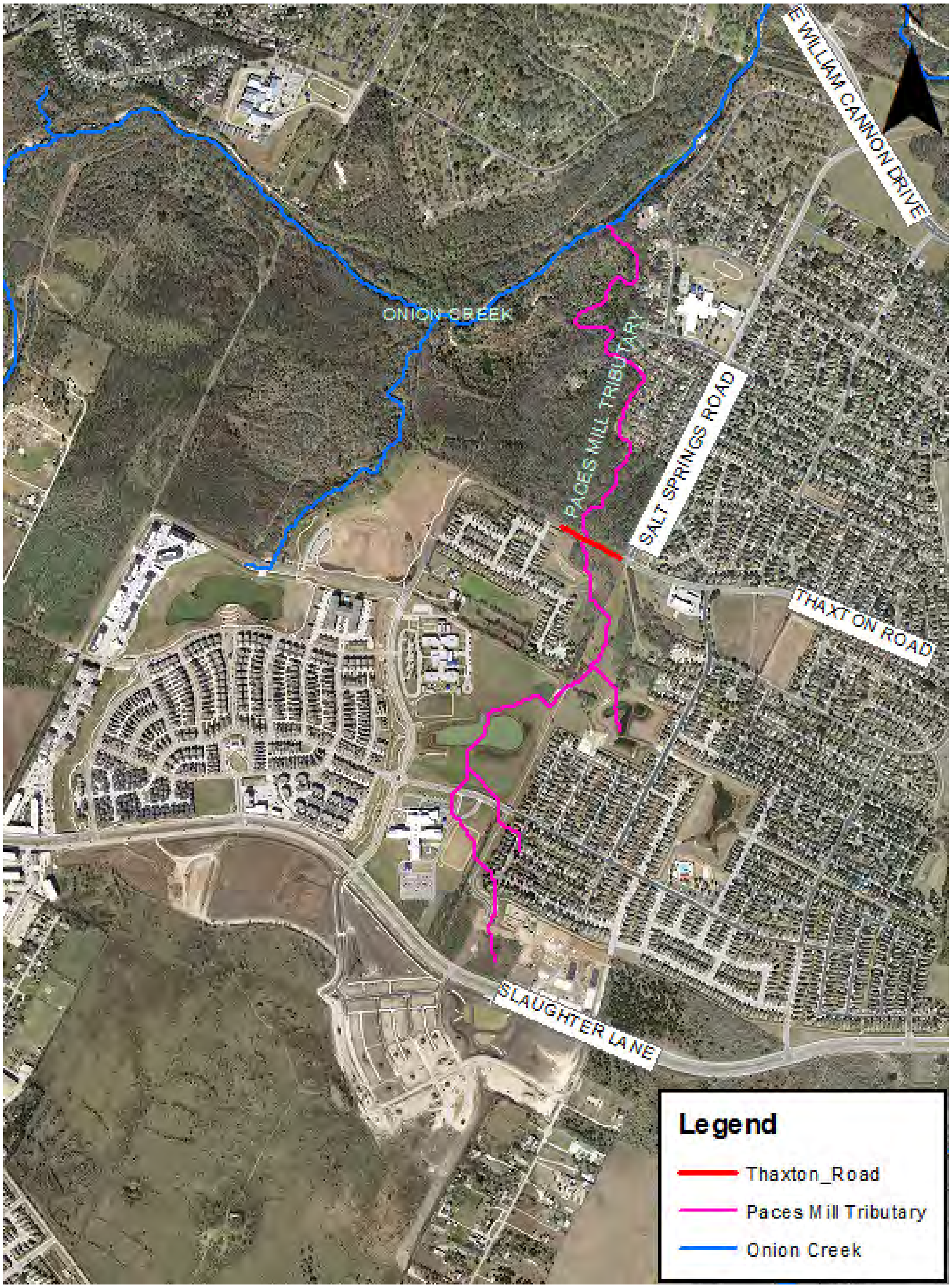
8 FLOOD RISK REDUCTION ANALYSIS

8.1 THAXTON ROAD IMPROVEMENTS

K Friese + Associates, Inc. (KFA) contracted with the City of Austin (COA) to evaluate and provide design alternatives to reduce flood risk at Thaxton Road. Thaxton Road is a known low water crossing and has a history of stormwater overtopping the road. Stormwater runoff produced by the Paces Mill tributary drains naturally to the crossing, which is drained by existing culverts that run perpendicularly under Thaxton Road. Thaxton Road overtops during the 5-year storm event (0.27-ft) due to low capacity within the existing culverts. This low water crossing has the potential to become dangerous to traffic in events exceeding the 2-year event.

Drainage improvement alternatives to reduce the flood risk at Thaxton Road are presented in this technical memo. The paramount drainage deficiency at Thaxton Road is the culverts. Generally, the culverts are under capacity and shallow compared to the road which reduces the allowable headwater depth. Proposed improvements increase the conveyance capability of the Thaxton Road culverts and lower the profile of the culverts. These improvements are not designed to meet DCM 1.2.4.D directly but are instead based on level of service. To meet the level of service requirements, the design improvements will eliminate overtopping of the road for the 2-, 10-, 25-, and 100-year events. See Figure 12 for a location map and proposed study area.

Figure 12. Location Map



8.1.1 Hydrologic Analysis

This section identifies hydrologic output used in design alternatives for Thaxton Road. For this study, a copy of the effective model had been truncated and the basin parameters re-assessed. This assessment is discussed more in depth in the Existing Conditions H&H Report. Table 13 summarizes the flow results of the hydrologic analysis. The design of the culvert sizes is based upon Ultimate Condition flows. Below is a list of the large-scale updates to the effective hydrologic model.

- Meteorology: Updated from using old COA criteria to the COA Atlas 14 rainfall
- Reservoir Routing: Added Vertex Pond
- Record event Recreation: Removed all initial abstraction values and reverted to default values in HEC-HMS

Table 13. Ultimate Design Flows at Thaxton Road

Hydrologic Results			
Design Storm	Design Flow (cfs)	HEC-HMS Basin Model	HEC-HMS Simulation
2	779.20	KFA_Ult_50/20_Trunc	ULT2YrTtrunc
10	1931.00	KFA_Ult_10_Trunc	ULT10YrTtrunc
25	2750.20	KFA_Ult_04_Trunc	ULT25YrTtrunc
100	4062.00	KFA_Ult_01_Trunc	ULT100YrTtrunc

8.1.2 Existing Hydraulic Performance

The existing structure is four (4), 48-inch concrete pipe culverts at a 2.6% slope. The water surface elevations (WSEL) for each design storm under Ultimate Conditions are shown in the attached culvert exhibits. Tabulated output is a product of the HEC-RAS plan labeled “KFA_ULT_Frequency”.

Table 14: Existing Conditions Hydraulic Results

Design Storm	Pipe Flow (cfs)	Headwater Elevation	Tailwater Elevation	Flow Over Road (cfs)	Velocity Over Road (fps)	Depth Over Road (ft)	Culvert DS Velocity (fps)
2	402.27	562.28	558.67	376.33	1.73	0.56	13.77
10	519.17	562.77	560.05	1410.23	2.43	1.10	10.33
25	459.04	563.10	560.67	2290.56	2.79	1.42	9.13
100	423.95	563.44	561.40	3629.25	3.19	1.81	8.43

8.1.3 Proposed Hydraulic Performance

The water surface elevations (WSEL) for each design storm under proposed conditions are shown in the attached culvert exhibits as Appendix A. The proposed grading around the culvert structures is 1:1 for the upstream slope and 3:1 for the side slopes upstream and downstream. Existing utilities located adjacent to Thaxton Road which may be in conflict are listed below:

- 8-inch wastewater line 19-feet upstream of the culvert: There is no conflict with the proposed designs.

- 24-inch water line with 42-inch encasement 37-feet downstream of the culvert: There is no conflict with the proposed designs.
- 24-inch storm drain that outfall on the west side of the downstream channel: The existing headwall will need to be removed and the storm drain line will be truncated to the proposed headwall for all designs.
- 66-inch storm drain that outfall on the east side of the downstream channel: The existing headwall will need to be removed and the storm drain line will be truncated to the proposed headwall for all designs.
- Power pole needs to be moved in the 100-year design.

2-YEAR DESIGN

The proposed design for the 2-year storm is four (4), 6-foot x 4-foot culverts at a 0.5% slope. The 2-year proposed design is shown in the 2-year exhibit attached in Appendix A.

Table 15. 2-Year Design Hydraulic Results

Design Storm	Pipe Flow (cfs)	Headwater Elevation	Tailwater Elevation	Flow Over Road (cfs)	Velocity Over Road (fps)	Depth Over Road (ft)	Culvert DS Velocity (fps)
2	778.60	560.24	558.63	0	N/A	N/A	8.11
10	1001.51	562.72	559.98	927.89	2.31	1.00	10.43
25	974.57	563.06	560.50	1775.03	2.75	1.39	10.15
100	971.02	563.49	561.01	3082.19	3.23	1.86	10.11

10-YEAR DESIGN

The proposed design for the 10-year storm is five (5), 8-foot x 6-foot culverts at a 0.5% slope. The 10-year proposed design is shown in the 10-year exhibit attached in Appendix A.

Table 16. 10-Year Design Hydraulic Results

Design Storm	Pipe Flow (cfs)	Elevation (ft)	Elevation (ft)	Flow Over Road (cfs)	Velocity Over Road (fps)	Depth Over Road (ft)	Culvert DS Velocity (fps)
2	778.60	558.92	558.69	0	N/A	N/A	3.55
10	1929.40	561.54	560.12	0	N/A	N/A	8.04
25	2145.47	562.45	560.60	604.13	2.07	0.80	8.94
100	2241.35	562.99	561.02	1811.85	2.76	1.4	9.34

25-YEAR DESIGN

The proposed design for the 25-year storm is ten (10), 8-foot x 6-foot culverts at a 0.5% slope. The 25-year proposed design is shown in the 25-year exhibit attached in Appendix A.

Table 17. 25-Year Design Hydraulic Results

Design Storm	Pipe Flow (cfs)	Headwater Elevation	Tailwater Elevation	Flow Over Road (cfs)	Velocity Over Road (fps)	Depth Over Road (ft)	Culvert DS Velocity (fps)
2	778.60	558.80	558.75	0	N/A	N/A	1.75
10	1929.40	560.62	560.31	0	N/A	N/A	4.02
25	2749.60	561.57	560.90	0	N/A	N/A	5.73
100	3321.88	562.5	561.48	731.33	2.17	0.88	6.92

100-YEAR DESIGN

The proposed design for the 100-year storm is fifteen (15), 8-foot x 6-foot culverts at a 0.5% slope. The 100-year proposed design is shown in the 100-year exhibit attached in Appendix A. Even with these culvert improvements, the tailwater elevation still overtops Thaxton Road. Raising the roadway elevation by approximately one foot (elevation 562.5') eliminates the potential for the roadway to be overtopped in the 100-year storm. The extents of the proposed Thaxton Road improvements are also shown in the attached Appendix A. The roadway improvements will conflict with an existing power pole that will need to be relocated. The power pole is located approximately 200-ft from the upstream channel of Thaxton Road.

Table 18. 100-Year Design Hydraulic Results

Design Storm	Pipe Flow (cfs)	Headwater Elevation	Tailwater Elevation	Flow Over Road (cfs)	Velocity Over Road (fps)	Depth Over Road (ft)	Culvert DS Velocity (fps)
2	778.60	558.79	558.77	0	N/A	N/A	1.21
10	1929.40	560.50	560.37	0	N/A	N/A	2.68
25	2749.60	561.28	561.00	0	N/A	N/A	3.82
100	4053.20	562.32	561.67	0	N/A	N/A	5.63

8.1.4 Engineer's Opinion of Probable Cost (OPC)

An Engineer's Opinion of Probable Cost was calculated for each level of service. The construction cost estimate is approximately $0.5 million for the 2-year design, $0.7 million for the 10-year design, $1 million for the 25-year design, and $1.7 million for 100-year design. These cost estimates are attached in

Appendix B.

8.1.5 Project Impacts

As part of the Thaxton road analysis, the KFA team performed an analysis to estimate maximum potential impacts due to conveyance improvements at Thaxton Road. This analysis involved removing the crossing all together to observe the maximum loss in storage expected in the reach due to improvements. For the smaller flows there is an increase in storage due to the existing Thaxton Road culvert system having the conveyance capacity for smaller flows. This is reflected in Table 19 as paired data for the reach.

Table 19. Paired Data Comparison from Thaxton Road Crossing Removal

Reach RLOCR350A		
Storage with Thaxton Crossing (ac-ft)	Storage without Thaxton Crossing (ac-ft)	Discharge (cfs)
1.58	1.6	30
2.31	2.35	50
3.98	4.07	110
6.67	6.66	220
14.89	13.11	550
22.09	21.85	1090
37.8	35.43	2720
42.1	39.99	3260
45.62	42.92	3810
52.38	49.77	4770
59.64	57.48	6100
63.22	61.31	6700

The increase in flows from the expected storage loss of the Thaxton Road crossing removal are shown in Table 20. There is a decrease in flows for the 2-year storm near Thaxton Road. The 2-year storm is the only storm event that does not overtop Thaxton Road. The basin models and simulations of the HEC-HMS runs are shown in Table 21. See Appendix C for the hydrologic flow results with and without the Thaxton Road Crossing.

Table 20. Flow Increase from Storage Loss

Post-Construction Flows Increase (Ultimate Hydrology) (cfs)				
Element	**2 - Year**	**10 - Year**	**25 - Year**	**100 - Year**
LOCR320	0	0	0	0
VertexPond	0	0	0	0
LOCR330	0	0	0	0
JLOCR330	0	0	0	0
RLOCR340C	0	0	0	0
LOCR340C	0	0	0	0
JLOCR340C	0	0	0	0
JLOCR320_340C	0	0	0	0
LOCR340A	0	0	0	0
PCM_1_200	0	0	0	0
JLOCR340A	0	0	0	0
RLOCR340B	0	0	0	0
LOCR340B	0	0	0	0
PCM_1_100	0	0	0	0
JLOCR340B	0	0	0	0
JLOCR340B_340C	0	0	0	0
RLOCR350A	-2.7	7.8	14	2.8
LOCR350A	0	0	0	0
JLOCR350A	-2.6	19.6	30.1	7.8
RLOCR350B	15.1	8.4	21.6	15.6

Post-Construction Flows Increase (Ultimate Hydrology) (cfs)				
Element	2 - Year	10 - Year	25 - Year	100 - Year
LOCR350B	0	0	0	0
JLOCR350B	15	8.4	21.6	17.4
RLOCR350C	18.1	5.9	21.8	18
LOCR350C	0	0	0	0
JLOCR350C	19.1	5.9	21.8	18

Table 21. HEC-HMS Models and Simulations

HEC-HMS Basin Model	HEC-HMS Simulation
KFA_Ult_Thaxton_Imprv	ThaxtonRemoval_2Yr
	ThaxtonRemoval_10Yr
	ThaxtonRemoval_25Yr
	ThaxtonRemoval_100Yr

8.2 PRIMARY ANALYSIS

The primary analysis follows calibration of the existing hydraulic model and serves to provide high level analysis of possible improvement combinations that will reduce flood risk to the Paces Mill neighborhood and improve the local community. Analytics produced in the primary analysis phase were used to determine preferred alternatives for more in-depth analysis in the Secondary Analysis phase.

The primary analysis phase consists of development of 9 unique combinations of physical improvements that could be done to reduce flood risk to the Paces Mill neighborhood. These improvement combinations are preliminary and designed with focus on maintaining flow within channel banks.

Roughness values are adjusted in kind with proposed channel geometric modifications.

References to floodplain that follow refer to the simulated flood extents as determined using the calibrated hydraulic model as a basis that have been amended to include any proposed improvements.

8.2.1 Alternatives

The alternatives that were developed for the primary analysis are described in Table 22.

Table 22. Primary Analysis Alternatives

No.	Description	Terrain Input	Roughness Input	Output
1A	Non-structural improvements - Buyout of homes in the 10-year floodplain. This alternative itemizes the homes inundated in the 10-year fully developed floodplain. The existing (pre-project) conditions simulation of the 10-year fully developed storm is used to determine homes at risk of flooding in this alternative. For this analysis home acquisition cost is determined as $386 per square foot of structure plus $50,000 for demolition.	Terrain model based on the on the ground survey by Zamora	Roughness distribution determined during the existing hydraulic model calibration process	2 homes have expected inundation in the fully developed 10-year event.
2A	10-year Natural Channel - 10-yr storm runoff designed to stay within channel banks. This alternative limits improvements to areas outside of the Waters of the United States (WOTUS) to minimize permitting requirements.	Terrain model based on the on the ground survey by Zamora. This surface was amended to include dual benches. The lower bench is a minimum of 2 feet above the flowline of the existing channel and a minimum width of 25 feet and the secondary bench is 3.5 feet above the first with a minimum width of 60.	In areas of proposed channel improvement, the roughness value chosen was 0.12. This value is lower than existing overbank roughness but is believed to be indicative of a fully regrown improved area with a prescribed planting plan.	This alternative is expected to alleviate flood risk for 7 of 15 homes with existing risk from the 100-year event, 8 of 8 homes from the 25-year event, and 2 of 2 homes from the 10-year event.
1B	Non-structural improvements - Buyout of homes in the 25-year floodplain. This alternative itemizes the homes inundated in the 25 year fully developed floodplain. The existing (pre-project) conditions simulation of the 25-year fully developed storm is used to determine homes at risk of flooding in this alternative.	Terrain model based on the on the ground survey by Zamora	Roughness distribution determined during the existing hydraulic model calibration process	8 homes have expected inundation in the fully developed 25-year event.

No.	Description	Terrain Input	Roughness Input	Output
3A	25-year Engineered Channel - 25-yr storm runoff to stay within channel banks. This alternative uses a more direct alignment than the existing channel and a basic trapezoidal shape.	Terrain model based on the on the ground survey by Zamora. This surface was amended to include a trapezoidal channel that somewhat follows the existing channel but does intersect the existing channel several times. The trapezoidal channel has a bottom width of 25' and 3:1 side slopes.	In areas of proposed channel improvement, the roughness value chosen was 0.06. This is the expected roughness of non-frequently mowed native grasses.	This alternative is expected to alleviate flood risk for 10 of 15 homes with existing risk from the 100-year event, 8 of 8 homes from the 25-year event, and 2 of 2 homes from the 10-year event.
2B	25-year Natural Channel – 25-year storm runoff to stay within channel banks. This alternative limits improvements to areas outside of the WOTUS to minimize permitting requirements.	This design alternative uses the surveyed channel as a baseline with improved benches of varying width. Similar to other natural channel alternatives, benching beings a minimum of two feet above the existing channel flow line.	In areas of proposed channel improvement, the roughness value chosen was 0.12. This value is lower than existing overbank roughness but is believed to be indicative of a fully regrown improved area with a prescribed planting plan.	This alternative is expected to alleviate flood risk for 15 of 15 homes with existing risk from the 100-year event, 8 of 8 homes from the 25-year event, and 2 of 2 homes from the 10-year event.
1C	Non-structural improvements - Buyout of homes in the 100-year floodplain. This alternative itemizes the homes inundated in the 100 year fully developed floodplain. The existing (pre-project) conditions simulation of the 100-year fully developed storm is used to determine homes at risk of flooding in this alternative.	Terrain model based on the ground survey by Zamora	Roughness distribution determined during the existing hydraulic model calibration process	15 homes have expected inundation in the fully developed 100-year event.
3B	100-year Engineered Channel – 100-year storm to stay within channel banks. This alternative uses a more direct alignment	Terrain model based on the on the ground survey by Zamora. This surface was amended to	In areas of proposed channel improvement, the	0 homes have finished floor elevations within

No.	Description	Terrain Input	Roughness Input	Output
	than the existing channel and a basic trapezoidal shape.	include a trapezoidal channel that somewhat follows the existing channel but does intersect the existing channel several times. The trapezoidal channel has a varying bottom width of 35' to 40' and 3:1 sideslopes.	roughness value chosen was 0.06. This is the expected roughness of non-frequently mowed native grasses.	fully developed 100-year floodplain.
2C	100-year Natural Channel – 100-year storm to stay within channel banks. This alternative limits improvements to areas outside of the WOTUS to minimize permitting requirements.	This design alternative uses the surveyed channel as a baseline with improved benches of varying width. Similar to other natural channel alternatives, benching beings a minimum of two feet above the existing channel flow line. The length of developed channel exceeds that of the 25-year natural channel.	In areas of proposed channel improvement, the roughness value chosen was 0.12. This value is lower than existing overbank roughness but is believed to be indicative of a fully regrown improved area with a prescribed planting plan.	This alternative is expected to alleviate flood risk for 15 of 15 homes with existing risk from the 100-year event, 8 of 8 homes from the 25-year event, and 2 of 2 homes from the 10-year event.
4A	25-year Channel + Floodwall – 25-year Channel Improvement + Wall	The terrain input for this alternative is identical to the 25-year natural channel design. A weir element (of sufficient height to not overtop) is provided along the left side of the channel protecting the neighborhood from floodwater.	In areas of proposed channel improvement, the roughness value chosen was 0.12. This value is lower than existing overbank roughness but is believed to be indicative of a fully regrown improved area with a prescribed planting plan.	Preliminary hydraulic modeling indicates that a flood wall with height between 2 to 5 feet will be required to provide protection from the 100-year event. This alternative is expected to alleviate flood risk for 15 of 15 homes with existing risk from the 100-year event. 0 homes have finished

No.	Description	Terrain Input	Roughness Input	Output
				floor elevations within fully developed 100-year floodplain.
5A	Flood Wall Only – No channel improvement, Wall Only.	The terrain input for this alternative is identical to the surveyed terrain. A weir element (of sufficient height to not overtop) is provided along the right side of the channel protecting the neighborhood from floodwater.	This alternative utilizes the roughness distribution determined during the existing hydraulic model calibration process.	Preliminary hydraulic modeling indicates that a flood wall with height between 2 to 8 feet will be required to provide protection from the 100-year event. This alternative is expected to alleviate flood risk for 15 of 15 homes with existing risk from the 100-year event.
1F	Flexible Design 1 – Bypass Culverts – Flexible alternative model selected by WPD. This alternative uses a trio of 12'x10' culverts that bypass flow from immediately downstream of the flooded neighborhood area directly to the north. Effectively this serves to lower the design tailwater at the downstream end of the neighborhood. Some channel improvements are provided to reduce losses parallel to Paces Mill Lane. An inline structure is included to simulate conveyance blockage that estimate the effects of a trash screening rack at the upstream headwall structure.	Terrain model based on the on the ground survey by Zamora. This surface was amended to include a include basins upstream and downstream of the bypass culverts and some widening of the existing engineering channel.	This alternative utilizes a terrain model based on the on the ground survey by Zamora. Amendments to the roughness distribution are provided in the basins upstream and downstream of the culverts reflecting riprap lining. The engineered channel roughness is designated as 0.06 to reflect inconsistently maintained native grasses.	There are widespread flood extents but 0 homes have finished floors within the proposed floodplain.

No.	Description	Terrain Input	Roughness Input	Output
2F	Flexible Design 2 – Reduced Manning's 'n' – no structural changes – Flexible alternative model selected by WPD. This alternative uses reduced roughness values that reflect regular maintenance of the channel and overbanks. This would be accomplished with regular mowing and pruning of flood-prone areas in the tributary.	Terrain model based on the ground survey by Zamora.	To reflect maintenance such as regular mowing and pruning of the floodplain, the channel bottom roughness is designated as 0.07 and overbank roughness is designated as 0.09. This is reflected in the entire roughness distribution but actual maintained limits should be limited to the proposed flood extents.	This alternative is expected to alleviate flood risk for 6 of 15 homes with existing risk from the 100-year event, 1 of 8 homes from the 25-year event, and 2 of 2 homes from the 10-year event.
3F	Flexible Design 3 – Hybrid 100-Year Engineered Channel – Flexible alternative model selected by WPD. This alternative uses conveyance improvements as outlined in the 100-year engineered channel alternative and adds channel benching in locations between the existing and proposed channel valleys.	This alternative utilizes a terrain model based on the on the ground survey by Zamora. This surface was amended to include a trapezoidal channel that somewhat follows the existing channel but does intersect the existing channel several times. The trapezoidal channel has a varying bottom width of 35' to 40' and 3:1 side slopes. Benching is provided at 2' above the proposed channel flowline.	In areas of proposed channel improvement, the roughness value chosen was 0.06. This is the expected roughness of non-frequently mowed native grasses.	0 homes have finished floor elevations within fully developed 100-year floodplain.

8.2.2 Matrix Results

The proposed alternatives generally have similarities to one another in concept such as natural channel, engineered channel, and floodwall. In this exercise using a design standard of 'within channel banks' may have produced some designs beyond what is necessary to serve the neighborhood if removing homes' finished floor from the floodplain is a more realistic goal. If this is the realized goal, then the 'overdesigned' scenarios may seem excessive in scope and cost. This assessment is in alignment with the provided matrix results (Appendix H).

8.2.3 Recommended Alternatives

The alternatives that were recommended for further study for the primary analysis are described in Table 23. See Appendix D for schematic drawings of the proposed improvements and Appendix E for inundation extent exhibits.

Table 23. Primary Analysis Recommended Alternatives

Alternative	**Description**
3B – 100-year Engineered Channel	This is tied for third highest scoring alternative in the matrix (70) with a lower cost and providing the highest level of service. This alternative is ***recommended*** for further analysis.
3F – 100-year Hybrid Channel	This is tied for third highest scoring alternative in the matrix (70) with a lower cost and providing the highest level of service. This alternative is recommended for further analysis. The 100-year engineered channel is expected to be less expensive than the hybrid channel, however proposed benching adds some potential environmental improvement possibilities.
2A – 10-year Natural Channel	Most presented alternatives rely on using park land for conveyance improvements. This use of land may be considered an intrusion and may be undesired. Regardless of score if a conveyance improvement is desired it may be prudent or even beneficial to pursue a project that shares goals of both Watershed Protection and Parks departments. Given the uncertainty of other parties this alternative is recommended provisionally for further analysis.
1B – Buyout of Homes in the 25-year Floodplain	This is the highest scoring alternative resulting from the scoring matrix (77). Although this may be unappealing to residents in the neighborhood it is expected to be both cost effective and effective in reducing homes at risk to flooding. This alternative is recommended for further analysis.

8.3 SECONDARY ANALYSIS

The Secondary Analysis phase of the preliminary engineering study of flooding in the Paces Mill Tributary adds refined analyses to three alternatives identified in the Primary Analysis phase and analyzes potential adverse impacts on the tributary and Onion Creek. The proposed 10-Year Natural Channel design has minimal impact on flood storage and flow within the tributary. Thus, this design is considered feasible with minor alteration to the channel design. The 100-Year Engineered Channel and 100-Year Hybrid Channels both substantially reduce flood storage within the channel and increase flow in the channel.

Both designs would be classified as adverse impacts per COA ECM 1.7 requirements. The 100-Year Engineered Channel and 100-Year Hybrid Channel proposed designs would require significant design changes to become compliant with COA ECM.

8.3.1 Introduction

From the primary alternative analysis phase, a total of three alternatives were selected for further analysis. The selected alternatives were the 100-Year Level of Service Engineered Channel, the 100-Year Level of Service Hybrid Engineered/Natural Channel, and the 10-Year Level of Service Natural Channel. In this memorandum, they are referred to simply as the engineered, hybrid, and natural channel alternatives, respectively. Proposed design schematics are provided in Appendix I.

This secondary phase of analysis aims to understand the potential adverse impacts of the selected alternatives. Statements of project impacts are defined by the City of Austin (COA) Watershed Protection Department's (WPD) No Adverse Impacts Guidelines document dated December 11, 2017. The provisions of the document that apply in this case are two: first is that there shall be no increases in water surfaces caused by the project, this can be observed in a hydraulic model as producing no rise, or alternatively can be assumed negligible if flow changes vary by less than 1% as a result of the project. The second provision is that the project shall cause no net reduction in flood storage.

A 1D hydraulic model was utilized to determine the change in channel storage. The channel storage table in the hydrologic model was updated based upon the results from the 1D hydraulic model. The 1D steady hydraulic analyses were developed to duplicate output of 2D hydraulic analysis results including water surface elevation, velocity, reach length, and channel storage.

8.3.2 Refinements to Hydraulic Alternatives

Refinements were made to the Engineered Channel and Hybrid Channel alternatives to best align with the findings of the geomorphic assessment of the channel. Both the engineered and hybrid channel in the primary analysis phase proposed a trapezoidal shaped cross section with a bottom width of approximately 35' as primary conveyance throughout proposed reach sections 2 and 3. However, it was theorized that the proposed improvements would ultimately lead to channel instability within the improved reaches due to high channel slope. Grade control structures (channel drops) were added to the channel design to reduce the channel slope to match the stable downstream channel slope. The natural channel alternative remains unaltered from the primary analysis as the bank-full channel is to remain unchanged and the existing channel is stable per the Geomorphic Assessment.

The revised engineered channel alternative will have a bottom width of 25 feet with benches of varying widths and starting 2 feet above the proposed flowline of the channel. Since significant reach length is proposed to be removed, multiple drops along the new engineered channel are proposed to provide a stable slope of approximately 0.6%.

Similar to refinements made to the engineered channel, the hybrid channel, which consists of a proposed engineered section to replace the existing engineered channel section that runs parallel to Paces Mill Lane (Subreach 2 in Geomorphic Assessment). The proposed engineered channel is trapezoidal with a bottom width of 20 feet with varying bench widths and includes multiple drop structures for grade control. Downstream of the existing engineered section the natural bank-full channel is proposed to remain with secondary conveyance improvements along the overbank leaving the natural channel untouched.

Proposed design schematics are provided in Appendix I. Proposed design inundation extents are provided in Appendix J. Proposed design cost estimates are provided in Appendix K.

The current plans for 2D hydraulic models are:

- Existing Conditions
    - KFA_ULT2D_Frequency_2Yr
    - KFA_ULT2D_Frequency_10Yr
    - KFA_ULT2D_Frequency_25Yr
    - KFA_ULT2D_Frequency_100Yr
- Hybrid Design
    - KFA_Secondary_Hybrid_2Yr
    - KFA_Secondary_Hybrid_10Yr
    - KFA_Secondary_Hybrid_25Yr
    - KFA_Secondary_Hybrid_100Yr
- Engineered Channel
    - KFA_Secondary_EngChan_2Yr
    - KFA_Secondary_EngChan_10Yr
    - KFA_Secondary_EngChan_25Yr
    - KFA_Secondary_EngChan_100Yr
- Natural Channel
    - KFA_10YrNatChan_2Yr
    - KFA_10YrNatChan_10Yr
    - KFA_10YrNatChan_25Yr
    - KFA_10YrNatChan_100Yr

8.3.3 Process for Development of 1D Hyraulic Models

Development of 1D parameters is primarily driven by the output of the 2D models. Duplication of the results from the 2D models is the primary objective. Each 1D modeling component is discussed further below:

- Input
    - Geometry file
        - Reach Alignment
            - Reach alignments follow the flowline of the primary conveyance course, existing or proposed.
        - Bank Stations
            - Bank stations generally occur approximately 2 feet above the channel flowline. This bank height does vary in natural channel areas. In proposed channel sections banks and benches are proposed to be 2 feet above the proposed flowline.
        - Overbank Lengths
            - Overbank lengths are controlled by the flow paths lines visible in RAS Mapper. These flowpaths generally include the majority of conveyed flow.
        - Cross section locations
            - Cross section always follow 2D hydraulic grade contours and their locations were chosen with a few objectives in mind:
                - Isolate each subreach for comparison purposes and provide locations for station equations for results comparison.

        - Provide cross sections at locations of substation channel variation to best capture volumetric variation within the channel.
        - Provide cross sections at locations of hydraulic grade inflection. By varying roughness values at these locations hydraulic grade lines are duplicated.
    - Roughness
        - Roughness values input into the 1D cross sections initially matched those of the 2D models. These values were scaled across each entire cross section in order to replicate 2D results. 1D maximum roughness values of 0.12 and 0.24 are used for in-bank and overbank locations respectively.
    - Lateral structures
        - There is some lateral discharge from the basin expected near existing channel cross section 1445 where some runoff is expected to overflow into the basins west of the project reach and not return to the system. Flow loss at this location is characterized using a lateral weir structure, and flows removed using a flow discharge equation based on 2D model results.
        - There is a mined-out area serving as a storage area at approximately existing channel cross section 800. In larger events this area will inundate and has the potential to cascade back into the channel at approximately existing channel cross section 200. Because the analysis was done using steady state hydraulics this phenomenon cannot be well modeled, and for simplicity lateral flow at this location is ignored. This is not believed to substantially change the outcome of the analysis.
    - Ineffective areas
        - Ineffective areas are largely subjective, in locations where flow velocity is negligible or transverse to the reach, or where backwater locations may be located.
- Flows
    - Flows used in this analysis are ultimate flows based on HMS modeling done prior to the primary analysis and are reflective of improvements expected at Thaxton Road.
    - These are HMS node flows and not flows from 2D model results. No iterations have been performed to minimize discrepancies between output 1D hydraulic grade lines and varied flows based on hydrologic model output (discussed later). Discrepancies are expected to be minimal and generally smaller than what would be deemed an acceptable match between 1D and 2D results.

The current plans for 1D hydraulic models are:

- KFA_Secondary1D_Existing
- KFA_Secondary1D_Hybrid
- KFA_Secondary1D_EngChan
- KFA_Secondary1D_NatChan

8.3.4 1D Hydraulic Model Results

The 1D hydraulic model serves two purposes in this Secondary Analysis. First purpose is determining flood storage within each alternative. Second purpose is the 1D hydraulic model provides information about the storage discharge relationship of the channel in a hydrologic model. Hydrologic parameter development is discussed in depth in the following section. Storage results for each alternative are included in Figure 13. (Note: results are based on the subreaches identified in the Geomorphic Assessment.)

Incremental Subreach Storage

Subreach 1	Total Subreach Storage (ac-ft)			
Return Event	Ex	Hybrid	Eng	Natural
2-Yr	18.37	18.18	18.57	18.08
10-Yr	23.07	22.7	23.07	22.63
25-Yr	55.03	55.23	56.07	54.67
100-Yr	59.11	58.05	58.9	58.53
Subreach 2	Total Subreach Storage (ac-ft)			
Return Event	Ex	Hybrid	Eng	Natural
2-Yr	9.04	4.6	3.46	9.58
10-Yr	22.33	8.64	7.2	23.37
25-Yr	34.85	16.53	18.95	34.98
100-Yr	48.65	21.67	23.15	46.53
Subreach 3	Total Subreach Storage (ac-ft)			
Return Event	Ex	Hybrid	Eng	Natural
2-Yr	4.39	4.08	3.19	5.62
10-Yr	9.95	7.99	6.28	11.88
25-Yr	15.72	10.48	8.38	16.35
100-Yr	24.1	14.94	11.86	23.55
Subreach 4	Total Subreach Storage (ac-ft)			
Return Event	Ex	Hybrid	Eng	Natural
2-Yr	11.29	10.64	11.85	12.58
10-Yr	27.56	25.55	27.76	29.36
25-Yr	37.65	35.12	37.47	39.21
100-Yr	52.1	48.37	50.94	52.61
Total Project	Total Reach Storage (ac-ft)			
Return Event	Ex	Hybrid	Eng	Natural
2-Yr	43.09	37.5	37.07	45.86
10-Yr	82.91	64.88	64.31	87.24
25-Yr	143.25	117.36	120.87	145.21
100-Yr	183.96	143.03	144.85	181.22

Proposed Change in Subreach Storage

Subreach 1	Proposed Change in Subreach Storage (ac-ft)			
Return Event	Ex	Hybrid	Eng	Natural
2-Yr	0	-0.19	0.2	-0.29
10-Yr	0	-0.37	0	-0.44
25-Yr	0	0.2	1.04	-0.36
100-Yr	0	-1.06	-0.21	-0.58
Subreach 2	Proposed Change in Subreach Storage (ac-ft)			
Return Event	Ex	Hybrid	Eng	Natural
2-Yr	0	-4.44	-5.58	0.54
10-Yr	0	-13.69	-15.13	1.04
25-Yr	0	-18.32	-15.9	0.13
100-Yr	0	-26.98	-25.5	-2.12
Subreach 3	Proposed Change in Subreach Storage (ac-ft)			
Return Event	Ex	Hybrid	Eng	Natural
2-Yr	0	-0.31	-1.2	1.23
10-Yr	0	-1.96	-3.67	1.93
25-Yr	0	-5.24	-7.34	0.63
100-Yr	0	-9.16	-12.24	-0.55
Subreach 4	Proposed Change in Subreach Storage (ac-ft)			
Return Event	Ex	Hybrid	Eng	Natural
2-Yr	0	-0.65	0.56	1.29
10-Yr	0	-2.01	0.2	1.8
25-Yr	0	-2.53	-0.18	1.56
100-Yr	0	-3.73	-1.16	0.51
Total Project	Proposed Change in Reach Storage (ac-ft)			
Return Event	Ex	Hybrid	Eng	Natural
2-Yr	0	-5.59	-6.02	2.77
10-Yr	0	-18.03	-18.6	4.33
25-Yr	0	-25.89	-22.38	1.96
100-Yr	0	-40.93	-39.11	-2.74

Figure 13. 1D Hydraulic Model Storage Results

Refer to Appendix K for hydraulic model output.

8.3.5 Hydrologic Model Development

The hydrologic model's purpose in this Secondary Analysis is to identify any loss in channel storage and determine if there are any increases in discharge from the project reach. This analysis was performed by revising the Modified Puls reach routing parameters in the hydrologic model based upon the channel storage results in the 1D hydraulic model. This was limited to adjusting storage discharge relationships only, no adjustments were made to model reach element subreach counts. Estimates for reach storage discharge relationships for improved areas are derived from the 1D hydraulic model. Hydrologic model reach elements RLOCR350B and RLOCR350C represent the improved reaches in the hydrologic model. The relationships that were derived are shown in Figure 14.

Reach RLOCR350C

Existing	(STA 2761 - 0)	Hybrid	(STA 2779 - 0)	EngChan	(STA 2384 - 0)	NatChan	(STA 2761 - 0)
Storage (ac-ft)	Flow (cfs)	Storage (ac-ft)	Flow (cfs)	Storage (ac-ft)	Flow (cfs)	Storage (ac-ft)	Flow (cfs)
0	0	0	0	0	0	0	0
1.92	30	1.64	30	1.68	30	1.97	30
2.8	50	2.42	50	2.34	50	2.89	50
4.18	110	3.53	110	3.02	110	4.59	110
6.92	220	5.98	220	4.83	220	7.25	220
14.15	550	11.27	550	9.6	550	14.91	550
25.11	1090	18.09	1090	16.09	1090	27.25	1090
57.67	2720	35.86	2720	32.54	2720	59.61	2720
68.89	3260	41.78	3260	37.93	3260	69.31	3260
78.58	3810	47.84	3810	43.6	3810	78.36	3810
95.31	4770	57.6	4770	53.69	4770	93.79	4770
118.45	6100	72.59	6100	69.25	6100	115.75	6100
134.11	6700	79.59	6700	77.04	6700	129.43	6700

Reach RLOCR350B

Existing	(STA 4361 - 2761)	Hybrid	(STA 4179 - 2779)	EngChan	(STA 3783 - 2384)	NatChan	(STA 4361 - 2761)
Storage (ac-ft)	Flow (cfs)	Storage (ac-ft)	Flow (cfs)	Storage (ac-ft)	Flow (cfs)	Storage (ac-ft)	Flow (cfs)
0	0	0	0	0	0	0	0
0.9	30	0.88	30	0.94	30	1.05	30
1.32	50	1.28	50	1.38	50	1.53	50
2.35	110	2.27	110	2.47	110	2.67	110
4.01	220	3.79	220	4.18	220	4.53	220
9.53	550	9.16	550	10.2	550	11.19	550
18.21	1090	17.17	1090	19.16	1090	20.79	1090
43.97	2720	39.1	2720	41.46	2720	46.43	2720
52.04	3260	45.73	3260	47.71	3260	53.87	3260
59.9	3810	52.69	3810	54.25	3810	61.1	3810
74	4770	63.79	4770	65.25	4770	73.84	4770
92.99	6100	78.2	6100	79.37	6100	89.93	6100
101.19	6700	84.34	6700	85.3	6700	96.91	6700

Figure 14. Hydrologic Model Relationships

This input was developed using the following HEC-RAS plans:

- KFA_Secondary_Routing_Existing
- KFA_Secondary_Routing_Hybrid
- KFA_Secondary_Routing_EngChan
- KFA_Secondary_Routing_NatChan

8.3.6 Hydrologic Model Results

HEC-HMS node element JLOCR350C is the node immediately downstream of the reaches being improved. It is also the most downstream element in the Paces Mill Tributary and is at the confluence with Onion Creek. It is also the limit of the impacts analysis. No watershed-wide timing based analysis has been performed. The flow change impacts are tabulated in Figure 15.

HEC-HMS Node JLOCR350C				
FLOW (cfs)				
Return Event	2-Year	10-Year	25-Year	100-Year
Existing	734	1847	2642	3999
Hybrid	760	1950	2791	4165
EngChan	754	1953	2795	4179
NatChan	718	1844	2644	4042
TOTAL FLOW CHANGE (cfs)				
Return Event	2-Year	10-Year	25-Year	100-Year
Existing	0.0	0.0	0.0	0.0
Hybrid	25.7	103.3	148.8	166.2
EngChan	20.0	105.9	152.3	180.1
NatChan	-16.0	-2.5	2.0	42.7
TOTAL FLOW CHANGE (%)				
Return Event	2-Year	10-Year	25-Year	100-Year
Existing	0.0	0.0	0.0	0.0
Hybrid	3.4	5.3	5.3	4.0
EngChan	2.7	5.4	5.4	4.3
NatChan	-2.2	-0.1	0.1	1.1

Figure 15. Hydrologic Flow Change Impacts

Refer to Appendix L for hydrologic model output.

8.3.7 Paces Mill Reach Results + Conclusions

Both the proposed engineered channel and hybrid channel designs appear to cause substantial reduction in channel storage during all evaluated storm events. These deficits are relatively large making these two designs not compliant with COA No Adverse Impacts Guidelines within the Paces Mill Tributary. The natural channel design does improve flood storage in the 2, 10, and 25-Year events and shows a rather small deficit in the 100-Year event. This indicates that the Natural Channel design may need only minor refinement to meet COA No Adverse Impacts Guidelines when considering storage requirements.

Simulations show there are significant flow increases that would be expected when considering both the hybrid and engineered alternatives. Flow increases in the tributary are expected to exceed 5 percent in some storm events. These flows, however, do not pose significant adverse impacts to Onion Creek. The natural channel alternative, again, appears to perform much more favorably, producing close to net-neutral flow changes.

8.3.8 Project Mitigation Options

Two major components of concern when implementing any of the outlined alternatives are the overall potential impacts of the project on the watershed as discussed in the Results Conclusions Section and the local effects of the improvements ensuring they are properly integrated into the existing reach where localized issues could occur.

The Reach Results Conclusion section above outlines that the Natural Channel design has a minimal effect on the reach while the Engineered Channel and Hybrid Channel Alternatives would both have some local impacts within the reach. Increases in conveyance capability typically lead to loss of storage and increased flows downstream. The loss of storage in the Paces Mill Tributary itself is not of particular concern to the tributary itself, as current storage manifests itself as yard and structure flooding which is undesired. The loss of storage is only of critical consequence when viewing increased flows and flood depths in Paces Mill Tributary and in Onion Creek.

Adverse impacts guidelines state that increased water surface elevations as a result of impacts can be mitigated by containing widened floodplains within a drainage easement. This is a viable solution to expected rise-related impacts within the reach. Exhibits showing what easements would be required to contain expected widened floodplains in the Paces Mill Tributary are provided in Appendix N.

Impacts of the project on the main stem Onion Creek have been assessed by Watershed Protection Department, and implementation of any of the alternatives on the main stem of Onion Creek are minimal, producing expected variations in flow of less than 0.01%. Tabulated below are the expected changes in flow at JLOCR310_350 and JLOCRT360_390, which correspond to the confluence of the Paces Mill Tributary and the main stem of Onion Creek, and Onion Creek at East William Cannon Road respectively.

	Computed Peak Flow at HMS Element (cfs)									
ONI Design Storm	JLOCR310_350					JLOCR360_390				
(Pre-Atlas 14)	REG	Pre-Project	Hybrid	Engineered	Natural	REG	Pre-Project	Hybrid	Engineered	Natural
SC FD 025YR	58,429	58,563	58,557	58,557	58,568	58,334	58,469	58,463	58,463	58,474
SC FD 100YR	108,407	108,631	108,617	108,618	108,642	108,416	108,641	108,628	108,628	108,652
SC EX 500YR	164,872	165,070	165,054	165,055	165,083	164,769	164,969	164,953	164,954	164,982

	Percent change (%)									
ONI Design Storm	JLOCR310_350					JLOCR360_390				
(Pre-Atlas 14)	REG	Pre-Project	Hybrid	Engineered	Natural	REG	Pre-Project	Hybrid	Engineered	Natural
SC FD 025YR	N/A	0.23%	-0.01%	-0.01%	0.01%	N/A	0.2%	-0.01%	-0.01%	0.01%
SC FD100YR	N/A	0.21%	-0.01%	-0.01%	0.01%	N/A	0.2%	-0.01%	-0.01%	0.01%
SC EX 500YR	N/A	0.12%	-0.01%	-0.01%	0.01%	N/A	0.1%	-0.01%	-0.01%	0.01%

	Net Change of Computed Peak Flow at HMS Element (cfs)									
ONI Design Storm	JLOCR310_350					JLOCR360_390				
(Pre-Atlas 14)	REG	Pre-Project	Hybrid	Engineered	Natural	REG	Pre-Project	Hybrid	Engineered	Natural
SC FD 025YR	N/A	134	-6	-6	5	N/A	135	-6	-6	5
SC FD100YR	N/A	224	-14	-13	11	N/A	225	-13	-13	11
SC EX 500YR	N/A	198	-16	-15	13	N/A	200	-16	-15	13

Implementing any of the three proposed alternatives within the tributary does have the ability to hydraulically affect subreaches at the upstream and downstream ends of the improvements. These local hydraulic changes can potentially include increased velocities which may be of significance to the long-term stability of the reach. Analyses were performed to map expected velocity changes due to each alternative. These exhibits are provided in Appendix J and show some expected increases at tie in locations; typically, of less than 2 feet per second in the 2-year storm event. Mitigation of increased velocities, particularly at transitions between existing channel reach segments and improved segments warrant further analysis for stability or alterations to tie in design including armoring of transition areas.

9 SCHEMATIC DESIGN OF HYBRID OPTION

9.1 PERMITTING

Permitting for the hybrid design option would require local and federal review and approval. The project location is within the City of Austin's Full Purpose Jurisdiction. Prior to construction, the project shall need to obtain a site development permit or a general permit from the City of Austin. Due to the proposed modifications of the channel within the Critical Water Quality Zone (CWQZ), the project will require a variance from the land development code (LDC). The project would not be able to utilize the general permit program if a variance from LDC is required.

For the site development permit, the project will need to show the construction within the Erosion Hazard Zone (EHZ) will not cause erosion and the stream and banks will be stable. For the construction within the 100-year floodplain and the CWQZ, the project will need to provide a Functional Assessment of Floodplain Health along with a Riparian Restoration Plan.

The project is located within the Onion Creek Metropolitan Park. The project will need to obtain approval from COA Parks and Recreation Department (PRD) prior to site development permit approval.

A portion of the proposed improvements are within the Ordinary High Water Mark (OHWM) of the Paces Mill Tributary which defines the boundary of waters of the U.S. for the tributary. The project will require authorization under Section 404 of the Clean Water Act. It is anticipated that Nationwide Permit 43 which allows for expansion or construction of stormwater management facilities that do not cause the loss of greater than 0.5 acres of waters of the U.S could be used for this project. However, mitigation may be required by the U.S. Army Corps of Engineers (USACE) for impacts to the channel in excess of 0.03 acres as a condition of the Nationwide Permit.

The project is located within the defined FEMA floodplain for Paces Mill Tributary. Channel and overbank modifications within the FEMA floodplain will require a Letter of Map Revision to reflect changes within the floodplain.

9.2 COST ESTIMATES

For the schematic design of the Hybrid option, the Engineer's Opinion of Construction Costs (EOCC) for the project to be constructed is estimated to be $6.5 million. The costs include channel excavation, channel stabilization, erosion control, tree removal and mitigation, and mobilization. The estimated engineering cost for the design and permitting of the project is $1 million. Refer to Appendix O for Hybrid Channel Schematic Design EOCC.

9.3 CONSTRUCTABILITY

Construction of the proposed improvements for the hybrid option will require access through the neighborhood to the creek. The project includes two access points at the ends of the project, upstream and downstream. Construction will include excavation and removal of materials. Spoils from the excavation will need to be removed from the project area and stored outside of the floodplain. Due to the proximity of the project to a neighborhood, hours of operation would be limited to daytime hours. The project location should be far enough from home foundations to not impact them; however, seismic activity may be measured during construction for homeowner confidence. The project is located upstream of environmentally sensitive features located near the confluence of Paces Mill Tributary with Onion Creek. Sediment and erosion control during construction will need to be continually checked and maintained in proper working order.

9.4 MAINTENANCE REQUIREMENTS

The hybrid option assumes continual maintenance to control vegetation in order to meet the Manning's 'n' values for the bench areas at 0.06. The bench areas should be mowed occasionally to prevent establishment of brush and trees in the bench areas, but regular mowing is not required.

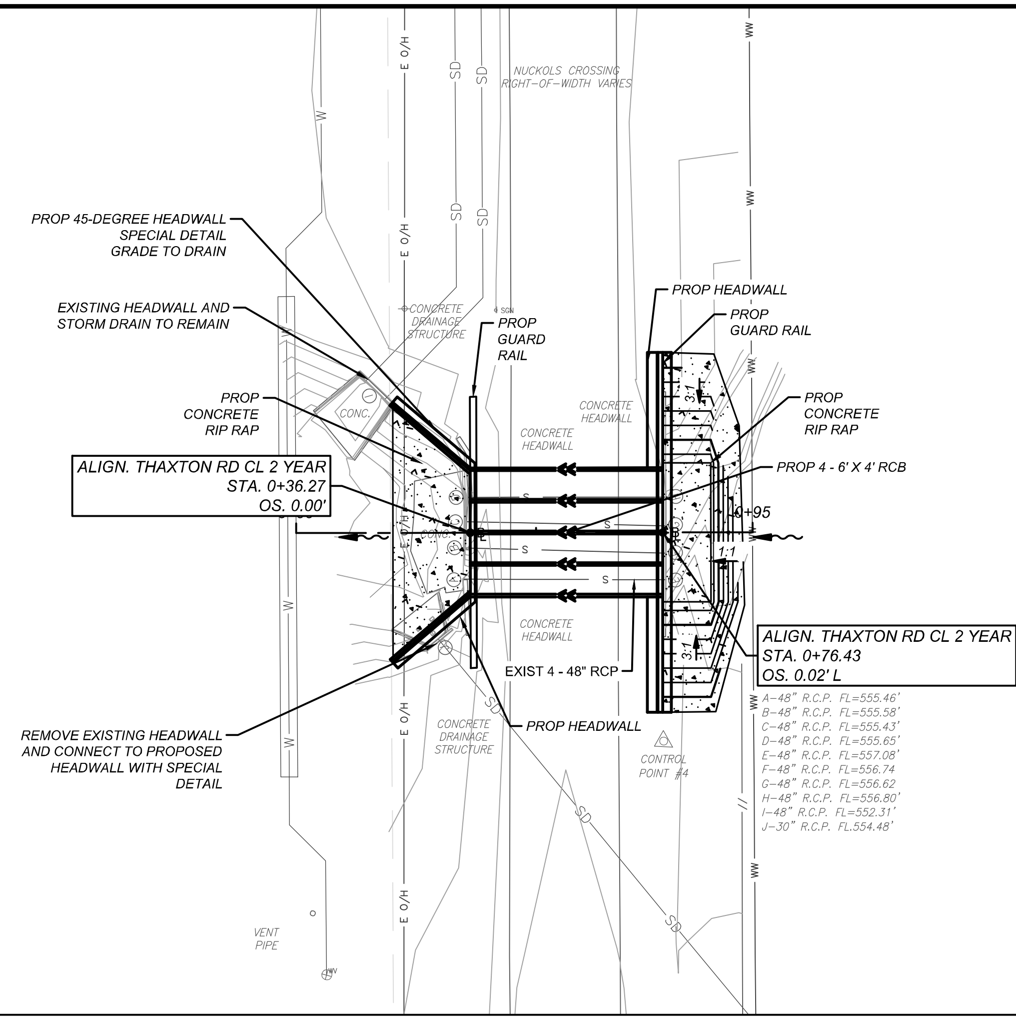
9.5 ENVIRONMENTAL IMPACT

HDR analyzed the proposed hybrid design using Texas Rapid Assessment Method (TXRAM) developed by USACE (Environmental Memo). Since the proposed improvements for the hybrid design would be above the existing channel thalweg except in the existing engineered section, the impact of the project is isolated to the riparian buffer of the Paces Mill Tributary. The project would result in fill below the OHWM of the existing channel were the engineered section approaches the natural channel. The hybrid design option scored slightly lower than the existing channel TXRAM score for three of the five segments.

No mapped critical habitat for any of the federally listed endangered or threatened species are within or near the project area. There are no documented occurrences of any state listed threatened or endangered species within the proposed project area.

Construction of the project would be within the CWQZ for the channel. Impact to the CWQZ should be mitigated by revegetating in accordance with COA's ECM. The project will also require tree mitigation for existing trees to be removed for construction of the channel improvements and construction activities. No Critical Environmental Features (CEF) were identified within the project area; however, a few CEFs were identified downstream of the project and would need to be protected from construction activities.

