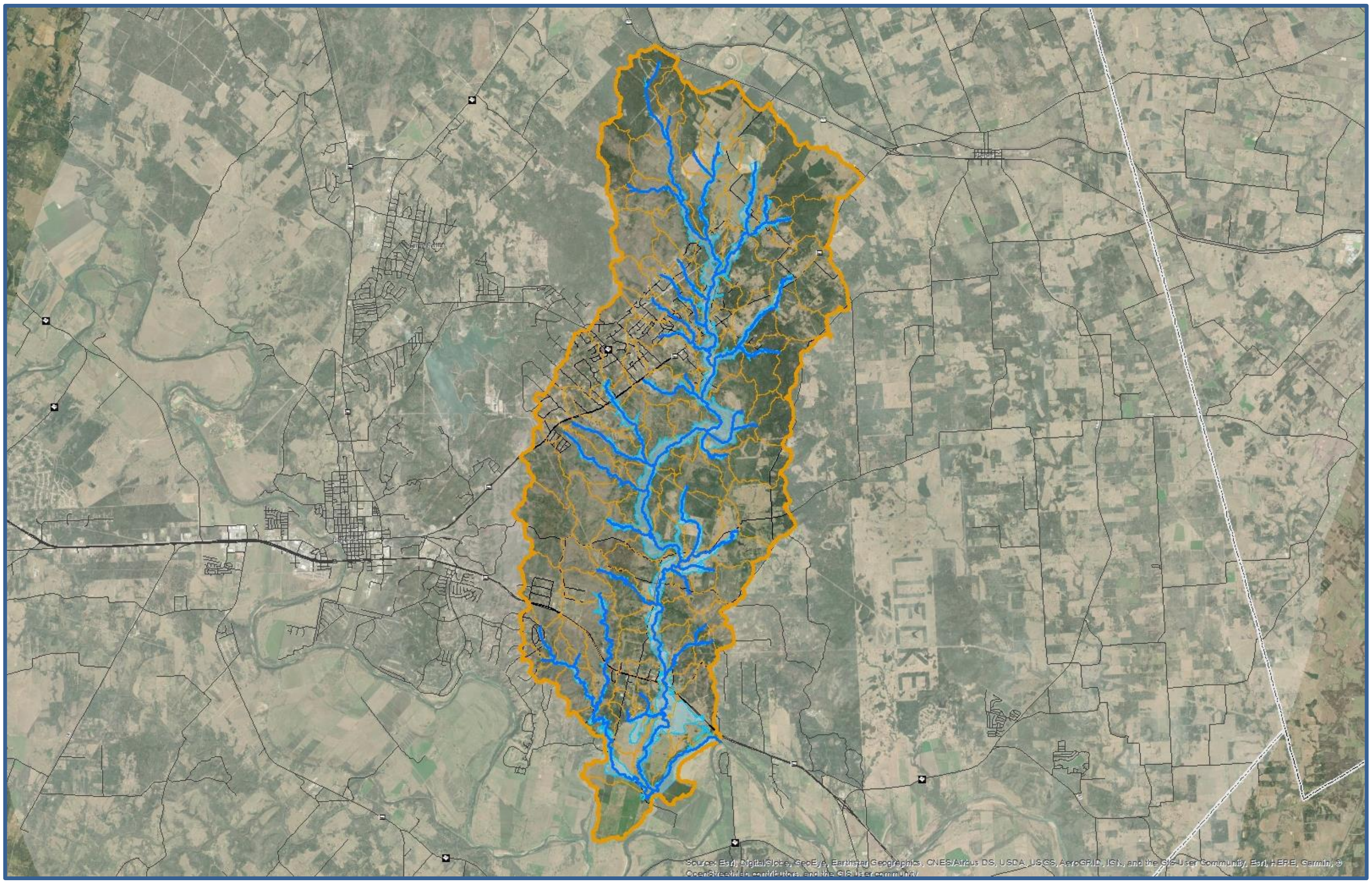
Final Report, Contract #1800012308
Received 1/12/2021



ALUM CREEK WATERSHED STUDY
BASTROP COUNTY, TEXAS
FLOOD PROTECTION PLANNING GRANT

Prepared for
Bastrop County

Prepared by
Halff Associates, Inc.

TBPELS Engineering Firm #312
9500 Amberglen Blvd., Bldg. F, Ste. 125
Austin, TX 78729

October 21, 2020

STATE OF TEXAS
PAUL A. MORALES
91082
LICENSED
PROFESSIONAL ENGINEER

HALFF

October 21, 2020 AVO 35837

Michael Vielleux, P.E.
Engineer III River Science Program - Texas Water Development Board
1700 North Congress Ave.
Austin, Texas 78711-3231

Sent via email.

RE: Completed: Contract 1800012308 - Bastrop County - Alum Creek Watershed Study - Draft Final Report Comments

Dear Michael Vielleux,

Halff Associates, Inc. (Halff) is submitting this letter in response to Texas Water Development Board (TWDB) review comments of the Bastrop County Flood Protection Planning report for the above referenced TWDB contract. The following TWDB review comments were received by the County on October 01, 2020 and are included for reference along with Halff's response.

TWDB Specific Draft Report Comments:

1. 1.0 Introduction, 2nd paragraph, states that in 2019, Bastrop County was approved for a TWDB Flood Protection Planning grant, while the grant was awarded in 2018 with the contract between TWDB and the county being executed in 2019. Please, update as applicable.

   Response: The year that the grant was awarded was corrected to 2018. A sentence clarifying that the contract was executed in 2019 was added.

2. 2.1 Public Meetings, 1st paragraph, indicates that three public meetings were held and provides dates for two public meetings that have been held while the paragraph concludes by stating that a third public meeting will be held and references Appendix B which has information for two public meetings. Please, update this information as appropriate.

   Response: The third public meeting was held on October 7th, 2020. The report is updated accordingly.

3. 2.2.1 Topographic Data, references TNRIS StatMap while this should read TNRIS StratMap. Please, update as appropriate. Also, please, note that the definition for the acronym for TNRIS in the List of Acronyms and Abbreviations is wrong. Please, see the above comment requesting that the document be reviewed for typos.

   Response: The definition for the acronym TNRIS was corrected. The reference to TNRIS StratMap was corrected.

4. 3.0 Hydrologic Modeling, describes the hydrologic modeling conducted for the study and discusses peak flows being determined for various ACE events for existing conditions in the watershed while page 1 of the contracts SOW indicates that the model will include both existing and future land use conditions, however, no discussion of future conditions was provided. Please, include a discussion of future conditions hydrologic modeling or a discussion on why the community chose not to proceed with future conditions hydrologic modeling.

   Response: High density development is not a concern within the Alum Creek watershed due to its rural nature. Current Bastrop County Subdivision Ordinance requires new development to have less than 20% impervious cover and coordination with US Fish & Wildlife is required due to threatened and endangered species.

5. 4.6 Hydraulic Results, indicates that profiles were plotted for the 4% and 1% ACE for existing conditions while the SOW indicates that flood profiles for the 2-year, 5-year-, 10-year, 25-year, 50-year, 100-year, and 500-year frequency storm events will be developed for the existing watershed conditions. Please, update the report with all seven ACE flood profiles noted in the SOW or include a discussion on why the community chose not to include all seven in the study.

   Response: The report was updated to note that only the 1% ACE profiles were plotted because all streams are limited detail. However, the hydraulic models where run for seven profiles. Clarification was added to the report text.

6. 4.6 Hydraulic Results, indicates that profiles were plotted for the 4% and 1% ACE existing condition storms and are included in Appendix F-2 while Appendix F-2 only includes profiles for the 1% ACE. Please, update the appendix as applicable.

   Response: The report was updated to note that only the 1% ACE profiles were plotted because all streams are analyzed using limited detail methods.

7. 5.0 Flood Mitigation Evaluation, last sentence in the introductory paragraph discusses a wide range of potential flood mitigation alternatives. However, the remainder of this report section focuses only on structural culvert/bridge replacements, a single regional pond, and certain property buyouts. Please update this section to include a discussion on how mitigation alternatives were narrowed to the ones presented.

   Response: Due to the rural nature of the Alum Creek watershed, development is sparse throughout the study area. Large scale mitigation projects would not provide a solution to enough residents within the County to make the project feasible. The priority of the County was to focus on vehicular road safety and increase the level of service of creek crossings during storm events. Section 5 has been updated to add this discussion.

8. 5.3 Roadway Crossing Alternatives, indicate 5 roadway crossings were selected by the County to focus on. This selection does not match the highest 5 in the urgency rating listed in Table 5-1 and there is little clarity on how that change occurred. It is not clear why only 5 were selected, nor is the recommended priority for the 5 selected clear. Please update this section to better explain roadway crossing priorities and how they were determined.

   Response: The County selected the top five county roadways with the information provided since TxDOT roads are not in their jurisdiction. Selections were based on repetitive damage, housing density, and immediate needs. Discussion was added to the report to clarify.

9. Contract 1800012308, Exhibit B SOW, page 2 of 3, indicates that a flood profile for fully developed 100-year watershed conditions will be developed while the draft report does not appear to include that information. Please, update the report to include this information or provide a discussion on why the community chose not to include this step in their study.

   Response: See response to comment #4 above.

10. Table of Contents, the List of Appendices are all referenced as page IV. Please, update or remove the appendix page numbers as necessary and consider moving the appendix list towards the end of the table of contents.

    Response: Removed the list of appendices in the Table of Contents.

11. 5.3 Road Crossing Alternatives, improvements to state roads were proposed with no mention of coordination with TxDOT. Please, provide a discussion on how road improvements will be coordinated with TxDOT.

    Response: State Highway 71/95 and State Highway 21 are TxDOT roads, Bastrop County does not have jurisdiction over those roadways and TxDOT is not a participating member in the FPP Grant. Discussion was added to the report for Bastrop County to share study results with TxDOT.

12. Table 5-2 and Appendix H includes a summary of roadway improvements and probable cost estimates, however, no discussion on how the costs were derived was provided. Please, provide a discussion on how the probable cost estimates were derived for the road crossings in Table 5-2 and Appendix H.

    Response: TxDOT's average low-bid unit prices were used to base the unit price of the individual bid items listed in the estimates of probable cost for the proposed roadway crossing improvements. Recent bid tabs for Bastrop County projects were also used to determine unit costs that are needed for each improvement. Discussion was added to the report.

13. 5.4.2 Benefit Cost Analysis, a BCA was performed on the Regional Detention Pond however there is not a BCA for the buyout of structures. Please, provide either an additional BCA for the acquisition of the impacted structures or a justification why a BCA was not performed.

    Response: According to FEMA memo Cost Effectiveness Determinations for Acquisitions and Elevations in Special Flood Hazard Areas, dated August 2013, states that a structure acquisition value less than $276,000 is considered a viable project. Bastrop County CAD indicates property values are less than $276,000, therefore a BCA was not performed.

14. 5.4.2 Benefit Cost Analysis and Appendix H provide cost estimates for regional detention, however, no discussion or breakdown of those cost estimates was provided. Please, provide a discussion and budget breakdown indicating the regional detention cost estimates.

    Response: The regional detention project costs are located in Appendix H-3. In addition, see response to comment #12 above regarding how cost estimates were developed.

15. Contract 1800012308, Exhibit B SOW, page 2 of 3, indicates that it is anticipated that FEMA's Flood Module Benefit Cost Analysis software will be used, however this software was not used. Please provide a discussion of why the BCA analysis methodology used was chosen along with any of the supporting information and data used to support the BCA analysis.

    Response: A simplified BCA was used for this study because Alum Creek is a rural watershed and high density development is not anticipated, therefore a simplified BCA was found to be sufficient.

Please do not hesitate to contact me at (512) 777-4547 or email me at pMorales@halff.com if you have any questions. Halff appreciates working with Bastrop County and the TWDB on the Flood Protection Planning study which will help to reduce flood risk.

Sincerely,
HALFF ASSOCIATES, INC.

Paul Morales, PE, CFM, CPESC

Copy:

Carolyn Dill, PE (Bastrop County)

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LIST OF ACRONYMS AND ABBREVIATIONS

AADT	Average Annual Daily Traffic
ACE	Annual Chance of Exceedance
ac-feet	acre-feet
BCA	Benefit Cost Analysis
BLE	Base Level Engineering
CAPCOG	Capital Area Council of Governments
cfs	cubic feet per second
CMP	Corrugated Metal Pipe
CN	Curve Number
DEM	Digital Elevation Model
DTM	Digital Terrain Model
FEMA	Federal Emergency Management Agency
FIS	Flood Insurance Study
ft	feet/foot
GIS	Geographic Information System
GPS	Global Positioning System
HEC	Hydrologic Engineering Center (U.S. Army Corps of Engineers)
HMS	Hydrologic Modeling System
IC	Impervious Cover
ITE	Institute of Transportation Engineers
LiDAR	Light Detection and Ranging
NAD	North American Datum
NAVD	North American Vertical Datum
NRCS	Natural Resources Conservation Service
NLCD	National Land Cover Database
QC/QAQC	Quality Control/Quality Assurance Quality Control
RAS	River Analysis System
RCP	Reinforced Concrete Pipe
RS/XS	HEC-RAS River Station
SCS	Soil Conservation Service (now Natural Resources Conservation Service)
SIR	Scientific Investigations Report
sq. mi.	square mile
SSURGO	Soil Survey Geographic
TCEQ	Texas Commission of Environmental Quality
TIN	triangulated irregular network
TNRIS	Texas Natural Resources Information Service
TxDOT	Texas Department of Transportation
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
WSEL	Water Surface Elevation
WSS	Web Soil Survey

1.0 INTRODUCTION

Upon award of a Texas Water Development Board (TWDB) Flood Protection Planning grant in 2007, Bastrop County began a phased county-wide drainage study in partnership with TWDB and the U. S. Army Corps of Engineers (USACE). Between 2007 and 2018 the County obtained LiDAR and completed hydrologic, hydraulic, and mitigation analyses for selected streams within the Cedar Creek, Dry Creek, Walnut Creek, Willow Creek, Gazley Creek, Piney Creek, and Gills Branch watersheds. Bastrop County has historically experienced flooding including many areas experiencing severe rainfall events within the county as recently as August 2017 during Hurricane Harvey. The flood of July 1869 is considered to be the worst flood on record in Bastrop County. During that severe flood event, the Colorado River crested at 51 feet at Austin, 60.3 feet at Bastrop, 56.7 feet at La Grange, 51.6 feet at Columbus, 51.9 feet at Wharton and 56.1 feet at Bay City. Since 1991, Bastrop County has been declared under 12 flood related federal disasters. Most recently, the County received five disaster declarations for flooding between May 2015 and September 2017.

In 2018, Bastrop County was approved for a TWDB Flood Protection Planning (FPP) Grant to conduct hydrologic, hydraulic, and mitigation analyses for Alum Creek and Wilbarger Creek watersheds. The contract between TWDB and Bastrop County was executed in 2019. The following pages include discussions of the methods, procedures, and assumptions used in preparation of this study for the Alum Creek Watershed Flood Protection Planning Study.

A hydrologic and hydraulic analysis of the Alum Creek watershed in Bastrop County, Texas was performed by Halff Associates, Inc. This study is part of the larger Bastrop County FPP studies conducted in cooperation with Bastrop County and the TWDB. The goals of this study were to analyze the hydrologic characteristics of the watershed, develop limited detailed floodplains, and identify flood mitigation alternatives to reduce flood risk within the Alum Creek watershed.

Alum Creek extends from the northern portion of the watershed and discharges to the southeast at the confluence with Colorado River as shown in **Appendix A-1**. Alum Creek is primarily rural and is located fully within Bastrop County. The watershed overview also shows burn scar boundaries for the 2009 Wilderness Ridge Fire, 2011 Bastrop County Complex Fire, and 2015 Hidden Pines Fire which are considered in the study and the effects on the current hydrology.

Table 1-1 below lists the watershed's 72.3 study stream miles contained within the 54.5 square mile drainage area. Alum Creek, Little Alum Creek, Price Creek and Tributaries 1 – 11 were based on current effective FEMA naming conventions, while Tributaries 67 and higher are based on FEMA Base Level Engineering (BLE) naming conventions. The tables in the report will refer to streams by their Stream ID, shown below in **Table 1-1.**

TABLE 1-1: STUDIED STREAM PARAMETER SUMMARY

Study Streams	Stream ID	Limited Detail Study (Miles)	Drainage Area (Square Miles)	Number of Structure Crossings
Alum Creek	AC	20.97	13.1	8
Alum Creek Tributary 1	AC_T1	2.00	1.61	1
Alum Creek Tributary 2	AC_T2	1.29	1.87	1
Alum Creek Tributary 3	AC_T3	1.38	2.85	0
Alum Creek Tributary 4	AC_T4	0.12	2.74	2
Alum Creek Tributary 5	AC_T5	2.17	1.04	0
Alum Creek Tributary 6	AC_T6	0.49	1.04	0
Alum Creek Tributary 7	AC_T7	0.68	3.01	3
Alum Creek Tributary 8	AC_T8	1.54	1.18	4
Alum Creek Tributary 9	AC_T9	1.35	2.72	2
Alum Creek Tributary 10	AC_T10	1.49	1.79	1
Alum Creek Tributary 11	AC_T11	0.46	1.74	1
Alum Creek Tributary 67	AC_T67	0.60	0.79	1
Alum Creek Tributary 87	AC_T87	2.32	0.48	2
Alum Creek Tributary 93	AC_T93	0.89	0.93	0
Alum Creek Tributary 107	AC_T107	1.84	1.15	0
Alum Creek Tributary 107A	ACT_A107A	1.73	0.12	0
Alum Creek Tributary 110	AC_T110	0.47	0.47	0
Alum Creek Tributary 124	AC_T124	0.58	0.68	0
Alum Creek Tributary 129	AC_T129	1.14	0.63	3
Alum Creek Tributary 131	AC_T131	2.59	1.09	1
Alum Creek Tributary 137	AC_T137	0.27	0.8	0
Alum Creek Tributary 138	AC_T138	0.33	0.65	0
Alum Creek Tributary 143	AC_T143	1.58	0.76	0
Alum Creek Tributary 148	AC_T148	1.15	1.26	0
Alum Creek Tributary 160	AC_T160	2.18	0.31	1
Alum Creek Tributary 162	AC_T162	1.75	0.93	1
Alum Creek Tributary 166	AC_T166	1.19	0.55	0
Alum Creek Tributary 167	AC_T167	0.84	0.36	0
Alum Creek Tributary 168	AC_T168	3.05	0.31	0
Alum Creek Tributary 169	AC_T169	1.13	0.65	0
Alum Creek Tributary 173	AC_T173	0.79	2.02	1
Alum Creek Tributary 174	AC_T174	2.77	0.17	0
Alum Creek Tributary 175	AC_T175	0.56	0.32	0
Little Alum Creek	LAC	6.70	3.51	2
Price Creek	PC	1.89	0.86	2
	Totals	72.30	54.5	35

2.0 DATA COLLECTION

2.1 Public Meetings

Three public meetings were held over the course of the study. These meetings with the community were important to ensure that community stakeholders understand the goals and scope of the project. The first public meeting, held Tuesday, May 7th, 2019, was held to solicit public input on areas with flood risk concern within Alum Creek Watershed. The second public meeting was held on May 14th, 2020, to provide feedback on the identified floodplain and proposed flood mitigation projects. A third public meeting was held on October 7th, 2020 to provide the County and residents with a summary of the results of the study. **Appendix B** includes the announcement flyer, sign-in sheet, agenda, and meeting minutes for the public meetings.

2.2 Obtain Base Mapping Info

2.2.1 Topographic Data

The primary source of terrain data used for this hydraulic study was developed from the TNRIS StratMap 2017 Central Texas LiDAR, surveyed by Fugro Geospatial, Inc. The data was provided in LiDAR Aerial Survey (LAS) format and converted to an ESRI multipoint feature class within a geodatabase. Multipoint files were projected and adjusted into Horizontal NAD83 State Plane and Vertical NAVD88 using a US foot measurement. The resulting feature class was processed into an ESRI terrain and converted into a DEM with 3-foot cell sizes, illustrated in **Figure 2.1**. Both the hydrologic and hydraulic analysis for Alum Creek were completed based upon this topographic data.

2.3 Field Reconnaissance

Because the streams in this watershed were studied using limited detailed methodology, no field survey was collected for this study. In 2019, field reconnaissance was performed on the study area's accessible bridge and culvert sites, providing field measured dimensions of road crossings. The photos of the upstream channel, downstream channel, upstream face, and downstream face were taken for all the structures. Detailed Field Observation Reports for the study along with photos of the structures are included in **Appendix C**.

2.4 Environmental Constraints

An environmental desktop analysis was conducted to identify potential environmental constraints and permitting requirements for proposed projects within the Alum Creek watershed. Numerous sources were reviewed to identify potential environmental constraints in the study area, including: socioeconomic data from the U.S. Census Bureau (USCB), Texas Parks and Wildlife Department (TPWD) threatened and endangered species by county and Element Occurrence locations, U.S. Fish and Wildlife Service (USFWS) critical habitats and National Wetlands Inventory (NWI) maps, Texas Commission on Environmental Quality (TCEQ) hazardous materials, and cultural resources data from the Texas Historical Commission (THC). A detailed Environmental Constraints Analysis report is included in **Appendix D**.

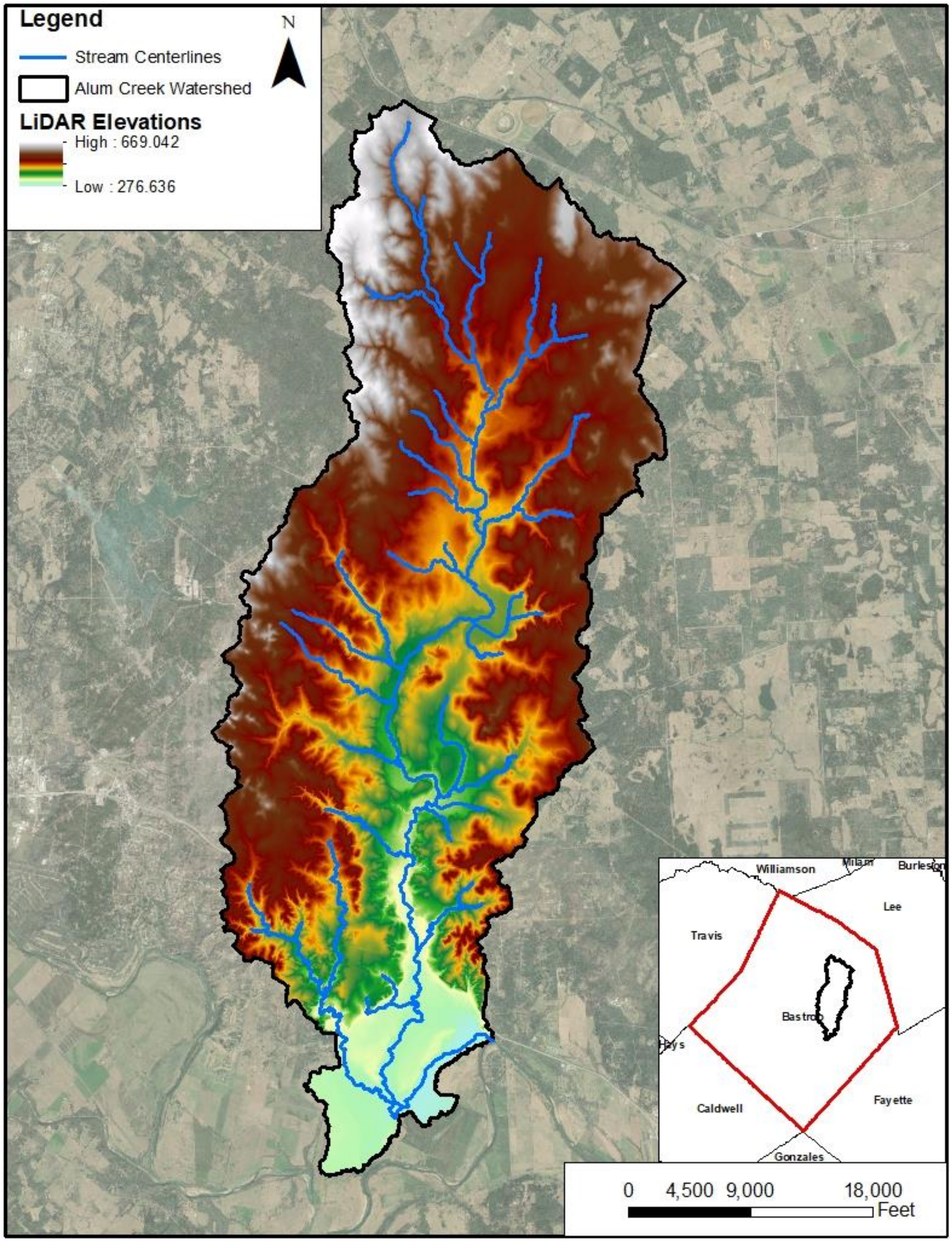


FIGURE 2-1: ALUM CREEK WATERSHED DEM

3.0 HYDROLOGIC MODELING

This study's hydrologic modeling was conducted using the United States Army Corps of Engineers (USACE) Hydrologic Engineering Center's (HEC) Hydrologic Modeling System (HEC-HMS). The hydrologic model for Alum Creek was developed in HEC-HMS version 4.3. The hydrologic model was developed for existing landuse conditions. Future conditions was not analyzed because high density development is not anticipated within the Alum Creek watershed due to Bastrop County Subdivision Ordinance restrictions and Threatened and Endangered Species within the area.

The HEC-HMS model simulates runoff based on subbasin parameters including drainage area, rainfall, soil infiltration losses, transformation of rainfall excess to runoff, and channel routing. Peak flows were determined for 2-year, 5-year, 10-year, 25-year, 50-year, 100-year, and 500-year annual chance rainfall events for existing conditions in the watershed based on current development. These methods are used to simulate peak discharges for each of the seven frequency events at different locations of the watershed to be applied in hydraulic modeling.

3.1 Storm Events

The hydrologic model for this study analyzed seven storm events. Storm event categories discussed within this report are in terms of the percent Annual Chance Exceedance (ACE) terminology. **Table 3-1** below relates this to the classic annual recurrence interval nomenclature.

TABLE 3-1: STORM EVENT CATEGORY NOMENCLATURE

Classic Terminology	Percent Annual Chance Exceedance
2-Year Storm	50% ACE
5-Year Storm	20% ACE
10-Year Storm	10% ACE
25-Year Storm	4% ACE
50-Year Storm	2% ACE
100-Year Storm	1% ACE
500-Year Storm	0.2% ACE

3.2 Drainage Basin Area Delineation

The hydrologic model was developed using ESRI ArcHydro tools and HEC-GeoHMS with the TNRIS 2017 1.4-meter LiDAR terrain data. HEC-GeoHMS (USACE 2013) was used to delineate the contributing watershed boundary for the Alum Creek watershed of 54.5 sq. mi. Subbasins were broken at road crossings, confluences, and other points of interest. The final delineation consists of 122 subbasins ranging from 0.024 square miles to 1.28 square miles, with the average subbasin size being 0.45 square miles. A detailed subbasin map is included in **Appendix A-2**.

3.3 Precipitation Data

Precipitation data was obtained from the *National Oceanic and Atmospheric Administrations (NOAA) Atlas 14, Precipitation-Frequency Atlas of the United States, Volume 11, Version 2: Texas* using the centroid of Bastrop County [Lat. 30.1034, Long. -97.3119] as the reference point. A frequency-based hypothetical storm with a 24-hour duration and balanced distribution was used for the various frequency event simulations in HEC-HMS. Bastrop County centroid storm depths are summarized in

Table 3-2.

TABLE 3-2: BASTROP COUNTY FREQUENCY STORM DEPTHS

Frequency-Depth-Duration (Inches)							
Duration	**50% 2-Yr**	**20% 5-Yr**	**10% 10-Yr**	**4% 25-Yr**	**2% 50-Yr**	**1% 100-Yr**	**0.2% 500-Yr**
5 min	0.54	0.67	0.78	0.93	1.04	1.15	1.43
15 min	1.08	1.34	1.56	1.85	2.07	2.29	2.83
1 hr	2.01	2.50	2.90	3.45	3.87	4.29	5.44
2 hr	2.47	3.14	3.71	4.52	5.15	5.82	7.70
3 hr	2.75	3.53	4.22	5.22	6.02	6.89	9.36
6 hr	3.22	4.20	5.10	6.43	7.53	8.77	12.30
12 hr	3.68	4.84	5.94	7.60	9.02	10.60	15.40
24 hr	4.17	5.52	6.82	8.82	10.60	12.60	18.50

3.4 Areal Reduction

The Alum Creek watershed encompasses a total area of 54.5 square miles. This study applied the standard approach for watershed modeling, using point rainfall up to a total cumulative area of approximately 10 square miles. For contributing drainage areas larger than 10 square miles, areal reduction curves published by the U.S. Weather Bureau were used to reduce the rainfall totals (U.S. Weather Bureau 1958).

The area-reduced flows for the Alum Creek watershed were simulated using the HEC-HMS Depth-Area Analysis routine. Each hydrologic element with a drainage area greater than 10 square miles was selected to run as an analysis point.

3.5 Parameter Determination

3.5.1 Soil

Watershed-wide soil information was obtained from the Natural Resource Conservation Service (NRCS) Web Soil Survey (WSS) website. **Appendix A-3** shows the distribution of soil types within the Alum Creek watershed. Type A is the dominant soil type with concentrations of type B along the outfall of the main stem. **Appendix E-1** contains a table of the hydrologic soil types and SSURGO soil classifications for Alum Creek watershed.

3.5.2 Land Cover

Land cover information was provided from the USGS's 2011 National Land Cover Database (NLCD). Land cover designations were thoroughly evaluated against ESRI's World Imagery basemap for accuracy of cover type. **Appendix A-4** shows the designated land cover from the NLCD. The land cover classifications were reclassified with respect to the appropriate cover descriptions for Curve Numbers (CN) from the U.S. Department of Agriculture's Urban Hydrology for Small Watershed Technical Release 55 (TR-55) Documentation. The classifications were also assigned a "Hydrologic Condition" of Poor or fair for CN calculation purposes, based on burn scar boundaries for the 2009 Wilderness Ridge Fire, the 2011 Bastrop County Complex Fire, and the 2015 Hidden Pines Fire provided by the County. Poor soils condition was used for the subbasins in the burned scar areas, and fair soils condition was used for the subbasins outside of the burn scars areas. **Figure 3-1** shows the boundaries of the three separate forest fire events that occurred within Bastrop County and their coincidence with Alum Creek. For subbasins that have both poor and fair condition areas, the weighted average was used to calculate CN. A comparison between fair and poor conditions results are discussed **Section 3.7**.

3.5.3 Runoff Losses

The Natural Resources Conservation Service (NRCS) CN loss rate method was used for the study. The CN method utilizes a curve number and initial abstraction. For purposes of this study the default HEC-HMS calculations were used for the initial abstraction values. Percent impervious values for each subbasin was developed based on aerial data and parcel data within the watershed, impervious cover is shown in **Appendix A-5**. HEC-GeoHMS and GIS tools were utilized to compute composite CN's based on land cover and soil type. **Appendix E-2** presents the designated CN based on the landuse and soil and the resulting composite CN for each subbasin.

3.5.4 Unit Hydrograph

Natural Resource Conservation Service (NRCS) TR-55 unit hydrograph was selected to define the unit hydrographs overall shape and timing. The time of concentration calculations were split into three sections including sheet, shallow concentrated, and channel flow. Sheet flow length was determined to be 100 feet because Alum Creek watershed is primarily a rural area. Sheet flow was calculated using Manning's kinematic solution (Overtop and Meadows 1976) as provided in TR-55. Manning's n-values in Table 3-1 of the TR-55 documentation were used for sheet flow for various surface conditions.

Standard time of concentration (t_c) values were computed for shallow concentrated flow using Equation 3-1 from TR-55. Velocities were based on watercourse slope and determined using Figure 3-1 of the TR-55 documentation. Channel flow t_c values were computed using Manning's equation, bankfull average velocity, and Equation 3-4 of the TR-55 documentation.

Lag time (t_{lag}) for each watershed was calculated by:

$$t_{lag} = 0.6\, t_c$$

Appendix E-3 lists assumptions and lag time calculations for all subbasins within the watershed.

3.6 Channel Routing

The Modified Puls method was selected to route hydrographs for the modeled study reaches within the Alum Creek watershed where hydraulic models were developed. Storage discharge relationships were computed using the Hydrologic Engineering Center (HEC), HEC-RAS program (Version 5.0.7) model developed for the study streams. The HEC-RAS model development is discussed in Section 4. **Appendix E-4** lists the computed modified puls discharge-storage relationships and the routing steps used in the HEC-HMS model.

The Muskingum-Cunge method was selected to route hydrographs for reaches with definable channels not included in the modeled study reaches. For each Muskingum-Cunge routing reach an 8-point cross section was developed. Cross-sections were cut from the LiDAR 3ft x 3ft DEM based on their spatial location. Cross-sections were extracted using LiDAR at the most representative location for each routing reach. Tables in **Appendix E-5** display the computed cross-sections and parameters used for the Muskingum-Cunge routing in the HEC-HMS model.

3.7 Hydrologic Results

A summary of areal reduced computed peak flows for the 50%, 20%, 10%, 4%, 2%, 1%, and 0.2% frequency storms is available in **Appendix E-6**. A summary of subbasin peak discharges for each of the frequency events are displayed in **Appendix E-7**.

A comparison was conducted to understand the effects of the forest fires that Bastrop County experienced on the runoff from Alum Creek watershed. To conduct this analysis the soil conditions throughout the watershed were categorized as fair. This resulted in an overall average decrease of 14% in peak flows for the 1% ACE storm when comparing poor to fair land use conditions in the burn scar areas of the watershed. The northeast basins that are outside of the burn scars had no change in peak discharge because they were not affected by the fires. Basins in the northwest side of the watershed have the largest percent differences, 50% to 85%, in the smaller frequency storms such as 50%, 20%, and 10% ACE's. The average percent differences in the peak flows from the composite CN to the peak flows from all fair soil condition

CN's are summarized in **Table 3-3**. The percent differences at all junctions are summarized in **Appendix E-8**.

TABLE 3-3: FAIR AND POOR SOIL CONDITION COMAPRISON – % DIFFERENCE IN PEAK FLOWS

Storm Event	50% ACE	20% ACE	10% ACE	4% ACE	2% ACE	1% ACE	0.2% ACE	Overall Average
Average Difference	34%	28%	25%	20%	16%	14%	9%	21%

3.8 Comparison of Peak Flows

The Alum Creek computed peak flows for the 1% ACE storm were compared to results from nearby watershed studies within Bastrop County. The studies used for the comparison include Gills Branch, Piney Creek, Willow Creek, Gazley Creek, and Walnut Creek from the 2020 Lower Colorado-Cummins Watershed Flood Risk Study. The Base Level Engineering (BLE) values shown for Alum Creek are from the 2018 Lower Colorado-Cummins BLE study and are based on regression equations developed using the USGS Scientific Investigations Report (SIR) 2009-5087. This comparison is shown in **Appendix E-9.** The computed peak flows are slightly lower than the flow rate per square mile compared to the surrounding watershed studies but are considered reasonable. Soil type A is the dominant soil within the watershed, with concentrations of soil type B near the outfall of the main stem. Type A and B soils are very sandy with low run off potential, causing more infiltration of rainfall. In addition, Alum Creek has a narrow watershed shape and the time to peak of the tributaries when flowing into the main stem is at the same time during a storm event. Therefore, there are minimal coincident peaks when comparing the tributary and main stem peaks in the watershed as the flood wave progresses downstream. While Alum Creek peak flows are slightly lower than BLE and Piney Creek, Alum Creek watershed follows approximately the same trendline and appear reasonable.

