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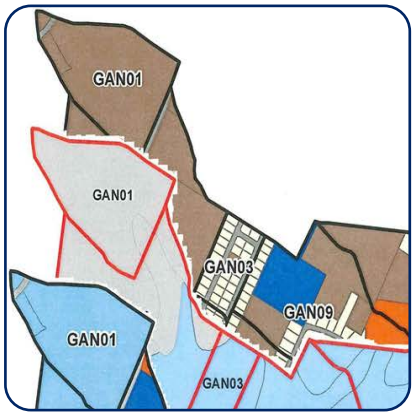
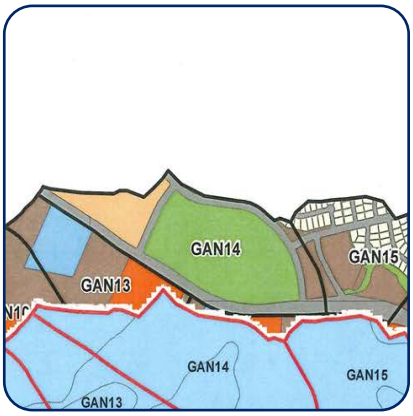
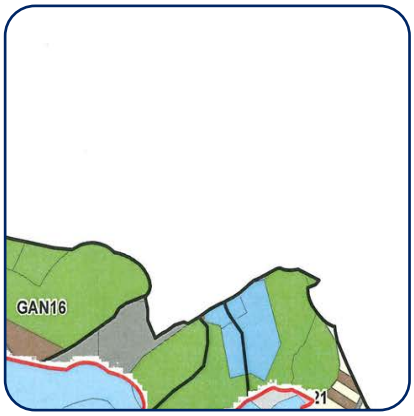
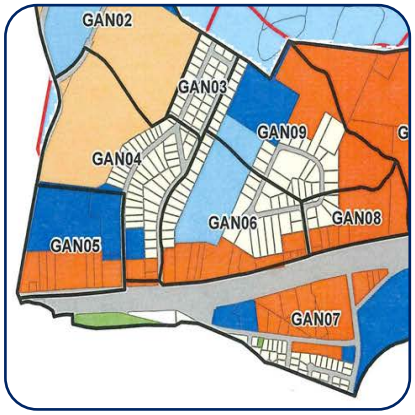
Gaines Tributary – Barton Creek Oak Acres

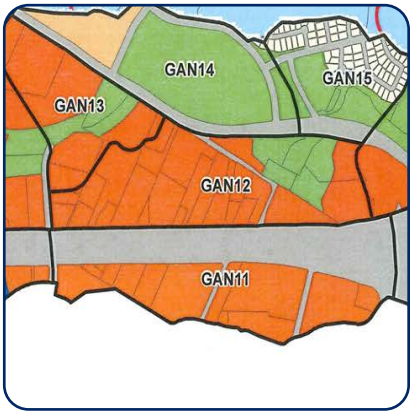
Preliminary Engineering Report

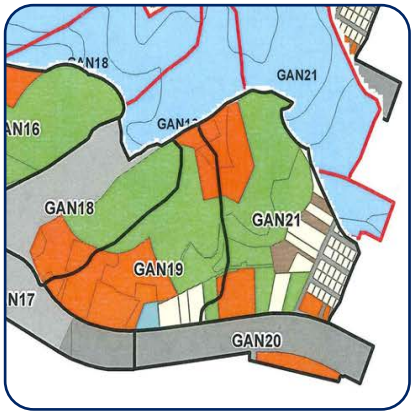


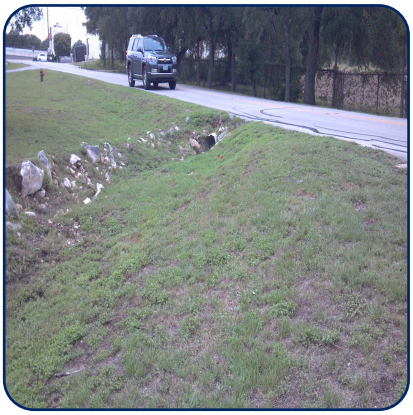


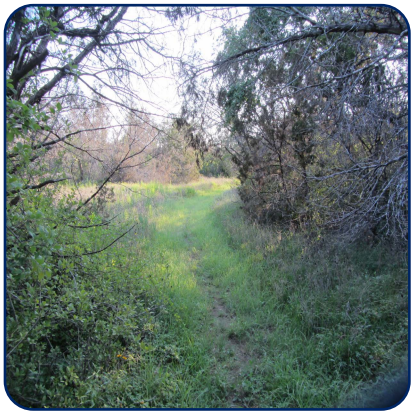












Gaines Tributary – Barton Creek Oak Acres
Preliminary Engineering Report

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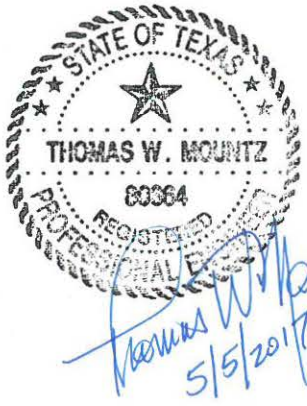

Project No. 11005.20
May 2017

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1 Executive Summary

This preliminary engineering report (PER) is supplemental to the 2014 Gaines Tributary Hydrologic and Hydraulic Analysis Report that developed floodplain models for the waterway and proposed improvements to minimize flooding from the 1% chance regulatory design storm. The PER was prepared to update the hydraulic model results and provide preliminary engineering design and estimated costs for various options for drainage improvements. The improvements that have been defined include both riverine improvements to Gaines Tributary and localized improvements for the storm drain collection systems that convey stormwater to Gaines Tributary. Flooding within the Gaines watershed is from a lack of managed/organized conveyance consistent with current City of Austin design standards and regulations. Williamson Creek overflows its bank and during larger storm events and propagates a second hydrograph peak downstream in Gaines Tributary.

The infrastructure proposed in the two options are floodplain reconfiguration improvements meant to manage the floodplain inundation limits and reduce roadway overtopping. The improvements will not result in downstream adverse impacts. Option 1 includes traditional improvements to the existing channels and culvert upgrades at road crossings. These improvements were first defined with estimated costs in the 2014 Gaines Tributary report and will require some residential and commercial structure buyouts to accommodate easement relocation and widening. Option 2 consists of alternative channel and culvert improvements that would maximize flow conveyance within existing easements and avoid environmental regulation/permit issues and structure buyouts required for Option 1.

For these improvements to function as intended and not cause any downstream impacts they must be implemented starting from downstream and working upstream. This sequence of construction is predicated on the channel and culvert improvements on Gaines Tributary being performed prior to any of the localized storm drain improvements. The engineer recommends Option 2 for the final design and construction of Gaines Tributary improvements. Option 2 does not require the buyout of existing homes or businesses, requires limited easement acquisition, and has significantly lower environmental impacts to the Barton Creek Watershed.

2 Introduction

The April 25, 2014 Gaines Tributary Hydrologic and Hydraulic Analysis was a comprehensive study of the Gaines Watershed within Austin, Travis County, Texas. This preliminary engineering report (PER) is a supplement to that report. The objectives of this PER are summarized as follows:

1) Develop a two-dimensional model of the spillover condition from Williamson Creek to better quantify flows entering into Gaines Tributary.
2) Evaluation of conveyance improvements through the overland area where the Williamson Creek overflows enter into Gaines Tributary.
3) Evaluation of improvements to alleviate localized flooding along the northern portion of the Oak Park Subdivision including the Oak Park North Tributary.
4) Evaluation of improvements to alleviate localized flooding along the southern portion of the Oak Park Subdivision.

5) Evaluation of improvements to alleviate localized flooding within the Oak Acres Subdivision.
6) Evaluation of conveyance improvements along the main stem of Gaines Tributary to alleviate riverine flooding.

3 Hydrologic and Hydraulic Update

3.1 Williamson Creek Overflow

In the 2013 Gaines Tributary Hydrologic and Hydraulic Analysis, the Williamson Creek overflows were approximated using lateral weirs within HEC-RAS. Based on the one dimensional limitations of HEC-RAS, the flat terrain, and the development that exists within the area where the overflow occurs, approximating the overflow from Williamson Creek was challenging. After numerous simulations the hydrograph that generated the highest peak flow was selected (1,694 cfs for the 1% storm event) by the City in order to complete the 2013 hydrologic and hydraulic analysis and define the parameters of the preliminary engineering objectives for this project. The City's primary objective for this PER was to evaluate the overflow from Williamson Creek using a 2-dimensional (2D) model to better estimate the flows that could be reasonably approximated entering into Gaines Tributary.

The Williamson Creek overflows along with the runoff generated by the watershed of Gaines Tributary for the 1% storm event under fully developed conditions are the basis for the infrastructure that has been sized in this PER. The hydrologic and hydraulic results for the overflow will serve as an update to the 2013 report for the 1% storm event.

3.2 Two – Dimensional Methodology

The InfoWorks ICM 2D – Dimensional modeling software was selected to perform the simulations of the overflow from Williamson Creek. The developed model consists of a 1-dimensional (1D) river reach representing Williamson Creek and a 2D mesh area representing the location where the overflow occurs.

3.2.1 Hydraulic Setup

The 1D river reach for Williamson Creek was developed by importing the HEC-RAS model for Williamson Creek into InfoWorks. The 2D mesh area is then developed on the north bank of Williamson Creek where the overflow will occur. The 2D zone was developed using topography data collected specifically for this project. LiDAR data supplemented with on the ground survey was collected to create a high quality terrain model that would accurately represent the area where the overflow occurs. Hydraulic parameters such as roughness zones, porous walls, and breaklines are added to the mesh to further define the hydraulic characteristics of the zone.

3.2.1.1 Roughness Zones

The model uses Manning roughness (n) zones to define the general overland characteristics that the mesh is intended to simulate. These zones can be in any shape, size, and quantity that the user defines.

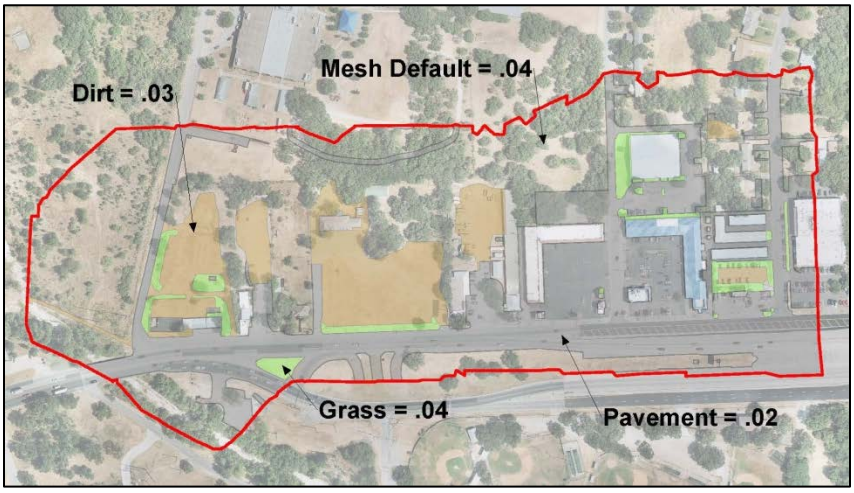


Figure 1: Roughness Zones

3.2.1.2 Porous Walls and Buildings

Porous Walls are line objects used as part of the mesh generation process. The lines represent walls with a specified porosity and height which are taken into account during the 2D simulation process. Buildings are represented as voids in the mesh. When a void is placed in the mesh to represent solid based objects, flow cannot occur through that object.

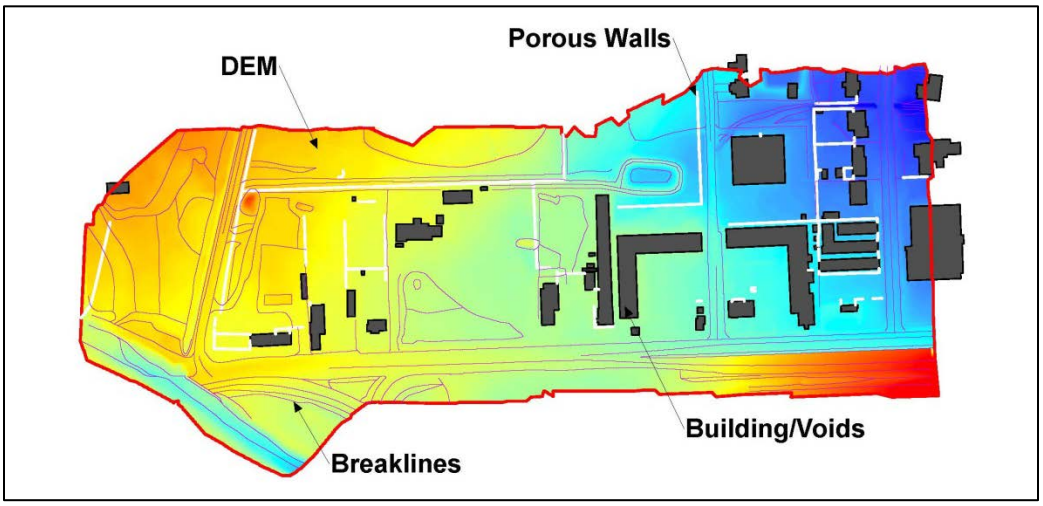


Figure 2: Mesh Features

3.2.2 2D Model Setup

The City's Williamson Creek HECRAS hydraulic model was truncated to capture the section of the creek where the overflow occurs, and then imported into Infoworks. Input hydrographs from the Williamson Creek hydrologic model were then added. Highly detailed survey data was collected specifically for the area where the overflow occurs. This data was used to create a triangular integrated network (TIN) within Infoworks to represent the surface mesh so that flow characteristics could be simulated. This Williamson Creek overflow mesh is the 2D ground surface simulation that is used to reasonably quantify the overflows from Williamson Creek. Figure 3 shows a graphical layout of the 2D model and highlights the three main features.