Appendix A: Thaxton Road Improvement Schematics



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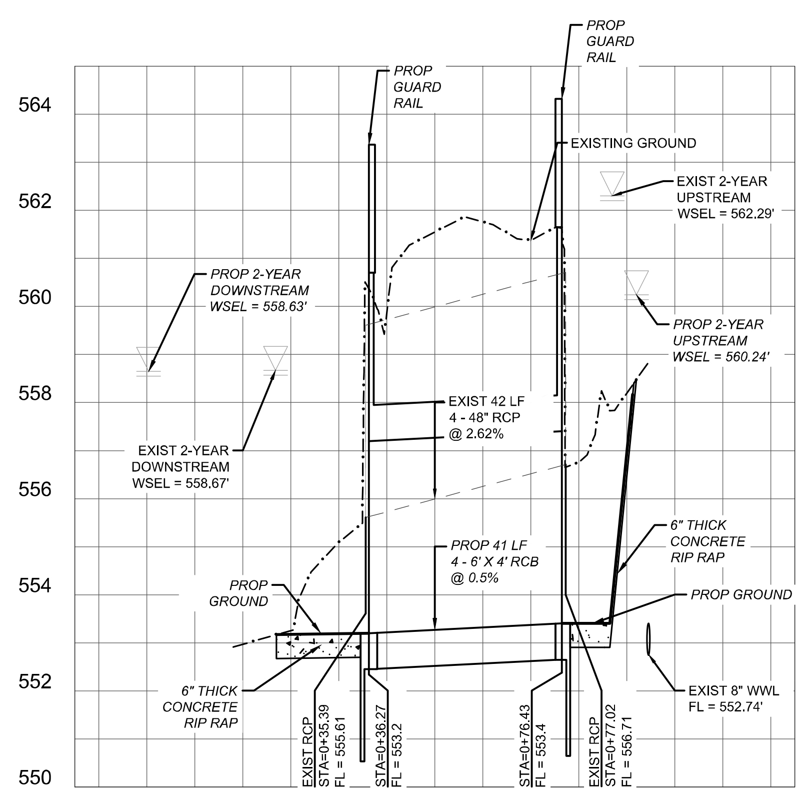
HORIZONTAL SCALE IN FEET



0 2 4
VERTICAL SCALE IN FEET

REV. NO.	BY	DATE	REVISION DESCRIPTION

PRELIMINARY

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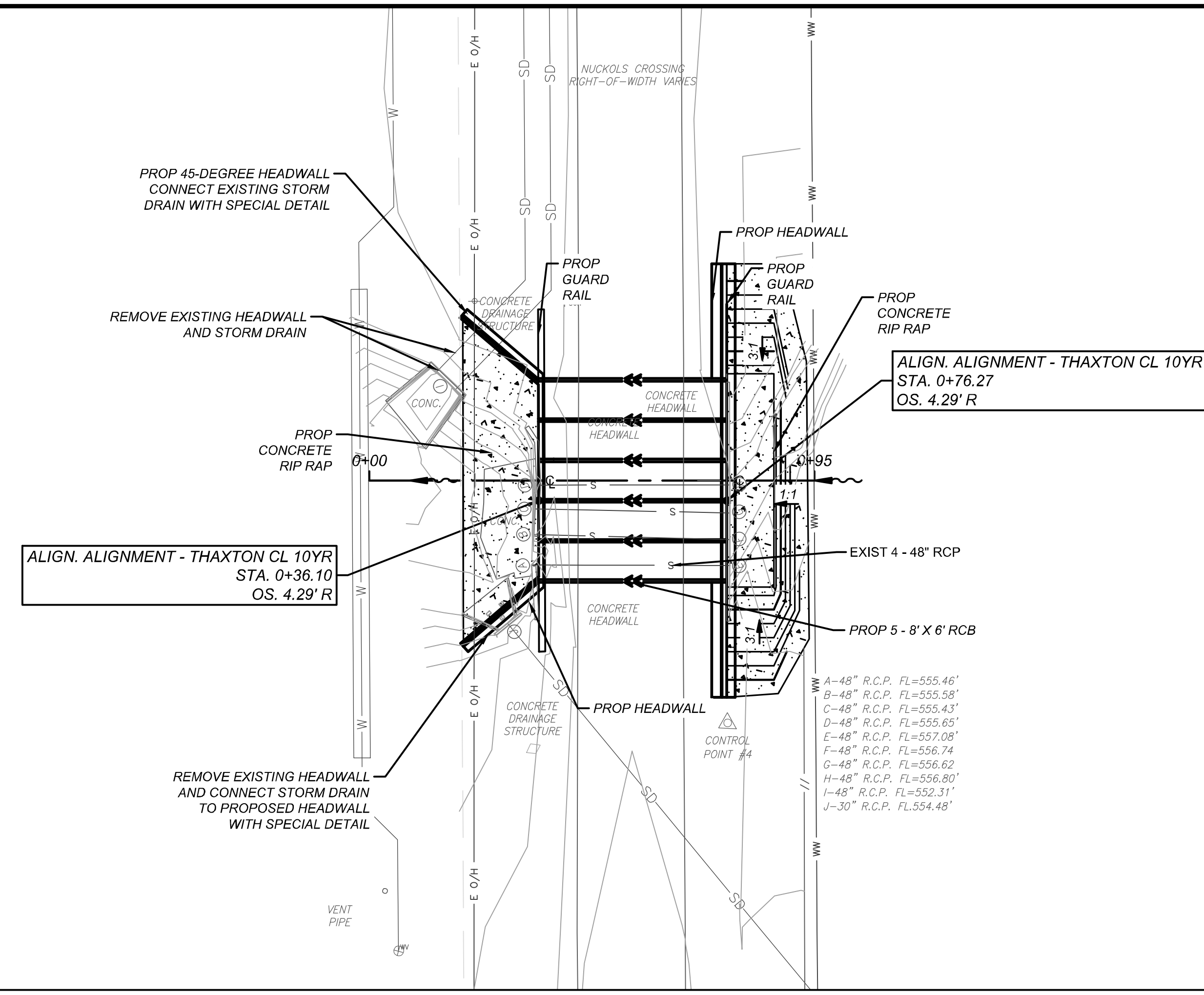
PACES MILL FLOOD RISK REDUCTION STUDY

THAXTON ROAD IMPROVEMENTS

2-YEAR LEVEL-OF-SERVICE DESIGN

CITY OF AUSTIN FOUNDED 1839

NOTES	NAME	DATE
SURVEY BY		
DRAWN BY		
DESIGNED BY		
CHECKED BY		
REVIEWED BY		



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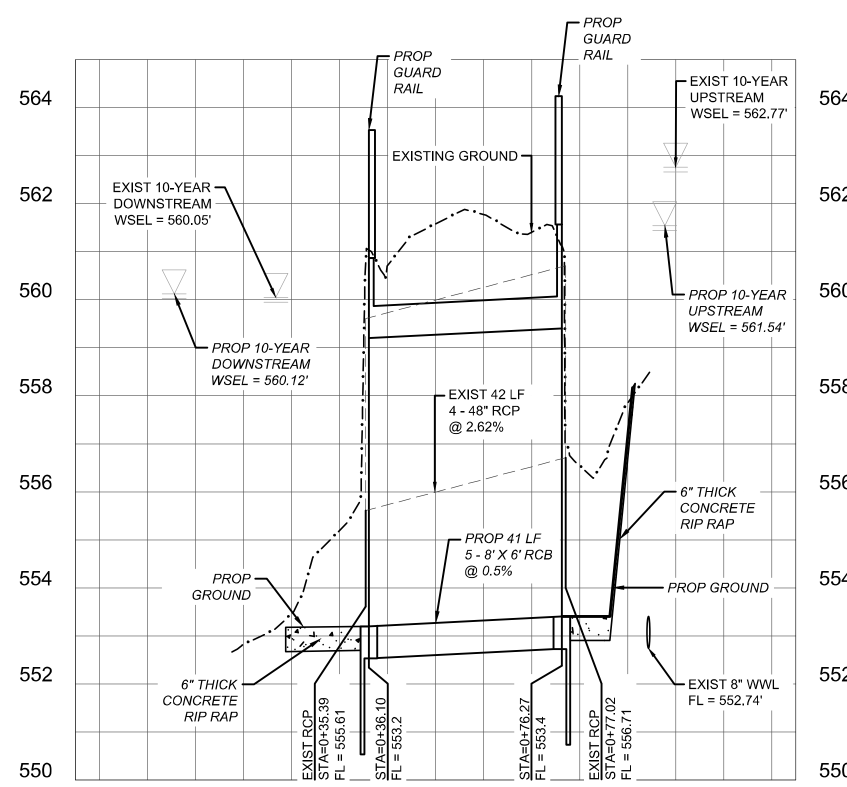
HORIZONTAL SCALE IN FEET



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VERTICAL SCALE IN FEET

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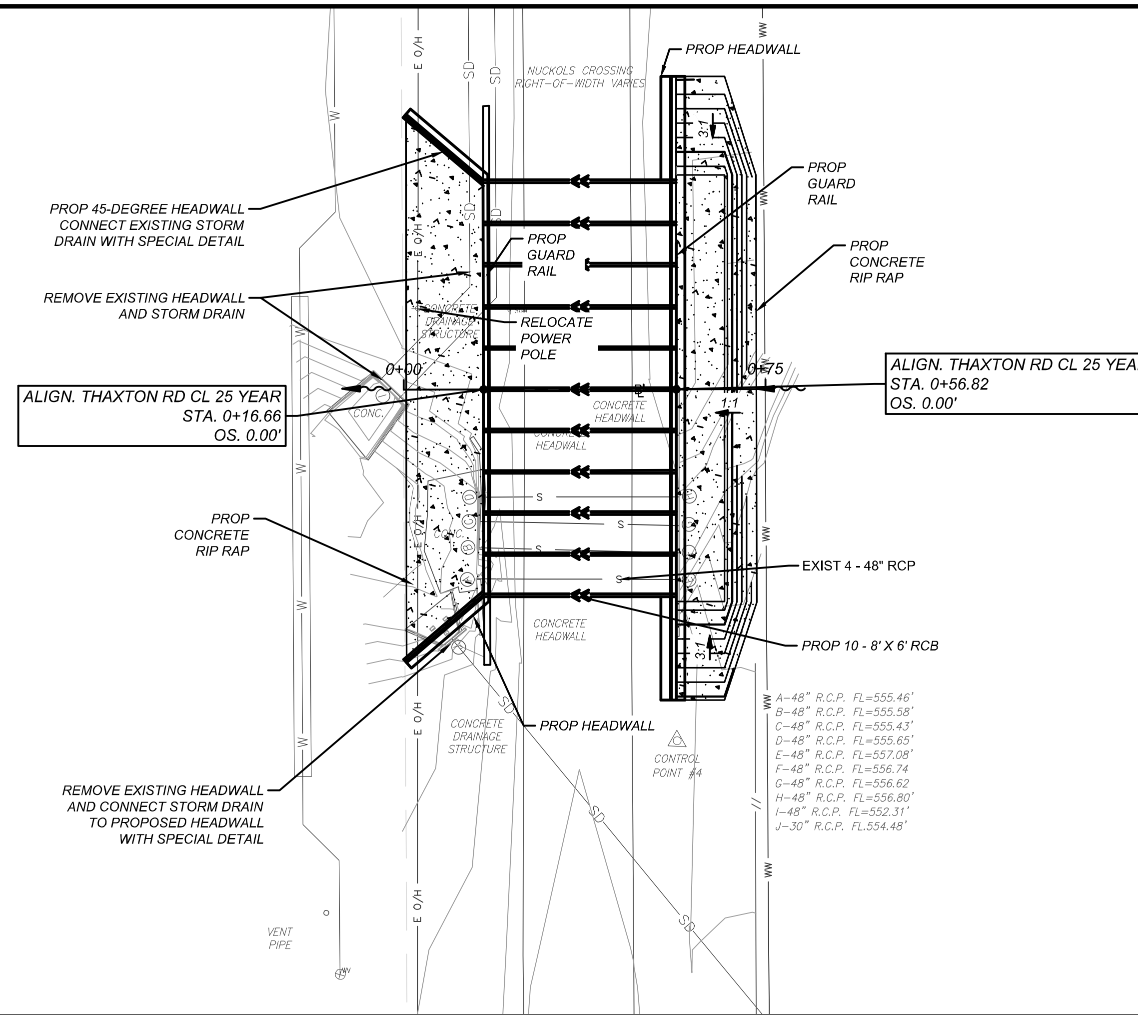
PACES MILL FLOOD RISK REDUCTION STUDY

THAXTON ROAD IMPROVEMENTS

10-YEAR LEVEL-OF-SERVICE DESIGN

CITY OF AUSTIN
FOUNDED 1839

NOTES	NAME	DATE
SURVEY BY		
DRAWN BY		
DESIGNED BY		
CHECKED BY		
REVIEWED BY		



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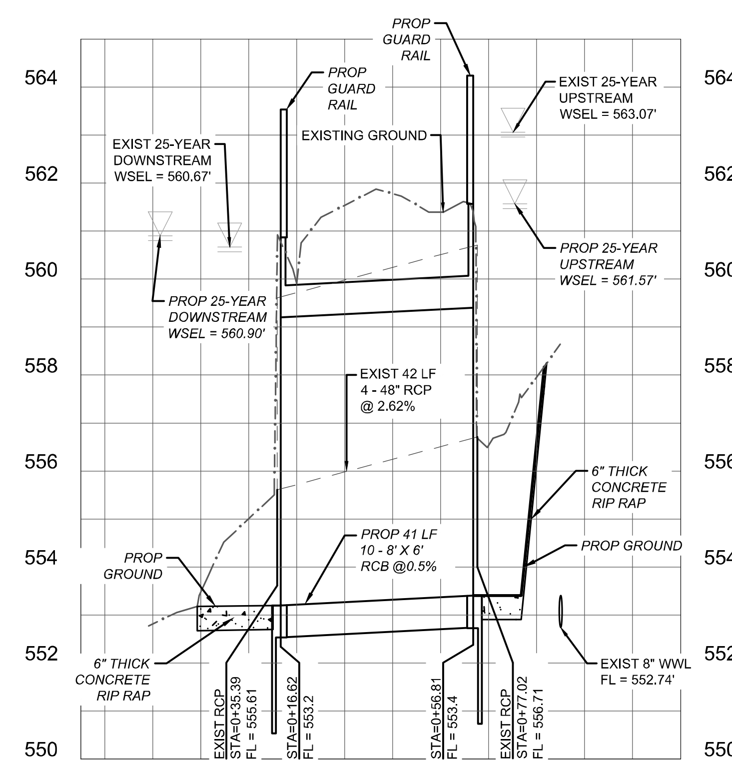
HORIZONTAL SCALE IN FEET



0 20 40
VERTICAL SCALE IN FEET

REV. NO.	BY	DATE	REVISION DESCRIPTION

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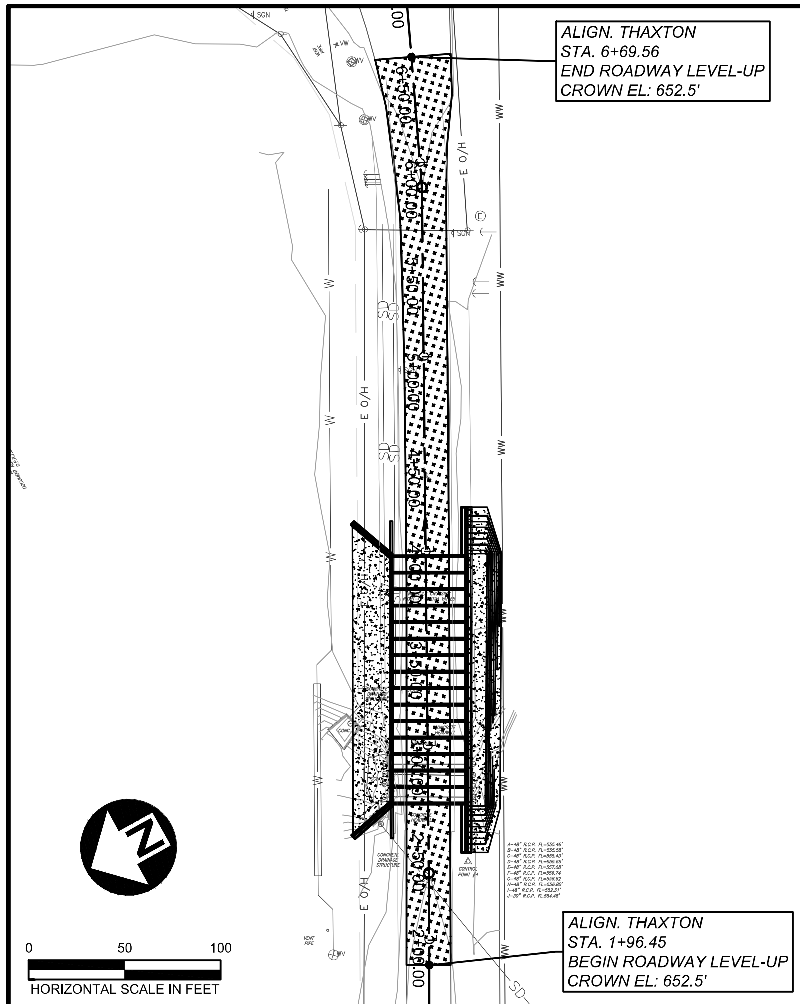
PACES MILL FLOOD RISK REDUCTION STUDY

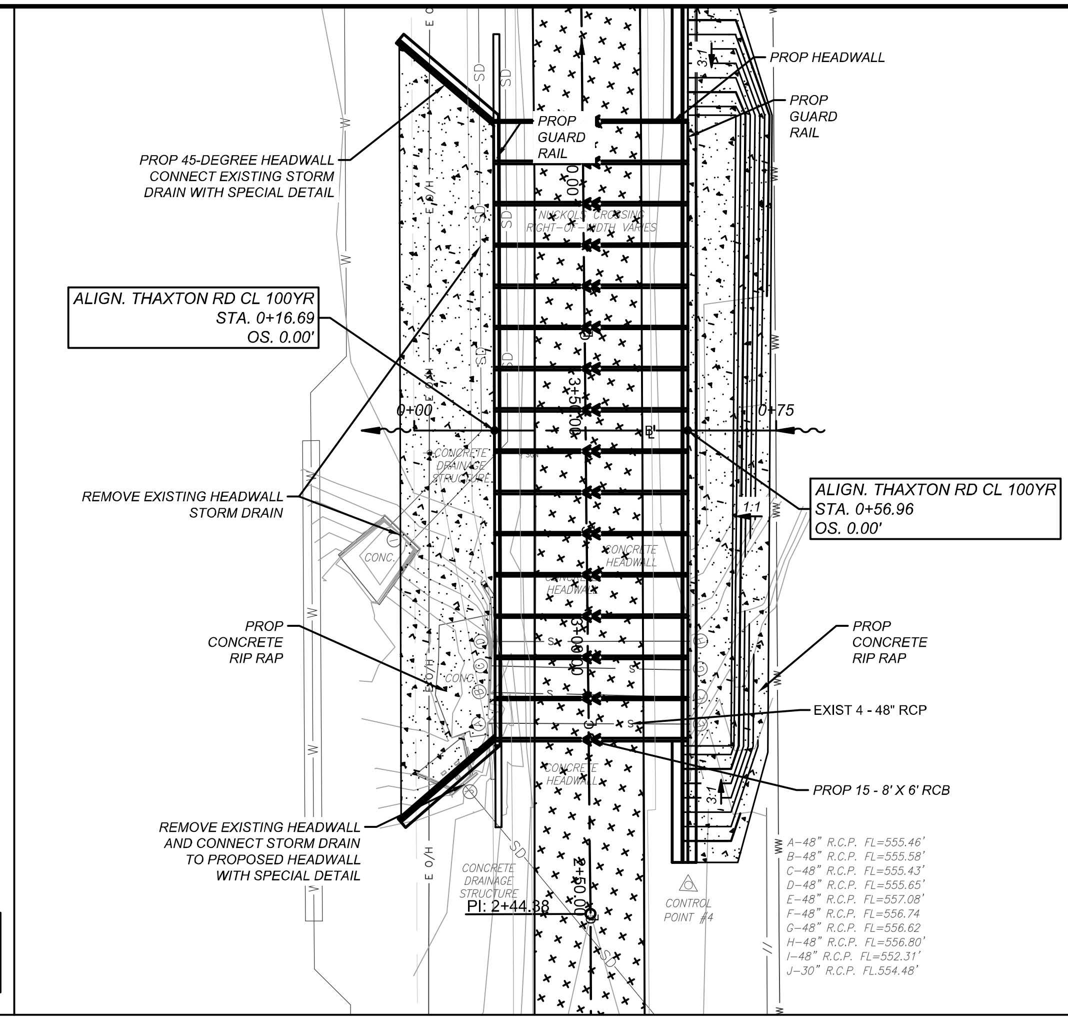
THAXTON ROAD IMPROVEMENTS

25-YEAR LEVEL-OF-SERVICE DESIGN

CITY OF AUSTIN FOUNDED 1839

NOTES	NAME	DATE
SURVEY BY		
DRAWN BY		
DESIGNED BY		
CHECKED BY		
REVIEWED BY		





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HORIZONTAL SCALE IN FEET

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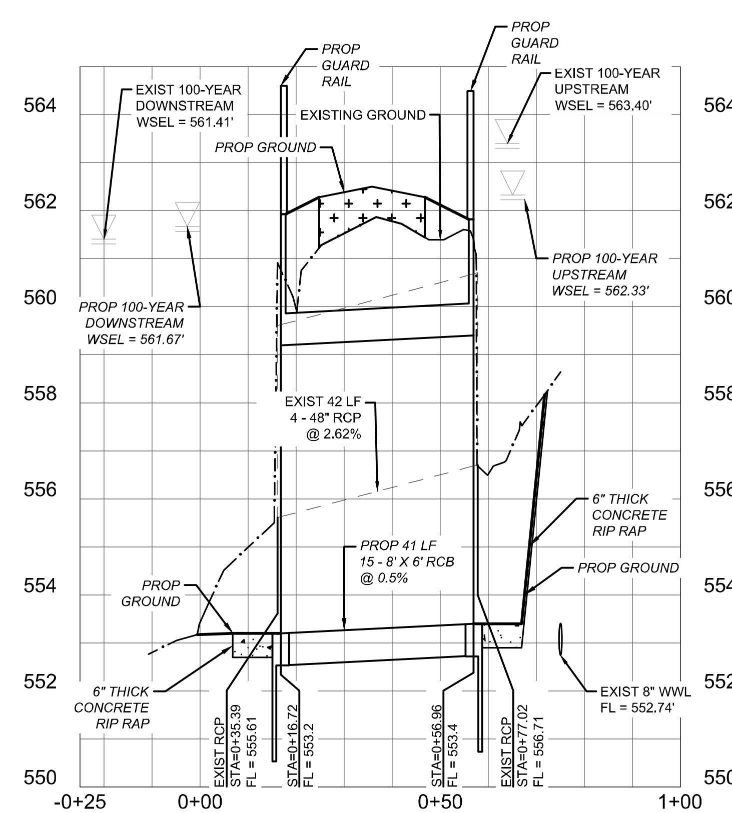
VERTICAL SCALE IN FEET



REV. NO.	BY	DATE	REVISION DESCRIPTION

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PACES MILL FLOOD RISK REDUCTION STUDY

THAXTON ROAD IMPROVEMENTS

100-YEAR LEVEL-OF-SERVICE DESIGN

CITY OF AUSTIN FOUNDED 1839

NOTES	NAME	DATE
SURVEY BY		
DRAWN BY		
DESIGNED BY		
CHECKED BY		
REVIEWED BY		

Appendix B: Thaxton Road Engineer's Opinion of Probable Cost (OPC)

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING

2-Year Design OPC

BID ITEM NO.	ITEM DESCRIPTION	UNIT	QTY.	UNIT COST	TOTAL COST
101S-B	PREPARING RIGHT OF WAY	STA	1	$ 10,000.00	$ 10,000.00
111S-A	EXCAVATION	CY	437	$ 50.00	$ 21,870.00
210S-A	FLEXIBLE BASE	CY	21	$ 100.00	$ 2,100.00
340S-B3	HOT MIX ASPHALTIC CONCRETE PAVEMENT, 3 INCHES, TYPE C	SY	63	$ 50.00	$ 3,150.00
414S-C	CAST-IN-PLACE PORTLAND CEMENT CONCRETE RETAINING WALL, INCLUDING REINFORCEMENT	CY	37	$ 1,500.00	$ 55,800.00
430S-B	P.C. CONCRETE CURB AND GUTTER (FINE GRADING)	LF	54	$ 50.00	$ 2,700.00
509S-1	TRENCH EXCAVATION SAFETY PROTECTIVE SYSTEMS, (ALL DEPTHS)	LF	168	$ 10.00	$ 1,680.00
559S-6X4	PRECAST CONCRETE BOX CULVERTS, 6 FT X 4 FT	LF	168	$ 600.00	$ 100,800.00
559S-8X6	PRECAST CONCRETE BOX CULVERTS, 8 FT X 6 FT	LF	0	$ 800.00	$ -
591S-A	DRY ROCK RIPRAP, D50 = 18 IN	SY	0	$ 130.00	$ -
591S-F	CONCRETE RIPRAP, 6 IN	SY	238	$ 300.00	$ 71,400.00
605S	SOIL RETENTION BLANKET CLASS 2; TYPE H, COMPLETE AND IN PLACE	SY	64	$ 10.00	$ 644.44
639S	ROCK BERM	LF	29	$ 45.00	$ 1,305.00
641S	STABILIZED CONSTRUCTION ENTRANCE	EA	2	$ 3,500.00	$ 7,000.00
642S	SILT FENCE FOR EROSION CONTROL	LF	150	$ 10.00	$ 1,500.00
700S-TM	TOTAL MOBILIZATION PAYMENT	LS	1	$ 18,897.47	$ 18,897.47
704	METAL BEAM GUARD RAILING	LF	300	$ 50.00	$ 15,000.00
704-T	METAL BEAM GUARD RAILING, TERMINAL ANCHOR SECTIONS	EA	2	$ 1,000.00	$ 2,000.00
802S-A	PROJECT SIGN	EA	1	$ 1,000.00	$ 1,000.00
803S-MO	BARRICADES, SIGNS, AND TRAFFIC HANDLING	MO	6	$ 5,000.00	$ 30,000.00
SS1000	COFFER DAM & SITE DEWATERING	LS	1	$ 50,000.00	$ 50,000.00
CONSTRUCTION SUBTOTAL					***$ 396,846.92***
	CONTINGENCY (30% OF SUBTOTAL)				$ 119,055.00
CONSTRUCTION COST ESTIMATE					**$ 515,901.92**

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING

10-Year Design OPC

BID ITEM NO.	ITEM DESCRIPTION	UNIT	QTY.	UNIT COST	TOTAL COST
101S-B	PREPARING RIGHT OF WAY	STA	1	$ 10,000.00	$ 10,000.00
111S-A	EXCAVATION	CY	705	$ 50.00	$ 35,235.00
210S-A	FLEXIBLE BASE	CY	34	$ 100.00	$ 3,383.33
340S-B3	HOT MIX ASPHALTIC CONCRETE PAVEMENT, 3 INCHES, TYPE C	SY	102	$ 50.00	$ 5,075.00
414S-C	CAST-IN-PLACE PORTLAND CEMENT CONCRETE RETAINING WALL, INCLUDING REINFORCEMENT	CY	41	$ 1,500.00	$ 60,750.00
430S-B	P.C. CONCRETE CURB AND GUTTER (FINE GRADING)	LF	87	$ 50.00	$ 4,350.00
509S-1	TRENCH EXCAVATION SAFETY PROTECTIVE SYSTEMS, (ALL DEPTHS)	LF	210	$ 10.00	$ 2,100.00
559S-6X4	PRECAST CONCRETE BOX CULVERTS, 6 FT X 4 FT	LF	0	$ 600.00	$ -
559S-8X6	PRECAST CONCRETE BOX CULVERTS, 8 FT X 6 FT	LF	210	$ 800.00	$ 168,000.00
591S-A	DRY ROCK RIPRAP, D50 = 18 IN	SY	0	$ 130.00	$ -
591S-F	CONCRETE RIPRAP, 6 IN	SY	268	$ 300.00	$ 80,352.00
605S	SOIL RETENTION BLANKET CLASS 2; TYPE H, COMPLETE AND IN PLACE	SY	101	$ 10.00	$ 1,011.11
639S	ROCK BERM	LF	46	$ 45.00	$ 2,047.50
641S	STABILIZED CONSTRUCTION ENTRANCE	EA	2	$ 3,500.00	$ 7,000.00
642S	SILT FENCE FOR EROSION CONTROL	LF	185	$ 10.00	$ 1,850.00
700S-TM	TOTAL MOBILIZATION PAYMENT	LS	1	$ 23,957.70	$ 23,957.70
704	METAL BEAM GUARD RAILING	LF	300	$ 50.00	$ 15,000.00
704-T	METAL BEAM GUARD RAILING, TERMINAL ANCHOR SECTIONS	EA	2	$ 1,000.00	$ 2,000.00
802S-A	PROJECT SIGN	EA	1	$ 1,000.00	$ 1,000.00
803S-MO	BARRICADES, SIGNS, AND TRAFFIC HANDLING	MO	6	$ 5,000.00	$ 30,000.00
SS1000	COFFER DAM & SITE DEWATERING	LS	1	$ 50,000.00	$ 50,000.00
CONSTRUCTION SUBTOTAL					***$ 503,111.64***
	CONTINGENCY (30% OF SUBTOTAL)				$ 150,934.00
CONSTRUCTION COST ESTIMATE					**$ 654,045.64**

25-Year Design OPC

BID ITEM NO.	ITEM DESCRIPTION	UNIT	QTY.	UNIT COST	TOTAL COST
101S-B	PREPARING RIGHT OF WAY	STA	1	$ 10,000.00	$ 10,000.00
111S-A	EXCAVATION	CY	1407	$ 50.00	$ 70,348.50
210S-A	FLEXIBLE BASE	CY	68	$ 100.00	$ 6,755.00
340S-B3	HOT MIX ASPHALTIC CONCRETE PAVEMENT, 3 INCHES, TYPE C	SY	203	$ 50.00	$ 10,132.50
414S-C	CAST-IN-PLACE PORTLAND CEMENT CONCRETE RETAINING WALL, INCLUDING REINFORCEMENT	CY	37	$ 1,500.00	$ 55,200.00
430S-B	P.C. CONCRETE CURB AND GUTTER (FINE GRADING)	LF	174	$ 50.00	$ 8,685.00
509S-1	TRENCH EXCAVATION SAFETY PROTECTIVE SYSTEMS, (ALL DEPTHS)	LF	420	$ 10.00	$ 4,200.00
559S-6X4	PRECAST CONCRETE BOX CULVERTS, 6 FT X 4 FT	LF	0	$ 600.00	$ -
559S-8X6	PRECAST CONCRETE BOX CULVERTS, 8 FT X 6 FT	LF	420	$ 800.00	$ 336,000.00
591S-A	DRY ROCK RIPRAP, D50 = 18 IN	SY	0	$ 130.00	$ -
591S-F	CONCRETE RIPRAP, 6 IN	SY	405	$ 300.00	$ 121,485.00
605S	SOIL RETENTION BLANKET CLASS 2; TYPE H, COMPLETE AND IN PLACE	SY	197	$ 10.00	$ 1,974.44
639S	ROCK BERM	LF	54	$ 45.00	$ 2,430.00
641S	STABILIZED CONSTRUCTION ENTRANCE	EA	2	$ 3,500.00	$ 7,000.00
642S	SILT FENCE FOR EROSION CONTROL	LF	260	$ 10.00	$ 2,597.00
700S-TM	TOTAL MOBILIZATION PAYMENT	LS	1	$ 36,740.37	$ 36,740.37
704	METAL BEAM GUARD RAILING	LF	300	$ 50.00	$ 15,000.00
704-T	METAL BEAM GUARD RAILING, TERMINAL ANCHOR SECTIONS	EA	2	$ 1,000.00	$ 2,000.00
802S-A	PROJECT SIGN	EA	1	$ 1,000.00	$ 1,000.00
803S-MO	BARRICADES, SIGNS, AND TRAFFIC HANDLING	MO	6	$ 5,000.00	$ 30,000.00
SS1000	COFFER DAM & SITE DEWATERING	LS	1	$ 50,000.00	$ 50,000.00
CONSTRUCTION SUBTOTAL					***$ 771,547.82***
	CONTINGENCY (30% OF SUBTOTAL)				$ 231,465.00
CONSTRUCTION COST ESTIMATE					**$ 1,003,012.82**

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING

100-Year Design OPC

BID ITEM NO.	ITEM DESCRIPTION	UNIT	QTY.	UNIT COST	TOTAL COST
101S-B	PREPARING RIGHT OF WAY	STA	6	$ 10,000.00	$ 60,000.00
111S-A	EXCAVATION	CY	2095	$ 50.00	$ 104,757.30
210S-A	FLEXIBLE BASE	CY	284	$ 100.00	$ 28,400.00
340S-B3	HOT MIX ASPHALTIC CONCRETE PAVEMENT, 3 INCHES, TYPE C	SY	1705	$ 50.00	$ 85,263.50
414S-C	CAST-IN-PLACE PORTLAND CEMENT CONCRETE RETAINING WALL, INCLUDING REINFORCEMENT	CY	53	$ 1,500.00	$ 78,750.00
430S-B	P.C. CONCRETE CURB AND GUTTER (FINE GRADING)	LF	944	$ 50.00	$ 47,200.00
509S-1	TRENCH EXCAVATION SAFETY PROTECTIVE SYSTEMS, (ALL DEPTHS)	LF	630	$ 10.00	$ 6,300.00
559S-6X4	PRECAST CONCRETE BOX CULVERTS, 6 FT X 4 FT	LF	0	$ 600.00	$ -
559S-8X6	PRECAST CONCRETE BOX CULVERTS, 8 FT X 6 FT	LF	630	$ 800.00	$ 504,000.00
591S-A	DRY ROCK RIPRAP, D50 = 18 IN	SY	0	$ 130.00	$ -
591S-F	CONCRETE RIPRAP, 6 IN	SY	644	$ 300.00	$ 193,155.00
605S	SOIL RETENTION BLANKET CLASS 2; TYPE H, COMPLETE AND IN PLACE	SY	292	$ 10.00	$ 2,918.44
639S	ROCK BERM	LF	106	$ 45.00	$ 4,770.00
641S	STABILIZED CONSTRUCTION ENTRANCE	EA	2	$ 3,500.00	$ 7,000.00
642S	SILT FENCE FOR EROSION CONTROL	LF	360	$ 10.00	$ 3,596.60
700S-TM	TOTAL MOBILIZATION PAYMENT	LS	1	$ 61,205.54	$ 61,205.54
704	METAL BEAM GUARD RAILING	LF	300	$ 50.00	$ 15,000.00
704-T	METAL BEAM GUARD RAILING, TERMINAL ANCHOR SECTIONS	EA	2	$ 1,000.00	$ 2,000.00
802S-A	PROJECT SIGN	EA	1	$ 1,000.00	$ 1,000.00
803S-MO	BARRICADES, SIGNS, AND TRAFFIC HANDLING	MO	6	$ 5,000.00	$ 30,000.00
SS1000	COFFER DAM & SITE DEWATERING	LS	1	$ 50,000.00	$ 50,000.00
CONSTRUCTION SUBTOTAL					***$ 1,285,316.39***
	CONTINGENCY (30% OF SUBTOTAL)				$ 385,595.00
CONSTRUCTION COST ESTIMATE					**$ 1,670,911.39**

Appendix C: Thaxton Road Hydrologic Flow Results

The hydrologic flow results with the Thaxton Road crossing are shown in **Table 1**.

Table 1: Hydrologic Flows with Thaxton Road Crossing

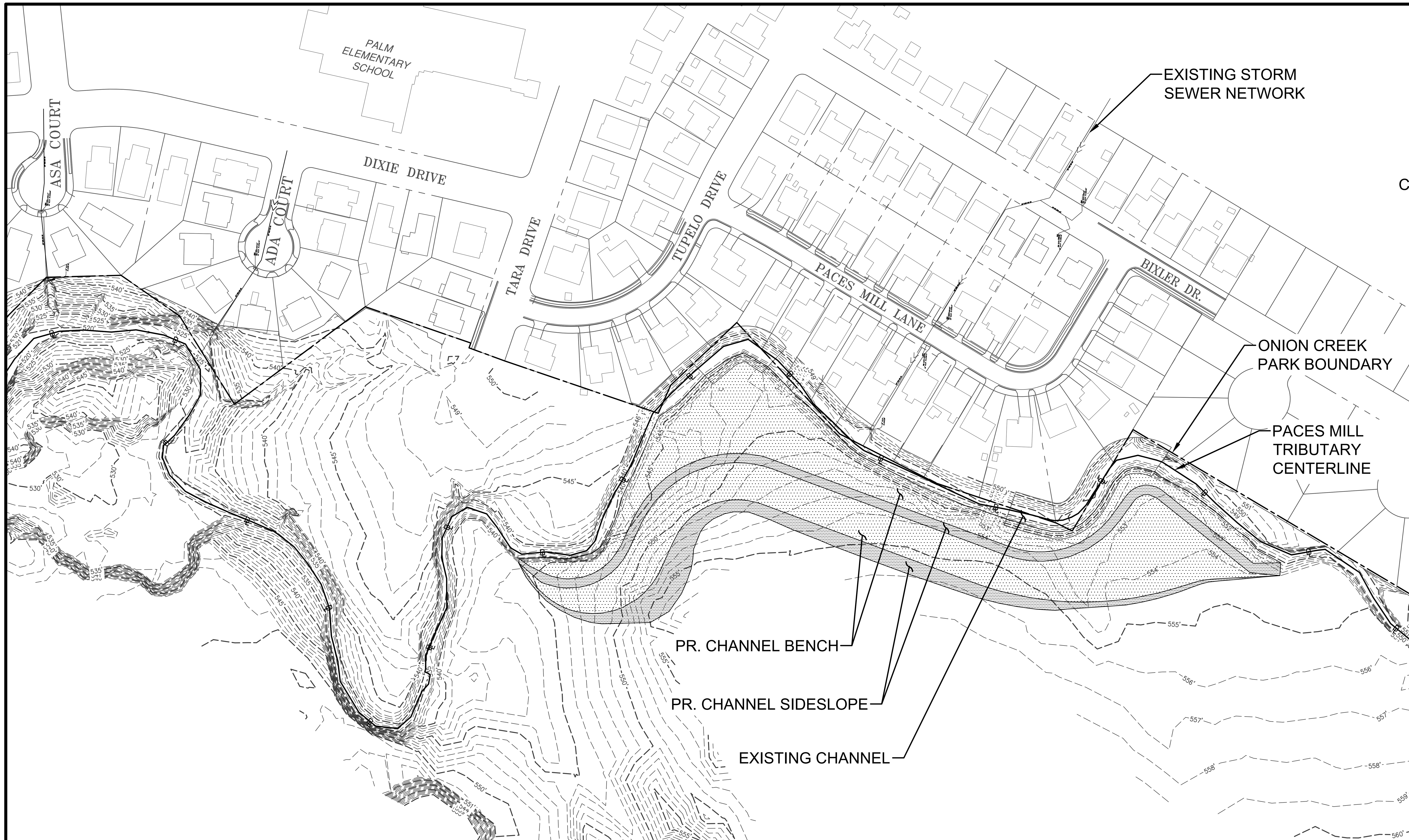
Pre-Construction Flows (Ultimate Hydrology) (cfs)				
Element	2 - Year	10 - Year	25 - Year	100 - Year
LOCR320	495.1	937.2	1195.6	1600.5
VertexPond	131.3	430.6	620.4	1095
LOCR330	525.9	980.4	1244.1	1654.4
JLOCR330	525.9	980.4	1244.1	1654.4
RLOCR340C	490.1	922.2	1176.2	1571.8
LOCR340C	31.1	67.1	88.8	122.9
JLOCR340C	507.1	960.7	1226.4	1640.4
JLOCR320_340C	576.1	1298.9	1751.4	2580.6
LOCR340A	352.9	668.3	852.7	1139.3
PCM_1_200	87.7	274.6	713.2	1163.4
JLOCR340A	87.7	274.6	713.2	1163.4
RLOCR340B	87.6	274.3	703.9	1130.8
LOCR340B	268.7	514.9	659.9	886
PCM_1_100	153.7	432.5	772.4	1903.3
JLOCR340B	153.7	432.5	772.4	1903.3
JLOCR340B_340C	728.5	1719.2	2457.2	3481.4
RLOCR350A	691.8	1694.2	2413.8	3453.6
LOCR350A	211.4	443.9	586.4	812.5
JLOCR350A	779.2	1931	2750.2	4062
RLOCR350B	730.1	1876.5	2663.2	3929.5
LOCR350B	125.2	280.5	380	541.1
JLOCR350B	750	1935.4	2750.1	4080
RLOCR350C	733.7	1898.8	2697.6	4002.7
LOCR350C	97.6	224.6	306.9	441.3
JLOCR350C	751.6	1956.6	2784	4146.9

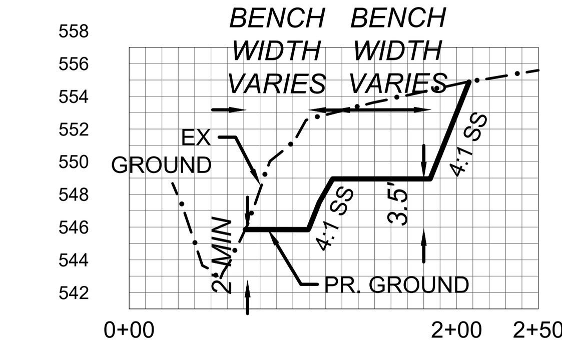
The hydrologic flow results without the Thaxton Road crossing are shown in **Table 2**.

Table 2: Hydrologic Flows without Thaxton Road Crossing

Post-Construction Flows (Ultimate Hydrology) (cfs)				
Element	2 - Year	10 - Year	25 - Year	100 - Year
LOCR320	495.1	937.2	1195.6	1600.5
VertexPond	131.3	430.6	620.4	1095
LOCR330	525.9	980.4	1244.1	1654.4
JLOCR330	525.9	980.4	1244.1	1654.4
RLOCR340C	490.1	922.2	1176.2	1571.8
LOCR340C	31.1	67.1	88.8	122.9
JLOCR340C	507.1	960.7	1226.4	1640.4
JLOCR320_340C	576.1	1298.9	1751.4	2580.6
LOCR340A	352.9	668.3	852.7	1139.3
PCM_1_200	87.7	274.6	713.2	1163.4
JLOCR340A	87.7	274.6	713.2	1163.4
RLOCR340B	87.6	274.3	703.9	1130.8
LOCR340B	268.7	514.9	659.9	886
PCM_1_100	153.7	432.5	772.4	1903.3
JLOCR340B	153.7	432.5	772.4	1903.3
JLOCR340B_340C	728.5	1719.2	2457.2	3481.4
RLOCR350A	689.1	1702	2427.8	3456.4
LOCR350A	211.4	443.9	586.4	812.5
JLOCR350A	776.6	1950.6	2780.3	4069.8
RLOCR350B	745.2	1884.9	2684.8	3945.1
LOCR350B	125.2	280.5	380	541.1
JLOCR350B	765	1943.8	2771.7	4097.4
RLOCR350C	751.8	1904.7	2719.4	4020.7
LOCR350C	97.6	224.6	306.9	441.3
JLOCR350C	770.7	1962.5	2805.8	4164.9

Appendix D: Primary Analysis Proposed Design Schematics





CHANNEL IMPROVEMENT TYP. SECTION

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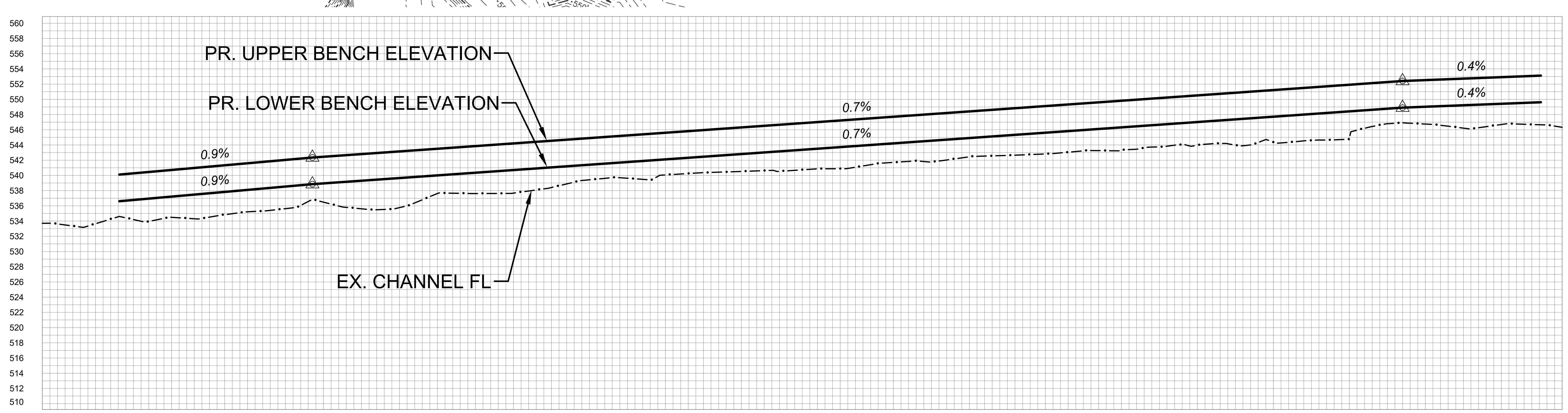

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PACES MILL FLOOD RISK REDUCTION STUDY

PRIMARY ANALYSIS

10-YEAR NATURAL CHANNEL

CITY OF AUSTIN — FOUNDED 1839

NOTES	NAME	DATE
SURVEY BY	GRZ	04/21
DRAWN BY	JDH	08/21
DESIGNED BY	PAS	08/21
CHECKED BY	AEW	08/21
REVIEWED BY		

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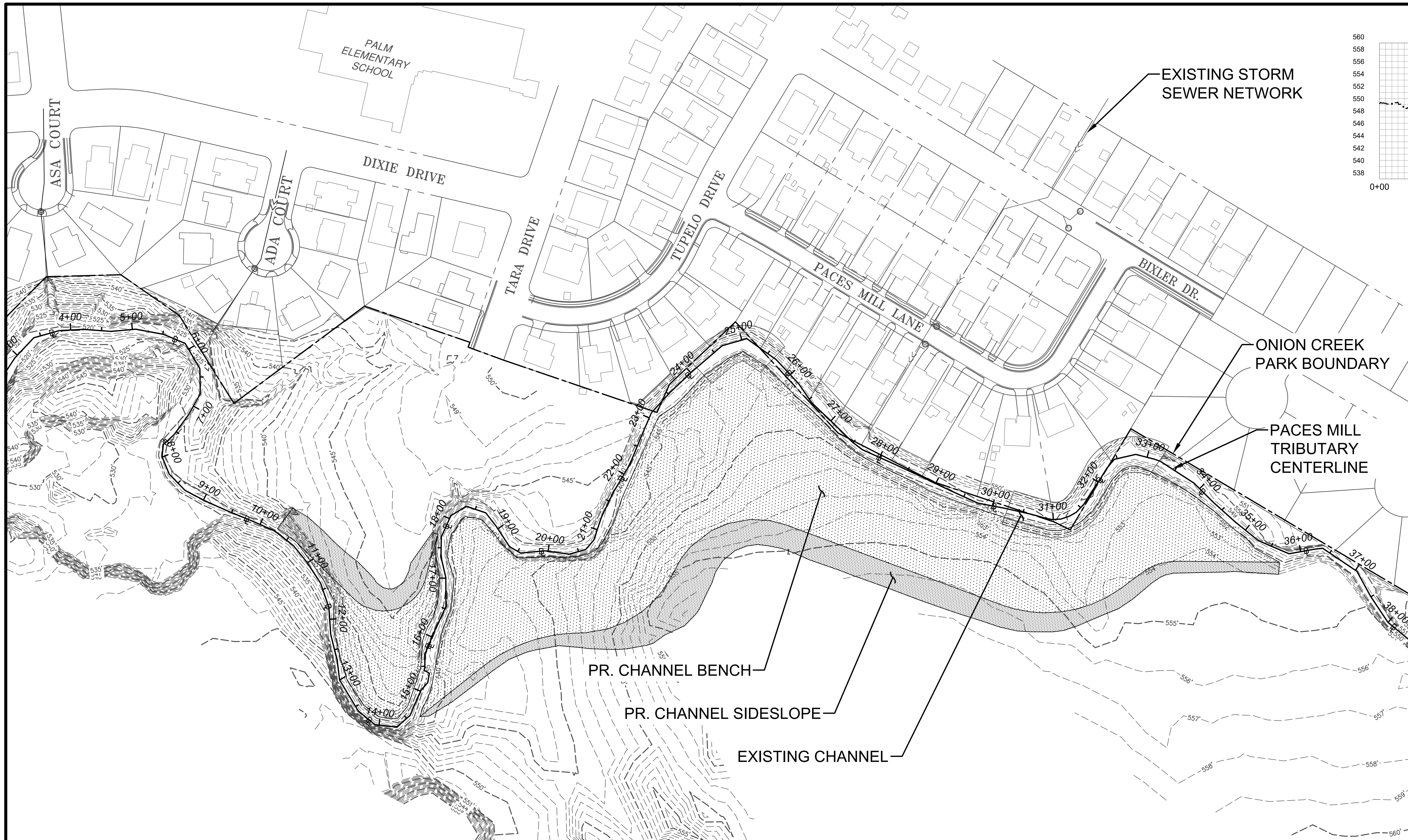
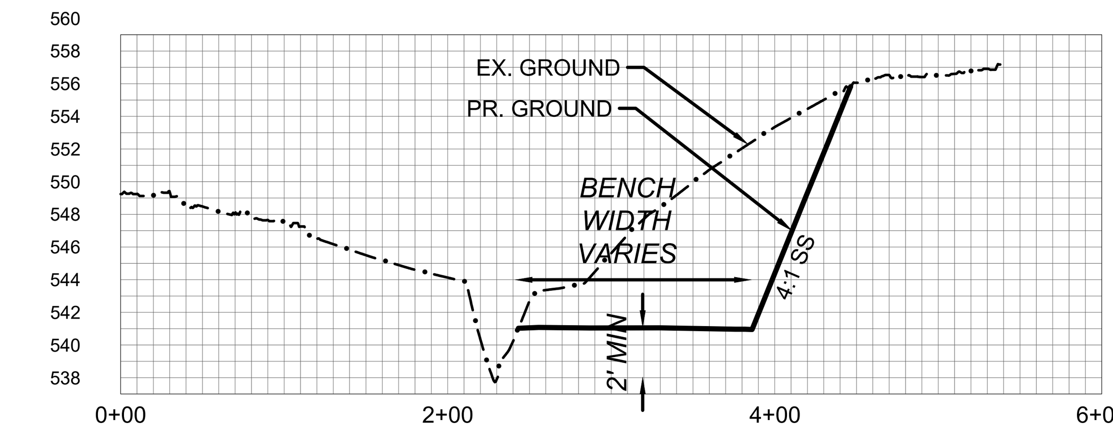
SHEET 1 OF 7





CHANNEL IMPROVEMENT TYP. SECTION

LEGEND

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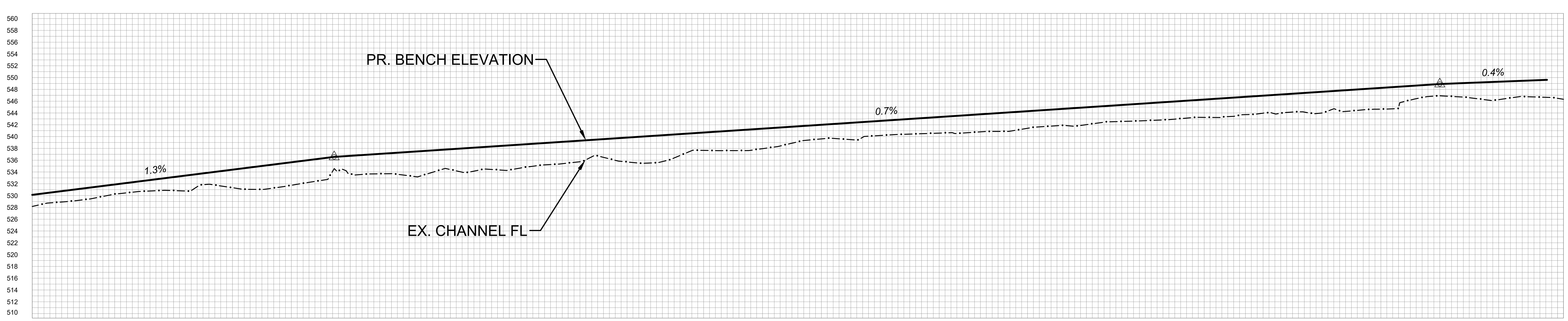
(hatched pattern)	SLOPE (PR)



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PACES MILL FLOOD RISK REDUCTION STUDY

PRIMARY ANALYSIS

25-YEAR NATURAL CHANNEL

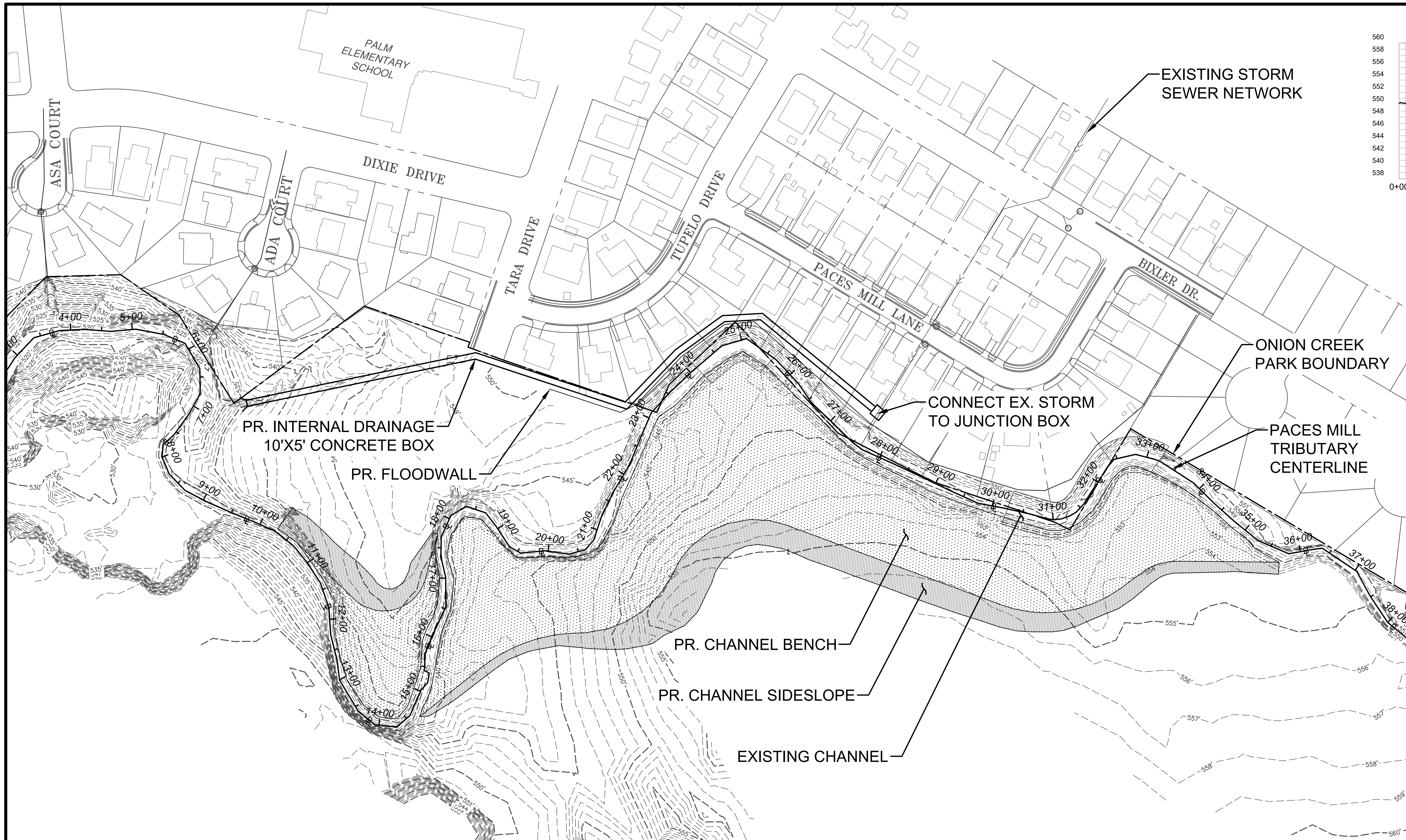
NOTES	NAME	DATE
SURVEY BY	GRZ	04/21
DRAWN BY	JDH	08/21
DESIGNED BY	PAS	08/21
CHECKED BY	AEW	08/21
REVIEWED BY		