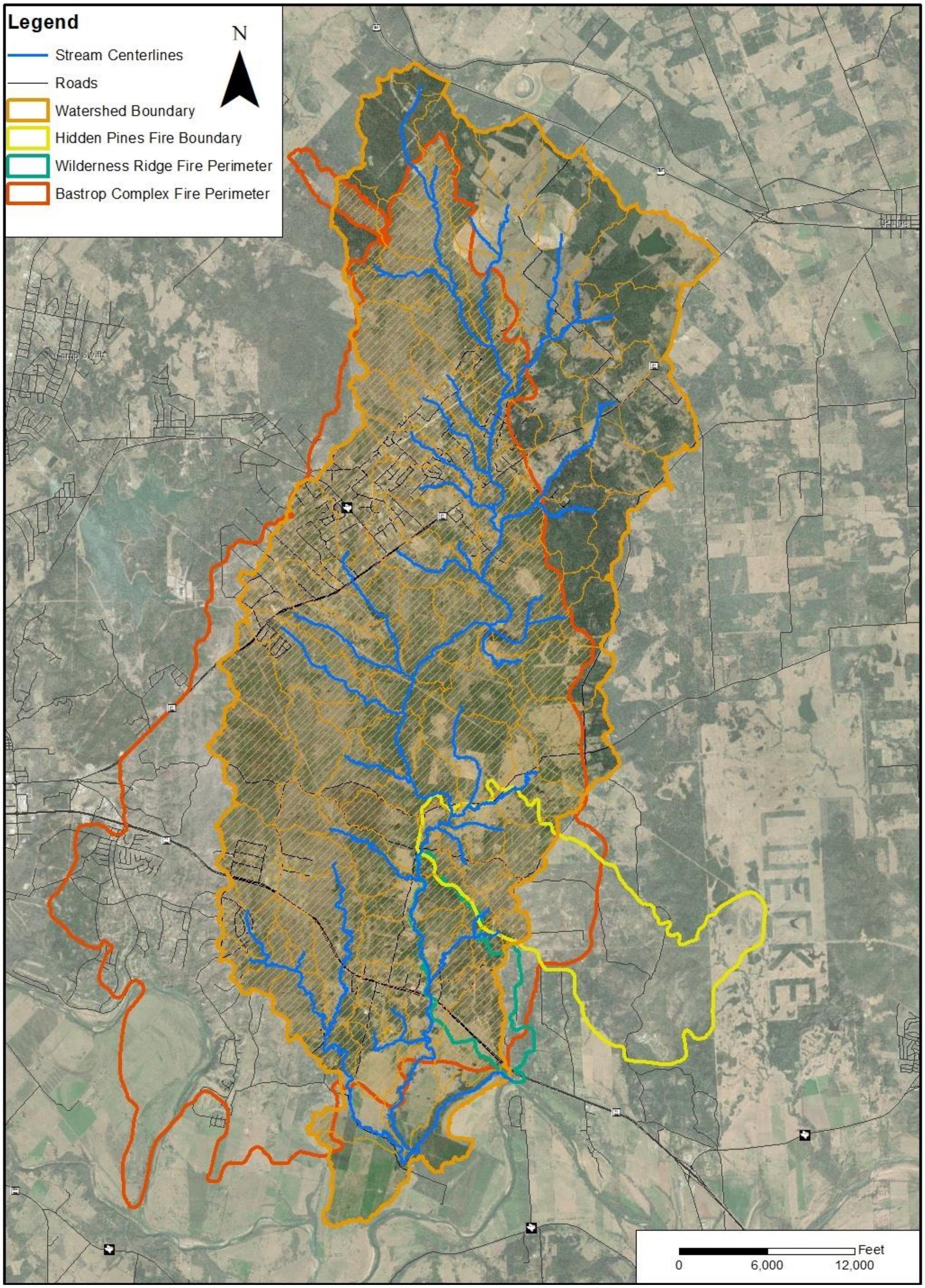


FIGURE 3-1: BASINS AFFECTED BY THE FOREST FIRES

4.0 HYDRAULIC MODEL ANALYSIS

The hydraulic models for the Alum Creek main stem and all Alum Creek Tributaries were built in HEC-RAS version 5.0.7 to estimate the water surface profiles for the seven modeled flood events. Hydraulic work maps containing habitable structures in the floodplain, modeled roadway crossings, and cross section stationing can be found in **Appendix G-1**.

4.1 Manning's Roughness Coefficients

Manning's "n" values were assigned by visual inspection and analysis of aerial imagery. The channel n-values for Alum Creek were determined to vary between 0.04-0.065. **Table 4-1** summarizes the channel n-values used for this study. The overbank n-values varied between 0.06-1.0. **Table 4-2** summarizes the land use classifications and respective Manning's n-value classifications.

TABLE 4-1: MANNINGS N-VALUE ASSUMPTION FOR CHANNEL

Channel Conditions	Manning's N-Value
Clean, winding, some pools and shoals	0.040-0.045
Same as above, but some weeds and stones	0.045
Same as above, lower stages, more ineffective slopes and sections	0.050
In between above and below	0.055
Same as n=0.05 but more stones	0.06-0.065

TABLE 4-2: EXISTING LANDUSE CLASSIFICATIONS MANNINGS N-VALUES

Classification	Manning's N-Value
Open Water	1.0
Developed, High Intensity	0.12
Developed, Medium Intensity	0.12
Deciduous Forest	0.1
Evergreen Forest	0.1
Mixed Forest	0.1
Woody Wetlands	0.1
Shrub/Scrub	0.08
Developed, Low Intensity	0.075
Developed, Open Space	0.07
Barren Land (Rock/Sand/Clay)	0.06
Cultivated Crops	0.06
Emergent Herbaceous Wetlands	0.06
Grassland/Herbaceous	0.06
Pasture/Hay	0.06

4.2 Cross Section Point Filtering Approach

Extracting cross sections using GeoRAS and the 3ft x 3ft hydraulic DEM resulted in many cross-sections containing more than the maximum 500 points allowed for HEC-RAS, version 5.0.7 modeling. The HEC-RAS cross section filter was selected to reduce cross sections points to 500.

4.3 Boundary Conditions

The normal depth method was used for the downstream boundary condition for Alum Creek and its tributaries. This type of boundary option requires the user to enter an energy slope for the downstream location by determining the average slope between the channel flowlines of the downstream cross sections within HEC-RAS.

4.4 Geometry Data

The stream centerline, channel cross sections, and lateral structures were generated based on the study's 3 ft x 3 ft DEM. Hydraulic cross sections were placed every 500 feet along stream centerlines to depict the studied channel.

Bridge and culvert structures were entered and modeled using field reconnaissance data. Ineffective areas were placed based on the methodology described in the HEC-RAS Hydraulic Reference Manual. The ineffective area expansion and contraction ratios for structures were specified as 1:1 on the upstream cross section and 2:1 for the downstream section.

Cross section expansion and contraction coefficients were left at the default values of 0.1 and 0.3, except at structures where they were changed to 0.3 and 0.5 for the two cross sections upstream of a structure and one downstream.

During the development of hydraulic models for the watershed it was discovered that there are three areas within the watershed where overflow occurs. Lateral structures were added along the high points parallel to the stream to best quantify overflow that leaves the channel.

4.5 Peak Flow Data

Peak flows from the Alum Creek hydrology model were entered into the hydraulic model. Flow change locations were placed at hydrologic junctions and subbasin locations spaced to be approximately one-half to one-third upstream of a subbasin divide and at confluences of tributaries. The peak flows and flow change locations are tabulated and summarized in **Appendix F-1**.

4.6 Hydraulic Results

Profiles were plotted from the HEC-RAS results only for the 1% ACE existing condition storms because all streams are studied as limited detail guidance. The profiles are included in **Appendix F-2**. Although the 1% frequency storm is discussed in this report, the hydraulic models were run for the 50%, 20%, 10%, 4%, 2%, 1%, and 0.2% frequency storm events and the respective results can be seen in the hydraulic models.

The Alum Creek 1% ACE floodplain was generated using HEC-RAS model results and Arc GIS tools. Water surface elevations triangulated irregular networks (TIN) were created from the hydraulic model results then converted to water surface DEMs. These DEMs were intersected with the hydraulic ground surface DEM to calculate and create polygon features of inundated areas. The 1% ACE floodplain extents, stream centerline, and cross sections are included in the hydraulic work maps, found in **Appendix G-1**. The work maps reference additional information in relation to the floodplain including over topping road crossings, structures located within the floodplain, and project study limits.

There are 56 habitable structures that fall within the footprint of the 1% ACE and a total of 31 road crossings that are overtopped during the 1% ACE storm.

A comparison of the new floodplains to the National Flood Hazard Layer (NFHL) is shown in **Appendix G-2**. Changes in the floodplain width are categorized as increase, decrease, or no change. Increases in floodplain width are shown in red, decreases are shown in green and where there has been no change the floodplain is grey. In some areas, primarily upstream of the watershed along the main stem and Alum Creek Tributary 11, the floodplain extents have narrowed. This is attributed to the updated LiDAR which more accurately represents the topography in this area. The mid portion of the watershed between Highway 21 and Highway 71 saw small changes in the floodplain extents along the main stem. The lower portion of the watershed had both increases and decreases of the extents based on studied streamlines and study limits. The large increase in the floodplain south of Highway 71 is based on low lying floodplain and the high likelihood of inundation during a storm event. The decrease in floodplain along the lower portion of Little Alum Creek and Alum Creek are due to floodplain extents being drawn at the connection to the Colorado River floodplain.

5.0 FLOOD MITIGATION EVALUATION

The flood mitigation concepts discussed within this report are conceptual evaluations of potential flood mitigation solutions. They are high-level feasibility concepts that may be refined through subsequent preliminary engineering analysis and coordination with project stakeholders. Reduction of flood risk can be accomplished using hydrologic alternatives (detention/retention ponds), hydraulic alternatives (diversions, floodwalls, channel improvements, etc.), or a combination of these alternatives.

The following mitigation strategies were considered, but not pursued further because anticipated project benefit does not outweigh the costs or risks associated with implementation. Large scale mitigation projects would not provide a solution to enough residents within the County to make the project feasible. Channel excavations would decrease the width of the floodplain and as a result decrease the number homes in the floodplain. A large volume of channel excavation would be required and the costs associated with the removal of soil material would most likely be greater than the cost of removing the homes. Additionally, environmental permits would need to be obtained to excavate within Waters of the US due to the presence of the endangered Houston Toad species. Another potential solution to prevent homes from being inundated during a storm event is to raise the finished floor elevation of the home. Raising the foundation of a home would reduce the chance of water entering the home during a flood event. According to FEMA's Homeowner's Guide to Retrofitting it is possible to raise multiple types of foundations, with costs varying between different foundation types. There is a total of 56 homes within the 100-year floodplain in Alum Creek where many of the homes are clustered north of SH-21. The Bastrop Appraisal District database indicated that of those 22 homes, only 4 of those homes do not have slab foundations. Slab foundations can be raised, but there is risk of damaging the home. Moreover, the cost of raising a home can be prohibitive for homeowners. Elevating structures is an option for the homeowners but was not the focus of this study.

The overall flood mitigation objective is to reduce bridge and culvert overtopping during the 1% ACE to the extent possible and to protect the safety of Bastrop County residents within the study area. The priority of the County was to focus on vehicular road safety and increase the level of service of creek crossings during storm events. In many cases, the evaluated alternatives reduce existing flood risk but elimination of 1% ACE flood risk was not possible in all locations. In accordance with the Subdivision Regulations for Bastrop County, all culverts shall be designed to convey the 4% ACE storm, and the headwater surface elevation shall not exceed the minimum roadway surface elevation. The headwater depth for a 1% ACE storm shall not exceed 1 foot over the minimum roadway surface elevation (Bastrop County, 2017). The following sections discuss the flood mitigation analysis including conceptual-level estimates of project cost.

5.2 Road Crossing Urgency Rating Evaluation

An urgency ranking of bridge, culvert, and low water crossing structures was developed for the Alum Creek watershed to prioritize roadway crossings according to flood and public safety risk. Prioritizing road structures susceptible to flood overtopping and a threat to public safety, helps focus available resources.

5.2.1 Traffic Count Determination

The traffic count for each crossing within the study basin was derived from traffic and saturation count data recorded by TxDOT in 2018 and the Institute of Transportation Engineers (ITE) Trip Generation Manual, 10th Edition (2020). These maps were spatially referenced to political, geographical, and structural landmarks within the watershed. Parcel data was utilized to best estimate the number of residences that utilize the road crossing. A spatial analysis was manually performed using aerial imagery and roadway networks in conjunction with the traffic count maps to determine a relative traffic pattern for residents that may use the roadway crossing to leave and return to their home. The number of entrances and exits for the residences along the road were located in order to estimate the number of potential routes that would utilize the roadway crossing. An average daily trip per household of 9.44 was assigned to each residential dwelling from the ITE Trip Generation Manual. The daily trip per household was multiplied by the number of residences and modified by the number of available alternative routes to obtain the traffic count for each crossing.

5.2.2 Urgency Rating Evaluation

Halff Associates developed an urgency calculation for 31 structures of the 35 structures analyzed in this study because they are overtopped by a storm event. **Appendix A-6** shows the locations of the overtopping roadways within the Alum watershed. The urgency rating is calculated by taking the Average Annual Daily Traffic Count divided by the Annual Chance of Flooding. The Annual Chance of Flooding was obtained from the hydraulic models developed for this study. The higher a structure's urgency rating, the higher the flood risk for that structure. A summary of the urgency rating is presented in

Table 5-1 below. A complete urgency rating analysis for all 31 structures is provided in **Appendix H-1**.

TABLE 5-1: ROADWAY CROSSING URGENCY RATING

Stream Name	Road Name	Structure Type	Average Daily Traffic Count (vehicles/day)	Annual Chance of Flooding	Equivalent Rainfall Depth (in)	Urgency Rating	Risk Rank
Alum Creek	State Highway 21 West	Bridge	13,385	20%	5.52	2,677	1
Alum Creek Tributary 4	State Highway 21 West	Culverts	13,385	10%	6.82	1,339	2
Alum Creek	TX-71/TX-95	Bridge	21,970	4%	8.82	879	3
Alum Creek Tributary 87	Cardinal Drive	Culverts	1,510	50%	4.17	755	4
Alum Creek	TX-71/TX-96	Bridge	21,970	2%	10.6	439	5
Price Creek	State Highway 21 West	Culverts	13,385	2%	10.6	268	6
Little Alum Creek	Ponderosa Road	Bridge	390	50%	4.17	195	7
Alum Creek Tributary 129	Ponderosa Loop	Culverts	320	50%	4.17	160	8
Alum Creek Tributary 8	Ponderosa Loop	Culverts	230	50%	4.17	115	9
Alum Creek Tributary 8	Cardinal Drive	Culverts	220	50%	4.17	110	10
Alum Creek Tributary 10	Old Potato Road	Bridge	200	50%	4.17	100	11
Alum Creek Tributary 4	Kelley Rd E	Culverts	180	50%	4.17	90	12
Alum Creek Tributary 7	Squirrel Run	Culverts	180	50%	4.17	90	12
Alum Creek	Cardinal Drive	Culverts	170	50%	4.17	85	14
Alum Creek	Bowie Drive	Culverts	170	50%	4.17	85	14
Alum Creek Tributary 11	Cardinal Drive	Culverts	170	50%	4.17	85	14
Alum Creek	Mustang Drive	Bridge	130	50%	4.17	65	17
Alum Creek Tributary 173	Pine Shadow Lane	Culverts	90	50%	4.17	45	18
Alum Creek Tributary 7	Kinsey Road	Bridge	180	20%	5.52	36	19
Price Creek	Jim Bowie Drive	Culverts	140	20%	5.52	28	20
Alum Creek	Gotier Trace Road	Bridge	50	50%	4.17	25	21
Alum Creek Tributary 1	Gotier Trace Road	Culverts	50	50%	4.17	25	21
Alum Creek Tributary 8	Bowie Drive	Culverts	50	50%	4.17	25	21
Alum Creek Tributary 87	Cardinal Loop	Culverts	120	20%	5.52	24	24
Alum Creek	Park Road 1C	Culverts	40	50%	4.17	20	25
Alum Creek Tributary 160	Park Road 1C	Culverts	40	50%	4.17	20	25
Alum Creek Tributary 9	Old Potato Road	Culverts	200	10%	6.82	20	25
Alum Creek Tributary 129	Quiet Drive	Culverts	30	50%	4.17	15	28
Alum Creek Tributary 129	Peaceful Lane	Culverts	10	50%	4.17	5	29
Alum Creek Tributary 8	Alamo Court	Culverts	10	50%	4.17	5	29
Alum Creek Tributary 9	McBride Lane	Culverts	10	50%	4.17	5	29

5.3 Road Crossing Alternatives

The urgency rating takes into consideration the risk of a roadway overtopping during a storm event The County selected the five roadway crossings located below based on repetitive damage, housing density, availability of alternative ingress and egress and immediate needs. Bastrop County does not have jurisdiction over State Highway 71/95 or State Highway 21 because these roads are under the jurisdiction of TxDOT roads. TxDOT is not a participating member in this FPP Grant. It is recommended Bastrop County share the urgency rating developed for this study with TxDOT's District Engineer, District Roadway Planning Engineer, and Bastrop Area Engineer to aid with planning and prioritizing roadway improvements. The location of these roadway crossings can be referenced in **Appendix A-6.** An alternative analysis of the following five crossings was conducted to identify potential improvements to reduce risk.

- Alum Creek Cardinal Drive crossing
- Alum Creek Tributary 1 Gotier Trace Road crossing
- Alum Creek Tributary 11 Cardinal Drive crossing
- Alum Creek Tributary 87 Cardinal Drive crossing
- Alum Creek Tributary 8 Ponderosa Loop crossing

Table 5-2 provides details of the existing condition structure and level of service, in addition to the proposed improvement, level of service, and estimate of probable cost for each structure. TxDOT's average low-bid unit prices was used to base the price of the individual bid items listed in the estimates of probable cost for the proposed roadway crossing improvements. Recent bid tabs for Bastrop County projects were used to develop bid items that are needed for each improvement. All structures existing conditions are overtopped during the 50% ACE storm.

TABLE 5-2: ROADWAY IMPROVEMENT SUMMARY

Road Crossing	Structure ID [Lat., Long.]	Existing Conditions		Proposed Improvement			
		Existing Culvert	Overtopping Event (ACE)	Culvert Improvement	Roadway Improvement	Overtopping Event (ACE)	Probable Cost Estimate
Alum Creek Cardinal Drive	AC_STR_700 [30.1905, -97.2037] & AC_STR_700_West [30.1903, -97.2044]	2 - 31" x 41" CMPs (west) 1 - 1.25' CMP (east)	50% (2-year)	2 - 4' x 3' RCBs (west) 4 - 4' x 2' RCBs (east)	310 LF of Raised Roadway	10% (10-year)	$545,000
Alum Creek Tributary 1 Gotier Trace	AC_T1_STR_100 [30.1045, -97.2095]	1 - 2.5' CMP	50% (2-year)	2 - 12' x 6' RCBs	300 LF of Raised Roadway 460 LF Channel Improvement	50% (2-year)	$533,900
Alum Creek Tributary 11 Cardinal Drive	AC_T11_STR_100 [30.1914, -97.2021]	4 - 4' CMPs	50% (2-year)	5 - 7' x 6' RCBs	360 LF of Raised Roadway	4% (25-year)	$719,200
Alum Creek Tributary 87 Cardinal Drive	AC_UN_STR_400 [30.1648, -97.2127]	2 - 4' CMPs	50% (2-year)	3 - 8' x 6' RCBs	100 LF of Raised Roadway	0.2% (500-year)	$351,900
Alum Creek Tributary 8 Ponderosa Loop	AC_T8_STR_300 [30.1822, -97.2096]	3 - 4' CMPs	50% (2-year)	3 - 8' x 5' RCBs	192 LF of Raised Roadway	4% (25-year)	$430,900

5.3.1 Road Crossing 1 – Alum Creek Cardinal Drive crossing

The crossing on Alum Creek on Cardinal Drive [Lat. 30.1905, Long. -97.2037] and the culvert structure approximately 250 feet west of the crossing [Lat. 30.1903, Long. -97.2044] are located in a residential area north of Highway 21. Hydraulic analysis shows existing condition Alum Creek overtopping Cardinal Drive to a depth of 1.1 feet during the 50% ACE and 3.7 feet during the 1% ACE at both structures.

To help reduce roadway inundation four 4 feet x 2 feet reinforced concrete box culverts on the east, two 4 feet x 3 feet concrete box culverts on the west, and approximately 310 linear feet of roadway profile changes with an elevation increase of 1.0 foot is recommended. Extended channel improvements were not necessary for this crossing because the small pond just downstream of the crossing mitigates impacts of the improved crossing. However, the channel immediately adjacent to the roadways will need to be widened to accommodate the culverts.

The proposed culverts do not meet the Bastrop County Subdivision Regulations to pass the 4% ACE. However, the water surface elevations for the more frequent 50% and 20% ACE are reduced below the proposed top of road elevations as displayed in **Appendix H-2**. An estimate of probable cost for the proposed roadway crossing improvements is shown in **Appendix H-3** which was determined to be $545,000.

5.3.2 Road Crossing 2 – Alum Creek Tributary 1 Gotier Trace Road crossing

The crossing on Gotier Trace Road is located near the center of the watershed [Lat. 30.1045, Long. -97.2095]. Hydraulic analysis shows existing condition Alum Creek Tributary 1 overtopping Gotier Trace Road to a depth of 1.8 feet during the 50% ACE and 3.9 feet during the 1% ACE.

To help reduce roadway inundation, two 12 feet x 6 feet reinforced concrete box culverts, approximately 300 linear feet of roadway profile changes with an elevation increase of 1.0 foot, and channel improvements are proposed. The proposed channel improvements extend approximately 275 feet upstream and approximately 180 feet downstream of the structure in order to reduce the channel slope from 3% to 1% and lower the flowline of the crossing by 3.2 feet for installation of the larger culverts. Additionally, the channel will need to be widened to accommodate the new culverts.

The proposed culverts do not meet the Subdivision Regulations for Bastrop County to pass the 4% ACE and are still overtopped by all the storm events. However, the overtopping depths of 50% and 1% ACE were reduced to 0.4 feet and 2.0 feet, respectively, as seen in **Appendix H-2.** An estimate of probable cost for the proposed roadway crossing improvements is shown in **Appendix H-3** which was determined to be $533,900.

5.3.3 Road Crossing 3 – Alum Creek Tributary 11 Cardinal Drive crossing

The crossing on Cardinal Drive on Alum Creek Tributary 11 is approximately 600 feet east of the Cardinal Drive crossing on Alum Creek [Lat. 30.1914, Long. -97.2021]. Hydraulic analysis shows the overtopping of Cardinal Drive to a depth of almost 1.0 feet during the 50% ACE and 2.9 feet during the 1% ACE.

To help reduce roadway inundation, five 7 feet x 6 feet reinforced concrete box culverts and approximately 360 linear feet of roadway profile changes with an elevation increase of 1.0 foot are proposed. The channel will need to be widened to accommodate the new culverts.

The proposed culverts do not meet the Subdivision Regulations for Bastrop County to pass the 4% ACE. However, they fully convey the 50%, 20%, and 10% ACE storms, as seen in **Appendix H-2.** A detailed cost estimate for the proposed roadway crossing improvements is shown in **Appendix H-3** which was determined to be $719,200.

5.3.4 Road Crossing 4 – Alum Creek Tributary 87 Cardinal Drive crossing

The crossing on Cardinal Drive is approximately a third of a mile off of Highway 21 in a residential area [Lat. 30.1648, Long. -97.2127]. Hydraulic analysis shows the overtopping of Cardinal Drive to a depth of almost 0.2 feet during the 50% ACE and 1.9 feet during the 1% ACE.

To help reduce roadway inundation, three 8 feet x 6 feet reinforced concrete box culverts and approximately 100 linear feet of roadway profile changes with an elevation increase of 1.0 foot are proposed. The channel will need to be widened to accommodate the new culverts.

The proposed culverts meet the Subdivision Regulations for Bastrop County to pass the 4% ACE and fully convey the 50%, 20%, 10%, 4%, 2%, and 1% ACE storms, as seen in **Appendix H-2**. An estimate of probable cost for the proposed roadway crossing improvements is shown in **Appendix H-3** which was determined to be $351,900.

5.3.5 Road Crossing 5 – Alum Creek Tributary 8 Ponderosa Loop crossing

The crossing on Ponderosa Loop is located in a residential area north of Highway 21 [Lat. 30.1822, Long. -97.2096]. Hydraulic analysis shows the overtopping of Ponderosa Loop to a depth of almost 0.6 feet during the 50% ACE and 2.7 feet during the 1% ACE.

To help reduce roadway inundation three 8 feet x 5 feet reinforced concrete box culverts and approximately 190 linear feet of roadway profile changes with an elevation increase of 1.0 foot are proposed. The channel will need to be widened to accommodate the new culverts.

The proposed culverts do not meet the Subdivision Regulations for Bastrop County to pass the 4% ACE. However, they fully convey the 50%, 20%, and 10% ACE storms, as seen in **Appendix H-2**. A detailed cost estimate for the proposed roadway crossing improvements is shown in **Appendix H-3** which was determined to be $430,900.

5.4 Regional Detention Pond Alternative

The hydrologic and hydraulic analysis developed in this study was used to identify areas of flood risk. There are currently 22 homes within the 1% ACE existing condition floodplain in the upper portion of the watershed at the confluence of Alum Creek and Alum Creek Tributary 9. A regional detention pond would decrease the existing conditions floodplain elevations by temporarily detaining flood waters for later release in order to alter the timing and magnitude of peak flows. The resultant reduction of peak flows reduces flood risk for the residences downstream of the pond. The proposed location for the regional detention is in a sparsely populated area of the County and in a naturally depressed area along Alum Creek.

A conceptual regional detention pond located in the upper portion of the watershed at the confluence of Alum Creek and Alum Creek Tributary 9. Detention in this location will reduce peak flows further downstream along Alum Creek to lower flood elevations during a 1% ACE storm. The detention pond would only hold water during a storm event; otherwise, it will be a dry pond. As an in-line structure (dam) along Alum Creek, this potential regional detention would be created within a natural basin that could be spanned by an approximately 1,700-foot long earthen embankment. The regional detention facility would have a contributing drainage area of 12.9 square miles with a 16-foot high dam (top elevation at 641 feet) that could store approximately 625 acre-feet of water as shown in **Exhibit A-7**. An earthen embankment of this size would be classified by TCEQ Dam Safety as a Small, High Hazard dam due to homes located downstream of the embankment. This TCEQ classification of dam would require continued maintenance in perpetuity.

Hydrologic analysis of the conceptual detention facility reduced the 1% ACE peak flow at the confluence of Alum Creek and Alum Creek Tributary 9 by approximately 64%. To achieve this 64% reduction, the outfall structure would be designed to release 10,800 cfs during the 1% ACE storm event. This reduction of peak flow was entered into the Alum Creek hydraulic model that resulted in a slight reduction of the 1% ACE flood elevations as shown in **Exhibit A-7**. The regional detention alternative removes 12 homes from the 1% ACE water elevations. However, the hydrologic and hydraulic evaluation of a conceptual detention facility resulted in minimal reductions to the 1% ACE floodplain.

5.4.2 Benefit Cost Analysis

A benefit to cost ratio was prepared to provide a comparison of the existing hydrology and hydraulic data to the proposed hydrology and hydraulic data. This data, along with information from Bastrop County's Appraisal District website regarding property and infrastructure values is compared to the cost of constructing the proposed detention pond. The estimated probable cost of constructing the detention facility is $4,518,000 and is shown in **Appendix H-3.** The benefit to cost ratio of constructing a detention facility is well below one at 0.01, causing this alternative to be cost prohibitive. This analysis of feasibility is shown in **Appendix H-4** High density development is not anticipated within the Alum Creek watershed due to Subdivision Ordinance requiring new developments to have less than 20% impervious cover and restrictions due to threatened and endangered species in the area. Therefore, a simplified BCA was found to be sufficient. The cost of buy outs for the 16 structures within the floodplain is $4,119,852 and does not include maintenance costs; therefore, buying out the properties is more feasible than constructing a dam. A benefit to cost ratio was not prepared for the acquisition of the 16 structures that remain within the floodplain because the buyout option per a FEMA guidance that acquisitions less than $276,000 are considered cost effective. In addition, due to the height and storage volume of the conceptual regional detention, this detention facility would require design to meet TCEQ Dam Safety requirement.

6.0 FLOOD MONITORING EVALUATION

Flood resilience includes a variety of strategy. A common strategic particularly common in Flash Flood Ally is flood monitoring. Flood monitoring via the use of gaging stations provides real-time information to the public and emergency personnel during storm events. Opportunities identified for Alum Creek include identifying roadway overtopping risk, locations for stream gage placement, and flood monitoring systems. Implementation of a flood monitoring system could reduce the use of county resources during storm events and improve safety of residents.

6.1 Roadway Overtopping Risk Determination

As part of this study, an urgency rating was developed for 31 roadways in the Alum Creek watershed that overtop during storm events. **Table 5-1** above shows the equivalent rainfall depth for the storm events that would overtop these roadway crossings. It should be noted that Atlas 14, 24-hour storm duration rainfall depths were used in this analysis and the minimum roadway elevations were retrieved from the hydraulic models. The County may utilize this information to monitor rainfall gages within the watershed and deploy road crews to close road crossings with greater confidence.

6.2 Stream Gage Placement Opportunities

Stream gage placement is ideal along critical roadways and low water crossings that serve as the only point of ingress or egress for residents. As such, gage placement along the Alum Creek crossings of State Highway (SH) 21 and SH 71 are proposed. **Figure 6-1** below displays these potential stream gage placements at SH 21 and SH 71. These two roadways have the greatest Annual Average Daily Traffic within the watershed and therefore are a public safety threat when overtopped. Two common gaging devices include real-time precipitation gages and stream stage gages. Following implementation of gaging stations, development of rating curves and observation of gage data at specific locations can be established with alerting triggers during storm events. These triggers can activate on-site safety measures such as automated flood gate closure or flood warning lights. These gaging networks and devices monitor developing flood threats and either activate on-site safety measures or send alerts to emergency personnel and the public.

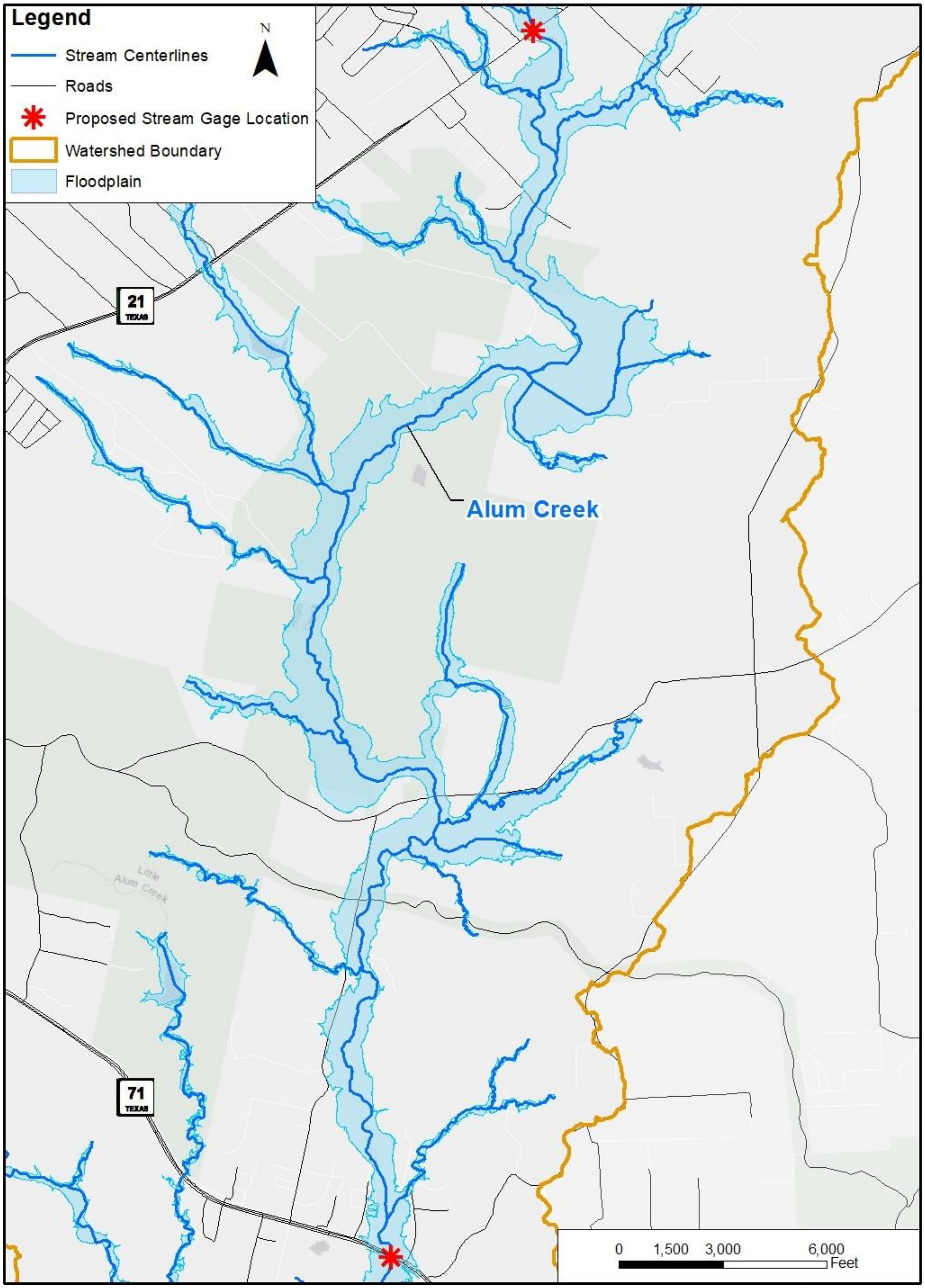


FIGURE 6-1: PROPOSED STREAM GAGE LOCATIONS

6.3 Flood Hazard Web Map

Many entities such as the Upper Brushy Creek Water Control and Improvement District and Hays County are using Flood Monitoring Systems with the development of interactive web maps. A public and/or secured web map can be developed for the public and emergency personnel to monitor flood risk within the County. Of particular interest in this study, would be road closures and flood threat within the Alum Creek watershed. Common components of these web maps include stream gage readings, colored symbology to visualize flood threat, and display of inundation mapping. Frequency floodplains for storm events can be accessed in a secured Flood Monitoring System that displays real-time inundation levels associated with flood gage readings, radar rainfall, and NWS rainfall. These web maps can be developed to leverage existing information such as the City of Austin ATX Floods data, the Lower Colorado River Authority Hydromet, and the US Geologic Survey gaging and inundation data. The City of Austin ATX Floods website allows the County to manually log into the website and identify low water crossings that are closed due to high water. Once stream gages are installed, these closure notifications could be automatic. A Flood Monitoring System and associated web map would enhance the County's ability to makes real time decisions regarding flood risk thus improving public safety.

6.3.1 Automated Creek Crossing Alerts

Stream gages on creek crossings can activate triggers to alert residents of high water at road crossings. Once an alert is triggered by a particular gage reading, signal lights can be activated, text alerts can be activated, and/or flood gates can be automatically closed at the crossing. The roadway closure and/or flashing light warnings would notify drivers that the road is unsafe to cross.