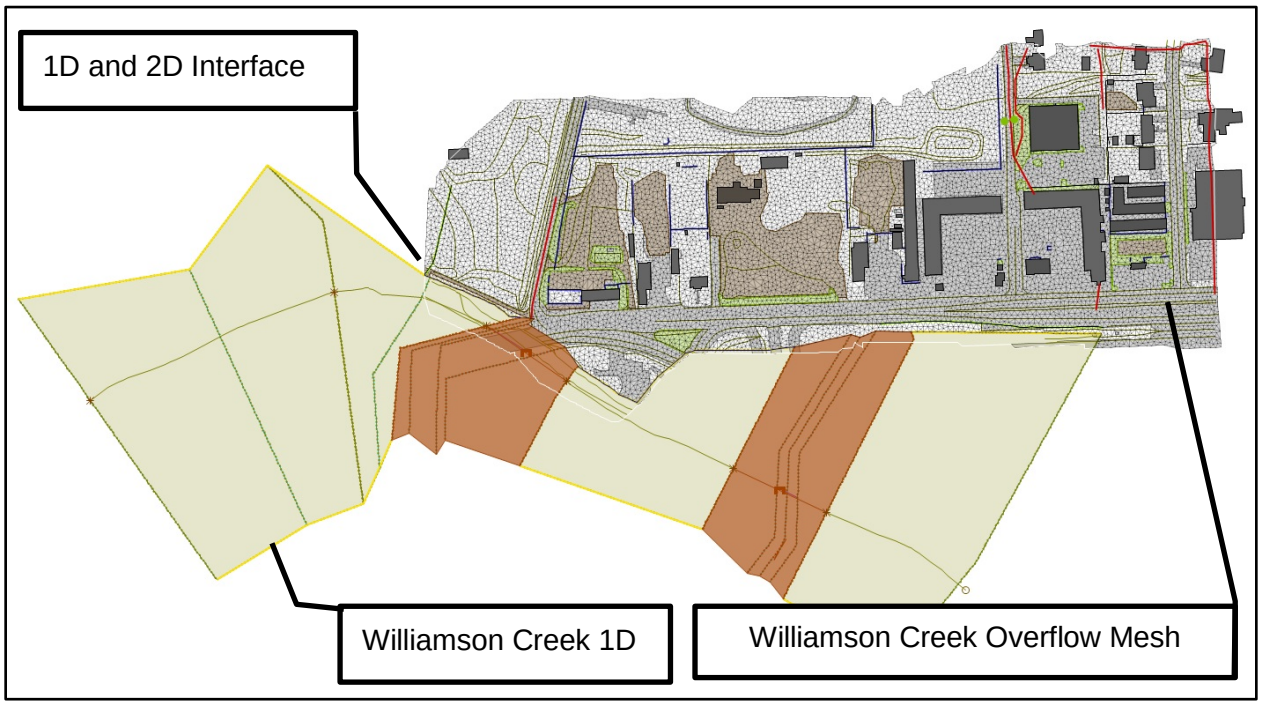


Figure 3: Model Network of Williamson Creek Overflow

3.3 Results and Hydrologic/Hydraulic Update

The results of the model were assessed and evaluated using Network Result Lines (NRL) that are placed on the mesh at locations where peak flow rates were to be quantified. NRL's are user defined and can be used to check, confirm, and/or evaluate the results generated by the model. NRL's are essentially windows within the model and will report positive and negative flows across the line. Ideally, the lines are drawn perpendicular to one-way flows in order to obtain a complete hydrograph at a particular location. However, observing two-way flows across an NRL can also reveal or confirm a situation within the mesh that has been observed or suspected in the field. Figure 4 depicts the NRL's across the 2D mesh that was used to evaluate results associated with the Williamson Creek overflows into Gaines Tributary.

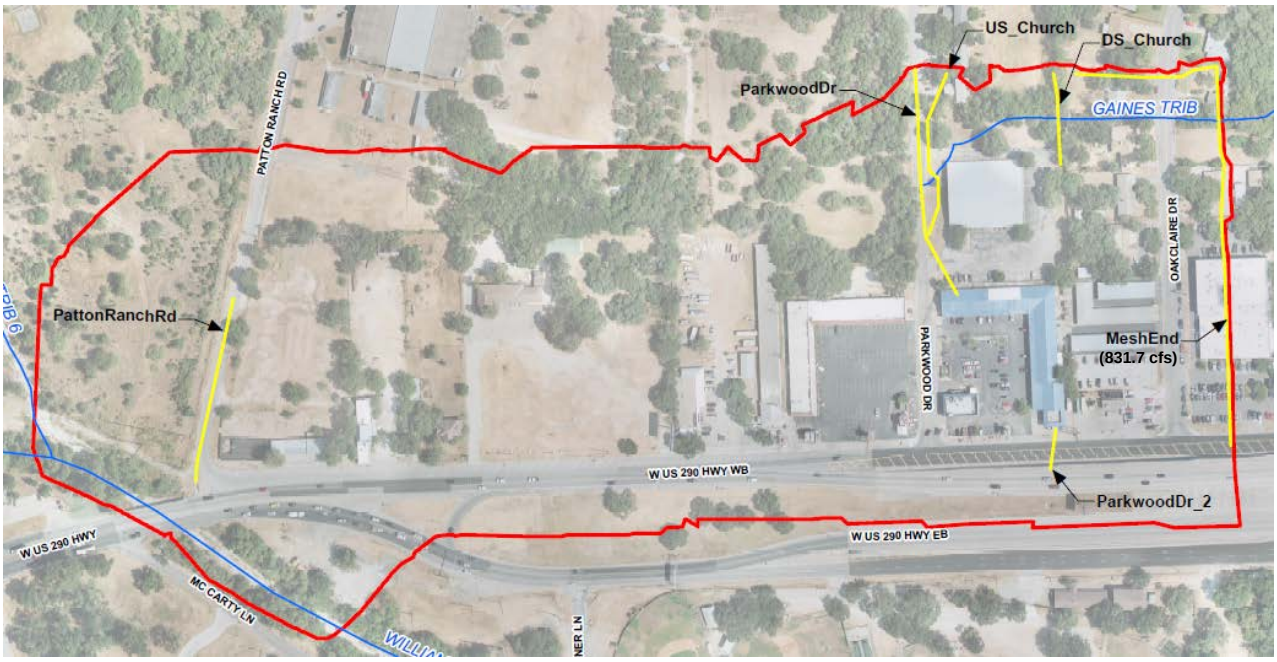


Figure 4: 2D Network Result Lines

Observations from the NRL results evaluation include:

1. The stormsewer system along US-290 was modeled, but only showed a capacity of 60 cfs, so it was not included in the final model results.
2. A sensitivity analysis was conducted where n-values and fence porosity were modified and the model was found to be fairly sensitive to n-values, but changing fence porosity made little affect.
3. The resulting combined flow leaving the 2D “MeshEnd” line and entering Gaines Tributary is 831.7 cfs.

In the 2013 Gaines Tributary Hydrologic and Hydraulic Analysis the Williamson Creek overflows were approximated using HEC-RAS and yielded a peak flow rate of 1,694 cfs that would be added into Gaines Tributary. The use of the 2D InfoWorks ICM model resulted in a lower peak flow rate of 831.7 cfs entering Gaines Tributary and necessitated updating the 2013 Gaines Tributary Hydrologic and Hydraulic Analysis.

The hydrograph results from the Mesh End NRL are taken from the 2D model and entered as a user defined hydrograph into the Gaines Tributary HEC-HMS model. The timing of the overflow lags behind the main stem of Gaines by roughly 44 minutes near Harper Park Drive. This lag is sufficient to not exceed the Gaines only peak as depicted in Figure 5.

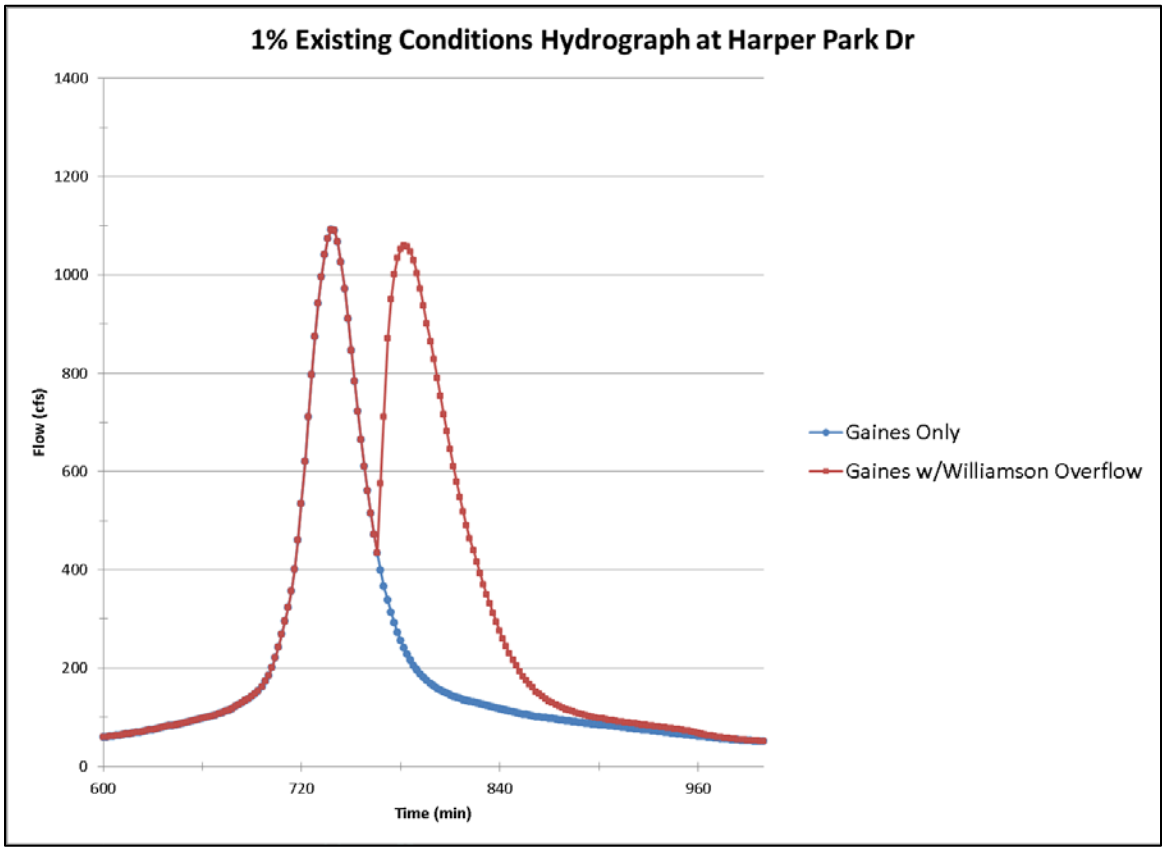


Figure 5: Hydrograph Comparison

This PER includes an update to the hydrologic results for the Williamson Creek overflow hydrograph combined with the Gaines Tributary peak flows for the 1% annual event Fully Developed Conditions. The updated hydrologic and hydraulic summary tables can be found in Appendix C. The highlighted yellow columns represent the 2D Williamson Creek Overflows. The highlighted green column on the hydraulic summary table represents the results inclusive of the Option 2 Improvements that are discussed in Section 3 below. The digital data for the hydrologic and hydraulic analyses can be found in Appendix D.

4 Riverine and Localized Floodplain Improvements

The 2014 analysis of this project included identifying flood control improvements within Gaines Tributary to reduce floodplain inundation limits by way of reducing base flood elevations and/or conveyance improvements. The Hydraulic analysis found a number of structures to be inundated as well as being located well within the floodplain. Structural flood controls such as detention ponds, flood diversion improvements, conveyance improvements, etc., were all considered in an effort to alter the flood condition of the watershed. Each of these projects has a high variability in complexity and cost.

Because of the unavailability of suitable land, the use of a regional detention pond was not a viable option and therefore not considered. A flood diversion structure had been initially considered as a potential alternative for preventing Williamson Creek from overflowing into Gaines. However, with the contributing drainage area of Gaines being a huge source of flooding by itself, the addition of a flood diversion structure would not solve the current flooding problems in Gaines. Therefore, channel improvements and culvert upgrades at each of the existing road crossings will be necessary to reduce base flood elevations and reduce the impact of the Gaines Tributary floodplain on homes and businesses in the study area.

Two sets of proposed improvements (Option 1 and Option 2) are presented herein for the Gaines Tributary study area. Each set of improvements is discussed in the following paragraphs along with estimated construction, engineering, and permitting costs. The discussion on each option also addresses the potential costs and impacts due to conflicts with existing utilities and environmental permitting. Option 1 outlines improvements to the existing channel and culvert upgrades at road crossings as identified in the original 2014 study. Option 2 proposes alternative improvements that would avoid buyouts or reduce the number of buyouts resulting from Option 1 and limit disruptions to the neighborhood and environmental features, as well as meet the overall engineering objectives of the project.

4.1 Utility Conflict Considerations

A major concern of proposed remedial drainage projects in established neighborhoods is conflicts with existing utilities. City of Austin record drawings and maps were used to locate and size existing water, wastewater, and storm drain lines within the project area. Each component of the proposed options presented in following paragraphs, roadway culvert crossings, channel construction, and local storm drain improvements will impact the existing utilities to varying degrees. The specific impacts expected with each alternative will be discussed and the estimated cost of repair and/or relocation is included with each proposed cost estimate.

4.2 Environmental & Cultural Resources Analysis

The full extent of the proposed alternative flood management options of this study lie within the Edwards Aquifer Recharge Zone in the Barton Creek watershed. Further, the City of Austin has established Erosion Hazard Buffer zones and Critical Creek Buffer zones along each of the existing waterways. Within these zones, one must also identify, in the design phase, Critical Environmental Features that may exist and impact the design. There is at least one reported karst feature near the existing Gaines Tributary channel in Oak Park Subdivision that will need

to be verified. The City tree ordinance also regulates the removal of significant, protected, and heritage trees within the proposed project area. A tree survey was conducted with the initiation of this project; however the survey did not include the Gaines Tributary critical creek buffer zone through the Oak Blvd. crossing. For either alternative selected for design additional tree survey will be required for the project extents. The purpose of this proposed project is to improve drainage and relieve flooding of existing structures in the floodplain. Corrective measures will require impacts to the existing waterways and culverts. The design alternative chosen will require extensive inaction and cooperation with Environmental review staff to address the impacts on each issue cited above.

4.3 Option 1 Improvements

Option 1 (Figures A1 through A4) consists of channel improvements and culvert upgrades at and along the existing drainage ways. These are traditional conveyance improvements that would impact homes and businesses in order to make room for the infrastructure necessary to convey the fully developed 1% (100 Year) storm event. These improvements were first defined with estimated costs in the April 25, 2014 Gaines Tributary H&H Analysis report.