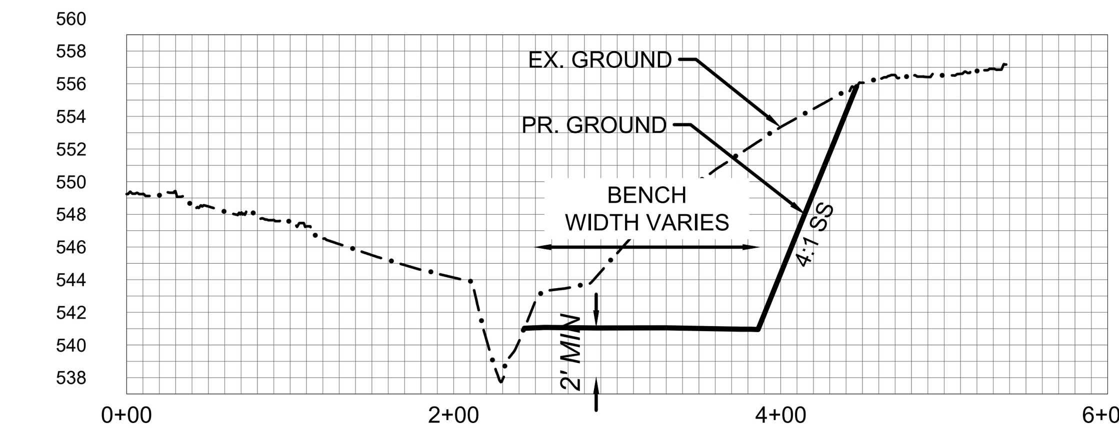
-

SHEET 2 OF 7

JOHN HIGGENBOTHAM

PAUL SHATTUCK





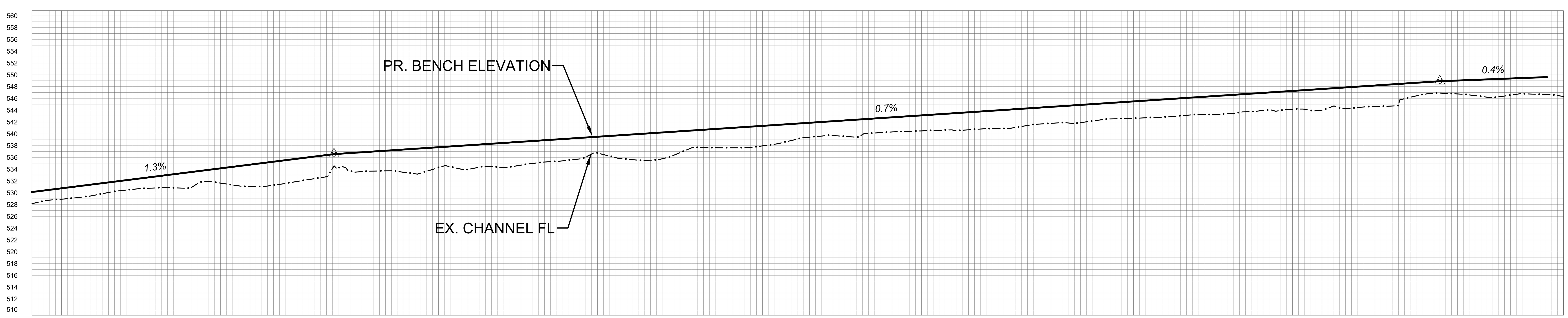
CHANNEL IMPROVEMENT TYP. SECTION

HORIZONTAL SCALE IN FEET: 0, 100, 200

VERTICAL SCALE IN FEET: 0, 10, 20

LEGEND

(dotted pattern)	BENCH OR CHANNEL BOTTOM (PR)
(hatched pattern)	SLOPE (PR)



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PACES MILL FLOOD RISK REDUCTION STUDY

PRIMARY ANALYSIS

25-YEAR NATURAL CHANNEL WITH FLOODWALL

CITY OF AUSTIN FOUNDED 1839

NOTES	NAME	DATE
SURVEY BY	GRZ	04/21
DRAWN BY	JDH	08/21
DESIGNED BY	PAS	08/21
CHECKED BY	AEW	08/21
REVIEWED BY		

-

SHEET 3 OF 7

JOHN HIGGENBOTHAM

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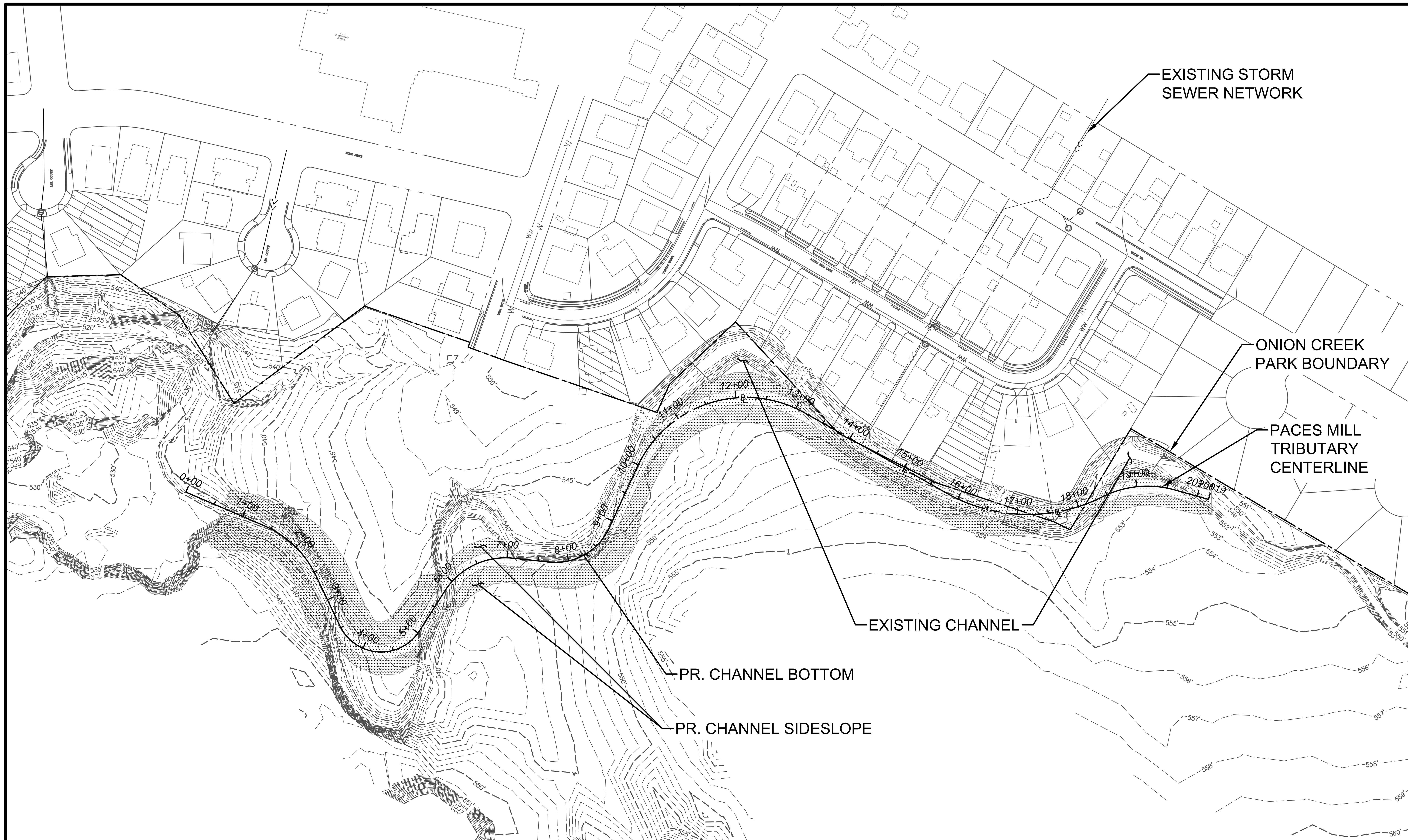

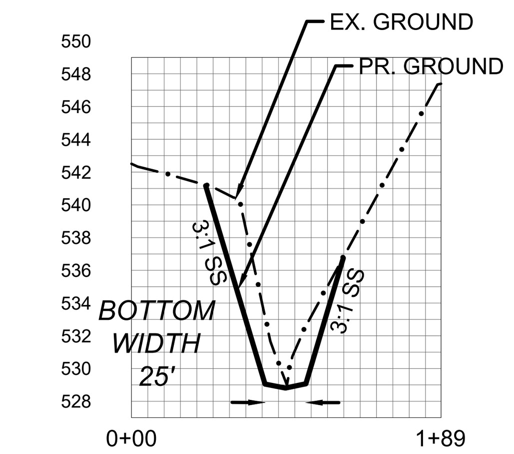

CHANNEL IMPROVEMENT
TYP. SECTION

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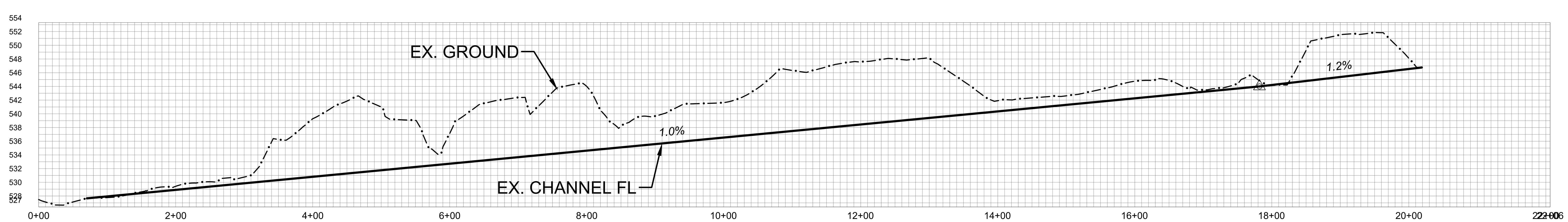
HORIZONTAL SCALE IN FEET

0 10 20
VERTICAL SCALE IN FEET

LEGEND

BENCH OR CHANNEL BOTTOM (PR)

SLOPE (PR)



REV. NO.	BY	DATE	REVISION DESCRIPTION

PRELIMINARY

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IT IS NOT TO BE USED FOR CONSTRUCTION, BIDDING OR PERMIT PURPOSES.

JOHN HIGGENBOTHAM

PACES MILL FLOOD RISK REDUCTION STUDY

PRIMARY ANALYSIS

25-YEAR ENGINEERED CHANNEL

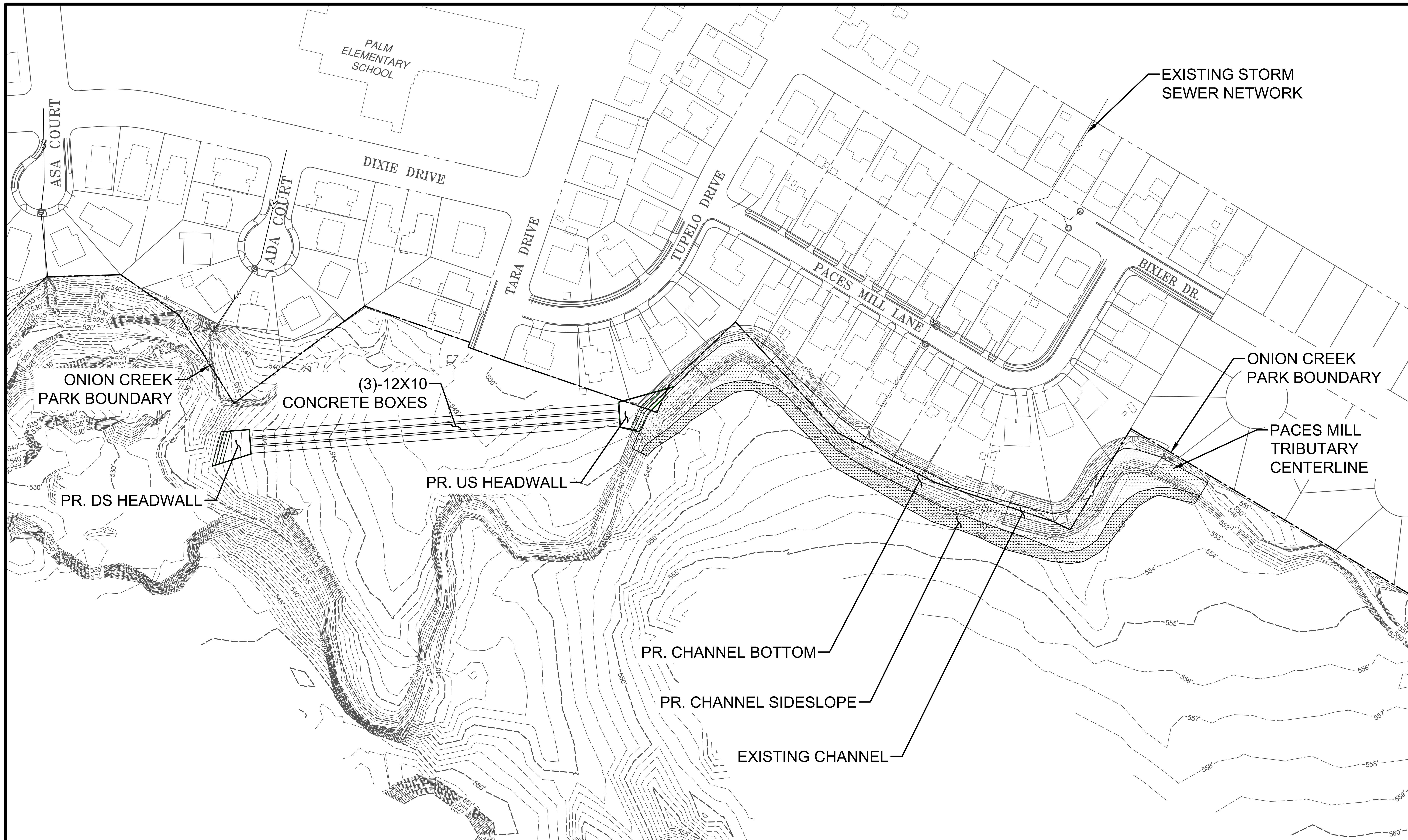
CITY OF AUSTIN FOUNDED 1839

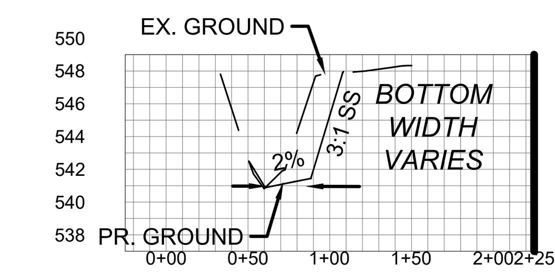
NOTES	NAME	DATE
SURVEY BY	GRZ	04/21
DRAWN BY	JDH	08/21
DESIGNED BY	PAS	08/21
CHECKED BY	AEW	08/21
REVIEWED BY		

-

SHEET 4 OF 7

PAUL SHATTUCK





CHANNEL IMPROVEMENT TYP. SECTION

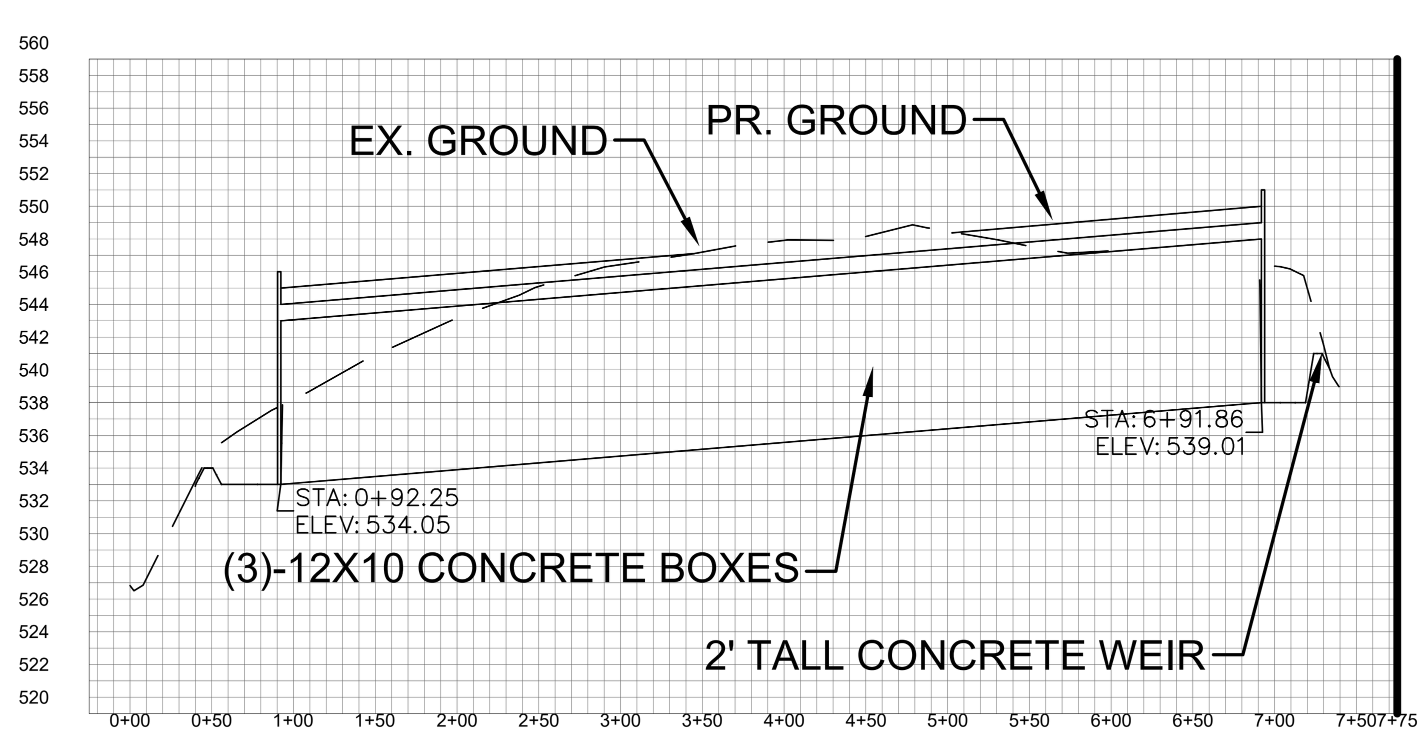
0 100 200
HORIZONTAL SCALE IN FEET

0 10 20
VERTICAL SCALE IN FEET

LEGEND

BENCH OR CHANNEL BOTTOM (PR)

SLOPE (PR)



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JOHN HIGGENBOTHAM

PACES MILL FLOOD RISK REDUCTION STUDY

PRIMARY ANALYSIS

FLEXIBLE DESIGN 1

CITY OF AUSTIN FOUNDED 1839

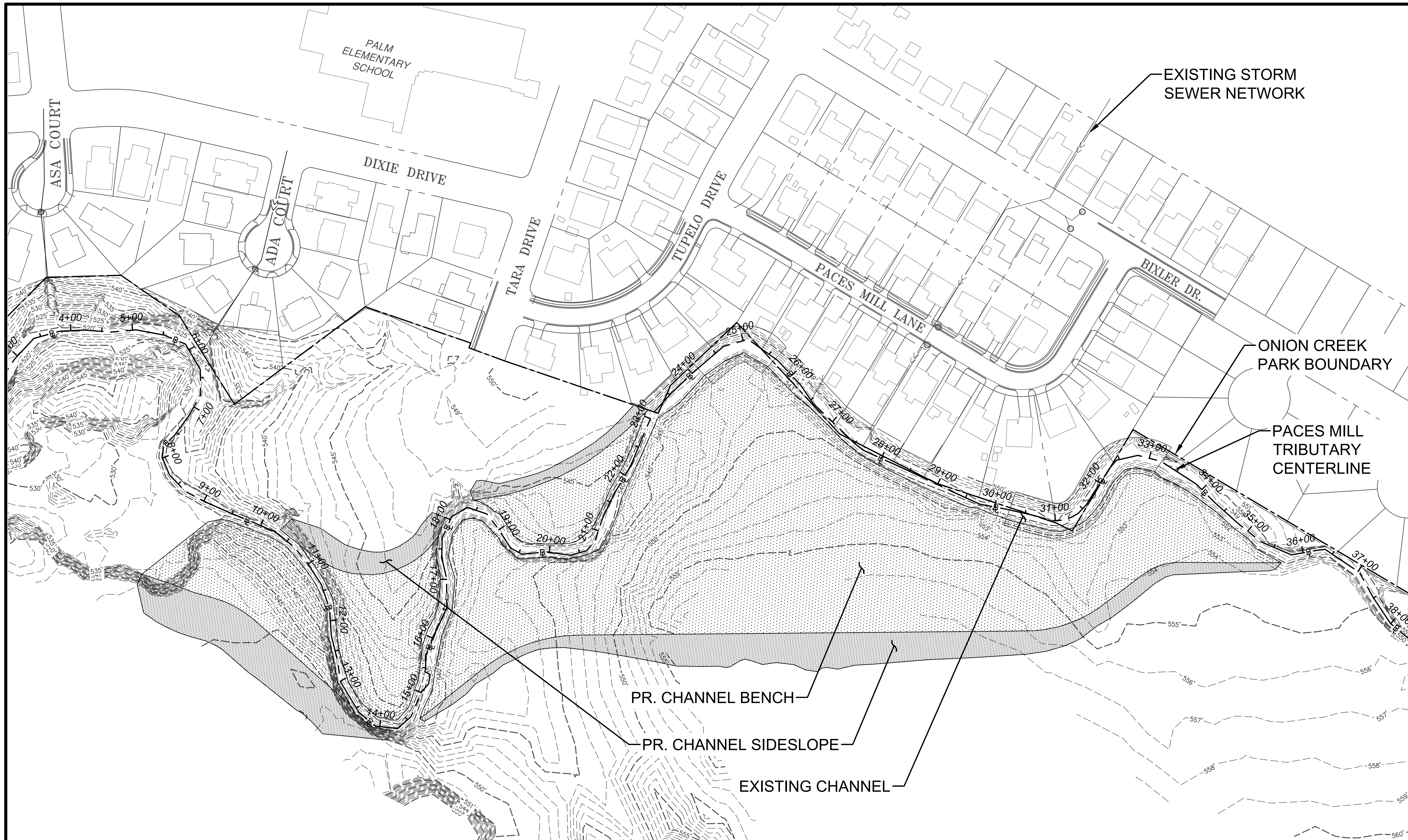
NOTES	NAME	DATE
SURVEY BY	GRZ	04/21
DRAWN BY	JDH	08/21
DESIGNED BY	PAS	08/21
CHECKED BY	AEW	08/21
REVIEWED BY		

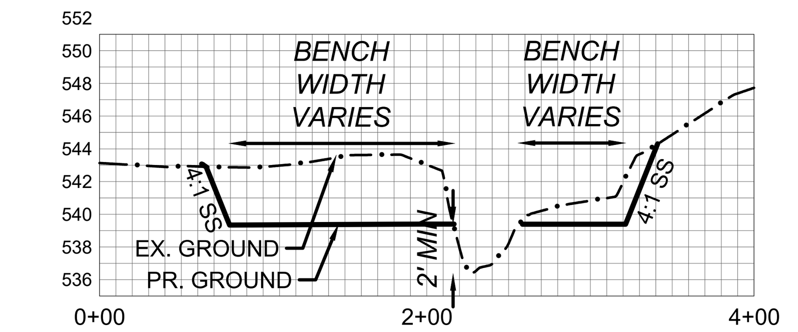
X:\PROJECTS\0767_COA_PACES MILL FRR\DWG\X0767_SHT01.DWG, ---, COA_ESD.STB

-

SHEET 5 OF 7

PAUL SHATTUCK





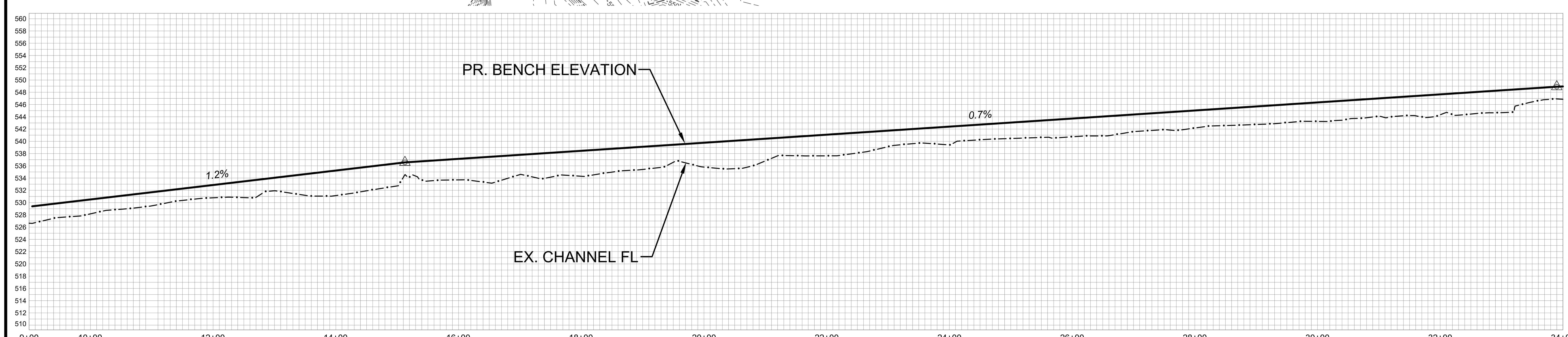
CHANNEL IMPROVEMENT TYP. SECTION

0 100 200
HORIZONTAL SCALE IN FEET

0 10 20
VERTICAL SCALE IN FEET

LEGEND

	BENCH OR CHANNEL BOTTOM (PR)
	SLOPE (PR)



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PACES MILL FLOOD RISK REDUCTION STUDY

PRIMARY ANALYSIS

100-YEAR NATURAL CHANNEL

CITY OF AUSTIN FOUNDED 1839

NOTES	NAME	DATE
SURVEY BY	GRZ	04/21
DRAWN BY	JDH	08/21
DESIGNED BY	PAS	08/21
CHECKED BY	AEW	08/21
REVIEWED BY		

-

SHEET 6 OF 7

JOHN HIGGENBOTHAM

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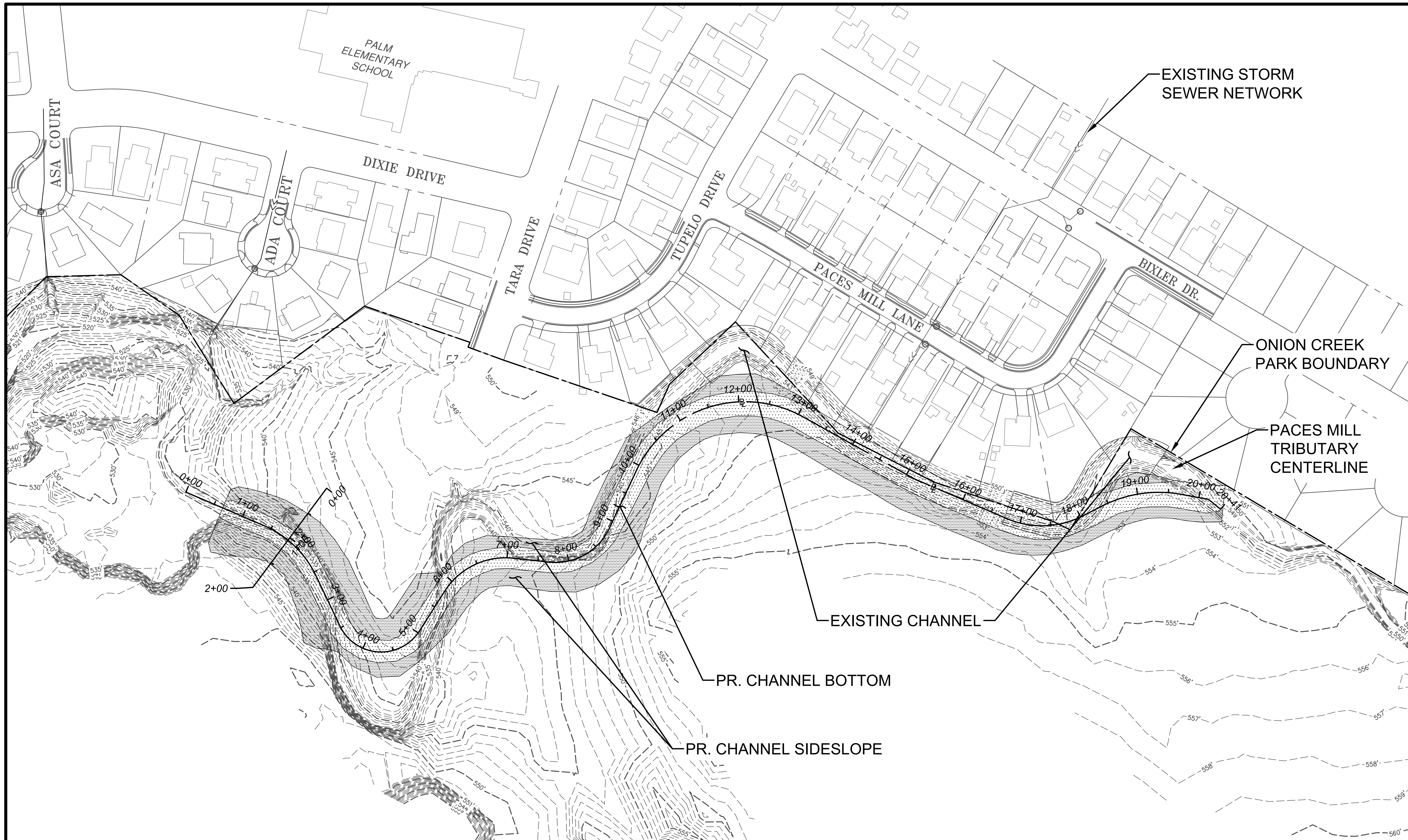
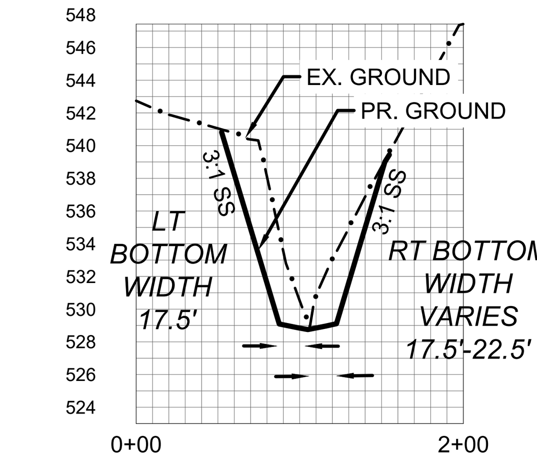
PAUL SHATTUCK





CHANNEL IMPROVEMENT TYP. SECTION

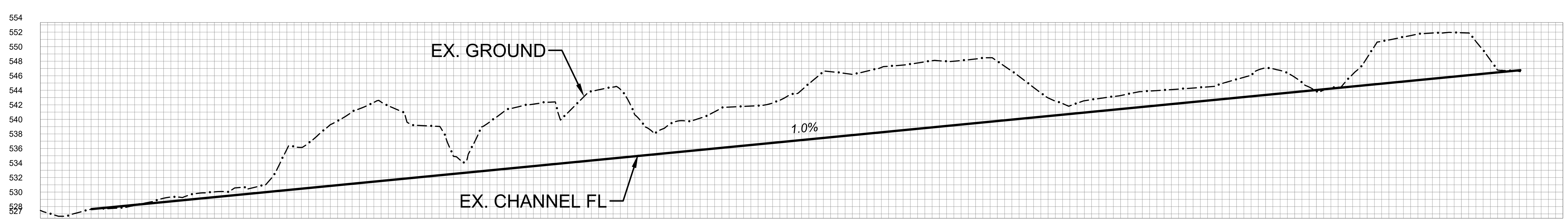
HORIZONTAL SCALE IN FEET (0, 100, 200)

VERTICAL SCALE IN FEET (0, 10, 20)

LEGEND

BENCH OR CHANNEL BOTTOM (PR)

SLOPE (PR)



REV. NO.	BY	DATE	REVISION DESCRIPTION

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JOHN HIGGENBOTHAM

PACES MILL FLOOD RISK REDUCTION STUDY

PRIMARY ANALYSIS

100-YEAR ENGINEERED CHANNEL

CITY OF AUSTIN FOUNDED 1839

NOTES	NAME	DATE
SURVEY BY	GRZ	04/21
DRAWN BY	JDH	08/21
DESIGNED BY	PAS	08/21
CHECKED BY	AEW	08/21
REVIEWED BY		

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PAUL SHATTUCK

-

SHEET 7 OF 7

Appendix E: Primary Analysis Inundation Exhibits

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Existing 2-Year Inundation Boundary
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets

City of Austin
Paces Mill Lane
Flood Risk Reduction

Existing 2-Year
Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 8/20/2021

CITY OF AUSTIN FOUNDED 1839

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Existing 10-Year Inundation Boundary
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets

City of Austin
Paces Mill Lane
Flood Risk Reduction

Existing 10-Year
Inundation Boundary

N

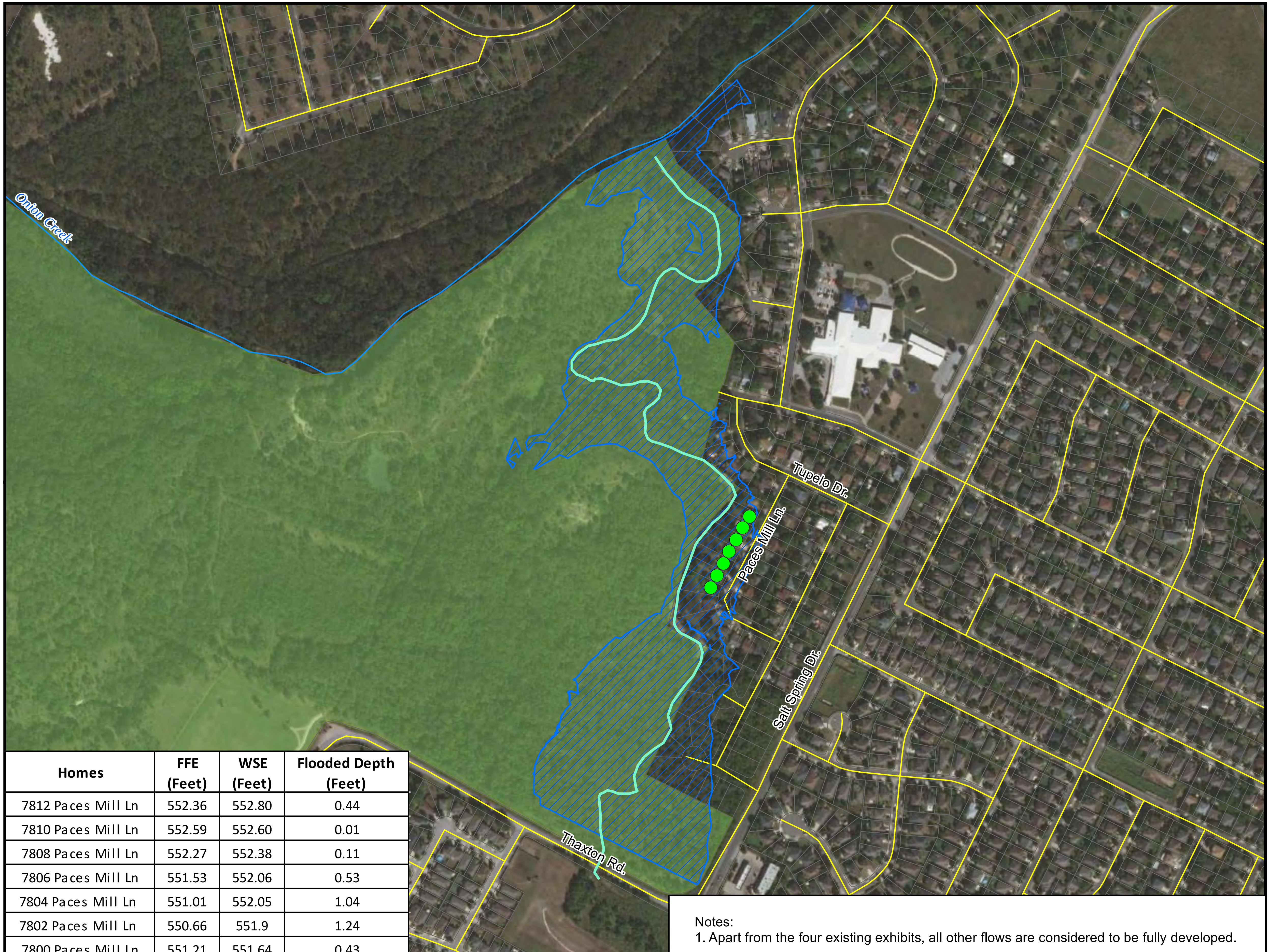
0 200 400

1 inch = 400 feet

Date: 8/20/2021

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING

FIRM NO. 6535



Homes	FFE (Feet)	WSE (Feet)	Flooded Depth (Feet)
7812 Paces Mill Ln	552.36	552.80	0.44
7810 Paces Mill Ln	552.59	552.60	0.01
7808 Paces Mill Ln	552.27	552.38	0.11
7806 Paces Mill Ln	551.53	552.06	0.53
7804 Paces Mill Ln	551.01	552.05	1.04
7802 Paces Mill Ln	550.66	551.9	1.24
7800 Paces Mill Ln	551.21	551.64	0.43

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.

Legend

- Existing 25-Year Inundation Boundary
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets
- Flooded Homes

City of Austin
Paces Mill Lane
Flood Risk Reduction

Existing 25-Year Inundation Boundary

N

0 200 400

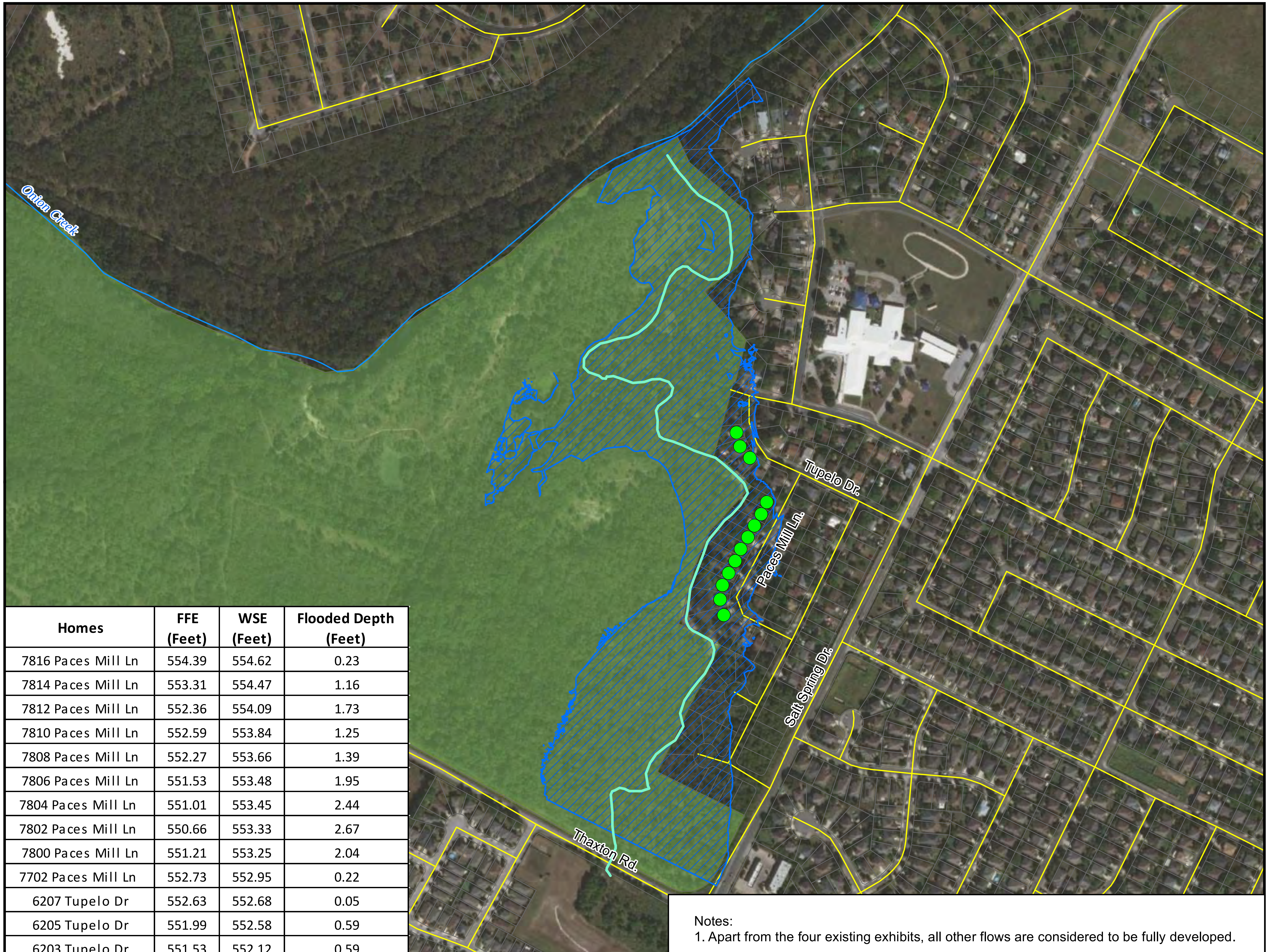
1 inch = 400 feet

Date: 8/20/2021

CITY OF AUSTIN FOUNDED 1839

K·FRIESE + ASSOCIATES PUBLIC PROJECT ENGINEERING

FIRM NO. 6535



Homes	FFE (Feet)	WSE (Feet)	Flooded Depth (Feet)
7816 Paces Mill Ln	554.39	554.62	0.23
7814 Paces Mill Ln	553.31	554.47	1.16
7812 Paces Mill Ln	552.36	554.09	1.73
7810 Paces Mill Ln	552.59	553.84	1.25
7808 Paces Mill Ln	552.27	553.66	1.39
7806 Paces Mill Ln	551.53	553.48	1.95
7804 Paces Mill Ln	551.01	553.45	2.44
7802 Paces Mill Ln	550.66	553.33	2.67
7800 Paces Mill Ln	551.21	553.25	2.04
7702 Paces Mill Ln	552.73	552.95	0.22
6207 Tupelo Dr	552.63	552.68	0.05
6205 Tupelo Dr	551.99	552.58	0.59
6203 Tupelo Dr	551.53	552.12	0.59

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.

Legend

- Existing 100-Year Inundation Boundary
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets
- Flooded Homes

City of Austin Paces Mill Lane Flood Risk Reduction

Existing 100-Year Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 8/20/2021

CITY OF AUSTIN FOUNDED 1839

K·FRIESE + ASSOCIATES PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Ultimate 2-Year Inundation Boundary
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets

City of Austin
Paces Mill Lane
Flood Risk Reduction

Fully-Developed 2-Year Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 8/20/2021

CITY OF AUSTIN FOUNDED 1839

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Homes	FFE (Feet)	WSE (Feet)	Flooded Depth (Feet)
7804 Paces Mill Ln	551.01	551.26	0.25
7802 Paces Mill Ln	550.66	550.92	0.26

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.

Legend

- Ultimate 10-Year Inundation Boundary
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets
- Flooded Homes

City of Austin Paces Mill Lane Flood Risk Reduction

Fully-Developed 10-Year Inundation Boundary

N

0 200 400

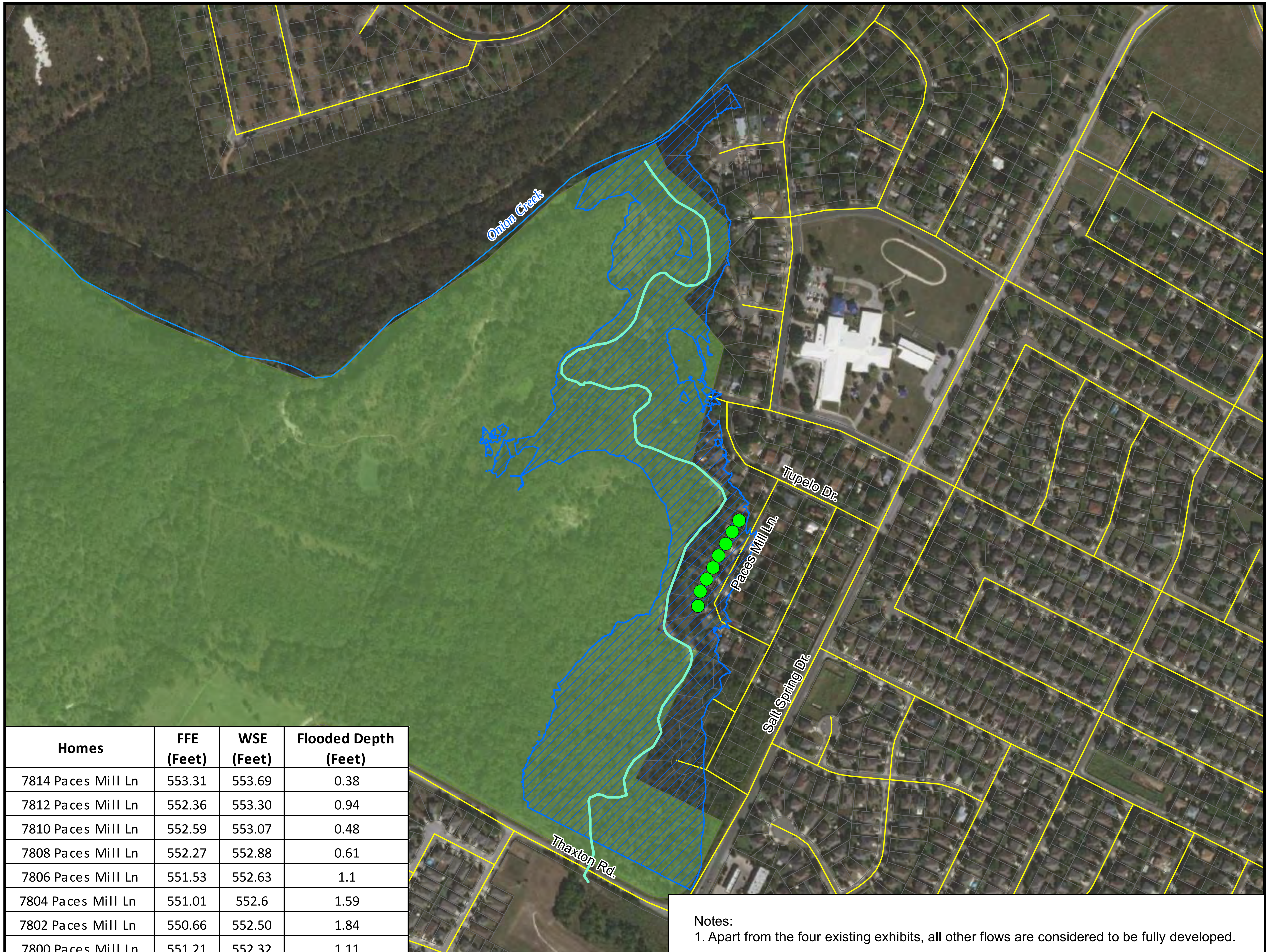
1 inch = 400 feet

Date: 8/20/2021

CITY OF AUSTIN FOUNDED 1839

K·FRIESE + ASSOCIATES PUBLIC PROJECT ENGINEERING

FIRM NO. 6535



Homes	FFE (Feet)	WSE (Feet)	Flooded Depth (Feet)
7814 Paces Mill Ln	553.31	553.69	0.38
7812 Paces Mill Ln	552.36	553.30	0.94
7810 Paces Mill Ln	552.59	553.07	0.48
7808 Paces Mill Ln	552.27	552.88	0.61
7806 Paces Mill Ln	551.53	552.63	1.1
7804 Paces Mill Ln	551.01	552.6	1.59
7802 Paces Mill Ln	550.66	552.50	1.84
7800 Paces Mill Ln	551.21	552.32	1.11

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.

Legend

- Ultimate 25-Year Inundation Boundary
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets
- Flooded Homes

City of Austin
Paces Mill Lane
Flood Risk Reduction

Fully Developed 25-Year Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 8/20/2021

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Homes	FFE (Feet)	WSE (Feet)	Flooded Depth (Feet)
7818 Paces Mill Ln	555.14	555.28	0.14
7816 Paces Mill Ln	554.39	555.13	0.74
7814 Paces Mill Ln	553.31	554.98	1.67
7812 Paces Mill Ln	552.36	554.59	2.23
7810 Paces Mill Ln	552.59	554.35	1.76
7808 Paces Mill Ln	552.27	554.18	1.91
7806 Paces Mill Ln	551.53	553.96	2.43
7804 Paces Mill Ln	551.01	553.98	2.97
7802 Paces Mill Ln	550.66	553.92	3.26
7800 Paces Mill Ln	551.21	553.89	2.68
7702 Paces Mill Ln	552.73	553.53	0.80
6207 Tupelo Dr	552.63	553.19	0.56
6205 Tupelo Dr	551.99	553.04	1.05
6203 Tupelo Dr	551.53	552.59	1.06
6111 Tupelo Dr	551.84	551.96	0.12

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.