Appendix A: Exhibits

A-1 Watershed Overview

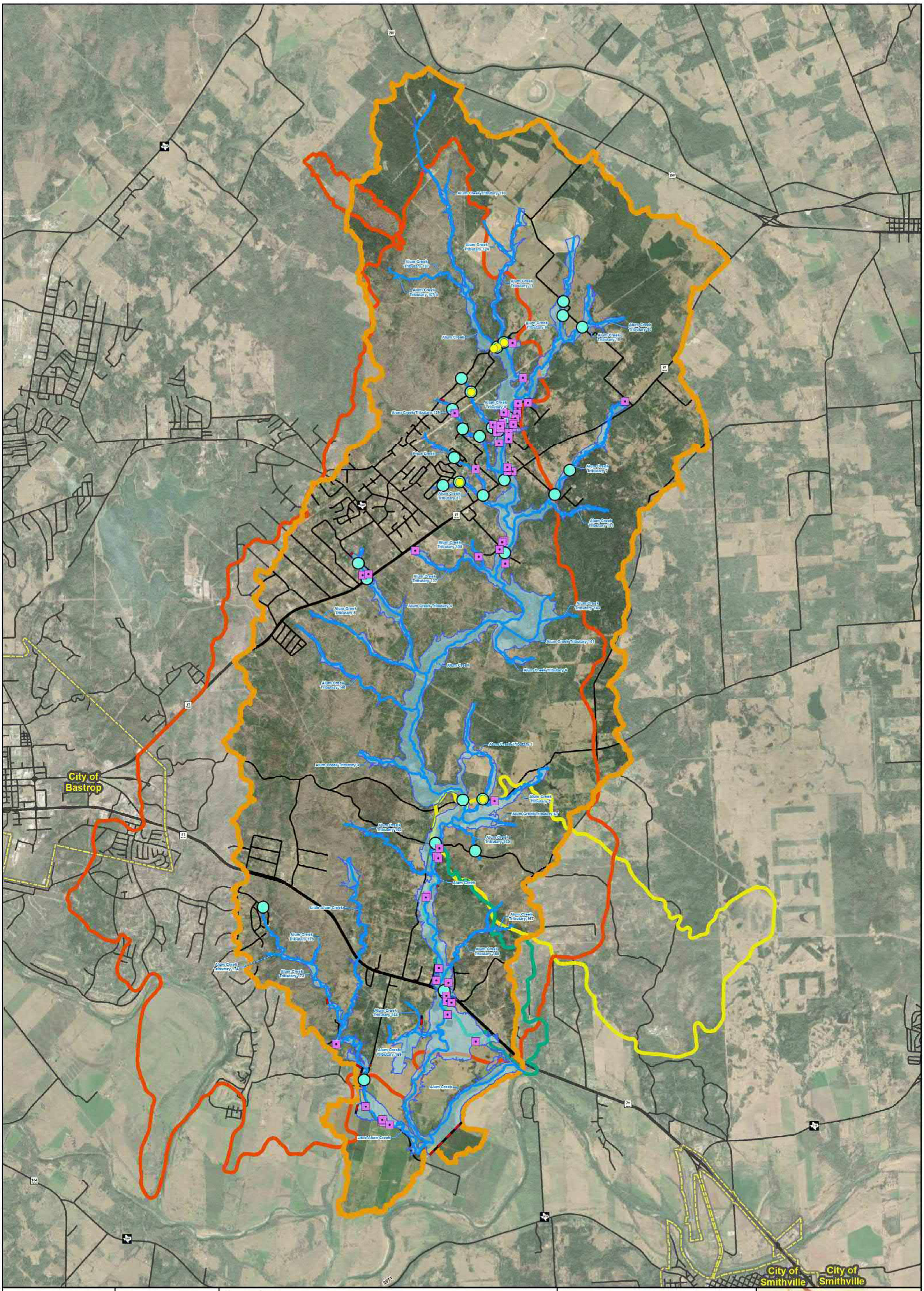


Exhibit A-1
Watershed Overview

Overview

Legend

- Overtopped Road Crossing
- Structures in 100yr Floodplain
- Roadway Improvements
- Stream Centerlines
- Limit of Study
- Roads
- Watershed Boundary
- Floodplain
- Bastrop Complex Fire Perimeter
- Hidden Pines Fire Boundary
- Wilderness Ridge Fire Perimeter
- City Boundary

N

0 6,000 12,000 Feet

1 inch = 6,000 feet

THE STATE OF TEXAS COUNTY OF BASTROP

HALFF

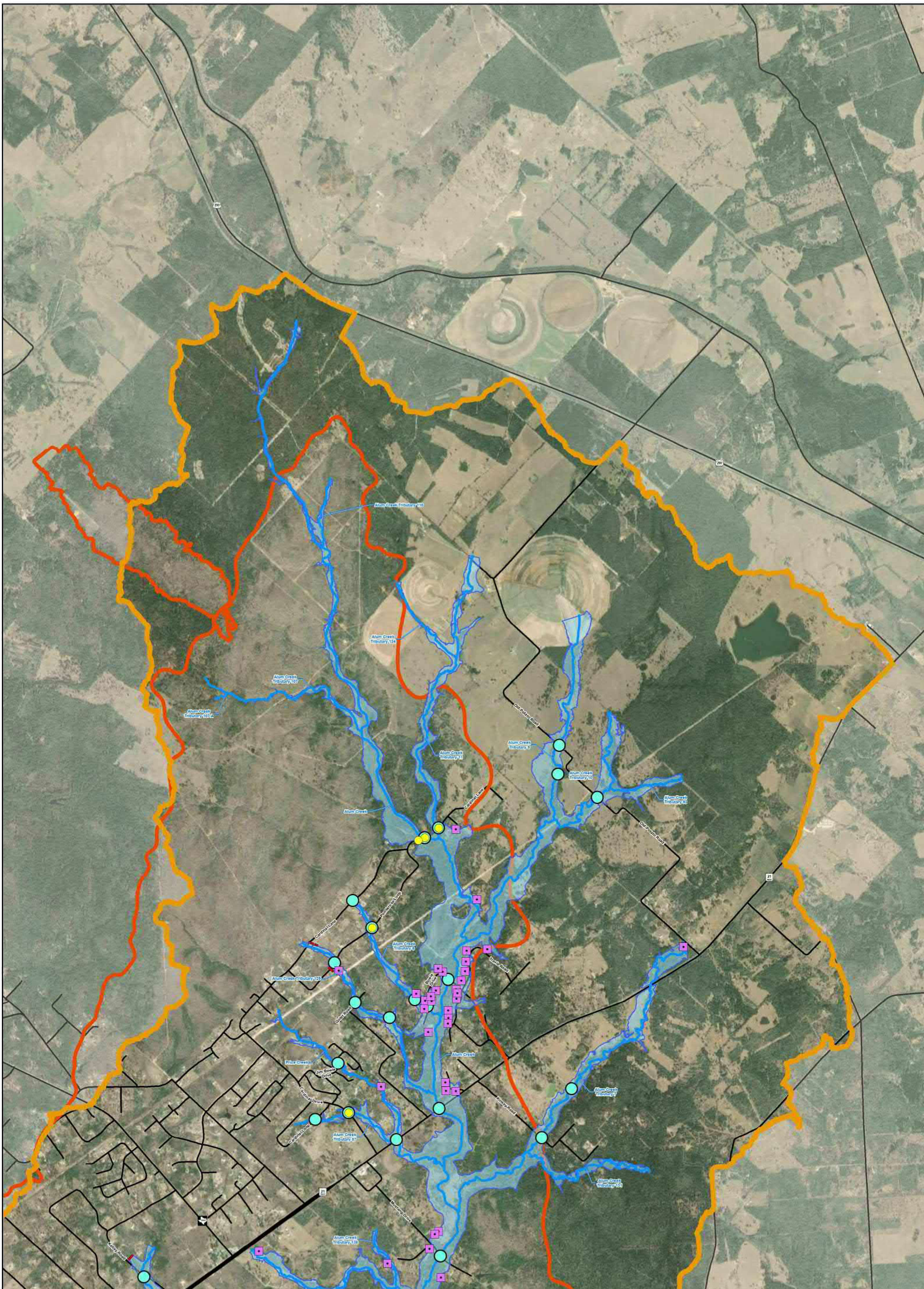


Exhibit A-1
Watershed Overview

Upper Watershed

THE STATE OF TEXAS
COUNTY OF BASTROP

HALFF

Legend

- Overtopped Road Crossing
- Structures in 100yr Floodplain
- Roadway Improvements
- Stream Centerlines
- Limit of Study
- Roads
- Watershed Boundary
- Floodplain
- Bastrop Complex Fire Perimeter

N

0 3,000 6,000 Feet

1 inch = 3,000 feet

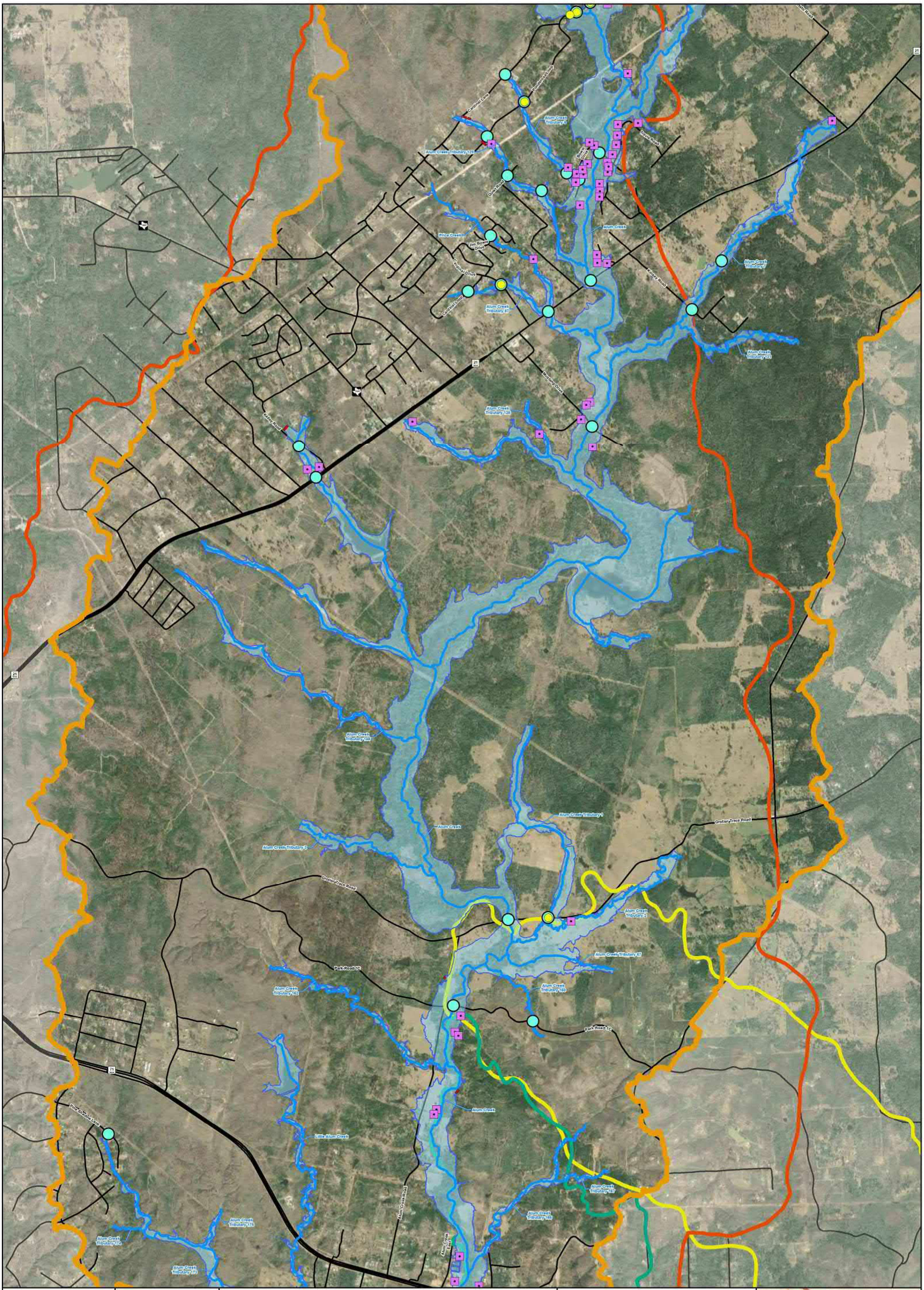


Exhibit A-1 Watershed Overview	Mid Watershed

HALFF

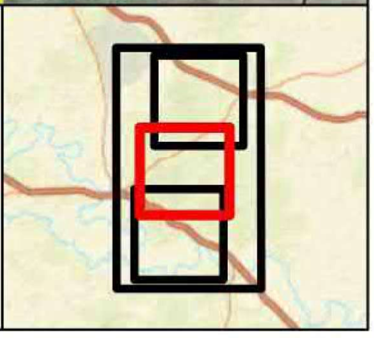
Legend

- Overtopped Road Crossing
- Structures in 100yr Floodplain
- Roadway Improvements
- Stream Centerlines
- Limit of Study
- Roads
- Watershed Boundary
- Floodplain
- Bastrop Complex Fire Perimeter
- Hidden Pines Fire Boundary
- Wilderness Ridge Fire Perimeter

N

0 3,000 6,000 Feet

1 inch = 3,000 feet



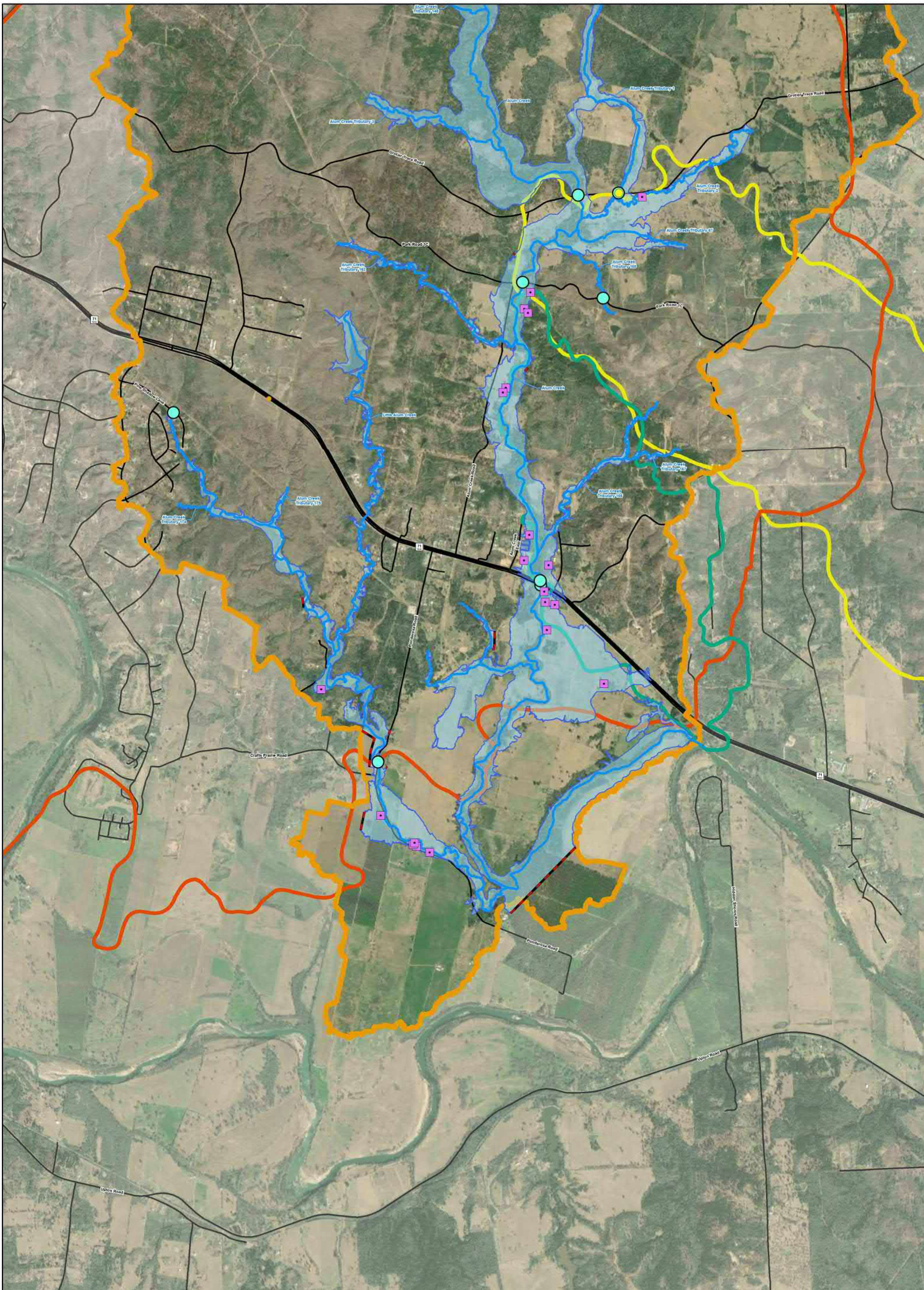


Exhibit A-1
Watershed Overview

Lower Watershed

HALFF

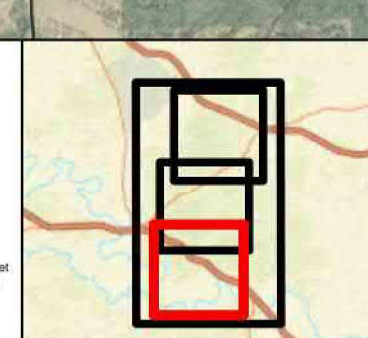
Legend

- Overtopped Road Crossing
- Structures in 100yr Floodplain
- Roadway Improvements
- Stream Centerlines
- Limit of Study
- Roads
- Watershed Boundary
- Floodplain
- Bastrop Complex Fire Perimeter
- Hidden Pines Fire Boundary
- Wilderness Ridge Fire Perimeter

N

0 3,000 6,000 Feet

1 inch = 3,000 feet



Appendix A: Exhibits

A-2 Subbasin Map

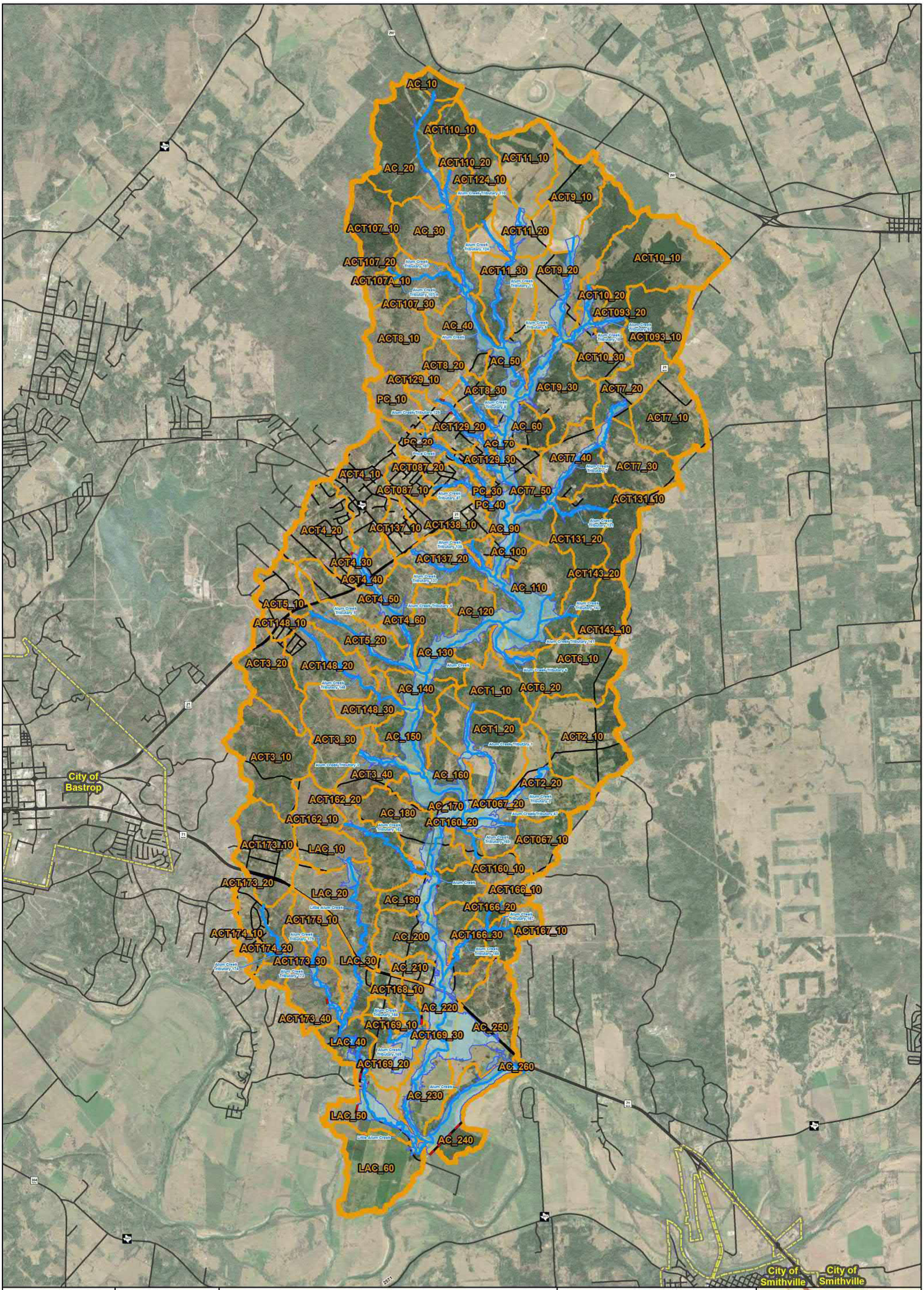


Exhibit A-2 Subbasin Map

Overview

Legend

- Stream Centerlines
- Limit of Study
- Roads
- Alum Creek Subbasins
- Floodplain
- City Boundary

N

0 6,000 12,000 Feet

1 inch = 6,000 feet

THE STATE OF TEXAS COUNTY OF BASTROP

HALFF

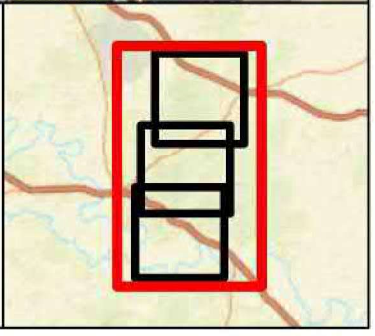


Exhibit A-2
Subbasin Map

Upper Watershed

THE STATE OF TEXAS COUNTY OF BASTROP

HALFF

Legend

- Stream Centerlines
- Limit of Study
- Roads
- Alum Creek Subbasins
- Floodplain

N

0 3,000 6,000 Feet

1 inch = 3,000 feet

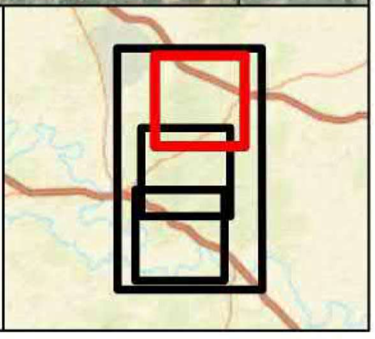


Exhibit A-2 Subbasin Map

Mid Watershed

THE STATE OF TEXAS COUNTY OF BASTROP

HALFF

Legend

- Stream Centerlines
- Limit of Study
- Roads
- Alum Creek Subbasins
- Floodplain

N

0 3,000 6,000 Feet

1 inch = 3,000 feet

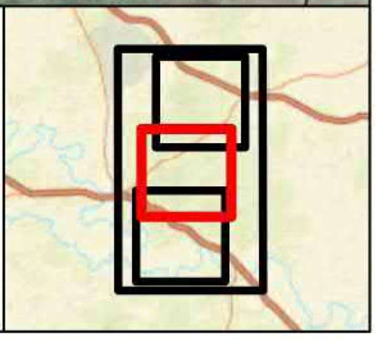


Exhibit A-2 Subbasin Map	Lower Watershed

Legend

- Stream Centerlines
- Limit of Study
- Roads
- Alum Creek Subbasins
- Floodplain

N

0 3,000 6,000 Feet

1 inch = 3,000 feet

THE STATE OF TEXAS COUNTY OF BASTROP

HALFF

Appendix A: Exhibits

A-3 Soil Map

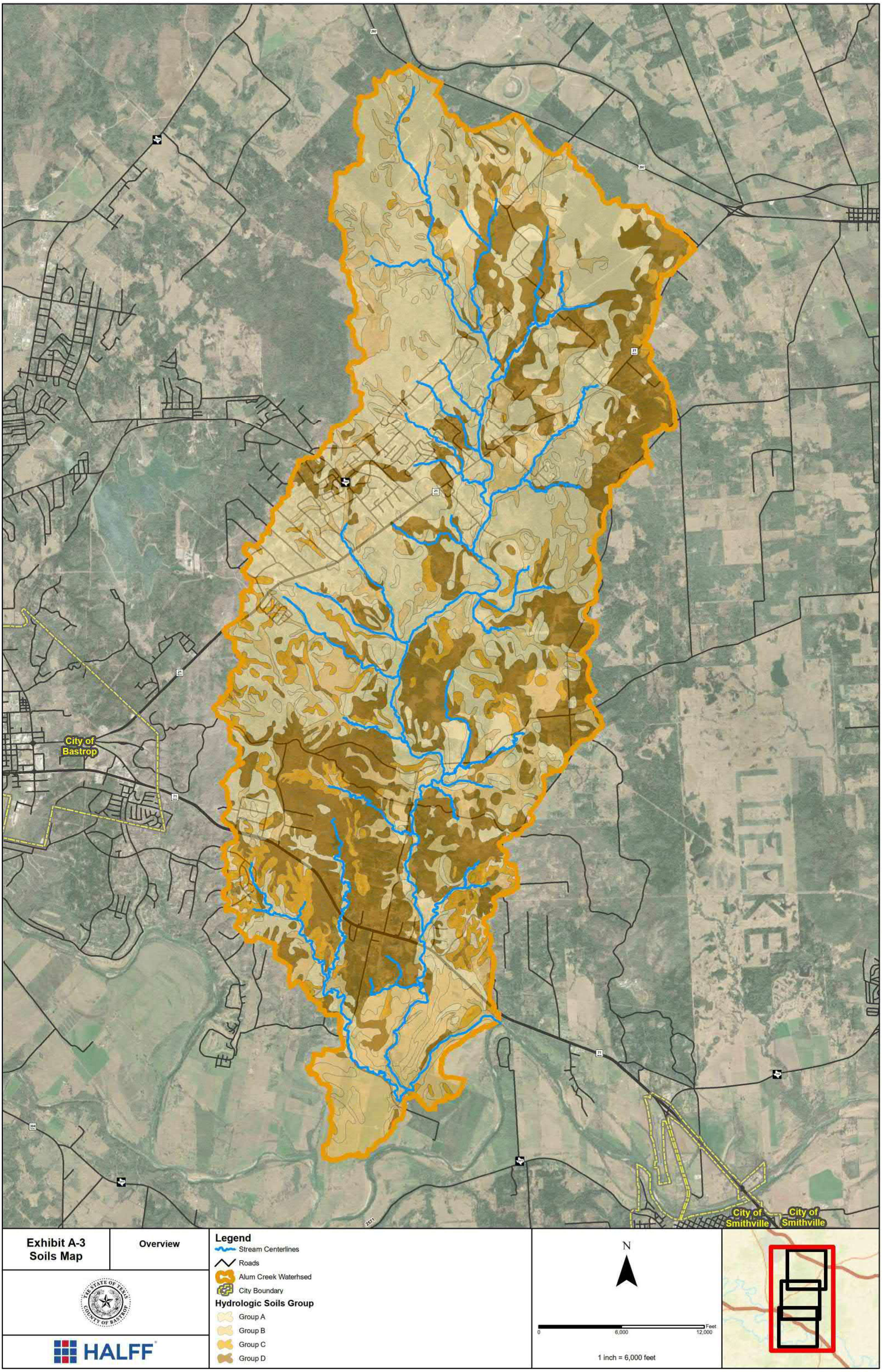


Exhibit A-3
Soils Map

Overview

HALFF

Exhibit A-3
Soils Map

Upper Watershed

THE STATE OF TEXAS
COUNTY OF BASTROP

HALFF

Legend

Stream Centerlines
Roads
Alum Creek Waterhsed

Hydrologic Soils Group

Group A
Group B
Group C
Group D

N

0 3,000 6,000 Feet

1 inch = 3,000 feet

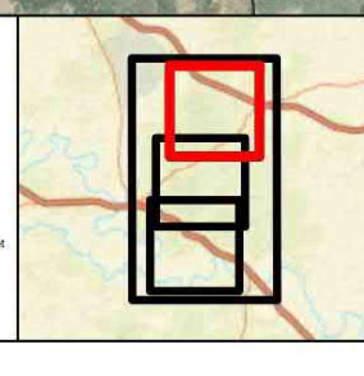


Exhibit A-3 Soils Map	Mid Watershed

THE STATE OF TEXAS · COUNTY OF BASTROP

HALFF

Legend

- Stream Centerlines
- Roads
- Alum Creek Waterhsed

Hydrologic Soils Group

- Group A
- Group B
- Group C
- Group D

N

0 3,000 6,000 Feet

1 inch = 3,000 feet

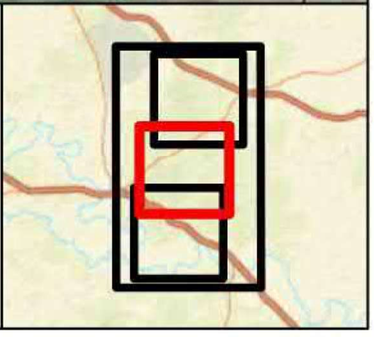


Exhibit A-3
Soils Map

Lower Watershed

THE STATE OF TEXAS · COUNTY OF BASTROP

HALFF

Legend

- Stream Centerlines
- Roads
- Alum Creek Waterhsed

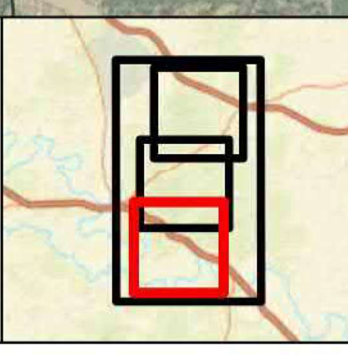
Hydrologic Soils Group

- Group A
- Group B
- Group C
- Group D

N

0 3,000 6,000 Feet

1 inch = 3,000 feet



Appendix A: Exhibits

A-4 Landuse Map

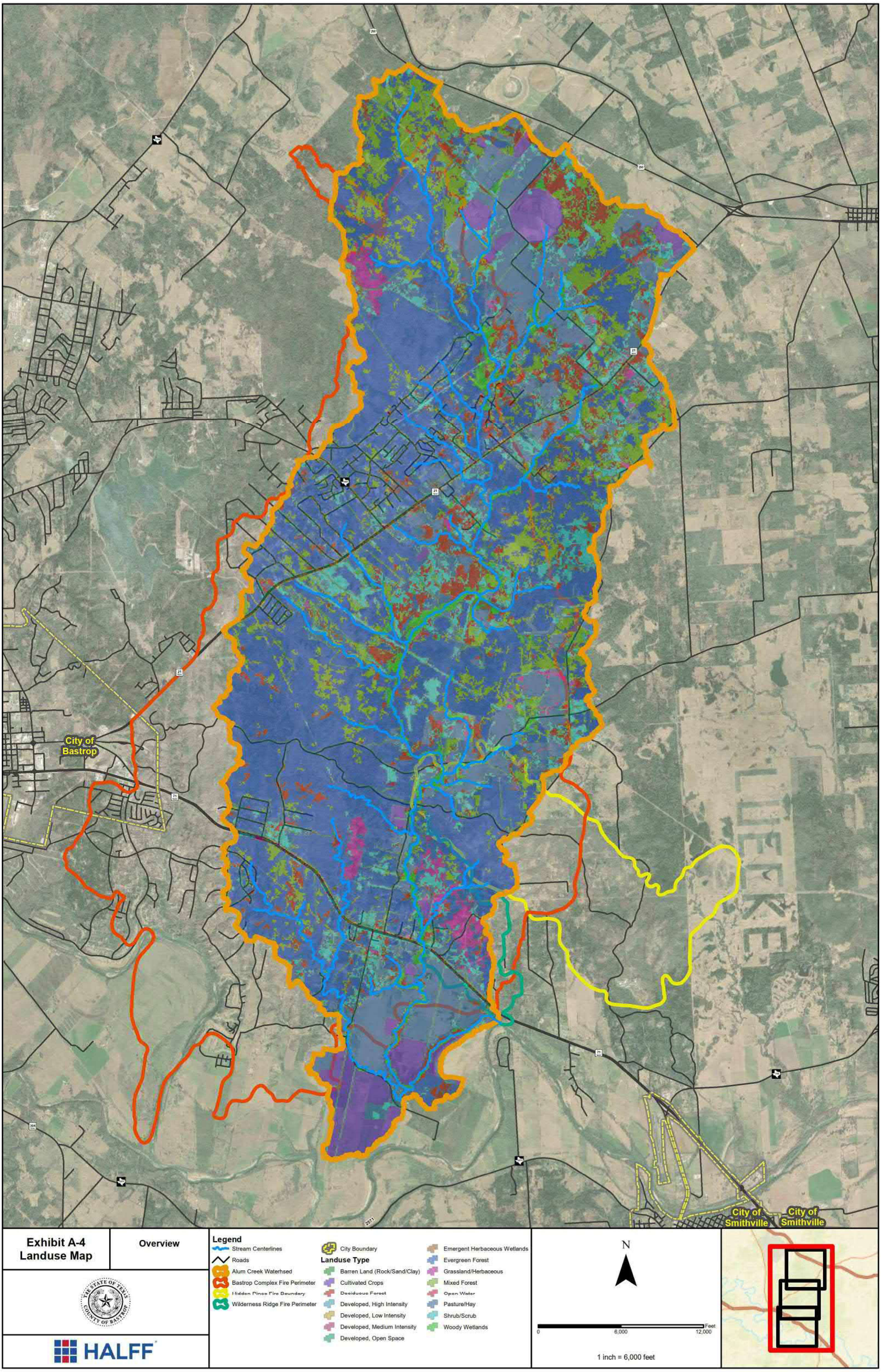


Exhibit A-4
Landuse Map

Overview

THE STATE OF TEXAS COUNTY OF BASTROP

HALFF

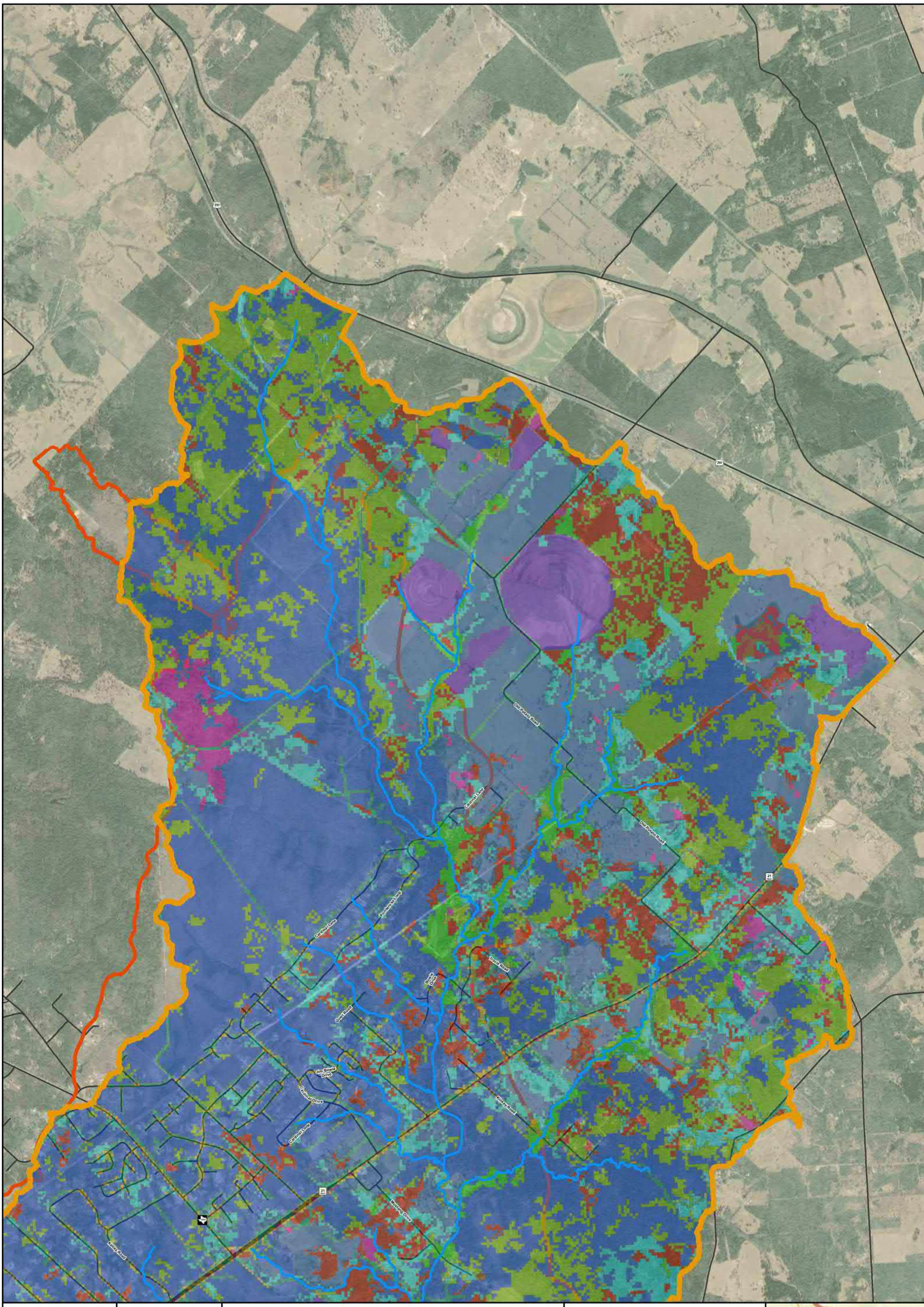


Exhibit A-4
Landuse Map

Upper Watershed

Legend

- Stream Centerlines
- Roads
- Alum Creek Waterhsed
- Bastrop Complex Fire Perimeter

Landuse Type

- Barren Land (Rock/Sand/Clay)
- Cultivated Crops
- Deciduous Forest
- Developed, High Intensity
- Developed, Low Intensity
- Developed, Medium Intensity
- Developed, Open Space
- Emergent Herbaceous Wetlands
- Evergreen Forest
- Grassland/Herbaceous
- Mixed Forest
- Open Water
- Pasture/Hay
- Shrub/Scrub
- Woody Wetlands

N

0 3,000 6,000 Feet

1 inch = 3,000 feet

THE STATE OF TEXAS COUNTY OF BASTROP

HALFF

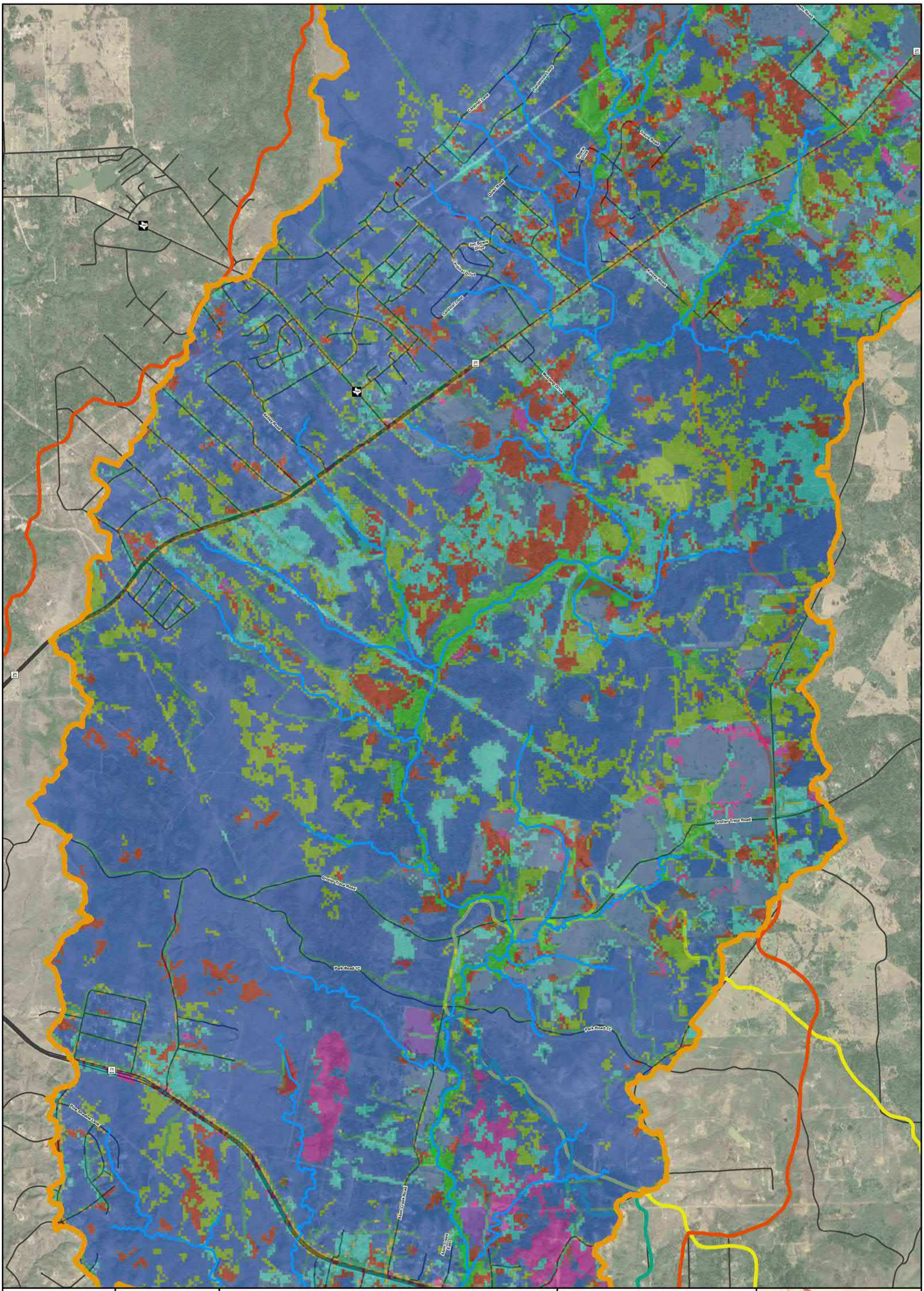


Exhibit A-4
Landuse Map

Mid Watershed

THE STATE OF TEXAS · COUNTY OF BASTROP

HALFF

Legend

- Stream Centerlines
- Roads
- Alum Creek Waterhsed
- Bastrop Complex Fire Perimeter
- Hidden Pines Fire Boundary
- Wilderness Ridge Fire Perimeter