4.3.1 Oak Park North Improvements

The structural improvements needed to reduce base flood elevations and contain the floodplain within the small unnamed tributary that crosses Parkwood Drive and Oakclaire Drive just north of Oakclaire Lane are summarized on Figure A2 in Appendix A. These improvements include:

a) An interceptor channel along the western boundary of the Oak Park Subdivision.
b) Conveyance improvements along the Oak Park North Tributary that include culvert upgrades at the Parkwood Drive and Oakclaire Drive road crossings and an improved channel section.

These improvements would warrant the removal of four homes for construction of these improvements. Associated buyout costs are included in the Cost Estimate below. In addition, the proposed culverts will require relocation of the existing water and sanitary sewer lines. Estimated costs for the relocation are included below.

The City of Austin also requested an upgrade of the local drainage system to convey localized flood flows in accordance with City of Austin Drainage Design Criteria. Therefore this alternative includes new storm drain collection systems within Parkwood Drive and Oakclaire Drive connecting to the proposed channel improvements. The proposed system will impact existing utilities and service lines located in the two streets as shown on Figure A1 in Appendix A.

The engineer's opinion of probable cost is presented in Table 1.

Table 1: Cost Estimate for Oak Park North

Engineers Opinion of Probable Construction Cost					
Item	Description	Quantity	Unit	Unit Price	Amount
120S	Channel Excavation	10000	CY	$ 30.00	$ 300,000.00
102S	Misc. Demolition	1	LS	$ 50,000.00	$ 50,000.00
102S	Clearing & Grubbing	1	LS	$ 10,000.00	$ 10,000.00
559S	60' - 6'x4' RCB (including misc. concrete works) - PW	3	EA	$ 30,000.00	$ 90,000.00
559S	60' - 6'x4' RCB (including misc. concrete works) - OC	3	EA	$ 30,000.00	$ 90,000.00
559S	24" RCP (including inlets & manholes)	1600	LF	$ 200.00	$ 320,000.00
510W	Repair sanitary lines	220	LF	$ 120.00	$ 26,400.00
510W	Repair water lines	220	LF	$ 120.00	$ 26,400.00
200S	1/2 - Road Reconstruction over Storm Drain System	1600	LF	$ 200.00	$ 320,000.00
800S	Temporary Traffic Control	1	LS	$ 15,000.00	$ 15,000.00
600S	Misc. Erosion & Sedimentation Controls	1	LS	$ 200,000.00	$ 200,000.00
608S	Planting & Revegetation (87,500 SF)	10000	SY	$ 7.00	$ 70,000.00
	Subtotal				$ 1,517,800.00
	Engineering and Survey	15%			$ 227,670.00
	Construction Contingency	35%			$ 531,230.00
	Project Construction Cost				$ 2,276,700.00
	Property Buyout Cost (including misc. soft costs)	4	Homes	$ 405,000.00	$ 1,620,000.00
	Easement Acquisition Cost	180,000	SF	$ 4.00	$ 720,000.00
	Property Acquisition Cost				$ 2,340,000.00
	TOTAL PROJECT COST				**$ 4,616,700.00**

4.3.2 Oak Park South Improvements

4.3.2.1 Localized Storm Drain Improvements

The structural improvements needed for Oak Park south are storm drain improvements that will intercept and convey both offsite drainage areas and drainage areas within the subdivision to Gaines Tributary. These improvements are summarized on Figure A3 in Appendix A. These improvements include:

a) An interceptor channel along the western boundary that will drain to the south.
b) An inlet collector for the interceptor channel near the School Road and Parkwood Drive intersection.
c) The addition of a storm drain collection system to convey off-site flows collected through the Oak Park Subdivision to Gaines Tributary.

The City of Austin also requested an upgrade of the local drainage system to convey localized flood flows in accordance with City of Austin Drainage Design Criteria. Therefore this

alternative includes a new storm drain collection system within Oakclaire Drive connecting to the proposed channel improvements. The proposed system will impact existing utilities and service lines located in the two streets as shown on Figure A1 in Appendix A.

The engineer's opinion of probable cost is presented in Table 2.

Table 2: Cost Estimate for Oak Park South Localized Improvements

Engineers Opinion of Probable Cost						
Item	Description	Quantity	Unit	Unit Price		Amount
120S	Channel Excavation	4000	CY	$ 30.00	$	120,000.00
102S	Misc. Demolition	1	LS	$ 30,000.00	$	30,000.00
102S	Clearing & Grubbing	1	LS	$ 8,000.00	$	8,000.00
559S	48" RCP (including misc. concrete works)	800	LF	$ 250.00	$	200,000.00
559S	30" RCP (including inlets & manholes)	950	LF	$ 200.00	$	190,000.00
200S	1/2 - Road Reconstruction over Storm Drain System	950	LF	$ 200.00	$	190,000.00
510W	Repair sanitary lines	50	LF	$ 110.00	$	5,500.00
510W	Repair water lines	250	LF	$ 110.00	$	27,500.00
800S	Temporary Traffic Control	1	LS	$ 15,000.00	$	15,000.00
600S	Misc. Erosion & Sedimentation Controls	1	LS	$100,000.00	$	100,000.00
800S	Planting & Revegetation (60,000SF)	6700	SY	$ 7.00	$	46,900.00
	Subtotal				$	932,900.00
	Engineering and Surveying	15%			$	139,935.00
	Environemntal Permitting (Federal, State & Local)	10%			$	93,290.00
	Construction Contingency	35%			$	326,515.00
	Project Construction Cost				$	1,492,640.00
	Easement Acquisition Cost	75000	SF	$ 4.00	$	300,000.00
	TOTAL PROJECT COST				**$**	**1,792,640.00**

4.3.2.2 Gaines Improvements (Williamson Creek Overflow)

With the Williamson Creek overflow 2D analysis, the structural improvements within Gaines Tributary have been adjusted to account for the additional flows that enter into Gaines Tributary. There is channel widening that will be needed in the headwaters where the overflow enters into Gaines along with increased culvert capacity at each of the road crossings. Figure A3 in Appendix A provides a graphical representation of the channel widening improvements and culvert upgrades needed for this scenario. These improvements include:

a) Add a Williamson Creek overflow channel that will intercept flows and convey to Gaines Tributary.
b) Channel Improvements from Parkwood Drive to Harpers Park that include culvert upgrades at the Parkwood Drive and Oakclaire Drive road crossings.
c) These improvements would warrant the removal of one home for construction of these improvements.

Associated home buyout costs are included in the Cost Estimate below. In addition, the proposed culverts will require relocation of the existing water and sanitary sewer as shown on Figure A1 in Appendix A. Estimated costs for the relocation are included below.

The engineer's opinion of probable cost is presented in Table 3.

Table 3: Cost Estimate for Williamson Creek Overflow Improvements

Engineers Opinion of Probable Cost						
Item	Description	Quantity	Unit	Unit Price		Amount
120S	Channel Excavation	10000	CY	$ 30.00	$	300,000.00
102S	Misc. Demolition	1	LS	$ 50,000.00	$	50,000.00
102S	Clearing & Grubbing	1	LS	$ 16,000.00	$	16,000.00
559S	150' - 7'x4' RCB (including misc. concrete works)	3	EA	$ 60,000.00	$	180,000.00
559S	50' - 7'x4' RCB (including misc. concrete works)	3	EA	$ 20,000.00	$	60,000.00
200S	Phased Road Reconstruction at Crossings	200	LF	$ 700.00	$	140,000.00
510W	Repair sanitary lines	150	LF	$ 110.00	$	16,500.00
510W	Repair water lines	150	LF	$ 110.00	$	16,500.00
800S	Temporary Traffic Control	1	LS	$ 15,000.00	$	15,000.00
600S	Misc. Erosion & Sedimentation Controls	1	LS	$220,000.00	$	220,000.00
608S	Planting & Revegetation (126,500 SF)	14000	SY	$ 7.00	$	98,000.00
	Subtotal				$	1,112,000.00
	Engineering and Surveying	15%			$	166,800.00
	Environemntal Permitting (Federal, State & Local)	10%			$	111,200.00
	Construction Contingency	35%			$	389,200.00
	Project Construction Cost				$	1,779,200.00
	Property Buyout Cost (including misc. soft costs)	1	Home	$460,000.00	$	460,000.00
	Lot Buyout Cost	1	Lot	$200,000.00	$	200,000.00
	Easement Acquisition Cost	110,000	SF	$ 4.00	$	440,000.00
	Property Acquisition Cost				$	1,100,000.00
	TOTAL PROJECT COST				**$**	**2,879,200.00**

4.3.3 Oak Acres Improvements

The structural improvements proposed for the Oak Acres area include riverine improvements to Gaines Tributary to reduce flood overtopping of the only access road to the existing neighborhood and inundation of existing homes. The City of Austin also requested localized rehabilitation/improvements to the storm drainage system of the Oak Acres subdivision. These improvements are summarized on Figure A4 in Appendix A and the engineer's opinion of probable cost is presented in Table 4. Proposed improvements include:

a) Roadside ditch improvements along North and South Oak Blvd.
b) Storm drain improvements to convey the roadside ditch flows to Gaines Tributary near the Oak Blvd. road crossing.

c) Riverine channel Improvements on Gaines Tributary starting just upstream of Oak Blvd. to downstream of the Oak Acres Subdivision
d) Culvert upgrades at the Oak Blvd. road crossing.

These improvements would warrant the removal of one commercial business for construction of the channel improvements. Associated buyout costs for the structure are included in the Cost Estimate below. In addition, the proposed culverts will require relocation of the existing water and sanitary sewer lines. Estimated utility relocation costs are included below.

The approximately 1300 LF of proposed channel improvements to the creek will require extensive coordination with City of Austin Environmental Department staff to mitigate impacts to the Critical Creek Buffer zone, Edwards Aquifer recharge zone, and to significant and protected trees in the existing floodplain. In addition the channelization will require a Section 404 permit from the U.S. Army Corps of Engineers and a waterway development permit from the City.

The improvements to the local drainage system are to convey localized flood flows in accordance with City of Austin Drainage Design Criteria. The proposed improvements may impact existing utilities and service lines as shown on Figure A1 in Appendix A. The local improvements will also impact existing driveways and driveway culverts. Demolition and replacement costs are included in the estimates below.

Table 4: Cost Estimate for Oak Acres Localized Improvements

Engineers Opinion of Probable Cost						
Item	Description	Quantity	Unit	Unit Price		Amount
120S	Roadside Drainage and Collection Swales	8000	CY	$ 30.00	$	240,000.00
102S	Misc. Demolition	1	LS	$ 15,000.00	$	15,000.00
102S	Clearing & Grubbing	1	LS	$ 10,000.00	$	10,000.00
559S	Repair/replace driveway 18" RCP culverts	220	LF	$ 200.00	$	44,000.00
433S	Repair/replace 6"concrete driveways (200 SF avg)	3600	SF	$ 10.00	$	36,000.00
559S	Misc. Pipe Culvert Crossings	3	EA	$ 10,000.00	$	30,000.00
200S	Misc. Road Reconstruction and Repairs	1	LS	$ 100,000.00	$	100,000.00
510W	Repair sanitary lines	50	LF	$ 110.00	$	5,500.00
510W	Repair water lines	250	LF	$ 110.00	$	27,500.00
800S	Temporary Traffic Control	1	LS	$ 5,000.00	$	5,000.00
600S	Misc. Erosion & Sedimentation Controls	1	LS	$ 30,000.00	$	30,000.00
608S	Planting & Revegetation (44,000 SF)	4900	SY	$ 15.00	$	73,500.00
	Subtotal				$	616,500.00
	Engineering and Surveying	15%			$	92,475.00
	Environemntal Permitting (Federal, State & Local)	5%			$	30,825.00
	Construction Contingency	35%			$	215,775.00
	TOTAL PROJECT COST				**$**	**955,575.00**

Table 5: Cost Estimate for Oak Acres Gaines Improvements

Engineers Opinion of Probable Cost						
Item	Description	Quantity	Unit	Unit Price		Amount
120S	Channel Excavation	14500	CY	$ 30.00	$	435,000.00
102S	Misc. Demolition	1	LS	$ 50,000.00	$	50,000.00
102S	Clearing & Grubbing	1	LS	$ 200,000.00	$	200,000.00
559S	50' - 6'x3' RCB (including misc. concrete works)	10	EA	$ 18,000.00	$	180,000.00
200S	Phased Road Reconstruction at Crossing	400	LF	$ 700.00	$	280,000.00
510W	Repair/relocate sanitary lines & manholes	500	LF	$ 200.00	$	100,000.00
510W	Repair water lines	100	LF	$ 110.00	$	11,000.00
800S	Temporary Traffic Control	1	LS	$ 10,000.00	$	10,000.00
600S	Misc. Erosion & Sedimentation Controls	1	LS	$ 150,000.00	$	150,000.00
608S	Planting & Revegetation (120,000 sf)	13400	SY	$ 7.00	$	93,800.00
	Subtotal				$	1,509,800.00
	Engineering and Surveying	15%			$	226,470.00
	Environemntal Permitting (Federal, State & Local)	20%			$	301,960.00
	Construction Contingency	35%			$	528,430.00
	Project Construction Cost				$	2,566,660.00
	Property Buyout Cost (including misc. soft costs)	1	Com	$ 1,000,000.00	$	1,000,000.00
	Easement Acquisition Cost	433,800	SF	$ 4.00	$	1,735,200.00
	Property Acquisition Cost				$	2,735,200.00
	TOTAL PROJECT COST				**$**	**5,301,860.00**

4.4 Option 2 Improvements

Option 2 (Figures B1 through B4) consists of alternative channel improvements and culvert upgrades that remain within the existing water courses and provide infrastructure necessary to convey the fully developed 1% (100 Year) storm event. The intent of these proposed improvements is to minimize impacts to existing structures while still ensuring that finished floors, to the extent possible, are above adjacent floodplain water surface elevations. The option further intends to limit environmental impacts to the maximum extent possible.