Legend

- Ultimate 100-Year Inundation Boundary
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets
- Flooded Homes

City of Austin
Paces Mill Lane
Flood Risk Reduction

Fully-Developed 100-Year Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 8/20/2021

CITY OF AUSTIN FOUNDED 1839

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Proposed 2-Year Inundation Boundary
- Proposed 25-year Channel Bottom (25-ft)
- Proposed 25-year Channel Side Slope (3:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets

City of Austin
Paces Mill Lane
Flood Risk Reduction

25-Year Engineered Channel
Proposed 2-Year
Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 8/20/2021

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Proposed 10-Year Inundation Boundary
- Proposed 25-year Channel Bottom (25-ft)
- Proposed 25-year Channel Side Slope (3:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets

City of Austin Paces Mill Lane Flood Risk Reduction

25-Year Engineered Channel
Proposed 10-Year
Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 8/20/2021

CITY OF AUSTIN FOUNDED 1839

K·FRIESE + ASSOCIATES PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Proposed 25-Year Inundation Boundary
- Proposed 25-year Channel Bottom (25-ft)
- Proposed 25-year Channel Side Slope (3:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets

City of Austin Paces Mill Lane Flood Risk Reduction

25-Year Engineered Channel
Proposed 25-Year
Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 8/20/2021

CITY OF AUSTIN FOUNDED 1839

K·FRIESE + ASSOCIATES PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Proposed 100-Year Inundation Boundary
- Proposed 25-year Channel Bottom (25-ft)
- Proposed 25-year Channel Side Slope (3:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets

City of Austin
Paces Mill Lane
Flood Risk Reduction

25-Year Engineered Channel
Proposed 100-Year
Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 8/20/2021

CITY OF AUSTIN FOUNDED 1839

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Proposed 2-Year Inundation Boundary
- Proposed 100-year Channel Bottom (Varies, 17.5-22.5-ft)
- Proposed 100-year Channel Side Slope (3:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets

City of Austin
Paces Mill Lane
Flood Risk Reduction

100-Year Engineered Channel
Proposed 2-Year
Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 8/20/2021

CITY OF AUSTIN
FOUNDED 1839

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Proposed 10-Year Inundation Boundary
- Proposed 100-year Channel Bottom (Varies, 17.5-22.5-ft)
- Proposed 100-year Channel Side Slope (3:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets

City of Austin Paces Mill Lane Flood Risk Reduction

100-Year Engineered Channel
Proposed 10-Year
Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 8/20/2021

CITY OF AUSTIN FOUNDED 1839

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Proposed 25-Year Inundation Boundary
- Proposed 100-year Channel Bottom (Varies, 17.5-22.5-ft)
- Proposed 100-year Channel Side Slope (3:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets

City of Austin Paces Mill Lane Flood Risk Reduction

100-Year Engineered Channel
Proposed 25-Year
Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 8/20/2021

CITY OF AUSTIN FOUNDED 1839

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Proposed 100-Year Inundation Boundary
- Proposed 100-year Channel Bottom (Varies, 17.5-22.5-ft)
- Proposed 100-year Channel Side Slope (3:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets

City of Austin Paces Mill Lane Flood Risk Reduction

100-Year Engineered Channel
Proposed 100-Year
Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 8/20/2021

CITY OF AUSTIN FOUNDED 1839

K·FRIESE + ASSOCIATES PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Proposed 2-Year Inundation Boundary
- Proposed Channel Bench (Varies 0-160-ft)
- Proposed Channel Side Slope (4:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets

City of Austin Paces Mill Lane Flood Risk Reduction

10-Year Natural Channel
Proposed 2-Year
Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 8/20/2021

CITY OF AUSTIN FOUNDED 1839

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Proposed 10-Year Inundation Boundary
- Proposed Channel Bench (Varies 0-160-ft)
- Proposed Channel Side Slope (4:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets

City of Austin
Paces Mill Lane
Flood Risk Reduction

10-Year Natural Channel
Proposed 10-Year
Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 8/20/2021

CITY OF AUSTIN
FOUNDED 1839

K·FRIESE
+ ASSOCIATES
PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Proposed 25-Year Inundation Boundary
- Proposed Channel Bench (Varies 0-160-ft)
- Proposed Channel Side Slope (4:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets

City of Austin
Paces Mill Lane
Flood Risk Reduction

10-Year Natural Channel
Proposed 25-Year
Inundation Boundary

N

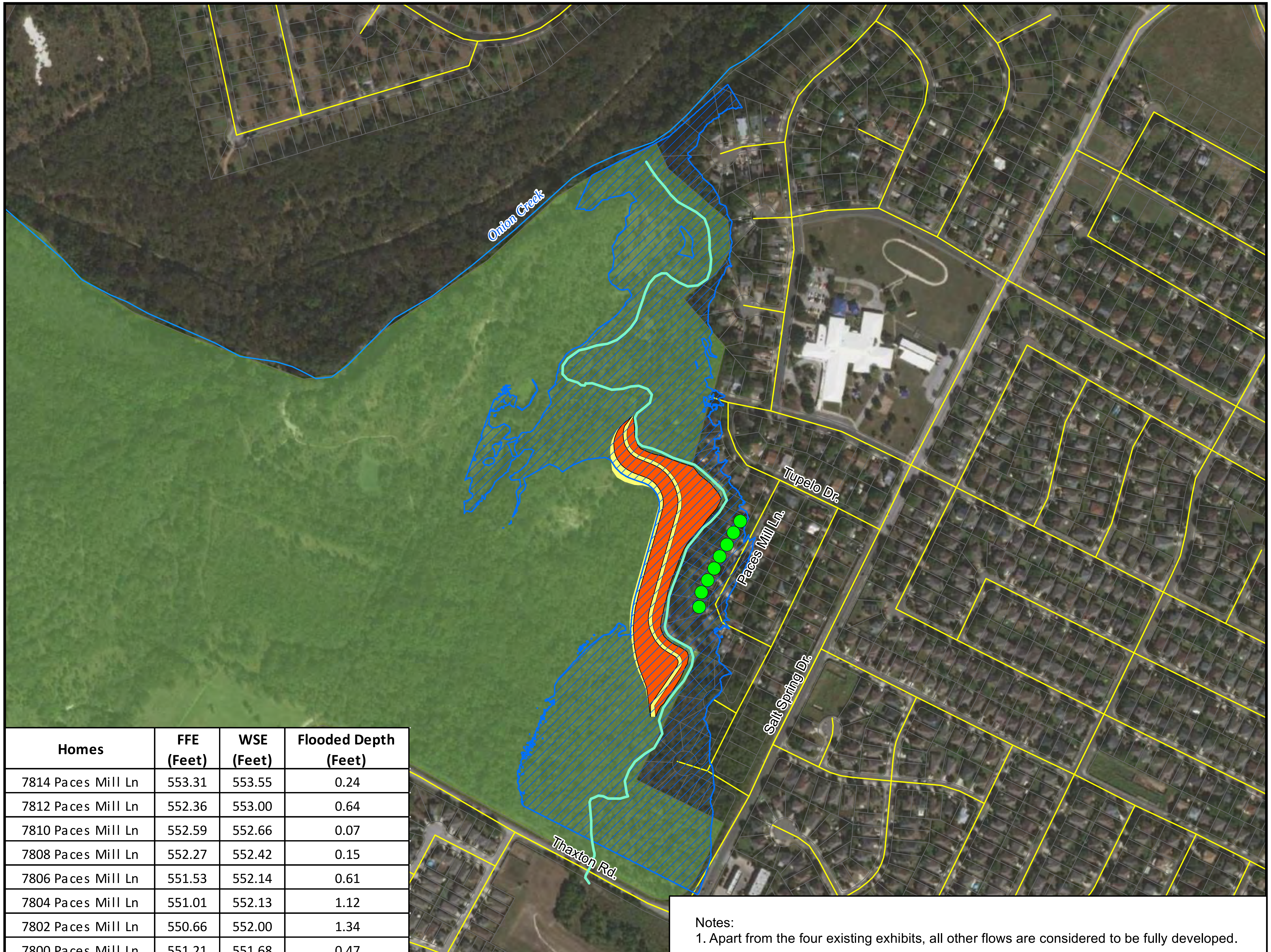
0 200 400

1 inch = 400 feet

Date: 8/20/2021

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING

FIRM NO. 6535



Homes	FFE (Feet)	WSE (Feet)	Flooded Depth (Feet)
7814 Paces Mill Ln	553.31	553.55	0.24
7812 Paces Mill Ln	552.36	553.00	0.64
7810 Paces Mill Ln	552.59	552.66	0.07
7808 Paces Mill Ln	552.27	552.42	0.15
7806 Paces Mill Ln	551.53	552.14	0.61
7804 Paces Mill Ln	551.01	552.13	1.12
7802 Paces Mill Ln	550.66	552.00	1.34
7800 Paces Mill Ln	551.21	551.68	0.47

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.

Legend

- Proposed 100-Year Inundation Boundary
- Proposed Channel Bench (Varies 0-160-ft)
- Proposed Channel Side Slope (4:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets
- Flooded Homes

City of Austin
Paces Mill Lane
Flood Risk Reduction

10-Year Natural Channel
Proposed 100-Year
Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 8/25/2021

CITY OF AUSTIN
FOUNDED 1839

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Legend

- Proposed 2-Year Inundation Boundary
- Proposed Channel Bench (Varies 0-273-ft)
- Proposed Channel Side Slope (4:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets

City of Austin Paces Mill Lane Flood Risk Reduction

25-Year Natural Channel
Proposed 2-Year
Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 8/20/2021

CITY OF AUSTIN FOUNDED 1839

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Proposed Channel Bench (Varies 0-273-ft)
- Proposed Channel Side Slope (4:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets

City of Austin Paces Mill Lane Flood Risk Reduction

25-Year Natural Channel
Proposed 10-Year
Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 8/20/2021

CITY OF AUSTIN FOUNDED 1839

K·FRIESE + ASSOCIATES PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Proposed 25-Year Inundation Boundary
- Proposed Channel Bench (Varies 0-273-ft)
- Proposed Channel Side Slope (4:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets

City of Austin Paces Mill Lane Flood Risk Reduction

25-Year Natural Channel Proposed 25-Year Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 8/20/2021

CITY OF AUSTIN FOUNDED 1839

K·FRIESE + ASSOCIATES PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Proposed 100-Year Inundation Boundary
- Proposed Channel Bench (Varies 0-273-ft)
- Proposed Channel Side Slope (4:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets

City of Austin Paces Mill Lane Flood Risk Reduction

25-Year Natural Channel
Proposed 100-Year
Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 8/20/2021

CITY OF AUSTIN FOUNDED 1839

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Proposed 2-Year Inundation Boundary
- Proposed Channel Bench (Varies 0-457-ft)
- Proposed Channel Side Slope (4:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets

City of Austin Paces Mill Lane Flood Risk Reduction

100-Year Natural Channel
Proposed 2-Year Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 8/20/2021

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Proposed 10-Year Inundation Boundary
- Proposed Channel Bench (Varies 0-457-ft)
- Proposed Channel Side Slope (4:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets

City of Austin
Paces Mill Lane
Flood Risk Reduction

100-Year Natural Channel
Proposed 10-Year
Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 8/20/2021

CITY OF AUSTIN FOUNDED 1839

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- 25-Year Inundation Boundary
- Proposed Channel Bench (Varies 0-457-ft)
- Proposed Channel Side Slope (4:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets

City of Austin
Paces Mill Lane
Flood Risk Reduction
100-Year Natural Channel
Proposed 25-Year
Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 8/20/2021

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Proposed 100-Year Inundation Boundary
- Proposed Channel Bench (Varies 0-457-ft)
- Proposed Channel Side Slope (4:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets

City of Austin Paces Mill Lane Flood Risk Reduction

100-Year Natural Channel
Proposed 100-Year
Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 8/20/2021

CITY OF AUSTIN FOUNDED 1839

K·FRIESE + ASSOCIATES PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Proposed 2-Year Inundation Boundary
- Proposed Channel Bottom (35-ft typical)
- Proposed Channel Side Slope (3:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets
- Proposed 3-12x10 Concrete Box Culvert

City of Austin Paces Mill Lane Flood Risk Reduction

Culvert Bypass
Proposed 2-Year
Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 8/20/2021

CITY OF AUSTIN FOUNDED 1839

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Proposed 10-Year Inundation Boundary
- Proposed Channel Bottom (35-ft typical)
- Proposed Channel Side Slope (3:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets
- Proposed 3-12x10 Concrete Box Culvert

City of Austin
Paces Mill Lane
Flood Risk Reduction

Culvert Bypass
Proposed 10-Year
Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 8/20/2021

CITY OF AUSTIN FOUNDED 1839

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Proposed 25-Year Inundation Boundary
- Proposed Channel Bottom (35-ft typical)
- Proposed Channel Side Slope (3:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets
- Proposed 3-12x10 Concrete Box Culvert

City of Austin Paces Mill Lane Flood Risk Reduction

Culvert Bypass
Proposed 25-Year Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 8/20/2021

CITY OF AUSTIN FOUNDED 1839

K·FRIESE + ASSOCIATES PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Proposed 100-Year Inundation Boundary
- Proposed Channel Bottom (35-ft typical)
- Proposed Channel Side Slope (3:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets
- Proposed 3-12x10 Concrete Box Culvert

City of Austin
Paces Mill Lane
Flood Risk Reduction

Culvert Bypass
Proposed 100-Year
Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 8/20/2021

CITY OF AUSTIN
FOUNDED 1839

K·FRIESE
+ ASSOCIATES
PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Proposed 2-Year Inundation Boundary
- Proposed Channel Maintenance
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets

City of Austin
Paces Mill Lane
Flood Risk Reduction

Channel Maintenance
Proposed 2-Year
Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 8/20/2021

CITY OF AUSTIN
FOUNDED 1839

K·FRIESE
+ ASSOCIATES
PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Proposed 10-Year Inundation Boundary
- Proposed Channel Maintenance
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets

City of Austin Paces Mill Lane Flood Risk Reduction

Channel Maintenance Proposed 10-Year Inundation Boundary

N

0 200 400

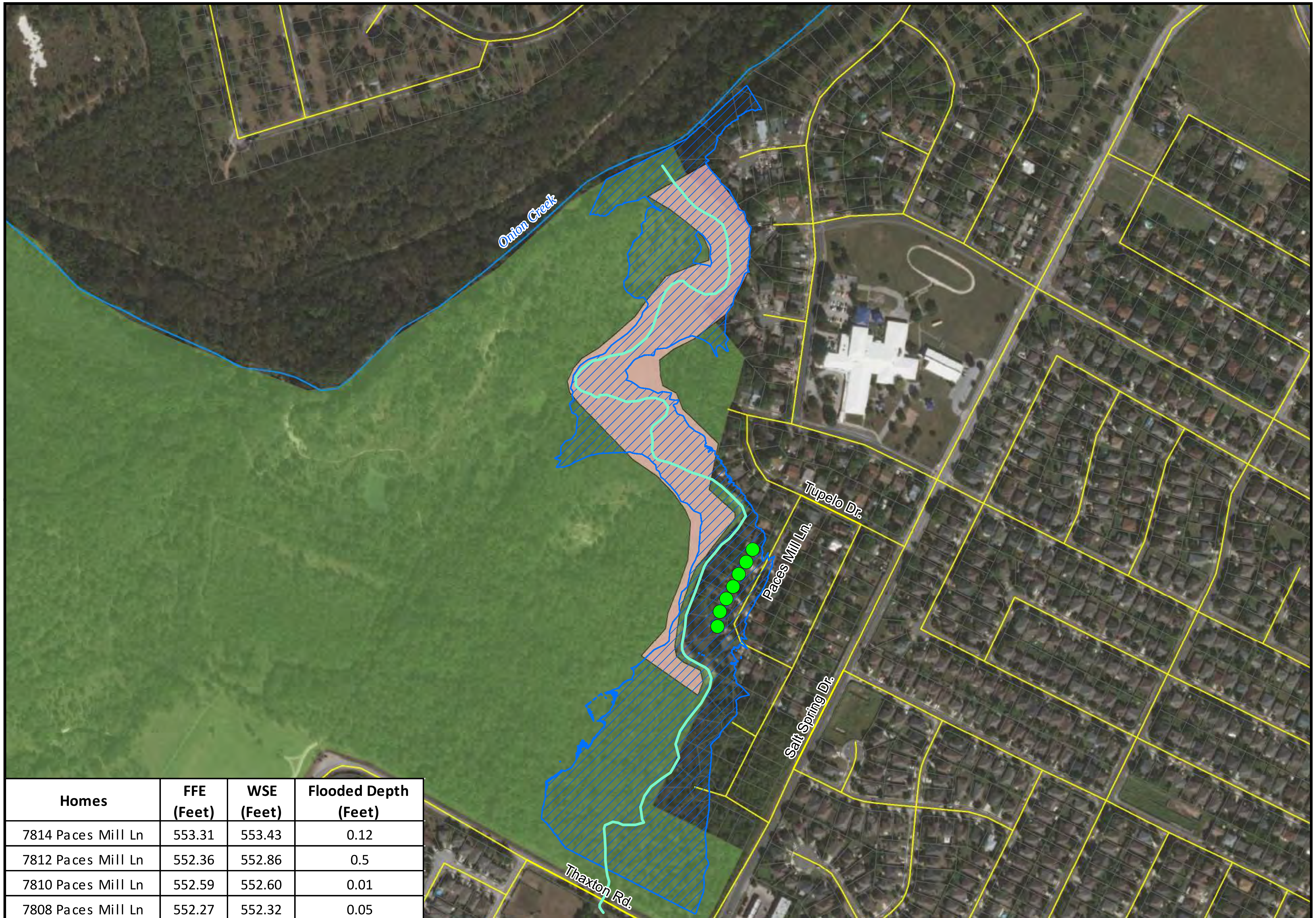
1 inch = 400 feet

Date: 8/20/2021

CITY OF AUSTIN FOUNDED 1839

K·FRIESE + ASSOCIATES PUBLIC PROJECT ENGINEERING

FIRM NO. 6535



Homes	FFE (Feet)	WSE (Feet)	Flooded Depth (Feet)
7814 Paces Mill Ln	553.31	553.43	0.12
7812 Paces Mill Ln	552.36	552.86	0.5
7810 Paces Mill Ln	552.59	552.60	0.01
7808 Paces Mill Ln	552.27	552.32	0.05
7806 Paces Mill Ln	551.53	551.95	0.42
7804 Paces Mill Ln	551.01	551.96	0.95
7802 Paces Mill Ln	550.66	551.38	0.72

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.

Legend

- Proposed 25-Year Inundation Boundary
- Proposed Channel Maintenance
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets
- Flooded Homes

City of Austin Paces Mill Lane Flood Risk Reduction

Channel Maintenance
Proposed 25-Year
Inundation Boundary

N

0 200 400

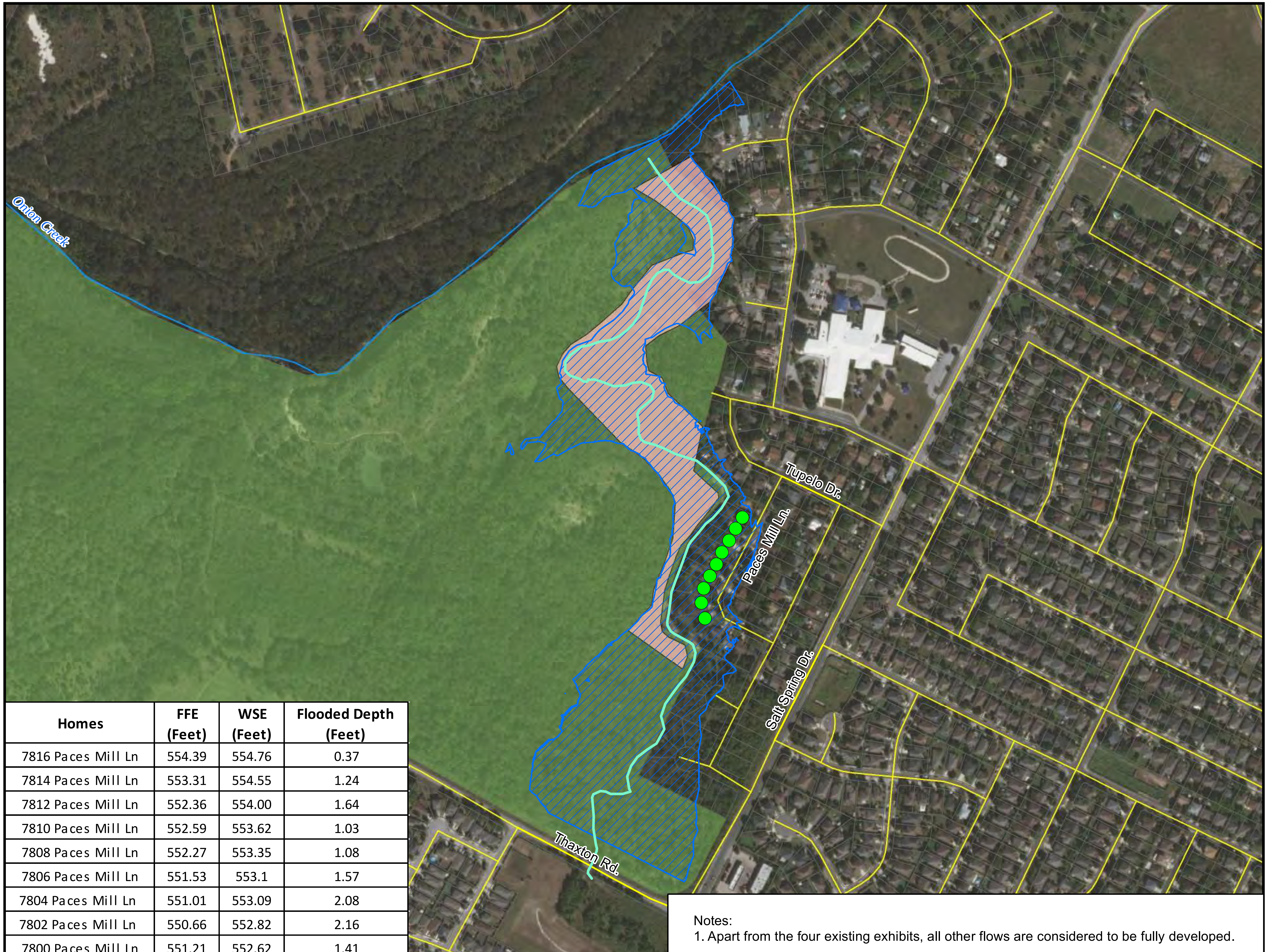
1 inch = 400 feet

Date: 8/20/2021

CITY OF AUSTIN FOUNDED 1839

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING

FIRM NO. 6535



Legend

- Proposed 100-Year Inundation Boundary
- Proposed Channel Maintenance
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets
- Flooded Homes

Homes	FFE (Feet)	WSE (Feet)	Flooded Depth (Feet)
7816 Paces Mill Ln	554.39	554.76	0.37
7814 Paces Mill Ln	553.31	554.55	1.24
7812 Paces Mill Ln	552.36	554.00	1.64
7810 Paces Mill Ln	552.59	553.62	1.03
7808 Paces Mill Ln	552.27	553.35	1.08
7806 Paces Mill Ln	551.53	553.1	1.57
7804 Paces Mill Ln	551.01	553.09	2.08
7802 Paces Mill Ln	550.66	552.82	2.16
7800 Paces Mill Ln	551.21	552.62	1.41

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.

City of Austin
Paces Mill Lane
Flood Risk Reduction

Channel Maintenance
Proposed 100-Year
Inundation Boundary

N

0 200 400

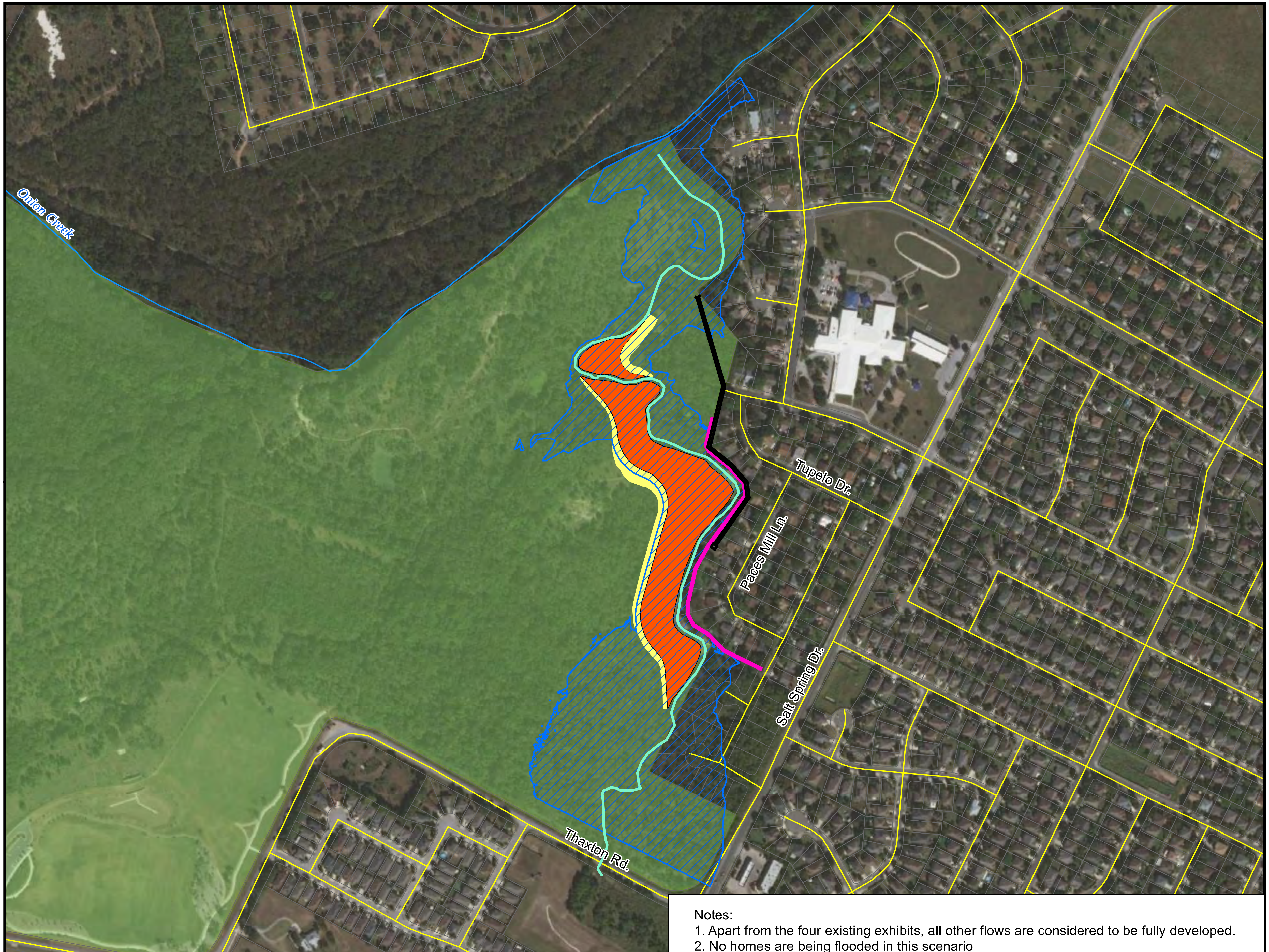
1 inch = 400 feet

Date: 8/20/2021

CITY OF AUSTIN FOUNDED 1839

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING

FIRM NO. 6535



Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Proposed 25-Year Inundation Boundary
- Proposed Channel Bench (Varies 0-273-ft)
- Proposed Channel Side Slope (4:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Proposed 10x5 Concrete Box Culvert
- Proposed Flood Wall (1333-ft)
- Onion Creek Centerline
- Streets

City of Austin
Paces Mill Lane
Flood Risk Reduction
25-Year Natural Channel
Flood Wall-Proposed
25-Year Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 8/20/2021

CITY OF AUSTIN FOUNDED 1839

K·FRIESE + ASSOCIATES PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Legend

- Proposed 100-Year Inundation Boundary
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Proposed Flood Wall (1601-ft)
- Proposed 10x5 Concrete Box Culvert
- Onion Creek Centerline
- Streets

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

City of Austin
Paces Mill Lane
Flood Risk Reduction

Flood Wall
Proposed 100-Year
Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 8/20/2021

CITY OF AUSTIN FOUNDED 1839

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Appendix F: Primary Analysis Engineer's Opinion of Probable Cost (OPC)

CITY OF AUSTIN
PACES MILL FRR
ENGINEER'S OPC
30% SUBMITTAL

ALT 1F - BYPASS CULVERTS

BID ITEM NO.	ITEM DESCRIPTION	UNIT	QTY.	UNIT COST	TOTAL COST
102S-C	CLEARING AND GRUBBING	LS		10%	$ 487,402.50
111S-A	EXCAVATION	CY	8250	$ 50.00	$ 412,500.00
414S-C	CAST-IN-PLACE PORTLAND CEMENT CONCRETE RETAINING WALL, INCLUDING REINFORCEMENT	CY	85	$ 1,500.00	$ 127,500.00
509S-1	TRENCH EXCAVATION SAFETY PROTECTIVE SYSTEMS, (ALL DEPTHS)	LF	1800	$ 10.00	$ 18,000.00
559S-10X8	PRECAST CONCRETE BOX CULVERTS, 12 FT X 10 FT	LF	1800	$ 2,000.00	$ 3,600,000.00
591S-A	DRY ROCK RIPRAP, D50 = 18 IN	SY	0	$ 130.00	$ -
591S-F	CONCRETE RIPRAP, 6 IN	SY	650	$ 300.00	$ 195,000.00
604S-E	NATIVE SEEDING FOR EROSION CONTROL, BROADCAST SEEDING	SY	13350	$ 1.50	$ 20,025.00
605S	SOIL RETENTION BLANKET CLASS 2; TYPE H, COMPLETE AND IN PLACE	SY	8150	$ 10.00	$ 81,500.00
608S-1	PLANTING TYPE _, SIZE IN INCHES _	EA	0		$ -
608S-2	IRRIGATION SYSTEM	LS	1	$ 15,000.00	$ 15,000.00
609S-A	TOPSOIL AND SEEDBED PREPARATION	SY	13350	$ 15.00	$ 200,250.00
609S-C	NATIVE SEEDING	SY	13350	$ 5.00	$ 66,750.00
610S-A	PROTECTIVE FENCING TYPE A CHAIN LINK FENCE	LF	2500	$ 4.00	$ 10,000.00
639S	ROCK BERM	LF	300	$ 45.00	$ 13,500.00
641S	STABILIZED CONSTRUCTION ENTRANCE	EA	2	$ 3,500.00	$ 7,000.00
642S	SILT FENCE FOR EROSION CONTROL	LF	2500	$ 10.00	$ 25,000.00
700S-TM	TOTAL MOBILIZATION PAYMENT	LS	1	5%	$ 268,071.38
802S-A	PROJECT SIGN	EA	2	$ 1,000.00	$ 2,000.00
803S-MO	BARRICADES, SIGNS, AND TRAFFIC HANDLING	MO	6	$ 5,000.00	$ 30,000.00
SS1000	COFFER DAM & SITE DEWATERING	LS	1	$ 50,000.00	$ 50,000.00
SP610S	TREE REMOVAL	AC	2	$ 345,000.00	$ 517,500.00
CONSTRUCTION SUBTOTAL					***$ 6,146,998.88***
	CONTINGENCY (30% OF SUBTOTAL)				$ 1,844,099.66
CONSTRUCTION COST ESTIMATE					**$ 7,991,098.54**

This document is released for interim review under the authority of Paul Shattuck, P.E., #129381 on August 25, 2021 and is not to be used for other purposes.

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING
Firm #6535

CITY OF AUSTIN
PACES MILL FRR
ENGINEER'S OPC
30% SUBMITTAL

ALT 2A - 10YR NATURAL CHANNEL

BID ITEM NO.	ITEM DESCRIPTION	UNIT	QTY.	UNIT COST	TOTAL COST
102S-C	CLEARING AND GRUBBING	LS		10%	$ 225,950.00
111S-A	EXCAVATION	CY	27000	$ 50.00	$ 1,350,000.00
414S-C	CAST-IN-PLACE PORTLAND CEMENT CONCRETE RETAINING WALL, INCLUDING REINFORCEMENT	CY	0	$ 1,500.00	$ -
509S-1	TRENCH EXCAVATION SAFETY PROTECTIVE SYSTEMS, (ALL DEPTHS)	LF	0	$ 10.00	$ -
559S-10X8	PRECAST CONCRETE BOX CULVERTS, 10 FT X 12 FT	LF	0	$ 2,000.00	$ -
591S-A	DRY ROCK RIPRAP, D50 = 18 IN	SY	0	$ 130.00	$ -
591S-F	CONCRETE RIPRAP, 6 IN	SY	0	$ 300.00	$ -
604S-E	NATIVE SEEDING FOR EROSION CONTROL, BROADCAST SEEDING	SY	23000	$ 1.50	$ 34,500.00
605S	SOIL RETENTION BLANKET CLASS 2; TYPE H, COMPLETE AND IN PLACE	SY	23000	$ 10.00	$ 230,000.00
608S-1	PLANTING TYPE _, SIZE IN INCHES _	EA	0		$ -
608S-2	IRRIGATION SYSTEM	LS	1	$ 15,000.00	$ 15,000.00
609S-A	TOPSOIL AND SEEDBED PREPARATION	SY	23000	$ 15.00	$ 345,000.00
609S-C	NATIVE SEEDING	SY	23000	$ 5.00	$ 115,000.00
610S-A	PROTECTIVE FENCING TYPE A CHAIN LINK FENCE	LF	3000	$ 4.00	$ 12,000.00
639S	ROCK BERM	LF	200	$ 45.00	$ 9,000.00
641S	STABILIZED CONSTRUCTION ENTRANCE	EA	2	$ 3,500.00	$ 7,000.00
642S	SILT FENCE FOR EROSION CONTROL	LF	3000	$ 10.00	$ 30,000.00
700S-TM	TOTAL MOBILIZATION PAYMENT	LS	1	5%	$ 124,272.50
802S-A	PROJECT SIGN	EA	2	$ 1,000.00	$ 2,000.00
803S-MO	BARRICADES, SIGNS, AND TRAFFIC HANDLING	MO	12	$ 5,000.00	$ 60,000.00
SS1000	COFFER DAM & SITE DEWATERING	LS	1	$ 50,000.00	$ 50,000.00
SP610S	TREE REMOVAL	AC	5	$ 345,000.00	$ 1,725,000.00
CONSTRUCTION SUBTOTAL					***$ 4,334,722.50***
	CONTINGENCY (30% OF SUBTOTAL)				$ 1,300,416.75
CONSTRUCTION COST ESTIMATE					**$ 5,635,139.25**

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K FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING
Firm #6535

CITY OF AUSTIN
PACES MILL FRR
ENGINEER'S OPC
30% SUBMITTAL

ALT 2B - 25YR NATURAL CHANNEL

BID ITEM NO.	ITEM DESCRIPTION	UNIT	QTY.	UNIT COST	TOTAL COST
102S-C	CLEARING AND GRUBBING	LS	0	10%	$ 423,450.00
111S-A	EXCAVATION	CY	59000	$ 50.00	$ 2,950,000.00
414S-C	CAST-IN-PLACE PORTLAND CEMENT CONCRETE RETAINING WALL, INCLUDING REINFORCEMENT	CY	0	$ 1,500.00	$ -
509S-1	TRENCH EXCAVATION SAFETY PROTECTIVE SYSTEMS, (ALL DEPTHS)	LF	0	$ 10.00	$ -
559S-10X8	PRECAST CONCRETE BOX CULVERTS, 10 FT X 12 FT	LF	0	$ 2,000.00	$ -
591S-A	DRY ROCK RIPRAP, D50 = 18 IN	SY	100	$ 130.00	$ 13,000.00
591S-F	CONCRETE RIPRAP, 6 IN	SY	0	$ 300.00	$ -
604S-E	NATIVE SEEDING FOR EROSION CONTROL, BROADCAST SEEDING	SY	35000	$ 1.50	$ 52,500.00
605S	SOIL RETENTION BLANKET CLASS 2; TYPE H, COMPLETE AND IN PLACE	SY	35000	$ 10.00	$ 350,000.00
608S-1	PLANTING TYPE _, SIZE IN INCHES _	EA			$ -
608S-2	IRRIGATION SYSTEM	LS	1	$ 15,000.00	$ 15,000.00
609S-A	TOPSOIL AND SEEDBED PREPARATION	SY	35000	$ 15.00	$ 525,000.00
609S-C	NATIVE SEEDING	SY	35000	$ 5.00	$ 175,000.00
610S-A	PROTECTIVE FENCING TYPE A CHAIN LINK FENCE	LF	4000	$ 4.00	$ 16,000.00
639S	ROCK BERM	LF	200	$ 45.00	$ 9,000.00
641S	STABILIZED CONSTRUCTION ENTRANCE	EA	2	$ 3,500.00	$ 7,000.00
642S	SILT FENCE FOR EROSION CONTROL	LF	4000	$ 10.00	$ 40,000.00
700S-TM	TOTAL MOBILIZATION PAYMENT	LS	1	5%	$ 353,647.50
802S-A	PROJECT SIGN	EA	2	$ 1,000.00	$ 2,000.00
803S-MO	BARRICADES, SIGNS, AND TRAFFIC HANDLING	MO	6	$ 5,000.00	$ 30,000.00
SS1000	COFFER DAM & SITE DEWATERING	LS	1	$ 50,000.00	$ 50,000.00
SP610S	TREE REMOVAL	AC	7	$ 345,000.00	$ 2,415,000.00
CONSTRUCTION SUBTOTAL					***$ 7,426,597.50***
	CONTINGENCY (30% OF SUBTOTAL)				$ 2,227,979.25
CONSTRUCTION COST ESTIMATE					**$ 9,654,576.75**

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K·FRIESE
+ ASSOCIATES
PUBLIC PROJECT ENGINEERING
Firm #6535

CITY OF AUSTIN
PACES MILL FRR
ENGINEER'S OPC
30% SUBMITTAL

ALT 2C - 100YR NATURAL CHANNEL

BID ITEM NO.	ITEM DESCRIPTION	UNIT	QTY.	UNIT COST	TOTAL COST
102S-C	CLEARING AND GRUBBING	LS		10%	$ 658,750.00
111S-A	EXCAVATION	CY	115000	$ 50.00	$ 5,750,000.00
414S-C	CAST-IN-PLACE PORTLAND CEMENT CONCRETE RETAINING WALL, INCLUDING REINFORCEMENT	CY	0	$ 1,500.00	$ -
509S-1	TRENCH EXCAVATION SAFETY PROTECTIVE SYSTEMS, (ALL DEPTHS)	LF	0	$ 10.00	$ -
559S-10X8	PRECAST CONCRETE BOX CULVERTS, 10 FT X 12 FT	LF	0	$ 2,000.00	$ -
591S-A	DRY ROCK RIPRAP, D50 = 18 IN	SY	0	$ 130.00	$ -
591S-F	CONCRETE RIPRAP, 6 IN	SY	0	$ 300.00	$ -
604S-E	NATIVE SEEDING FOR EROSION CONTROL, BROADCAST SEEDING	SY	54000	$ 1.50	$ 81,000.00
605S	SOIL RETENTION BLANKET CLASS 2; TYPE H, COMPLETE AND IN PLACE	SY	54000	$ 10.00	$ 540,000.00
608S-1	PLANTING TYPE _, SIZE IN INCHES _	EA			
608S-2	IRRIGATION SYSTEM	LS	1	$ 15,000.00	
609S-A	TOPSOIL AND SEEDBED PREPARATION	SY	54000	$ 15.00	
609S-C	NATIVE SEEDING	SY	54000	$ 5.00	
610S-A	PROTECTIVE FENCING TYPE A CHAIN LINK FENCE	LF	4500	$ 4.00	
639S	ROCK BERM	LF	500	$ 45.00	$ 22,500.00
641S	STABILIZED CONSTRUCTION ENTRANCE	EA	2	$ 3,500.00	$ 7,000.00
642S	SILT FENCE FOR EROSION CONTROL	LF	4500	$ 10.00	$ 45,000.00
700S-TM	TOTAL MOBILIZATION PAYMENT	LS	1	5%	$ 362,312.50
802S-A	PROJECT SIGN	EA	2	$ 1,000.00	$ 2,000.00
803S-MO	BARRICADES, SIGNS, AND TRAFFIC HANDLING	MO	18	$ 5,000.00	$ 90,000.00
SS1000	COFFER DAM & SITE DEWATERING	LS	1	$ 50,000.00	$ 50,000.00
SP610S	TREE REMOVAL	AC	12	$ 345,000.00	$ 4,140,000.00
CONSTRUCTION SUBTOTAL					***$ 11,748,562.50***
	CONTINGENCY (30% OF SUBTOTAL)				$ 3,524,568.75
CONSTRUCTION COST ESTIMATE					**$ 15,273,131.25**

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CITY OF AUSTIN
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ALT 2F - CHANNEL MAINTENANCE

BID ITEM NO.	ITEM DESCRIPTION	UNIT	QTY.	UNIT COST	TOTAL COST
102S-C	CLEARING AND GRUBBING	LS		10%	$ 8,900.00
111S-A	EXCAVATION	CY	0	$ 50.00	$ -
414S-C	CAST-IN-PLACE PORTLAND CEMENT CONCRETE RETAINING WALL, INCLUDING REINFORCEMENT	CY	0	$ 1,500.00	$ -
509S-1	TRENCH EXCAVATION SAFETY PROTECTIVE SYSTEMS, (ALL DEPTHS)	LF	0	$ 10.00	$ -
559S-10X8	PRECAST CONCRETE BOX CULVERTS, 10 FT X 12 FT	LF	0	$ 2,000.00	$ -
591S-A	DRY ROCK RIPRAP, D50 = 18 IN	SY	0	$ 130.00	$ -
591S-F	CONCRETE RIPRAP, 6 IN	SY	0	$ 300.00	$ -
604S-E	NATIVE SEEDING FOR EROSION CONTROL, BROADCAST SEEDING	SY	0	$ 1.50	$ -
605S	SOIL RETENTION BLANKET CLASS 2; TYPE H, COMPLETE AND IN PLACE	SY	0	$ 10.00	$ -
608S-1	PLANTING TYPE _, SIZE IN INCHES _	EA	0		$ -
608S-2	IRRIGATION SYSTEM	LS	0	$ 15,000.00	$ -
609S-A	TOPSOIL AND SEEDBED PREPARATION	SY	0	$ 15.00	$ -
609S-C	NATIVE SEEDING	SY	0	$ 5.00	$ -
610S-A	PROTECTIVE FENCING TYPE A CHAIN LINK FENCE	LF	0	$ 4.00	$ -
639S	ROCK BERM	LF	0	$ 45.00	$ -
641S	STABILIZED CONSTRUCTION ENTRANCE	EA	2	$ 3,500.00	$ 7,000.00
642S	SILT FENCE FOR EROSION CONTROL	LF	0	$ 10.00	$ -
700S-TM	TOTAL MOBILIZATION PAYMENT	LS	1	5%	$ 0.05
802S-A	PROJECT SIGN	EA	2	$ 1,000.00	$ 2,000.00
803S-MO	BARRICADES, SIGNS, AND TRAFFIC HANDLING	MO	6	$ 5,000.00	$ 30,000.00
SS1000	COFFER DAM & SITE DEWATERING	LS	1	$ 50,000.00	$ 50,000.00
SP610S	TREE REMOVAL	AC	2	$ 345,000.00	$ 690,000.00
CONSTRUCTION SUBTOTAL					***$ 787,900.05***
	CONTINGENCY (30% OF SUBTOTAL)				$ 236,370.02
CONSTRUCTION COST ESTIMATE					**$ 1,024,270.07**

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ALT 3A - 25YR ENGINEERED CHANNEL

BID ITEM NO.	ITEM DESCRIPTION	UNIT	QTY.	UNIT COST	TOTAL COST
102S-C	CLEARING AND GRUBBING	LS		10%	$ 158,825.00
111S-A	EXCAVATION	CY	19000	$ 50.00	$ 950,000.00
414S-C	CAST-IN-PLACE PORTLAND CEMENT CONCRETE RETAINING WALL, INCLUDING REINFORCEMENT	CY	0	$ 1,500.00	$ -
509S-1	TRENCH EXCAVATION SAFETY PROTECTIVE SYSTEMS, (ALL DEPTHS)	LF	0	$ 10.00	$ -
559S-10X8	PRECAST CONCRETE BOX CULVERTS, 10 FT X 12 FT	LF	0	$ 2,000.00	$ -
591S-A	DRY ROCK RIPRAP, D50 = 18 IN	SY	0	$ 130.00	$ -
591S-F	CONCRETE RIPRAP, 6 IN	SY	0	$ 300.00	$ -
604S-E	NATIVE SEEDING FOR EROSION CONTROL, BROADCAST SEEDING	SY	13500	$ 1.50	$ 20,250.00
605S	SOIL RETENTION BLANKET CLASS 2; TYPE H, COMPLETE AND IN PLACE	SY	13500	$ 10.00	$ 135,000.00
608S-1	PLANTING TYPE _, SIZE IN INCHES _	EA			$ -
608S-2	IRRIGATION SYSTEM	LS	1	$ 15,000.00	$ 15,000.00
609S-A	TOPSOIL AND SEEDBED PREPARATION	SY	13500	$ 15.00	$ 202,500.00
609S-C	NATIVE SEEDING	SY	13500	$ 5.00	$ 67,500.00
610S-A	PROTECTIVE FENCING TYPE A CHAIN LINK FENCE	LF	5000	$ 4.00	$ 20,000.00
639S	ROCK BERM	LF	200	$ 45.00	$ 9,000.00
641S	STABILIZED CONSTRUCTION ENTRANCE	EA	2	$ 3,500.00	$ 7,000.00
642S	SILT FENCE FOR EROSION CONTROL	LF	5000	$ 10.00	$ 50,000.00
700S-TM	TOTAL MOBILIZATION PAYMENT	LS	1	5%	$ 87,353.75
802S-A	PROJECT SIGN	EA	2	$ 1,000.00	$ 2,000.00
803S-MO	BARRICADES, SIGNS, AND TRAFFIC HANDLING	MO	12	$ 5,000.00	$ 60,000.00
SS1000	COFFER DAM & SITE DEWATERING	LS	1	$ 50,000.00	$ 50,000.00
SP610S	TREE REMOVAL	AC	3	$ 345,000.00	$ 1,035,000.00
CONSTRUCTION SUBTOTAL					***$ 2,869,428.75***
	CONTINGENCY (30% OF SUBTOTAL)				$ 860,828.63
CONSTRUCTION COST ESTIMATE					**$ 3,730,257.38**

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ALT 3B - 100YR ENGINEERED CHANNEL

BID ITEM NO.	ITEM DESCRIPTION	UNIT	QTY.	UNIT COST	TOTAL COST
102S-C	CLEARING AND GRUBBING	LS		10%	$ 206,880.00
111S-A	EXCAVATION	CY	26000	$ 50.00	$ 1,300,000.00
414S-C	CAST-IN-PLACE PORTLAND CEMENT CONCRETE RETAINING WALL, INCLUDING REINFORCEMENT	CY	0	$ 1,500.00	$ -
509S-1	TRENCH EXCAVATION SAFETY PROTECTIVE SYSTEMS, (ALL DEPTHS)	LF	0	$ 10.00	$ -
559S-10X8	PRECAST CONCRETE BOX CULVERTS, 10 FT X 12 FT	LF	0	$ 2,000.00	$ -
591S-A	DRY ROCK RIPRAP, D50 = 18 IN	SY	0	$ 130.00	$ -
591S-F	CONCRETE RIPRAP, 6 IN	SY	0	$ 300.00	$ -
604S-E	NATIVE SEEDING FOR EROSION CONTROL, BROADCAST SEEDING	SY	18000	$ 1.50	$ 27,000.00
605S	SOIL RETENTION BLANKET CLASS 2; TYPE H, COMPLETE AND IN PLACE	SY	18000	$ 10.00	$ 180,000.00
608S-1	PLANTING TYPE _, SIZE IN INCHES _	EA	0		$ -
608S-2	IRRIGATION SYSTEM	LS	1	$ 15,000.00	$ 15,000.00
609S-A	TOPSOIL AND SEEDBED PREPARATION	SY	18000	$ 15.00	$ 270,000.00
609S-C	NATIVE SEEDING	SY	18000	$ 5.00	$ 90,000.00
610S-A	PROTECTIVE FENCING TYPE A CHAIN LINK FENCE	LF	4200	$ 4.00	$ 16,800.00
639S	ROCK BERM	LF	200	$ 45.00	$ 9,000.00
641S	STABILIZED CONSTRUCTION ENTRANCE	EA	2	$ 3,500.00	$ 7,000.00
642S	SILT FENCE FOR EROSION CONTROL	LF	4200	$ 10.00	$ 42,000.00
700S-TM	TOTAL MOBILIZATION PAYMENT	LS	1	5%	$ 113,784.00
802S-A	PROJECT SIGN	EA	2	$ 1,000.00	$ 2,000.00
803S-MO	BARRICADES, SIGNS, AND TRAFFIC HANDLING	MO	12	$ 5,000.00	$ 60,000.00
SS1000	COFFER DAM & SITE DEWATERING	LS	1	$ 50,000.00	$ 50,000.00
SP610S	TREE REMOVAL	AC	4	$ 345,000.00	$ 1,380,000.00
CONSTRUCTION SUBTOTAL					***$ 3,769,464.00***
	CONTINGENCY (30% OF SUBTOTAL)				$ 1,130,839.20
CONSTRUCTION COST ESTIMATE					**$ 4,900,303.20**

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CITY OF AUSTIN
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ALT 4A - 25YR NATURAL CHANNEL PLUS FLOODWALL

BID ITEM NO.	ITEM DESCRIPTION	UNIT	QTY.	UNIT COST	TOTAL COST
102S-C	CLEARING AND GRUBBING	LS	0	10%	$ 752,050.00
111S-A	EXCAVATION	CY	59000	$ 50.00	$ 2,950,000.00
414S-C	CAST-IN-PLACE PORTLAND CEMENT CONCRETE RETAINING WALL, INCLUDING REINFORCEMENT	CY	1333	$ 1,500.00	$ 1,999,500.00
509S-1	TRENCH EXCAVATION SAFETY PROTECTIVE SYSTEMS, (ALL DEPTHS)	LF	1150	$ 10.00	$ 11,500.00
559S-10X8	PRECAST CONCRETE BOX CULVERTS, 10 FT X 5 FT	LF	1150	$ 1,000.00	$ 1,150,000.00
506S-J12X6X6	JUNCTION BOX (12FT. X 6 FT. X 6 FT.)	EA	3	$ 20,000.00	$ 60,000.00
591S-A	DRY ROCK RIPRAP, D50 = 18 IN	SY	100	$ 130.00	$ 13,000.00
591S-F	CONCRETE RIPRAP, 6 IN	SY	0	$ 300.00	$ -
604S-E	NATIVE SEEDING FOR EROSION CONTROL, BROADCAST SEEDING	SY	35000	$ 1.50	$ 52,500.00
605S	SOIL RETENTION BLANKET CLASS 2; TYPE H, COMPLETE AND IN PLACE	SY	35000	$ 10.00	$ 350,000.00
608S-1	PLANTING TYPE _, SIZE IN INCHES _	EA			$ -
608S-2	IRRIGATION SYSTEM	LS	1	$ 15,000.00	$ 15,000.00
609S-A	TOPSOIL AND SEEDBED PREPARATION	SY	35000	$ 15.00	$ 525,000.00
609S-C	NATIVE SEEDING	SY	35000	$ 5.00	$ 175,000.00
610S-A	PROTECTIVE FENCING TYPE A CHAIN LINK FENCE	LF	6500	$ 4.00	$ 26,000.00
639S	ROCK BERM	LF	200	$ 45.00	$ 9,000.00
641S	STABILIZED CONSTRUCTION ENTRANCE	EA	2	$ 3,500.00	$ 7,000.00
642S	SILT FENCE FOR EROSION CONTROL	LF	6500	$ 10.00	$ 65,000.00
700S-TM	TOTAL MOBILIZATION PAYMENT	LS	1	5%	$ 534,377.50
802S-A	PROJECT SIGN	EA	2	$ 1,000.00	$ 2,000.00
803S-MO	BARRICADES, SIGNS, AND TRAFFIC HANDLING	MO	12	$ 5,000.00	$ 60,000.00
SS1000	COFFER DAM & SITE DEWATERING	LS	1	$ 50,000.00	$ 50,000.00
SP610S	TREE REMOVAL	AC	7	$ 345,000.00	$ 2,415,000.00
CONSTRUCTION SUBTOTAL					***$ 11,221,927.50***
	CONTINGENCY (30% OF SUBTOTAL)				$ 3,366,578.25
	EASEMENT COST				$ 2,486,866.80
CONSTRUCTION COST ESTIMATE					**$ 14,588,505.75**

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ALT 5A - FLOODWALL ONLY

BID ITEM NO.	ITEM DESCRIPTION	UNIT	QTY.	UNIT COST	TOTAL COST
102S-C	CLEARING AND GRUBBING	LS	0	10%	$ 326,996.67
111S-A	EXCAVATION	CY	0	$ 50.00	$ -
414S-C	CAST-IN-PLACE PORTLAND CEMENT CONCRETE RETAINING WALL, INCLUDING REINFORCEMENT	CY	1228	$ 1,500.00	$ 1,841,666.67
509S-1	TRENCH EXCAVATION SAFETY PROTECTIVE SYSTEMS, (ALL DEPTHS)	LF	1150	$ 10.00	$ 11,500.00
559S-10X8	PRECAST CONCRETE BOX CULVERTS, 10 FT X 5 FT	LF	1150	$ 1,000.00	$ 1,150,000.00
506S-J12X6X6	JUNCTION BOX (12FT. X 6 FT. X 6 FT.)	EA	3	$ 20,000.00	$ 60,000.00
591S-A	DRY ROCK RIPRAP, D50 = 18 IN	SY	0	$ 130.00	$ -
591S-F	CONCRETE RIPRAP, 6 IN	SY	0	$ 300.00	$ -
604S-E	NATIVE SEEDING FOR EROSION CONTROL, BROADCAST SEEDING	SY	2600	$ 1.50	$ 3,900.00
605S	SOIL RETENTION BLANKET CLASS 2; TYPE H, COMPLETE AND IN PLACE	SY	2600	$ 10.00	$ 26,000.00
608S-1	PLANTING TYPE _, SIZE IN INCHES _	EA			$ -
608S-2	IRRIGATION SYSTEM	LS	1	$ 15,000.00	$ 15,000.00
609S-A	TOPSOIL AND SEEDBED PREPARATION	SY	2600	$ 15.00	$ 39,000.00
609S-C	NATIVE SEEDING	SY	2600	$ 5.00	$ 13,000.00
610S-A	PROTECTIVE FENCING TYPE A CHAIN LINK FENCE	LF	2600	$ 4.00	$ 10,400.00
639S	ROCK BERM	LF	100	$ 45.00	$ 4,500.00
641S	STABILIZED CONSTRUCTION ENTRANCE	EA	2	$ 3,500.00	$ 7,000.00
642S	SILT FENCE FOR EROSION CONTROL	LF	2600	$ 10.00	$ 26,000.00
700S-TM	TOTAL MOBILIZATION PAYMENT	LS	1	5%	$ 179,848.17
802S-A	PROJECT SIGN	EA	2	$ 1,000.00	$ 2,000.00
803S-MO	BARRICADES, SIGNS, AND TRAFFIC HANDLING	MO	12	$ 5,000.00	$ 60,000.00
SS1000	COFFER DAM & SITE DEWATERING	LS	0	$ 50,000.00	$ -
CONSTRUCTION SUBTOTAL					***$ 3,776,811.50***
	CONTINGENCY (30% OF SUBTOTAL)				$ 1,133,043.45
	EASEMENTS				$ 2,486,866.80
CONSTRUCTION COST ESTIMATE					**$ 4,909,854.95**

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Appendix G: Primary Analysis Primary Analysis Evaluation Rubric

Environmental Constraints and Permitting Efforts

Criteria	% of Points	Points
Minimal – Limited to no environmental impact or permitting effort	100%	10
Minimal to Moderate – Short term, moderate environmental impact during construction. Minimal environmental survey and permitting expected. Local site plan permitting, or variances required.	80%	8
Moderate – Short term impacts during construction. Environmental surveys required and local site plan permitting, or variances required. Nationwide or Individual permit likely required.	60%	6
Moderate to Significant – Long term, moderate environmental impact with permits among multiple jurisdictions. More challenging local site plan permitting, and Nationwide or Individual Permit likely required.	40%	4
Significant – Long term, significant environmental impact with significant permits among multiple jurisdictions	20%	2

Note: We will use the sampled ratings copied on the right.

Land and Easement Acquisition

Criteria	% of Points	Points
No easement or land acquisition required.	100%	15
Easement required, but no land acquisition is required.	80%	12
Land Acquisition is required, or project is generally limited to the existing channel boundary.	60%	9
Land Acquisition is required, or project overlaps with the Onion Creek Metro Park Master Plan.	40%	6
Land Acquisition is required, or project interferes with the Onion Creek Metro Park Master Plan.	20%	3

Notes: The buyout alternatives score the max points because the buyout becomes the project.

Potential Major Utility Impacts

Criteria	% of Points	Points
No impacts to major utilities	100%	5
Relocation of water, gas, AE, or Telecom	80%	4
Relocation of wastewater or storm water	60%	3
Relocation of more than 1 major utility	40%	2
Relocation of more than 2 major utilities	20%	1

Notes:

Time Implementation

Criteria	% of Points	Points
Requires less than 1 year to implement project and complete project	100%	5
Requires more than 1 year, but less than 2 years to implement project and complete project	80%	4
Requires more than 2 years, but less than 3 years to implement project and complete project	60%	3
Requires more than 3 years, but less than 4 years to implement project and complete project	40%	2
Requires more than 4 years to implement project and complete project	20%	1

Notes:

Social/Community Impacts

Criteria	% of Points	Points
Minimual - No displacement of homes, and no encumbrance on private property (e.g. by a drainage pipe, culvert, floodwall, or other structure)	100%	10
Moderate displacement of homes, and moderate encumbrance on public or private property (e.g. by a drainage pipe, culvert, floodwall, or other structure).	50%	5
Significant displacement of homes, and moderate encumbrance on public or private property (e.g. by a drainage pipe, culvert, floodwall, or other structure).	20%	2

Ecological Restoration

Criteria	% of Points	Points
Alternative increases floodplain heterogeneity, increases canopy cover, reduces soil compaction, increases cover of wetland vegetation	100%	10
Alternative increases floodplain heterogeneity, or increases canopy, or reduces soil compaction, or increases cover of wetland vegetation	75%	6
Alternative does not improve floodplain health parameters	50%	3
Alternative reduces rating of floodplain health parameters	0%	0

Source of parameters: Functional Assessment of Floodplain health

Note: Each alternative gets points for each of the three benefit that it provides. See the table below for point valuation of each alternative.