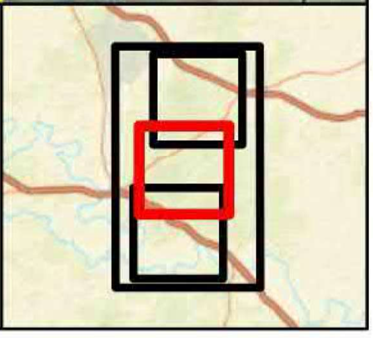
Landuse Type

- Cultivated Crops
- Deciduous Forest
- Developed, High Intensity
- Developed, Low Intensity
- Developed, Medium Intensity
- Developed, Open Space
- Emergent Herbaceous Wetlands
- Evergreen Forest
- Grassland/Herbaceous
- Mixed Forest
- Open Water
- Pasture/Hay
- Shrub/Scrub
- Woody Wetlands

N

0 3,000 6,000 Feet

1 inch = 3,000 feet



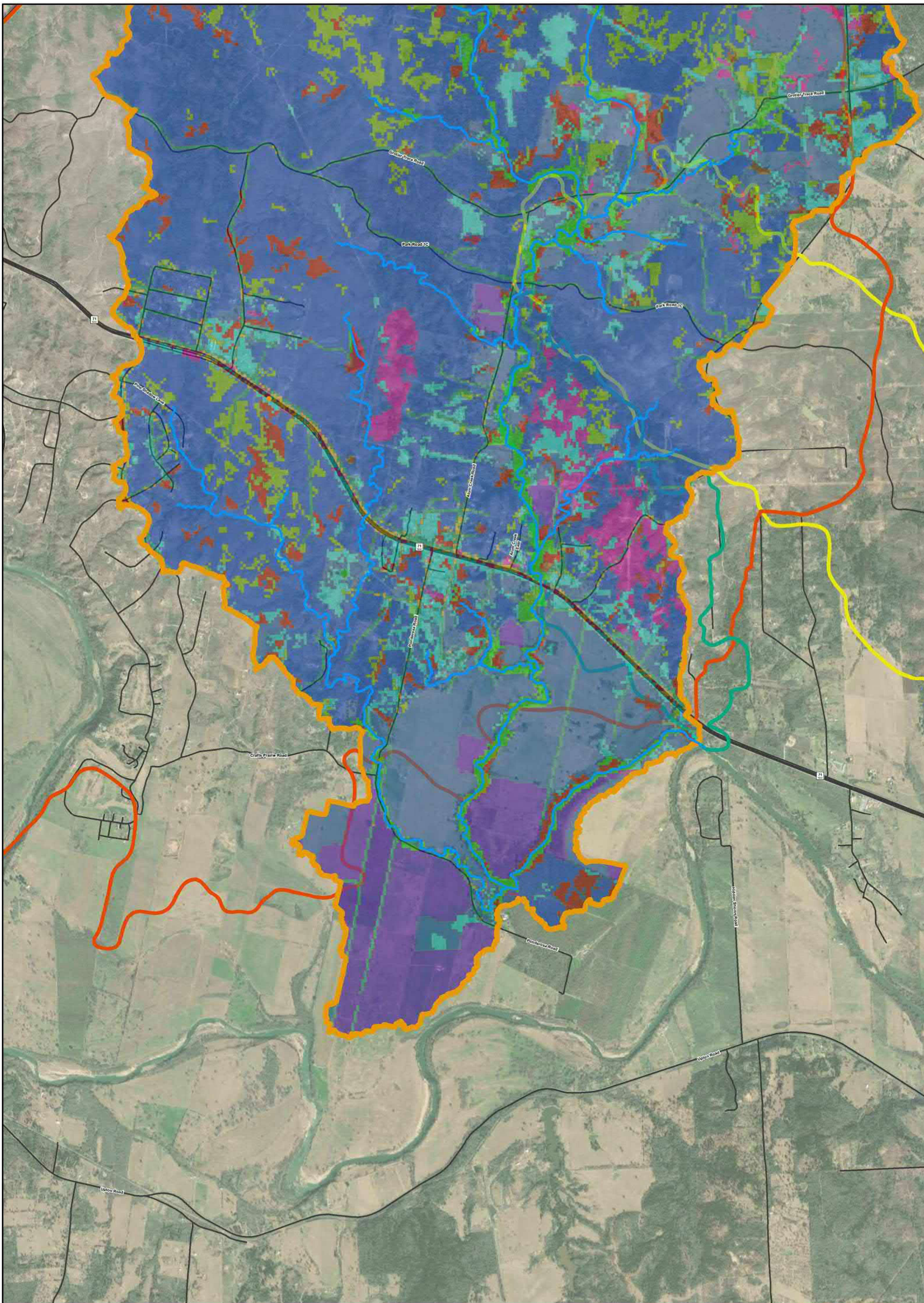


Exhibit A-4
Landuse Map

Lower Watershed

Legend

- Stream Centerlines
- Roads
- Alum Creek Watershed
- Bastrop Complex Fire Perimeter
- Hidden Pines Fire Boundary
- Wilderness Ridge Fire Perimeter

Landuse Type

- Barren Land (Rock/Sand/Clay)
- Cultivated Crops
- Deciduous Forest
- Developed, High Intensity
- Developed, Low Intensity
- Developed, Medium Intensity
- Developed, Open Space
- Emergent Herbaceous Wetlands
- Evergreen Forest
- Grassland/Herbaceous
- Mixed Forest
- Open Water
- Pasture/Hay
- Shrub/Scrub
- Woody Wetlands

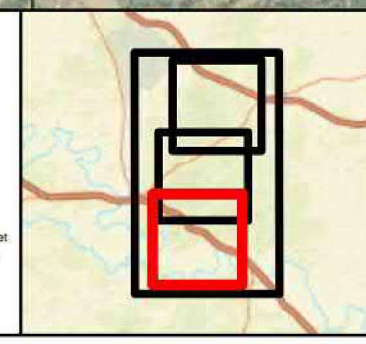
N

0 3,000 6,000 Feet

1 inch = 3,000 feet

THE STATE OF TEXAS · COUNTY OF BASTROP

HALFF



Appendix A: Exhibits

A-5 Percent Impervious Map

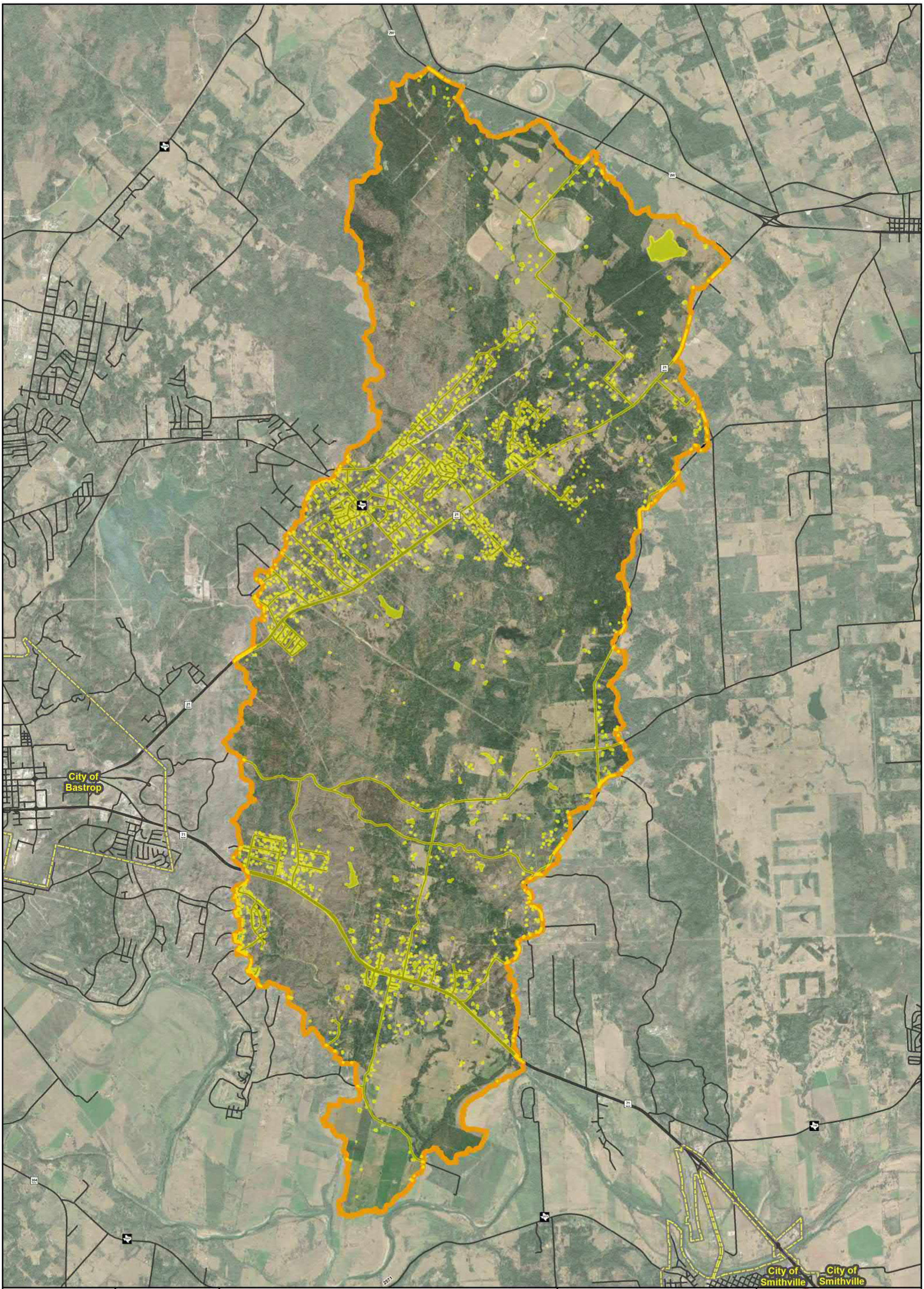


Exhibit A-5 Impervious Cover Map

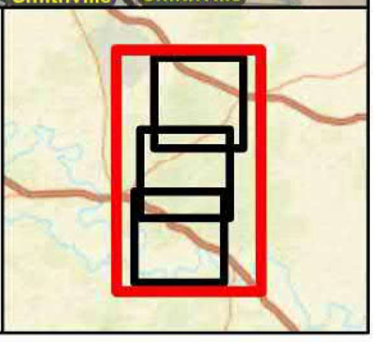
Overview

Legend
- Roads
- Alum Creek Waterhsed
- City Boundary
- Impervious Cover

N

0 — 6,000 — 12,000 Feet

1 inch = 6,000 feet



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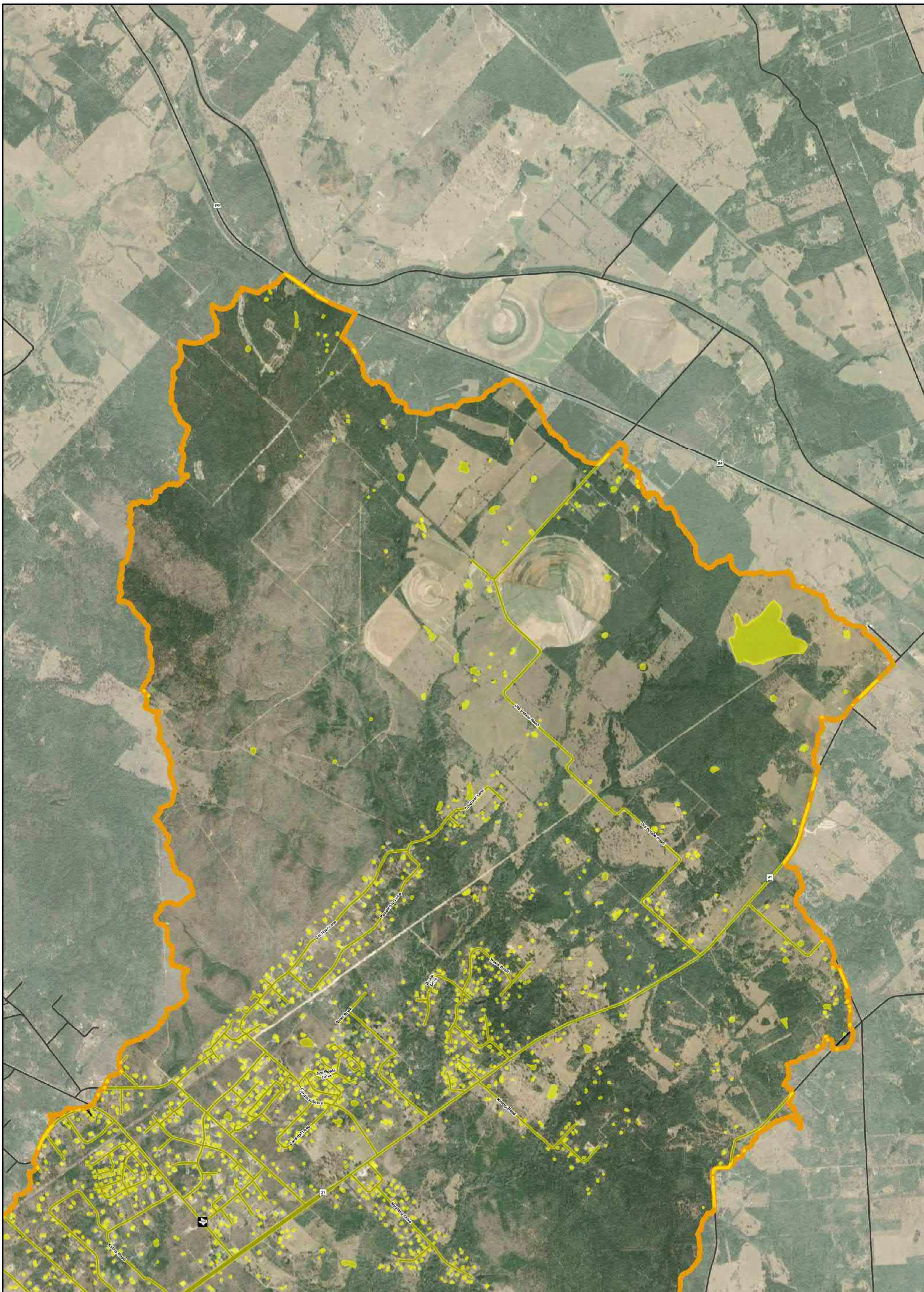


Exhibit A-5 Impervious Cover Map	Upper Watershed

HALFF

Legend

Roads

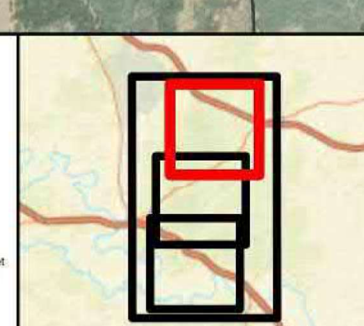
Alum Creek Waterhsed

Impervious Cover

N

0 3,000 6,000 Feet

1 inch = 3,000 feet



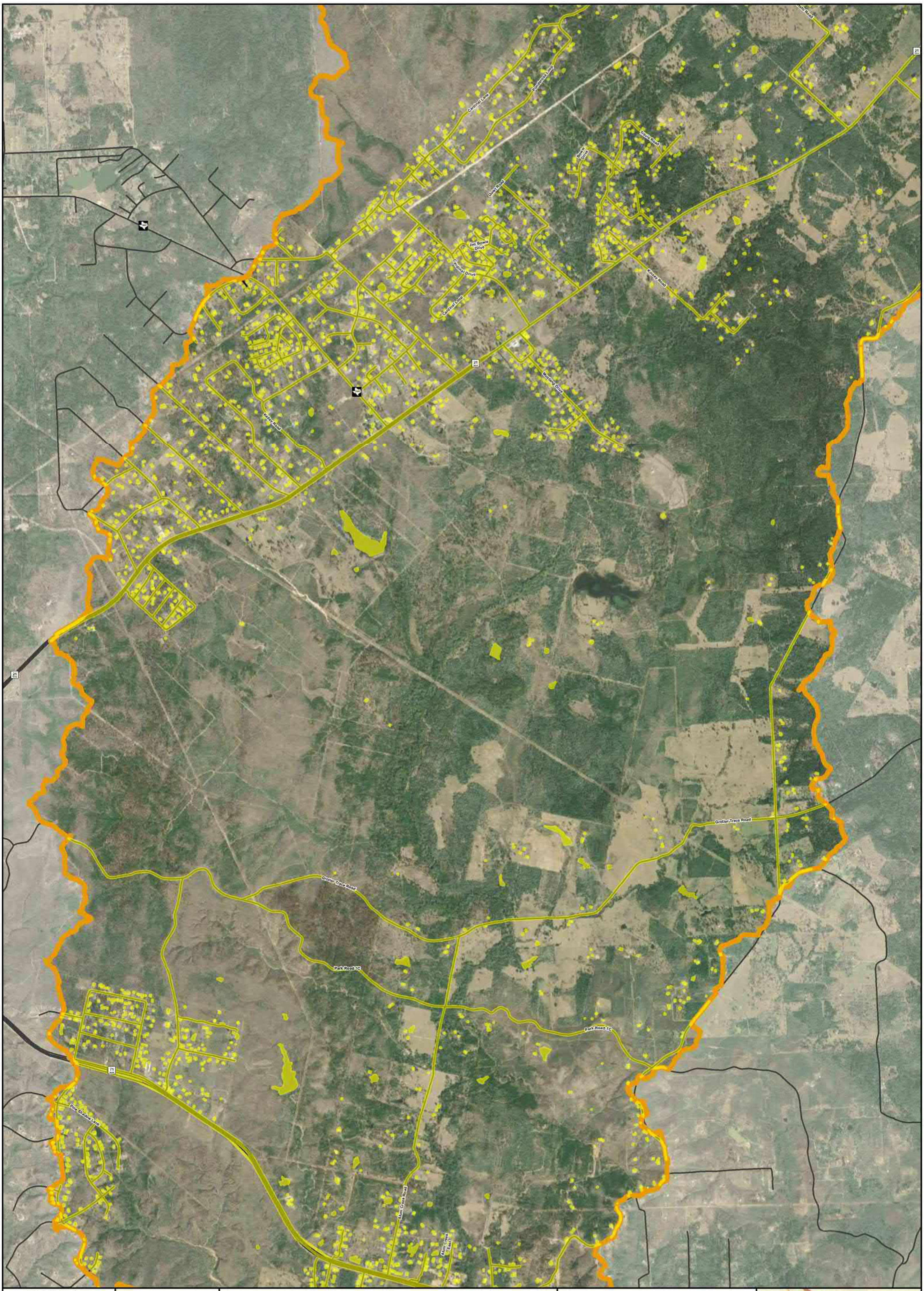


Exhibit A-5 Impervious Cover Map

Mid Watershed

Legend

Roads

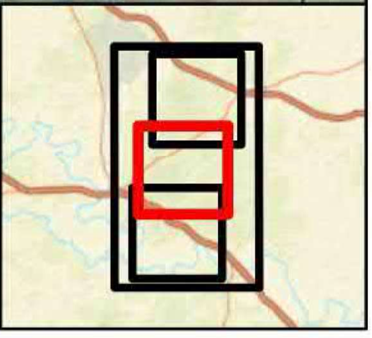
Alum Creek Waterhsed

Impervious Cover

N

0 3,000 6,000 Feet

1 inch = 3,000 feet



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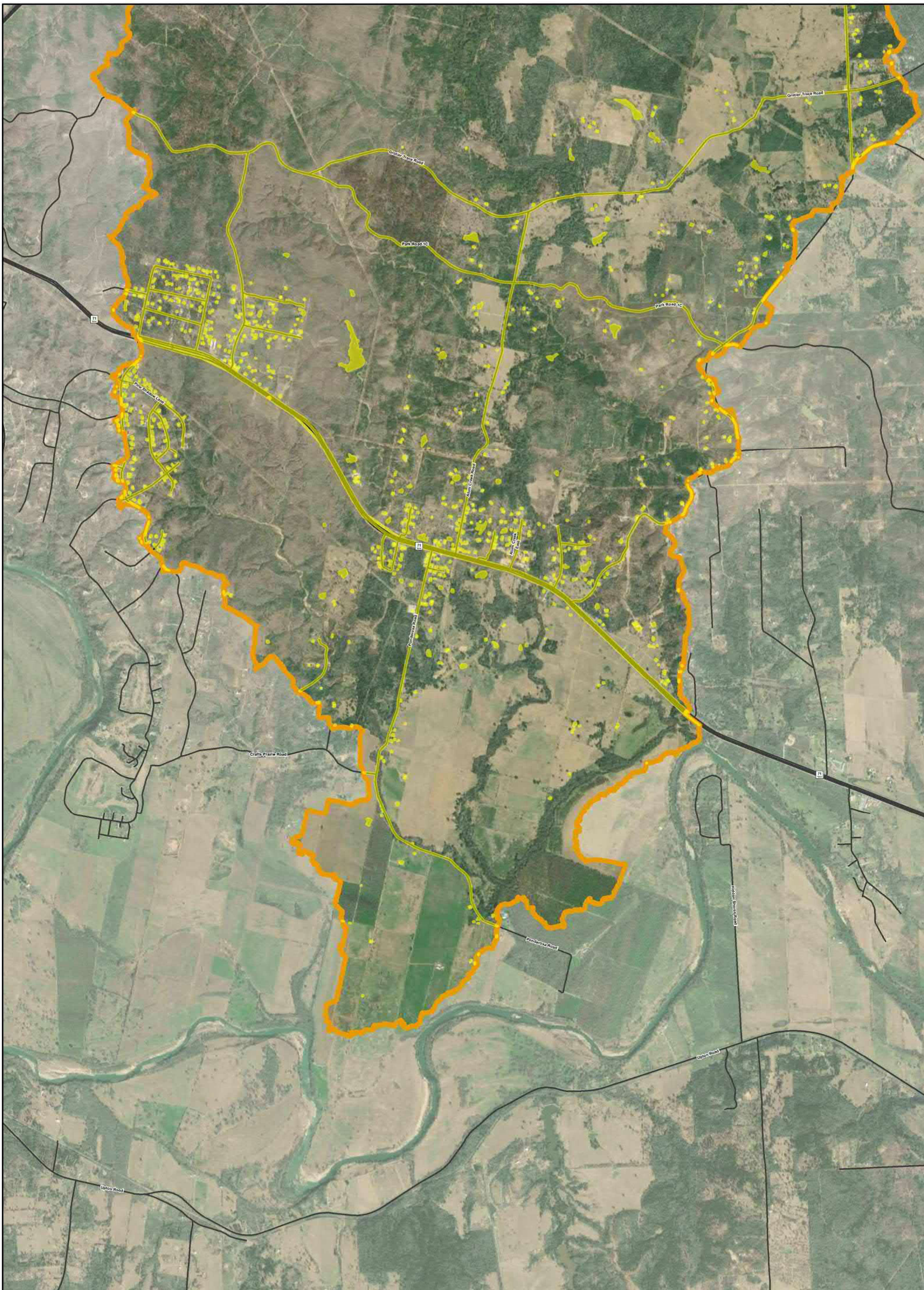


Exhibit A-5 Impervious Cover Map

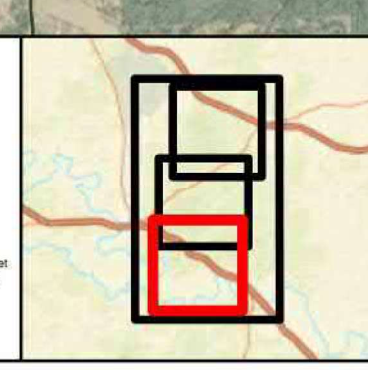
Lower Watershed

Legend
- Roads
- Alum Creek Waterhsed
- Impervious Cover

N

0 3,000 6,000 Feet

1 inch = 3,000 feet



THE STATE OF TEXAS COUNTY OF BASTROP

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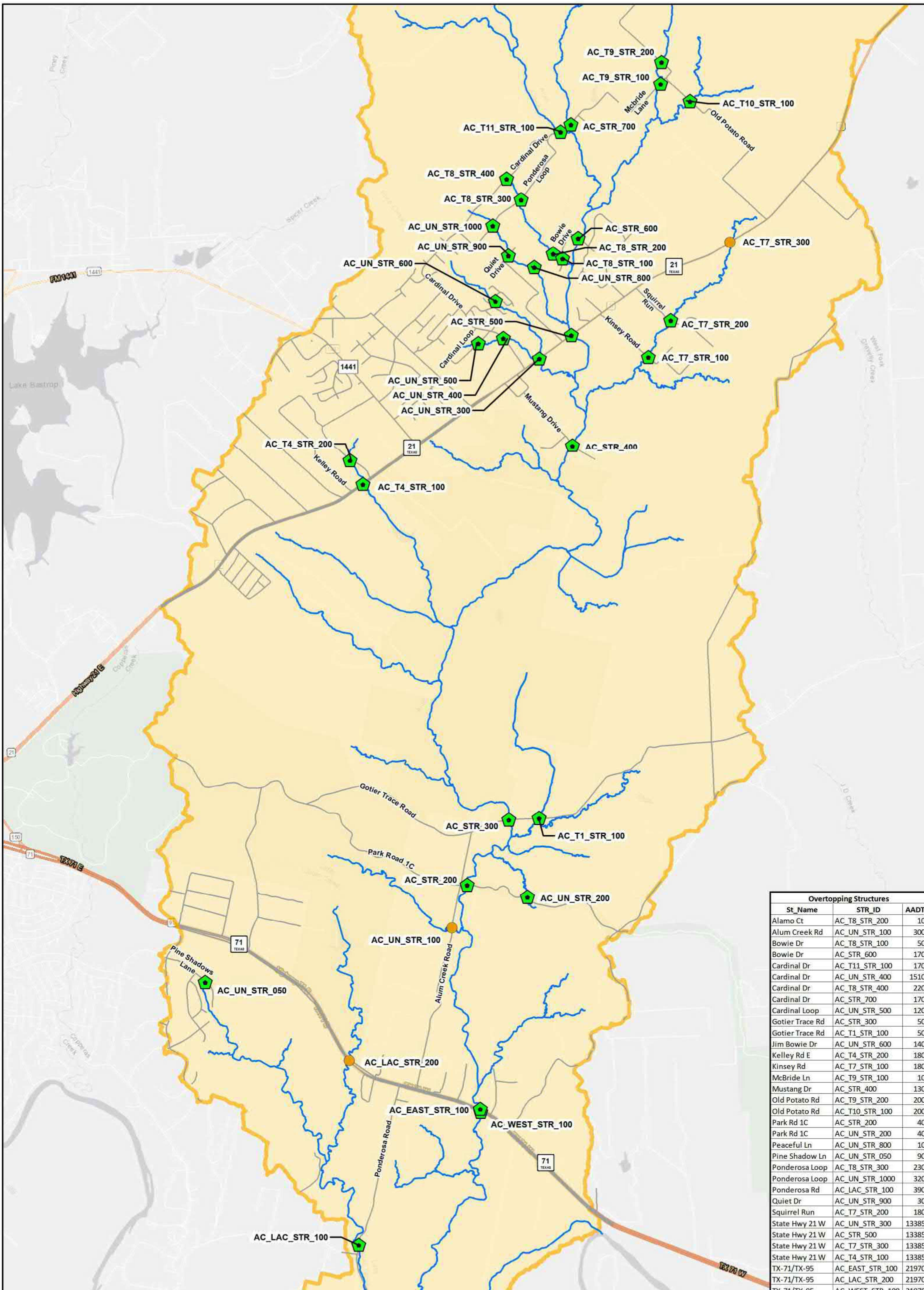
Appendix A: Exhibits

A-6 Overtopping Road Crossing Map



Overtopping Structures		
St_Name	STR_ID	AADT
Alamo Ct	AC_T8_STR_200	10
Alum Creek Rd	AC_UN_STR_100	300
Bowie Dr	AC_T8_STR_100	50
Bowie Dr	AC_STR_600	170
Cardinal Dr	AC_T11_STR_100	170
Cardinal Dr	AC_UN_STR_400	1510
Cardinal Dr	AC_T8_STR_400	220
Cardinal Dr	AC_STR_700	170
Cardinal Loop	AC_UN_STR_500	120
Gotier Trace Rd	AC_STR_300	50
Gotier Trace Rd	AC_T1_STR_100	50
Jim Bowie Dr	AC_UN_STR_600	140
Kelley Rd E	AC_T4_STR_200	180
Kinsey Rd	AC_T7_STR_100	180
McBride Ln	AC_T9_STR_100	10
Mustang Dr	AC_STR_400	130
Old Potato Rd	AC_T9_STR_200	200
Old Potato Rd	AC_T10_STR_100	200
Park Rd 1C	AC_STR_200	40
Park Rd 1C	AC_UN_STR_200	40
Peaceful Ln	AC_UN_STR_800	10
Pine Shadow Ln	AC_UN_STR_050	90
Ponderosa Loop	AC_T8_STR_300	230
Ponderosa Loop	AC_UN_STR_1000	320
Ponderosa Rd	AC_LAC_STR_100	390
Quiet Dr	AC_UN_STR_900	30
Squirrel Run	AC_T7_STR_200	180
State Hwy 21 W	AC_UN_STR_300	13385
State Hwy 21 W	AC_STR_500	13385
State Hwy 21 W	AC_T7_STR_300	13385
State Hwy 21 W	AC_T4_STR_100	13385
TX-71/TX-95	AC_EAST_STR_100	21970
TX-71/TX-95	AC_LAC_STR_200	21970
TX-71/TX-95	AC_WEST_STR_100	21970

Exhibit A-6
Road Crossing Map

Legend

Crossing Overtop

- Yes
- No

- Study Streams
- Roads
- Alum Creek Watershed

N

0 2,000 4,000 Feet

1 inch = 4,000 feet

THE STATE OF TEXAS COUNTY OF BASTROP

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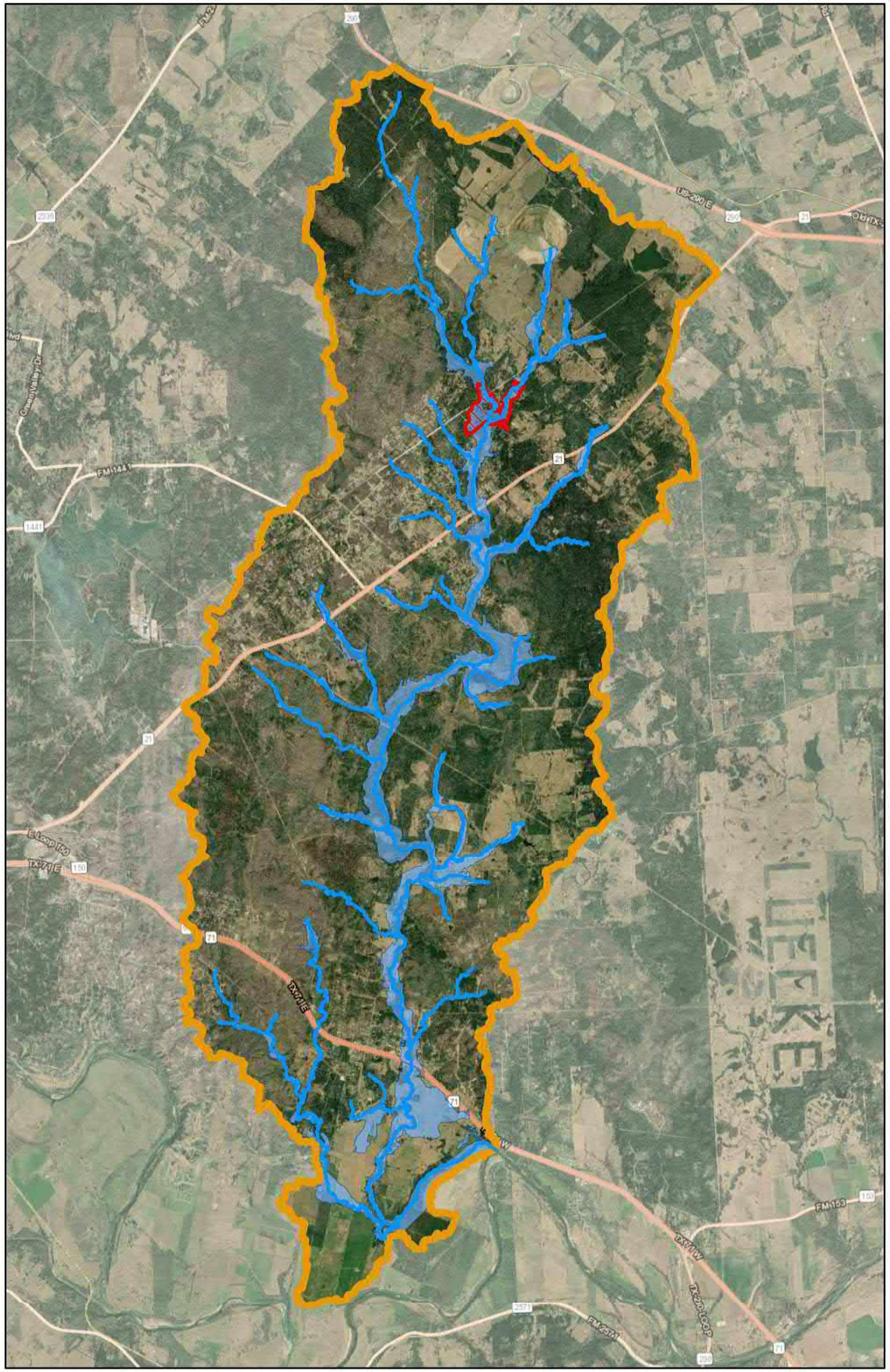
Appendix A: Exhibits

A-7 Proposed Regional Detention



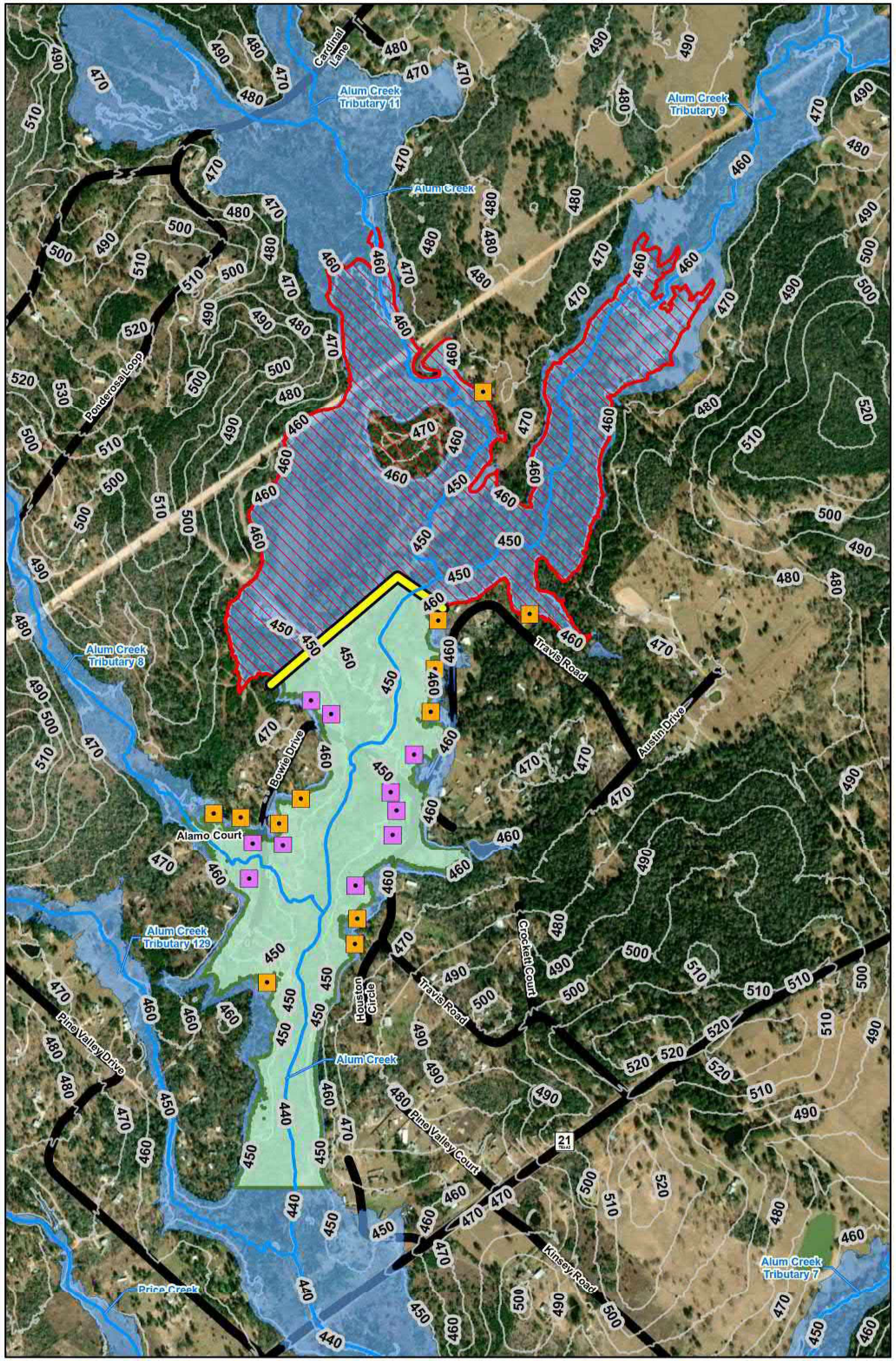


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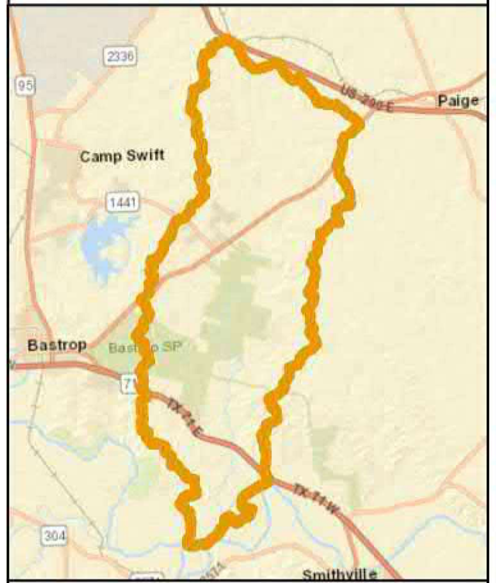
Exhibit A-7
Regional Detention Pond Alternative