4.4.1 Oak Park North Improvements

These improvements are similar to Option 1. Structural improvements needed to reduce base flood elevations and contain the floodplain within the small unnamed tributary that crosses Parkwood Drive and Oakclaire Drive just north of Oakclaire Lane are shown on Figure B2 in Appendix B. These improvements include:

a) An interceptor channel along the western boundary of the Oak Park Subdivision north and south of the existing tributary to intercept all flows from the existing offsite drainage area.

b) Conveyance improvements within the Oak Park North Tributary that include a concrete “flume” channel and culvert upgrades at the Parkwood Drive and Oakclaire Drive road crossings with an improved velocity dissipation transition connection to the downstream Harper Park diversion channel. The flume is designed to convey the fully developed 100-year flow of 852 cfs at velocities of 10 to 24 fps.

This option does not warrant the removal of any homes and is depicted in Figure B2. The engineer’s opinion of probable cost is presented in Table 6. The proposed culvert and channel improvements may require relocation/adjustment of the existing water and sanitary sewer lines. Estimated costs for the relocation are included below.

The City of Austin also requested an upgrade of the local drainage system to convey localized flood flows in accordance with City of Austin Drainage Design Criteria. Therefore this option includes new storm drain collection systems within Parkwood Drive and Oakclaire Drive connecting to the proposed channel improvements. The proposed system will impact existing utilities and service lines located in the two streets as shown on Figure B1 in Appendix B.

The engineer’s opinion of probable cost is presented in Table 6.

Table 6: Cost Estimate for Oak Park North

Engineers Opinion of Probable Construction Cost					
Item	Description	Quantity	Unit	Unit Price	Amount
1205	Channel Excavation	8900	CY	$ 30.00	$ 267,000.00
102S	Misc. Demolition	1	LS	$ 50,000.00	$ 50,000.00
102S	Clearing & Grubbing	1	LS	$ 12,000.00	$ 12,000.00
403S	20'x4' Concrete Flume Cast in Place (620 LF)	643	CY	$ 450.00	$ 289,350.00
559S	20'x4' Precast Bridge Culvert(including conc. pad)	192	LF	$ 1,200.00	$ 230,400.00
500S	Concrete Inlet/Outlet Structure w/ Dissipators	2	LS	$ 20,000.00	$ 40,000.00
559S	24" RCP (including inlets & manholes)	1600	LF	$ 200.00	$ 320,000.00
200S	1/2 - Road Reconstruction over Storm Drain System	1600	LF	$ 200.00	$ 320,000.00
510W	Repair sanitary lines	220	LF	$ 110.00	$ 24,200.00
510W	Repair water lines	220	LF	$ 110.00	$ 24,200.00
800S	Temporary Traffic Control	1	LS	$ 15,000.00	$ 15,000.00
600S	Misc. Erosion & Sedimentation Controls	1	LS	$ 200,000.00	$ 200,000.00
608S	Planting & Revegetation (95,000 SF)	10600	SY	$ 7.00	$ 74,200.00
	Subtotal				$ 1,599,350.00
	Engineering and Survey	15%			$ 239,902.50
	Construction Contingency	35%			$ 559,772.50
	Project Construction Cost				$ 2,399,025.00
	Easement Acquisition Cost	7,500	SF	$ 4.00	$ 30,000.00
	TOTAL PROJECT COST				**$ 2,429,025.00**

4.4.2 Oak Park South Improvements

4.4.2.1 Localized Storm Drain Improvements

The structural improvements needed for Oak Park south are storm drain improvements that will intercept and convey both offsite drainage areas and drainage areas within the subdivision to Gaines Tributary. These improvements are summarized on Figure A3 in Appendix A. These improvements include:

a) An interceptor channel along the western boundary that will drain to the south.
b) An inlet collector for the interceptor channel near the School Road and Parkwood Drive intersection.
c) The addition of a storm drain collection system to convey off-site flows collected through to the existing 42" RCP connecting to the subdivision detention pond adjacent to Gaines Tributary. The proposed system will impact existing utilities and service lines located in the two streets as shown on Figure B1 in Appendix B.

The City of Austin also requested an upgrade of the local drainage system to convey localized flood flows in accordance with City of Austin Drainage Design Criteria. Therefore this alternative includes a new storm drain collection system within Oakclaire Drive connecting to the proposed channel improvements. The proposed system will impact existing utilities and service lines located in the two streets. It is also shown on Figure B1.

This option is depicted in Figure B2 in Appendix B and the engineer's opinion of probable cost is presented in Table 7.

Table 7: Cost Estimate for Oak Park South Localized Improvements

Engineers Opinion of Probable Cost							
Item	Description	Quantity	Unit	Unit Price		Amount	
120S	Channel Excavation	3100	CY	$	30.00	$	93,000.00
102S	Misc. Demolition	1	LS	$	30,000.00	$	30,000.00
102S	Clearing & Grubbing	1	LS	$	6,000.00	$	6,000.00
559S	36" RCP (including inlets & manholes)	300	LF	$	250.00	$	75,000.00
559S	24" RCP (including inlets & manholes)	650	LF	$	200.00	$	130,000.00
200S	1/2 - Road Reconstruction over Storm Drain System	950	LF	$	200.00	$	190,000.00
510W	Repair sanitary lines	50	LF	$	110.00	$	5,500.00
510W	Repair water lines	250	LF	$	110.00	$	27,500.00
800S	Temporary Traffic Control	1	LS	$	15,000.00	$	15,000.00
600S	Misc. Erosion & Sedimentation Controls	1	LS	$	50,000.00	$	50,000.00
608S	Planting & Revegetation (27,500 SF)	3100	SY	$	7.00	$	21,700.00
	Subtotal					$	550,700.00
	Engineering and Surveying	15%				$	82,605.00
	Environemntal Permitting (Federal, State & Local)	5%				$	27,535.00
	Construction Contingency	35%				$	192,745.00
	Total Project Cost					**$**	**853,585.00**

4.4.2.2 Gaines Improvements (Williamson Creek Overflow)

These improvements are similar to Option 1. The Williamson Creek overflow 2D analysis shows the need for structural improvements within Gaines Tributary to account for the additional flows that enter into Gaines Tributary. There are channel improvements that will be needed in the headwaters where the overflow enters into Gaines along with increased culvert capacity at each of the road crossings. Figure B3 in Appendix B provides a graphical representation of the channel widening improvements and culvert upgrades needed for this scenario. These improvements include:

a) Add a Williamson Creek overflow channel that will intercept flows and convey to Gaines Tributary. The intercept channel will placed to receive flow from along U.S. 290.
b) Concrete “flume” channel improvements from the overflow intercept channel upstream of Parkwood Drive to Harpers Park that include culvert upgrades at the Parkwood Drive and Oakclaire Drive road crossings. The flume is designed to convey the fully developed 100-year flow with Williamson Creek Overflow (859 cfs) at velocities of 15 to 18 fps.
c) An energy/velocity dissipation structure will be required to transition from the flume to the natural channel downstream in Harper Park.

Proposed channel improvements have been angled and extended along the current waterway to avoid any buyouts. Although buyouts can be avoided with this option the concrete flume will need to be placed within the existing channel section. In addition, the proposed improvements may require relocation/adjustment of the existing water and sanitary sewer lines as shown on Figure B1 in Appendix B. Estimated costs for the relocation are included below.

Engineer’s opinion of probable cost is presented in Table 8.

Table 8: Cost Estimate for Oak Park South Gaines Improvements

Engineers Opinion of Probable Cost					
Item	Description	Quantity	Unit	Unit Price	Amount
120S	Channel Excavation	10000	CY	$ 30.00	$ 300,000.00
102S	Misc. Demolition	1	LS	$ 20,000.00	$ 20,000.00
102S	Clearing & Grubbing	1	LS	$ 10,000.00	$ 10,000.00
403S	20'x4' Concrete Flume Cast in Place (750 LF)	780	CY	$ 450.00	$ 351,000.00
500S	Concrete Inlet/Outlet Structure w/ Dissipators	2	LS	$ 20,000.00	$ 40,000.00
559S	20'x4' Precast Bridge Culvert(including conc. pad)	192	LF	$ 1,200.00	$ 230,400.00
200S	Phased Road Reconstruction at Crossings	200	LF	$ 700.00	$ 140,000.00
510W	Repair sanitary lines	50	LF	$ 110.00	$ 5,500.00
510W	Repair water lines	100	LF	$ 110.00	$ 11,000.00
600S	Misc. Erosion & Sedimentation Controls	1	LS	$ 75,000.00	$ 75,000.00
608S	Planting & Revegetation (55,000 SF)	6100	SY	$ 7.00	$ 42,700.00
	Subtotal				$ 1,225,600.00
	Engineering and Surveying	15%			$ 183,840.00
	Environemntal Permitting (Federal, State & Local)	10%			$ 122,560.00
	Construction Contingency	35%			$ 428,960.00
	Project Construction Cost				$ 1,960,960.00
	Easement Acquisition Cost	67,000	SF	$ 4.00	$ 268,000.00
	Property Acquisition Cost				$ 268,000.00
	TOTAL PROJECT COST				**$ 2,228,960.00**

4.4.3 Oak Acres Improvements

The localized improvements are unchanged between the two options (Table 9). The City of Austin requested localized rehabilitation/improvements to the local storm drainage system of the Oak Acres subdivision. The improvements are to convey localized flood flows in accordance with City of Austin Drainage Design Criteria. The proposed improvements may impact existing utilities and service lines as shown on Figure B1 in Appendix B. The local improvements will also impact existing driveways and driveway culverts. Demolition and replacement costs are included in the estimates below. These improvements are summarized on Figure B4 in Appendix B and the engineer's opinion of probable cost is presented in Table 9.

The Gaines Tributary improvements differ from Option 1. In this option, channel cleaning and widening is limited to the area immediately upstream and downstream of the proposed culvert upgrade at Oak Blvd, consisting of rectangular, open bottom, bridge culverts. Oak Boulevard will be raised to an elevation above the 1% chance storm water surface elevation to provide all-weather access to the neighborhood. These improvements will lower 1% chance WSE to below adjacent structure finished floor elevations. The proposed culverts and roadway reconstruction will require relocation of the existing water and sanitary sewer lines. Estimated utility relocation costs are included below. These improvements are summarized on Figure B4 in Appendix B and the engineer's opinion of probable cost is presented in Table 10.

Proposed improvements include:

a) Roadside ditch improvements along North and South Oak Blvd.
b) Storm drain improvements to convey the roadside ditch flows to Gaines Tributary near the Oak Blvd. road crossing.
c) Riverine channel cleaning and widening on Gaines Tributary limited to just upstream of Oak Blvd. to just downstream of the roadway.
d) Bridge Culvert upgrades at the Oak Blvd. road crossing.
e) Reconstruct Oak Blvd. across waterway to intersection with North/South Oak Blvd.
f) Utility adjustment and relocation as needed.

Table 9: Cost Estimate for Oak Acres Localized Improvements

Engineers Opinion of Probable Cost					
Item	Description	Quantity	Unit	Unit Price	Amount
120S	Roadside Drainage and Collection Swales	8000	CY	$ 30.00	$ 240,000.00
102S	Misc. Demolition	1	LS	$ 15,000.00	$ 15,000.00
102S	Clearing & Grubbing	1	LS	$ 10,000.00	$ 10,000.00
559S	Repair/replace driveway 18" RCP culverts	220	LF	$ 200.00	$ 44,000.00
433S	Repair/replace 6"concrete driveways (200 SF avg)	3600	SF	$ 10.00	$ 36,000.00
559S	Misc. Pipe Culvert Crossings	3	EA	$ 10,000.00	$ 30,000.00
200S	Misc. Road Reconstruction and Repairs	1	LS	$100,000.00	$ 100,000.00
510W	Repair sanitary lines	50	LF	$ 110.00	$ 5,500.00
510W	Repair water lines	250	LF	$ 110.00	$ 27,500.00
800S	Temporary Traffic Control	1	LS	$ 5,000.00	$ 5,000.00
600S	Misc. Erosion & Sedimentation Controls	1	LS	$ 30,000.00	$ 30,000.00
608S	Planting & Revegetation (44,000 SF)	4900	SY	$ 15.00	$ 73,500.00
	Subtotal				$ 616,500.00
	Engineering and Surveying	15%			$ 92,475.00
	Environemntal Permitting (Federal, State & Local)	5%			$ 30,825.00
	Construction Contingency	35%			$ 215,775.00
	TOTAL PROJECT COST				**$ 955,575.00**

Table 10: Cost Estimate for Oak Acres Gaines Improvements

Engineers Opinion of Probable Cost					
Item	Description	Quantity	Unit	Unit Price	Amount
120S	Channel Excavation	400	CY	$ 30.00	$ 12,000.00
102S	Misc. Demolition	1	LS	$ 75,000.00	$ 75,000.00
102S	Clearing & Grubbing	1	LS	$ 10,000.00	$ 10,000.00
559S	24'x6' Precast Bridge Culvert(including foot pads)	112	LF	$ 2,000.00	$ 224,000.00
403S	Cast-In-Place Reinforced Concrete Footings	19	CY	$ 600.00	$ 11,400.00
414S	Reinforced Concrete Headwalls& Wingwalls	21.5	CY	$ 1,000.00	$ 21,500.00
200S	Phased Road Reconstruction at Crossing	800	LF	$ 600.00	$ 480,000.00
510W	Repair/relocate sanitary lines & manholes	250	LF	$ 200.00	$ 50,000.00
510W	Repair water lines	100	LF	$ 110.00	$ 11,000.00
800S	Temporary Traffic Control	1	LS	$ 10,000.00	$ 10,000.00
600S	Misc. Erosion & Sedimentation Controls	1	LS	$ 50,000.00	$ 50,000.00
608S	Planting & Revegetation (10,000 SF)	1100	SY	$ 7.00	$ 7,700.00
	Subtotal				$ 962,600.00
	Engineering and Surveying	15%			$ 144,390.00
	Environemntal Permitting (Federal, State & Local)	15%			$ 144,390.00
	Construction Contingency	35%			$ 336,910.00
	Project Construction Cost				$ 1,588,290.00
	Easement Acquisition Cost	-	SF	$ 4.00	$ -
	TOTAL PROJECT COST				**$ 1,588,290.00**

4.5 Summary of Improvements

The improvements that have been defined include both riverine improvements to Gaines Tributary and localized improvements for the storm drain collection systems that convey stormwater to Gaines Tributary. Option 1 includes traditional improvements to the existing channels and culvert upgrades at road crossings. These improvements were first defined with estimated costs in the April 25, 2014 Gaines Tributary H&H Analysis report and will require some residential and commercial structure buyouts to accommodate easement relocation and widening. Option 2 consists of alternative channel and culvert improvements that would maximize flow conveyance within existing easements and avoid environmental regulation/permit issues and structure buyouts required for Option 1.