Criteria	% of Points	Max Points
Percentage of homes removed from 100YR flood plain i.e. FFE is higher than 100YR WSEL (out of 15)	50%	10
Percentage of homes that gain safe access to roadway in 100YR flood plain (out of 25)	30%	6
Percentage of homes that lose all floodplain from their property (out of 34)	20%	4
Total points		20

	Alternatives												
	Buyouts			Natural Channel			Engineered Channel		Floodwall		Bypass	Vegetation Management	Hybrid
Type of benefit	Alt 1A - 10YR	Alt 1B - 25YR	Alt 1C - 100YR	Alt 2A - 10YR	Alt 2B - 25YR	Alt 2C - 100YR	Alt 3A - 25YR	Alt3B - 100YR	Alt 4A - Hybrid	Alt 5A - Only	Alt F1	Alt F2	Alt F3
No. of homes with Interior Flood risk removed	2	8	15	7	15	15	10	15	15	15	10	6	15
Points earned for benefit	1	5	10	5	10	10	7	10	10	10	7	4	10
No. of homes with Safe Access made available	2	8	15	10	18	25	9	16	25	25	13	8	16
Points earned for benefit	0	2	4	2	4	6	2	4	6	6	3	2	4
No. of homes with Yard flood risk removed	2	8	15	9	13	20	12	14	20	20	11	8	14
Points earned for benefit	0	1	2	1	2	2	1	2	2	2	1	1	2
Total points	*2*	*8*	*15*	*8*	*16*	*18*	*10*	*15*	*18*	*18*	*11*	*7*	*15*

Cost Effectiveness of Flood Risk Reduction for 25-yr Storm ($/ft- home of Flood Reduction)

Criteria	% of Points	Points
Less thank $700k per foot of structural inundation reduction	100%	15
Greater than or equal to $700k and less than $800k per foot of structural inundation reduction	80%	12
Greater than or equal to $800k and less than $900k per foot of structural inundation reduction	60%	9
Greater than or equal to $900k and less than $1M per foot of structural inundation reduction	40%	6
Greater than or equal to $1M per foot of structural inundation reduction	20%	3

Cost Effectiveness of Flood Risk Reduction for 100-yr Storm ($/ft - home of Flood Reduction)

Criteria	% of Points	Points
Less than $200k per foot of structural inundation reduction	100%	10
Greater than or equal to $200k and less than $325k per foot of structural inundation reduction	80%	8
Greater than or equal to $325k and less than $450k per foot of structural inundation reduction	60%	6
Greater than or equal to $450k and less than $575k per foot of structural inundation reduction	40%	4
Greater than or equal to $575k per foot of structural inundation reduction reduction	20%	2

15 Homes in Floodplain			Based on Preliminary Alts Tech memo	Based on Preliminary Alts Tech memo			For use in Criteria Matrix	
	Alternative	**Matrix Score**	**Estimate Cost (Millions)**	**Homes Removed From FD 100-YR Floodplain**	**25Yr Depth Removed**	**100-YR Depth removed**	Cost Effectiveness of Flood Risk Reduction for 25-yr Storm ($ per ft of Flood Reduction)	Cost Effectiveness of Flood Risk Reduction for 100-yr Storm ($ per ft of Flood Reduction)
1A	10-YR Buyouts		$ 0.97	2	3.43	6.23	$ 283,673	$ 156,180
1B	25-YR Buyouts		$ 4.34	8	8.05	18.91	$ 538,634	$ 229,297
1C	100-YR Buyouts		$ 8.07	15	8.05	23.38	$ 1,002,981	$ 345,338
2A	10-YR Natural Channel		$ 6.23	7	8.05	18.74	$ 773,913	$ 332,444
2B	25-YR Natural Channel		$ 10.61	15	8.05	23.38	$ 1,318,012	$ 453,807
2C	100-YR Natural Channel		$ 17.03	15	8.05	23.38	$ 2,115,528	$ 728,400
3A	25-YR Engineered Channel		$ 4.15	10	8.05	22.15	$ 515,528	$ 187,359
3B	100-YR Engineered Channel		$ 5.46	15	8.05	23.38	$ 678,261	$ 233,533
4	25-YR Channel with Floodwall		$ 17.47	15	8.05	23.38	$ 2,170,186	$ 747,220
5	Floodwall		$ 8.16	15	8.05	23.38	$ 1,013,665	$ 349,016
F1	Bypass Culvert		$ 9.36	10	8.05	20.82	$ 1,162,733	$ 449,568
F2	Channel Maintenance		$ 1.10	6	5.28	10.8	$ 208,333	$ 101,852
F3	Hybrid		$ 5.76	15	8.05	23.38	$ 715,528	$ 246,364

Operations and Maintenance Cost BEFORE

Criteria	% of Points	Points
No Annual Operations or Maintenance (O&M) Cost	100%	5
Less than $50,000/yr Annual O&M Cost	80%	4
Less than $100,000/yr Annual O&M Cost	60%	3
Less than $200,000/yr Annual O&M Cost	40%	2
More than $200,000/yr Annual O&M Cost	20%	1

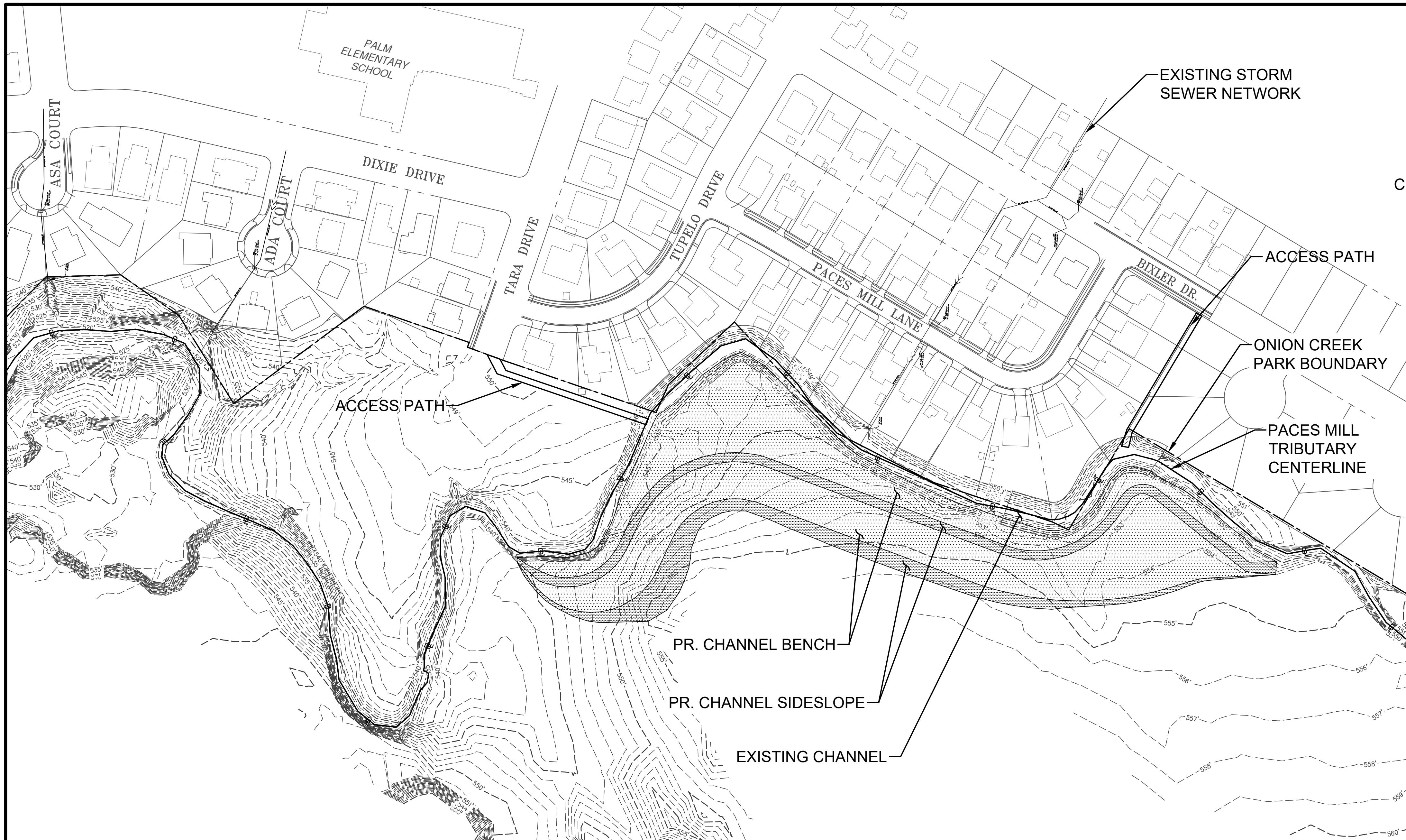
Notes: O&M Cost are currently placeholders. Need a range of typical annual O&M costs for channel maintenance
Include a value for complexity of maintenance: earthwork, concrete, access, internal or professional services required, risk of failure

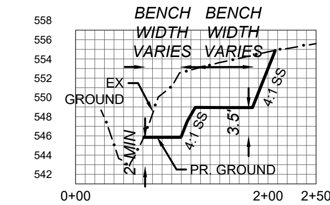
Appendix H: Primary Analysis Primary Analysis Matrix Results

Criteria		Max Score	Alternative 1A - 10YR FP Buyouts	Alternative 1B - 25YR FP Buyouts	Alternative 1C - 100YR FP Buyouts	Alternative 2A - 10YR Natural Channel	Alternative 2B - 25YR Natural Channel	Alternative 2C - 100YR Natural Channel	Alternative 3A - 25YR Engineered Channel	Alternative 3B - 100YR Engineered Channe	Alternative 4A - 25Yr Channel w Floodwall	Alternative 5A - Floodwall Only	Alternative 1F - Bypass Culverts	Alternative 2F - Channel Maintenance	Alternative 3F - Hybrid Channel
Project Delivery		30													
	Environmental Constraints	10	10	10	10	6	4	3	5	4	2	5	6	5	4
	Land and Easement Acquisition	15	15	15	15	8	7	6	9	8	5	10	10	9	8
	Potential Major Utility Impacts	0													
	Time to Implementation	5	5	5	5	3	2	2	3	3	1	2	2	4	3
Impacts		40													
	Social/Community Impacts	10	8	5	3	10	10	10	10	10	2	2	6	10	10
	Ecological Uplift Benefits	10	3	3	3	6	6	6	4	4	4	3	2	2	4
	Flood Risk Reduction (100-yr Storm) Benefits	20	2	8	15	8	16	18	10	15	18	18	11	7	15
Cost		30													
	Cost Effectiveness of Flood Risk Reduction for 25-yr Storm ($/ft- home of Flood Reduction) [4]	15	15	15	3	12	3	3	15	15	3	3	3	15	15
	Cost Effectiveness of Flood Risk Reduction for 100-yr Storm ($/ft- home of Flood Reduction) [4]	10	10	8	6	6	4	2	10	8	2	6	4	10	8
	Qualitative Score for O&M Cost [5]	5	5	5	5	3	3	3	3	3	1	1	2	1	3
		Score	**73**	**74**	**65**	**62**	**55**	**53**	**69**	**70**	**38**	**50**	**46**	**63**	**70**

Notes: Please see rubric tabs for determining the point values.

Appendix I: Secondary Analysis Proposed Design Schematics





CHANNEL IMPROVEMENT TYP. SECTION

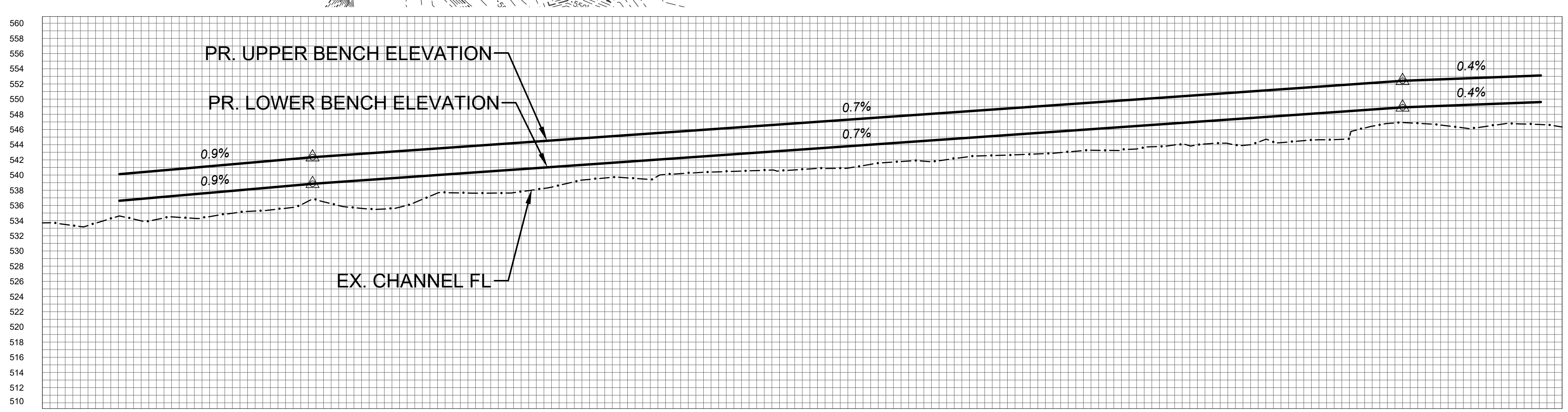
0 100 200
HORIZONTAL SCALE IN FEET

0 10 20
VERTICAL SCALE IN FEET

LEGEND

BENCH OR CHANNEL BOTTOM (PR)

SLOPE (PR)



REV. NO.	BY	DATE	REVISION DESCRIPTION

PRELIMINARY

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF INTERIM REVIEW UNDER THE AUTHORITY OF PAUL SHATTUCK, P.E. LIC. # 129381 02/07/2022.

IT IS NOT TO BE USED FOR CONSTRUCTION, BIDDING OR PERMIT PURPOSES.

JOHN HIGGENBOTHAM

PACES MILL FLOOD RISK REDUCTION STUDY

SECONDARY ANALYSIS

10-YEAR NATURAL CHANNEL

CITY OF AUSTIN FOUNDED 1839

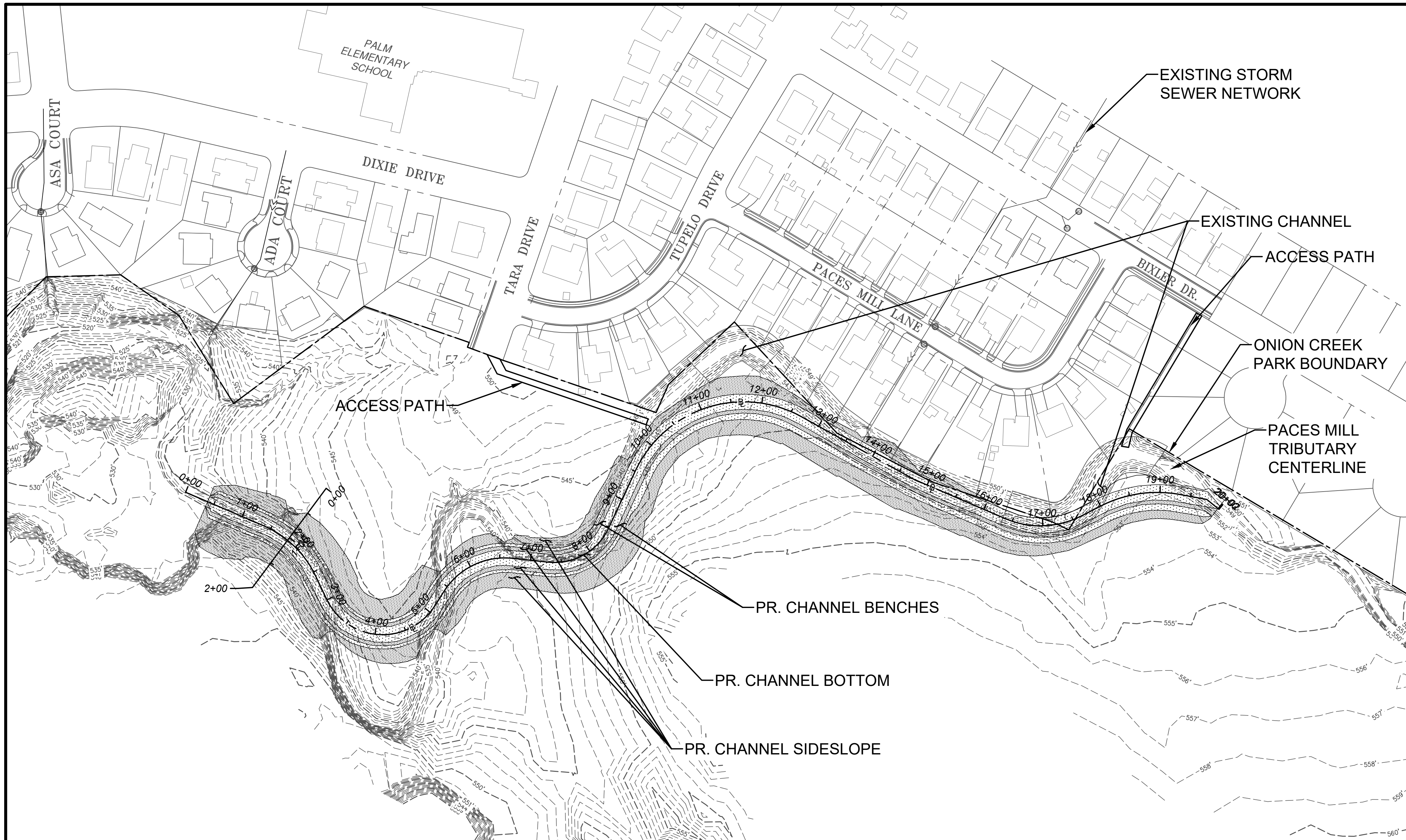
NOTES	NAME	DATE
SURVEY BY	GRZ	04/21
DRAWN BY	JDH	08/21
DESIGNED BY	PAS	08/21
CHECKED BY	AEW	08/21
REVIEWED BY		

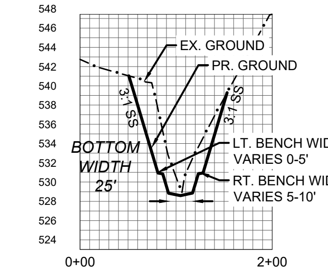
X:\PROJECTS\0767_COA_PACES MILL FRR\DWG\X0767_SH101.DWG, --, COA_ESD.STB

PAUL SHATTUCK

-

SHEET 1 OF 3





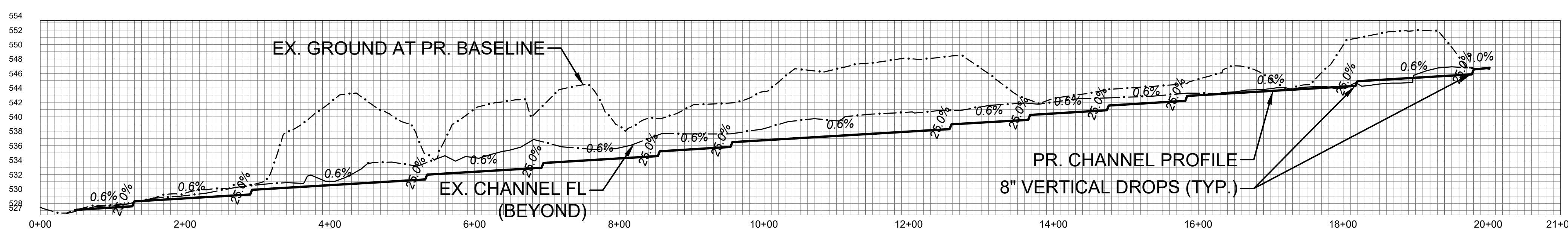
CHANNEL IMPROVEMENT TYP. SECTION

0 100 200
HORIZONTAL SCALE IN FEET

0 10 20
VERTICAL SCALE IN FEET

LEGEND

	BENCH OR CHANNEL BOTTOM (PR)
	SLOPE (PR)



REV. NO.	BY	DATE	REVISION DESCRIPTION

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PACES MILL FLOOD RISK REDUCTION STUDY

SECONDARY ANALYSIS

100-YEAR ENGINEERED CHANNEL

CITY OF AUSTIN FOUNDED 1839

NOTES	NAME	DATE
SURVEY BY	GRZ	04/21
DRAWN BY	JDH	08/21
DESIGNED BY	PAS	08/21
CHECKED BY	AEW	08/21
REVIEWED BY		

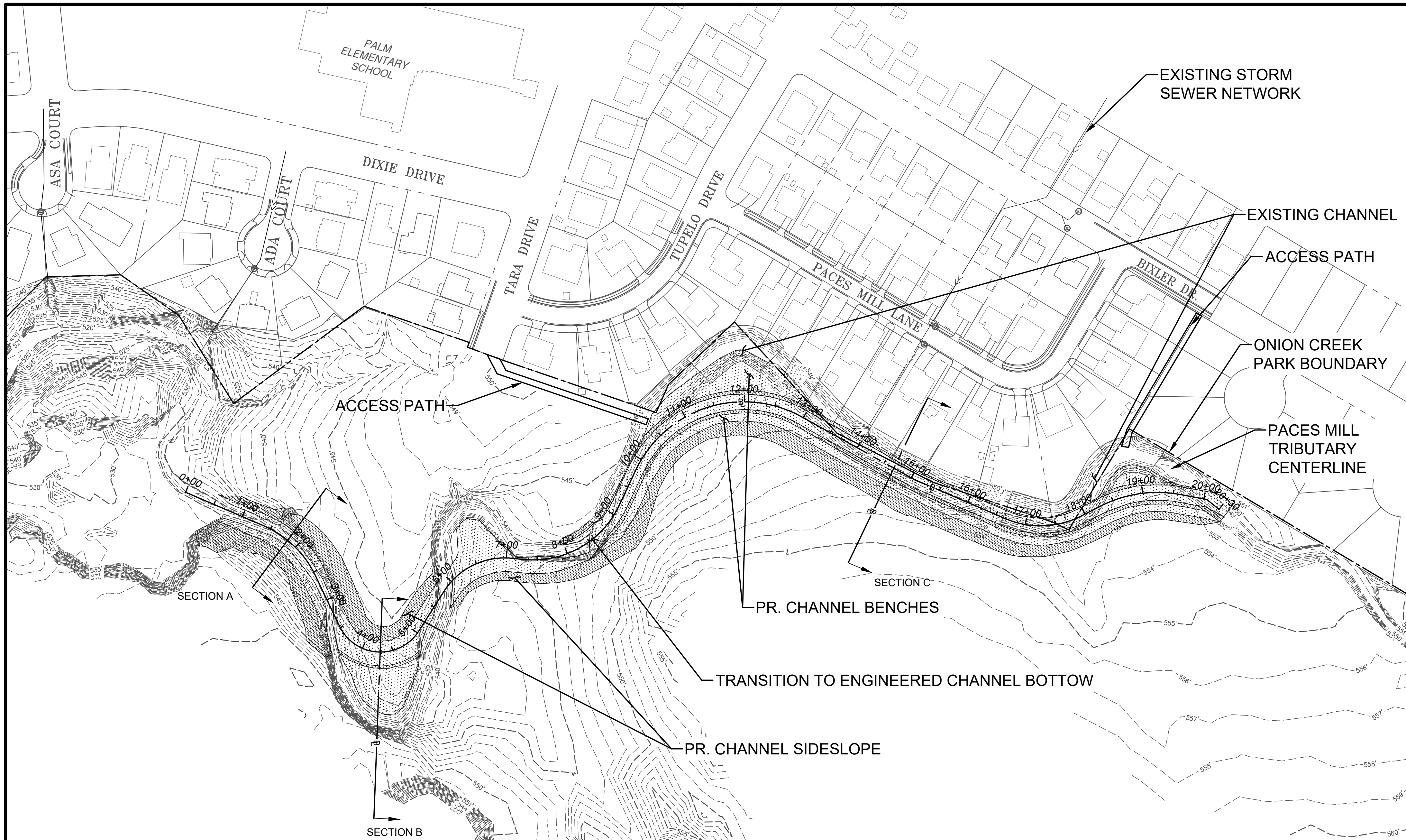
-

SHEET 2 OF 3

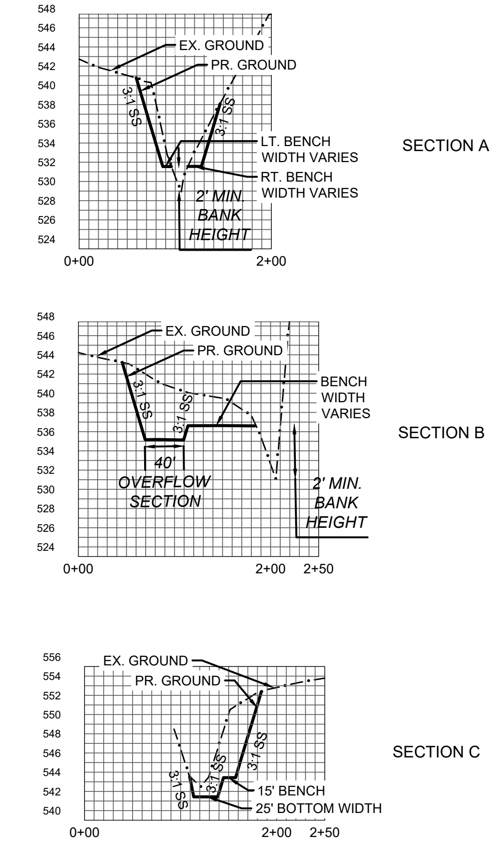
JOHN HIGGENBOTHAM

X:\PROJECTS\0767_COA_PACES MILL FRR\DWG\0767_SH101.DWG, ---, COA_ESD.STB

PAUL SHATTUCK

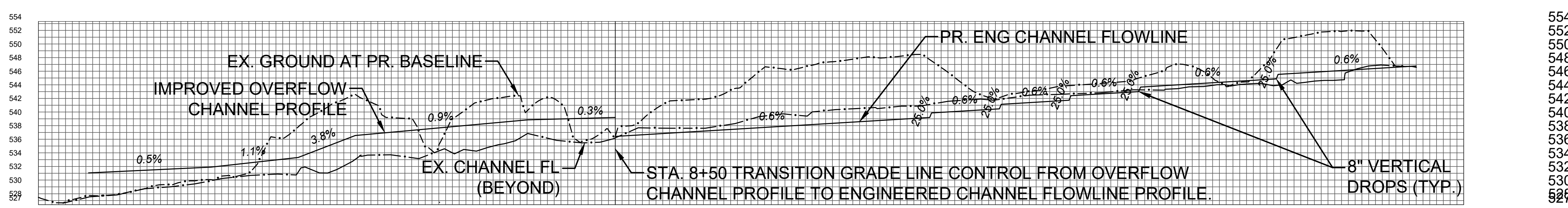


CHANNEL IMPROVEMENT TYP. SECTIONS



LEGEND

	BENCH OR CHANNEL BOTTOM (PR)
	SLOPE (PR)



0 100 200
HORIZONTAL SCALE IN FEET

0 10 20
VERTICAL SCALE IN FEET

REV. NO.	BY	DATE	REVISION DESCRIPTION

PRELIMINARY

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JOHN HIGGENBOTHAM

PACES MILL FLOOD RISK REDUCTION STUDY

SECONDARY ANALYSIS

100-YEAR HYBRID CHANNEL

CITY OF AUSTIN FOUNDED 1839

NOTES	NAME	DATE
SURVEY BY	GRZ	04/21
DRAWN BY	JDH	08/21
DESIGNED BY	PAS	08/21
CHECKED BY	AEW	08/21
REVIEWED BY		

X:\PROJECTS\0767_COA_PACES MILL FRR\DWG\X0767_SH101.DWG, ---, COA_ESD.STB

-

SHEET 3 OF 3

PAUL SHATTUCK

Appendix J: Secondary Analysis Inundation and Velocity Change Exhibits

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Proposed 2-Year Inundation Boundary
- Proposed 100-year Channel Bottom (25 ft typical)
- Proposed 100-year Channel Side Slope (3:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets

City of Austin
Paces Mill Lane
Flood Risk Reduction
Secondary Analysis

100-Year LOS
Hybrid Channel
Proposed 2-Year
Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 2/9/2022

CITY OF AUSTIN FOUNDED 1839

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Proposed 10-Year Inundation Boundary
- Proposed 100-year Channel Bottom (25 ft typical)
- Proposed 100-year Channel Side Slope (3:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets

City of Austin Paces Mill Lane Flood Risk Reduction Secondary Analysis

100-Year LOS Hybrid Channel Proposed 10-Year Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 2/9/2022

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Proposed 25-Year Inundation Boundary
- Proposed 100-year Channel Bottom (25 ft typical)
- Proposed 100-year Channel Side Slope (3:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets

City of Austin Paces Mill Lane Flood Risk Reduction Secondary Analysis

100-Year LOS
Hybrid Channel
Proposed 25-Year
Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 2/9/2022

CITY OF AUSTIN FOUNDED 1839

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Proposed 100-Year Inundation Boundary
- Proposed 100-year Channel Bottom (25 ft typical)
- Proposed 100-year Channel Side Slope (3:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets

City of Austin
Paces Mill Lane
Flood Risk Reduction
Secondary Analysis

100-Year LOS
Hybrid Channel
Proposed 100-Year
Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 2/9/2022

CITY OF AUSTIN
FOUNDED 1839

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Proposed 2-Year Inundation Boundary
- Proposed 100-year Channel Bottom (25 ft)
- Proposed 100-year Channel Side Slope (3:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets

City of Austin Paces Mill Lane Flood Risk Reduction Secondary Analysis

100-Year LOS Engineered Channel Proposed 2-Year Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 2/9/2022

CITY OF AUSTIN FOUNDED 1839

K·FRIESE + ASSOCIATES PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Proposed 10-Year Inundation Boundary
- Proposed 100-year Channel Bottom (25 ft)
- Proposed 100-year Channel Side Slope (3:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets

**City of Austin
Paces Mill Lane
Flood Risk Reduction
Secondary Analysis**

100-Year LOS
Engineered Channel
Proposed 10-Year
Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 2/9/2022

CITY OF AUSTIN
FOUNDED 1839

K·FRIESE
+ ASSOCIATES
PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Proposed 25-Year Inundation Boundary
- Proposed 100-year Channel Bottom (25 ft)
- Proposed 100-year Channel Side Slope (3:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets

City of Austin Paces Mill Lane Flood Risk Reduction Secondary Analysis

100-Year LOS Engineered Channel Proposed 25-Year Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 2/9/2022

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Proposed 100-Year Inundation Boundary
- Proposed 100-year Channel Bottom (25 ft)
- Proposed 100-year Channel Side Slope (3:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets

City of Austin Paces Mill Lane Flood Risk Reduction Secondary Analysis

100-Year LOS Engineered Channel Proposed 100-Year Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 2/9/2022

CITY OF AUSTIN FOUNDED 1839

K·FRIESE + ASSOCIATES PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Proposed 2-Year Inundation Boundary
- Proposed Channel Bench (Varies 0-160-ft)
- Proposed Channel Side Slope (4:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets

City of Austin Paces Mill Lane Flood Risk Reduction Secondary Analysis

10-Year LOS
Natural Channel
Proposed 2-Year
Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 2/9/2022

CITY OF AUSTIN FOUNDED 1839

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Proposed 10-Year Inundation Boundary
- Proposed Channel Bench (Varies 0-160-ft)
- Proposed Channel Side Slope (4:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets

City of Austin Paces Mill Lane Flood Risk Reduction Secondary Analysis

10-Year LOS
Natural Channel
Proposed 10-Year
Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 2/9/2022

CITY OF AUSTIN FOUNDED 1839

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Proposed 25-Year Inundation Boundary
- Proposed Channel Bench (Varies 0-160-ft)
- Proposed Channel Side Slope (4:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets

City of Austin Paces Mill Lane Flood Risk Reduction Secondary Analysis

10-Year LOS
Natural Channel
Proposed 25-Year Inundation Boundary

N

0 200 400

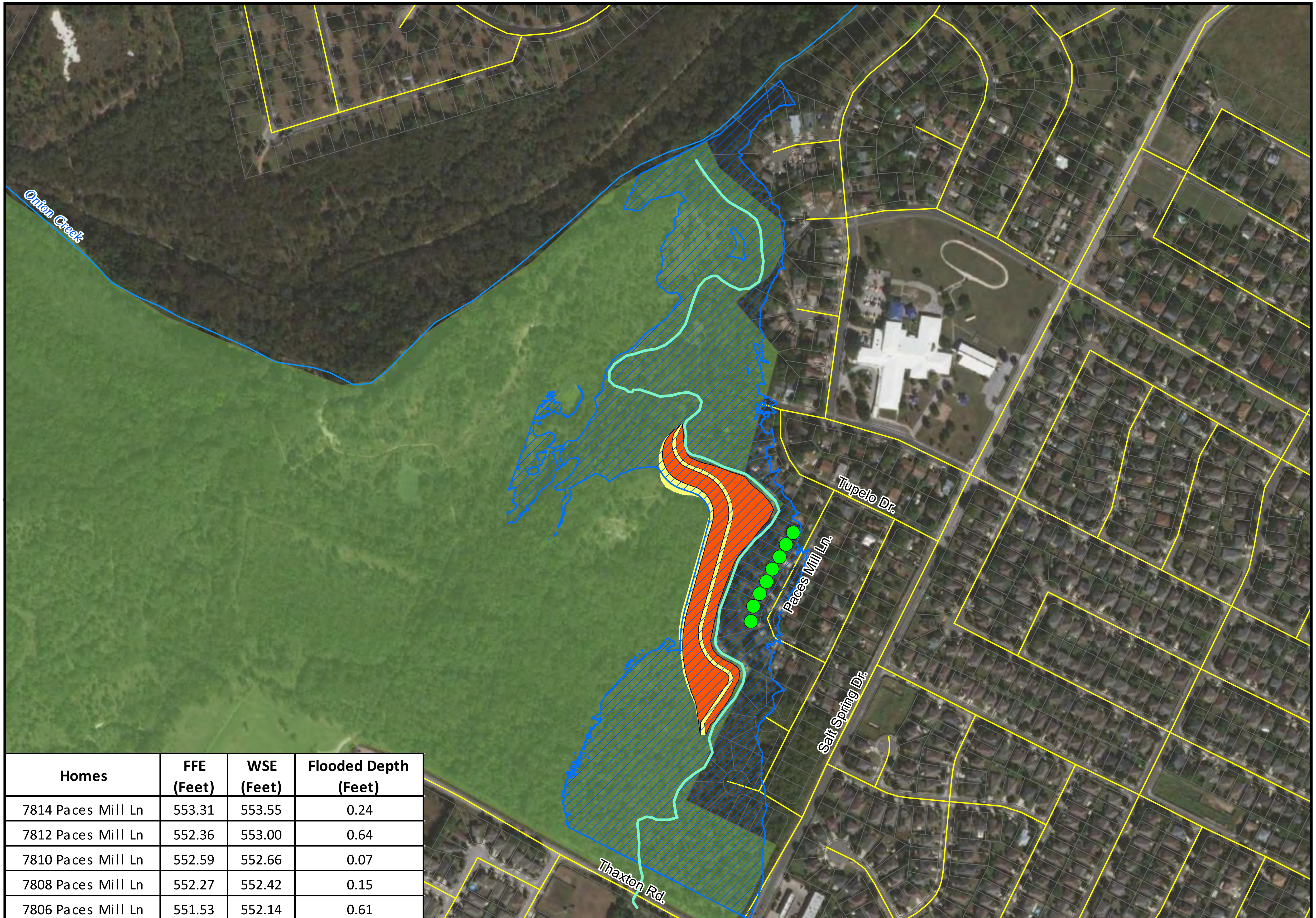
1 inch = 400 feet

Date: 2/9/2022

CITY OF AUSTIN FOUNDED 1839

K·FRIESE + ASSOCIATES PUBLIC PROJECT ENGINEERING

FIRM NO. 6535



Homes	FFE (Feet)	WSE (Feet)	Flooded Depth (Feet)
7814 Paces Mill Ln	553.31	553.55	0.24
7812 Paces Mill Ln	552.36	553.00	0.64
7810 Paces Mill Ln	552.59	552.66	0.07
7808 Paces Mill Ln	552.27	552.42	0.15
7806 Paces Mill Ln	551.53	552.14	0.61
7804 Paces Mill Ln	551.01	552.13	1.12
7802 Paces Mill Ln	550.66	552.00	1.34
7800 Paces Mill Ln	551.21	551.68	0.47

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.

Legend

- Proposed 100-Year Inundation Boundary
- Proposed Channel Bench (Varies 0-160-ft)
- Proposed Channel Side Slope (4:1)
- Onion Creek District Park
- Parcels
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets
- Flooded Homes

City of Austin Paces Mill Lane Flood Risk Reduction Secondary Analysis

10-Year LOS
Natural Channel
Proposed 100-Year
Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 2/9/2022

CITY OF AUSTIN
FOUNDED 1839

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING

FIRM NO. 6535

Appendix K: Secondary Analysis Hydraulic Output

Pre-Project Conditions (Ultimate)										
Reach	River Sta	Profile	Q Total	W.S. Elev	E.G. Elev	Vel Chnl	Flow Area	Vel Left	Vel Right	Volume
			(cfs)	(ft)	(ft)	(ft/s)	(sq ft)	(ft/s)	(ft/s)	(acre-ft)
Reach 1	4361	KFA_50%	770.1	559.59	559.65	1.93	473.99	0.34	0.69	43.09
Reach 1	4361	KFA_10%	1961	561.36	561.44	2.78	1305.53	0.83	0.67	82.91
Reach 1	4361	KFA_4%	2779.1	562.12	562.21	3.07	1796.3	0.91	0.89	143.25
Reach 1	4361	KFA_1%	4058.6	563.03	563.13	3.37	2493.06	1.13	1.05	183.96
Reach 1	4053	KFA_50%	770.1	558.41	558.46	2.37	637	0.44	0.71	39.45
Reach 1	4053	KFA_10%	1961	560	560.04	2.63	1545.99	0.79	1.09	73.94
Reach 1	4053	KFA_4%	2779.1	560.75	560.8	2.72	2083.33	0.93	1.22	131.14
Reach 1	4053	KFA_1%	4058.6	561.67	561.72	2.83	2812.55	1.11	1.37	167.49
Reach 1	3692	KFA_50%	770.1	556.5	556.54	2.17	642.01	0.65	0.78	34.93
Reach 1	3692	KFA_10%	1961	558.24	558.29	2.63	1446.48	1.01	1.12	63.93
Reach 1	3692	KFA_4%	2779.1	559.03	559.08	2.85	1916.41	1.14	1.26	117.94
Reach 1	3692	KFA_1%	4058.6	560.04	560.1	3.05	2605.69	1.3	1.39	149.82
Reach 1	3421	KFA_50%	770.1	553.47	553.77	4.67	233.58	0.86	1.08	32.26
Reach 1	3421	KFA_10%	1961	555.44	555.61	4.55	858.87	1.26	1.95	56.89
Reach 1	3421	KFA_4%	2779.1	556.35	556.48	4.29	1283.69	1.48	2.03	108.16
Reach 1	3421	KFA_1%	4058.6	557.6	557.7	4.08	1941.3	1.61	2.07	135.9
Reach 1	3321	KFA_50%	764.5	550.41	550.89	5.53	138.23			31.8
Reach 1	3321	KFA_10%	1942.3	552.74	553.64	7.62	269.53	0.15	0.69	55.35
Reach 1	3321	KFA_4%	2770.6	553.78	554.89	8.62	560.19	0.46	1.08	105.6
Reach 1	3321	KFA_1%	4094.4	555.11	556.41	9.7	969.69	0.76	1.48	131.86
Reach 1	3208	KFA_50%	764.5	549.82	550.28	5.42	141.12	0.45		31.44
Reach 1	3208	KFA_10%	1942.3	552.29	553.04	7.06	335.13	0.81	1	54.46
Reach 1	3208	KFA_4%	2770.6	553.41	554.3	7.82	558.82	0.85	1.84	104.12
Reach 1	3208	KFA_1%	4094.4	554.79	555.85	8.85	893.84	1.03	2.61	129.43
Reach 1	3003	KFA_50%	764.5	548.97	549.45	5.54	138.02			30.78
Reach 1	3003	KFA_10%	1942.3	551.57	552.32	6.98	311.82	0.14	0.54	53.01
Reach 1	3003	KFA_4%	2770.6	552.78	553.64	7.61	477.48	0.31	1.11	101.76
Reach 1	3003	KFA_1%	4094.4	554.16	555.22	8.7	690.05	0.49	1.65	125.6
Reach 1	2761	KFA_50%	764.5	548.52	548.69	3.29	236.95		0.52	29.74
Reach 1	2761	KFA_10%	1942.3	551.12	551.49	4.97	491.27	0.22	0.64	50.62
Reach 1	2761	KFA_4%	2770.6	552.39	552.85	5.68	692.79	0.36	1.01	97.72
Reach 1	2761	KFA_1%	4094.4	553.76	554.39	6.8	965.41	0.5	1.44	119.12
Reach 1	2584	KFA_50%	764.5	548.23	548.4	3.35	231.42	0.05	1.1	28.78
Reach 1	2584	KFA_10%	1942.3	550.75	551.12	5.07	630.02	0.2	0.81	48.19
Reach 1	2584	KFA_4%	2770.6	551.99	552.46	5.85	960.55	0.28	1.02	93.8
Reach 1	2584	KFA_1%	4094.4	553.26	553.93	7.13	1368.43	0.38	1.33	113.2
Reach 1	2421	KFA_50%	764.5	548.07	548.23	3.26	236.76	0.95	0.24	27.91
Reach 1	2421	KFA_10%	1942.3	550.56	550.92	4.98	599.36	0.59	0.49	46.43
Reach 1	2421	KFA_4%	2770.6	551.81	552.24	5.65	925.08	0.71	0.81	91.35
Reach 1	2421	KFA_1%	4094.4	553.08	553.65	6.72	1330.34	0.89	1.23	109.84
Reach 1	2329	KFA_50%	764.5	547.72	547.88	3.25	279.11	0.42	0.41	27.41
Reach 1	2329	KFA_10%	1942.3	550.24	550.48	4.38	733.7	1.06	1.1	45.4
Reach 1	2329	KFA_4%	2770.6	551.54	551.79	4.71	1067.32	1.17	1.66	89.88
Reach 1	2329	KFA_1%	4094.4	552.83	553.14	5.42	1462.48	1.39	2.26	107.76
Reach 1	2109	KFA_50%	764.5	545.97	546.08	2.92	371.16	0.71	0.9	25.76
Reach 1	2109	KFA_10%	1942.3	548.58	548.7	3.53	908.56	0.95	1.49	41.24
Reach 1	2109	KFA_4%	2770.6	550.05	550.16	3.67	1350.23	1.14	1.53	83.6
Reach 1	2109	KFA_1%	4094.4	551.26	551.39	4	1826.17	1.34	1.83	98.61

Pre-Project Conditions (Ultimate) (Continued)										
Reach	River Sta	Profile	Q Total	W.S. Elev	E.G. Elev	Vel Chnl	Flow Area	Vel Left	Vel Right	Volume
			(cfs)	(ft)	(ft)	(ft/s)	(sq ft)	(ft/s)	(ft/s)	(acre-ft)
Reach 1	1918	KFA_50%	764.5	544.86	544.9	1.96	522.06	0.54	1.18	24.15
Reach 1	1918	KFA_10%	1942.3	547.51	547.58	2.71	1119.91	1.03	1.56	37.96
Reach 1	1918	KFA_4%	2770.6	549.05	549.13	3.13	1664.38	1.29	1.1	78.9
Reach 1	1918	KFA_1%	4094.4	550.26	550.35	3.48	2320.26	1.62	1.1	92
Reach 1	1673	KFA_50%	764.5	543.5	543.68	3.62	278.97	0.83	0.7	22.29
Reach 1	1673	KFA_10%	1942.3	546.37	546.51	3.98	989.2	1.23	0.96	34.04
Reach 1	1673	KFA_4%	2770.6	548.06	548.17	3.74	1669.24	1.32	0.67	72.93
Reach 1	1673	KFA_1%	4094.4	549.26	549.37	4.08	2497.24	1.53	0.74	83.21
Reach 1	1672		Lat Struct							
Reach 1	1632	KFA_50%	764.5	543.31	543.46	3.31	338.03	0.6	1.01	21.85
Reach 1	1632	KFA_10%	1942.3	546.22	546.3	3.01	1203.38	1.23	0.8	31.59
Reach 1	1632	KFA_4%	2770.6	547.95	548	2.72	2026.72	1.31	0.59	68.82
Reach 1	1632	KFA_1%	4094.4	549.15	549.21	2.91	2957.55	1.51	0.71	77.59
Reach 1	1592	KFA_50%	764.5	543.16	543.24	2.6	443.88	0.82	0.82	21.31
Reach 1	1592	KFA_10%	1942.3	546.06	546.13	2.77	1162.71	1.32	1	29.37
Reach 1	1592	KFA_4%	2768.95	547.83	547.89	2.68	1939.87	1.36	0.72	65.23
Reach 1	1592	KFA_1%	4066.9	549.04	549.1	2.88	2744	1.47	0.95	72.86
Reach 1	1319	KFA_50%	764.5	541.76	541.88	3.2	325.35		1.35	19.45
Reach 1	1319	KFA_10%	1942.3	545.12	545.26	3.82	767.95		1.83	25.3
Reach 1	1319	KFA_4%	2768.95	547.17	547.29	3.79	1371.33	0.46	1.46	59.3
Reach 1	1319	KFA_1%	4066.9	548.47	548.58	3.83	1977.96	0.67	1.65	65.27
Reach 1	1101	KFA_50%	764.5	537.83	538.2	5.11	183.83	1.67	1.62	18.37
Reach 1	1101	KFA_10%	1942.3	540.95	541.59	7.2	377.99	2.64	2.6	23.07
Reach 1	1101	KFA_4%	2768.95	544.69	545.08	6.08	828.05	2.36	1.13	55.03
Reach 1	1101	KFA_1%	4066.9	545.87	546.4	7.32	1128.68	2.87	1.46	59.11
Reach 1	928	KFA_50%	776	535.2	535.52	5.32	269.71	1.34	1.43	17.52
Reach 1	928	KFA_10%	1949	537.44	538.29	9.01	451.87	2.26	2.13	21.54
Reach 1	928	KFA_4%	2802.65	543.57	543.84	5.74	1464.44	1.39	1.04	50.59
Reach 1	928	KFA_1%	4132.3	544.3	544.75	7.67	1649.7	1.84	1.44	53.34
Reach 1	799	KFA_50%	776	534.88	534.95	3.32	635.29	0.87	0.87	13.95
Reach 1	799	KFA_10%	1949	536.96	537.17	5.7	964.19	1.56	1.41	16.23
Reach 1	799	KFA_4%	2802.65	543.5	543.61	4.11	2603.12	1.19	0.63	38.94
Reach 1	799	KFA_1%	4132.3	544.21	544.38	5.45	2909.54	1.59	0.87	40.78
Reach 1	746	KFA_50%	776	534.77	534.82	2.55	476.25	1.22	1.51	12.24
Reach 1	746	KFA_10%	1949	536.75	536.91	4.56	703.85	2.24	2.5	13.7
Reach 1	746	KFA_4%	2802.65	543.5	543.54	2.76	2003.8	0.91	1.36	33.37
Reach 1	746	KFA_1%	4132.3	544.19	544.27	3.74	2179.22	1.24	1.86	34.81
Reach 1	504	KFA_50%	776	534.05	534.08	1.63	674.59	0.76	0.46	9.43
Reach 1	504	KFA_10%	1949	535	535.16	3.71	758.69	1.73	1.06	10.06
Reach 1	504	KFA_4%	2802.65	543.14	543.22	2.72	1718.92	1.23	0.83	22.44
Reach 1	504	KFA_1%	4132.3	543.52	543.67	3.92	1777.74	1.78	1.16	22.89
Reach 1	379	KFA_50%	776	533.98	534	1.22	961.59	0.56	0.59	7.21
Reach 1	379	KFA_10%	1949	534.67	534.75	2.84	1046.8	1.32	1.35	7.62
Reach 1	379	KFA_4%	2802.65	543.07	543.1	1.98	2298.99	0.99	0.93	16.99
Reach 1	379	KFA_1%	4132.3	543.37	543.44	2.87	2352.48	1.42	1.34	17.28
Reach 1	60	KFA_50%	776	533.89	533.91	1.14	1090.16	0.19	0.16	
Reach 1	60	KFA_10%	1949	534.18	534.29	2.81	1121.75	0.46	0.41	
Reach 1	60	KFA_4%	2802.65	542.89	542.97	2.49	2589.23	0.38	0.25	
Reach 1	60	KFA_1%	4132.3	543	543.17	3.64	2620.5	0.56	0.36	

Hybrid Channel (Ultimate)										
Reach	River Sta	Profile	Q Total	W.S. Elev	E.G. Elev	Vel Chnl	Flow Area	Vel Left	Vel Right	Volume
			(cfs)	(ft)	(ft)	(ft/s)	(sq ft)	(ft/s)	(ft/s)	(acre-ft)
Reach 1	4178	KFA_50%	770.1	559.18	559.25	2.16	401.06	0.16	0.42	37.5
Reach 1	4178	KFA_10%	1961	561.02	561.18	3.51	1107.99	0.58	0.43	64.88
Reach 1	4178	KFA_4%	2779.1	561.82	562.01	4	1593.57	0.69	0.63	117.36
Reach 1	4178	KFA_1%	4058.6	562.77	562.99	4.58	2284.31	0.88	0.79	143.03
Reach 1	3870	KFA_50%	770.1	558.55	558.6	2.17	706.95	0.44	0.68	33.88
Reach 1	3870	KFA_10%	1961	560.17	560.21	2.43	1664.21	0.76	1.03	56.15
Reach 1	3870	KFA_4%	2779.1	560.94	560.98	2.53	2227.07	0.89	1.15	105.42
Reach 1	3870	KFA_1%	4058.6	561.85	561.89	2.67	2960.47	1.07	1.3	126.75
Reach 1	3509	KFA_50%	770.1	556.25	556.31	2.44	554.52	0.69	0.84	29.4
Reach 1	3509	KFA_10%	1961	558.28	558.33	2.59	1472.68	1	1.1	45.67
Reach 1	3509	KFA_4%	2779.1	559.14	559.19	2.76	1985.78	1.11	1.21	91.54
Reach 1	3509	KFA_1%	4058.6	560.08	560.14	3.02	2634.47	1.28	1.38	108.5
Reach 1	3270	KFA_50%	764.5	552.05	552.59	6.35	149.78	2.9	2.45	27.4
Reach 1	3270	KFA_10%	1942.3	553.85	554.89	9.44	342.71	3.38	2.47	40.4
Reach 1	3270	KFA_4%	2770.6	554.76	555.81	10.15	620.23	1.95	2.5	83.93
Reach 1	3270	KFA_1%	4094.4	555.82	556.75	10.51	1104.36	1.86	2.61	97.5
Reach 1	3242	KFA_50%	764.5	551.46	551.91	5.61	145.47	3.95	0.34	27.31
Reach 1	3242	KFA_10%	1942.3	553.21	554.07	7.83	282.95	6.02	1.04	40.19
Reach 1	3242	KFA_4%	2770.6	554.16	555.04	8.54	517.07	3.84	0.95	83.54
Reach 1	3242	KFA_1%	4094.4	555.32	556.09	8.76	1027.83	2.5	1.36	96.73
Reach 1	3141	KFA_50%	764.5	550.04	550.18	3.26	260.99	1.68	2.83	26.86
Reach 1	3141	KFA_10%	1942.3	552.06	552.32	4.77	494.38	3.11	3.48	39.33
Reach 1	3141	KFA_4%	2770.6	553.18	553.45	5.27	735.55	3.52	2.98	82.24
Reach 1	3141	KFA_1%	4094.4	554.56	554.82	5.67	1270.53	1.89	2.82	94.66
Reach 1	3076	KFA_50%	764.5	549.39	549.55	3.03	242.13	1.38	3.41	26.44
Reach 1	3076	KFA_10%	1942.3	551.48	551.75	4.32	471.35	2.78	4.28	38.51
Reach 1	3076	KFA_4%	2770.6	552.59	552.92	4.83	609.08	3.41	4.65	81.13
Reach 1	3076	KFA_1%	4094.4	554.07	554.37	5.27	1067.26	1.94	4.11	92.88
Reach 1	2922	KFA_50%	764.5	548.13	548.46	4.72	169.4	2.31	0.36	25.75
Reach 1	2922	KFA_10%	1942.3	550.16	550.76	6.42	326.53	4.03	2.3	37.2
Reach 1	2922	KFA_4%	2770.6	551.24	551.97	7.22	427.97	4.63	2.15	79.4
Reach 1	2922	KFA_1%	4094.4	552.57	553.48	8.19	631.23	5.31	1.76	90.08
Reach 1	2853	KFA_50%	764.5	547.68	548.02	4.84	170.49	2.44		25.48
Reach 1	2853	KFA_10%	1942.3	549.66	550.32	6.82	315.72	3.98	1.75	36.68
Reach 1	2853	KFA_4%	2770.6	550.69	551.53	7.78	418.23	4.62	1.21	78.73
Reach 1	2853	KFA_1%	4094.4	552.01	553.04	8.84	612.13	5.29	1.66	89.07
Reach 1	2779	KFA_50%	764.5	546.77	547.33	6.18	131.3	3.42		25.23
Reach 1	2779	KFA_10%	1942.3	548.62	549.58	8.2	253.45	5.67	1.49	36.2
Reach 1	2779	KFA_4%	2770.6	549.61	550.79	9.16	329.03	6.41	2.61	78.09
Reach 1	2779	KFA_1%	4094.4	550.89	552.31	10.24	482	7.17	2.21	88.09
Reach 1	2520	KFA_50%	764.5	543.88	544.14	4.45	209.27	2.58	2.08	24.22
Reach 1	2520	KFA_10%	1942.3	546.16	546.56	5.73	419.37	3.72	3.2	34.22
Reach 1	2520	KFA_4%	2770.6	547.43	547.91	6.35	549.7	4.17	3.52	75.51
Reach 1	2520	KFA_1%	4094.4	548.94	549.54	7.25	731.7	4.79	3.91	84.54
Reach 1	2435	KFA_50%	764.5	543.57	543.68	3.19	347.87	1.91	1.45	23.64
Reach 1	2435	KFA_10%	1942.3	546.01	546.15	3.83	719.02	2.52	2.07	33.03
Reach 1	2435	KFA_4%	2770.6	547.34	547.51	4.16	937.23	2.76	2.35	73.95
Reach 1	2435	KFA_1%	4094.4	548.89	549.11	4.74	1206.74	3.16	2.77	82.51
Reach 1	2317	KFA_50%	764.5	542.97	543.37	2.16	239.86	1.3	6.68	22.78
Reach 1	2317	KFA_10%	1942.3	545.04	545.86	2.73	434.56	1.78	9.08	31.34
Reach 1	2317	KFA_4%	2770.6	546.22	547.22	2.99	557.91	1.97	9.87	71.76
Reach 1	2317	KFA_1%	4094.4	547.38	548.78	3.55	695.7	2.31	11.58	79.72
Reach 1	2106	KFA_50%	764.5	542.65	542.86	3.42	211.66	4.33	0.12	21.71
Reach 1	2106	KFA_10%	1942.3	544.85	545.34	5.11	381.41	6.57	0.37	29.41
Reach 1	2106	KFA_4%	2770.6	546.11	546.7	5.65	578.81	7.21	0.69	69.09
Reach 1	2106	KFA_1%	4094.4	547.35	548.14	6.66	823.72	8.41	0.99	76.18