Legend

- Structures Removed from
- Structures Remaining in
- Proposed Embankment
- 10ft Contours
- Proposed Detention
- Proposed 100 Year Floodplain (With
- Proposed 100 Year Floodplain (No
- Alum Creek Watershed



N

1 inch = 1,000 feet

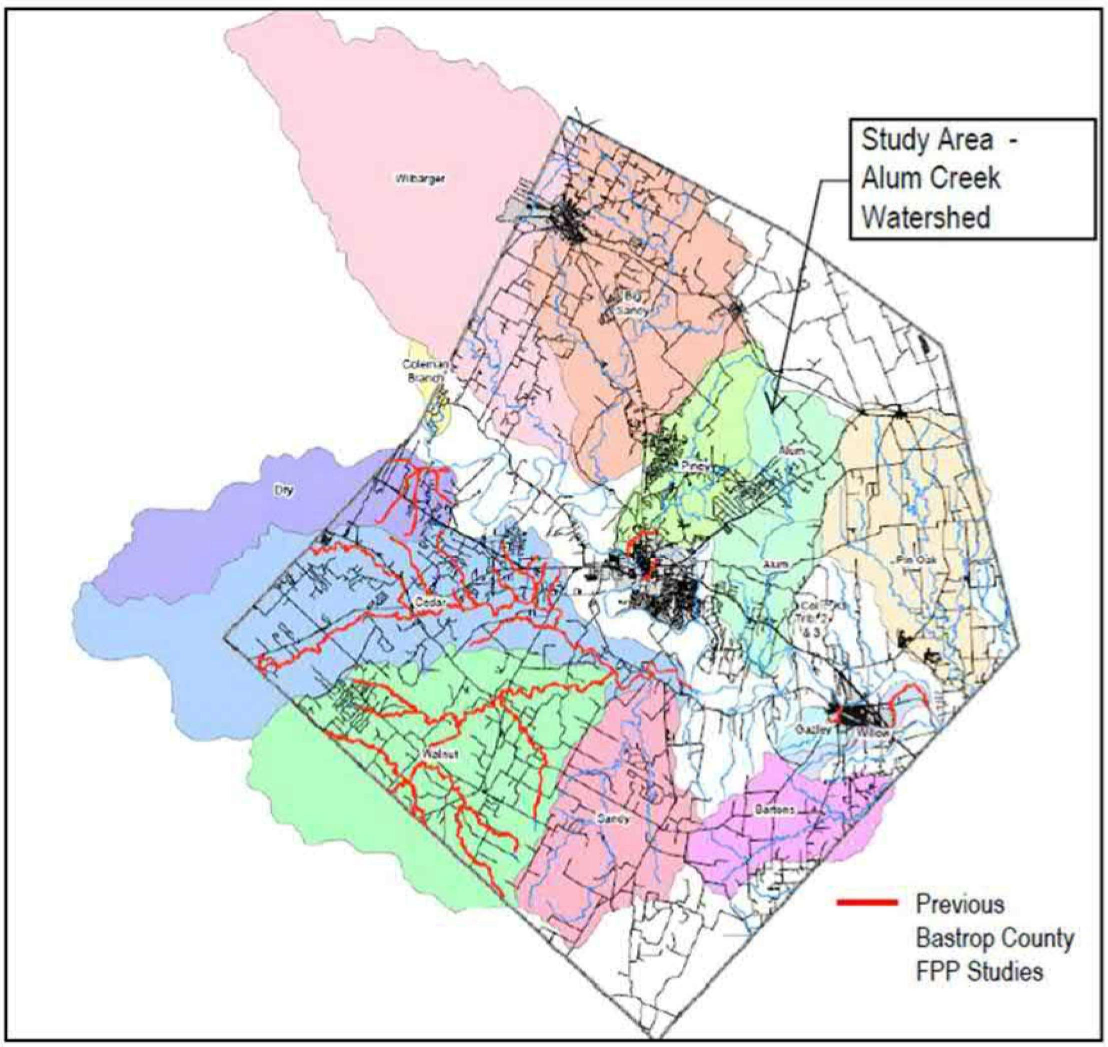
0 1,000 2,000 Feet

Appendix B: Public Meetings

Public Meeting

Tuesday, May 7, 2019
10:30 – 11:00 AM
TADS Multipurpose Room
211 Jackson St, Bastrop

Bastrop County has been awarded a Texas Water Development Board Flood Protection Planning Grant to conduct a study of the Alum Creek Watershed shown below. The study will investigate structural and nonstructural flood damage reduction projects and will be used to develop a Comprehensive Flood Protection Plan for Bastrop County. Public input is being solicited to help identify and quantify areas of concern and discuss possible solutions.



Questions about the study or the hearing can be directed to Carolyn Dill, P.E., County Engineer, at (512)581-7180 or by email at carolyn.dill@co.bastrop.tx.us.

HALFF

9500 Amberglen Blvd., Building F, Suite 125
Austin, Texas 78729
(512) 777-4600
Fax (512) 252-8141

MEETING AGENDA

May 7, 2019
Bastrop Co. FPP - Alum Creek

Bastrop County
TADS Multipurpose Room
211 Jackson St., Bastrop, TX

Type of Meeting:	Kickoff/Public Meeting #1
Meeting Start Time:	10:00
Meeting Stop Time:	11:00

Agenda

1. Study Overview
    a. Data collection
    b. Modeling and Mapping
        i. Hydrology
        ii. Hydraulics
        iii. Flood problem area identification
    c. Alternatives Analysis & Evaluation
    d. Flood Monitoring
    e. Reporting
2. Project Schedule
3. TWDB discussion
4. Areas of concern
    a. Homes flooded
    b. Roads overtopping
    c. Neighborhood access
5. Public input

Additional Information

Observers:

Resource persons:

Special notes:

9500 Amberglen Blvd., Building F, Suite 125
Austin, Texas 78729
(512) 777-4600
Fax (512) 252-8141

MEETING MINUTES

May 7, 2019
Bastrop Co. FPP - Alum Creek

Bastrop County
TADS Multipurpose Room
211 Jackson St., Bastrop, TX

Type of Meeting:	Kickoff/Public Meeting #1
Meeting Start Time:	10:00am
Meeting Stop Time:	11:30qm

Meeting Outline

Attendees:

Bastrop County: Clara Beckett, Carolyn Dill, Brenda Retzlaff

Texas Water Development Board: Sarah Hustead, Niamh Gray

Halff Associates: Paul Morales, Katherine Smith

1. Study Overview
    a. Data collection
        i. Field Reconnaissance - photos, measurements, sketches, and notes taken at each of the roadway structures. The information will be aggregated into an appendix in the final report.
        ii. Publicly available GIS spatial data has also been compiled
        iii. Bastrop county has three shapefile layers, roadway structure dimensions, county bridge information, and County roadways. Brenda will send this information to Halff.
        iv. Bastrop county also has drone video taken south of Hwy. 71 that they will share with Halff.
    b. Modeling and Mapping
        i. Hydrology – limited detail study using Atlas 14 data with subbasin breaks made at roadway structures and confluences.
            1. Halff will be cognizant of the change in the soil characteristics due to the three fires in the county in the past 10 years.
        ii. Hydraulics – limited detail study using 2017 LiDAR with cross sections every 500 feet
            1. The structure information from field reconnaissance will be input into the HEC-RAS 1-D model.
            2. 100-year floodplain maps will be generated both digitally and in print for county use.

   iii. Flood problem area identification – will be based on 100-yr flood plain extents and areas identified by County as indicated on the Alum Creek watershed overview map
      1. Some problem areas are unable to be improved by the county at this time because the land is private property.
   c. Alternatives Analysis & Evaluation
      i. Flood mitigation solutions may include road crossing improvements, and channel improvements, etc. and will include a benefit/cost analysis and cost estimate
      ii. Possibility to analyze roadway structures that have been studied with the HMGP studies
         1. Bowie Road
   d. Flood Monitoring
      i. Will prioritize structure's level of service by relating overtopping depth in accordance to the storm event. The goal will be to create a tool to help the county monitor roadways and know when to close and re-open roadways.
      ii. May consider identifying locations of new stream gages if it makes sense.
   e. Reporting
      i. When beginning the report process contact Sarah and she can send the TWDB report guidelines. The guidelines are also located in the contract.
      ii. Halff will refer to the environmental constraint documents for Bowie Drive as a starting point for Alum Creek

2. Project Schedule
   a. Three public meetings are required by the TWDB grant. The next two meetings will be public meetings held in the evening at a time agreed upon by all parties beforehand.
      i. Public meeting 2 will present information on modeling and mapping preliminary results along with initial flood solutions
      ii. Public meeting 3 will present finalized flood solutions, costs and report submittal information
   b. TWDB is granted up to 45 days to review the report draft. Halff is required to respond to TWDB comments within 45 days.
3. TWDB discussion
   a. TWDB requires that Sarah is present at all public meetings
   b. Sarah will be reviewing the final report for this FPP grant
   c. Allow for TWDB review time of 45 days and Halff response time of 45 days
4. Areas of concern
   a. Homes flooded
      i. Bowie Drive has residences that flood
      ii. County will provide flooding information for the watershed

b. Roads overtopping

i. Preliminary overtopping roadways are indicated based on BLE data as shown on the Alum Creek watershed map

ii. County identified roads that typically overtop or get washed out

c. Neighborhood access

i. Areas are indicated on the map where residences have only one point of egress and have no egress if the roadway is flooded

5. Public input

a. Questionnaires are available at the front desk of the county office as well as on the county's website.

Action Items

1. **<u>Bastrop County</u>**: To provide Halff with following data:
    i. Structures of county and bridge GIS shapefile from 2015-16
    ii. Burn scar for 2009 Wilderness Ridge Fire GIS shapefile
    iii. Drone video of area south of Hwy. 71 identifying debris build up
    iv. Design plans Alum Creek Rd. on Alum Creek Trib. 162
    v. Bowie Dr. environmental letters
    vi. GIS shapefile of flooded properties
    vii. Latest County roads in GIS shapefile
2. **<u>TWDB</u>**: Will provide guidance on preparing FPP study reports.
3. **<u>Halff Associates</u>**: Provide previous Bastrop Co. FPP watershed study to TWDB.

This concludes the Meeting Minutes. Our goal is to provide a complete and accurate summary of the proceedings of the subject meeting in these minutes. If you feel that any of the items listed above are not correct, or that any information is missing or incomplete, please contact Halff Associates so that the matter can be resolved, and a correction issued if necessary. These minutes will be assumed to be correct and accepted if we do not hear from you within ten (10) calendar days from your receipt.

Texas Water Development Board

HALFF

ALUM CREEK WATERSHED STUDY SIGN-IN SHEET

Project: ALUM CREEK WATERSHED STUDY **Date:** 7 MAY 2019

Location: TADS MULTIPURPOSE RM, 211 JACKSON ST. **City, State:** BASTROP, TX

PUBLIC MEETING 1

	Name	Address	Phone	Email
1.	Carolyn Dill	211 Jackson, Bastrop	512/581-7180	Carolyn.dill@co.bastrop.tx.us
2.	PAUL MORALES	HALFF ASSOC.	512/777-4547	PMORALES@HALFF.COM
3.	Katherine Smith	Halff Assoc.	512/777-4623	ksmith@halff.com
4.	Sara Hustead	TWDB	512.936.0129	Sara.Hustead@TWDB.texas.gov
5.	Niamh Gray	TWDB	512.475.1514	Niamh.Gray@TWDB.Texas.gov
6.	BRENDA RETZLAFF	211 JACKSON, BASTROP	512-581-7159	brenda.retzlaff@co.bastrop.TX.us
7.	CLARA BECKETT	do	512 988 1553	CLARA.BECKETT@CO.BASTROP.TX.US
8.	Brandon Mulder	1106 College St.	832 360 5499	bmulder@statesman.com
9.				
10.				
11.				
12.				
13.				
14.				
15.				

Alum Creek Watershed Study Public Meeting

Thursday, May 14th 2020
10 AM - 11 AM
Virtual Webex Meeting
https://bit.ly/2Wi27T6

Texas Water Development Board

THE STATE OF TEXAS COUNTY OF BASTROP

Bastrop County has been awarded a Texas Water Development Board Flood Protection Planning Grant to conduct a study of the Alum Creek Watershed shown below.

The study has identified floodplains, as well as areas at high risk of flooding during storm events. Public feedback is requested on the proposed flood mitigation projects, with the goal to reduce flood risk and improve the safety for residents during storm events. Opportunities to implement a flood monitoring system to assist the public during storm events will also be discussed.

Questions about the study can be directed to Carolyn Dill, P.E., Bastrop County Engineer, at (512) 581-7180 or by email at carolyn.dill@co.bastrop.tx.us

HALFF

9500 Amberglen Blvd., Building F, Suite 125
Austin, Texas 78729
(512) 777-4600
Fax (512) 252-8141

MEETING AGENDA

May 14, 2020
Bastrop Co. FPP - Alum Creek

Online Virtual Meeting

Type of Meeting:	Public Meeting #2
Meeting Start Time:	10:00am
Meeting Stop Time:	11:00am

Agenda

1. Floodplain Mapping
    a. Drainage area = 54.7 sq. mi.
    b. Stream miles = 73.5 mi.
    c. 100-year floodplain extents
        i. Habitable structures = 56
        ii. Roadways overtopping = 30
2. Alternatives Analysis & Evaluation
    a. Culvert improvements for 5 road crossings
    b. Regional detention facility
        i. Embankment length = 1,700 ft.
        ii. Embankment height = 16 ft.
        iii. Storage = 625 ac. ft.
3. Flood Monitoring
    a. Roadway overtopping risk
    b. Stream gage placement
    c. Flood monitoring web map
        i. Stream gages
        ii. Automated gates
4. Questions

Additional Information

Observers:

Resource persons:

Special notes:

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Austin, Texas 78729
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MEETING MINUTES

May 14, 2020
Bastrop Co. FPP - Alum Creek

Online Virtual Meeting

Type of Meeting:	Public Meeting #2
Meeting Start Time:	10:00am
Meeting Stop Time:	11:00am

Agenda

Attendees:

Bastrop County: Commissioner Clara Beckett, Carolyn Dill

Texas Water Development Board: Ivan Ortiz, Mike Vielleux

Halff Associates: Paul Morales, Katherine Smith

1. Floodplain Mapping
    a. Drainage area = 54.7 sq. mi.
    b. Stream miles = 73.5 mi.
    c. 100-year floodplain extents
        i. Habitable structures within the floodplain = 56
        ii. Roadways overtoppings at creek crossings = 30
2. Alternatives Analysis & Evaluation
    a. Culvert improvements for 5 road crossings identified by the county
        i. Culvert sizes were increased, and the road profiles were raised by 1 foot to maximize culvert sizes. This increased the level of service of the roads by reducing the frequency that the roads overtop and decreasing the depth of water overtopping during storm events.
        ii. Probable cost estimates were included and itemized estimates will be included in the report.
    b. Regional detention facility – detention facility would only hold water during storm events. Two homes on the upstream side of the proposed embankment limit the proposed elevation of the embankment.
        i. Embankment length = 1,700 ft.
        ii. Embankment height = 16 ft.
        iii. Storage = 625 ac. ft.
        iv. Currently there are 16 flooded structures are inundated based on assumed FFEs surrounding the proposed dam, if the dam is built 8 homes will be removed from the floodplain.
        v. The Benefit Cost ratio is not favorable for this project, and the culvert improvements will be a better use of county funds.

3. Flood Monitoring – The goal is to provide the county with tools that will help monitor flood risks at road crossings in the watershed and help better deploy county resources during storm events
    a. Roadway overtopping risk-
        i. Goal is to help direct crews for road closures during heavy rainfall events
        ii. A linear interpolation was conducted to find the rainfall depth that would cause riverine water surface elevation that overtop the road at the crossings. The hydraulic models were used to find the water surface elevations and Atlas 14 100-year, 24-hour rainfall depths were used.
    b. Stream gage placement –
        i. Can be placed on Highway 21 and 71, or other high traffic roads in the watershed to monitor water surface elevations at the road.
        ii. Gages could also be set with trigger elevations to engage automatic closure of road gates.
    c. Flood monitoring web map –
        i. Updates from gages at road crossings can be available for emergency personnel and public use to monitor road crossing statuses.
        ii. Stream/rainfall gages – stage and rainfall could be shown on the web map showing color codes for stages at good, watch, and warning stages.
        iii. Automated gates – can be triggered if a gage reaches a warning stage to close a road crossing
4. Questions

Action Items

1. **<u>Bastrop County</u>**: To provide Halff with following data:
    i. Review of rainfall depths at overtopping roads in the watershed
2. **<u>Halff Associates</u>**: To provide Bastrop County with following data:
    i. A combined PDFs of the meeting documents for the public meeting will be sent out to the County and TWDB
    ii. To conduct an analysis of the runoff comparing pre-fires and post-fires hydrology watershed response
    iii. Provide an exhibit showing the comparison between the FEMA Current Effective floodplain and the floodplain from the Alum Creek FPP analysis

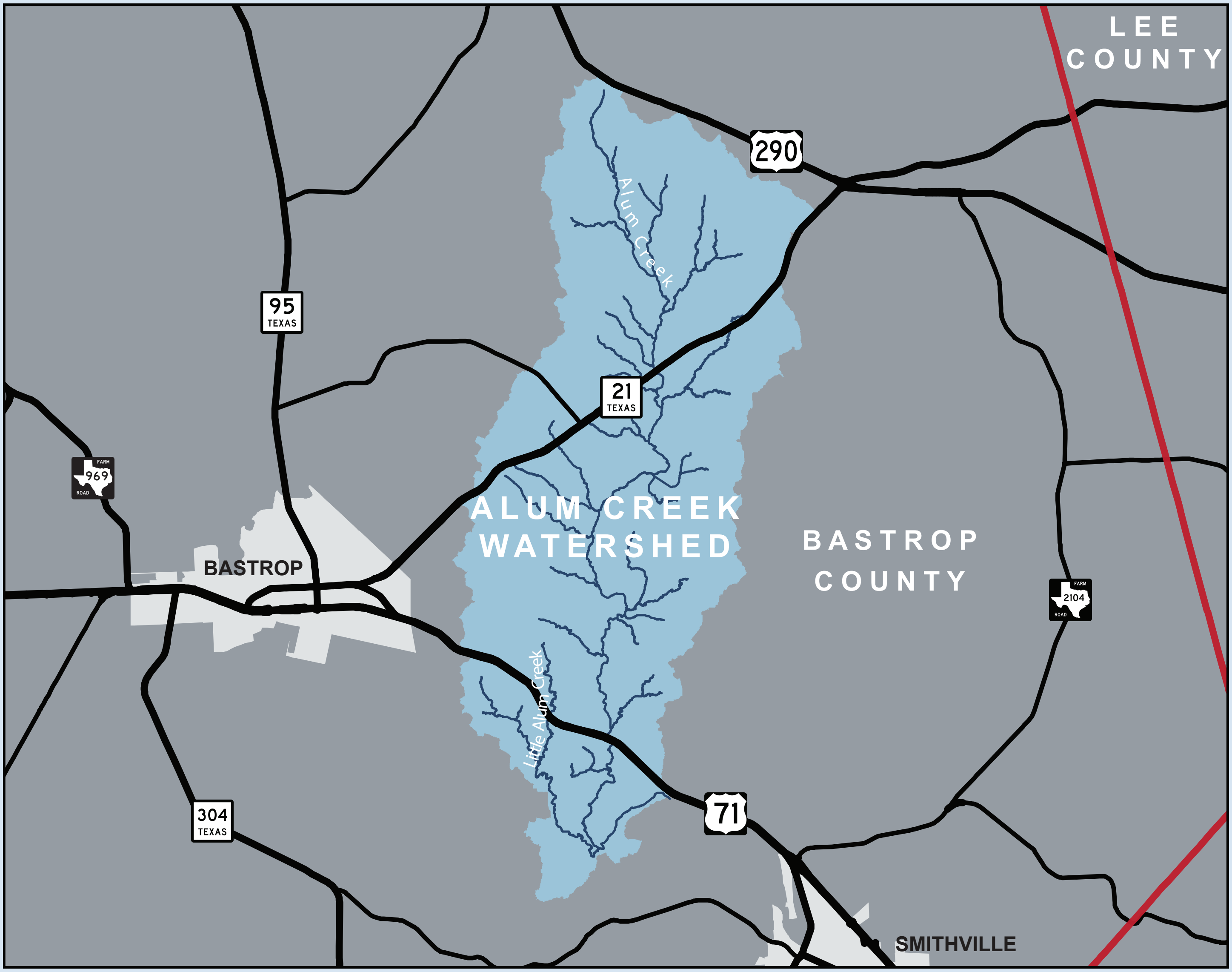
Alum Creek Watershed Study Public Meeting

Wednesday, October 7th 2020
10 AM - 11 AM
Virtual Webex Meeting
https://bit.ly/2RsByZs

Texas Water Development Board

THE STATE OF TEXAS COUNTY OF BASTROP

Bastrop County was awarded a Texas Water Development Board Flood Protection Planning Grant to conduct a study of the Alum Creek Watershed shown below.



The study has developed 100-year floodplains, as well as identified areas of high risk of flooding during storm events. An overview of the project study analysis and the proposed flood mitigation solutions to increase safety for residents will be presented to the public. A summary of flood monitoring opportunities within the watershed will also be discussed.

Questions about the study can be directed to Carolyn Dill, P.E., Bastrop County Engineer, at (512) 581-7180 or by email at carolyn.dill@co.bastrop.tx.us

BASTROP COUNTY
TWDB FLOOD PROTECTION PLANNING STUDY
ALUM CREEK

OCTOBER 7, 2020

VIRTUAL WEBEX MEETING

https://bit.ly/2RsByZs

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BASTROP COUNTY
TWDB FLOOD PROTECTION PLANNING STUDIES

AGENDA OUTLINE

- COUNTY FPP STUDIES
- ALUM CREEK WATERSHED
- H&H METHODOLOGY
- FLOOD MITIGATION SOLUTIONS
- FLOOD MONITORING OPPURTUNITIES
- NEXT STEPS

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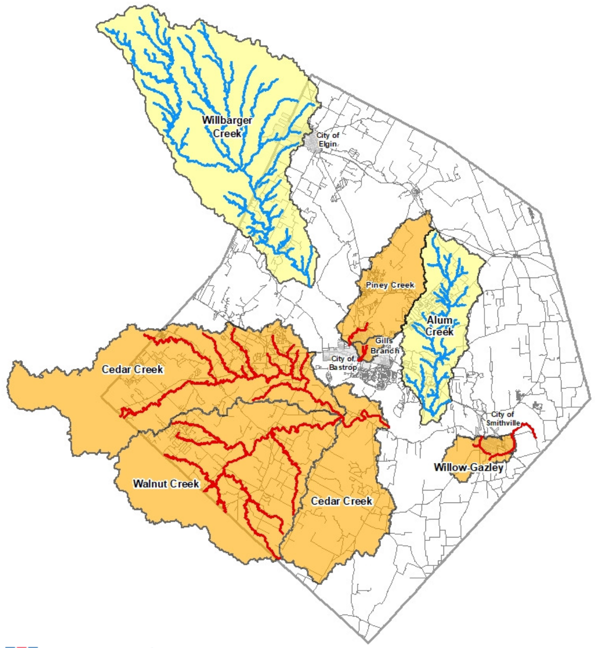

STUDIED WATERSHEDS

- 2008-2018 Bastrop Co. FPP
  - Cedar Creek
  - Walnut Creek
  - Sandy Creek
  - Willow Creek (Smithville)
  - Gazley Creek (Smithville)
  - Gills Branch (Bastrop)
  - Piney Creek (Bastrop)
- 2019 Bastrop Co. FPP
  - Alum Creek
  - Wilbarger Creek (Pflugerville & Travis Co.)

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ALUM CREEK STUDY OVERVIEW

- Drainage Area
  - 55 sq. miles
- Limited Detailed Study
  - 73.5 stream miles
- Floodplain Development
- Identification of Flooding Problems
- Flood Mitigation Solutions
- Flood Monitoring Opportunities

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BASTROP COUNTY
TWDB FLOOD PROTECTION PLANNING STUDIES

2019 LEVERAGED FUNDING FOR ALUM CREEK

Texas Water Development Board	50%
Bastrop County	50%
Total	100%

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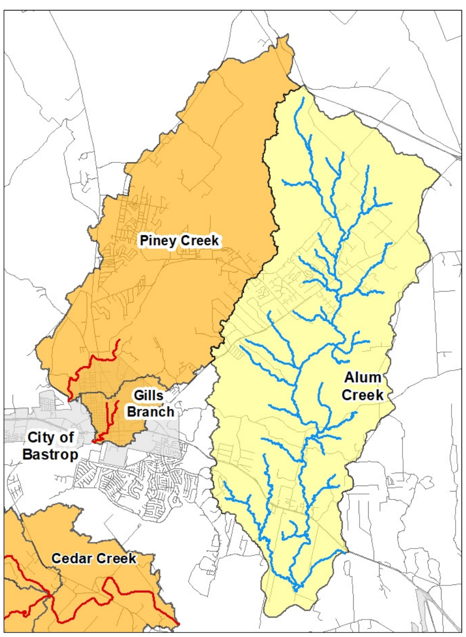

DATA COLLECTION

- Public Flood Problem Survey
- 2017 LiDAR terrain
  - Hydrology: 10'x10' DEM
  - Hydraulics: 3'x3' DEM
- SSURGO Soil Survey
- NLCD Land Use
- Field Reconnaissance
  - Field measurements
  - Field Sketches
  - Photos

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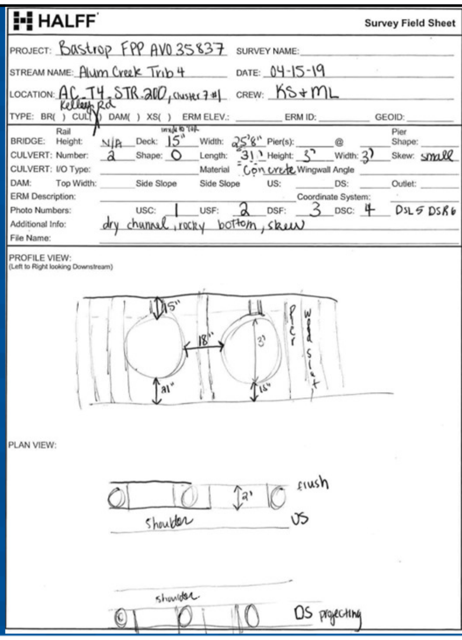

HALFF — Survey Field Sheet

PROJECT: Bastrop FPP AVO 35837 SURVEY NAME:
STREAM NAME: Alum Creek Trib 4 DATE: 04-15-19
LOCATION: AC_T4_STR_200, Cluster 7 #1 Kelley Rd CREW: KS + ML
TYPE: BR( ) CUL(X) DAM( ) XS( ) ERM ELEV.: ERM ID: GEOID:

BRIDGE: Rail Height: N/A Deck: 15" Width: 25'8" Pier(s): @ Pier Shape:
CULVERT: Number: 2 Shape: O Length: 31' Height: 3' Width: 3' Skew: small
CULVERT: I/O Type: Material: Concrete Wingwall Angle
DAM: Top Width: Side Slope Side Slope US: DS: Outlet:
ERM Description: Coordinate System:
Photo Numbers: USC: 1 USF: 2 DSF: 3 DSC: 4 DSL 5 DSR 6
Additional Info: dry channel, rocky bottom, skew
File Name:

PROFILE VIEW:
(Left to Right looking Downstream)

15" 18" 3' Pier Wd slat

PLAN VIEW:

flush shoulder US 2'

shoulder DS projecting

	Photo ID: Coordinates: Description:	AC_T4_STR_200_DSF 30.149992, -97.235395 Downstream face

	Photo ID: Coordinates: Description:	AC_T4_STR_200_DSC 30.149992, -97.235395 Downstream channel

035837.001 – Bastrop County Flood Protection Planning Studies – Alum Creek H&H – AC_T4_STR_200

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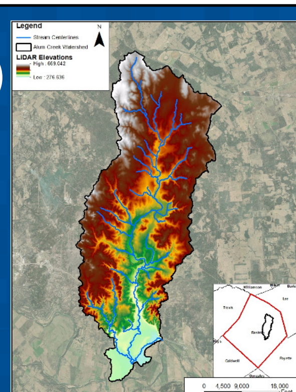
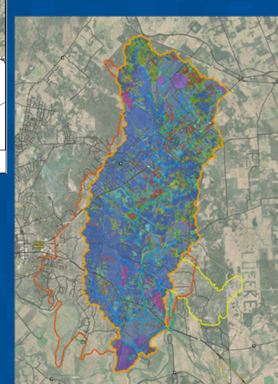
HYDROLOGY (RAINFALL RUNOFF)

1. **RAINFALL**
   - Source: NOAA Atlas 14
   - Distribution
2. **TOPOGRAPHY (GROUND SURFACE)**
   - LiDAR
   - Watershed Boundaries
   - Watershed Slopes
3. **SOILS**
   - Hydrologic Soil Types
   - Antecedent Moisture Condition
   - Considered Burn Scars
4. **LAND USE**
   - Existing Conditions





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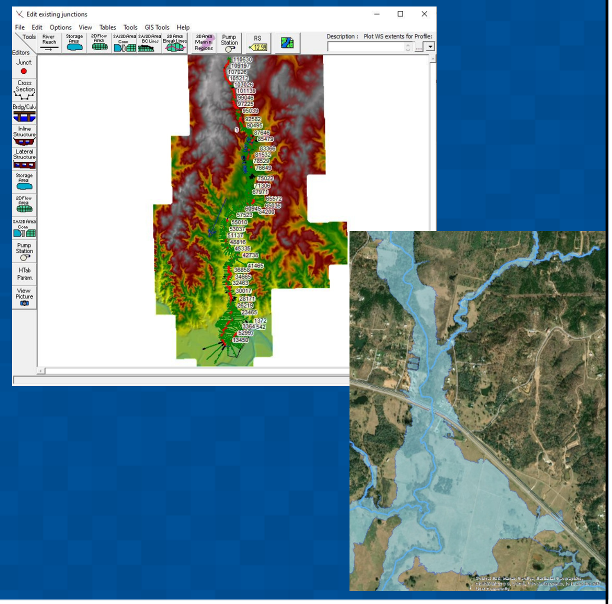
HYDRAULICS (CREEK FLOODING)

1. **HYDROLOGY**
   - Peak Discharge – 2, 5, 10, 25, 50, 100, and 500-year
2. **TOPOGRAPHY (GROUND SURFACE)**
   - LiDAR
   - Stream Slope/Definition
3. **CROSS-SECTION**
   - Location
   - Roughness Coefficients (N-values)
   - Expansion/Contraction Coefficients
   - Ineffective/Blocked Areas
4. **CROSSINGS/CONSTRICTIONS**
   - Bridges
   - Culverts
   - Small Stock Ponds



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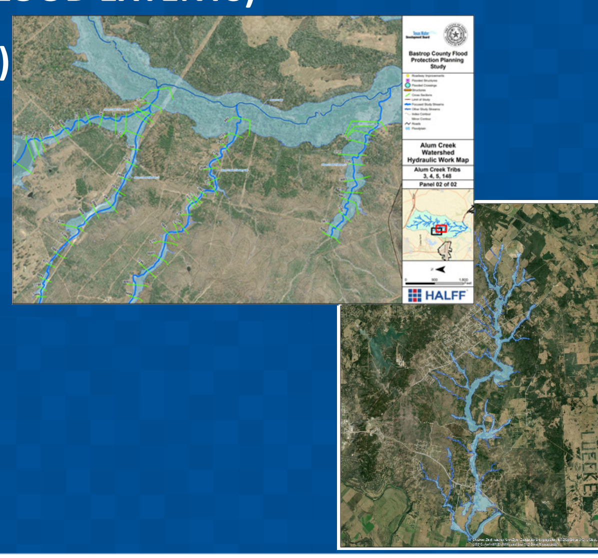
FLOODPLAIN MAPPING (FLOOD EXTENTS)

1. **TOPOGRAPHY (GROUND SURFACE)**
   - Drainage patterns
2. **CROSS-SECTION**
   - Extents of Floodplain 100-year for Limited Detail study
   - Width of Floodplain
3. **CROSSINGS/CONSTRICTIONS**
   - Overtopping Road Crossings



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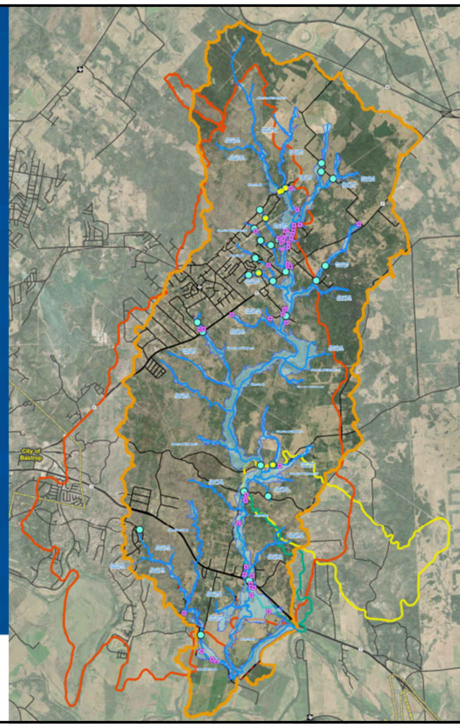

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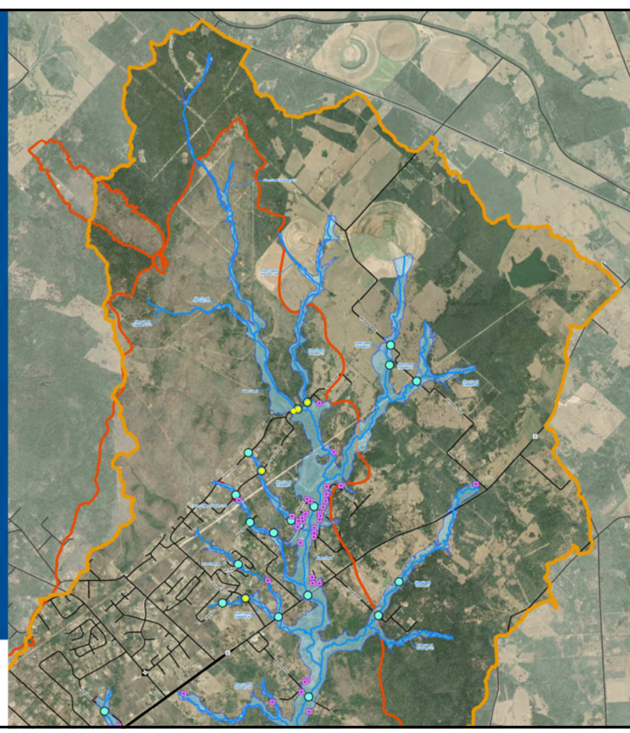