Table 11 provides a summary comparing the project totals for each option.

Table 11: Cost Estimate for Oak Acres Gaines Improvements

Gaines Area	OPTION 1	OPTION 2
Oak Park North	$ 4,616,700.00	$ 2,429,025.00
Oak Park South - Localized	$ 1,792,640.00	$ 853,585.00
Oak Park South - Gaines Improvements	$ 2,879,200.00	$ 2,228,960.00
Oak Acres - Localized	$ 955,575.00	$ 955,575.00
Oak Acres - Gaines Improvements	$ 5,301,860.00	$ 1,588,290.00
TOTAL	**$ 15,545,975.00**	**$ 8,055,435.00**

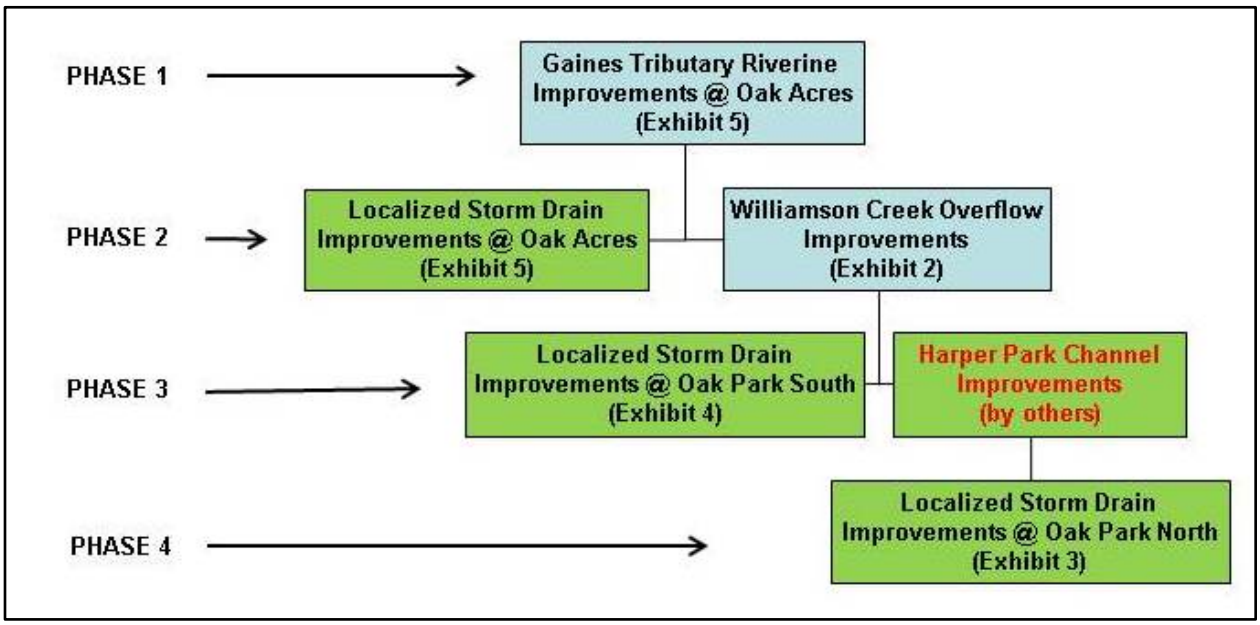
All of the flooding that occurs within the Gaines watershed is from a lack of managed/organized conveyance consistent with current City of Austin design standards and regulations. Floodplain storage or peak flow attenuation within the Gaines Tributary watershed is negligible, especially when Williamson Creek overflows its bank and propagates a second peak downstream in Gaines Tributary. The infrastructure proposed in either option are floodplain reconfiguration improvements meant to manage the floodplain inundation limits and reduce roadway overtopping. The improvements will not result in downstream adverse impacts.

The engineer recommends Option 2 for the final design and construction of Gaines Tributary improvements. Option 2 does not require the buyout of existing homes or businesses, requires limited easement acquisition, and has significantly lower environmental impacts to the Barton Creek Watershed.

4.6 Sequence of Improvements

For these improvements to function as intended and not cause any downstream impacts they must be implemented starting from downstream and working upstream. This sequence is predicated on the channel and culvert improvements on Gaines Tributary being performed prior to completing any of the localized storm drain improvements. The figure below is intended to serve as a graphical aid on the acceptable order for the improvements to occur. The localized improvements are shaded in green and the Gaines improvements are shaded in blue.

Figure 6: Sequence of Improvements



Appendix A – Option 1

Figure A1 – Overall Project Vicinity Map

A2

A3

A4

N

0 150' 300'
SCALE IN FEET

LEGEND

BUYOUTS

OAK PARK NORTH IMPROVEMENTS

OAK PARK SOUTH IMPROVEMENTS

OAK ACRES IMPROVEMENTS

SCHOOL RD.

PATTON RANCH RD.

PARKWOOD DR.

OAKCLAIRE DR.

OAKCLAIRE LN.

HARPER PARK DR.

OAK BLVD. N.

OAK BLVD. W.

OAK BLVD. S.

OAK BLVD.

8" WW

6" WL

12" WW

12" WL

16" WW

71

290

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OPTION 1
FIGURE A1 - OVERALL MAP

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Figure A2 – Oak Park North Improvements

N

0 100' 200'
SCALE IN FEET

OAK PARK NORTH
TRIBUTARY

PROP.
10' CURB INLET
(TYP.)

PROP.
10' CURB INLET
(TYP.)

PARKWOOD DR.

24" RCP

OAKCLAIRE DR

24" RCP

OAKCLAIRE LN

OAK PARK NORTH
TRIBUTARY INTERCEPT
FLOWLINE EL.=712.5

EXIST.
HARPER PARK
CHANNEL

HARPER PARK CHANNEL
TRIBUTARY INTERCEPT
FLOWLINE EL.=793.0

5'
MIN.

1
4

10'

PROPOSED
DRAINAGE SWALE
N.T.S

PROP.
HEADWALL
W/WINGWALLS

PROP.
DROP
STRUCTURE

PROP.
DROP
STRUCTURE

PARKWOOD DR.

FL OUT=806.0

PROP.
ROCK RIP-RAP

FL IN=806.5

PROP. 3-6'X4'
REINFORCED
CONCRETE
BOX CULVERTS

PROP.
ROCK RIP-RAP

0 50' 100'
SCALE IN FEET

PROP.
DROP
STRUCTURE

PROP.
ROCK RIP-RAP

PROP.
HEADWALL
W/WINGWALLS

FL IN=797.2

OAKCLAIRE DR

PROP. 3-6'X4'
REINFORCED CONCRETE
BOX CULVERTS

FL OUT=796.8

PROP.
ROCK RIP-RAP

0 50' 100'
SCALE IN FEET

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OPTION 1
FIGURE A2 - OAK PARK NORTH
IMPROVEMENTS

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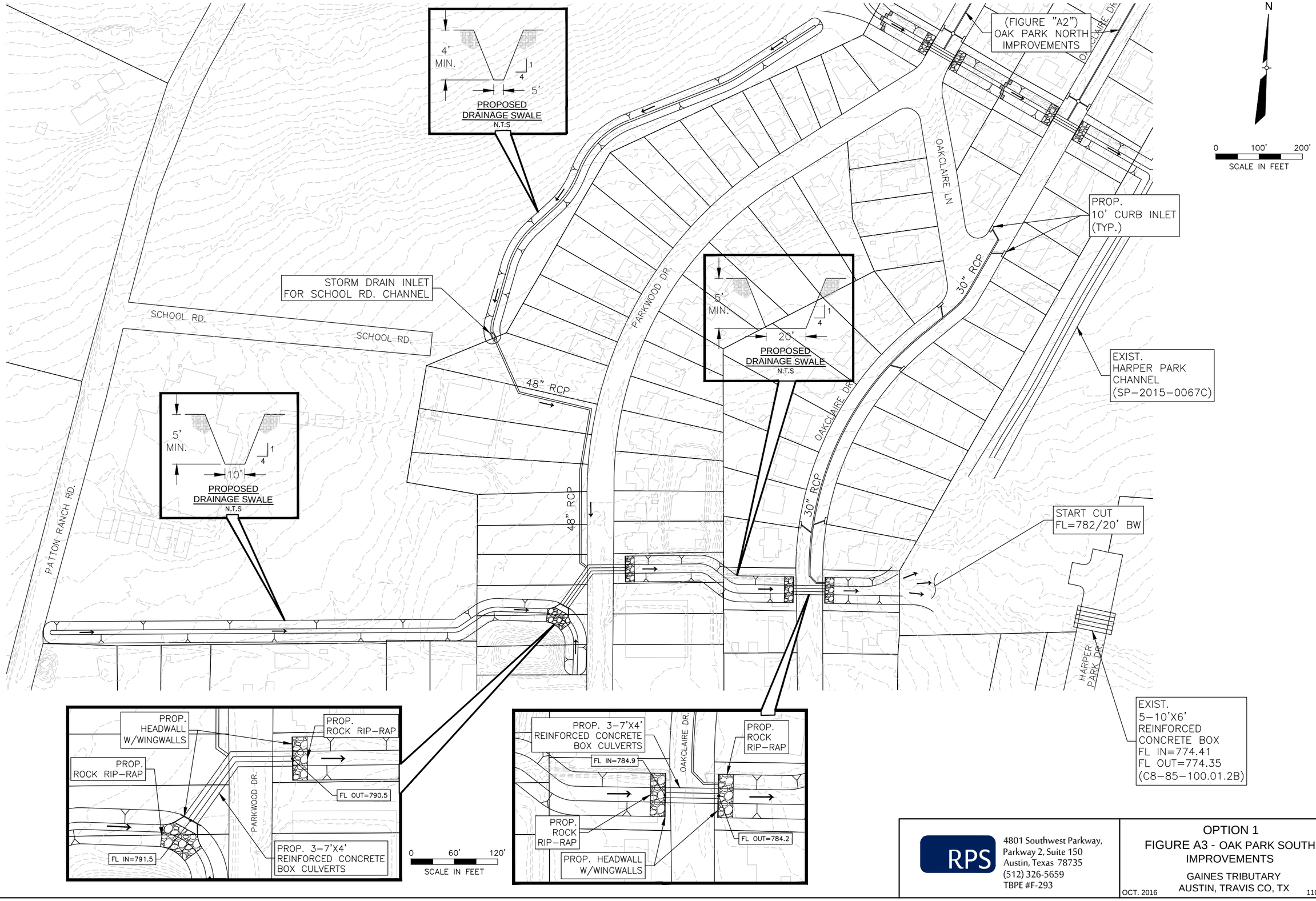
Figure A3 – Oak Park South Improvements



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OPTION 1

FIGURE A3 - OAK PARK SOUTH IMPROVEMENTS

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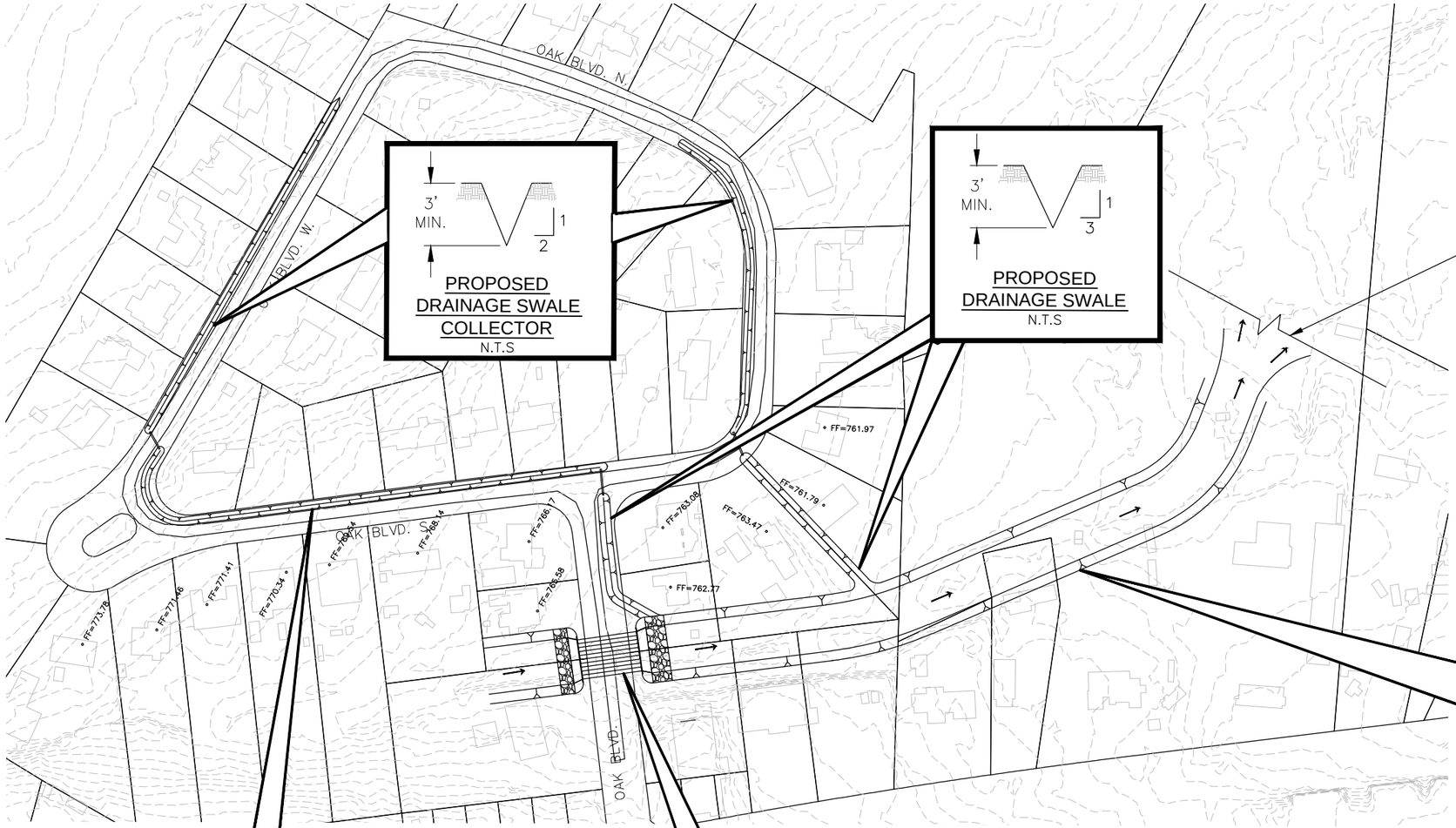
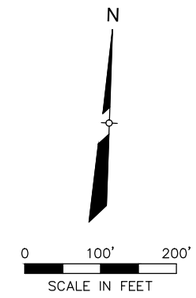
Figure A4 – Oak Acres Improvements

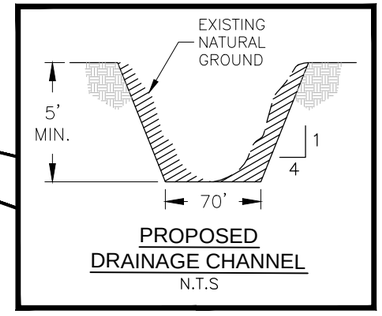


PROPOSED
DRAINAGE SWALE
COLLECTOR
N.T.S

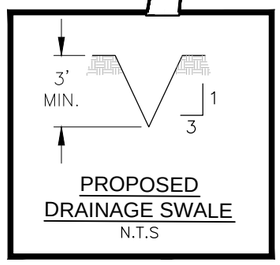
PROPOSED
DRAINAGE SWALE
N.T.S

TRANSITION PROPOSED DRAINAGE CHANNEL TO NATURAL CHANNEL.