Hybrid Channel (Ultimate) (Continued)										
Reach	River Sta	Profile	Q Total	W.S. Elev	E.G. Elev	Vel Chnl	Flow Area	Vel Left	Vel Right	Volume
			(cfs)	(ft)	(ft)	(ft/s)	(sq ft)	(ft/s)	(ft/s)	(acre-ft)
Reach 1	1918	KFA_50%	764.5	541.78	541.95	3.22	254.11	3.35	0.55	20.77
Reach 1	1918	KFA_10%	1942.3	544.04	544.29	3.81	562.56	4.46	1.34	27.59
Reach 1	1918	KFA_4%	2770.6	545.49	545.7	3.84	853.81	3.94	1.4	66.42
Reach 1	1918	KFA_1%	4094.4	546.76	546.99	4.36	1214.71	3.87	1.54	72.47
Reach 1	1807	KFA_50%	764.5	541.63	541.74	2.59	287.36	2.72	0.03	20.33
Reach 1	1807	KFA_10%	1942.3	544	544.15	2.76	626.73	3.31	0.58	26.7
Reach 1	1807	KFA_4%	2770.6	545.48	545.6	2.65	1025.32	2.78	0.42	65.14
Reach 1	1807	KFA_1%	4094.4	546.75	546.89	2.96	1439.58	2.91	0.65	70.75
Reach 1	1673	KFA_50%	764.5	541.05	541.41	5.14	173.82	2.74	2.55	19.85
Reach 1	1673	KFA_10%	1942.3	543.14	543.89	7.77	311.93	4.12	4.07	25.86
Reach 1	1673	KFA_4%	2770.6	544.71	545.4	8	592.94	2.04	4.02	63.93
Reach 1	1673	KFA_1%	4094.4	545.78	546.68	9.43	868.22	2.06	4.73	69.17
Reach 1	1633	KFA_50%	764.5	540.78	541.12	3.25	182.96	0.43	5.71	19.69
Reach 1	1633	KFA_10%	1942.3	542.67	543.5	4.7	318.13	0.83	8.67	25.58
Reach 1	1633	KFA_4%	2770.6	544.37	545.12	4.48	613.88	0.84	8.33	63.43
Reach 1	1633	KFA_1%	4094.4	545.4	546.35	5.19	877.82	1.26	9.56	68.47
Reach 1	1592	KFA_50%	764.5	539.95	540.39	2.74	179.3		6.39	19.54
Reach 1	1592	KFA_10%	1942.3	541.32	542.53	4.1	281.19	0.63	10.29	25.32
Reach 1	1592	KFA_4%	2770.6	544.09	544.61	2.76	877.61	0.81	7.01	62.51
Reach 1	1592	KFA_1%	4094.4	545.06	545.74	3.17	1218.69	1.09	8.18	67.07
Reach 1	1319	KFA_50%	764.5	537.32	537.66	4.07	166.62		4.99	18.88
Reach 1	1319	KFA_10%	1942.3	539.29	539.69	3.63	396.71		5.47	24.19
Reach 1	1319	KFA_4%	2770.6	543.78	543.93	1.61	979.94		3.26	58.99
Reach 1	1319	KFA_1%	4094.4	544.69	544.94	2.01	1114.83		4.24	62.35
Reach 1	1101	KFA_50%	764.5	535.69	536.07	3.99	159.14	5.34	5.32	18.18
Reach 1	1101	KFA_10%	1942.3	538.14	538.75	4.88	317.35	6.7	6.68	22.7
Reach 1	1101	KFA_4%	2770.6	543.64	543.81	2.6	841.64	3.45	3.52	55.23
Reach 1	1101	KFA_1%	4094.4	544.48	544.76	3.42	971.91	4.41	4.42	58.05
Reach 1	928	KFA_50%	776	534.97	535.27	4.81	256.22	1.26	0.86	17.4
Reach 1	928	KFA_10%	1949	537.09	537.91	8.18	424.52	2.13	1.46	21.31
Reach 1	928	KFA_4%	2804.3	543.45	543.7	5.05	1439.99	1.24	0.86	50.97
Reach 1	928	KFA_1%	4159.8	544.11	544.57	6.94	1603.19	1.69	1.2	53.24
Reach 1	799	KFA_50%	776	534.58	534.68	3.83	547.7	0.99	0.96	14.12
Reach 1	799	KFA_10%	1949	536.46	536.75	6.55	830.56	1.78	1.57	16.49
Reach 1	799	KFA_4%	2804.3	543.4	543.49	3.97	2365.38	1.15	0.77	39.83
Reach 1	799	KFA_1%	4159.8	544.03	544.21	5.53	2552.37	1.61	1.06	41.43
Reach 1	739	KFA_50%	776	534.41	534.48	3.09	431.72	1.29	1.63	12.46
Reach 1	739	KFA_10%	1949	536.1	536.33	5.7	610	2.46	2.85	14.07
Reach 1	739	KFA_4%	2804.3	543.36	543.43	3.56	2012.43	1.02	1.22	34.13
Reach 1	739	KFA_1%	4159.8	543.97	544.09	4.92	2209.84	1.42	1.64	35.37
Reach 1	681	KFA_50%	776	534.22	534.26	2.31	542.57	0.49	1.56	11.84
Reach 1	681	KFA_10%	1949	535.64	535.81	4.62	710.33	0.97	3.03	13.21
Reach 1	681	KFA_4%	2804.3	543.3	543.35	3.17	2233.69	0.53	1.36	31.37
Reach 1	681	KFA_1%	4159.8	543.85	543.94	4.44	2431.84	0.74	1.84	32.38
Reach 1	504	KFA_50%	776	534.07	534.1	1.69	675.82	0.75	0.49	9.44
Reach 1	504	KFA_10%	1949	535.07	535.23	3.82	764.93	1.7	1.11	10.12
Reach 1	504	KFA_4%	2804.3	543.15	543.22	2.82	1719.7	1.22	0.84	22.46
Reach 1	504	KFA_1%	4159.8	543.54	543.7	4.11	1780.19	1.77	1.16	22.92
Reach 1	379	KFA_50%	776	534	534.02	1.22	963.71	0.55	0.59	7.22
Reach 1	379	KFA_10%	1949	534.76	534.84	2.81	1058.14	1.31	1.34	7.65
Reach 1	379	KFA_4%	2804.3	543.08	543.11	1.98	2300.69	0.99	0.93	16.99
Reach 1	379	KFA_1%	4159.8	543.39	543.46	2.88	2356.67	1.43	1.35	17.3
Reach 1	60	KFA_50%	776	533.89	533.9	1	1090.16	0.37	0.32	
Reach 1	60	KFA_10%	1949	534.18	534.26	2.46	1121.75	0.9	0.8	
Reach 1	60	KFA_4%	2804.3	542.89	542.93	1.99	2589.23	0.69	0.44	
Reach 1	60	KFA_1%	4159.8	543	543.09	2.93	2620.5	1.02	0.66	

Engineered Channel (Ultimate)										
Reach	River Sta	Profile	Q Total	W.S. Elev	E.G. Elev	Vel Chnl	Flow Area	Vel Left	Vel Right	Volume
			(cfs)	(ft)	(ft)	(ft/s)	(sq ft)	(ft/s)	(ft/s)	(acre-ft)
Reach 1	3783	KFA_50%	770.1	559.76	559.81	1.86	506.03	0.37	0.65	37.07
Reach 1	3783	KFA_10%	1961	561.52	561.59	2.59	1404.1	0.82	0.68	64.31
Reach 1	3783	KFA_4%	2779	562.3	562.37	2.85	1920.21	0.9	0.88	120.87
Reach 1	3783	KFA_1%	4058.6	563.24	563.32	3.12	2666.3	1.08	1.03	144.85
Reach 1	3475	KFA_50%	770.1	558.62	558.66	2.08	738.53	0.44	0.67	33.01
Reach 1	3475	KFA_10%	1961	560.25	560.29	2.32	1722.86	0.74	1.01	54.5
Reach 1	3475	KFA_4%	2779	561.03	561.06	2.42	2293.38	0.88	1.13	107.74
Reach 1	3475	KFA_1%	4058.6	561.97	562.01	2.55	3062	1.03	1.28	127.1
Reach 1	3114	KFA_50%	764.5	556.59	556.64	2.05	678.02	0.63	0.75	28.04
Reach 1	3114	KFA_10%	1942.3	558.45	558.49	2.4	1564.58	0.95	1.04	43.55
Reach 1	3114	KFA_4%	2770.6	559.26	559.3	2.62	2064.82	1.08	1.17	93.4
Reach 1	3114	KFA_1%	4094.4	560.23	560.28	2.88	2743.35	1.26	1.34	108.2
Reach 1	2874	KFA_50%	764.5	552.66	553.03	5.53	180.59	1.03	2.85	25.62
Reach 1	2874	KFA_10%	1942.3	554.69	555.04	6.34	585.39	1.45	2.75	37.42
Reach 1	2874	KFA_4%	2770.6	555.66	555.88	5.57	994.67	1.64	2.74	84.63
Reach 1	2874	KFA_1%	4094.4	556.61	556.81	5.45	1465.34	1.99	2.89	96.07
Reach 1	2847	KFA_50%	764.5	550.46	551.32	7.72	108.41	4.27	2.28	25.54
Reach 1	2847	KFA_10%	1942.3	552.1	553.61	10.64	213.36	6.84	4.55	37.19
Reach 1	2847	KFA_4%	2770.6	552.99	554.79	11.84	284.74	7.78	4.89	84.27
Reach 1	2847	KFA_1%	4094.4	554.68	556	11.36	700.53	3.83	2.56	95.47
Reach 1	2746	KFA_50%	764.5	549.1	549.4	4.11	177.45	1.46	4.7	25.22
Reach 1	2746	KFA_10%	1942.3	551.04	551.48	5.38	371.57	3.31	5.46	36.55
Reach 1	2746	KFA_4%	2770.6	552.11	552.61	5.9	498.82	3.79	5.65	83.4
Reach 1	2746	KFA_1%	4094.4	553.64	554.08	6.22	803.96	3.71	4.69	93.91
Reach 1	2681	KFA_50%	764.5	548.56	548.78	3.92	203.83	1.92	3.76	24.87
Reach 1	2681	KFA_10%	1942.3	550.62	551	5.19	405.71	3.25	4.71	35.86
Reach 1	2681	KFA_4%	2770.6	551.74	552.19	5.73	527.69	3.64	5.2	82.48
Reach 1	2681	KFA_1%	4094.4	553.19	553.73	6.47	728.15	3.37	5.73	92.49
Reach 1	2527	KFA_50%	764.5	547.62	548.01	5.06	156.55	2.31		24.27
Reach 1	2527	KFA_10%	1942.3	549.69	550.35	6.73	308.22	4.11	2.09	34.67
Reach 1	2527	KFA_4%	2770.6	550.76	551.58	7.59	397.32	4.75	2.86	80.95
Reach 1	2527	KFA_1%	4094.4	552.11	553.14	8.63	583.12	5.44	1.72	90.23
Reach 1	2444	KFA_50%	764.5	547.15	547.52	5.04	160.17	2.95		23.96
Reach 1	2444	KFA_10%	1942.3	549.22	549.91	6.94	300.49	4.69	1.66	34.09
Reach 1	2444	KFA_4%	2770.6	550.27	551.15	7.91	391.96	5.37	1.37	80.19
Reach 1	2444	KFA_1%	4094.4	551.71	552.73	8.74	606.12	5.94	1.71	89.09
Reach 1	2384	KFA_50%	764.5	546.42	546.96	6.02	134.06	3.15		23.76
Reach 1	2384	KFA_10%	1942.3	548.33	549.31	8.25	251	5.52	0.97	33.71
Reach 1	2384	KFA_4%	2770.6	549.27	550.53	9.44	317.53	6.39	2.31	79.7
Reach 1	2384	KFA_1%	4094.4	550.53	552.13	10.76	442.69	7.31	2.07	88.34
Reach 1	2125	KFA_50%	764.5	543.52	543.89	5.13	170.6	2.35	2.17	22.86
Reach 1	2125	KFA_10%	1942.3	545.45	546.05	6.85	336.25	3.92	4.11	31.97
Reach 1	2125	KFA_4%	2770.6	546.63	547.31	7.38	447.79	4.39	4.76	77.44
Reach 1	2125	KFA_1%	4094.4	547.99	548.87	8.57	589.92	5.22	5.16	85.29
Reach 1	2040	KFA_50%	764.5	542.96	543.23	4.48	195.57	2.49	2.49	22.5
Reach 1	2040	KFA_10%	1942.3	544.94	545.38	5.97	385.81	3.72	3.9	31.25
Reach 1	2040	KFA_4%	2770.6	546.25	546.71	6.14	538.74	3.9	4.27	76.45
Reach 1	2040	KFA_1%	4094.4	547.68	548.23	6.79	729.7	4.36	4.81	83.95
Reach 1	1922	KFA_50%	764.5	541.73	542.22	5.75	146.05	3.01	1.93	22.03
Reach 1	1922	KFA_10%	1942.3	543.8	544.44	6.98	318.76	4.53	4.05	30.27
Reach 1	1922	KFA_4%	2770.6	545.44	546.03	6.73	477.93	4.45	4.3	75.02
Reach 1	1922	KFA_1%	4094.4	546.79	547.54	7.76	620.44	5.13	5.08	82.05
Reach 1	1717	KFA_50%	764.5	539.42	539.86	5.51	151.13	2.85	2.69	21.34
Reach 1	1717	KFA_10%	1942.3	541.65	542.43	7.58	291.53	4.45	4.3	28.85
Reach 1	1717	KFA_4%	2770.6	544.42	544.95	6.47	509.2	3.93	3.77	72.74
Reach 1	1717	KFA_1%	4094.4	545.61	546.36	7.91	677.53	4.83	3.39	79.05
Reach 1	1544	KFA_50%	764.5	538.01	538.37	5.01	166.13	2.57	2.56	20.72
Reach 1	1544	KFA_10%	1942.3	540.28	540.95	7.03	313.63	4.02	4.19	27.7
Reach 1	1544	KFA_4%	2770.6	544.05	544.37	5.18	724.66	3.11	2.04	70.52
Reach 1	1544	KFA_1%	4094.4	545.14	545.62	6.52	920.85	3.78	2.25	76.27

Engineered Channel (Ultimate) (Continued)										
Reach	River Sta	Profile	Q Total	W.S. Elev	E.G. Elev	Vel Chnl	Flow Area	Vel Left	Vel Right	Volume
			(cfs)	(ft)	(ft)	(ft/s)	(sq ft)	(ft/s)	(ft/s)	(acre-ft)
Reach 1	1511	KFA_50%	764.5	537.75	538.12	5.08	171.6	2.59	2	20.59
Reach 1	1511	KFA_10%	1942.3	540.1	540.68	6.77	369.34	3.9	2.63	27.44
Reach 1	1511	KFA_4%	2770.6	544.05	544.28	4.66	915.13	2.9	1.62	69.88
Reach 1	1511	KFA_1%	4094.4	545.15	545.49	5.85	1155.94	3	2	75.47
Reach 1	1466	KFA_50%	764.5	537.28	537.69	5.36	166.6	2.74	1.89	20.35
Reach 1	1466	KFA_10%	1942.3	539.61	540.23	7.02	354.33	4.09	2.82	26.8
Reach 1	1466	KFA_4%	2770.6	543.93	544.17	4.6	866.58	2.86	1.85	67.97
Reach 1	1466	KFA_1%	4094.4	544.97	545.32	5.88	1074.77	2.82	2.38	73.11
Reach 1	1435	KFA_50%	764.5	536.9	537.37	5.74	146.58	2.74	3.02	20.24
Reach 1	1435	KFA_10%	1942.3	539.24	539.97	7.36	301.57	4.19	4.69	26.58
Reach 1	1435	KFA_4%	2770.6	543.83	544.11	4.81	686.78	2.96	3.24	67.46
Reach 1	1435	KFA_1%	4094.4	544.78	545.24	6.3	856.84	2.89	4.04	72.52
Reach 1	1370	KFA_50%	764.5	536.41	536.75	4.85	171.96	2.44	2.56	20.01
Reach 1	1370	KFA_10%	1942.3	538.83	539.43	6.69	332.21	3.78	3.91	26.12
Reach 1	1370	KFA_4%	2770.6	543.78	544	4.31	832.67	2.08	2.61	66.37
Reach 1	1370	KFA_1%	4094.4	544.71	545.07	5.64	1058.1	2.02	3.42	71.19
Reach 1	1305	KFA_50%	764.5	536	536.31	4.66	196.78	1.57	2.39	19.71
Reach 1	1305	KFA_10%	1942.3	538.53	538.98	6	438.25	2.22	3.44	25.47
Reach 1	1305	KFA_4%	2770.6	543.76	543.9	3.61	1203.45	1.36	2.16	64.18
Reach 1	1305	KFA_1%	4094.4	544.69	544.91	4.75	1360.26	1.83	2.85	68.31
Reach 1	1289	KFA_50%	764.5	535.85	536.15	4.75	196.6	1.72	2.49	19.56
Reach 1	1289	KFA_10%	1942.3	538.35	538.81	6.13	425.75	2.44	3.58	25.01
Reach 1	1289	KFA_4%	2770.6	543.74	543.86	3.56	1343.19	1.15	2.17	62.06
Reach 1	1289	KFA_1%	4094.4	544.65	544.85	4.66	1548.24	1.52	2.84	65.63
Reach 1	1262	KFA_50%	764.5	535.65	535.98	4.84	200.74	1.85	0.63	19.39
Reach 1	1262	KFA_10%	1942.3	538.04	538.62	6.77	415.53	2.56	0.99	24.61
Reach 1	1262	KFA_4%	2770.6	543.66	543.83	4.01	1279.48	1.39	0.61	60.57
Reach 1	1262	KFA_1%	4094.4	544.5	544.79	5.38	1429.37	1.88	0.82	63.91
Reach 1	1101	KFA_50%	764.5	535.1	535.3	3.71	228.35	2.04	2.01	18.57
Reach 1	1101	KFA_10%	1942.3	537.4	537.83	5.72	391.25	3.33	3.29	23.07
Reach 1	1101	KFA_4%	2770.6	543.57	543.71	3.41	1005.02	2.1	2.09	56.07
Reach 1	1101	KFA_1%	4094.4	544.34	544.59	4.62	1119.51	2.79	2.76	58.9
Reach 1	928	KFA_50%	776	534.83	534.93	2.72	328.21	1.57	1.58	17.5
Reach 1	928	KFA_10%	1949	537	537.26	4.56	504.99	2.71	2.85	21.36
Reach 1	928	KFA_4%	2804.3	543.52	543.61	2.9	1566.63	1.75	0.94	51.28
Reach 1	928	KFA_1%	4159.8	544.26	544.42	4	1753.87	2.42	1.22	53.55
Reach 1	799	KFA_50%	776	534.64	534.71	3.33	590.59	0.96	0.97	14
Reach 1	799	KFA_10%	1949	536.65	536.85	5.66	899.71	1.72	1.57	16.15
Reach 1	799	KFA_4%	2804.3	543.46	543.53	3.61	2419.42	1.17	0.79	39.4
Reach 1	799	KFA_1%	4159.8	544.15	544.29	5.01	2626.45	1.62	1.08	40.86
Reach 1	739	KFA_50%	776	534.35	534.48	4.43	425.62	1.09	1.39	12.38
Reach 1	739	KFA_10%	1949	535.88	536.36	8.39	585.85	2.14	2.5	13.75
Reach 1	739	KFA_4%	2804.3	543.3	543.45	5.19	1990.68	0.88	1.06	33.96
Reach 1	739	KFA_1%	4159.8	543.84	544.14	7.24	2167.93	1.24	1.44	35.08
Reach 1	681	KFA_50%	776	534.18	534.22	2.27	538.12	0.52	1.6	11.77
Reach 1	681	KFA_10%	1949	535.48	535.65	4.61	690.97	1.05	3.16	12.92
Reach 1	681	KFA_4%	2804.3	543.28	543.33	3.07	2228.8	0.55	1.39	31.22
Reach 1	681	KFA_1%	4159.8	543.83	543.92	4.3	2425.18	0.78	1.88	32.13
Reach 1	504	KFA_50%	776	533.99	534.04	1.95	669.44	0.46	0.28	9.41
Reach 1	504	KFA_10%	1949	534.74	535	4.56	734.7	1.08	0.66	9.97
Reach 1	504	KFA_4%	2804.3	543.05	543.19	3.51	1704.99	0.81	0.54	22.39
Reach 1	504	KFA_1%	4159.8	543.34	543.63	5.14	1748.31	1.18	0.77	22.77
Reach 1	379	KFA_50%	776	533.96	533.99	1.64	958.98	0.33	0.36	7.2
Reach 1	379	KFA_10%	1949	534.58	534.75	3.88	1035.68	0.81	0.83	7.58
Reach 1	379	KFA_4%	2804.3	543.02	543.11	2.95	2291.09	0.66	0.62	16.96
Reach 1	379	KFA_1%	4159.8	543.28	543.46	4.31	2336.34	0.96	0.91	17.23
Reach 1	60	KFA_50%	776	533.89	533.9	1.02	1090.16	0.35	0.31	
Reach 1	60	KFA_10%	1949	534.18	534.26	2.5	1121.75	0.86	0.76	
Reach 1	60	KFA_4%	2804.3	542.89	542.93	2.04	2589.23	0.66	0.43	
Reach 1	60	KFA_1%	4159.8	543	543.1	3	2620.5	0.98	0.63	

Natural Channel (Ultimate)										
Reach	River Sta	Profile	Q Total	W.S. Elev	E.G. Elev	Vel Chnl	Flow Area	Vel Left	Vel Right	Volume
			(cfs)	(ft)	(ft)	(ft/s)	(sq ft)	(ft/s)	(ft/s)	(acre-ft)
Reach 1	4361	KFA_50%	770.1	560.19	560.23	1.67	658.6	0.4	0.16	45.86
Reach 1	4361	KFA_10%	1961	561.99	562.04	2.24	1703.4	0.68	0.65	87.24
Reach 1	4361	KFA_4%	2779.1	562.79	562.84	2.46	2298.23	0.84	0.75	145.21
Reach 1	4361	KFA_1%	4058.6	563.74	563.8	2.68	3098.68	0.95	0.95	181.22
Reach 1	4053	KFA_50%	770.1	558.87	558.9	1.81	864.5	0.4	0.63	40.94
Reach 1	4053	KFA_10%	1961	560.49	560.51	2.11	1888.11	0.7	0.94	76
Reach 1	4053	KFA_4%	2779.1	561.25	561.28	2.23	2471.53	0.83	1.06	130.37
Reach 1	4053	KFA_1%	4058.6	562.17	562.2	2.4	3232.59	0.99	1.21	161.61
Reach 1	3692	KFA_50%	770.1	556.18	556.26	2.53	532.58	0.69	0.85	36.01
Reach 1	3692	KFA_10%	1961	558.09	558.15	2.81	1365.65	1.05	1.16	65.13
Reach 1	3692	KFA_4%	2779.1	558.88	558.95	3.03	1824.48	1.17	1.31	116.2
Reach 1	3692	KFA_1%	4058.6	559.81	559.88	3.24	2438.66	1.39	1.44	143.1
Reach 1	3526	KFA_50%	770.1	553.24	553.45	4.49	278.85	2.95	1.22	34.28
Reach 1	3526	KFA_10%	1961	555.36	555.6	5.6	736.8	2.61	1.5	60.44
Reach 1	3526	KFA_4%	2779.1	556.12	556.35	5.96	1069.26	2.38	1.67	109.65
Reach 1	3526	KFA_1%	4058.6	557.1	557.32	6.26	1569.55	2.35	1.83	133.92
Reach 1	3321	KFA_50%	764.5	550.77	551.08	4.56	191.44	1.04		33.28
Reach 1	3321	KFA_10%	1942.3	552.91	553.45	6.29	530.99	0.93	2.36	57.88
Reach 1	3321	KFA_4%	2770.6	553.75	554.31	6.83	781.21	1.34	3.12	106
Reach 1	3321	KFA_1%	4094.4	554.86	555.46	7.46	1123.77	1.76	3.95	128.61
Reach 1	3207	KFA_50%	764.5	550.34	550.57	4.05	247.37	1.04		32.8
Reach 1	3207	KFA_10%	1942.3	552.56	552.92	5.39	652.21	1.11	0.5	56.81
Reach 1	3207	KFA_4%	2770.6	553.45	553.84	5.88	900.92	1.44	0.66	104.47
Reach 1	3207	KFA_1%	4094.4	554.59	555.03	6.56	1228.03	1.82	0.98	126.31
Reach 1	2996	KFA_50%	764.5	549.37	549.61	4.12	226.22	1.36		31.75
Reach 1	2996	KFA_10%	1942.3	551.45	551.9	5.84	484.37	1.51	1.46	54.35
Reach 1	2996	KFA_4%	2770.6	552.26	552.82	6.69	625.58	1.96	2.29	101.08
Reach 1	2996	KFA_1%	4094.4	553.23	553.98	7.94	797.39	2.55	3.29	121.49
Reach 1	2823	KFA_50%	764.5	547.59	548.04	5.71	163.75	2		30.97
Reach 1	2823	KFA_10%	1942.3	549.6	550.32	7.35	366.43	2.17	0.5	52.58
Reach 1	2823	KFA_4%	2770.6	550.62	551.31	7.55	563.13	2.53	1.08	98.52
Reach 1	2823	KFA_1%	4094.4	551.86	552.49	7.69	904.4	2.81	2.02	117.54
Reach 1	2760	KFA_50%	764.5	546.95	547.21	4.29	214.81	1.31	1.61	30.69
Reach 1	2760	KFA_10%	1942.3	549.18	549.59	5.6	481.03	1.69	2.09	51.95
Reach 1	2760	KFA_4%	2770.6	550.28	550.71	5.96	701.21	2.01	1.17	97.59
Reach 1	2760	KFA_1%	4094.4	551.58	552.02	6.33	1096.63	2.32	1.5	116.04
Reach 1	2584	KFA_50%	764.5	546.3	546.36	2.42	514.8	1.07		29.36
Reach 1	2584	KFA_10%	1942.3	548.74	548.85	3.45	1030.6	1.29	1.28	49.22
Reach 1	2584	KFA_4%	2770.6	549.93	550.05	3.75	1380.8	1.47	0.77	93.83
Reach 1	2584	KFA_1%	4094.4	551.26	551.41	4.29	1837.24	1.73	0.93	110.57
Reach 1	2421	KFA_50%	764.5	546.14	546.17	1.78	587.68	1.11		28.35
Reach 1	2421	KFA_10%	1942.3	548.59	548.65	2.55	1135.85	1.42	0.55	47.3
Reach 1	2421	KFA_4%	2770.6	549.79	549.86	2.84	1450.02	1.62	0.5	91.3
Reach 1	2421	KFA_1%	4094.4	551.11	551.21	3.36	1826.2	1.94	0.59	107.18
Reach 1	2329	KFA_50%	764.5	546.01	546.05	1.53	510.34	1.48		27.66
Reach 1	2329	KFA_10%	1942.3	548.45	548.51	2.26	1002.15	1.82	0.48	46
Reach 1	2329	KFA_4%	2770.6	549.66	549.73	2.5	1292.26	2.06	0.57	89.65
Reach 1	2329	KFA_1%	4094.4	550.97	551.07	2.93	1649.83	2.46	0.78	105.06
Reach 1	2109	KFA_50%	764.5	545.26	545.33	2.43	457.28	1.37	0.36	25.45
Reach 1	2109	KFA_10%	1942.3	547.73	547.8	2.72	1120.6	2	0.66	41.22
Reach 1	2109	KFA_4%	2770.6	549	549.08	2.85	1547.39	2.22	0.78	83.26
Reach 1	2109	KFA_1%	4094.4	550.23	550.34	3.31	2007.75	2.67	0.95	96.84

Natural Channel (Ultimate) (Continued)										
Reach	River Sta	Profile	Q Total	W.S. Elev	E.G. Elev	Vel Chnl	Flow Area	Vel Left	Vel Right	Volume
			(cfs)	(ft)	(ft)	(ft/s)	(sq ft)	(ft/s)	(ft/s)	(acre-ft)
Reach 1	1918	KFA_50%	764.5	544.44	544.5	2.35	428.44	0.58	1.3	23.83
Reach 1	1918	KFA_10%	1942.3	547.01	547.11	3.15	1014.25	0.99	1.67	37.41
Reach 1	1918	KFA_4%	2770.6	548.44	548.52	3.02	1529.9	1.27	1.59	78.07
Reach 1	1918	KFA_1%	4094.4	549.63	549.72	3.46	2008.05	1.63	1.7	90.24
Reach 1	1673	KFA_50%	764.5	543.49	543.67	3.58	278.43	0.95	0.8	22.1
Reach 1	1673	KFA_10%	1942.3	546.31	546.44	3.79	974.18	1.33	1.1	33.55
Reach 1	1673	KFA_4%	2770.6	547.98	548.08	3.52	1642.94	1.41	0.73	72.32
Reach 1	1673	KFA_1%	4094.4	549.15	549.25	3.84	2435.72	1.62	0.78	82.15
Reach 1	1632	KFA_50%	764.5	543.37	543.51	3.2	367.88	0.58	1.03	21.6
Reach 1	1632	KFA_10%	1942.3	546.21	546.28	2.87	1214.37	1.26	0.81	30.89
Reach 1	1632	KFA_4%	2770.6	547.91	547.96	2.63	2005.7	1.35	0.59	67.9
Reach 1	1632	KFA_1%	4094.4	549.08	549.13	2.86	2893.45	1.57	0.71	76.2
Reach 1	1631		Lat Struct							
Reach 1	1592	KFA_50%	764.5	543.23	543.35	2.97	352.61	0.54	0.97	21.09
Reach 1	1592	KFA_10%	1942.3	546.07	546.16	3.07	1061.47	1.33	1.14	28.99
Reach 1	1592	KFA_4%	2770.6	547.81	547.88	2.89	1822.6	1.39	0.81	64.89
Reach 1	1592	KFA_1%	4094.4	548.99	549.05	3.08	2602.95	1.52	1.03	72.24
Reach 1	1319	KFA_50%	764.5	541.75	541.88	3.2	324.71		1.35	19.19
Reach 1	1319	KFA_10%	1942.3	545.1	545.24	3.84	764.22		1.84	24.91
Reach 1	1319	KFA_4%	2770.6	547.15	547.27	3.81	1364.22	0.46	1.46	58.97
Reach 1	1319	KFA_1%	4094.4	548.42	548.53	3.91	1953.03	0.68	1.68	64.71
Reach 1	1101	KFA_50%	764.5	538.08	538.39	4.74	196.48	1.86	1.81	18.08
Reach 1	1101	KFA_10%	1942.3	541.3	541.81	6.52	403.84	2.86	2.81	22.63
Reach 1	1101	KFA_4%	2770.6	544.78	545.11	5.62	847.83	2.58	1.25	54.67
Reach 1	1101	KFA_1%	4094.4	545.97	546.4	6.69	1158.13	3.11	1.62	58.53
Reach 1	928	KFA_50%	776	535.17	535.47	5.23	267.59	1.65	1.17	17.22
Reach 1	928	KFA_10%	1949	537.46	538.24	8.72	453.92	2.73	1.84	21.05
Reach 1	928	KFA_4%	2804.3	543.52	543.75	5.4	1452.71	1.63	1.06	50.22
Reach 1	928	KFA_1%	4159.8	544.24	544.63	7.22	1635.1	2.16	1.48	52.72
Reach 1	799	KFA_50%	776	534.68	534.75	3.37	605.41	0.92	0.93	13.79
Reach 1	799	KFA_10%	1949	536.68	536.89	5.75	917.04	1.65	1.52	15.94
Reach 1	799	KFA_4%	2804.3	543.42	543.5	3.71	2441.15	1.13	0.78	38.67
Reach 1	799	KFA_1%	4159.8	544.08	544.22	5.08	2631.71	1.56	1.09	40.3
Reach 1	746	KFA_50%	776	534.49	534.63	4.31	446.71	1.01	1.27	12.16
Reach 1	746	KFA_10%	1949	536.17	536.62	7.95	634.17	1.92	2.22	13.54
Reach 1	746	KFA_4%	2804.3	543.33	543.46	4.71	1960.74	0.77	1.14	33.16
Reach 1	746	KFA_1%	4159.8	543.89	544.14	6.53	2102.84	1.07	1.6	34.43
Reach 1	504	KFA_50%	776	534.06	534.09	1.64	674.87	0.75	0.46	9.44
Reach 1	504	KFA_10%	1949	535.02	535.18	3.73	760.31	1.71	1.04	10.1
Reach 1	504	KFA_4%	2804.3	543.13	543.2	2.75	1716.99	1.22	0.82	22.44
Reach 1	504	KFA_1%	4159.8	543.5	543.66	3.98	1774.36	1.77	1.16	22.89
Reach 1	379	KFA_50%	776	533.99	534.01	1.2	963.03	0.57	0.6	7.22
Reach 1	379	KFA_10%	1949	534.73	534.81	2.76	1054.7	1.34	1.37	7.64
Reach 1	379	KFA_4%	2804.3	543.06	543.1	1.93	2298.81	1.01	0.95	16.99
Reach 1	379	KFA_1%	4159.8	543.37	543.44	2.81	2352.7	1.46	1.37	17.28
Reach 1	60	KFA_50%	776	533.89	533.9	0.99	1090.16	0.38	0.33	
Reach 1	60	KFA_10%	1949	534.18	534.25	2.44	1121.75	0.93	0.82	
Reach 1	60	KFA_4%	2804.3	542.89	542.93	1.97	2589.23	0.71	0.45	
Reach 1	60	KFA_1%	4159.8	543	543.09	2.9	2620.5	1.04	0.67	

Appendix L: Secondary Analysis Hydrologic Output

Existing Conditions (Ultimate) 2Yr		
Model Element	**Peak Flow (CFS)**	**Peak Time**
LOCR320	495.1	01Jan2001, 12:20
VertexPond	131.3	01Jan2001, 13:00
LOCR330	525.9	01Jan2001, 12:18
JLOCR330	525.9	01Jan2001, 12:18
RLOCR340C	490.1	01Jan2001, 12:28
LOCR340C	31.1	01Jan2001, 12:14
JLOCR340C	507.1	01Jan2001, 12:26
JLOCR320_340C	576.1	01Jan2001, 12:28
LOCR340A	352.9	01Jan2001, 12:10
PCM_1_200	87.7	01Jan2001, 12:34
JLOCR340A	87.7	01Jan2001, 12:34
RLOCR340B	87.6	01Jan2001, 12:36
LOCR340B	268.7	01Jan2001, 12:08
PCM_1_100	153.1	01Jan2001, 12:24
JLOCR340B	153.1	01Jan2001, 12:24
JLOCR340B_340C	727.9	01Jan2001, 12:28
RLOCR350A	688.5	01Jan2001, 12:40
LOCR350A	211.4	01Jan2001, 12:16
JLOCR350A	776	01Jan2001, 12:40
RLOCR350B	734.1	01Jan2001, 12:52
LOCR350B	125.2	01Jan2001, 12:12
JLOCR350B	753.1	01Jan2001, 12:52
RLOCR350C	719.1	01Jan2001, 13:08
LOCR350C	97.6	01Jan2001, 12:16
JLOCR350C	734.3	01Jan2001, 13:08

Existing Conditions (Ultimate) 10Yr		
Model Element	**Peak Flow (CFS)**	**Peak Time**
LOCR320	937.2	01Jan2001, 12:20
VertexPond	430.6	01Jan2001, 12:44
LOCR330	980.4	01Jan2001, 12:16
JLOCR330	980.4	01Jan2001, 12:16
RLOCR340C	922.2	01Jan2001, 12:26
LOCR340C	67.1	01Jan2001, 12:14
JLOCR340C	960.7	01Jan2001, 12:26
JLOCR320_340C	1298.9	01Jan2001, 12:28
LOCR340A	668.3	01Jan2001, 12:10
PCM_1_200	274.6	01Jan2001, 12:26
JLOCR340A	274.6	01Jan2001, 12:26
RLOCR340B	274	01Jan2001, 12:26
LOCR340B	514.9	01Jan2001, 12:08
PCM_1_100	430.5	01Jan2001, 12:22
JLOCR340B	430.5	01Jan2001, 12:22
JLOCR340B_340C	1717.9	01Jan2001, 12:28
RLOCR350A	1700.7	01Jan2001, 12:34
LOCR350A	443.9	01Jan2001, 12:16
JLOCR350A	1949	01Jan2001, 12:32
RLOCR350B	1842.7	01Jan2001, 12:44
LOCR350B	280.5	01Jan2001, 12:10
JLOCR350B	1898	01Jan2001, 12:44
RLOCR350C	1802.3	01Jan2001, 13:00
LOCR350C	224.6	01Jan2001, 12:16
JLOCR350C	1846.6	01Jan2001, 13:00

Existing Conditions (Ultimate) 25Yr		
Model Element	**Peak Flow (CFS)**	**Peak Time**
LOCR320	1195.6	01Jan2001, 12:20
VertexPond	620.4	01Jan2001, 12:42
LOCR330	1244.1	01Jan2001, 12:16
JLOCR330	1244.1	01Jan2001, 12:16
RLOCR340C	1176.2	01Jan2001, 12:26
LOCR340C	88.8	01Jan2001, 12:12
JLOCR340C	1226.4	01Jan2001, 12:26
JLOCR320_340C	1751.4	01Jan2001, 12:28
LOCR340A	852.7	01Jan2001, 12:10
PCM_1_200	713.2	01Jan2001, 12:14
JLOCR340A	713.2	01Jan2001, 12:14
RLOCR340B	697.6	01Jan2001, 12:16
LOCR340B	659.9	01Jan2001, 12:08
PCM_1_100	768.5	01Jan2001, 12:22
JLOCR340B	768.5	01Jan2001, 12:22
JLOCR340B_340C	2457.8	01Jan2001, 12:26
RLOCR350A	2428	01Jan2001, 12:32
LOCR350A	586.4	01Jan2001, 12:16
JLOCR350A	2779.1	01Jan2001, 12:30
RLOCR350B	2629.8	01Jan2001, 12:42
LOCR350B	380	01Jan2001, 12:10
JLOCR350B	2711.9	01Jan2001, 12:42
RLOCR350C	2574.1	01Jan2001, 12:58
LOCR350C	306.9	01Jan2001, 12:16
JLOCR350C	2642.3	01Jan2001, 12:56

Existing Conditions (Ultimate) 100Yr		
Model Element	**Peak Flow (CFS)**	**Peak Time**
LOCR320	1600.5	01Jan2001, 12:20
VertexPond	1095	01Jan2001, 12:34
LOCR330	1654.4	01Jan2001, 12:16
JLOCR330	1654.4	01Jan2001, 12:16
RLOCR340C	1571.8	01Jan2001, 12:26
LOCR340C	122.9	01Jan2001, 12:12
JLOCR340C	1640.4	01Jan2001, 12:26
JLOCR320_340C	2580.6	01Jan2001, 12:30
LOCR340A	1139.3	01Jan2001, 12:10
PCM_1_200	1163.4	01Jan2001, 12:12
JLOCR340A	1163.4	01Jan2001, 12:12
RLOCR340B	1124	01Jan2001, 12:12
LOCR340B	886	01Jan2001, 12:08
PCM_1_100	1742.1	01Jan2001, 12:14
JLOCR340B	1742.1	01Jan2001, 12:14
JLOCR340B_340C	3486.3	01Jan2001, 12:28
RLOCR350A	3461.2	01Jan2001, 12:32
LOCR350A	812.5	01Jan2001, 12:16
JLOCR350A	4058.6	01Jan2001, 12:22
RLOCR350B	3889.7	01Jan2001, 12:38
LOCR350B	541.1	01Jan2001, 12:10
JLOCR350B	4024.2	01Jan2001, 12:38
RLOCR350C	3877.4	01Jan2001, 12:52
LOCR350C	441.3	01Jan2001, 12:16
JLOCR350C	3999.2	01Jan2001, 12:52

Proposed Hybrid Channel (Ultimate) 2Yr		
Model Element	Peak Flow (CFS)	Peak Time
LOCR320	495.1	01Jan2001, 12:20
VertexPond	131.3	01Jan2001, 13:00
LOCR330	525.9	01Jan2001, 12:18
JLOCR330	525.9	01Jan2001, 12:18
RLOCR340C	490.1	01Jan2001, 12:28
LOCR340C	31.1	01Jan2001, 12:14
JLOCR340C	507.1	01Jan2001, 12:26
JLOCR320_340C	576.1	01Jan2001, 12:28
LOCR340A	352.9	01Jan2001, 12:10
PCM_1_200	87.7	01Jan2001, 12:34
JLOCR340A	87.7	01Jan2001, 12:34
RLOCR340B	87.6	01Jan2001, 12:36
LOCR340B	268.7	01Jan2001, 12:08
PCM_1_100	153.1	01Jan2001, 12:24
JLOCR340B	153.1	01Jan2001, 12:24
JLOCR340B_340C	727.9	01Jan2001, 12:28
RLOCR350A	688.5	01Jan2001, 12:40
LOCR350A	211.4	01Jan2001, 12:16
JLOCR350A	776	01Jan2001, 12:40
RLOCR350B	738.6	01Jan2001, 12:52
LOCR350B	125.2	01Jan2001, 12:12
JLOCR350B	757.5	01Jan2001, 12:52
RLOCR350C	742.1	01Jan2001, 13:00
LOCR350C	97.6	01Jan2001, 12:16
JLOCR350C	760	01Jan2001, 13:00

Proposed Hybrid Channel (Ultimate) 10Yr		
Model Element	Peak Flow (CFS)	Peak Time
LOCR320	937.2	01Jan2001, 12:20
VertexPond	430.6	01Jan2001, 12:44
LOCR330	980.4	01Jan2001, 12:16
JLOCR330	980.4	01Jan2001, 12:16
RLOCR340C	922.2	01Jan2001, 12:26
LOCR340C	67.1	01Jan2001, 12:14
JLOCR340C	960.7	01Jan2001, 12:26
JLOCR320_340C	1298.9	01Jan2001, 12:28
LOCR340A	668.3	01Jan2001, 12:10
PCM_1_200	274.6	01Jan2001, 12:26
JLOCR340A	274.6	01Jan2001, 12:26
RLOCR340B	274	01Jan2001, 12:26
LOCR340B	514.9	01Jan2001, 12:08
PCM_1_100	430.5	01Jan2001, 12:22
JLOCR340B	430.5	01Jan2001, 12:22
JLOCR340B_340C	1717.9	01Jan2001, 12:28
RLOCR350A	1700.7	01Jan2001, 12:34
LOCR350A	443.9	01Jan2001, 12:16
JLOCR350A	1949	01Jan2001, 12:32
RLOCR350B	1869	01Jan2001, 12:42
LOCR350B	280.5	01Jan2001, 12:10
JLOCR350B	1927.9	01Jan2001, 12:42
RLOCR350C	1892.1	01Jan2001, 12:50
LOCR350C	224.6	01Jan2001, 12:16
JLOCR350C	1949.9	01Jan2001, 12:50

Proposed Hybrid Channel (Ultimate) 25Yr		
Model Element	Peak Flow (CFS)	Peak Time
LOCR320	1195.6	01Jan2001, 12:20
VertexPond	620.4	01Jan2001, 12:42
LOCR330	1244.1	01Jan2001, 12:16
JLOCR330	1244.1	01Jan2001, 12:16
RLOCR340C	1176.2	01Jan2001, 12:26
LOCR340C	88.8	01Jan2001, 12:12
JLOCR340C	1226.4	01Jan2001, 12:26
JLOCR320_340C	1751.4	01Jan2001, 12:28
LOCR340A	852.7	01Jan2001, 12:10
PCM_1_200	713.2	01Jan2001, 12:14
JLOCR340A	713.2	01Jan2001, 12:14
RLOCR340B	697.6	01Jan2001, 12:16
LOCR340B	659.9	01Jan2001, 12:08
PCM_1_100	768.5	01Jan2001, 12:22
JLOCR340B	768.5	01Jan2001, 12:22
JLOCR340B_340C	2457.8	01Jan2001, 12:26
RLOCR350A	2428	01Jan2001, 12:32
LOCR350A	586.4	01Jan2001, 12:16
JLOCR350A	2779.1	01Jan2001, 12:30
RLOCR350B	2666.4	01Jan2001, 12:40
LOCR350B	380	01Jan2001, 12:10
JLOCR350B	2753.3	01Jan2001, 12:40
RLOCR350C	2704.8	01Jan2001, 12:48
LOCR350C	306.9	01Jan2001, 12:16
JLOCR350C	2791.1	01Jan2001, 12:48

Proposed Hybrid Channel (Ultimate) 100Yr		
Model Element	Peak Flow (CFS)	Peak Time
LOCR320	1600.5	01Jan2001, 12:20
VertexPond	1095	01Jan2001, 12:34
LOCR330	1654.4	01Jan2001, 12:16
JLOCR330	1654.4	01Jan2001, 12:16
RLOCR340C	1571.8	01Jan2001, 12:26
LOCR340C	122.9	01Jan2001, 12:12
JLOCR340C	1640.4	01Jan2001, 12:26
JLOCR320_340C	2580.6	01Jan2001, 12:30
LOCR340A	1139.3	01Jan2001, 12:10
PCM_1_200	1163.4	01Jan2001, 12:12
JLOCR340A	1163.4	01Jan2001, 12:12
RLOCR340B	1124	01Jan2001, 12:12
LOCR340B	886	01Jan2001, 12:08
PCM_1_100	1742.1	01Jan2001, 12:14
JLOCR340B	1742.1	01Jan2001, 12:14
JLOCR340B_340C	3486.3	01Jan2001, 12:28
RLOCR350A	3461.2	01Jan2001, 12:32
LOCR350A	812.5	01Jan2001, 12:16
JLOCR350A	4058.6	01Jan2001, 12:22
RLOCR350B	3930	01Jan2001, 12:36
LOCR350B	541.1	01Jan2001, 12:10
JLOCR350B	4072.2	01Jan2001, 12:36
RLOCR350C	4021.2	01Jan2001, 12:44
LOCR350C	441.3	01Jan2001, 12:16
JLOCR350C	4165.4	01Jan2001, 12:44

Proposed Engineered Channel (Ultimate) 2Yr		
Model Element	Peak Flow (CFS)	Peak Time
LOCR320	495.1	01Jan2001, 12:20
VertexPond	131.3	01Jan2001, 13:00
LOCR330	525.9	01Jan2001, 12:18
JLOCR330	525.9	01Jan2001, 12:18
RLOCR340C	490.1	01Jan2001, 12:28
LOCR340C	31.1	01Jan2001, 12:14
JLOCR340C	507.1	01Jan2001, 12:26
JLOCR320_340C	576.1	01Jan2001, 12:28
LOCR340A	352.9	01Jan2001, 12:10
PCM_1_200	87.7	01Jan2001, 12:34
JLOCR340A	87.7	01Jan2001, 12:34
RLOCR340B	87.6	01Jan2001, 12:36
LOCR340B	268.7	01Jan2001, 12:08
PCM_1_100	153.1	01Jan2001, 12:24
JLOCR340B	153.1	01Jan2001, 12:24
JLOCR340B_340C	727.9	01Jan2001, 12:28
RLOCR350A	688.5	01Jan2001, 12:40
LOCR350A	211.4	01Jan2001, 12:16
JLOCR350A	776	01Jan2001, 12:40
RLOCR350B	731.1	01Jan2001, 12:52
LOCR350B	125.2	01Jan2001, 12:12
JLOCR350B	750.1	01Jan2001, 12:52
RLOCR350C	737.2	01Jan2001, 13:02
LOCR350C	97.6	01Jan2001, 12:16
JLOCR350C	754.3	01Jan2001, 13:02

Proposed Engineered Channel (Ultimate) 10Yr		
Model Element	Peak Flow (CFS)	Peak Time
LOCR320	937.2	01Jan2001, 12:20
VertexPond	430.6	01Jan2001, 12:44
LOCR330	980.4	01Jan2001, 12:16
JLOCR330	980.4	01Jan2001, 12:16
RLOCR340C	922.2	01Jan2001, 12:26
LOCR340C	67.1	01Jan2001, 12:14
JLOCR340C	960.7	01Jan2001, 12:26
JLOCR320_340C	1298.9	01Jan2001, 12:28
LOCR340A	668.3	01Jan2001, 12:10
PCM_1_200	274.6	01Jan2001, 12:26
JLOCR340A	274.6	01Jan2001, 12:26
RLOCR340B	274	01Jan2001, 12:26
LOCR340B	514.9	01Jan2001, 12:08
PCM_1_100	430.5	01Jan2001, 12:22
JLOCR340B	430.5	01Jan2001, 12:22
JLOCR340B_340C	1717.9	01Jan2001, 12:28
RLOCR350A	1700.7	01Jan2001, 12:34
LOCR350A	443.9	01Jan2001, 12:16
JLOCR350A	1949	01Jan2001, 12:32
RLOCR350B	1865.1	01Jan2001, 12:44
LOCR350B	280.5	01Jan2001, 12:10
JLOCR350B	1923.6	01Jan2001, 12:42
RLOCR350C	1894.7	01Jan2001, 12:50
LOCR350C	224.6	01Jan2001, 12:16
JLOCR350C	1952.5	01Jan2001, 12:50

Proposed Engineered Channel (Ultimate) 25Yr		
Model Element	Peak Flow (CFS)	Peak Time
LOCR320	1195.6	01Jan2001, 12:20
VertexPond	620.4	01Jan2001, 12:42
LOCR330	1244.1	01Jan2001, 12:16
JLOCR330	1244.1	01Jan2001, 12:16
RLOCR340C	1176.2	01Jan2001, 12:26
LOCR340C	88.8	01Jan2001, 12:12
JLOCR340C	1226.4	01Jan2001, 12:26
JLOCR320_340C	1751.4	01Jan2001, 12:28
LOCR340A	852.7	01Jan2001, 12:10
PCM_1_200	713.2	01Jan2001, 12:14
JLOCR340A	713.2	01Jan2001, 12:14
RLOCR340B	697.6	01Jan2001, 12:16
LOCR340B	659.9	01Jan2001, 12:08
PCM_1_100	768.5	01Jan2001, 12:22
JLOCR340B	768.5	01Jan2001, 12:22
JLOCR340B_340C	2457.8	01Jan2001, 12:26
RLOCR350A	2428	01Jan2001, 12:32
LOCR350A	586.4	01Jan2001, 12:16
JLOCR350A	2779.1	01Jan2001, 12:30
RLOCR350B	2662.1	01Jan2001, 12:40
LOCR350B	380	01Jan2001, 12:10
JLOCR350B	2749	01Jan2001, 12:40
RLOCR350C	2708.3	01Jan2001, 12:48
LOCR350C	306.9	01Jan2001, 12:16
JLOCR350C	2794.6	01Jan2001, 12:48

Proposed Engineered Channel (Ultimate) 100Yr		
Model Element	Peak Flow (CFS)	Peak Time
LOCR320	1600.5	01Jan2001, 12:20
VertexPond	1095	01Jan2001, 12:34
LOCR330	1654.4	01Jan2001, 12:16
JLOCR330	1654.4	01Jan2001, 12:16
RLOCR340C	1571.8	01Jan2001, 12:26
LOCR340C	122.9	01Jan2001, 12:12
JLOCR340C	1640.4	01Jan2001, 12:26
JLOCR320_340C	2580.6	01Jan2001, 12:30
LOCR340A	1139.3	01Jan2001, 12:10
PCM_1_200	1163.4	01Jan2001, 12:12
JLOCR340A	1163.4	01Jan2001, 12:12
RLOCR340B	1124	01Jan2001, 12:12
LOCR340B	886	01Jan2001, 12:08
PCM_1_100	1742.1	01Jan2001, 12:14
JLOCR340B	1742.1	01Jan2001, 12:14
JLOCR340B_340C	3486.3	01Jan2001, 12:28
RLOCR350A	3461.2	01Jan2001, 12:32
LOCR350A	812.5	01Jan2001, 12:16
JLOCR350A	4058.6	01Jan2001, 12:22
RLOCR350B	3936.4	01Jan2001, 12:36
LOCR350B	541.1	01Jan2001, 12:10
JLOCR350B	4080.3	01Jan2001, 12:34
RLOCR350C	4029.6	01Jan2001, 12:44
LOCR350C	441.3	01Jan2001, 12:16
JLOCR350C	4179.3	01Jan2001, 12:42

Proposed Natural Channel (Ultimate) 2Yr		
Model Element	Peak Flow (CFS)	Peak Time
LOCR320	495.1	01Jan2001, 12:20
VertexPond	131.3	01Jan2001, 13:00
LOCR330	525.9	01Jan2001, 12:18
JLOCR330	525.9	01Jan2001, 12:18
RLOCR340C	490.1	01Jan2001, 12:28
LOCR340C	31.1	01Jan2001, 12:14
JLOCR340C	507.1	01Jan2001, 12:26
JLOCR320_340C	576.1	01Jan2001, 12:28
LOCR340A	352.9	01Jan2001, 12:10
PCM_1_200	87.7	01Jan2001, 12:34
JLOCR340A	87.7	01Jan2001, 12:34
RLOCR340B	87.6	01Jan2001, 12:36
LOCR340B	268.7	01Jan2001, 12:08
PCM_1_100	153.1	01Jan2001, 12:24
JLOCR340B	153.1	01Jan2001, 12:24
JLOCR340B_340C	727.9	01Jan2001, 12:28
RLOCR350A	688.5	01Jan2001, 12:40
LOCR350A	211.4	01Jan2001, 12:16
JLOCR350A	776	01Jan2001, 12:40
RLOCR350B	726.1	01Jan2001, 12:54
LOCR350B	125.2	01Jan2001, 12:12
JLOCR350B	744.3	01Jan2001, 12:54
RLOCR350C	704.3	01Jan2001, 13:12
LOCR350C	97.6	01Jan2001, 12:16
JLOCR350C	718.3	01Jan2001, 13:12