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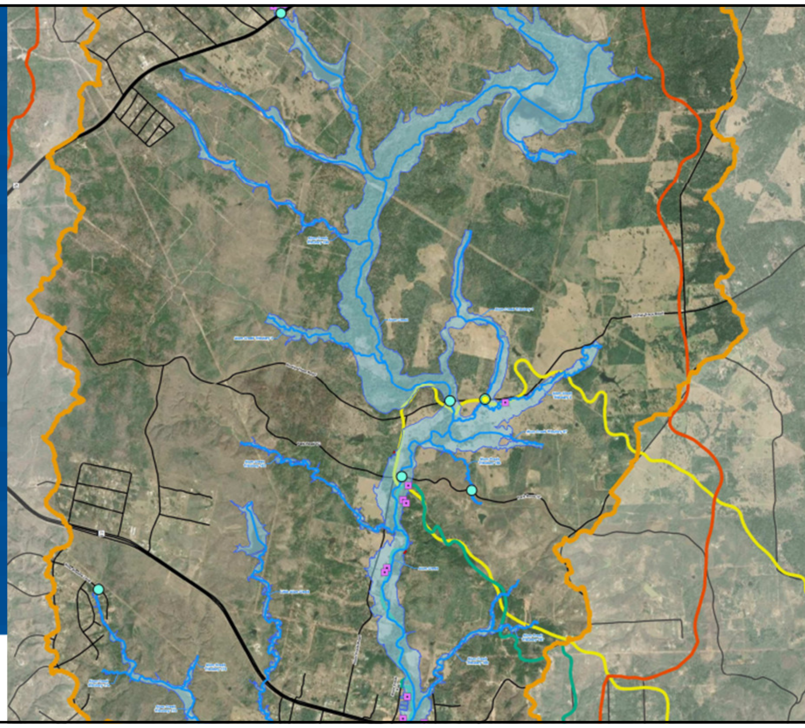

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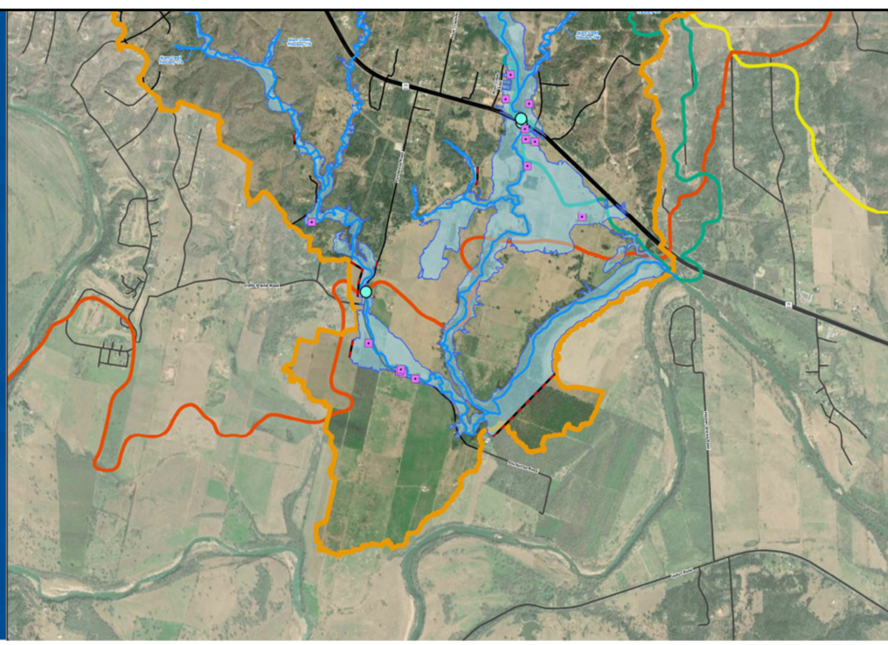

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CONCEPTUAL FLOOD MITIGATION ALTERNATIVES

REGIONAL DETENTION POND

CREEK CROSSING IMPROVEMENTS

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CULVERT IMPROVEMENTS

BOWIE DRIVE IN SMITHVILLE

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Stream Name	Road Name	Structure Type	Average Daily Traffic Count (vehicles/day)	Annual Chance of Flooding	Equivalent Rainfall Depth (in)	Urgency Rating	Risk Rank
Alum Creek	State Highway 21 W	Bridge	13,385	20%	5.52	2,677	1
Alum Creek Tributary 4	State Highway 21 W	Culverts	13,385	10%	6.82	1,339	2
Alum Creek	TX-71/TX-95	Bridge	21,970	4%	8.82	879	3
Alum Creek Tributary 87	Cardinal Drive	Culverts	1,510	50%	4.17	755	4
Alum Creek	TX-71/TX-96	Bridge	21,970	2%	10.6	439	5
Price Creek	State Highway 21 West	Culverts	13,385	2%	10.6	268	6
Little Alum Creek	Ponderosa Road	Bridge	390	50%	4.17	195	7
Alum Creek Tributary 129	Ponderosa Loop	Culverts	320	50%	4.17	160	8
Alum Creek Tributary 8	Ponderosa Loop	Culverts	230	50%	4.17	115	9
Alum Creek Tributary 8	Cardinal Drive	Culverts	220	50%	4.17	110	10
Alum Creek Tributary 10	Old Potato Road	Bridge	200	50%	4.17	100	11
Alum Creek Tributary 4	Kelley Rd E	Culverts	180	50%	4.17	90	12
Alum Creek Tributary 7	Squirrel Run	Culverts	180	50%	4.17	90	12
Alum Creek	Cardinal Drive	Culverts	170	50%	4.17	85	14
Alum Creek	Bowie Drive	Culverts	170	50%	4.17	85	14
Alum Creek Tributary 11	Cardinal Drive	Culverts	170	50%	4.17	85	14
Alum Creek	Mustang Drive	Bridge	130	50%	4.17	65	17
Alum Creek Tributary 173	Pine Shadow Lane	Culverts	90	50%	4.17	45	18
Alum Creek Tributary 7	Kinsey Road	Bridge	180	20%	5.52	36	19
Price Creek	Jim Bowie Drive	Culverts	140	20%	5.52	28	20
Alum Creek	Gotier Trace Road	Bridge	50	50%	4.17	25	21
Alum Creek Tributary 1	Gotier Trace Road	Culverts	50	50%	4.17	25	21
Alum Creek Tributary 8	Bowie Drive	Culverts	50	50%	4.17	25	21
Alum Creek Tributary 87	Cardinal Loop	Culverts	120	20%	5.52	24	24
Alum Creek	Park Road 1C	Culverts	40	50%	4.17	20	25
Alum Creek Tributary 160	Park Road 1C	Culverts	40	50%	4.17	20	25
Alum Creek Tributary 9	Old Potato Road	Culverts	200	10%	6.82	20	25

ROADWAY IMPROVEMENT RANKING

- Developed urgency risk ranking
- Determined Average Daily Traffic Counts
  - TxDOT Traffic Counts
  - Trip Generation Manual
- Determined annual chance of road overtopping

- Higher priority if the road is overtopped more frequently
- A higher urgency rating means the higher the flood risk for the structure

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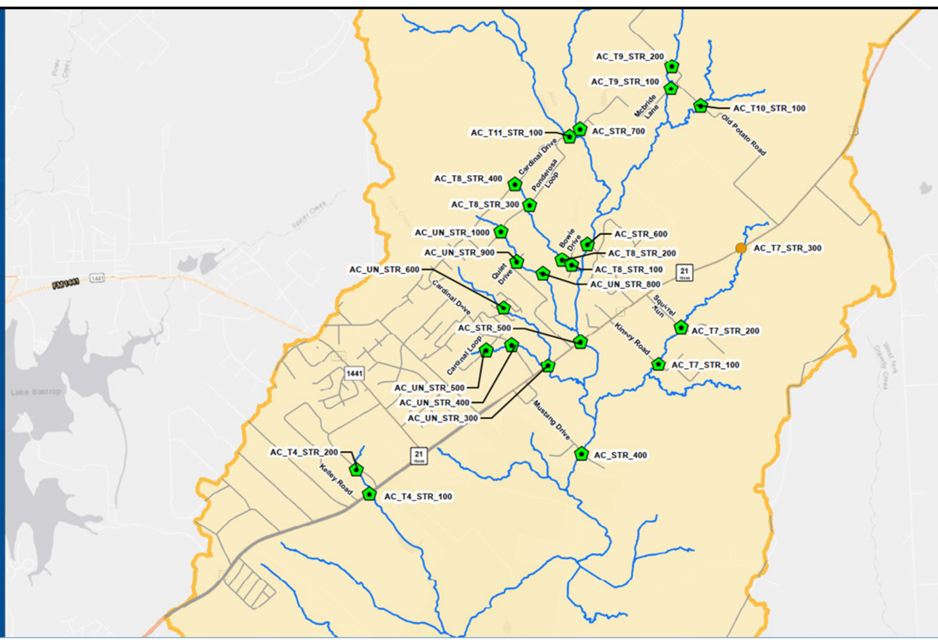

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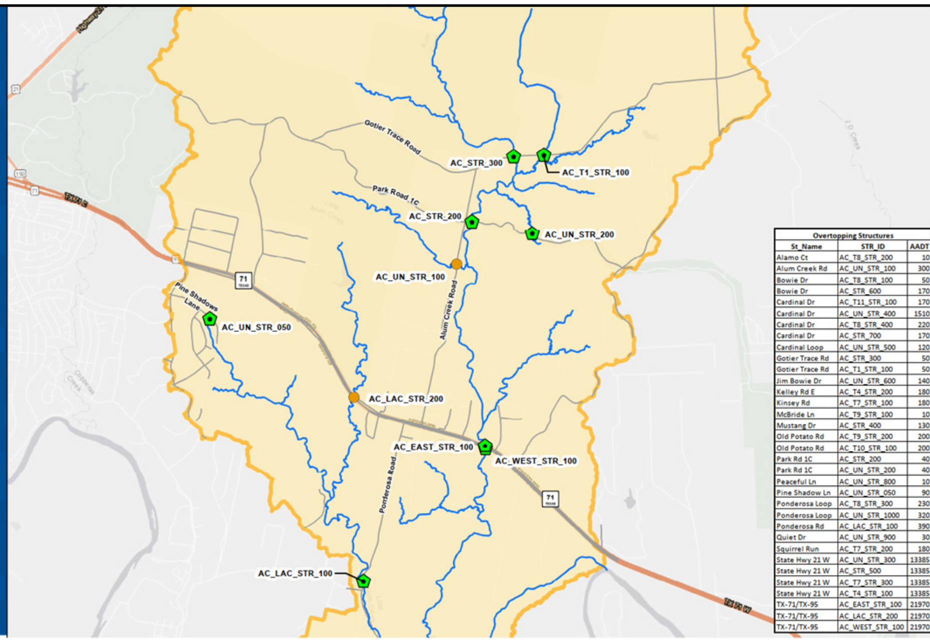

Overtopping Structures		
St_Name	STR_ID	AADT
Alamo Ct	AC_T8_STR_200	10
Alum Creek Rd	AC_UN_STR_100	300
Bowie Dr	AC_T8_STR_100	50
Bowie Dr	AC_STR_600	170
Cardinal Dr	AC_T11_STR_100	170
Cardinal Dr	AC_UN_STR_400	1510
Cardinal Dr	AC_T8_STR_400	220
Cardinal Dr	AC_STR_700	170
Cardinal Loop	AC_UN_STR_500	120
Gotier Trace Rd	AC_STR_300	50
Gotier Trace Rd	AC_T1_STR_100	50
Jim Bowie Dr	AC_UN_STR_600	140
Kelley Rd E	AC_T4_STR_200	180
Kinsey Rd	AC_T7_STR_100	180
McBride Ln	AC_T9_STR_100	10
Mustang Dr	AC_STR_400	130
Old Potato Rd	AC_T9_STR_200	200
Old Potato Rd	AC_T10_STR_100	200
Park Rd 1C	AC_STR_200	40
Park Rd 1C	AC_UN_STR_200	40
Peaceful Ln	AC_UN_STR_800	10
Pine Shadow Ln	AC_UN_STR_050	90
Ponderosa Loop	AC_T8_STR_300	230
Ponderosa Loop	AC_UN_STR_1000	320
Ponderosa Rd	AC_LAC_STR_100	390
Quiet Dr	AC_UN_STR_900	30
Squirrel Run	AC_T7_STR_200	180
State Hwy 21 W	AC_UN_STR_300	13385
State Hwy 21 W	AC_STR_500	13385
State Hwy 21 W	AC_T7_STR_300	13385
State Hwy 21 W	AC_T4_STR_100	13385
TX-71/TX-95	AC_EAST_STR_100	21970
TX-71/TX-95	AC_LAC_STR_200	21970
TX-71/TX-95	AC_WEST_STR_100	21970

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Road Crossing	Structure ID [Lat., Long.]	Existing Conditions	
		Existing Culvert	Overtopping Event (ACE)
Alum Creek Cardinal Drive	AC_STR_700 [30.1905, -97.2037] & AC_STR_700_West [30.1903, -97.2044]	2 - 31" x 41" CMPs (west) 1 - 1.25' CMP (east)	50% (2-year)
Alum Creek Tributary 1 Gotier Trace	AC_T1_STR_100 [30.1045, -97.2095]	1 - 2.5' CMP	50% (2-year)
Alum Creek Tributary 11 Cardinal Drive	AC_T11_STR_100 [30.1914, -97.2021]	4 - 4' CMPs	50% (2-year)
Alum Creek Tributary 87 Cardinal Drive	AC_UN_STR_400 [30.1648, -97.2127]	2 - 4' CMPs	50% (2-year)
Alum Creek Tributary 8 Ponderosa Loop	AC_T8_STR_300 [30.1822, -97.2096]	3 - 4' CMPs	50% (2-year)

SELECTED ROADWAY IMPROVEMENTS

- Top 5 County roads were selected
- Based on urgency risk rating, repetitive damage, housing density, availability of alternative ingress and egress and immediate needs.
- Existing conditions culverts are overtopped during the 50% ACE storm

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Road Crossing	Proposed Improvement			
	Culvert Improvement	Roadway Improvement	Overtopping Event (ACE)	Probable Cost Estimate
Alum Creek Cardinal Drive	2 - 4' x 3' RCBs (west) 4 - 4' x 2' RCBs (east)	310 LF of Raised Roadway	10% (10-year)	$545,000
Alum Creek Tributary 1 Gotier Trace	2 - 12' x 6' RCBs	300 LF of Raised Roadway 460 LF Channel Improvement	50% (2-year)	$533,900
Alum Creek Tributary 11 Cardinal Drive	5 - 7' x 6' RCBs	360 LF of Raised Roadway	4% (25-year)	$719,200
Alum Creek Tributary 87 Cardinal Drive	3 - 8' x 6' RCBs	100 LF of Raised Roadway	0.2% (500-year)	$351,900
Alum Creek Tributary 8 Ponderosa Loop	3 - 8' x 5' RCBs	192 LF of Raised Roadway	4% (25-year)	$430,900

PROPOSED ROADWAY IMPROVEMENTS

- Goal was to reduce flood overtopping as much as possible
- Roadways were raised 1 foot max to allow for larger culverts

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REGIONAL DETENTION POND

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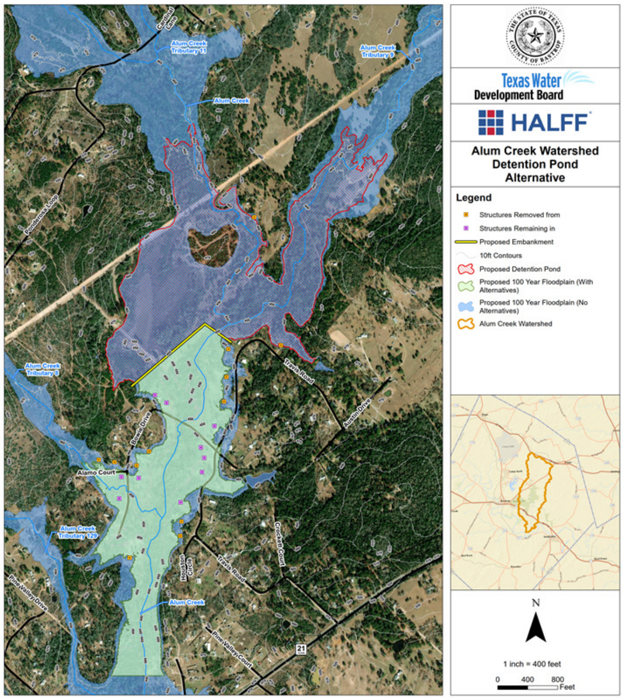

REGIONAL DETENTION FACILITY

- Length: 1700 LF earthen embankment
- Height: 16 foot
- Storage: 625 ac-ft
- TCEQ Dam Safety requirements

- 22 homes inundated during the 1% ACE event
- Removes 12 homes from the 1% ACE water elevations

- Estimated Probable Cost: $4,518,000
- Benefit/Cost Analysis: Not cost effective
- Home Buyouts: $4,119,852

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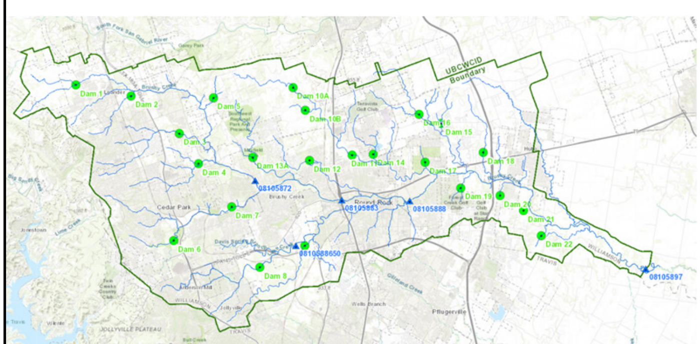

FLOOD MONITORING OPPURTUNITIES

- Stream/rainfall gage placement
  - Critical watershed locations
  - Major roadways
  - Select low water crossings

- Automated Creek Crossings
  - Alerts
  - Flood gates closures

- Flood Hazard Web Map
  - Stage and rainfall triggers
  - Color coded triggers for public use

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ALUM CREEK WATERSHED STUDY NEXT STEPS

- Pre-Disaster Mitigation (PDM) Grant
- Hazard Mitigation Grant Program (HGMP)
- Flood Mitigation Assistance (FMA) Grant
- GLO CDBG Mitigation Program (GLO CDBG-MIT)
- TWDB Flood Infrastructure Fund (FIF)
- Clean Water State Revolving Fund (CWSRF) Loan
- Building Resilient Infrastructure and Communities (BRIC)

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BASTROP COUNTY
TWDB FLOOD PROTECTION PLANNING STUDY
ALUM CREEK

QUESTIONS?

THANK YOU FOR YOUR TIME

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MEETING AGENDA

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Online Virtual Meeting

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1. Alum Creek Watershed Overview
   a. Drainage area = 54.7 sq. mi.
   b. Stream miles = 73.5 mi.
2. Hydrologic and Hydraulic Analysis
   a. Data Collected
   b. Models Developed
   c. 100-year floodplain extents
3. Alternatives Analysis & Evaluation
   a. Roadway Improvement Ranking
   b. Culvert improvements for 5 road crossings
      i. Cost Estimates
   c. Regional detention facility
      i. Pond Dimensions
      ii. Cost Estimate
      iii. Benefit Cost Analysis
4. Flood Monitoring
   a. Roadway Improvement Ranking
   b. Stream gage placement
   c. Flood monitoring web map
      i. Stream gages
      ii. Automated gates
5. Next Steps
   a. Grants
   b. Loans
6. Questions

Additional Information

Observers:

Resource persons:

Special notes:

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MEETING MINUTES

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Bastrop County: Commissioner Clara Beckett, Carolyn Dill

Texas Water Development Board: Ivan Ortiz

Halff Associates: Paul Morales, Katherine Smith

Bastrop County Residents: Cameron Drummond, James and Kimberly Fahrnkopf, Samuel and Karen Spangler

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    a. Drainage area = 54.7 sq. mi.
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2. Hydrologic and Hydraulic Analysis
    a. Data Collected
        i. 2017 LiDAR terrain
        ii. SSURGO Soil Survey from USGS
        iii. NLCD Land Use
        iv. Field Reconnaissance – measurements, sketches, and photos of all 35 creek crossing structures in the watershed
    b. Models Developed
        i. Hydrology Model determines the amount of rain running off of the ground and going into the streams during a storm event
        ii. Hydraulic Models determine the depth of water in the streams and the velocity of the stream during a storm event
    c. 100-year Floodplain Extents
        i. The extent of the 100-year floodplain is developed for existing conditions
        ii. The 100-year floodplain reflects whether or not a structure is overtopped during the 100-year storm
3. Alternatives Analysis & Evaluation
    a. Roadway Improvement Ranking

i. Determined Average Daily Traffic Counts from TxDOT Traffic Counts and Trip Generation Manual

ii. Determined annual chance of road overtopping

iii. Utilized the Traffic Count and chance of overtopping to prioritize roads

iv. A higher risk rank means the higher the flood risk for the structure

b. Culvert improvements for 5 road crossings identified by the county

i. Culvert sizes were increased, and the road profiles were raised by 1 foot to maximize culvert sizes. This increased the level of service of the roads by reducing the frequency that the roads overtop and decreasing the depth of water overtopping during storm events.

ii. Probable cost estimates were presented, and itemized estimates are included in the report.

c. Regional detention facility – detention facility would only hold water during storm events. Two homes on the upstream side of the proposed embankment limit the proposed elevation of the embankment.

i. Embankment length = 1,700 ft., embankment height = 16 ft., storage = 625 ac. ft. during a storm event

ii. Currently there are 22 homes inundated during the 1% ACE event, the proposed dam removes 12 homes from the 1% ACE water elevations

iii. The Benefit Cost ratio is not favorable for this project, the estimated probable cost is $4,518,000 and the estimated cost of home buyouts is $4,119,852

4. Flood Monitoring – The goal is to provide the county with tools that will help monitor flood risks at road crossings in the watershed and help better deploy county resources during storm events

a. Roadway overtopping risk-

i. Goal is to help direct crews for road closures during heavy rainfall events

ii. The rainfall depth that would cause riverine water surface elevation that overtop the road at the crossings was determined. The hydraulic models were used to find the water surface elevations and Atlas 14 100-year, 24-hour rainfall depths were used.

b. Stream gage placement –

i. Can be placed on Highway 21 and 71, or other high traffic roads and low water crossings in the watershed to monitor water surface elevations at the road.

ii. Gages could also be set with trigger elevations to engage automatic closure of road gates.

c. Flood monitoring web map –

i. Updates from gages at road crossings can be available for emergency personnel and public use to monitor road crossing statuses.

ii. Stream/rainfall gages – stage and rainfall could be shown on the web map showing color codes for stages at good, watch, and warning stages.

iii. Automated gates – can be triggered if a gage reaches a warning stage to close a road crossing

5. Next Steps
    a. Grants available for the County from both federal and state funds
        i. HGMP, FMA
    b. Loans available for the County from both federal and state funds
        i. CWSRF, FIF
6. Questions

Action Items

1. **Halff Associates**: To provide Bastrop County with following data:
    i. A PDF of the Public Meeting 3 presentation slides.

Appendix C: Field Reconnaissance

HALFF — Survey Field Sheet

PROJECT: Bastrop FPP AVO 35837 SURVEY NAME:

STREAM NAME: Alum Creek DATE: 04-23-19

LOCATION: TX 71, AC-STR-100, C92 US Westbound CREW: KS + ML

TYPE: BR(X) CUL( ) DAM( ) XS( ) ERM ELEV.: ____ ERM ID: ____ GEOID: ____

BRIDGE:	Rail Height:	2.5'	Deck:	2'	Width:	GIS	Pier(s):	4 rows, 10ea @		Pier Shape:	square
CULVERT:	Number:		Shape:		Length:		Height:		Width:		Skew:
CULVERT:	I/O Type:				Material:	concrete + metal	Wingwall Angle				
DAM:	Top Width:		Side Slope		Side Slope		US:		DS:		Outlet:

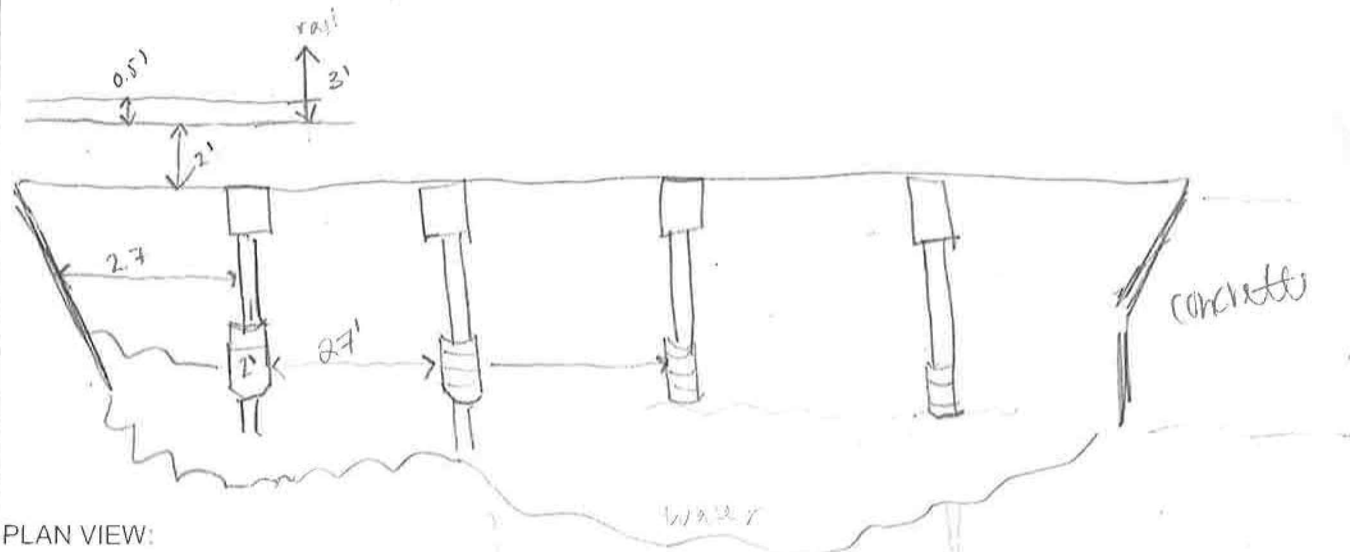
ERM Description: ____ Coordinate System: ____

Photo Numbers: USC: 1 USF: 2-4 DSF: 2 pics DSC: 1 pic w/ weeds

Additional Info: Severe scour US, large concrete block

File Name: pic of scour taken US (#4), bank erosion DS bridge (5+6), pics of debris

PROFILE VIEW:
(Left to Right looking Downstream)



PLAN VIEW:

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	Photo ID: Coordinates: Description:	AC_WEST_STR_100_USF2 30.068121, -97.219171 Upstream face
	Photo ID: Coordinates: Description:	AC_WEST_STR_100_USF3 30.068121, -97.219171 Upstream face

	Photo ID: Coordinates: Description:	AC_WEST_STR_100_USF4 30.068121, -97.219171 Upstream face
	Photo ID: Coordinates: Description:	AC_WEST_STR_100_DSF 30.068121, -97.219171 Downstream face

	Photo ID: Coordinates: Description:	AC_WEST_STR_100_DSF2 30.068121, -97.219171 Downstream face
	Photo ID: Coordinates: Description:	AC_WEST_STR_100_DSC 30.068121, -97.219171 Downstream channel

	Photo ID: Coordinates: Description:	AC_WEST_STR_100_US_PIER 30.068121, -97.219171 Pier
	Photo ID: Coordinates: Description:	AC_WEST_STR_100_US_SCOUR 30.068121, -97.219171 Scour

	Photo ID: Coordinates: Description:	AC_WEST_STR_100_EMBANKMENT 30.068121, -97.219171 Embankment

HALFF

Survey Field Sheet

PROJECT: ______ SURVEY NAME: ______

STREAM NAME: Alum Creek DATE: ______

LOCATION: TX 71, AC-STR.100, C92 DS Eastbound CREW: ______

TYPE: BR(X) CUL( ) DAM( ) XS( ) ERM ELEV.: ______ ERM ID: ______ GEOID: ______

BRIDGE: Rail Height: ______ Deck: 4.5' Width: GIS Pier(s): 3 @ ______ Pier Shape: round

CULVERT: Number: ______ Shape: ______ Length: ______ Height: ______ Width: ______ Skew: ______

CULVERT: I/O Type: ______ Material: concrete Wingwall Angle ______

DAM: Top Width: ______ Side Slope Side Slope US: ______ DS: ______ Outlet: ______

ERM Description: ______ Coordinate System: ______

Photo Numbers: USC: 1 USF: 2 3 DSF: 4 5 DSC: 1

Additional Info: rocky channel bottom

File Name: ______

PROFILE VIEW:
(Left to Right looking Downstream)

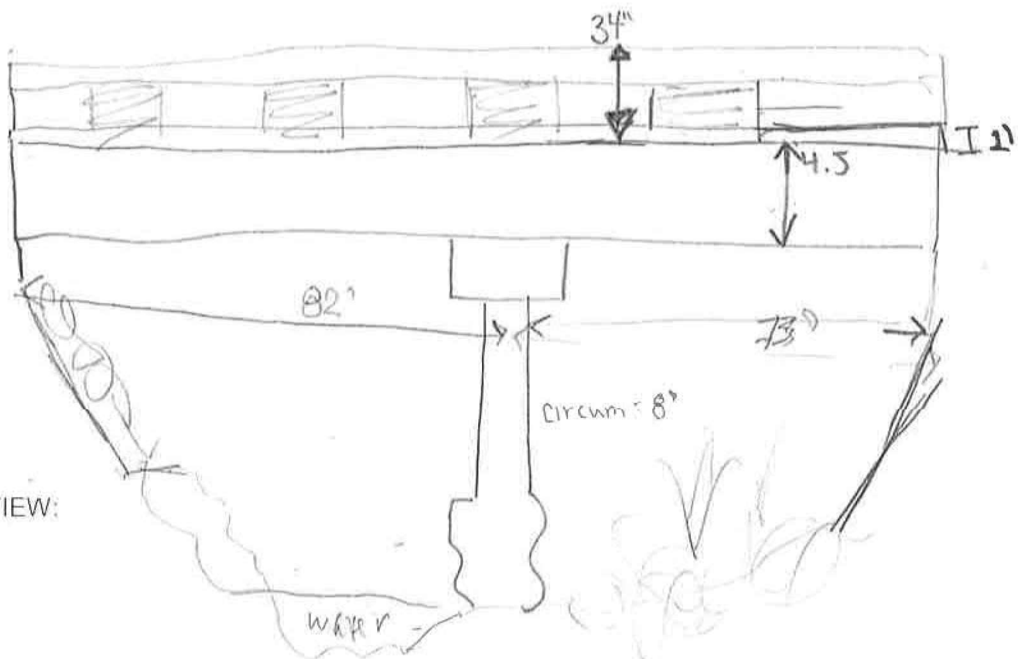

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	Photo ID: Coordinates: Description:	AC_EAST_STR_100_USF 30.068121, -97.219171 Upstream face

	Photo ID: Coordinates: Description:	AC_EAST_STR_100_USF2 30.068121, -97.219171 Upstream face
	Photo ID: Coordinates: Description:	AC_EAST_STR_100_DSF 30.068121, -97.219171 Downstream face

	Photo ID: Coordinates: Description:	AC_EAST_STR_100_DSF2 30.068121, -97.219171 Downstream face
	Photo ID: Coordinates: Description:	AC_EAST_STR_100_DSC 30.068121, -97.219171 Downstream channel

HALFF

Survey Field Sheet

PROJECT: Bastrop FPP AVO 35837 SURVEY NAME:

STREAM NAME: Alum Creek DATE: 04/23/19

LOCATION: Park Rd. 1C, AC-STR-200, C101 CREW: KS & ML

TYPE: BR( ) CUL(X) DAM( ) XS( ) ERM ELEV.: ERM ID: GEOID:

BRIDGE:	Rail Height:	N/A	Deck:	14"	Width:	23"	Pier(s):		@		Pier Shape:
CULVERT:	Number:	1	Shape:	O	Length:	36.5'	Height:	36"	Width:	36"	Skew:
CULVERT:	I/O Type:				Material:	reinforced concrete	Wingwall Angle				
DAM:	Top Width:		Side Slope		Side Slope		US:		DS:		Outlet:

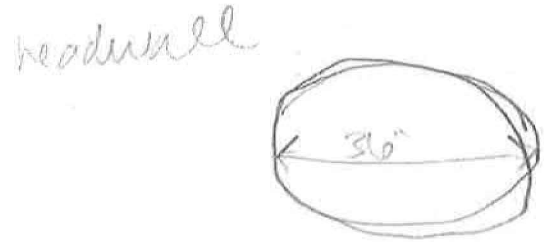
ERM Description: Coordinate System:

Photo Numbers: USC: 1 USF: 2 DSF: 3 DSC: 4 DSL 5 DSR 6 07

Additional Info: low water Xing, moving water, eroded banks, US culv high loss (inefficient)

File Name:

PROFILE VIEW:
(Left to Right looking Downstream)



PLAN VIEW:

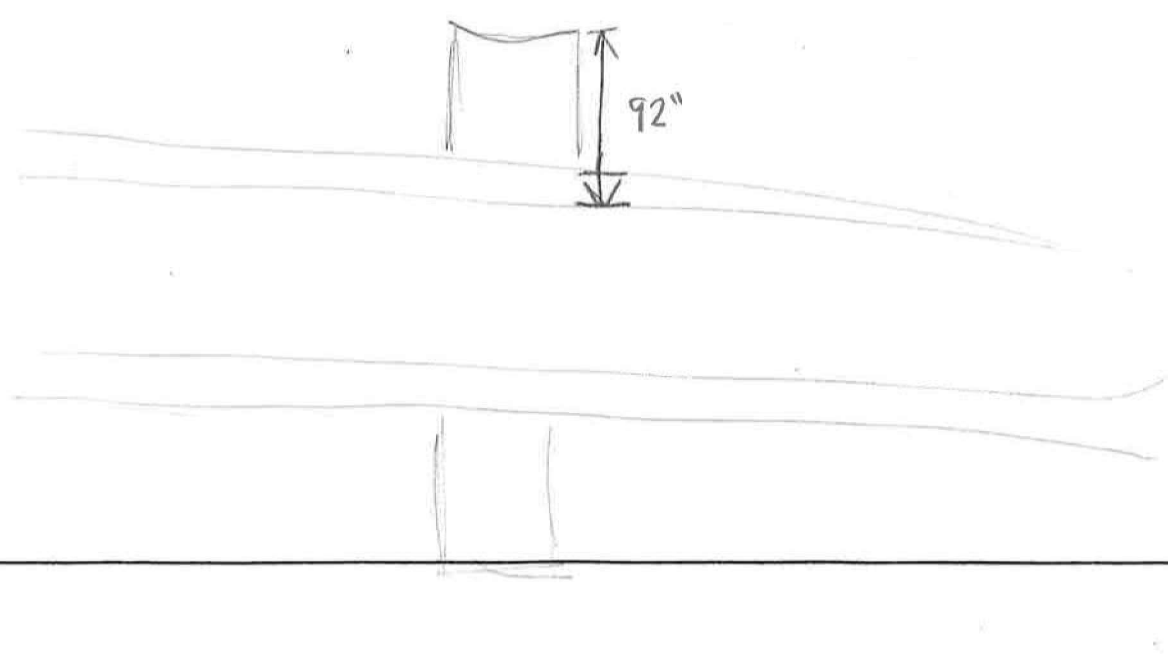


	Photo ID: Coordinates: Description:	AC_STR_200_USC 30.096337, -97.220159 Upstream channel
	Photo ID: Coordinates: Description:	AC_STR_200_USF 30.096337, -97.220159 Upstream face

	Photo ID: Coordinates: Description:	AC_STR_200_DSF 30.096337, -97.220159 Downstream face
	Photo ID: Coordinates: Description:	AC_STR_200_DSC 30.096337, -97.220159 Downstream channel

	Photo ID: Coordinates: Description:	AC_STR_200_DSL 30.096337, -97.220159 Downstream left
	Photo ID: Coordinates: Description:	AC_STR_200_DSR 30.096337, -97.220159 Downstream right

	Photo ID: Coordinates: Description:	AC_STR_200_OVERVIEW 30.096337, -97.220159 Overview

HALFF — Survey Field Sheet

PROJECT: Bastrop FPP AVO 35837 SURVEY NAME:

STREAM NAME: Alum Creek DATE: 04-23-19

LOCATION: Gotier Trace Rd, AC-STR.300, C81 CREW: KS + ML

TYPE: BR(X) CUL( ) DAM( ) XS( ) ERM ELEV.: ERM ID: GEOID:

BRIDGE: Rail Height: 28" Deck: 8" Width: 26' Pier(s): NO @ Pier Shape:

CULVERT: Number: Shape: Length: Height: Width: Skew:

CULVERT: I/O Type: Material: Wingwall Angle

DAM: Top Width: Side Slope Side Slope US: DS: Outlet:

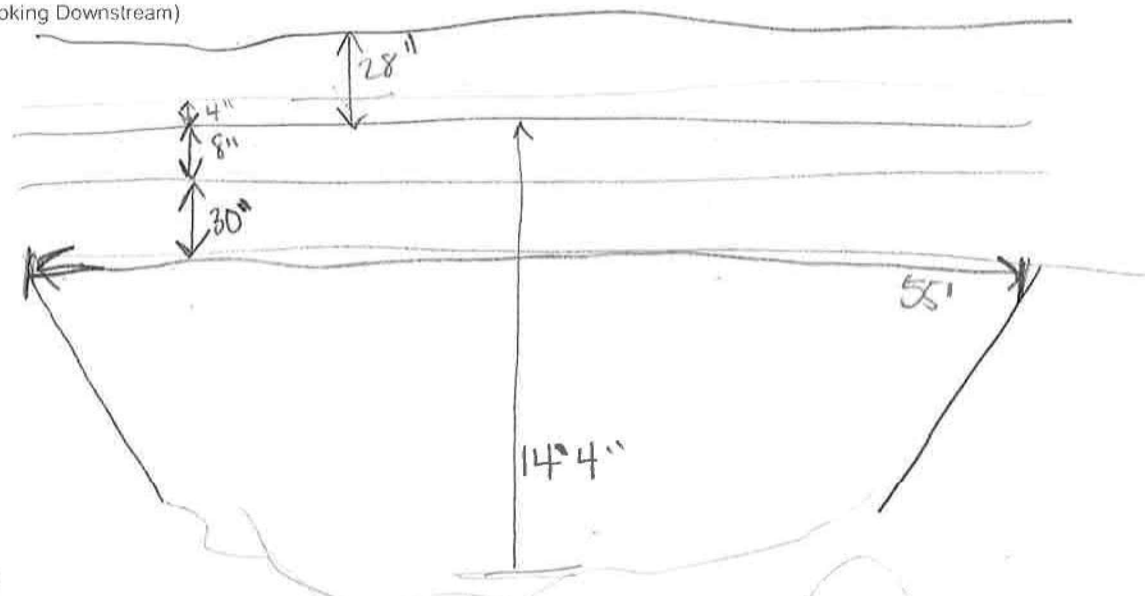
ERM Description: Coordinate System:

Photo Numbers: USC: 1 USF: 2 DSF: N/A DSC: 3 DSL 4 DSR 5 60

Additional Info:

File Name:

PROFILE VIEW:
(Left to Right looking Downstream)



PLAN VIEW:

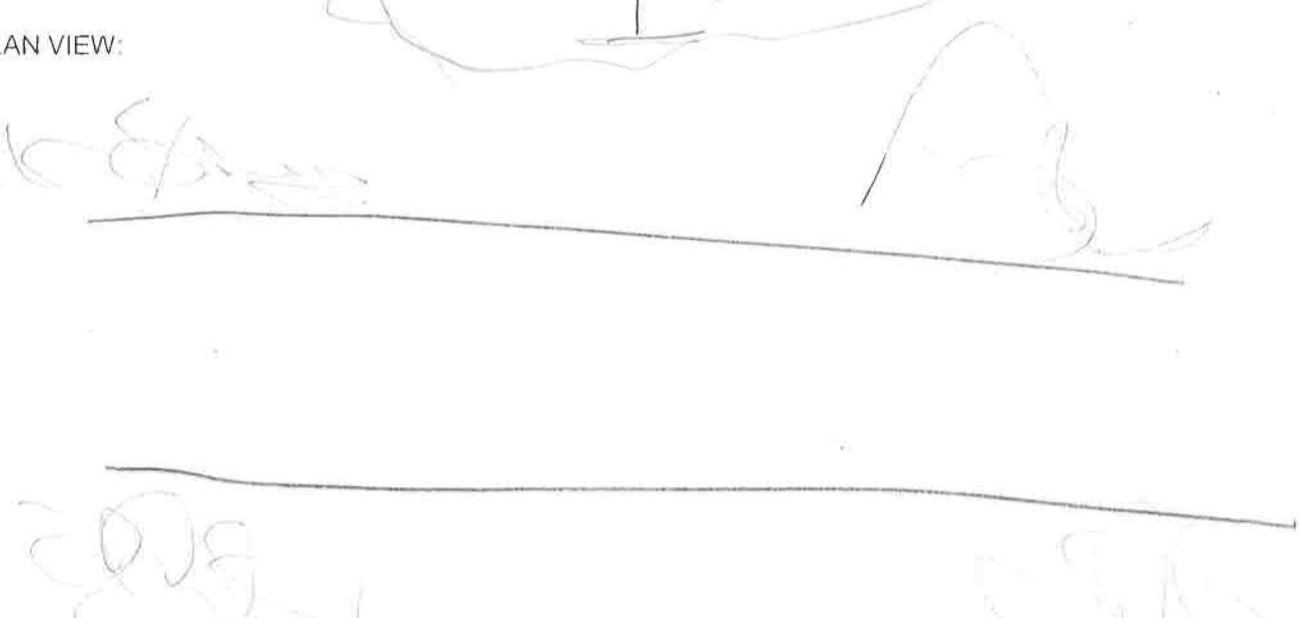


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	Photo ID: Coordinates: Description:	AC_STR_300_DSC 30.104368, -97.213881 Downstream channel
	Photo ID: Coordinates: Description:	AC_STR_300_DSL 30.104368, -97.213881 Downstream left

	Photo ID: Coordinates: Description:	AC_STR_300_DSR 30.104368, -97.213881 Downstream right
	Photo ID: Coordinates: Description:	AC_STR_300_OVERVIEW 30.104368, -97.213881 Overview

HALFF — Survey Field Sheet

PROJECT: Bastrop FPP AVO 35837 SURVEY NAME:

STREAM NAME: Alum Creek DATE: 04-15-19

LOCATION: Mustang Rd, AC-STR-400, C7#3 CREW: KS+ML

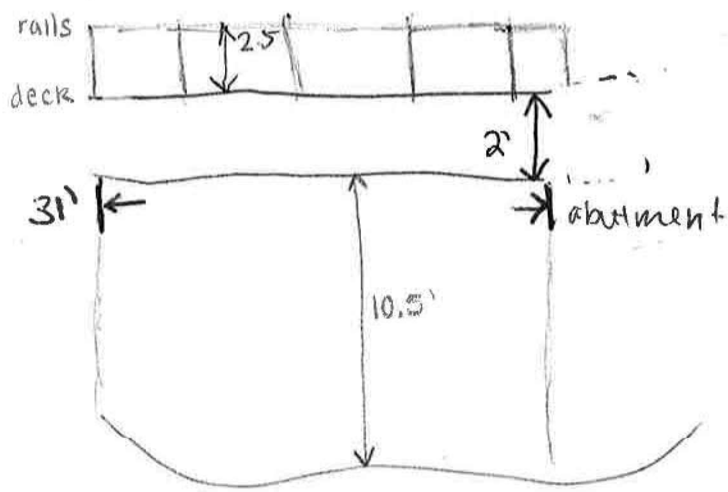
TYPE: BR(X) CUL( ) DAM( ) XS( ) ERM ELEV.: ERM ID: GEOID:

BRIDGE:	Rail Height:	2.5'	Deck:	2'	Width:	20'	Pier(s):	N/A	@		Pier Shape:
CULVERT:	Number:		Shape:		Length:		Height:		Width:		Skew:
CULVERT:	I/O Type:				Material:		Wingwall Angle				
DAM:	Top Width:		Side Slope		Side Slope		US:		DS:		Outlet:
ERM Description:							Coordinate System:				
Photo Numbers:			USC:	1	USF:	2	DSF:	3	DSC:	4	DSL5 DSR6 07

Additional Info: scour on DS, trees on overbanks. railroad flat car

File Name:

PROFILE VIEW:
(Left to Right looking Downstream)



PLAN VIEW:

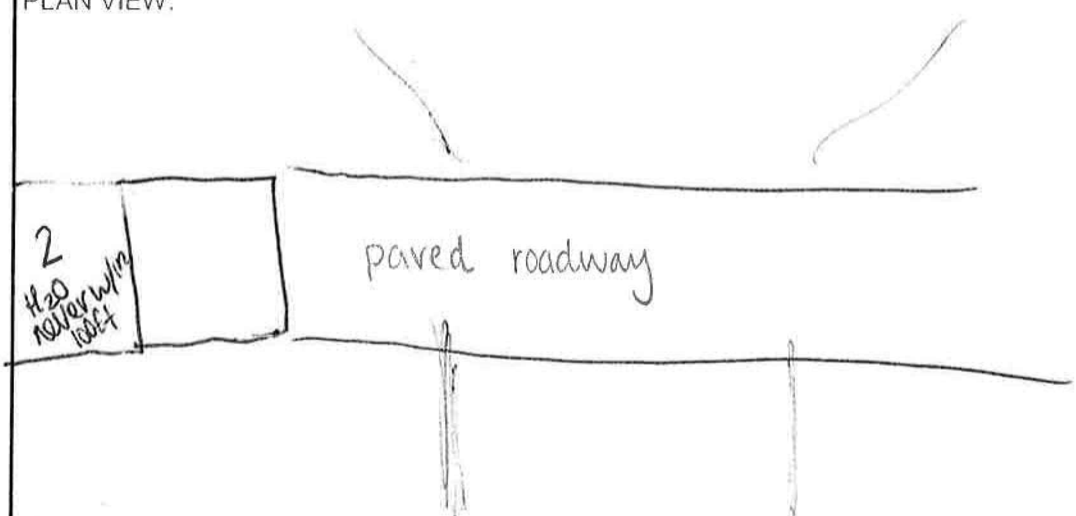


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	Photo ID: Coordinates: Description:	AC_STR_400_USF 30.151136, -97.203236 Upstream face

	Photo ID: Coordinates: Description:	AC_STR_400_DSF 30.151136, -97.203236 Downstream face
	Photo ID: Coordinates: Description:	AC_STR_400_DSC 30.151136, -97.203236 Downstream channel

	Photo ID: Coordinates: Description:	AC_STR_400_DSL 30.151136, -97.203236 Downstream left
	Photo ID: Coordinates: Description:	AC_STR_400_DSR 30.151136, -97.203236 Downstream right

	Photo ID: Coordinates: Description:	AC_STR_400_OVERVIEW 30.151136, -97.203236 Overview

HALFF

Survey Field Sheet

PROJECT: Bastrop FPP AVO 35837 SURVEY NAME:

STREAM NAME: Alum Creek DATE: 04-15-19

LOCATION: AC-STR-500, Cluster 5 #1, Hwy21 CREW: KS+ML

TYPE: BR(X) CUL( ) DAM( ) XS( ) ERM ELEV.: ERM ID: GEOID:

BRIDGE: Rail Height: 32" Deck: 8" Width: 54' Pier(s): 3 rows, 11 each @ 15" Pier Shape: square

CULVERT: Number: Shape: Length: Height: Width: Skew:

CULVERT: I/O Type: Material: Wingwall Angle

DAM: Top Width: Side Slope Side Slope US: DS: Outlet:

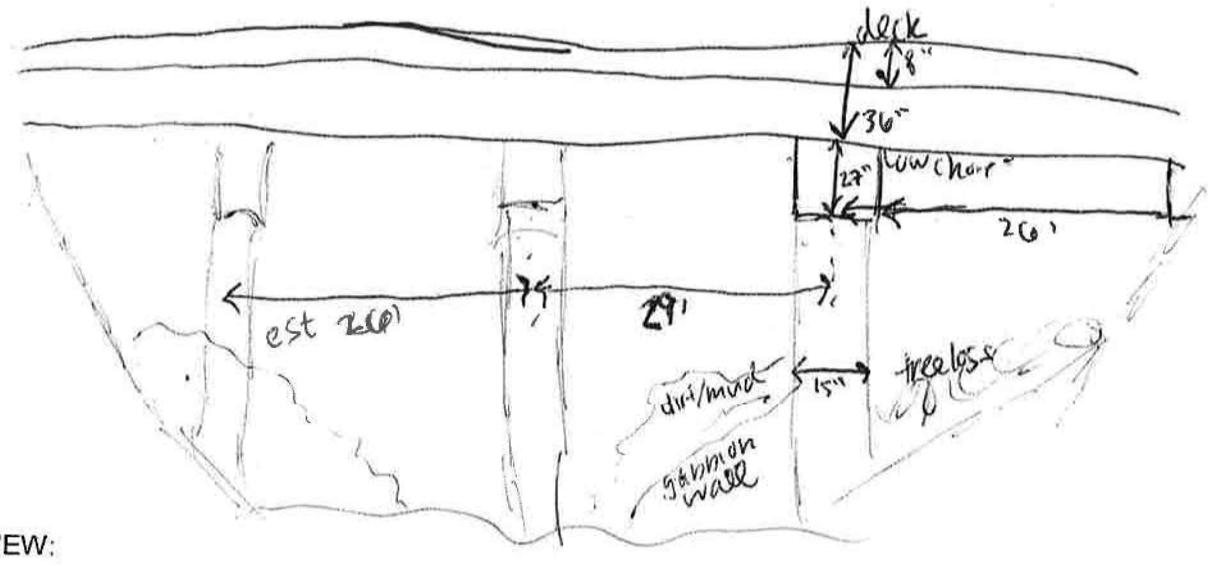
ERM Description: Coordinate System:

Photo Numbers: USC: 1 USF: 2,3,4 DSF: 5 DSC: 7 8 overall 9

Additional Info: brushy

File Name:

PROFILE VIEW:
(Left to Right looking Downstream)



PLAN VIEW:

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	Photo ID: Coordinates: Description:	AC_STR_500_USF1 30.164996, -97.202913 Upstream face

	Photo ID: Coordinates: Description:	AC_STR_500_USF2 30.164996, -97.202913 Upstream face
	Photo ID: Coordinates: Description:	AC_STR_500_USF3 30.164996, -97.202913 Upstream face

	Photo ID: Coordinates: Description:	AC_STR_500_DSF 30.164996, -97.202913 Downstream face
	Photo ID: Coordinates: Description:	AC_STR_500_DSC 30.164996, -97.202913 Downstream channel

	Photo ID: Coordinates: Description:	AC_STR_500_OVERVIEW 30.164996, -97.202913 Overview

HALFF

Survey Field Sheet

PROJECT: ______ SURVEY NAME: ______

STREAM NAME: ______ DATE: 11/27

LOCATION: AC-STR-600 CREW: MD & ML
30.1771 -97.2016

TYPE: BR( ) CUL(X) DAM( ) XS( ) ERM ELEV.: ______ ERM ID: ______ GEOID: ______

BRIDGE: Rail Height: ______ Deck: ______ Width: ______ Pier(s): ______ @ ______ Pier Shape: ______

CULVERT: Number: 5 Shape: box Length: ______ Height: 10' Width: 5' Skew: No

CULVERT: I/O Type: ______ Material: ______ Wingwall Angle ______

DAM: Top Width: ______ Side Slope ______ Side Slope ______ US: ______ DS: ______ Outlet: ______

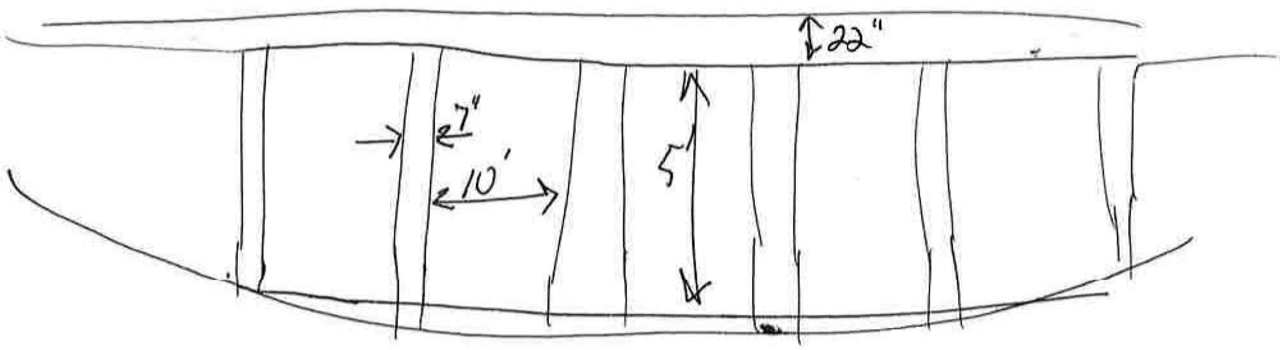
ERM Description: ______ Coordinate System: ______

Photo Numbers: USC: 1 USF: 2 DSF: 3 DSC: 4-5 ROB 6 ROB 7 overview 8

Additional Info: Temp road w/ 36" CMP downstream of 5-10'x5'

File Name: ______

PROFILE VIEW:
(Left to Right looking Downstream)



PLAN VIEW:

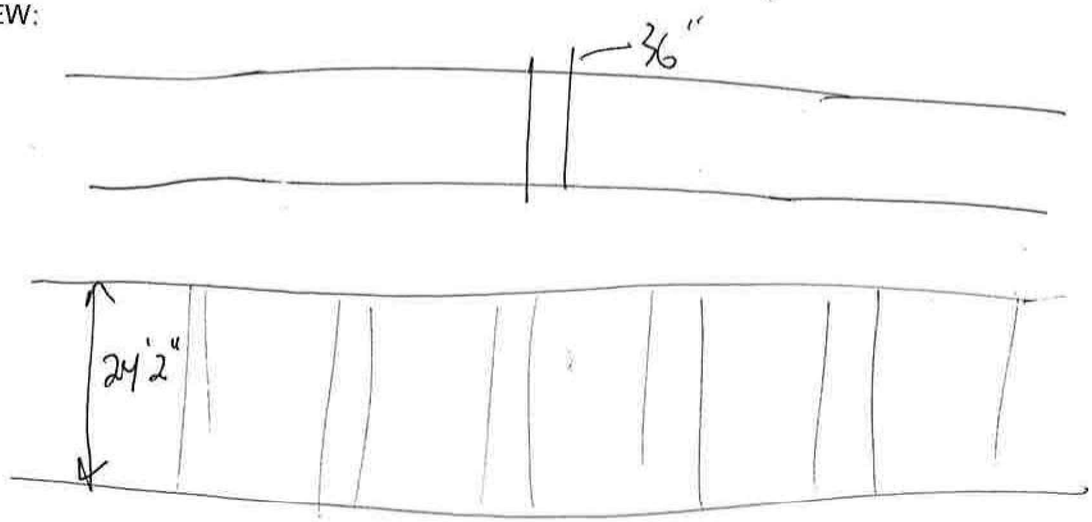


	Photo ID: Coordinates: Description:	AC_STR_600_USC 30.177099, -97.201552 Upstream channel
	Photo ID: Coordinates: Description:	AC_STR_600_USF 30.177099, -97.201552 Upstream face

	Photo ID: Coordinates: Description:	AC_STR_600_DSF 30.177099, -97.201552 Downstream face
	Photo ID: Coordinates: Description:	AC_STR_600_DSC_1 30.177099, -97.201552 Downstream channel, temporary road with 36" CMP downstream of five 10' x 5' box culverts

	Photo ID: Coordinates: Description:	AC_STR_600_DSC_2 30.177099, -97.201552 Downstream channel
	Photo ID: Coordinates: Description:	AC_STR_600_LOB 30.177099, -97.201552 Left overbank

	Photo ID: Coordinates: Description:	AC_STR_600_ROB 30.177099, -97.201552 Right overbank
	Photo ID: Coordinates: Description:	AC_STR_600_OVERVIEW 30.177099, -97.201552 Overview, temporary road with 36" CMP downstream of five 10' x 5' box culverts

HALFF Survey Field Sheet

PROJECT: Bastrop FPP AVO 35837 SURVEY NAME:

STREAM NAME: Alum Creek DATE: 04-[illegible]7-19

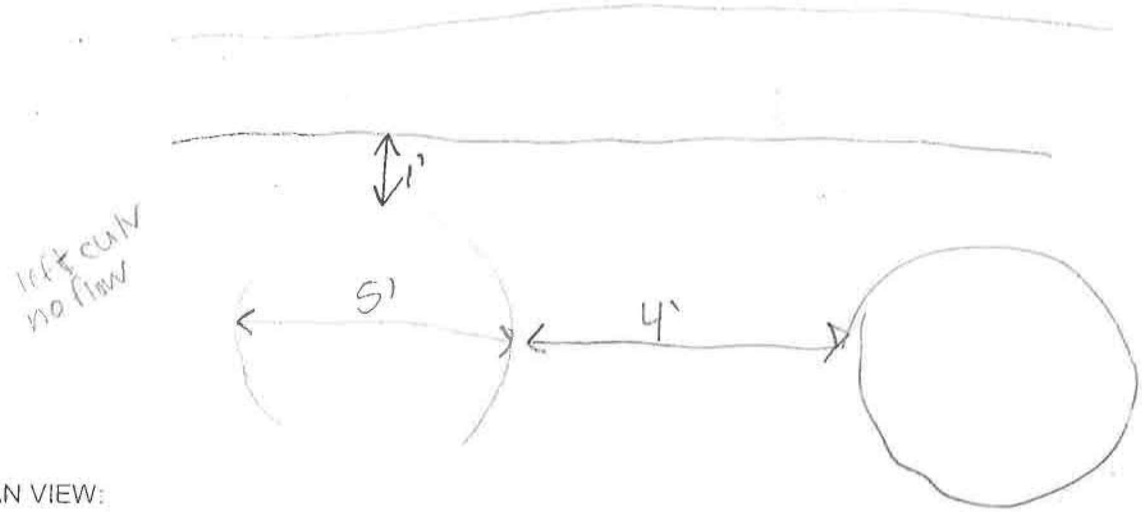
LOCATION: Bowie Dr., AC_STR_600, C31 CREW: KS+ML

TYPE: BR( ) CUL(X) DAM( ) XS( ) ERM ELEV.: ERM ID: GEOID:

BRIDGE:	Rail Height:		Deck:	1`	Width:	25.5 skew	Pier(s):		@		Pier Shape:
CULVERT:	Number:	2	Shape:	CMP	Length:	40' skew	Height:	5'	Width:	5'	Skew:
CULVERT:	I/O Type:	projected from fill	Material:		'Wingwall Angle						
DAM:	Top Width:		Side Slope		Side Slope		US:		DS:		Outlet:
ERM Description:					Coordinate System:						
Photo Numbers:			USC:	81	USF:	82	DSF:	83	DSC:	84	DSL DSR
Additional Info:		bottom rusted out, debris in L culv, trees in DS channel, US bottom rusted out of culv									
File Name:											

PROFILE VIEW:
(Left to Right looking Downstream)

D,US



PLAN VIEW:

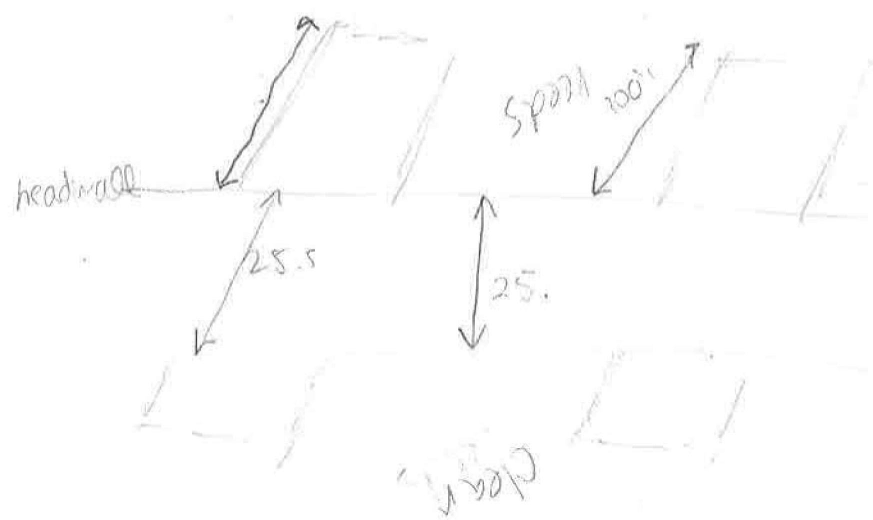


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	Photo ID: Coordinates: Description:	AC_STR_600_USF 30.177099, -97.201552 Upstream face

	Photo ID: Coordinates: Description:	AC_STR_600_DSF 30.177099, -97.201552 Downstream face
	Photo ID: Coordinates: Description:	AC_STR_600_DSC 30.177099, -97.201552 Downstream channel

	Photo ID: Coordinates: Description:	AC_STR_600_DSL 30.177099, -97.201552 Downstream left
	Photo ID: Coordinates: Description:	AC_STR_600_DSR 30.177099, -97.201552 Downstream right

	Photo ID: Coordinates: Description:	AC_STR_600_OVERVIEW 30.177099, -97.201552 Overview

HALFF — **Survey Field Sheet**

PROJECT: Alum — SURVEY NAME:

STREAM NAME: AC - STR - 700 (west of) — DATE: 01/30/20

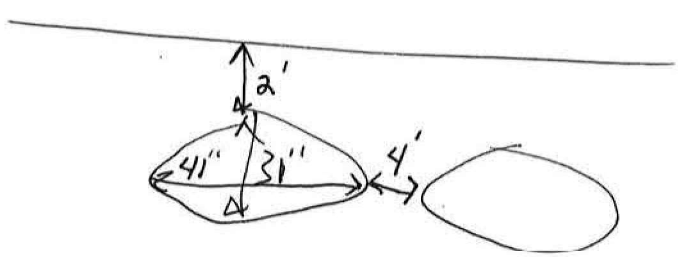
LOCATION: 30.190269, -97.29441 — CREW:

TYPE: BR( ) CUL(X) DAM( ) XS( ) ERM ELEV.: ____ ERM ID: ____ GEOID: ____

BRIDGE:	Rail Height:		Deck:		Width:		Pier(s):		@		Pier Shape:
CULVERT:	Number:	2	Shape:	arch	Length:	40'	Height:	31''	Width:	41''	Skew:
CULVERT:	I/O Type:				Material:		Wingwall Angle				
DAM:	Top Width:		Side Slope		Side Slope		US:		DS:		Outlet:
ERM Description:							Coordinate System:				
Photo Numbers:			USC:	1	USF:	2	DSF:	3	DSC:	4	#LOB 5 ROB 6 overview
Additional Info:											
File Name:											

PROFILE VIEW:
(Left to Right looking Downstream)

Culvert west of AC-STR-700
not on stream CL



PLAN VIEW:

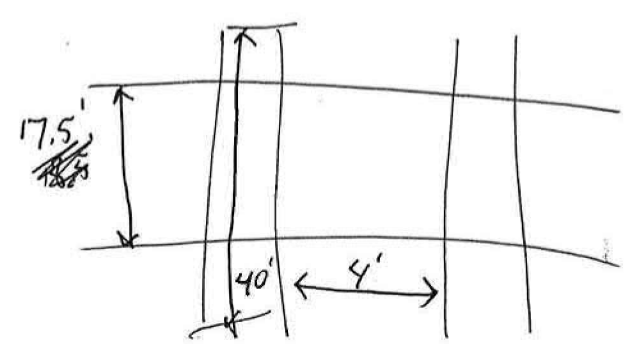


	Photo ID: Coordinates: Description:	AC_STR_700_West_USC 30.190262, -97.204393 Upstream channel
	Photo ID: Coordinates: Description:	AC_STR_700_West_USF 30.190262, -97.204393 Upstream face

	Photo ID: Coordinates: Description:	AC_STR_700_West_DSF 30.190262, -97.204393 Downstream face
	Photo ID: Coordinates: Description:	AC_STR_700_West_DSC 30.190262, -97.204393 Downstream channel

	Photo ID: Coordinates: Description:	AC_STR_700_West_LOB 30.190262, -97.204393 Left Overbank
	Photo ID: Coordinates: Description:	AC_STR_700_West_ROB 30.190262, -97.204393 Right Overbank

	Photo ID: Coordinates: Description:	AC_STR_700_West_OVERVIEW 30.190262, -97.204393 Overview

HALFF Survey Field Sheet

PROJECT: Bastrop FPP AVO 35837 SURVEY NAME:

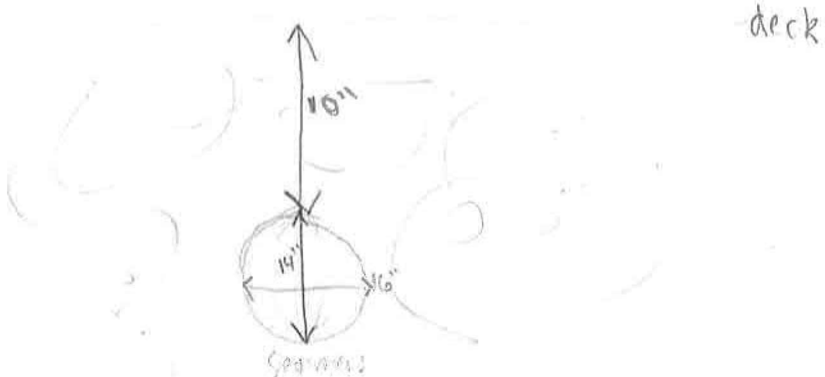
STREAM NAME: Alum Creek DATE: 04-17-19

LOCATION: Cardinal Ln, AC-STR-700, C21 CREW: KS+ML

TYPE: BR( ) CUL(X) DAM( ) XS( ) ERM ELEV.: ERM ID: GEOID:

BRIDGE:	Rail Height:		Deck:	10"	Width:	17'	Pier(s):	@		Pier Shape:	
CULVERT:	Number:	1	Shape:	CMP	Length:	30'	Height:	14"	Width: 14"	Skew:	
CULVERT:	I/O Type:				Material:	metal	Wingwall Angle				
DAM:	Top Width:		Side Slope		Side Slope		US:		DS:	Outlet:	
ERM Description:							Coordinate System:				
Photo Numbers:			USC:	8	USF:	9	DSF:	10	DSC: 11	DSL12 DSR13&14	
Additional Info:	boggy, partially crushed DS culv outlet										
File Name:											

PROFILE VIEW:
(Left to Right looking Downstream)



PLAN VIEW:

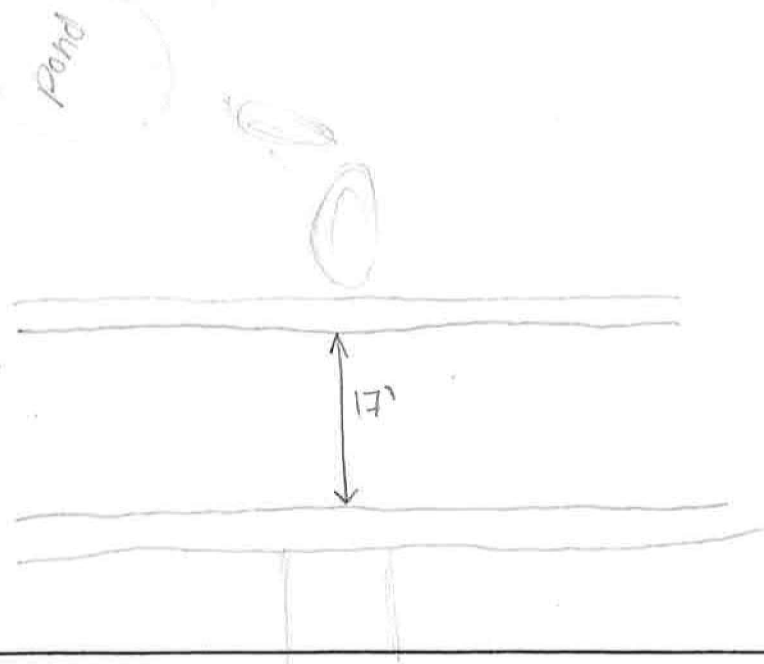


	Photo ID: Coordinates: Description:	AC_STR_700_USC 30.190269, -97.204410 Upstream channel
	Photo ID: Coordinates: Description:	AC_STR_700_USF 30.190269, -97.204410 Upstream face

	Photo ID: Coordinates: Description:	AC_STR_700_DSF 30.190269, -97.204410 Downstream face
	Photo ID: Coordinates: Description:	AC_STR_700_DSC 30.190269, -97.204410 Downstream channel

	Photo ID: Coordinates: Description:	AC_STR_700_DSL 30.190269, -97.204410 Downstream left
	Photo ID: Coordinates: Description:	AC_STR_700_DSR 30.190269, -97.204410 Downstream right

	Photo ID: Coordinates: Description:	AC_STR_700_OVERVIEW 30.190269, -97.204410 Overview

HALFF — Survey Field Sheet

PROJECT: Bastrop FPP AVO 35837 SURVEY NAME:

STREAM NAME: Little Alum Creek DATE: 04-23-17

LOCATION: Ponderosa Rd, AC-LAC.STR-100, C111 CREW: KS + MI

TYPE: BR(X) CUL( ) DAM( ) XS( ) ERM ELEV.:   ERM ID: GEOID:

BRIDGE: Rail Height: 27" Deck: 19" Width: 18.5' Pier(s): N/A @   Pier Shape:

CULVERT: Number: Shape: Length: Height: Width: Skew:

CULVERT: I/O Type: Material: Wingwall Angle:

DAM: Top Width: Side Slope   Side Slope   US: DS: Outlet:

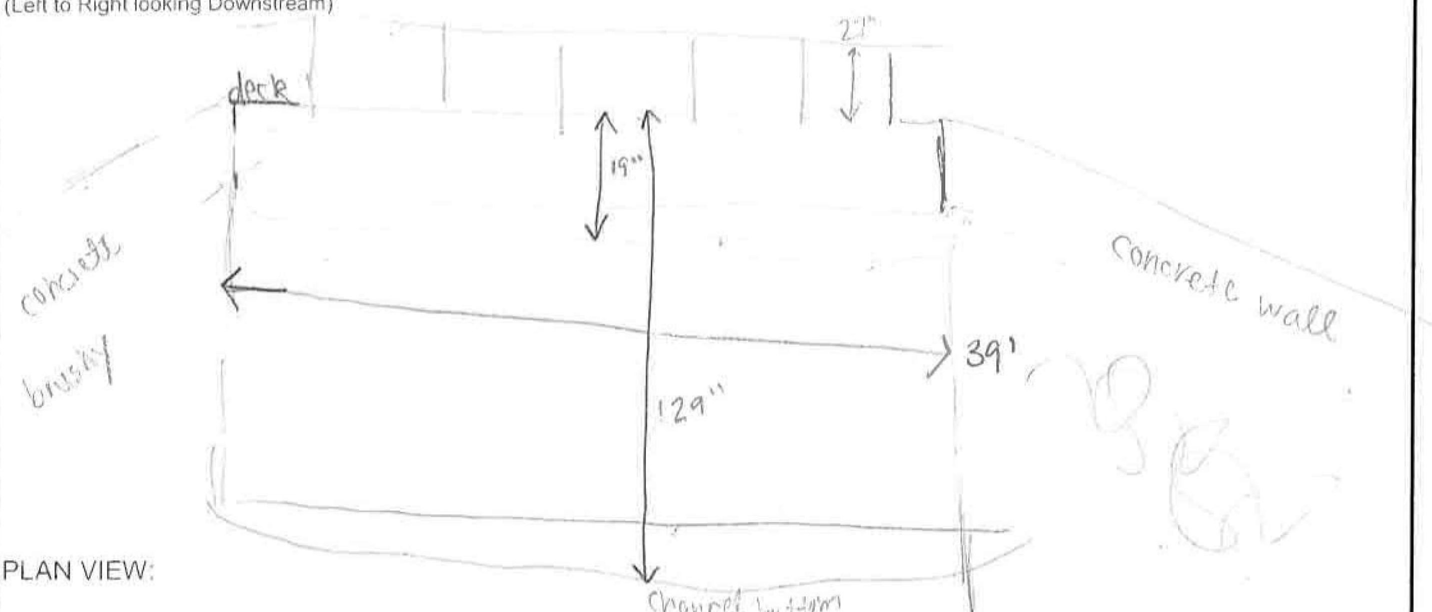
ERM Description: Coordinate System:

Photo Numbers: USC: 1 USF: 2 DSF: 3 DSC: 4 DSL 5 DSR 6 O 7

Additional Info:

File Name: brushy slopes, clear channel w/ rocky bottom, flowing water

PROFILE VIEW:
(Left to Right looking Downstream)



PLAN VIEW:

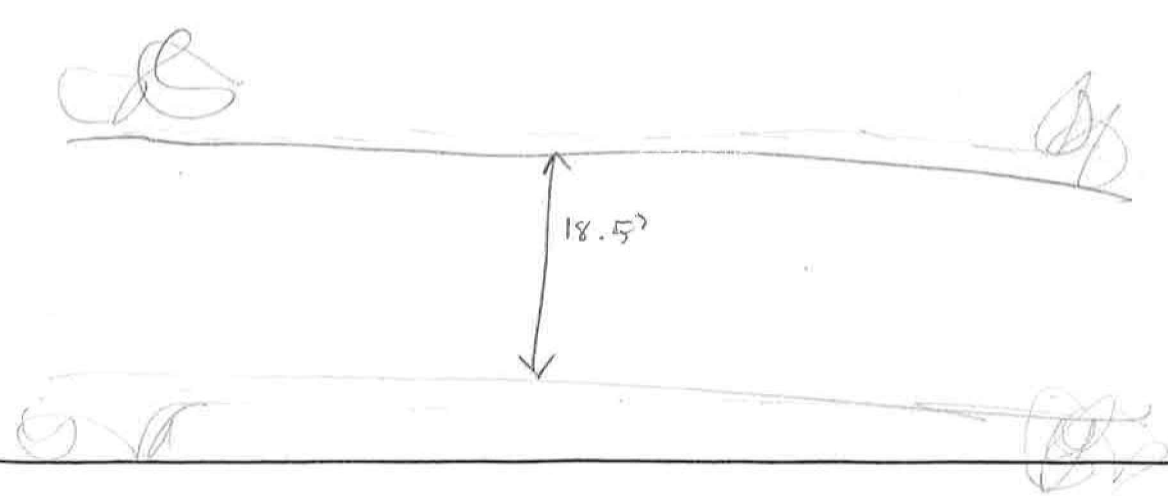


	Photo ID: Coordinates: Description:	AC_LAC_STR_100_USC 30.051607, -97.237270 Upstream channel
	Photo ID: Coordinates: Description:	AC_LAC_STR_100_USF 30.051607, -97.237270 Upstream face

	Photo ID: Coordinates: Description:	AC_LAC_STR_100_DSF 30.051607, -97.237270 Downstream face
	Photo ID: Coordinates: Description:	AC_LAC_STR_100_DSC 30.051607, -97.237270 Downstream channel

	Photo ID: Coordinates: Description:	AC_LAC_STR_100_DSL 30.051607, -97.237270 Downstream left
	Photo ID: Coordinates: Description:	AC_LAC_STR_100_DSR 30.051607, -97.237270 Downstream right