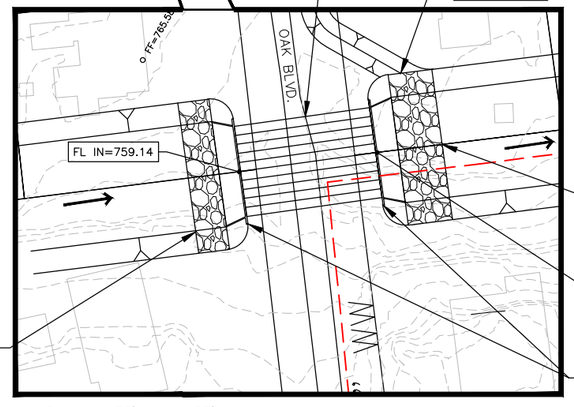
PROPOSED
DRAINAGE CHANNEL
N.T.S



PROPOSED
DRAINAGE SWALE
N.T.S

PROP. 10–6'X3'
REINFORCED CONCRETE
BOX CULVERTS

PROP.
DRAINAGE
SWALE



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OPTION 1
FIGURE A4 - OAK ACRES
IMPROVEMENTS
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Appendix B – Option 2

Figure B1 – Overall Project Vicinity Map
Figure B2 – Oak Park North Improvements
Figure B3 – Oak Park South Improvements
Figure B4 – Oak Acres Improvements

Figure B1 – Overall Project Vicinity Map

B2

B3

B4

N

0 150' 300'

SCALE IN FEET

OAK PARK NORTH IMPROVEMENTS

OAK PARK SOUTH IMPROVEMENTS

OAK ACRES IMPROVEMENTS

PARKWOOD DR.

OAKCLAIRE DR.

OAKCLAIRE LN.

SCHOOL RD.

SCHOOL RD.

DYKES ARRE DR.

TARPLEY PARK DR.

OAK BLVD. N.

OAK BLVD. W.

OAK BLVD.

8" WW

8" WL

12" WW

12" WL

16" WW

6" WL

FF=761.97

FF=762.77

71

290

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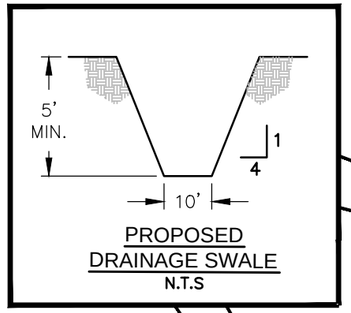
OPTION 2
FIGURE B1 - OVERALL MAP

GAINES TRIBUTARY
AUSTIN, TRAVIS CO, TX

OCT. 2016

11005.21

Figure B2 – Oak Park North Improvements



PROPOSED
DRAINAGE SWALE
N.T.S

OAK PARK NORTH
TRIBUTARY

PROP.
10' CURB INLET
(TYP.)

PROP.
10' CURB INLET
(TYP.)

OAK PARK NORTH
TRIBUTARY INTERCEPT
FLOWLINE EL.=815.0

PARKWOOD DR.

24" RCP

OAKCLAIRE DR

24" RCP

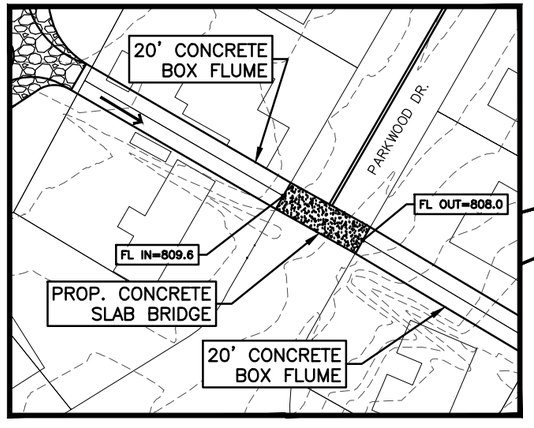
OAKCLAIRE LN

EXIST.
HARPER PARK
CHANNEL

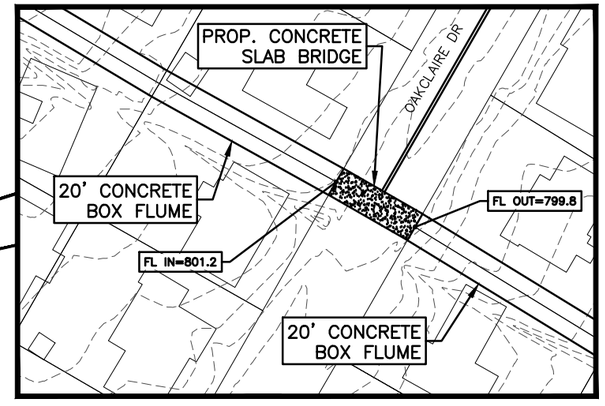
HARPER PARK CHANNEL
TRIBUTARY INTERCEPT
FLOWLINE EL.=794.0

N

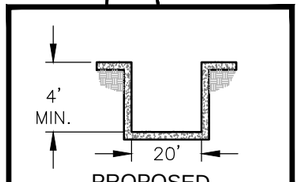
0 100' 200'
SCALE IN FEET



0 50' 100'
SCALE IN FEET



0 50' 100'
SCALE IN FEET



PROPOSED
CONCRETE BOX FLUME
N.T.S

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OPTION 2
FIGURE B2 - OAK ACRES
IMPROVEMENTS
GAINES TRIBUTARY
AUSTIN, TRAVIS CO, TX

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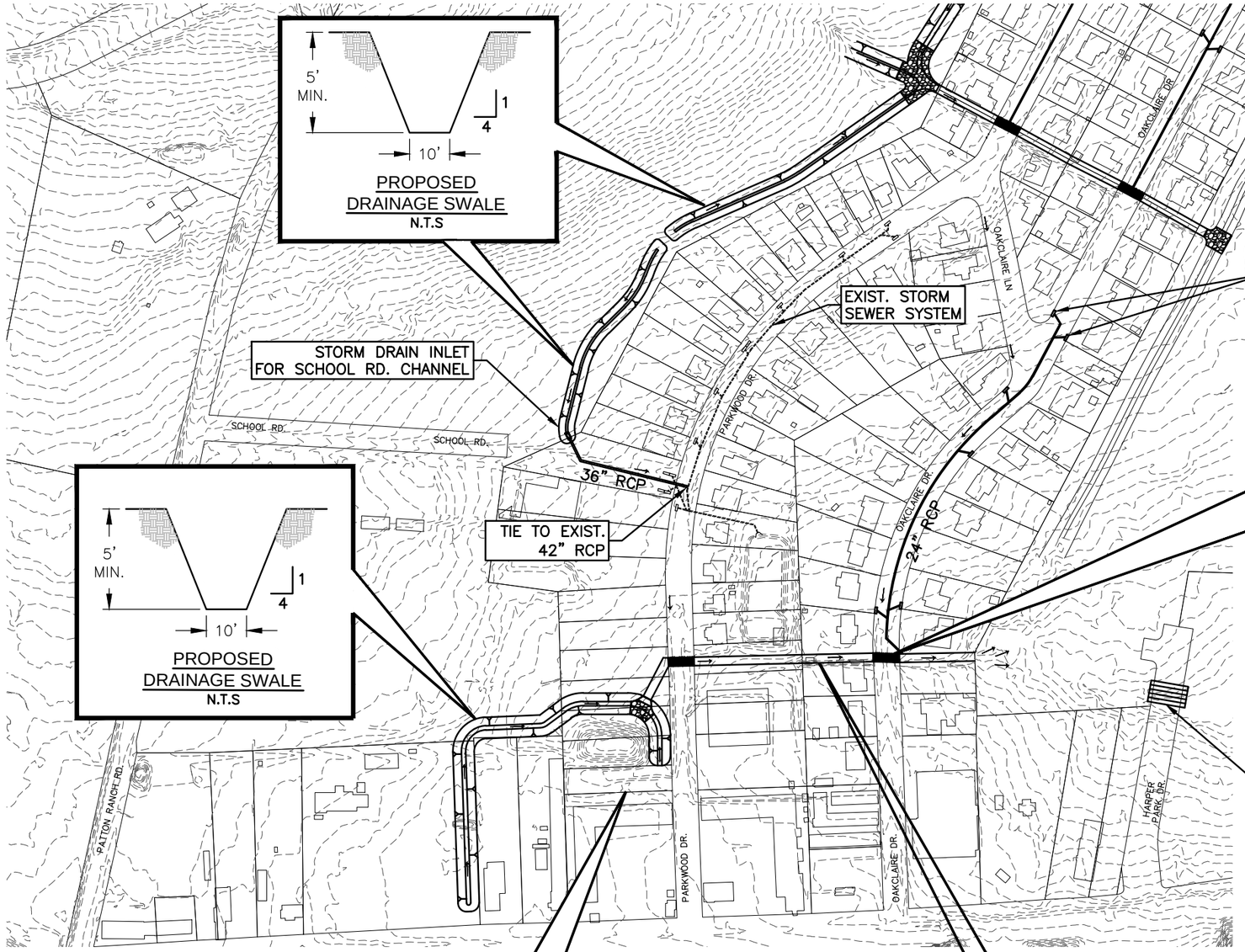
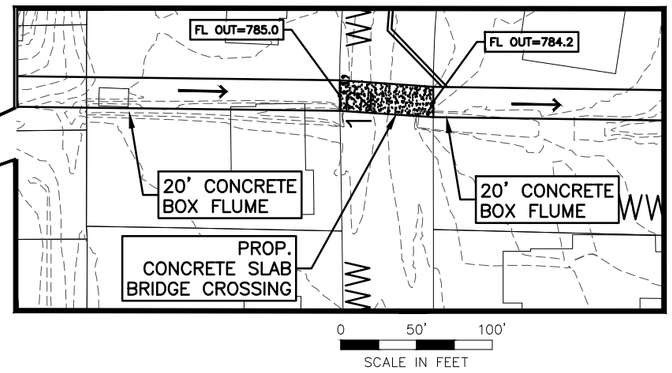
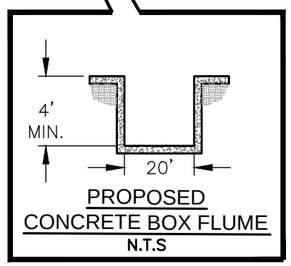
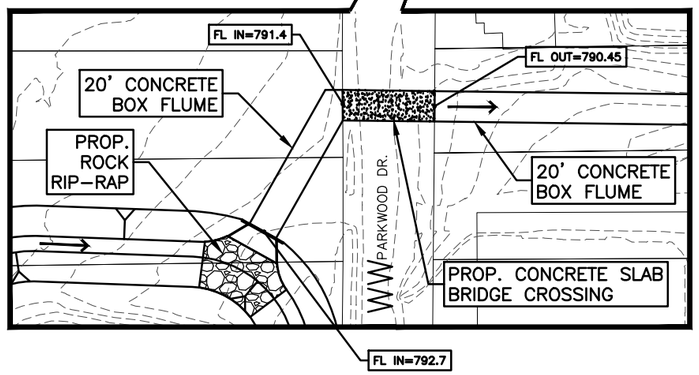
Figure B3 – Oak Park South Improvements

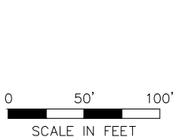




EXIST.
5–10'X6'
REINFORCED
CONCRETE BOX
FL IN=774.41
FL OUT=774.35
(C8–85–100.01.2B)







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OPTION 2
FIGURE B3 - OAK PARK
IMPROVEMENTS
GAINES TRIBUTARY
AUSTIN, TRAVIS CO, TX