Proposed Natural Channel (Ultimate) 10Yr		
Model Element	Peak Flow (CFS)	Peak Time
LOCR320	937.2	01Jan2001, 12:20
VertexPond	430.6	01Jan2001, 12:44
LOCR330	980.4	01Jan2001, 12:16
JLOCR330	980.4	01Jan2001, 12:16
RLOCR340C	922.2	01Jan2001, 12:26
LOCR340C	67.1	01Jan2001, 12:14
JLOCR340C	960.7	01Jan2001, 12:26
JLOCR320_340C	1298.9	01Jan2001, 12:28
LOCR340A	668.3	01Jan2001, 12:10
PCM_1_200	274.6	01Jan2001, 12:26
JLOCR340A	274.6	01Jan2001, 12:26
RLOCR340B	274	01Jan2001, 12:26
LOCR340B	514.9	01Jan2001, 12:08
PCM_1_100	430.5	01Jan2001, 12:22
JLOCR340B	430.5	01Jan2001, 12:22
JLOCR340B_340C	1717.9	01Jan2001, 12:28
RLOCR350A	1700.7	01Jan2001, 12:34
LOCR350A	443.9	01Jan2001, 12:16
JLOCR350A	1949	01Jan2001, 12:32
RLOCR350B	1842.6	01Jan2001, 12:44
LOCR350B	280.5	01Jan2001, 12:10
JLOCR350B	1898	01Jan2001, 12:44
RLOCR350C	1799.8	01Jan2001, 13:00
LOCR350C	224.6	01Jan2001, 12:16
JLOCR350C	1844.1	01Jan2001, 13:00

Proposed Natural Channel (Ultimate) 25Yr		
Model Element	Peak Flow (CFS)	Peak Time
LOCR320	1195.6	01Jan2001, 12:20
VertexPond	620.4	01Jan2001, 12:42
LOCR330	1244.1	01Jan2001, 12:16
JLOCR330	1244.1	01Jan2001, 12:16
RLOCR340C	1176.2	01Jan2001, 12:26
LOCR340C	88.8	01Jan2001, 12:12
JLOCR340C	1226.4	01Jan2001, 12:26
JLOCR320_340C	1751.4	01Jan2001, 12:28
LOCR340A	852.7	01Jan2001, 12:10
PCM_1_200	713.2	01Jan2001, 12:14
JLOCR340A	713.2	01Jan2001, 12:14
RLOCR340B	697.6	01Jan2001, 12:16
LOCR340B	659.9	01Jan2001, 12:08
PCM_1_100	768.5	01Jan2001, 12:22
JLOCR340B	768.5	01Jan2001, 12:22
JLOCR340B_340C	2457.8	01Jan2001, 12:26
RLOCR350A	2428	01Jan2001, 12:32
LOCR350A	586.4	01Jan2001, 12:16
JLOCR350A	2779.1	01Jan2001, 12:30
RLOCR350B	2631	01Jan2001, 12:42
LOCR350B	380	01Jan2001, 12:10
JLOCR350B	2713.1	01Jan2001, 12:42
RLOCR350C	2574.9	01Jan2001, 12:58
LOCR350C	306.9	01Jan2001, 12:16
JLOCR350C	2644.3	01Jan2001, 12:56

Proposed Natural Channel (Ultimate) 100Yr		
Model Element	Peak Flow (CFS)	Peak Time
LOCR320	1600.5	01Jan2001, 12:20
VertexPond	1095	01Jan2001, 12:34
LOCR330	1654.4	01Jan2001, 12:16
JLOCR330	1654.4	01Jan2001, 12:16
RLOCR340C	1571.8	01Jan2001, 12:26
LOCR340C	122.9	01Jan2001, 12:12
JLOCR340C	1640.4	01Jan2001, 12:26
JLOCR320_340C	2580.6	01Jan2001, 12:30
LOCR340A	1139.3	01Jan2001, 12:10
PCM_1_200	1163.4	01Jan2001, 12:12
JLOCR340A	1163.4	01Jan2001, 12:12
RLOCR340B	1124	01Jan2001, 12:12
LOCR340B	886	01Jan2001, 12:08
PCM_1_100	1742.1	01Jan2001, 12:14
JLOCR340B	1742.1	01Jan2001, 12:14
JLOCR340B_340C	3486.3	01Jan2001, 12:28
RLOCR350A	3461.2	01Jan2001, 12:32
LOCR350A	812.5	01Jan2001, 12:16
JLOCR350A	4058.6	01Jan2001, 12:22
RLOCR350B	3906.6	01Jan2001, 12:38
LOCR350B	541.1	01Jan2001, 12:10
JLOCR350B	4047.3	01Jan2001, 12:36
RLOCR350C	3915.5	01Jan2001, 12:50
LOCR350C	441.3	01Jan2001, 12:16
JLOCR350C	4041.9	01Jan2001, 12:50

Appendix M: Secondary Analysis Engineer's Opinion of Costs

CITY OF AUSTIN
PACES MILL FRR
ENGINEER'S OPINION OF PROBABLE COST
100 YEAR ENGINEERED CHANNEL

BID ITEM NO.	ITEM DESCRIPTION	UNIT	QTY.	UNIT COST	TOTAL COST
102S-C	CLEARING AND GRUBBING	LS		10%	$ 248,380.00
111S-A	EXCAVATION	CY	27100	$ 50.00	$ 1,355,000.00
414S-C	CAST-IN-PLACE PORTLAND CEMENT CONCRETE RETAINING WALL, INCLUDING REINFORCEMENT	CY	0	$ 1,500.00	$ -
509S-1	TRENCH EXCAVATION SAFETY PROTECTIVE SYSTEMS, (ALL DEPTHS)	LF	0	$ 10.00	$ -
559S-10X8	PRECAST CONCRETE BOX CULVERTS, 10 FT X 12 FT	LF	0	$ 2,000.00	$ -
591S-A	DRY ROCK RIPRAP, D50 = 18 IN	SY	0	$ 130.00	$ -
591S-F	CONCRETE RIPRAP, 6 IN	SY	1200	$ 300.00	$ 360,000.00
604S-E	NATIVE SEEDING FOR EROSION CONTROL, BROADCAST SEEDING	SY	18000	$ 1.50	$ 27,000.00
605S	SOIL RETENTION BLANKET CLASS 2; TYPE H, COMPLETE AND IN PLACE	SY	18000	$ 10.00	$ 180,000.00
608S-1	PLANTING TYPE _, SIZE IN INCHES _	EA	0		$ -
608S-2	IRRIGATION SYSTEM	LS	1	$ 15,000.00	$ 15,000.00
609S-A	TOPSOIL AND SEEDBED PREPARATION	SY	18000	$ 15.00	$ 270,000.00
609S-C	NATIVE SEEDING	SY	18000	$ 5.00	$ 90,000.00
610S-A	PROTECTIVE FENCING TYPE A CHAIN LINK FENCE	LF	4200	$ 4.00	$ 16,800.00
639S	ROCK BERM	LF	200	$ 45.00	$ 9,000.00
641S	STABILIZED CONSTRUCTION ENTRANCE	EA	2	$ 3,500.00	$ 7,000.00
642S	SILT FENCE FOR EROSION CONTROL	LF	4200	$ 10.00	$ 42,000.00
700S-TM	TOTAL MOBILIZATION PAYMENT	LS	1	5%	$ 196,609.00
802S-A	PROJECT SIGN	EA	2	$ 1,000.00	$ 2,000.00
803S-MO	BARRICADES, SIGNS, AND TRAFFIC HANDLING	MO	12	$ 5,000.00	$ 60,000.00
SS1000	COFFER DAM & SITE DEWATERING	LS	1	$ 50,000.00	$ 50,000.00
SP610S	TREE REMOVAL	AC	4	$ 200,000.00	$ 800,000.00
	TREE MITIGATION	AC	4	$ 100,000.00	$ 400,000.00
CONSTRUCTION SUBTOTAL					***$ 4,128,789.00***
	CONTINGENCY (30% OF SUBTOTAL)				$ 1,238,637.00
CONSTRUCTION COST ESTIMATE					**$ 5,367,426.00**
	ENGINEERING (15% OF CONSTRUCTION)				$ 805,113.90
TOTAL COST OF ALTERNATIVE					$ 6,172,539.90

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K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING
Firm #6535

CITY OF AUSTIN
PACES MILL FRR
ENGINEER'S OPINION OF PROBABLE COST
100 YEAR HYBRID CHANNEL

BID ITEM NO.	ITEM DESCRIPTION	UNIT	QTY.	UNIT COST	TOTAL COST
102S-C	CLEARING AND GRUBBING	LS		10%	$ 227,100.00
111S-A	EXCAVATION	CY	20400	$ 50.00	$ 1,020,000.00
414S-C	CAST-IN-PLACE PORTLAND CEMENT CONCRETE RETAINING WALL, INCLUDING REINFORCEMENT	CY	0	$ 1,500.00	$ -
509S-1	TRENCH EXCAVATION SAFETY PROTECTIVE SYSTEMS, (ALL DEPTHS)	LF	0	$ 10.00	$ -
559S-10X8	PRECAST CONCRETE BOX CULVERTS, 10 FT X 12 FT	LF	0	$ 2,000.00	$ -
591S-A	DRY ROCK RIPRAP, D50 = 18 IN	SY	4000	$ 130.00	$ 520,000.00
591S-F	CONCRETE RIPRAP, 6 IN	SY	0	$ 300.00	$ -
604S-E	NATIVE SEEDING FOR EROSION CONTROL, BROADCAST SEEDING	SY	16800	$ 1.50	$ 25,200.00
605S	SOIL RETENTION BLANKET CLASS 2; TYPE H, COMPLETE AND IN PLACE	SY	16800	$ 10.00	$ 168,000.00
608S-1	PLANTING TYPE _, SIZE IN INCHES _	EA	0		$ -
608S-2	IRRIGATION SYSTEM	LS	1	$ 15,000.00	$ 15,000.00
609S-A	TOPSOIL AND SEEDBED PREPARATION	SY	16800	$ 15.00	$ 252,000.00
609S-C	NATIVE SEEDING	SY	16800	$ 5.00	$ 84,000.00
610S-A	PROTECTIVE FENCING TYPE A CHAIN LINK FENCE	LF	4200	$ 4.00	$ 16,800.00
639S	ROCK BERM	LF	200	$ 45.00	$ 9,000.00
641S	STABILIZED CONSTRUCTION ENTRANCE	EA	2	$ 3,500.00	$ 7,000.00
642S	SILT FENCE FOR EROSION CONTROL	LF	4200	$ 10.00	$ 42,000.00
700S-TM	TOTAL MOBILIZATION PAYMENT	LS	1	5%	$ 184,905.00
802S-A	PROJECT SIGN	EA	2	$ 1,000.00	$ 2,000.00
803S-MO	BARRICADES, SIGNS, AND TRAFFIC HANDLING	MO	12	$ 5,000.00	$ 60,000.00
SS1000	COFFER DAM & SITE DEWATERING	LS	1	$ 50,000.00	$ 50,000.00
SP610S	TREE REMOVAL	AC	4	$ 200,000.00	$ 800,000.00
	TREE MITIGATION	AC	4	$ 100,000.00	$ 400,000.00
CONSTRUCTION SUBTOTAL					***$ 3,883,005.00***
	CONTINGENCY (30% OF SUBTOTAL)				$ 1,164,902.00
CONSTRUCTION COST ESTIMATE					**$ 5,047,907.00**
	ENGINEERING (15% OF CONSTRUCTION)				$ 757,186.05
TOTAL COST OF ALTERNATIVE					$ 5,805,093.05

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CITY OF AUSTIN
PACES MILL FRR
ENGINEER'S OPINION OF PROBABLE COST
10 YEAR NATURAL CHANNEL

BID ITEM NO.	ITEM DESCRIPTION	UNIT	QTY.	UNIT COST	TOTAL COST
102S-C	CLEARING AND GRUBBING	LS		10%	$ 240,250.00
111S-A	EXCAVATION	CY	27000	$ 50.00	$ 1,350,000.00
414S-C	CAST-IN-PLACE PORTLAND CEMENT CONCRETE RETAINING WALL, INCLUDING REINFORCEMENT	CY	0	$ 1,500.00	$ -
509S-1	TRENCH EXCAVATION SAFETY PROTECTIVE SYSTEMS, (ALL DEPTHS)	LF	0	$ 10.00	$ -
559S-10X8	PRECAST CONCRETE BOX CULVERTS, 10 FT X 12 FT	LF	0	$ 2,000.00	$ -
591S-A	DRY ROCK RIPRAP, D50 = 18 IN	SY	1100	$ 130.00	$ 143,000.00
591S-F	CONCRETE RIPRAP, 6 IN	SY	0	$ 300.00	$ -
604S-E	NATIVE SEEDING FOR EROSION CONTROL, BROADCAST SEEDING	SY	23000	$ 1.50	$ 34,500.00
605S	SOIL RETENTION BLANKET CLASS 2; TYPE H, COMPLETE AND IN PLACE	SY	23000	$ 10.00	$ 230,000.00
608S-1	PLANTING TYPE _, SIZE IN INCHES _	EA	0		$ -
608S-2	IRRIGATION SYSTEM	LS	1	$ 15,000.00	$ 15,000.00
609S-A	TOPSOIL AND SEEDBED PREPARATION	SY	23000	$ 15.00	$ 345,000.00
609S-C	NATIVE SEEDING	SY	23000	$ 5.00	$ 115,000.00
610S-A	PROTECTIVE FENCING TYPE A CHAIN LINK FENCE	LF	3000	$ 4.00	$ 12,000.00
639S	ROCK BERM	LF	200	$ 45.00	$ 9,000.00
641S	STABILIZED CONSTRUCTION ENTRANCE	EA	2	$ 3,500.00	$ 7,000.00
642S	SILT FENCE FOR EROSION CONTROL	LF	3000	$ 10.00	$ 30,000.00
700S-TM	TOTAL MOBILIZATION PAYMENT	LS	1	5%	$ 207,137.50
802S-A	PROJECT SIGN	EA	2	$ 1,000.00	$ 2,000.00
803S-MO	BARRICADES, SIGNS, AND TRAFFIC HANDLING	MO	12	$ 5,000.00	$ 60,000.00
SS1000	COFFER DAM & SITE DEWATERING	LS	1	$ 50,000.00	$ 50,000.00
SP610S	TREE REMOVAL	AC	5	$ 200,000.00	$ 1,000,000.00
	TREE MITIGATION	AC	5	$ 100,000.00	$ 500,000.00
CONSTRUCTION SUBTOTAL					***$ 4,349,887.50***
	CONTINGENCY (30% OF SUBTOTAL)				$ 1,304,967.00
CONSTRUCTION COST ESTIMATE					**$ 5,654,854.50**
	ENGINEERING (15% OF CONSTRUCTION)				$ 848,228.18
TOTAL COST OF ALTERNATIVE					$ 6,503,082.68

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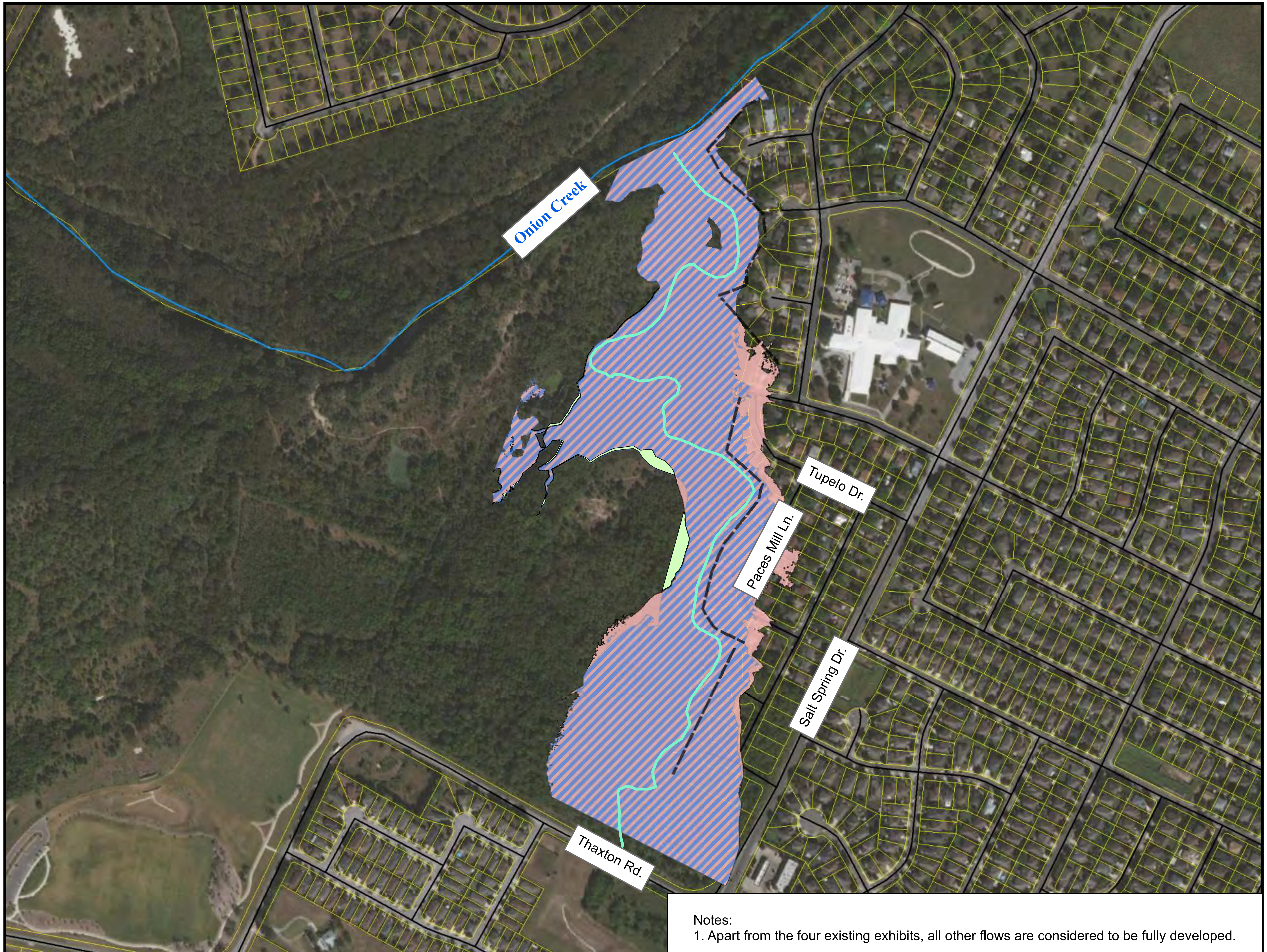
Appendix N: Secondary Analysis Mitigation Easement Exhibits



Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.

Legend

- Existing 100-year Inundation Boundary (Fully Developed)
- Proposed 100-Year Inundation Boundary
- Easements for 10-YR Natural Channel Floodplain
- Onion Creek District Park
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets
- Existing Easement

City of Austin
Paces Mill Lane
Flood Risk Reduction
Secondary Analysis

10-Year LOS Natural Channel Alternative

Proposed Easement for Containment of Expected Increase in100-Year Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 4/15/2022

CITY OF AUSTIN FOUNDED 1839

FIRM NO. 6535

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

Legend

- Existing 100-year Inundation Boundary (Fully Developed)
- Proposed 100-Year Inundation Boundary
- Onion Creek District Park
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets
- Existing Easement
- TCAD Parcels

City of Austin Paces Mill Lane Flood Risk Reduction Secondary Analysis

100-Year LOS Engineered Channel Alternative

Proposed Easement for Containment of Expected Increase in100-Year Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 4/14/2022

CITY OF AUSTIN FOUNDED 1839

FIRM NO. 6535

Legend

- Existing 100-year Inundation Boundary (Fully Developed)
- Proposed 100-Year Inundation Boundary
- Existing Easement
- Onion Creek District Park
- Paces Mill Tributary Centerline
- Onion Creek Centerline
- Streets

City of Austin Paces Mill Lane Flood Risk Reduction Secondary Analysis

100-Year LOS Hybrid Channel Alternative

Proposed Easement for Containment of Expected Increase in100-Year Inundation Boundary

N

0 200 400

1 inch = 400 feet

Date: 4/14/2022

CITY OF AUSTIN FOUNDED 1839

Notes:
1. Apart from the four existing exhibits, all other flows are considered to be fully developed.
2. No homes are being flooded in this scenario

FIRM NO. 6535

Appendix O: Schematic Design Engineer's Opinion of Construction Cost

CITY OF AUSTIN
PACES MILL FRR
ENGINEER'S OPINION OF PROBABLE COST
100 YEAR HYBRID CHANNEL

BID ITEM NO.	ITEM DESCRIPTION	UNIT	QTY.	UNIT COST	TOTAL COST
102S-C	CLEARING AND GRUBBING	LS		10%	$ 261,170.00
111S-A	EXCAVATION	CY	20400	$ 50.00	$ 1,020,000.00
414S-C	CAST-IN-PLACE PORTLAND CEMENT CONCRETE RETAINING WALL, INCLUDING REINFORCEMENT	CY	0	$ 1,500.00	$ -
509S-1	TRENCH EXCAVATION SAFETY PROTECTIVE SYSTEMS, (ALL DEPTHS)	LF	0	$ 10.00	$ -
559S-10X8	PRECAST CONCRETE BOX CULVERTS, 10 FT X 12 FT	LF	0	$ 2,000.00	$ -
591S-A	DRY ROCK RIPRAP, D50 = 18 IN	SY	4500	$ 130.00	$ 585,000.00
591S-A	DRY ROCK RIPRAP, D50 = 30 IN	SY	700	$ 291.00	$ 203,700.00
591S-F	CONCRETE RIPRAP, 6 IN	SY	0	$ 300.00	$ -
604S-E	NATIVE SEEDING FOR EROSION CONTROL, BROADCAST SEEDING	SY	16800	$ 1.50	$ 25,200.00
605S	SOIL RETENTION BLANKET CLASS 2; TYPE H, COMPLETE AND IN PLACE	SY	16800	$ 10.00	$ 168,000.00
608S-1	PLANTING TYPE _, SIZE IN INCHES _	EA	0		$ -
608S-2	IRRIGATION SYSTEM	LS	1	$ 15,000.00	$ 15,000.00
609S-A	TOPSOIL AND SEEDBED PREPARATION	SY	16800	$ 15.00	$ 252,000.00
609S-C	NATIVE SEEDING	SY	16800	$ 5.00	$ 84,000.00
610S-A	PROTECTIVE FENCING TYPE A CHAIN LINK FENCE	LF	4200	$ 4.00	$ 16,800.00
625S	Grade Stabilization Structure	LF	180	$ 400.00	$ 72,000.00
639S	ROCK BERM	LF	200	$ 45.00	$ 9,000.00
641S	STABILIZED CONSTRUCTION ENTRANCE	EA	2	$ 3,500.00	$ 7,000.00
642S	SILT FENCE FOR EROSION CONTROL	LF	4200	$ 10.00	$ 42,000.00
700S-TM	TOTAL MOBILIZATION PAYMENT	LS	1	5%	$ 203,643.50
802S-A	PROJECT SIGN	EA	2	$ 1,000.00	$ 2,000.00
803S-MO	BARRICADES, SIGNS, AND TRAFFIC HANDLING	MO	12	$ 5,000.00	$ 60,000.00
SS1000	COFFER DAM & SITE DEWATERING	LS	1	$ 50,000.00	$ 50,000.00
SP610S	TREE REMOVAL	AC	4	$ 200,000.00	$ 800,000.00
	TREE MITIGATION	AC	4	$ 100,000.00	$ 400,000.00
CONSTRUCTION SUBTOTAL					***$ 4,276,513.50***
	CONTINGENCY (30% OF SUBTOTAL)				$ 1,282,955.00
CONSTRUCTION COST ESTIMATE					**$ 5,559,468.50**
	ENGINEERING (15% OF CONSTRUCTION)				$ 833,920.28
TOTAL COST OF ALTERNATIVE					$ 6,393,388.78

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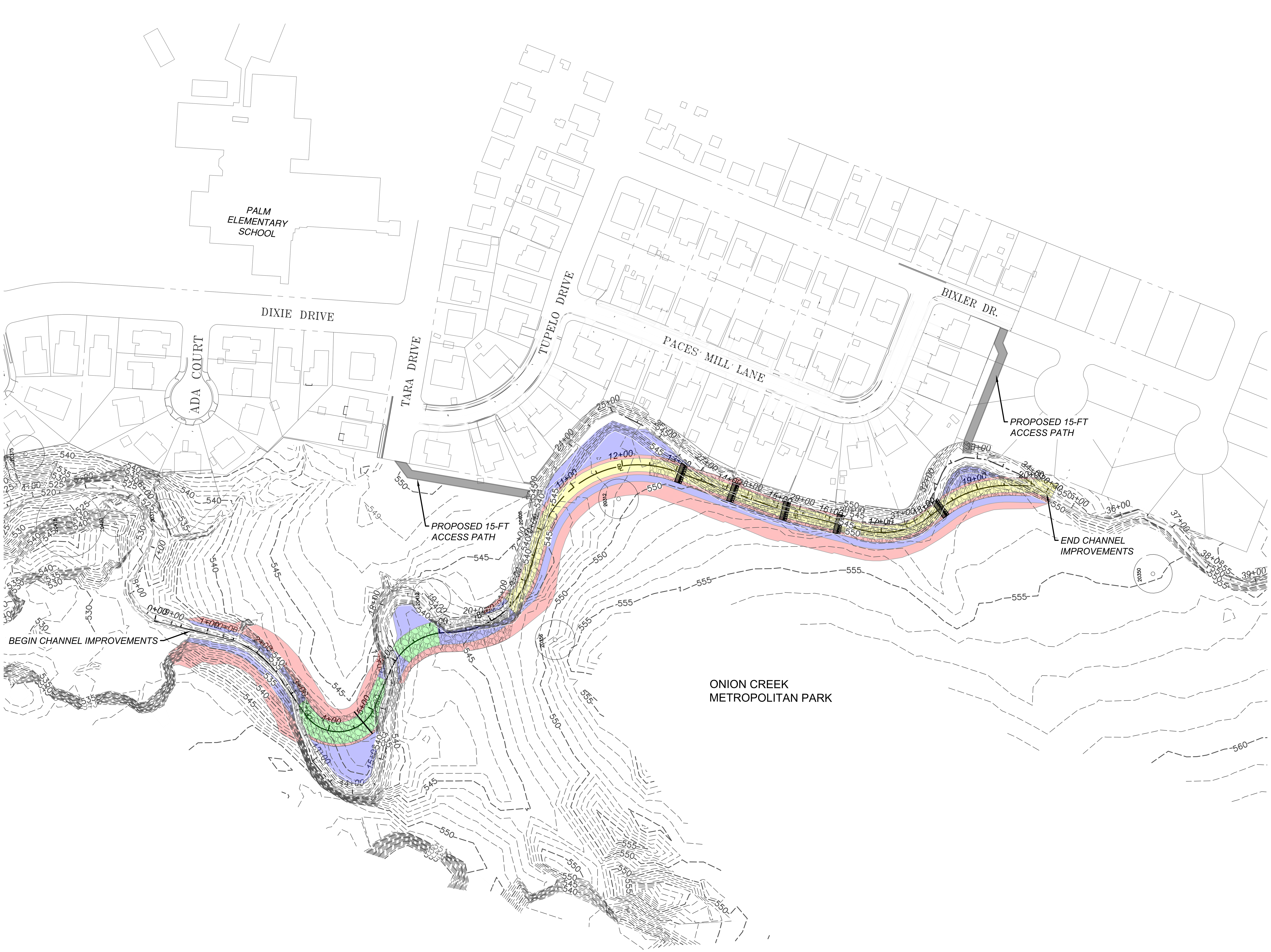
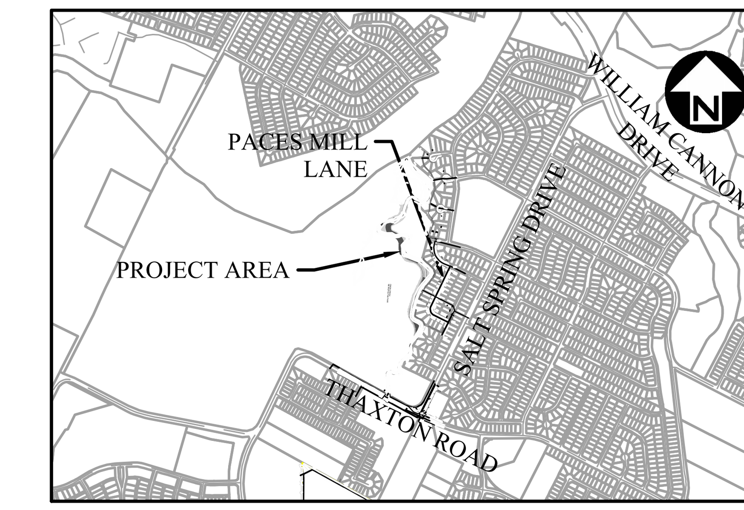
Appendix P: Schematic Design of 100-yr Hybid Channel Improvements





(green)	OVERFLOW CHANNEL
(yellow)	ENGINEERED CHANNEL
(red)	SLOPED CHANNEL
(blue)	BENCHING
(pattern)	RIP RAP
(pattern)	STRAIGHT STEPPED ROCK DROP

REV. NO.	BY	DATE	REVISION DESCRIPTION

INTERIM REVIEW
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CITY OF AUSTIN, TEXAS
CITY DEPARTMENT
WATERSHED PROTECTION DEPARTMENT

PACES MILL FLOODRISK PRELIMINARY STUDY

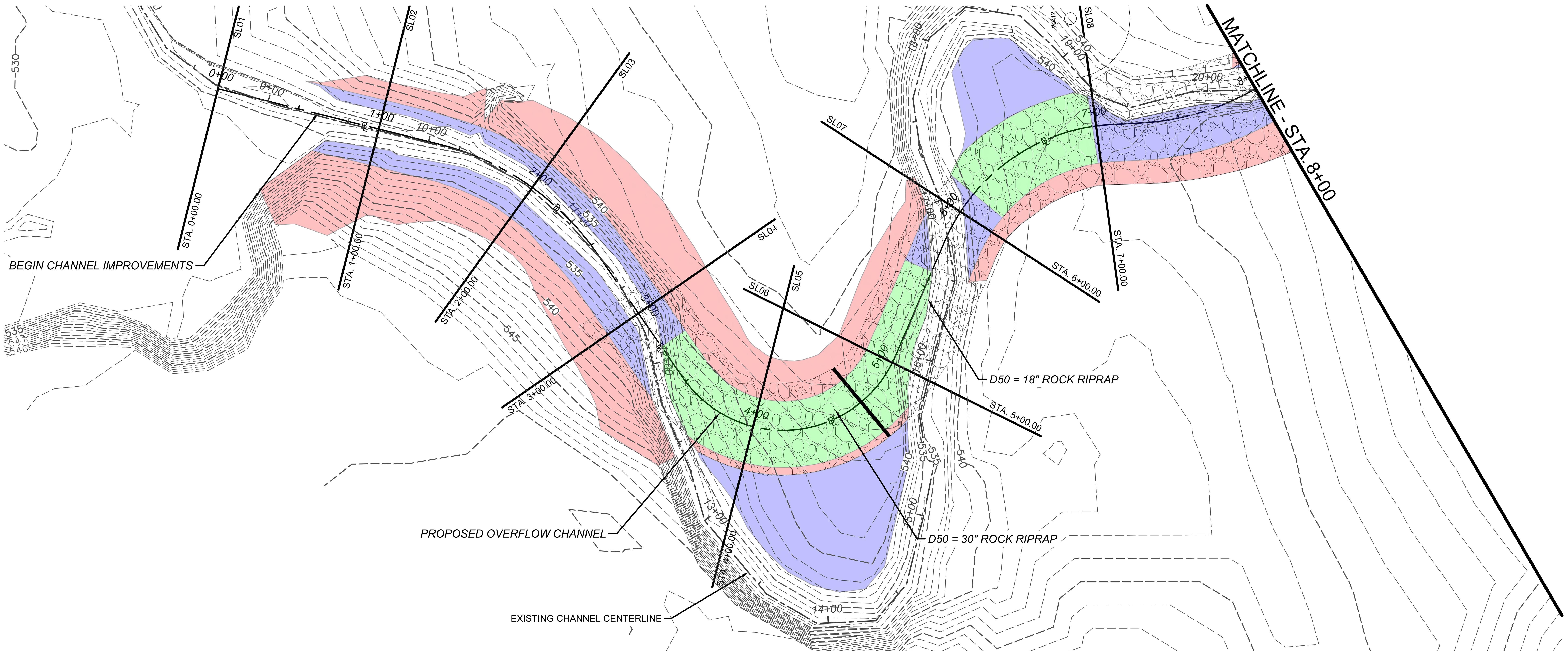
OVERALL MAP

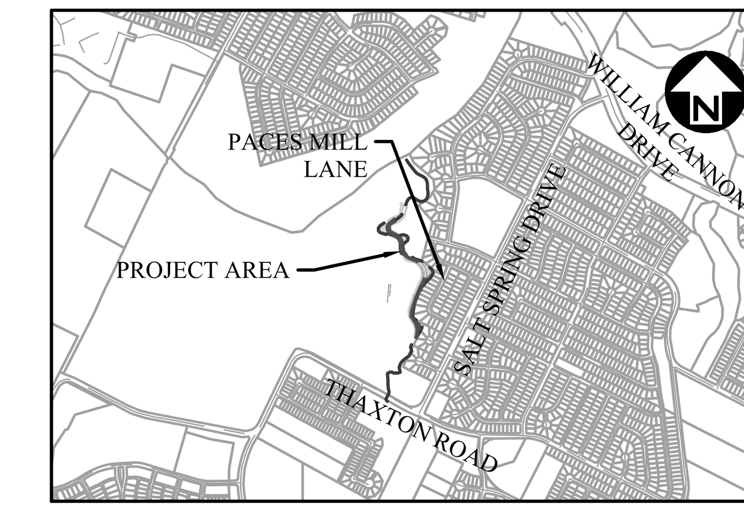
NOTES	NAME	DATE
SURVEY BY		
DRAWN BY		
DESIGNED BY		
CHECKED BY		
REVIEWED BY		

0 100 200
HORIZONTAL SCALE IN FEET

SHEET 1 OF 8

X:\PROJECTS\0767_COA_PACES MILL FRR\DWG\0767-C-DR-PLPR00.DWG, COA_PDF_22X34, COA_ESD.STB
4/7/2023 3:42 PM
KEN STEDMAN





OVERFLOW CHANNEL

ENGINEERED CHANNEL

SLOPED CHANNEL

BENCHING

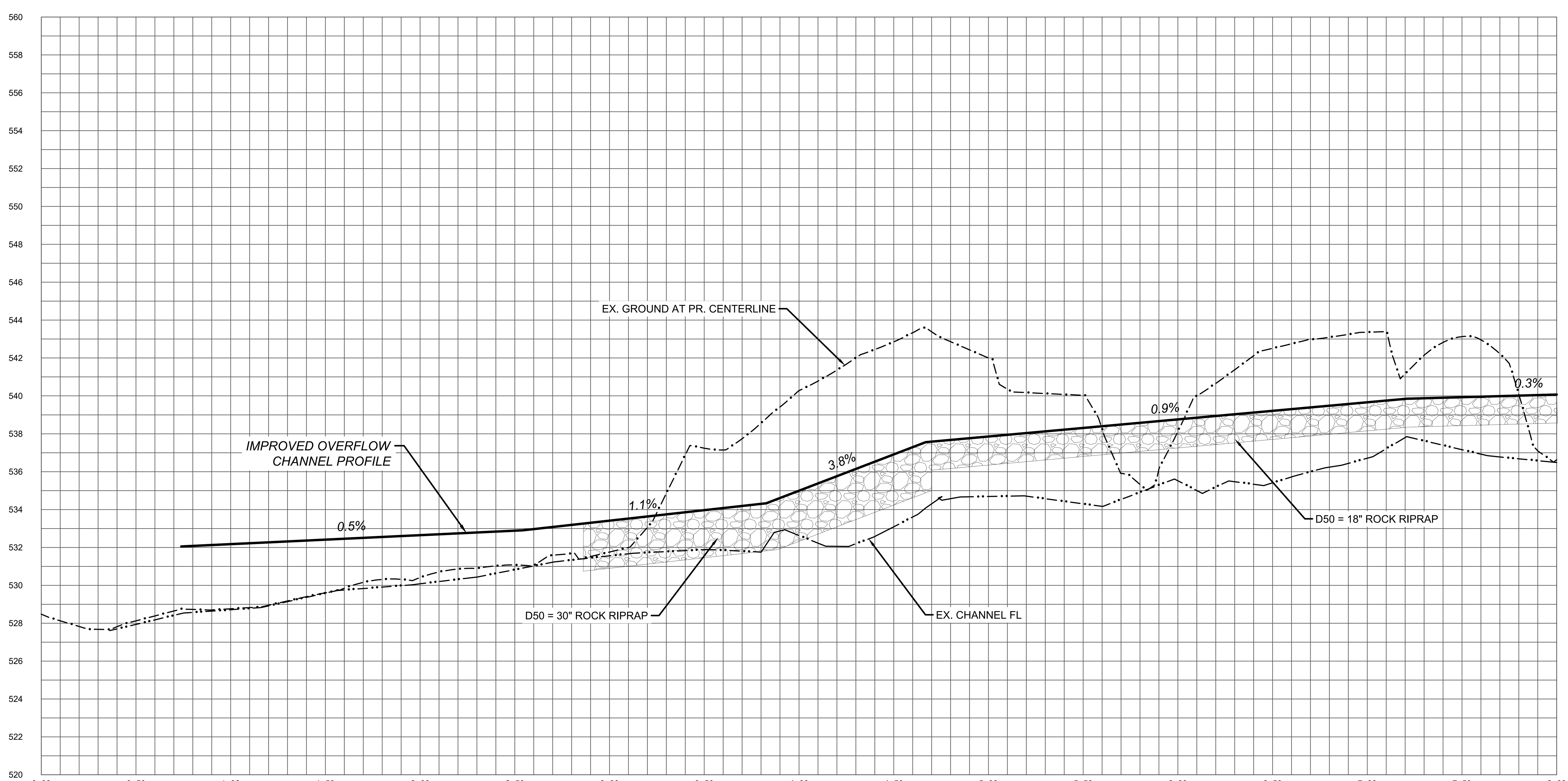
RIP RAP

STRAIGHT STEPPED ROCK DROP

NOTES

1) *ROCK RIPRAP SHALL FOLLOW COA SPECIFICATION 591S.*

2) *ROCK RIPRAP SHALL BE PLACED TO A DEPTH EQUIVALENT TO TWICE D50 ROCK SIZE.*



REV. NO.	BY	DATE	REVISION DESCRIPTION

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CITY OF AUSTIN, TEXAS
CITY DEPARTMENT
WATERSHED PROTECTION DEPARTMENT

PACES MILL FLOODRISK
PRELIMINARY STUDY

PLAN AND PROFILE
STA. 0+00 TO STA. 8+00

NOTES	NAME	DATE
SURVEY BY		
DRAWN BY		
DESIGNED BY		
CHECKED BY		
REVIEWED BY		

0 40 80
HORIZONTAL SCALE IN FEET
0 4 8
VERTICAL SCALE IN FEET

SHEET 2 OF 8

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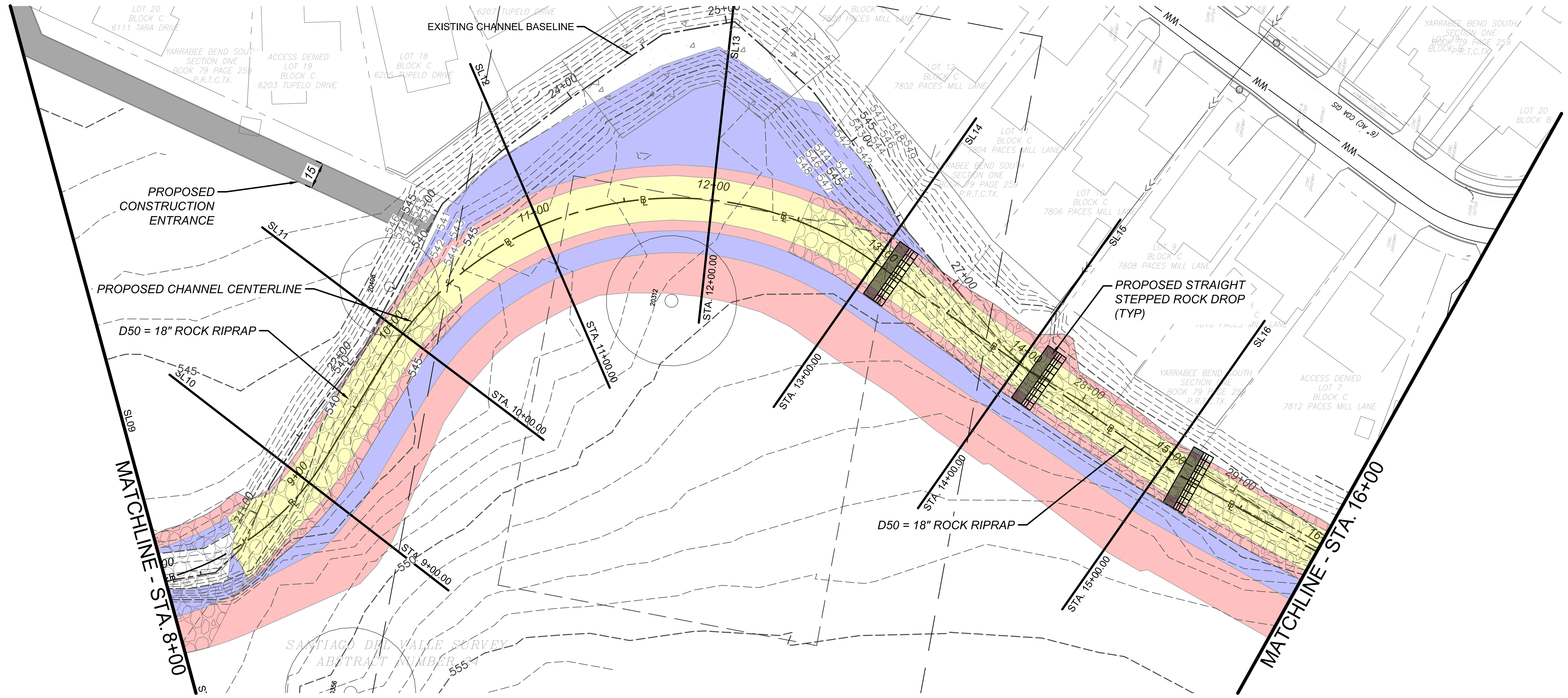
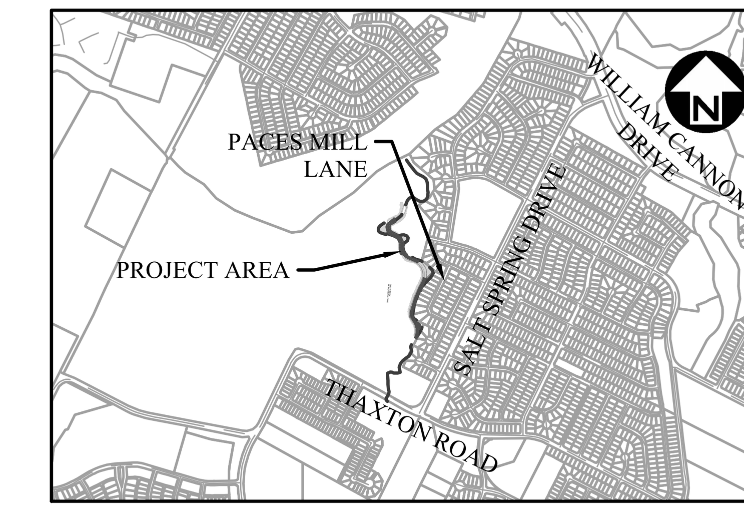
4/7/2023 3:42 PM
KEN STEDMAN





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OVERFLOW CHANNEL

ENGINEERED CHANNEL

SLOPED CHANNEL

BENCHING

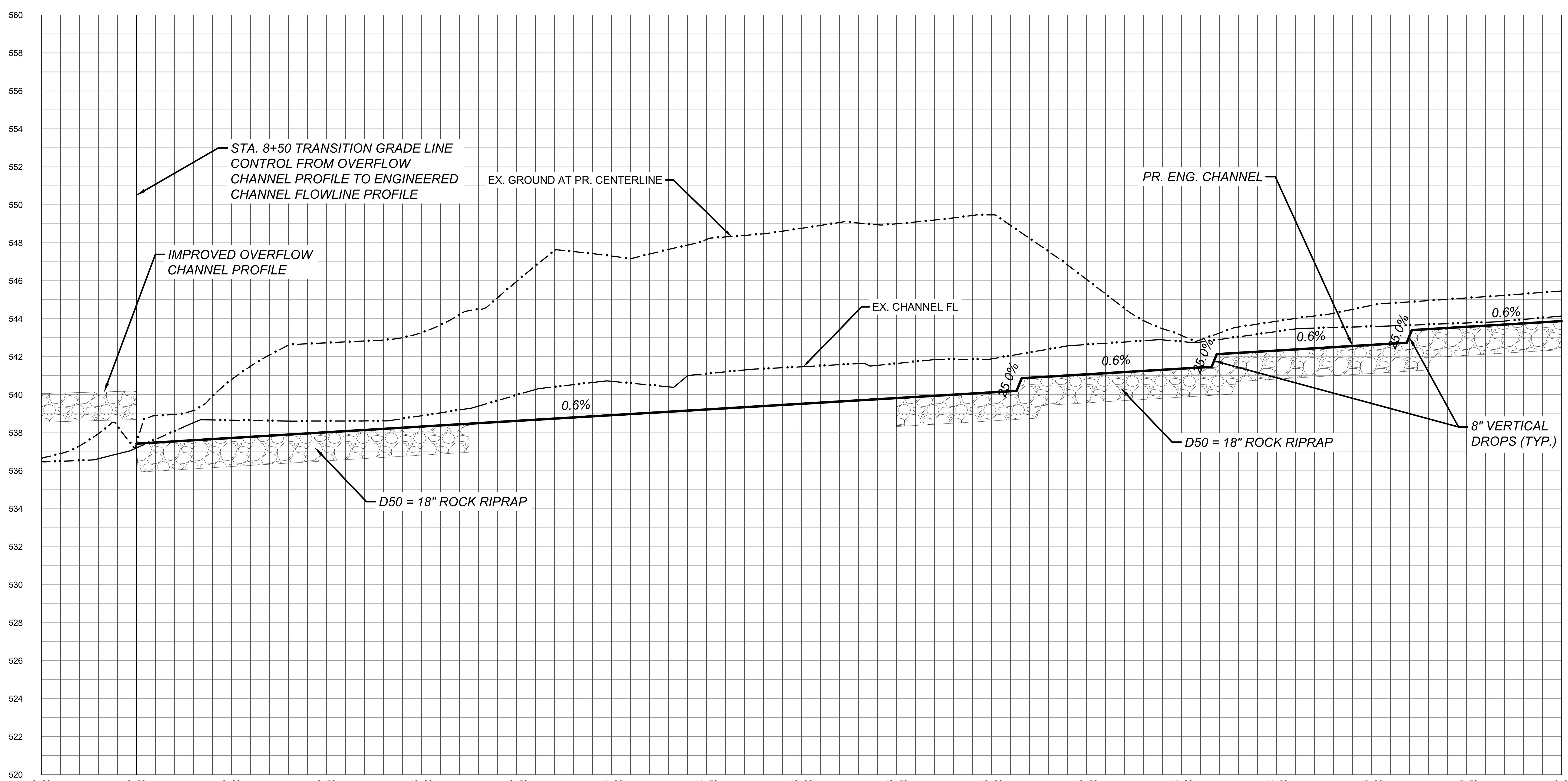
RIP RAP

STRAIGHT STEPPED ROCK DROP

NOTES

1) ROCK RIPRAP SHALL FOLLOW COA SPECIFICATION 591S.

2) ROCK RIPRAP SHALL BE PLACED TO A DEPTH EQUIVALENT TO TWICE D50 ROCK SIZE.



REV. NO.	BY	DATE	REVISION DESCRIPTION

CITY OF AUSTIN, TEXAS
CITY DEPARTMENT
WATERSHED PROTECTION DEPARTMENT

PACES MILL FLOODRISK PRELIMINARY STUDY

PLAN AND PROFILE STA. 8+00 TO STA. 16+00

NOTES	NAME	DATE
SURVEY BY		
DRAWN BY		
DESIGNED BY		
CHECKED BY		
REVIEWED BY		

0 40 80
HORIZONTAL SCALE IN FEET
0 4 8
VERTICAL SCALE IN FEET

SHEET 3 OF 8

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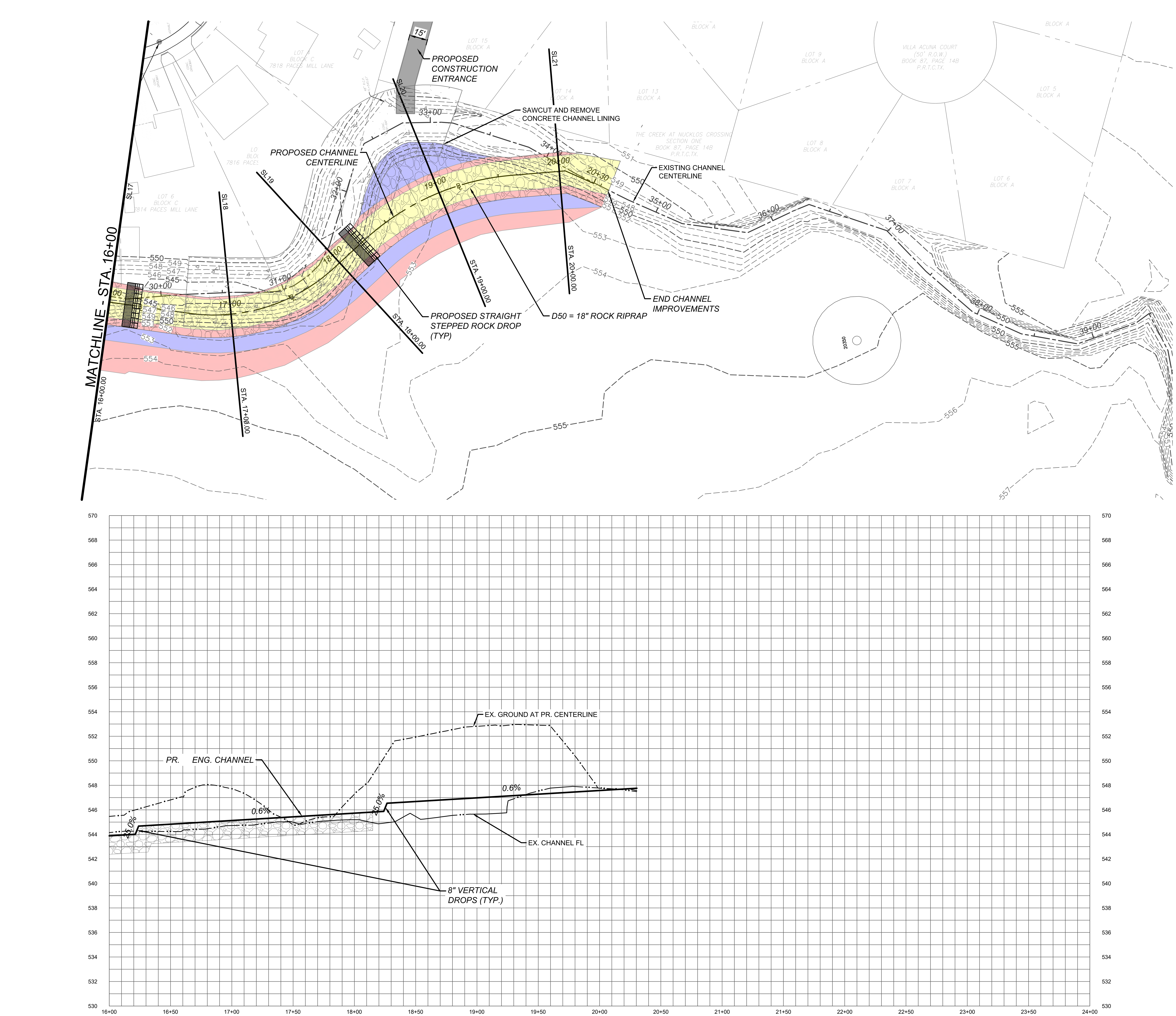
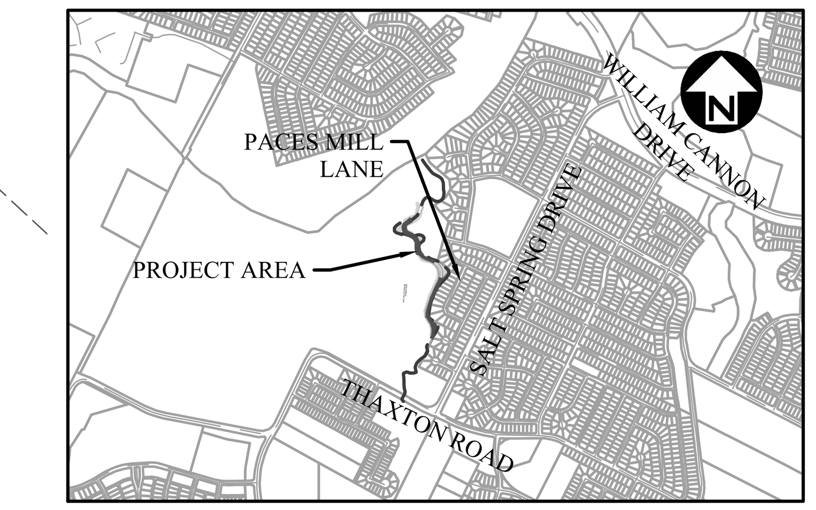
KEN STEDMAN





	OVERFLOW CHANNEL
	ENGINEERED CHANNEL
	SLOPED CHANNEL
	BENCHING
	RIP RAP
	STRAIGHT STEPPED ROCK DROP

NOTES

1) ROCK RIPRAP SHALL FOLLOW COA SPECIFICATION 591S.