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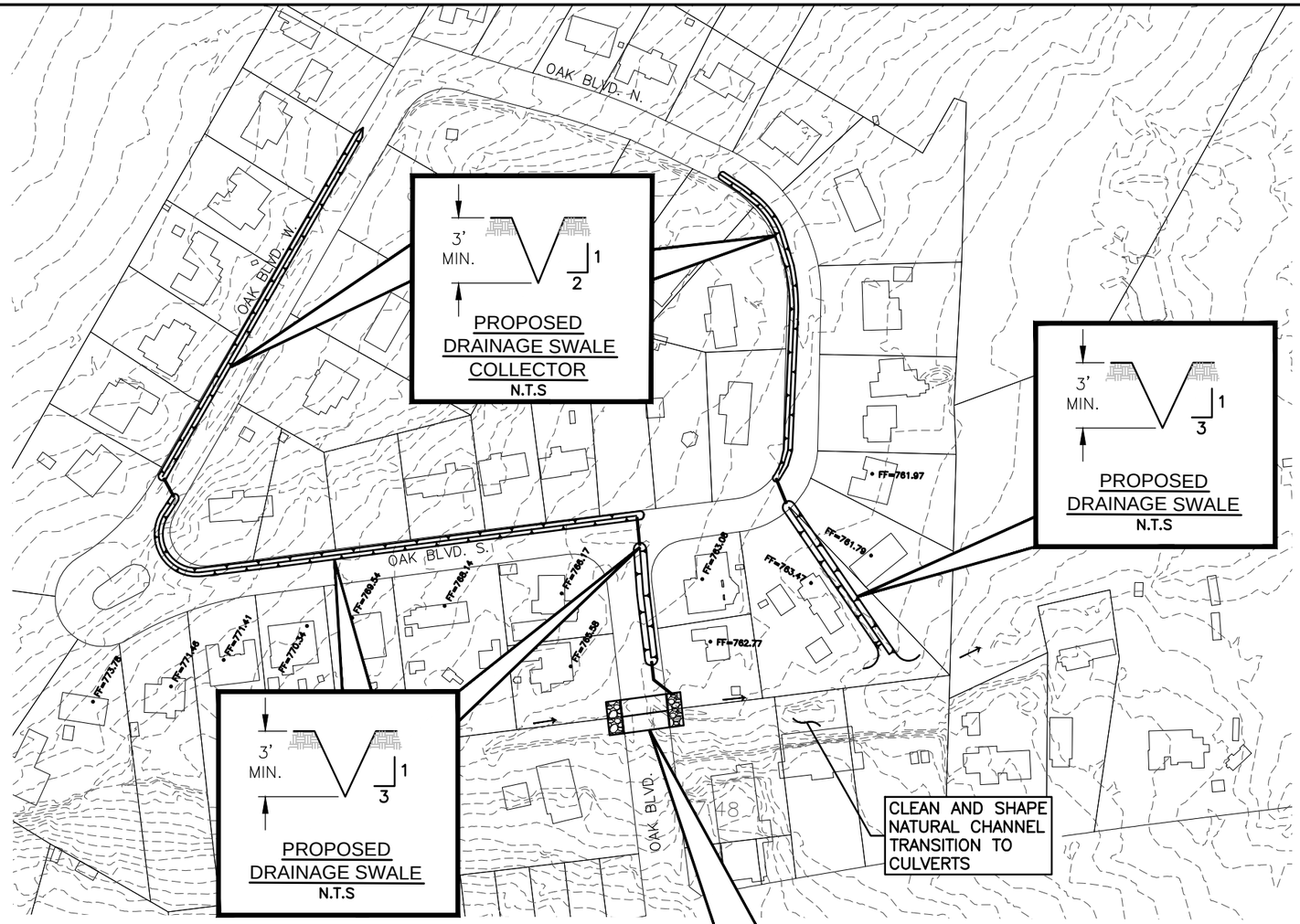
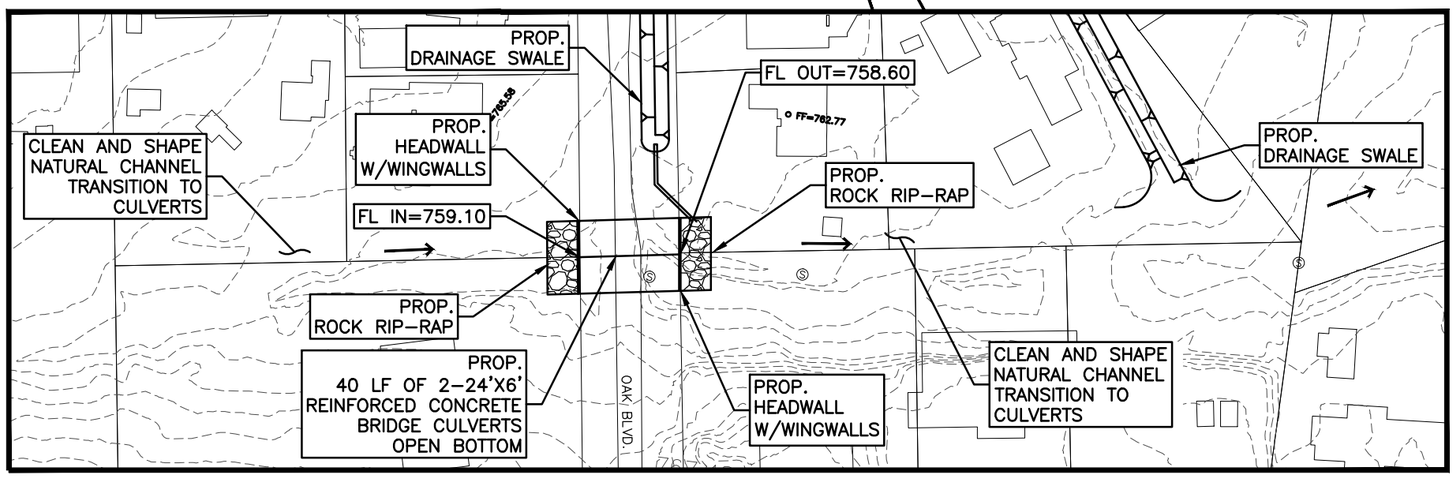
Figure B4 – Oak Acres Improvements





N

0 100' 200'
SCALE IN FEET

0 50' 100'
SCALE IN FEET

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OPTION 2
FIGURE B4 - OAK ACRES IMPROVEMENTS
GAINES TRIBUTARY
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OCT. 2016

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Appendix C – Hydrologic/Hydraulic Summary Tables

Updated Hydrologic Flow Summary

GAINES TRIBUTARY EXISTING CONDITIONS HYDROLOGIC FLOW SUMMARY

	Computed Peak Flow Rate (cfs)						
HEC-HMS Node	50%	20%	10%	4%	2%	1%	1%(WO2D)
GAN02	66.7	125.1	170	234.2	286.2	342.8	342.8
GAN01	40.2	78.3	107.7	149.7	183.9	221	221
R_GAN02	39.8	77.8	106.8	149.1	183.2	220.5	220.5
J_GAN02	105.4	202	276.3	382	467.5	560.6	560.6
R_GAN03	104.9	201	274.4	380.7	466.9	560.5	560.5
GAN03	22.6	35.5	44.9	57.9	68.4	79.7	79.7
J_GAN03	126.2	234.4	318.3	437.5	533.9	638.5	638.5
R_GAN06_U	125.4	233.7	316.8	433.9	530.9	635.1	635.1
GAN04	89	148.7	193.1	255.3	305.3	359.3	359.3
GAN05	75.5	118.9	150.5	194.7	230	268.1	268.1
Williamson Overflow							831.7
J_GAN05	75.5	118.9	150.5	194.7	230	268.1	858.1
J_GAN06_U	229.9	413.9	554.8	754.9	915.6	1091.1	1091.1
R_GAN06_L	208.4	377.7	507.2	698.2	851.5	1017.3	1017.3
GAN06	69.4	115	148.5	195.4	233	273.6	273.6
J_GAN06_L	270.4	483.6	644.8	883.9	1075.2	1279.6	1279.6
R_GAN08	228.9	433.4	588.5	820.1	995.1	1185.6	1185.6
GAN09	74.9	122.6	157.7	206.8	246.3	289	289
GAN08	32.8	51.3	64.8	83.6	98.7	115	115
J_GAN09	302.7	568.1	769.6	1067.9	1292.3	1535.3	1535.3
R_GAN10	225.7	478.1	669.6	938.9	1164.9	1397.6	1397.6
GAN07	242.2	373.1	468.3	601.2	707.5	822.5	822.5
J_GAN07	242.2	373.1	468.3	601.2	707.5	822.5	822.5
R_GAN08_TXDOT	238.5	365.2	457.1	584.5	685.9	795.6	795.6
GAN10	92.3	154.2	199.8	263.8	315	370.3	370.3
J_GAN10	397.5	669.7	947.5	1341.9	1660.7	2005.2	2005.2
R_GAN13	374.6	661.3	931	1314.8	1584	1895.4	1895.4
GAN13	68.5	110.6	141.5	184.6	219.1	256.6	256.6
J_GAN13	442.6	733.3	1026.8	1447.5	1730.3	2067.4	2067.4
R_GAN12	435.6	731.3	1022.2	1438.9	1723.1	2057.2	2057.2
GAN11	243.6	371.1	463.5	592.1	694.9	806.1	806.1

GAINES TRIBUTARY EXISTING CONDITIONS HYDROLOGIC FLOW SUMMARY

	Computed Peak Flow Rate (cfs)						
HEC-HMS Node	50%	20%	10%	4%	2%	1%	1%(WO2D)
J_GAN11	243.6	371.1	463.5	592.1	694.9	806.1	806.1
R_GAN12_TXDOT	239.9	363.6	452.6	575.8	673.7	779	779
GAN12	143.7	225.4	284.9	368	434.5	506.3	506.3
GAN14	101.1	166.4	214.4	281.6	335.4	393.6	393.6
J_GAN14	822.2	1324.3	1696.6	2254.3	2713.8	3156.5	3156.5
R_GAN15	819.5	1320.4	1692.1	2250.8	2709.2	3153.6	3153.6
GAN15	55.6	89.4	114.1	148.7	176.4	206.4	206.4
J_GAN15	873.9	1405.8	1803.3	2397.9	2883	3357.1	3357.1
R_GAN16	869	1401.3	1798.4	2392.8	2875.1	3350.2	3350.2
GAN16	78.3	135.4	177.6	236.8	284.2	335.6	335.6
J_GAN16	945.2	1532	1969.2	2618.9	3147.3	3671	3671
R_GAN18	940.7	1525.2	1962.6	2611.5	3137.3	3664.4	3664.4
GAN18	112.6	176.2	222.6	287.3	339.1	395	395
J_GAN18	999.5	1623.8	2087.9	2767.9	3326.3	3886	3886
R_GAN19	995	1617.6	2082.5	2761	3318	3877	3877
GAN19	98.6	164.3	212.7	280.5	334.7	393.3	393.3
GAN17	101.5	149.4	183.9	231.8	270.1	311.5	311.5
J_GAN17	101.5	149.4	183.9	231.8	270.1	311.5	311.5
R_GAN19_TXDOT	101.1	148.5	182.6	229.7	267.3	308.2	308.2
J_GAN19	1076.1	1758.6	2264.5	2996.1	3604.1	4223.7	4223.7
R_GAN21	1069.1	1750.1	2253.6	2985.5	3590.7	4207.6	4207.6
GAN21	89	149.4	194	256.7	306.8	361.1	361.1
GAN20	96.1	142.2	175.3	221.3	258.1	297.9	297.9
J_GAN20	96.1	142.2	175.3	221.3	258.1	297.9	297.9
R_GAN21_TXDOT	94.4	139.6	172	216.9	252.7	291.4	291.4
J_GAN21	1171.3	1924.4	2485.2	3290.2	3952.8	4645.2	4645.2

FULLY DEVELOPED CONDITIONS HYDROLOGIC FLOW SUMMARY

	Computed Peak Flow Rate (cfs)						
HEC-HMS Node	50%	20%	10%	4%	2%	1%	1%(WO2D)
GAN02	135.7	209.7	264	340	401	467.1	467.1
GAN01	95.3	146	183.2	235.2	277	322.3	322.3
R_GAN02	93.7	143.4	180.7	232.4	273.5	318.6	318.6
J_GAN02	228.3	353.1	444.7	572.4	674.4	785.7	785.7
R_GAN03	226.9	349.3	438.6	565.3	667.6	779	779
GAN03	23.6	36.4	45.8	58.8	69.2	80.5	80.5
J_GAN03	249.4	384.1	482.5	619.2	729.9	851.6	851.6
R_GAN06_U	246.1	380.5	479.1	615.5	722.1	843.1	843.1
GAN04	122.2	188.6	236.9	304.3	358.2	416.5	416.5
GAN05	79.4	122.8	154.3	198.3	233.4	271.4	271.4
Williamson Overflow							831.7
J_GAN05	79.4	122.8	154.3	198.3	233.4	271.4	858.2
J_GAN06_U	404.5	637.7	807.9	1045.8	1234.4	1446.3	1446.3
R_GAN06_L	346	548.4	704	918.8	1093.3	1289	1289
GAN06	89	136.8	171.5	219.9	258.6	300.4	300.4
J_GAN06_L	431	682.8	872.3	1138.7	1351.9	1589.4	1589.4
R_GAN08	364.8	599.3	781.9	1019.3	1206.5	1419.3	1419.3
GAN09	93.9	145.8	183.5	236.1	278.2	323.8	323.8
GAN08	35.8	54.4	67.8	86.5	101.4	117.6	117.6
J_GAN09	465.1	766.7	1001.1	1307.2	1547.9	1818.4	1818.4
R_GAN10	366.9	645.9	850.8	1146.4	1375.1	1616.8	1616.8
GAN07	257.7	388.8	483.7	615.8	721.5	835.8	835.8
J_GAN07	257.7	388.8	483.7	615.8	721.5	835.8	835.8
R_GAN08_TXDOT	253.5	380.2	471.6	598.3	699.5	808.7	808.7
GAN10	131.7	201.4	252	322.5	378.9	439.8	439.8
J_GAN10	512.5	902.8	1205.7	1626.7	1965.9	2325.4	2325.4
R_GAN13	490.1	885.7	1180	1547.3	1846.9	2198.1	2198.1
GAN13	92.5	143.3	180.2	231.7	272.9	317.4	317.4
J_GAN13	560.7	948.6	1265.8	1651.3	1970.3	2343.6	2343.6
R_GAN12	551.5	944.4	1257.9	1644.2	1960.1	2329.2	2329.2
GAN11	265.9	393.3	485	612.5	714.4	824.6	824.6