2) ROCK RIPRAP SHALL BE PLACED TO A DEPTH EQUIVALENT TO TWICE D50 ROCK SIZE.

INTERIM REVIEW
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REV. NO.	BY	DATE	REVISION DESCRIPTION

CITY OF AUSTIN, TEXAS
CITY DEPARTMENT
WATERSHED PROTECTION DEPARTMENT

PACES MILL FLOODRISK PRELIMINARY STUDY

PLAN AND PROFILE
STA. 16+00 TO END

NOTES	NAME	DATE
SURVEY BY		
DRAWN BY		
DESIGNED BY		
CHECKED BY		
REVIEWED BY		

0 40 80
HORIZONTAL SCALE IN FEET
0 4 8
VERTICAL SCALE IN FEET

SHEET 4 OF 8

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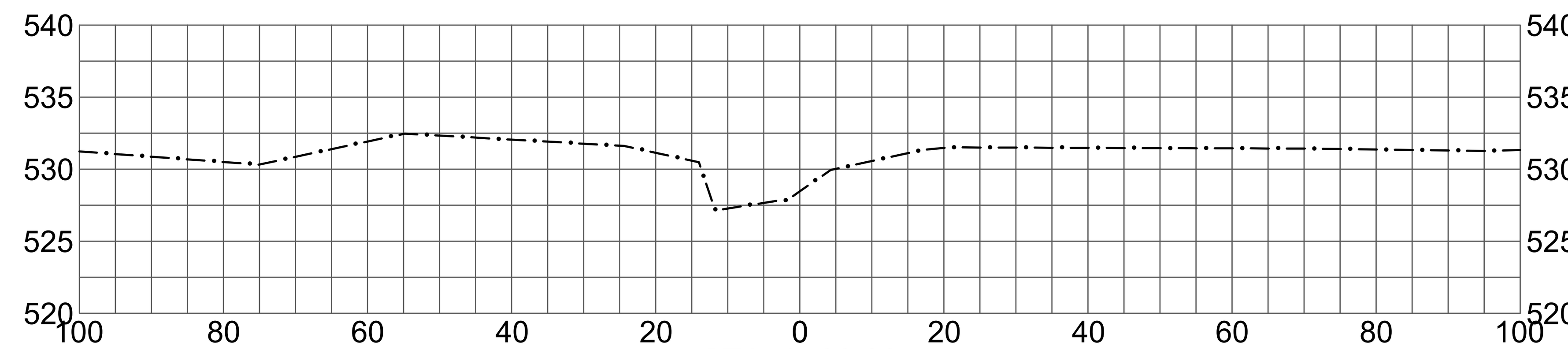

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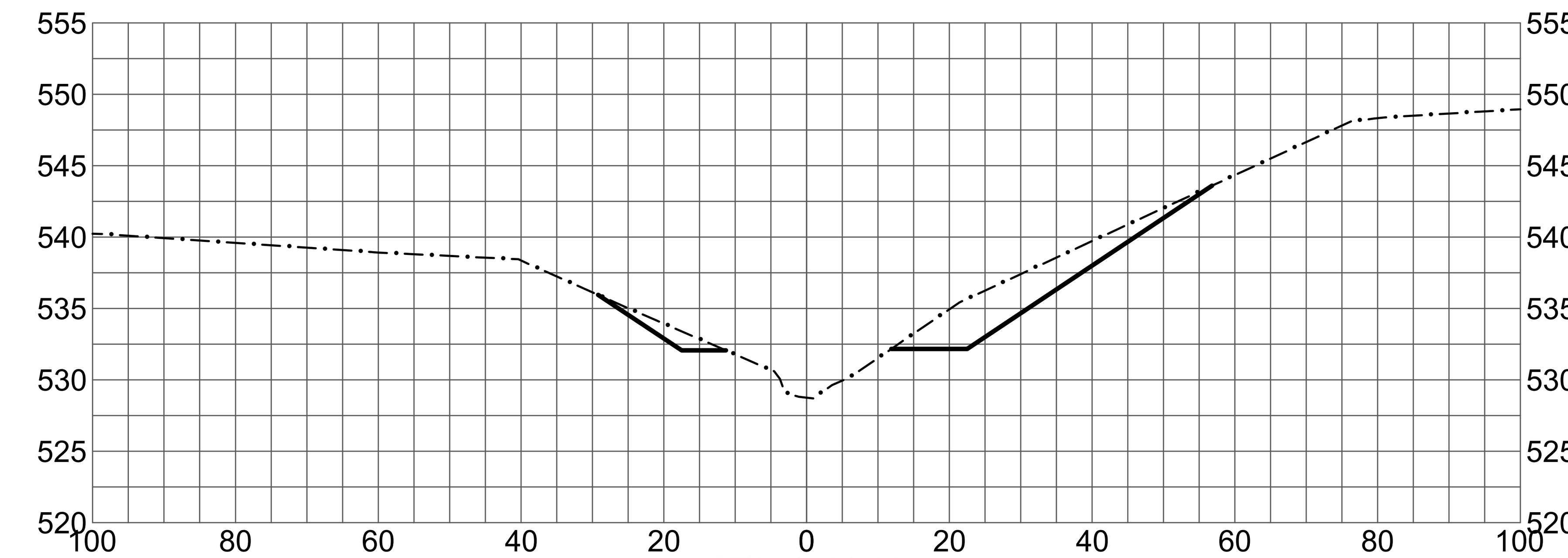

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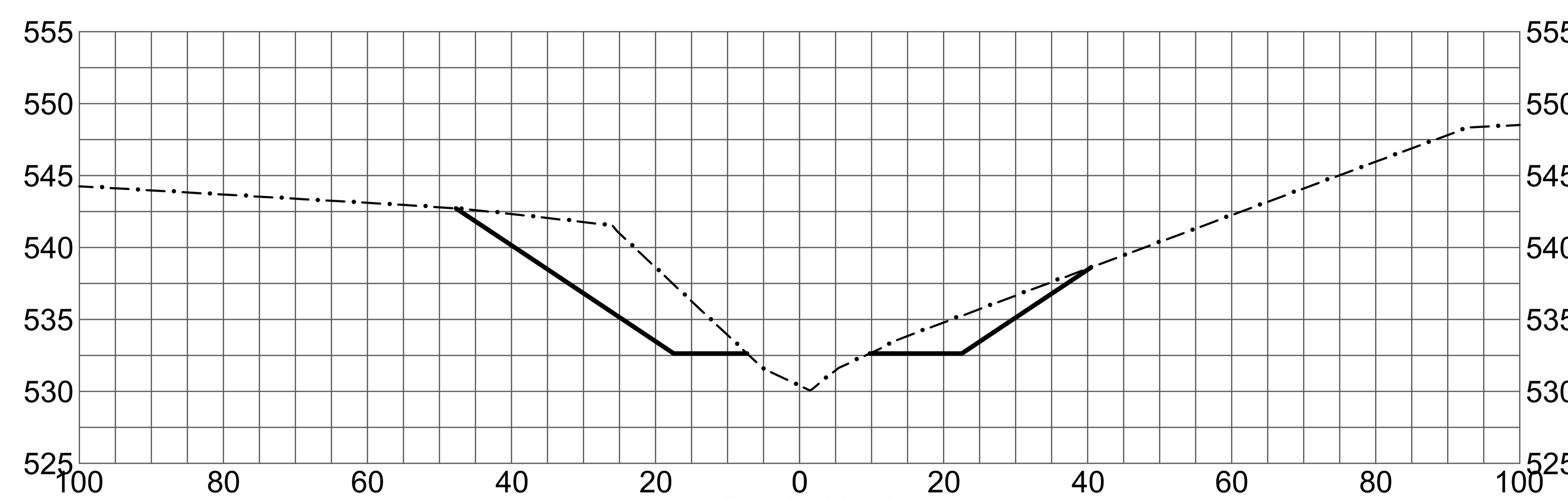

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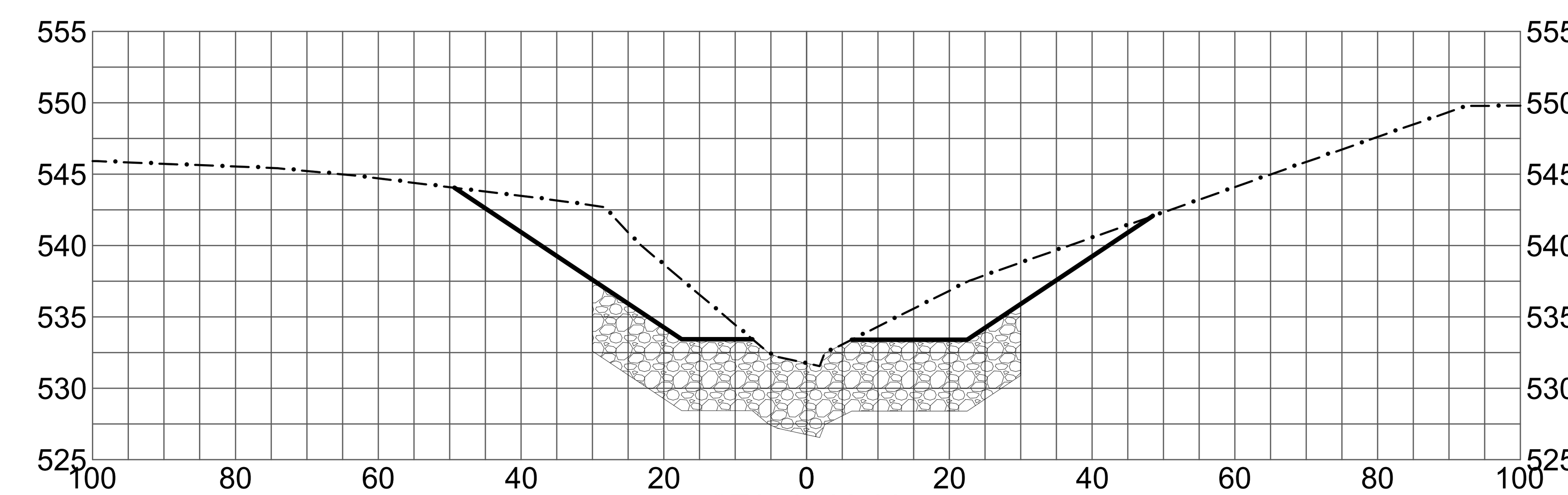

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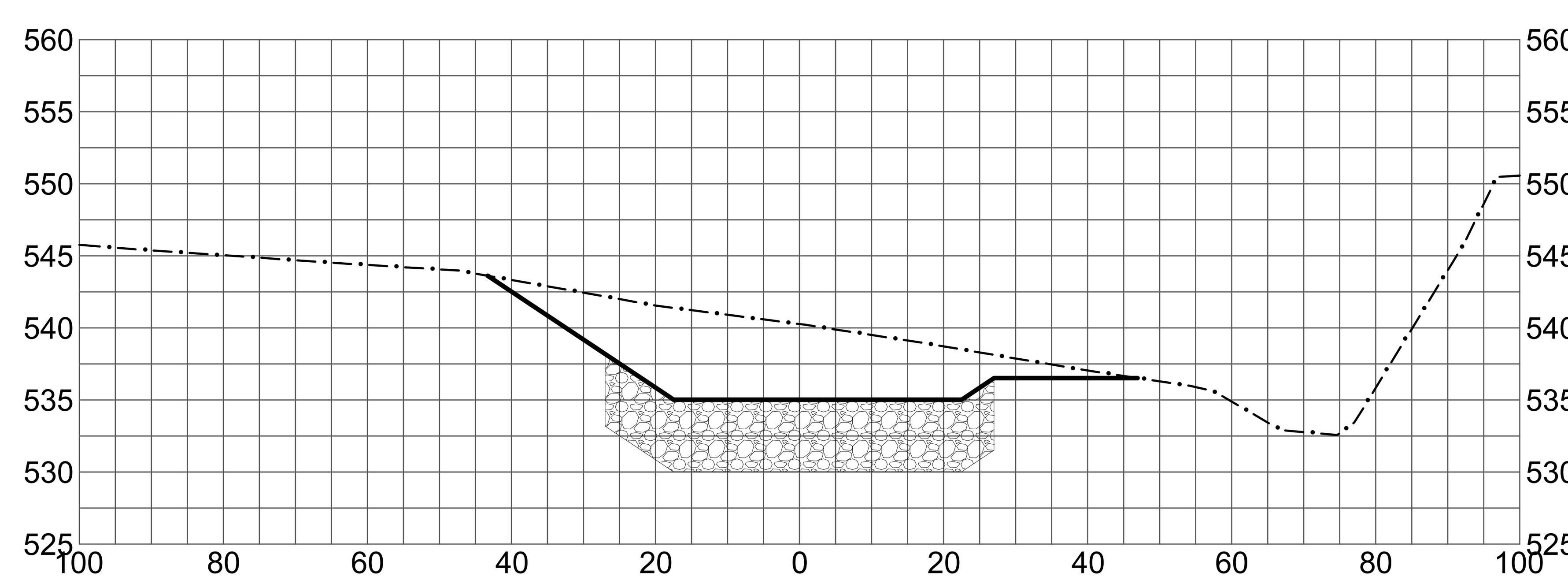

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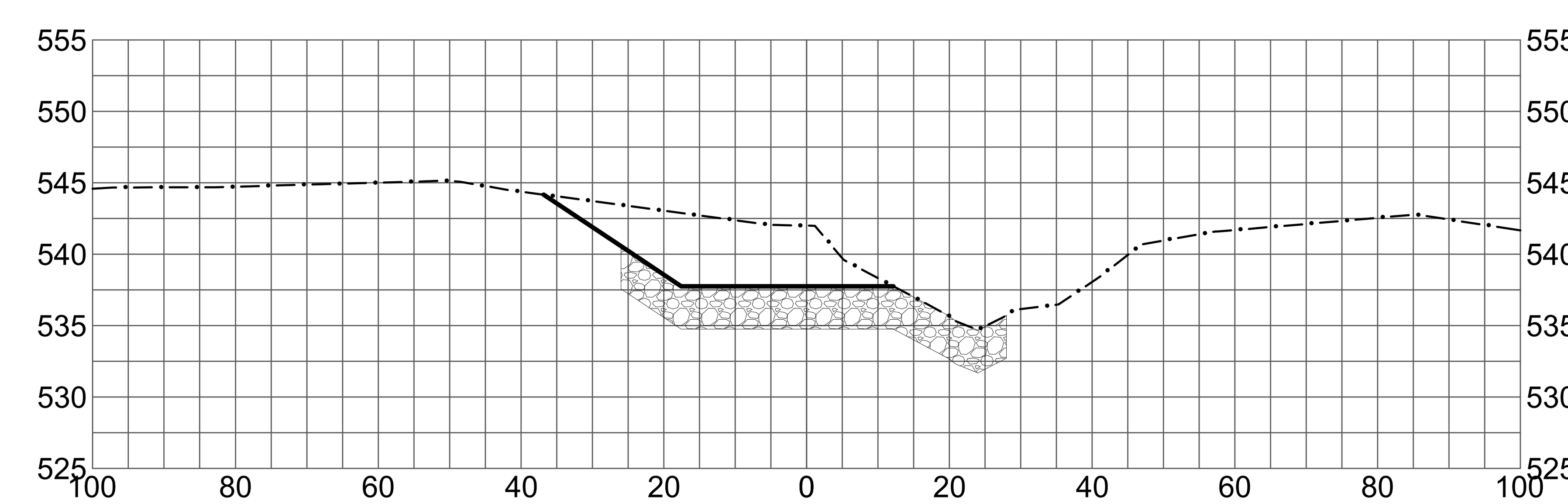

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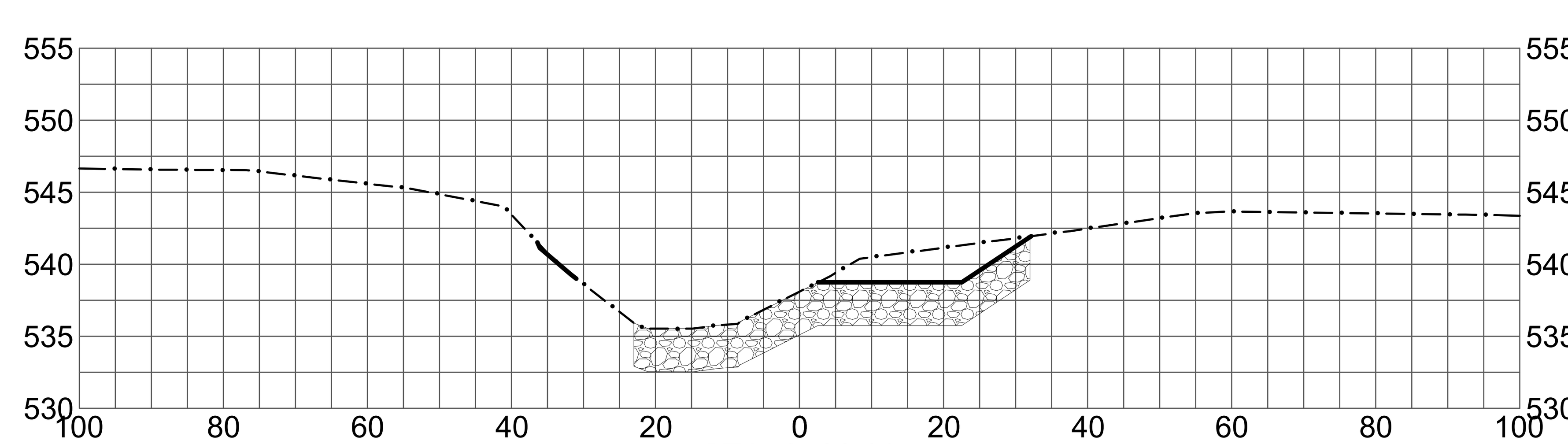
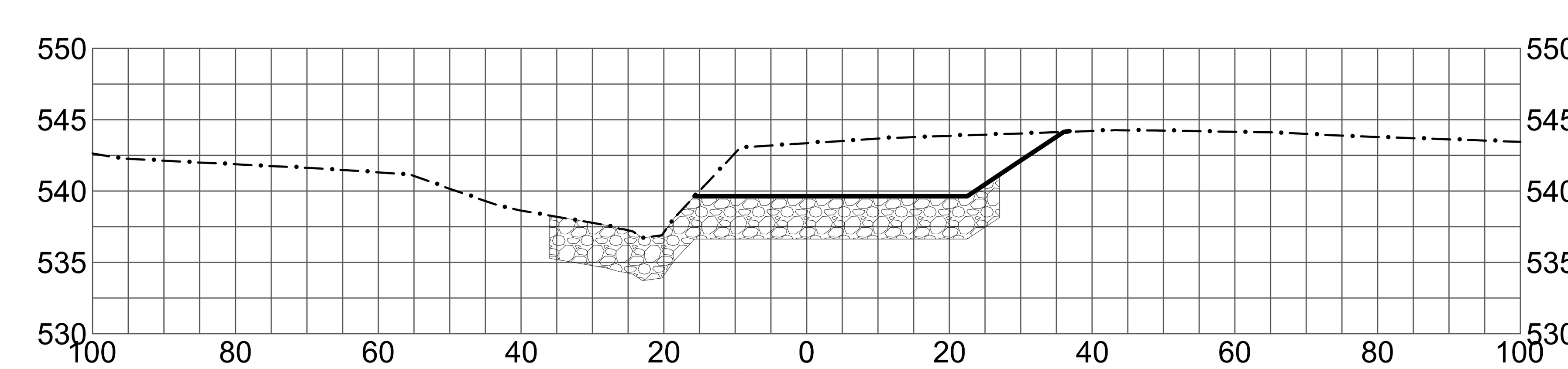


STA. 6+00.00



STA. 7+00.00

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CITY OF AUSTIN, TEXAS
CITY DEPARTMENT
WATERSHED PROTECTION DEPARTMENT

PACES MILL FLOODRISK
PRELIMINARY STUDY

CROSS SECTIONS
STA. 0+00 TO STA. 7+00

NOTES	NAME	DATE
SURVEY BY		
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REVIEWED BY		

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HORIZONTAL SCALE IN FEET
0 10 20
VERTICAL SCALE IN FEET

SHEET 5 OF 8

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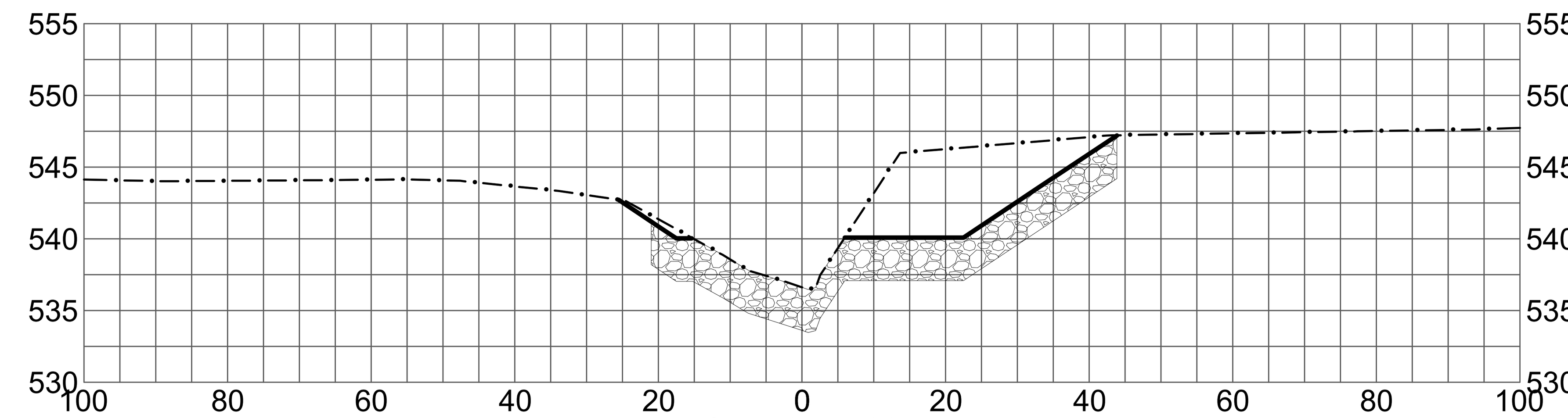
KEN STEDMAN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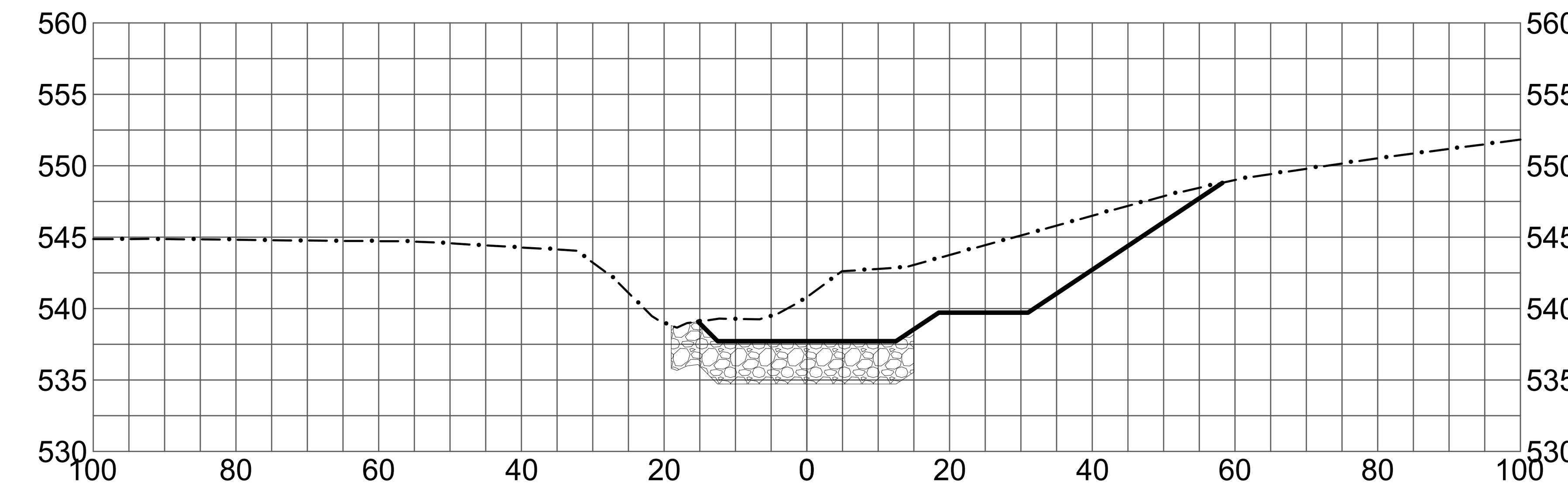
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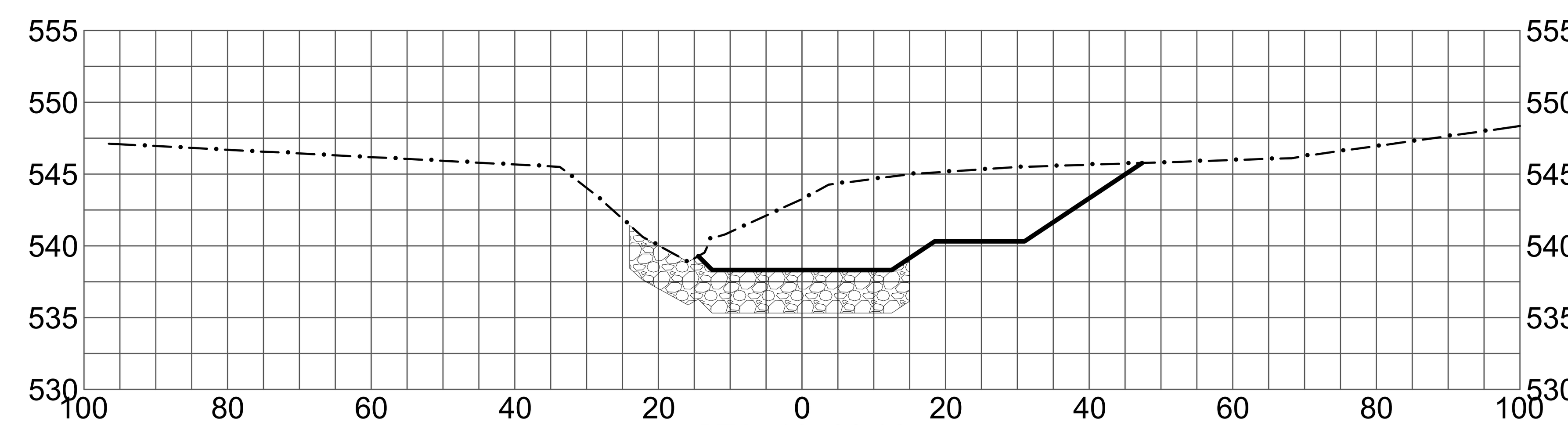
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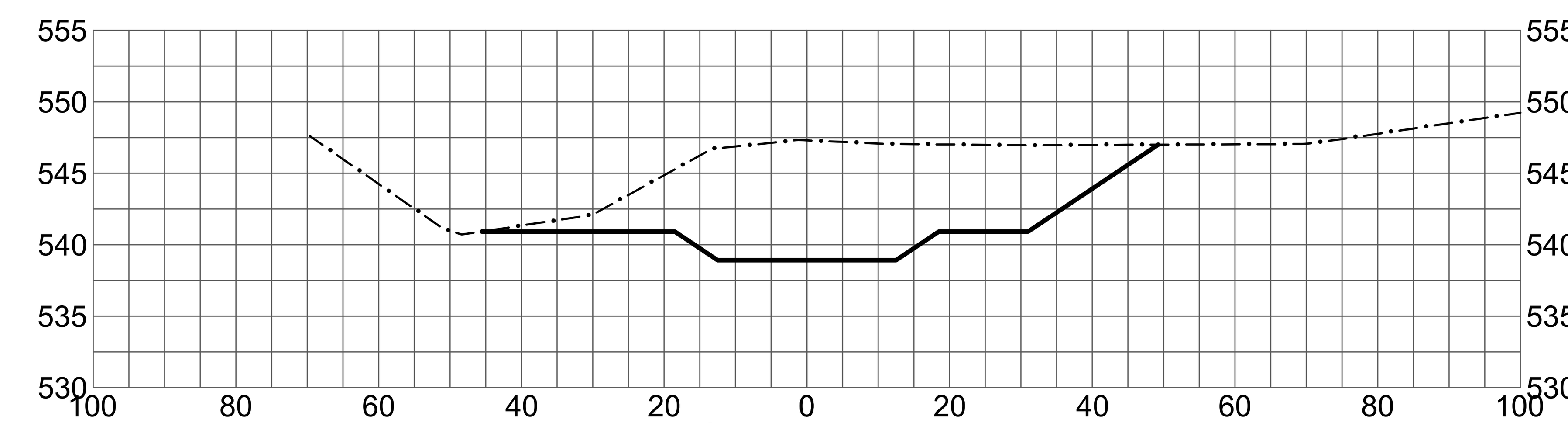
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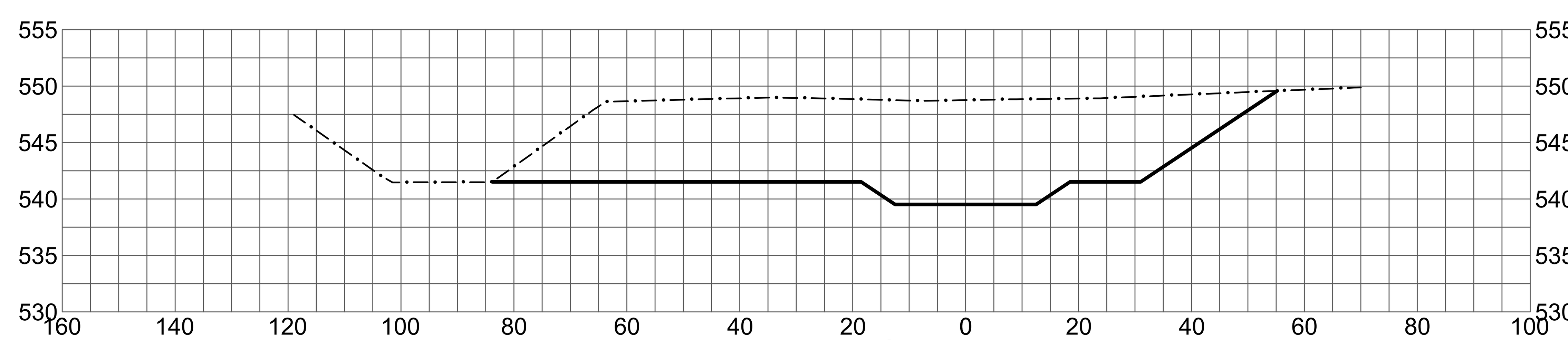
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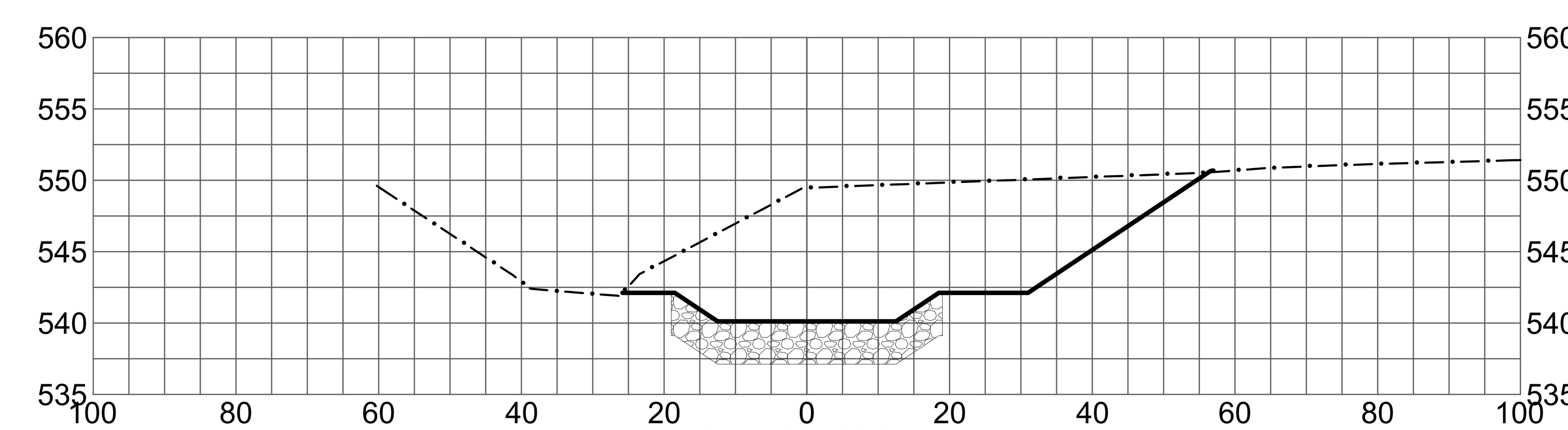
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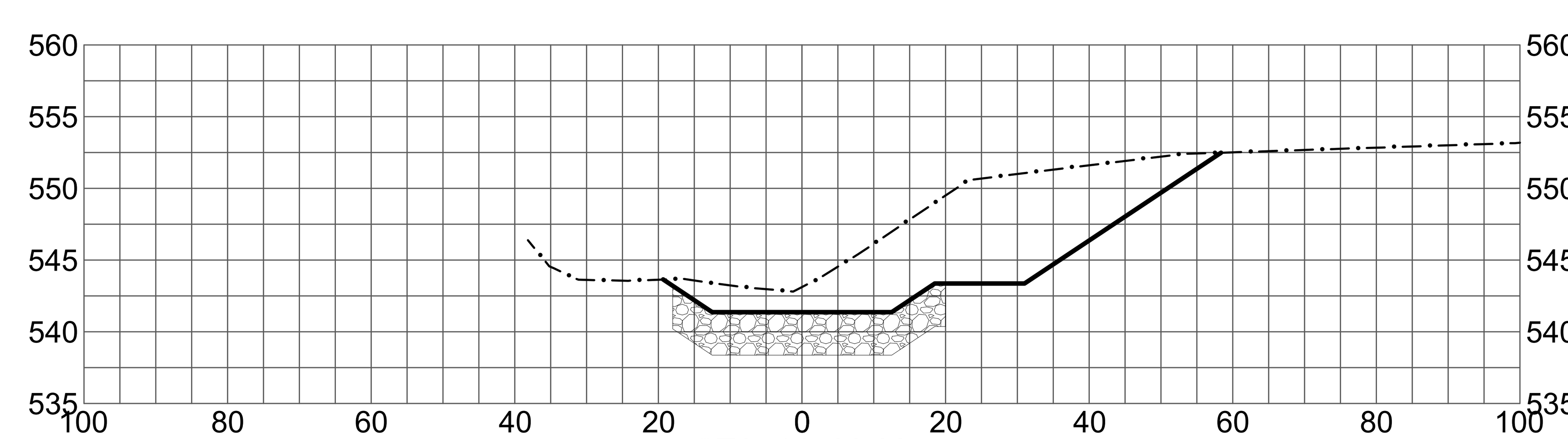
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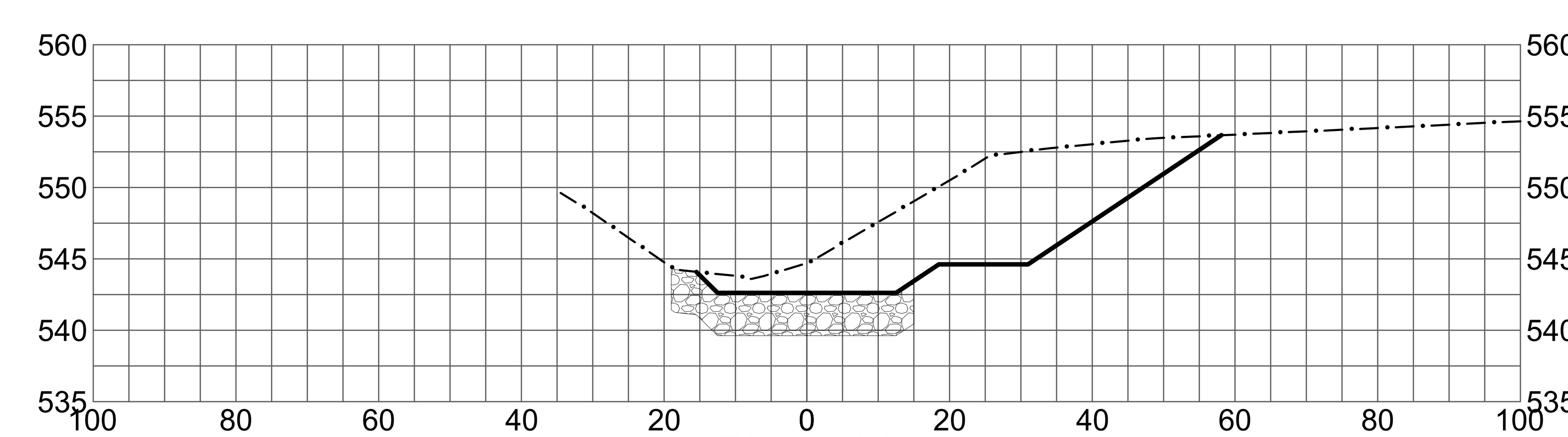
STA. 15+00.00

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CITY OF AUSTIN, TEXAS
CITY DEPARTMENT
WATERSHED PROTECTION DEPARTMENT

PACES MILL FLOODRISK
PRELIMINARY STUDY

CROSS SECTION
STA. 8+00 TO STA. 15+00

NOTES	NAME	DATE
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REVIEWED BY		

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HORIZONTAL SCALE IN FEET
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VERTICAL SCALE IN FEET

SHEET 6 OF 8

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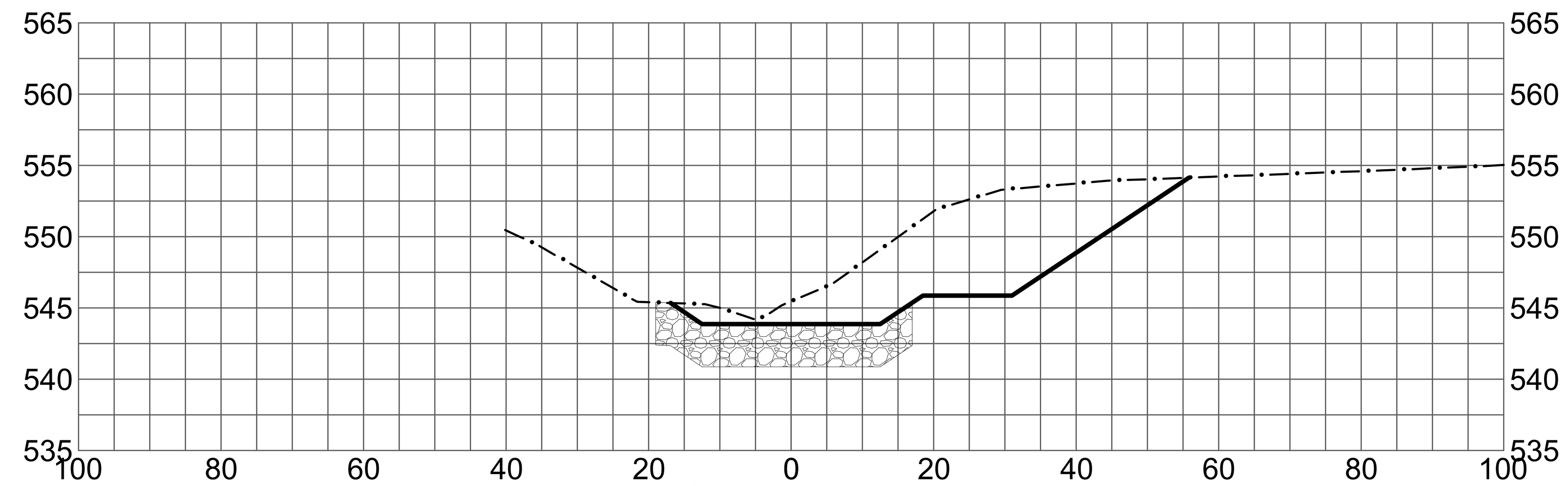
KEN STEDMAN



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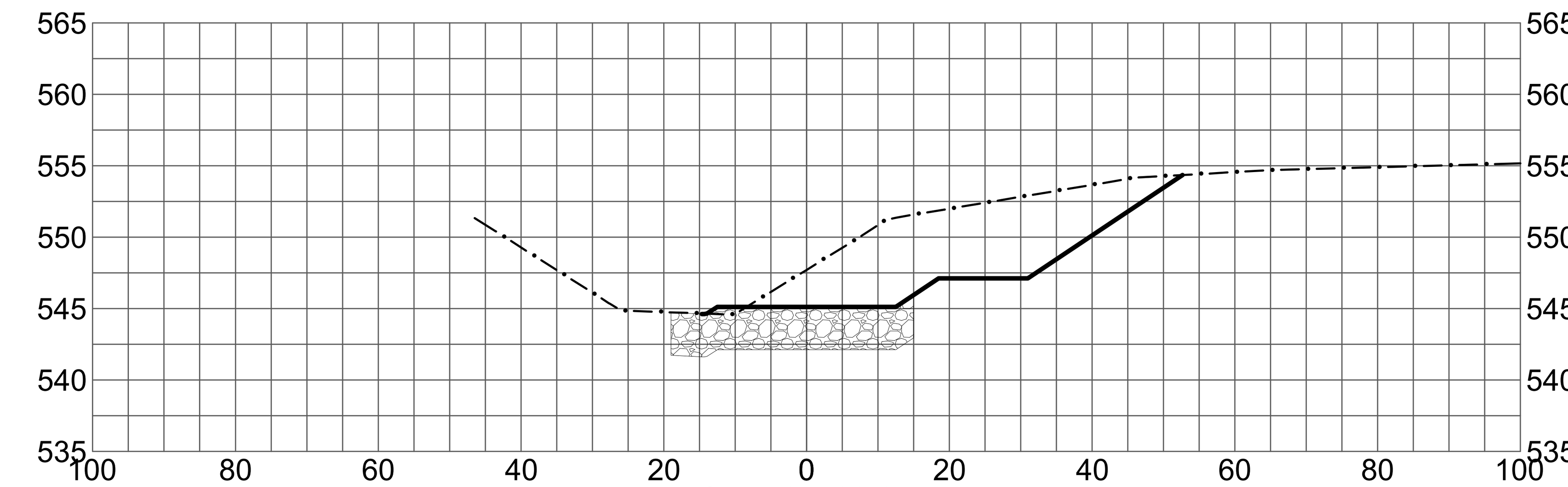

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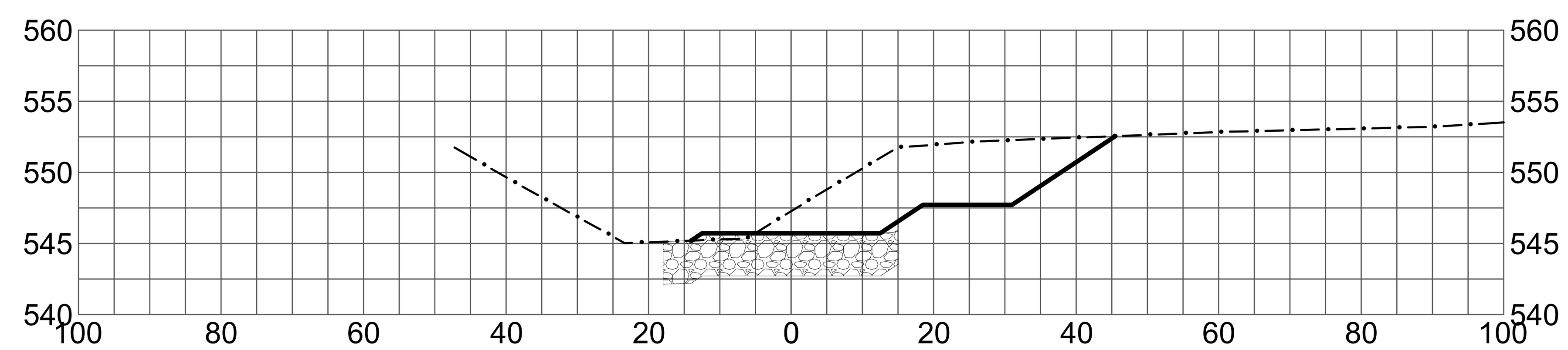

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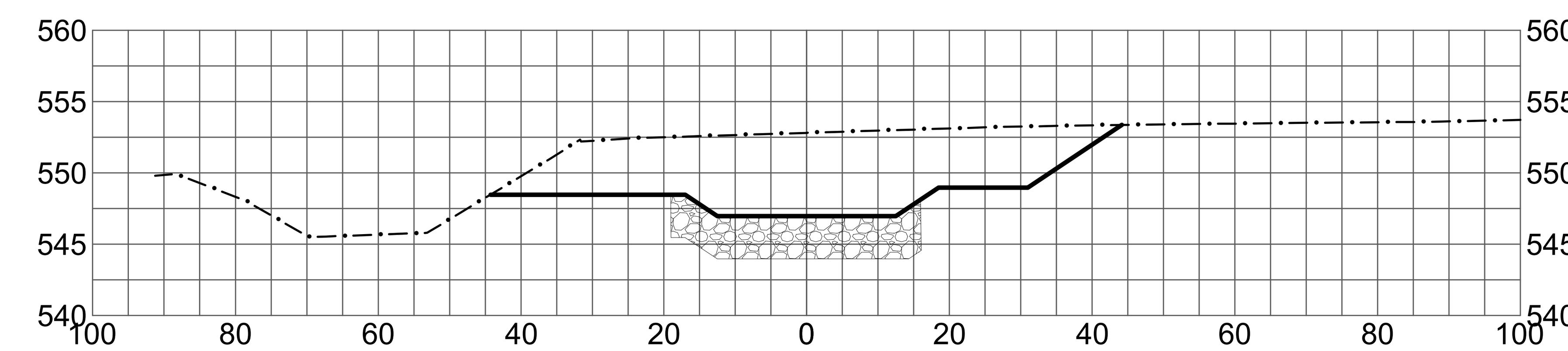

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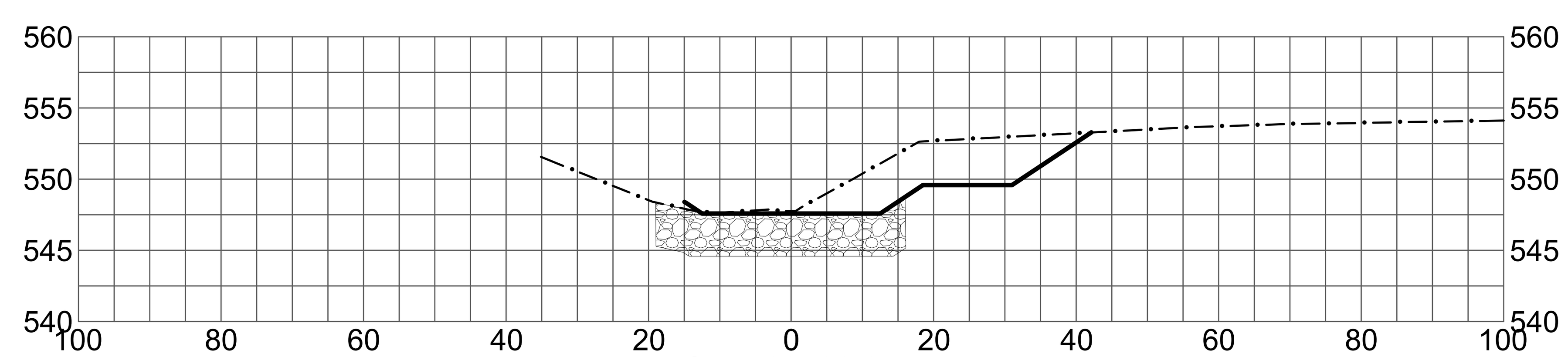

STA. 20+00.00

REV. NO.	BY	DATE	REVISION DESCRIPTION

INTERIM REVIEW

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CITY OF AUSTIN, TEXAS
CITY DEPARTMENT
WATERSHED PROTECTION DEPARTMENT

PACES MILL FLOODRISK
PRELIMINARY STUDY

CROSS SECTION
STA. 15+00 TO END

NOTES	NAME	DATE
SURVEY BY		
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DESIGNED BY		
CHECKED BY		
REVIEWED BY		

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HORIZONTAL SCALE IN FEET
0 10 20
VERTICAL SCALE IN FEET

SHEET 7 OF 8

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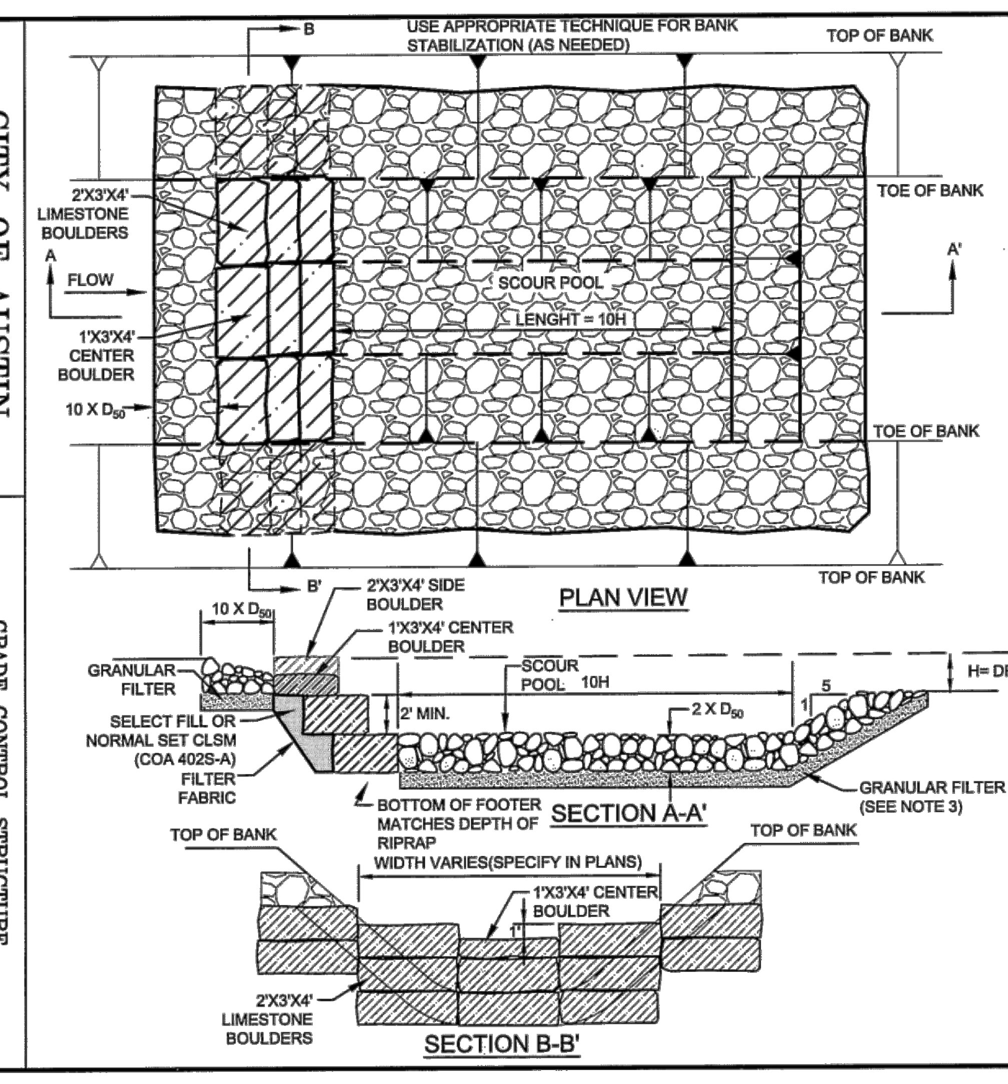
KEN STEDMAN



NOTES:
1. ROCK RIPRAP SHALL BE SOUND MATERIAL AND GRADED PER REQUIREMENTS SPECIFIED IN STANDARD SPECIFICATION ITEM NUMBER 591S.

2. ROCK RIPRAP D_{50} AND CLASS SIZE SHALL BE NOTED ON PLANS. GRADATION SHALL BE STABLE FOR THE DESIGN HYDRAULIC CONDITIONS AND IN ACCORDANCE WITH ECM 1.4.6.D ROCK RIPRAP, OR OTHER ENGINEERING STANDARD OF PRACTICE FOR SIZING ROCK RIPRAP.

3. AGGREGATE FOR GRANULAR FILTER SHALL BE DESIGNED ACCORDING TO ECM 1.4.6.D AND SHALL MEET THE REQUIREMENTS SPECIFIED FOR COARSE AGGREGATE IN SPECIFICATION ITEM NUMBER 403. AGGREGATE NOMINAL SIZE GRADE, NUMBER OF LAYERS AND LAYER THICKNESS SHOULD BE NOTED ON THE PLANS.

NOTES (BOULDERS):

1. BOULDERS SHALL BE DERIVED FROM NATURAL QUARRY LIMESTONE AND BE SPECIFIED AS EITHER "CUT" OR "NATURAL" PER THE PLANS. NATURAL BOULDERS SHALL HAVE A ROUGH SURFACE ON ALL EDGES, BUT THE TOP AND BOTTOM PARALLEL AND STACKABLE.
2. BOULDERS SHALL BE COMPRISED OF SOLID ROCK WITHOUT EXCESSIVE FRACTURES OR WEAK LAYERS AND HAVE A MINIMUM SPECIFIC GRAVITY OF 2.3

CITY OF AUSTIN WATERSHED PROTECTION DEPARTMENT	GRADE CONTROL STRUCTURE STRAIGHT STEPPED ROCK DROP	
11/14/16	THE ARCHITECT/ENGINEER ASSUMES RESPONSIBILITY FOR APPROPRIATE USE OF THIS STANDARD.	STANDARD NO. 625S-6

NOTES	NAME	DATE
SURVEY BY		
DRAWN BY		
DESIGNED BY		
CHECKED BY		
REVIEWED BY		

0 20 40
HORIZONTAL SCALE IN FEET
0 10 20
VERTICAL SCALE IN FEET

CITY OF AUSTIN, TEXAS
CITY DEPARTMENT
WATERSHED PROTECTION DEPARTMENT

PACES MILL FLOODRISK
PRELIMINARY STUDY

DETAILS

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SHEET 8 OF 8

KEN STEDMAN 4/7/2023 3:44 PM X:\PROJECTS\0767_COA_PACES MILL FRR\DWG\0767-C-DR-PLPR01.DWG, COA_PDF_22X34, COA_ESD.STB