FULLY DEVELOPED CONDITIONS HYDROLOGIC FLOW SUMMARY

	Computed Peak Flow Rate (cfs)						
HEC-HMS Node	50%	20%	10%	4%	2%	1%	1%(WO2D)
J_GAN11	265.9	393.3	485	612.5	714.4	824.6	824.6
R_GAN12_TXDOT	261.3	384.8	473.1	595	691.9	796.1	796.1
GAN12	150.4	232.1	291.4	374.2	440.4	511.9	511.9
GAN14	103.6	169.3	217.6	285.4	339.7	398.4	398.4
J_GAN14	977.2	1522.5	1947.4	2562.8	2992.8	3464.7	3464.7
R_GAN15	975.8	1519.9	1945.5	2554.8	2988.1	3461.7	3461.7
GAN15	57.7	92.1	117.3	152.6	180.8	211.3	211.3
J_GAN15	1031.4	1609	2061.8	2705.2	3163.7	3671.5	3671.5
R_GAN16	1025.6	1602.9	2056.4	2696.8	3156.1	3665.3	3665.3
GAN16	84.2	141.2	183.3	242.2	289.5	340.7	340.7
J_GAN16	1107.1	1741	2232.4	2931	3441	3992.5	3992.5
R_GAN18	1102.2	1735.1	2225.7	2924.7	3431.6	3986.8	3986.8
GAN18	117.1	180.8	227	291.5	343.1	398.8	398.8
J_GAN18	1168	1836.7	2352.8	3087.2	3632.2	4216.3	4216.3
R_GAN19	1162.4	1831.7	2346.2	3079.7	3623	4207.1	4207.1
GAN19	106.6	172.3	220.5	287.8	341.7	399.9	399.9
GAN17	104.9	152.9	187.3	235	273.1	314.3	314.3
J_GAN17	104.9	152.9	187.3	235	273.1	314.3	314.3
R_GAN19_TXDOT	104.4	151.9	185.8	232.8	270.2	311	311
J_GAN19	1254.6	1979	2532.5	3329.4	3925.9	4565.6	4565.6
R_GAN21	1245.7	1970.4	2521.4	3315.7	3910.2	4553.1	4553.1
GAN21	90.9	151.3	195.9	258.4	308.5	362.7	362.7
GAN20	96.6	142.6	175.8	221.8	258.5	298.3	298.3
J_GAN20	96.6	142.6	175.8	221.8	258.5	298.3	298.3
R_GAN21_TXDOT	94.9	140.1	172.4	217.4	253.1	291.8	291.8
J_GAN21	1352.6	2150.3	2756	3622	4286.8	4994	4994

Updated Hydraulic Computed WSEL Summary

Gaines Tributary
Computed Water Surface Elevation Summary Table
Existing Conditions

OAK PARK TRIBUTARY									
River Station	CWSEL (ft)								Description
	50%	20%	10%	4%	2%	1%	0.2%	1% (WO)	
10+20	817.86	818.00	818.20	818.38	818.45	818.51	818.73		
9+20	816.64	816.80	816.79	816.84	816.93	817.03	817.36		
8+03	814.71	814.30	815.16	815.28	815.36	815.42	815.71		
7+73									PARKWOOD DRIVE
7+38	811.93	812.65	813.10	813.67	813.80	813.84	814.12		
5+91	807.52	807.72	807.85	808.03	808.09	808.16	808.36		
4+68	805.05	805.17	805.15	805.32	805.38	805.46	805.54		
4+43									OAKCLAIRE DRIVE
4+10	803.24	803.60	803.76	803.88	803.96	804.03	804.26		
2+98	799.93	800.11	800.19	800.30	800.37	800.43	800.70		
2+05	797.02	797.26	797.40	797.58	797.70	797.81	798.08		

GAINES TRIBUTARY									
River Station	CWSEL (ft)								Description
	50%	20%	10%	4%	2%	1%	0.2%	1% (WO)	
140+37	797.42	797.50	797.51	797.58	797.60	797.62	797.75	798.37	
139+36	797.45	797.56	797.59	797.69	797.75	797.80	797.92	798.38	
138+95									PARKWOOD DRIVE
138+49	794.80	795.07	795.23	795.51	795.69	795.83	796.04	796.63	
137+10	792.43	792.53	792.54	792.63	792.71	792.75	792.97	793.80	
134+84	788.80	789.31	789.72	790.28	790.42	790.55	790.86	791.38	
133+91	788.31	788.86	789.32	790.13	790.27	790.40	790.40	791.16	
133+61									OAKCLAIRE DRIVE
133+31	787.47	787.86	787.96	788.17	788.30	788.47	788.71	790.26	
132+37	786.43	786.74	787.05	787.19	787.31	787.36	787.57	788.13	
131+49	782.88	783.16	783.35	783.62	783.77	783.88	784.17	785.03	
130+46	781.95	782.18	782.39	782.59	782.80	783.00	783.38	783.44	
128+33	779.56	780.01	780.20	780.50	780.70	780.84	781.24	780.84	
124+94	775.87	776.23	776.55	776.82	777.06	777.31	777.71	777.31	
123+55	773.51	774.35	774.57	774.98	775.12	775.24	775.70	775.24	
120+59	769.04	769.53	769.76	770.07	770.32	770.55	771.12	770.55	
117+54	766.08	766.67	767.17	767.76	768.09	768.36	768.99	768.36	
114+35	763.59	764.15	764.26	764.40	764.57	764.83	765.36	764.83	

Gaines Tributary

Computed Water Surface Elevation Summary Table

Existing Conditions

GAINES TRIBUTARY									
River Station	CWSEL (ft)								Description
	50%	20%	10%	4%	2%	1%	0.2%	1% (WO)	
113+29	763.62	764.23	764.40	764.67	764.83	764.97	765.30	764.97	
113+07									OAK BOULEVARD
112+81	761.72	762.45	762.84	763.31	763.61	763.89	764.49	763.89	
111+85	761.20	761.85	762.12	762.44	762.65	762.85	763.33	762.85	
110+98	760.52	761.09	761.42	761.84	762.15	762.43	763.01	762.43	
109+97	760.02	760.37	760.58	760.86	761.00	761.16	761.54	761.16	
108+62	758.74	759.22	759.46	759.76	760.01	760.17	760.54	760.17	
106+32	757.29	757.73	757.98	758.34	758.49	758.75	759.25	758.75	
105+36	756.50	756.87	757.10	757.22	757.47	757.50	757.94	757.50	
105+18									PRIVATE ROAD
105+01	756.25	756.50	756.73	757.01	757.18	757.36	757.74	757.36	
104+06	755.20	755.61	755.84	756.09	756.29	756.41	756.79	756.41	
102+99	754.20	754.45	754.59	754.81	754.87	755.06	755.28	755.06	
102+85									PRIVATE ROAD
102+71	753.83	754.16	754.36	754.60	754.77	754.91	755.21	754.91	
102+25	753.54	753.87	754.06	754.30	754.47	754.58	754.82	754.58	
101+76	752.94	753.17	753.41	753.53	753.57	753.84	754.19	753.84	
101+60									PRIVATE ROAD
101+39	753.00	753.32	753.49	753.70	753.84	753.97	754.28	753.97	
100+50	752.23	752.55	752.76	752.96	753.08	753.19	753.47	753.19	
97+14	750.02	750.46	750.71	750.98	751.14	751.30	751.66	751.30	
94+36	748.57	749.14	749.38	749.76	749.95	750.12	750.58	750.12	
90+31	746.32	746.86	747.18	747.56	747.81	748.28	748.64	748.28	
87+28	744.95	745.41	745.80	746.22	746.52	746.91	747.37	746.91	
84+76	743.32	743.83	744.30	744.82	745.09	745.40	745.95	745.40	
80+90	741.05	741.61	742.04	742.58	742.93	743.29	744.03	743.29	
77+25	739.48	740.24	740.82	741.49	741.90	742.33	743.24	742.33	
73+18	737.67	738.25	738.56	738.95	739.36	739.50	740.40	739.50	
69+61	734.30	735.11	736.08	737.30	738.17	739.35	740.15	739.35	
68+40	733.85	734.91	735.84	737.18	738.05	739.31	740.12	739.31	
67+55									SOUTHWEST PARKWAY
66+55	733.06	733.54	733.91	734.34	734.59	734.78	735.43	734.78	
65+06	732.31	732.82	733.18	733.56	733.83	734.03	734.57	734.03	

Gaines Tributary
Computed Water Surface Elevation Summary Table
Existing Conditions

GAINES TRIBUTARY									
River Station	CWSEL (ft)								Description
	50%	20%	10%	4%	2%	1%	0.2%	1% (WO)	
62+54	729.73	730.17	730.54	731.07	731.26	731.62	732.25	731.62	
59+90	727.94	728.41	728.79	729.28	729.58	729.87	730.61	729.87	

Gaines Tributary
Computed Water Surface Elevation Summary Table
Fully Developed Conditions

OAK PARK TRIBUTARY									
	CWSEL (ft)								
River Station	50%	20%	10%	4%	2%	1%	1% (WO)	1% (Prop. Rev **Op2** Mods.)	Description
10+20	818.13	818.34	818.42	818.5	818.57	818.66		818.13	
9+20	816.71	816.79	816.88	817.01	817.1	817.17		816.54	
8+03	815.07	815.23	815.32	815.41	815.48	815.58		812.09	
7+73									PARKWOOD DRIVE
7+38	812.73	813.42	813.8	813.82	813.92	814		810.26	
5+91	807.73	807.93	808.05	808.14	808.21	808.27		806.33	
4+68	805.17	805.31	805.33	805.43	805.49	805.55		803.15	
4+43									OAKCLAIRE DRIVE
4+10	803.66	803.83	803.92	804.01	804.1	804.16		801.70	
2+98	800.14	800.26	800.33	800.42	800.49	800.56		798.69	
2+05	797.03	797.19	797.29	797.41	797.5	797.59		795.75	

GAINES TRIBUTARY									
	CWSEL (ft)								
River Station	50%	20%	10%	4%	2%	1%	1% (WO)	1% (Prop. Rev **Op2** Mods.)	Description
140+37	797.43	797.56	797.55	797.59	797.6	797.63	798.37	794.45	
139+36	797.46	797.61	797.63	797.7	797.75	797.81	798.38	792.60	
138+95									PARKWOOD DRIVE
138+49	794.83	795.09	795.25	795.51	795.78	795.83	796.63	791.57	
137+10	792.45	792.56	792.54	792.63	792.7	792.76	793.80	789.84	
134+84	788.84	789.29	789.83	790.31	790.45	790.55	791.38	787.12	
133+91	788.38	788.68	789.44	790.16	790.31	790.39	791.16	785.99	
133+61									OAKCLAIRE DRIVE
133+31	787.51	787.89	787.98	788.18	788.32	788.48	790.26	785.36	
132+37	786.46	786.76	787.07	787.21	787.32	787.36	788.13	784.19	
131+49	782.91	783.19	783.38	783.64	783.78	783.9	785.03	783.76	
130+46	782.1	782.43	782.59	782.89	783.08	783.26	783.64	782.14	
128+33	779.99	780.31	780.57	780.81	780.98	781.17	781.17	780.56	
124+94	776.21	776.69	776.89	777.26	777.45	777.63	777.63	776.86	
123+55	774.33	774.72	775.05	775.2	775.42	775.64	775.64	775.15	
120+59	769.41	769.83	770.09	770.39	770.58	770.83	770.83	770.48	
117+54	766.49	767.16	767.58	768.09	768.43	768.71	768.71	767.53	

Gaines Tributary
Computed Water Surface Elevation Summary Table
Fully Developed Conditions

GAINES TRIBUTARY									
River Station	CWSEL (ft)								Description
	50%	20%	10%	4%	2%	1%	1% (WO)	1% (Prop. Rev Op2 Mods.)	
114+35	764.1	764.4	764.54	764.63	764.72	764.95	764.95	764.41	
113+29	764.13	764.47	764.66	764.84	765.02	765.17	765.17	761.98	
113+07									OAK BOULEVARD
112+81	762.28	762.86	763.2	763.58	763.85	764.12	764.12	761.45	
111+85	761.73	762.17	762.42	762.7	762.89	763.1	763.10	761.63	
110+98	761.04	761.49	761.77	762.12	762.36	762.63	762.63	761.30	
109+97	760.36	760.68	760.86	761.09	761.23	761.35	761.35	761.03	
108+62	758.92	759.36	759.59	759.92	760.12	760.32	760.32	759.55	
106+32	757.52	757.92	758.19	758.42	758.6	758.77	758.77	758.24	
105+36	756.81	757.15	757.22	757.5	757.67	757.83	757.83	757.83	
105+18									PRIVATE ROAD
105+01	756.41	756.72	756.96	757.19	757.37	757.53	757.53	757.13	
104+06	755.47	755.83	756.04	756.31	756.42	756.58	756.58	756.12	
102+99	754.36	754.58	754.75	754.87	755.06	755.15	755.15	755.15	
102+85									PRIVATE ROAD
102+71	754.05	754.36	754.55	754.78	754.92	755.05	755.05	754.28	
102+25	753.76	754.05	754.24	754.48	754.61	754.7	754.70	754.10	
101+76	753.09	753.42	753.62	753.59	753.77	754	754.00	753.93	
101+60									PRIVATE ROAD
101+39	753.22	753.49	753.66	753.85	753.98	754.13	754.13	753.39	
100+50	752.45	752.76	752.92	753.08	753.2	753.34	753.34	752.95	
97+14	750.33	750.7	750.92	751.16	751.31	751.47	751.47	750.81	
94+36	748.97	749.38	749.67	749.98	750.14	750.33	750.33	749.71	
90+31	746.64	747.16	747.44	747.8	748.27	748.43	748.43	747.31	
87+28	745.18	745.74	746.1	746.49	746.89	747.1	747.10	745.89	
84+76	743.55	744.22	744.7	745.07	745.38	745.61	745.61	744.75	
80+90	741.3	741.98	742.42	742.9	743.24	743.56	743.56	742.69	
77+25	739.82	740.69	741.24	741.82	742.23	742.65	742.65	740.93	
73+18	737.95	738.55	738.76	739.16	739.42	739.69	739.69	739.30	
69+61	734.62	735.7	736.79	737.85	739.18	739.67	739.67	736.86	
68+40	734.3	735.6	736.68	737.73	739	739.65	739.65	734.53	
67+55									SOUTHWEST PARKWAY
66+55	733.27	733.82	734.17	734.53	734.72	734.99	734.99	734.10	

Gaines Tributary
Computed Water Surface Elevation Summary Table
Fully Developed Conditions

GAINES TRIBUTARY									
River Station	CWSEL (ft)								Description
	50%	20%	10%	4%	2%	1%	1% (WO)	1% (Prop. Rev **Op2** Mods.)	
65+06	732.54	733.09	733.4	733.78	734.03	734.22	734.22	733.37	
62+54	729.93	730.47	730.88	731.17	731.46	731.77	731.77	731.77	
59+90	728.14	728.7	729.08	729.49	729.79	730.09	730.09	728.90	

Appendix D – Digital Data

Infoworks ICM 2D Model - Williamson Creek Overflow
HEC-HMS Gaines Tributary – Hydrologic Model
HEC-RAS Gaines Tributary – Hydraulic Model