	Photo ID: Coordinates: Description:	AC_LAC_STR_100_OVERVIEW 30.051607, -97.237270 Overview

HALFF — Survey Field Sheet

PROJECT: Bastrop FPP AVO 35837 SURVEY NAME:

STREAM NAME: Little Alum Creek DATE: 04-23-19

LOCATION: TX 71, AC-LAC-STR-200, C91 CREW: KS + ML

TYPE: BR( ) CUL(X) DAM( ) XS( ) ERM ELEV.: ______ ERM ID: ______ GEOID: ______

BRIDGE: Rail Height: N/A Deck: 50" Width: ______ Pier(s): ______ @ ______ Pier Shape: ______

CULVERT: Number: 3 Shape: box Length: ______ Height: 10' Width: 10' Skew: yes, bend in culv

CULVERT: I/O Type: mitered US Material: concrete Wingwall Angle 30°

DAM: Top Width: ______ Side Slope Side Slope US: ______ DS: ______ Outlet: ______

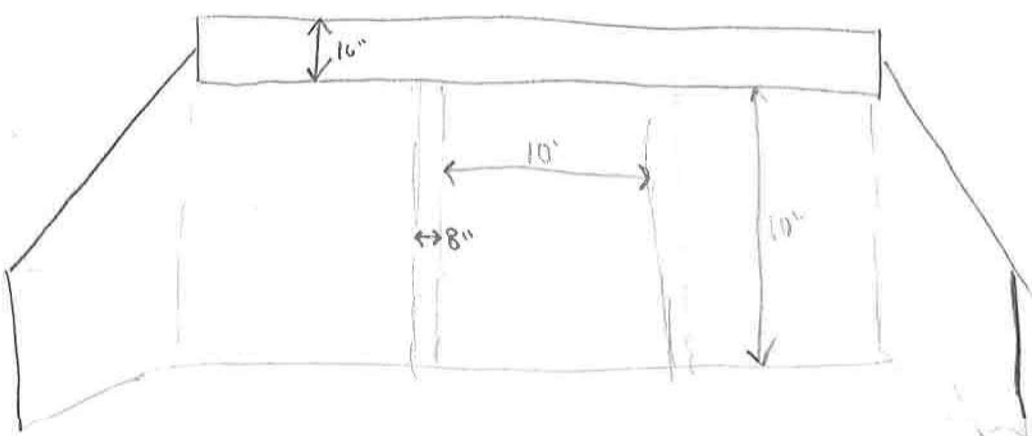
ERM Description: ______ Coordinate System: ______

Photo Numbers: USC: 1 USF: 2 DSF: 3 DSC: 4

Additional Info: middle culv large pile of rock, scour erosion 1 side facing DS [illegible],

File Name: burned stumps US. DS 2 left culverts no flow, sediment & trees growing

PROFILE VIEW:
(Left to Right looking Downstream)



US river comes in + then bends, DS drop off 2ft past soil buildup

PLAN VIEW:

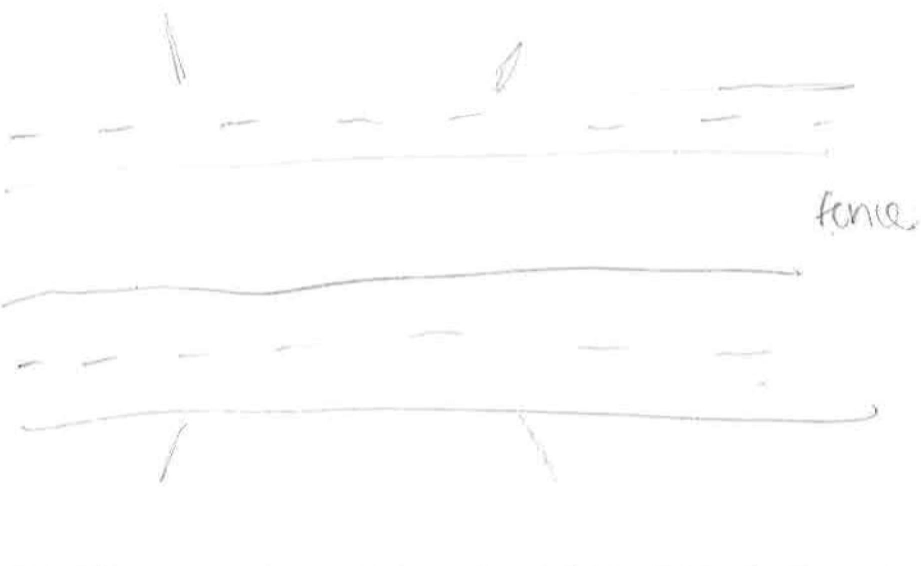


	Photo ID: Coordinates: Description:	AC_LAC_STR_200_USC 30.074800, -97.237755 Upstream channel
	Photo ID: Coordinates: Description:	AC_LAC_STR_200_USC2 30.074800, -97.237755 Upstream channel

	Photo ID: Coordinates: Description:	AC_LAC_STR_200_USC3 30.074800, -97.237755 Upstream channel
	Photo ID: Coordinates: Description:	AC_LAC_STR_200_USF 30.074800, -97.237755 Upstream face

	Photo ID: Coordinates: Description:	AC_LAC_STR_200_DSF 30.074800, -97.237755 Downstream face
		
	Photo ID: Coordinates: Description:	AC_LAC_STR_200_DSC 30.074800, -97.237755 Downstream channel

	Photo ID: Coordinates: Description:	AC_LAC_STR_200_CULVERTNUMBE R 30.074800, -97.237755 Culvert number

HALFF

Survey Field Sheet

PROJECT: ____________________ SURVEY NAME: ____________________

STREAM NAME: Unnamed Trib DATE: 04-23-19

LOCATION: AC-T1-STR.100 Gotier Trace C82 CREW: KS+ML

TYPE: BR( ) CUL(X) DAM( ) XS( ) ERM ELEV.: ________ ERM ID: ________ GEOID: ________

BRIDGE:	Rail Height:	N/A	Deck:	1'	Width:	19'	Pier(s):		@		Pier Shape:
CULVERT:	Number:	1	Shape:	CMP	Length:	30'	Height:	30"	Width:	30"	Skew: Y
CULVERT:	I/O Type:	proj from fill			Material:	metal	Wingwall Angle				
DAM:	Top Width:		Side Slope		Side Slope		US:		DS:		Outlet:
ERM Description:							Coordinate System:				
Photo Numbers:			USC:	1	USF:	2,3,4	DSF:	5	DSC:	6	DSL 7 DSR 8

Additional Info: standing water US (marsh), large amounts of debris @ culv b/c fence

File Name:

PROFILE VIEW:
(Left to Right looking Downstream)

PLAN VIEW:

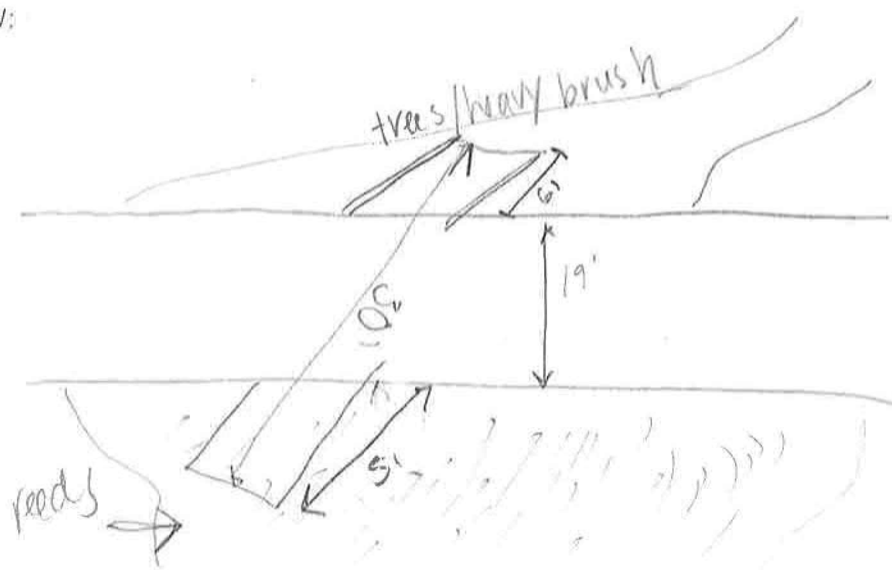


	Photo ID: Coordinates: Description:	AC_T1_STR_100_USC 30.104463, -97.209474 Upstream channel
	Photo ID: Coordinates: Description:	AC_T1_STR_100_USF 30.104463, -97.209474 Upstream face

	Photo ID: Coordinates: Description:	AC_T1_STR_100_USF2 30.104463, -97.209474 Upstream face
	Photo ID: Coordinates: Description:	AC_T1_STR_100_USF3 30.104463, -97.209474 Upstream face

Unable to access	Photo ID: Coordinates: Description:	AC_T1_STR_100_DSF 30.104463, -97.209474 Downstream face
	Photo ID: Coordinates: Description:	AC_T1_STR_100_DSC 30.104463, -97.209474 Downstream channel

	Photo ID: Coordinates: Description:	AC_T1_STR_100_DSL 30.104463, -97.209474 Downstream left
	Photo ID: Coordinates: Description:	AC_T1_STR_100_DSR 30.104463, -97.209474 Downstream right

HALFF Survey Field Sheet

PROJECT: Bastrop FPP AVO 35837 SURVEY NAME:

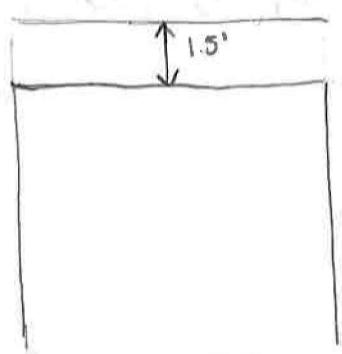
STREAM NAME: Alum Creek Trib 4 DATE: 04-15-19

LOCATION: AC-T4_STR-100, Hwy21, C72 CREW: KS + ML

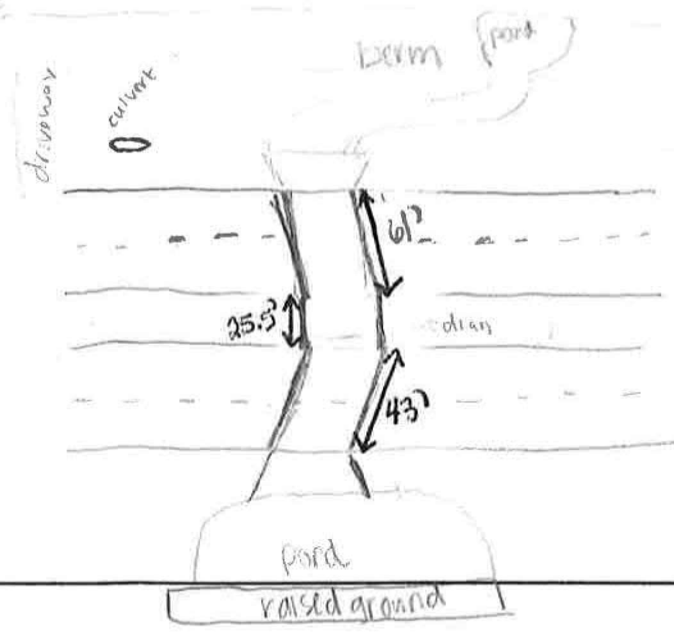
TYPE: BR( ) CUL(X) DAM( ) XS( ) ERM ELEV.: ERM ID: GEOID:

BRIDGE:	Rail Height:	33" US	Deck:		Width:		Pier(s):		@	Pier Shape:
CULVERT:	Number:	1	Shape: box	Length:	129.5	Height:	7'	Width:	7'	Skew:
CULVERT:	I/O Type:	mitered		Material:	concrete		Wingwall Angle	30°-45°		
DAM:	Top Width:		Side Slope	Side Slope		US:		DS:		Outlet:
ERM Description:						Coordinate System:				
Photo Numbers:			USC: 1	USF: 2		DSF: 3		DSC: 4		DSL 5 DSR 6
Additional Info:		Standing water in pond DS								
File Name:										

PROFILE VIEW:
(Left to Right looking Downstream)



PLAN VIEW:



* US side of Hwy higher elev than DS
* bend in culvert

	Photo ID: Coordinates: Description:	AC_T4_STR_100_USC 30.146960, -97.233609 Upstream channel
	Photo ID: Coordinates: Description:	AC_T4_STR_100_USF 30.146960, -97.233609 Upstream face

<table>
<tr><td></td><td>Photo ID:
Coordinates:
Description:</td><td>AC_T4_STR_100_DSF
30.146960, -97.233609
Downstream face</td></tr>
<tr><td></td><td>Photo ID:
Coordinates:
Description:</td><td>AC_T4_STR_100_DSC
30.146960, -97.233609
Downstream channel</td></tr>
</table>

	Photo ID: Coordinates: Description:	AC_T4_STR_100_DSC2 30.146960, -97.233609 Downstream channel
	Photo ID: Coordinates: Description:	AC_T4_STR_100_DSL 30.146960, -97.233609 Downstream left

	Photo ID: Coordinates: Description:	AC_T4_STR_100_DSR 30.146960, -97.233609 Downstream right

HALFF — **Survey Field Sheet**

PROJECT: Bastrop FPP AVO 35837 SURVEY NAME:

STREAM NAME: Alum Creek Trib 4 DATE: 04-15-19

LOCATION: AC_T4_STR-200, Cluster 7 #1 Kelley Rd CREW: KS + ML

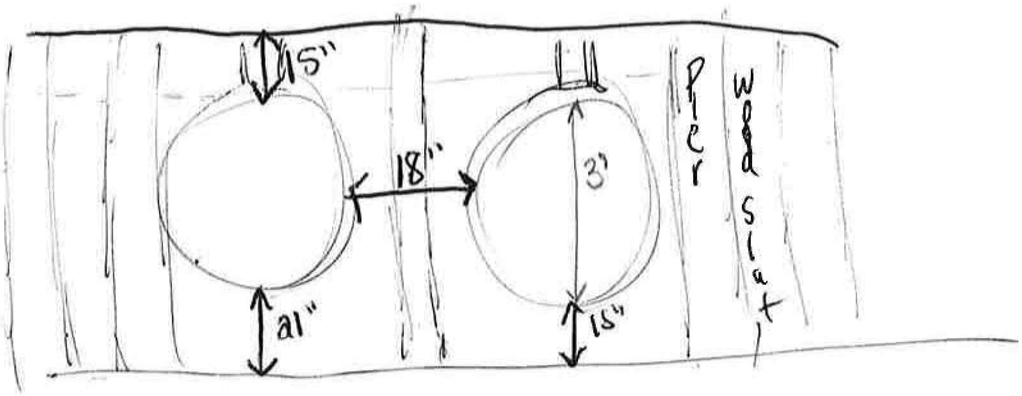
TYPE: BR( ) CUL(X) DAM( ) XS( ) ERM ELEV.: ERM ID: GEOID:

BRIDGE:	Rail Height:	N/A	Deck:	inside to top 15"	Width:	25'8"	Pier(s):		@		Pier Shape:	
CULVERT:	Number:	2	Shape:	O	Length:	31'	Height:	3'	Width:	3'	Skew:	small
CULVERT:	I/O Type:				Material	Concrete	Wingwall Angle					
DAM:	Top Width:		Side Slope		Side Slope		US:		DS:		Outlet:	
ERM Description:							Coordinate System:					
Photo Numbers:			USC:	1	USF:	2	DSF:	3	DSC:	4	DSL 5 DSR 6	

Additional Info: dry channel, rocky bottom, skew

File Name:

PROFILE VIEW:
(Left to Right looking Downstream)



PLAN VIEW:

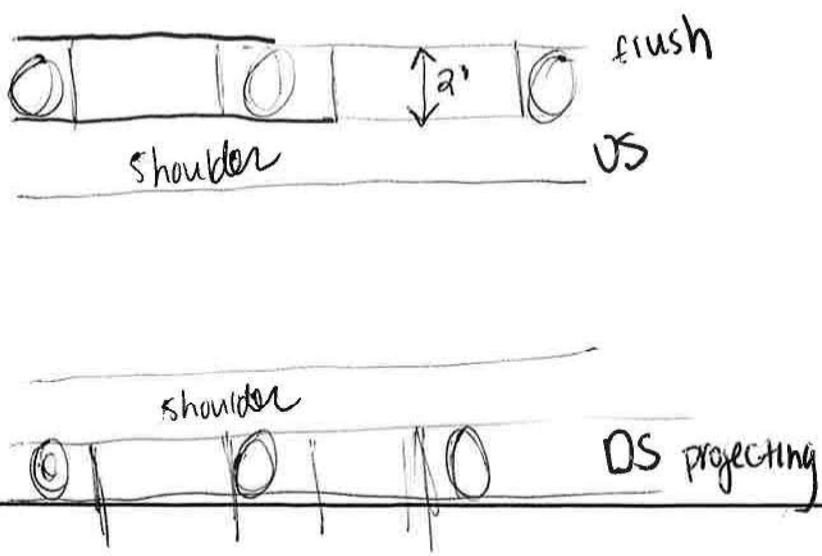


	Photo ID: Coordinates: Description:	AC_T4_STR_200_USC 30.149992, -97.235395 Upstream channel
	Photo ID: Coordinates: Description:	AC_T4_STR_200_USF 30.149992, -97.235395 Upstream face

	Photo ID: Coordinates: Description:	AC_T4_STR_200_DSF 30.149992, -97.235395 Downstream face
	Photo ID: Coordinates: Description:	AC_T4_STR_200_DSC 30.149992, -97.235395 Downstream channel

	Photo ID: Coordinates: Description:	AC_T4_STR_200_DSL 30.149992, -97.235395 Downstream left
	Photo ID: Coordinates: Description:	AC_T4_STR_200_DSR 30.149992, -97.235395 Downstream right

	Photo ID: Coordinates: Description:	AC_T4_STR_200_OVERVIEW 30.149992, -97.235395 Overview

HALFF

Survey Field Sheet

3

PROJECT: Bastrop FPP AVO 35837 SURVEY NAME:

STREAM NAME: Alum Creek Trib 7 DATE: 04-15-19

LOCATION: Cluster 6, Kinsey Rd, AC_T7_STR-100 CREW: KS+ML

TYPE: BR(X) CUL(~~X~~) DAM( ) XS( ) ERM ELEV.: ERM ID: GEOID:

BRIDGE: Rail Height: 29" Deck: 2'2" Width: 26' Pier(s): N/A @ Pier Shape:

CULVERT: Number: Shape: Length: Height: Width: Skew:

CULVERT: I/O Type: Material: Wingwall Angle

DAM: Top Width: Side Slope Side Slope US: DS: Outlet:

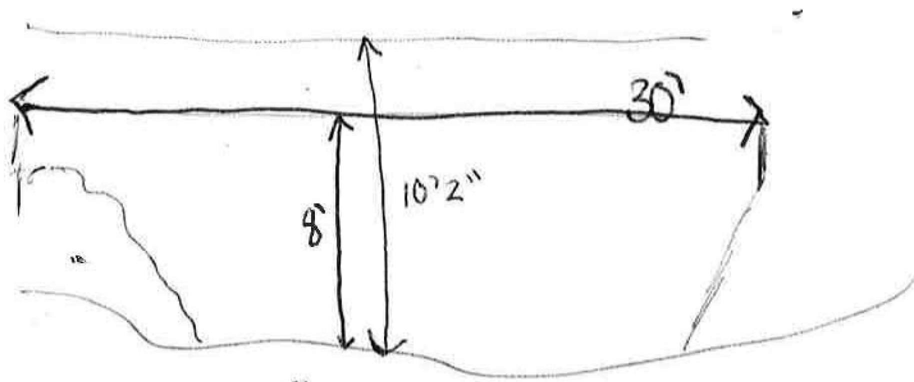
ERM Description: Coordinate System:

Photo Numbers: USC: 1 USF: 2 DSF: 3 DSC: 4 DSL 5 DSR 6 07

Additional Info: woody, trees in channel.

File Name:

PROFILE VIEW:
(Left to Right looking Downstream)



PLAN VIEW:

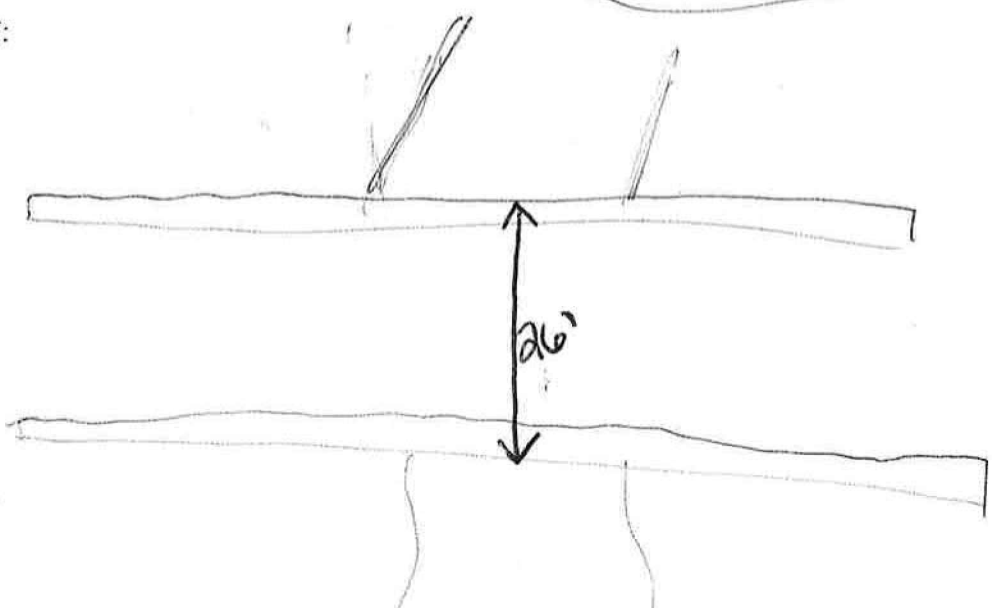


	Photo ID: Coordinates: Description:	AC_T7_STR_100_USC 30.161926, -97.191896 Upstream channel
	Photo ID: Coordinates: Description:	AC_T7_STR_100_USF 30.161926, -97.191896 Upstream face

	Photo ID: Coordinates: Description:	AC_T7_STR_100_DSF 30.161926, -97.191896 Downstream face
	Photo ID: Coordinates: Description:	AC_T7_STR_100_DSC 30.161926, -97.191896 Downstream channel

	Photo ID: Coordinates: Description:	AC_T7_STR_100_DSL 30.161926, -97.191896 Downstream left
	Photo ID: Coordinates: Description:	AC_T7_STR_100_DSR 30.161926, -97.191896 Downstream right

	Photo ID: Coordinates: Description:	AC_T7_STR_100_OVERVIEW 30.161926, -97.191896 Overview

HALFF — Survey Field Sheet

2

PROJECT: Bastrop FPP AW 35837 SURVEY NAME:

STREAM NAME: AC Trib 7., AC.T7_STR.200 DATE: 04-15-19

LOCATION: Squirrel Run, Cluster 6 #2 CREW: KS+ML

TYPE: BR( ) CUL(X) DAM( ) XS( ) ERM ELEV.: ERM ID: GEOID:

BRIDGE: Rail Height: N/A Deck: 18" cover Width: 14' Pier(s): @ Pier Shape:

CULVERT: Number: 1 Shape: O Length: 20.5' Height: Width: Skew:

CULVERT: I/O Type: Material: CMP Wingwall Angle

DAM: Top Width: Side Slope Side Slope US: DS: Outlet:

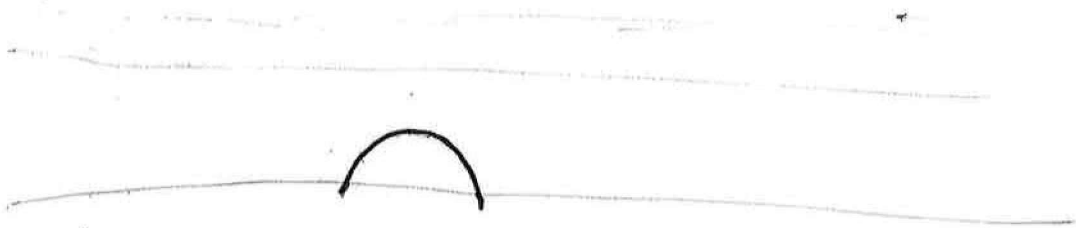
ERM Description: inlet projected, outlet mitered Coordinate System:

Photo Numbers: USC: 1 USF: 2 DSF: 3 DSC: 4 DSL 5 DSR 6 O 7

Additional Info: bad erosion DS; roadway crowned

File Name:

PROFILE VIEW:
(Left to Right looking Downstream)



PLAN VIEW:

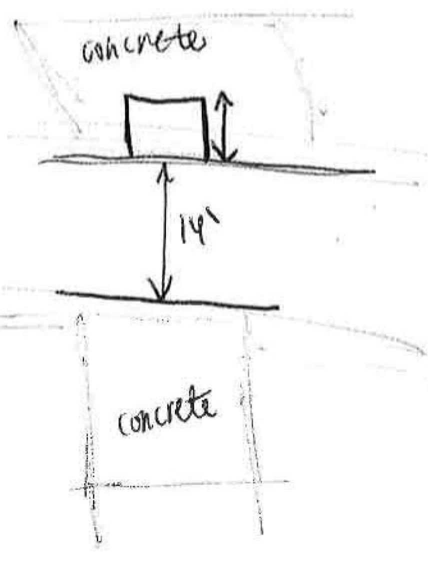


	Photo ID: Coordinates: Description:	AC_T7_STR_200_USC 30.166355, -97.188286 Upstream channel
	Photo ID: Coordinates: Description:	AC_T7_STR_200_USF 30.166355, -97.188286 Upstream face

	Photo ID: Coordinates: Description:	AC_T7_STR_200_DSF 30.166355, -97.188286 Downstream face
	Photo ID: Coordinates: Description:	AC_T7_STR_200_DSC 30.166355, -97.188286 Downstream channel

	Photo ID: Coordinates: Description:	AC_T7_STR_200_DSL 30.166355, -97.188286 Downstream left
	Photo ID: Coordinates: Description:	AC_T7_STR_200_DSR 30.166355, -97.188286 Downstream right

	Photo ID: Coordinates: Description:	AC_T7_STR_200_OVERVIEW 30.166355, -97.188286 Overview

HALFF

Survey Field Sheet

PROJECT: Bastrop FPP AVO 35837 SURVEY NAME:

STREAM NAME: Alum Creek Trib.7 DATE: 04-15-19

LOCATION: Hwy 21, Cluster 6, AC-T7-STR300 CREW: KS+ML

TYPE: BR(X) CUL( ) DAM( ) XS( ) ERM ELEV.: ERM ID: GEOID:

BRIDGE: Rail Height: 29" Deck: TOR to joint 3" Width: 62' Pier(s): 3 row, 1 leach@ 14" Pier Shape: square

CULVERT: Number: Shape: Length: Height: Width: Skew: in dir of flow

CULVERT: I/O Type: Material: Wingwall Angle

DAM: Top Width: Side Slope Side Slope US: DS: Outlet:

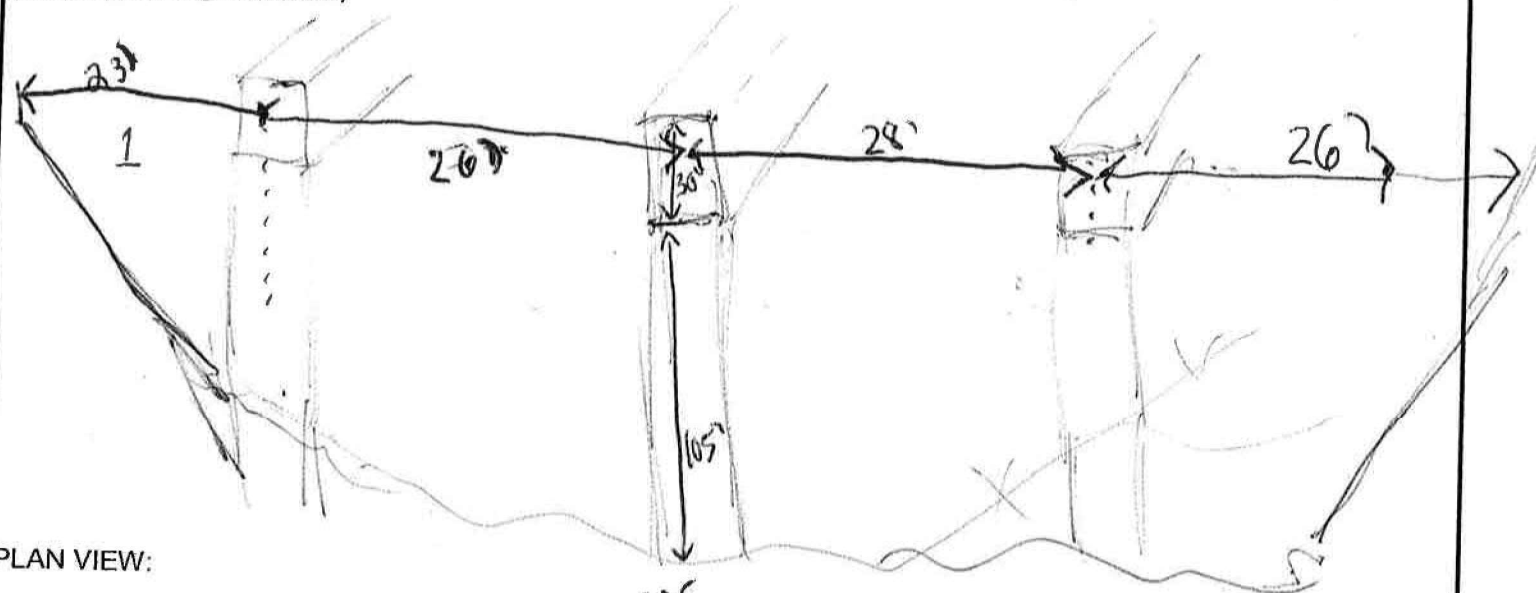
ERM Description: Coordinate System:

Photo Numbers: USC: 22 USF: 23-26 DSF: 27 DSC: 28 DSR, DSL

Additional Info: under bridge smooth ; concrete abutments w/ concrete riprap in middle

File Name:

PROFILE VIEW:
(Left to Right looking Downstream)



PLAN VIEW:

US

	Photo ID: Coordinates: Description:	AC_T7_STR_300_USC 30.176070, -97.179678 Upstream channel
	Photo ID: Coordinates: Description:	AC_T7_STR_300_USF1 30.176070, -97.179678 Upstream face

	Photo ID: Coordinates: Description:	AC_T7_STR_300_USF2 30.176070, -97.179678 Upstream face
	Photo ID: Coordinates: Description:	AC_T7_STR_300_USF3 30.176070, -97.179678 Upstream face

	Photo ID: Coordinates: Description:	AC_T7_STR_300_USF4 30.176070, -97.179678 Upstream face
	Photo ID: Coordinates: Description:	AC_T7_STR_300_DSF 30.176070, -97.179678 Downstream face

	Photo ID: Coordinates: Description:	AC_T7_STR_300_DSC 30.176070, -97.179678 Downstream channel
	Photo ID: Coordinates: Description:	AC_T7_STR_300_OVERVIEW 30.176070, -97.179678 Overview

	Photo ID: Coordinates: Description:	AC_T7_STR_300_EMBANKMENT 30.176070, -97.179678 Embankment
	Photo ID: Coordinates: Description:	AC_T7_STR_300_UNDER_BRIDGE 30.176070, -97.179678 Under the bridge

HALFF — **Survey Field Sheet**

PROJECT: Bastrop FPP AVO 35837 SURVEY NAME: ____

STREAM NAME: Alum Creek Trib. 8 DATE: 04-17-19

LOCATION: Bowie Dr., AC-T8-STR-100, C32 CREW: KS+ML

TYPE: BR( ) CUL(X) DAM( ) XS( ) ERM ELEV.: ____ ERM ID: ____ GEOID: ____

BRIDGE:	Rail Height:		Deck: 1'	Width: 17'	Pier(s):		@		Pier Shape:	
CULVERT:	Number:	2	Shape: CMP	Length: 30' 32'	Height: ~ 2'		Width: ~ 2'		Skew: N	
CULVERT:	I/O Type:			Material: metal	Wingwall Angle					
DAM:	Top Width:		Side Slope	Side Slope	US:		DS:		Outlet:	

ERM Description: ____ Coordinate System: ____

Photo Numbers: USC: L,R (70 71) USF: L,R (72 73) DSF: L,R (74 75) DSC: L,R (76 77) . DSL 78 DSR 79 080

Additional Info: chnl runs parallel to road US, rock

File Name: ____

PROFILE VIEW:
(Left to Right looking Downstream)

D15 DS

PLAN VIEW:

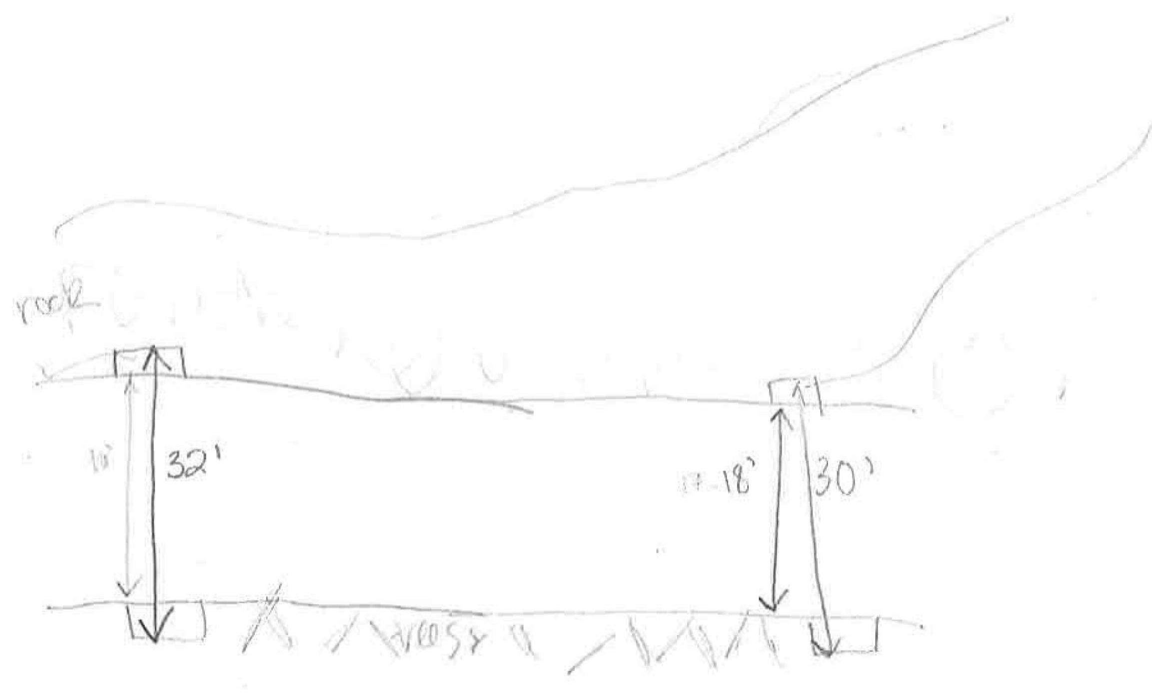


	Photo ID: Coordinates: Description:	AC_T8_STR_100_USC_LCULV 30.174636, -97.203896 Upstream channel of left culvert
	Photo ID: Coordinates: Description:	AC_T8_STR_100_USC_RCULV 30.174636, -97.203896 Upstream channel of right culvert

	Photo ID: Coordinates: Description:	AC_T8_STR_100_USF_ LCULV 30.174636, -97.203896 Upstream face of left culvert
	Photo ID: Coordinates: Description:	AC_T8_STR_100_USF_RCULV 30.174636, -97.203896 Upstream face of left culvert

	Photo ID: Coordinates: Description:	AC_T8_STR_100_DSF_LCULV 30.174636, -97.203896 Downstream face of left culvert
	Photo ID: Coordinates: Description:	AC_T8_STR_100_ DSF_RCULV 30.174636, -97.203896 Downstream face of right culvert

	Photo ID: Coordinates: Description:	AC_T8_STR_100_DSC_LCULV 30.174636, -97.203896 Downstream channel of left culvert
	Photo ID: Coordinates: Description:	AC_T8_STR_100_ DSC_RCULV 30.174636, -97.203896 Downstream channel of right culvert

	Photo ID: Coordinates: Description:	AC_T8_STR_100_DSL 30.174636, -97.203896 Downstream left
	Photo ID: Coordinates: Description:	AC_T8_STR_100_DSR 30.174636, -97.203896 Downstream right

	Photo ID: Coordinates: Description:	AC_T8_STR_100_OVERVIEW 30.174636, -97.203896 Overview

HALFF — Survey Field Sheet

PROJECT: Bastrop FPP AVO 35837 SURVEY NAME:

STREAM NAME: Alum Creek Trib 8 DATE: 04-17-19

LOCATION: Alamo Ct, AC_T8_STR_200, C33 CREW: KS + ML

TYPE: BR( ) CUL(X) DAM( ) XS( ) ERM ELEV.: ERM ID: GEOID:

BRIDGE:	Rail Height:		Deck: 1.5	Width:		Pier(s):	@		Pier Shape:		
CULVERT:	Number:	1	Shape: arch	Length: 20'		Height: 18"	Width: 20"		Skew:		
CULVERT:	I/O Type:			Material: metal		Wingwall Angle					
DAM:	Top Width:		Side Slope	Side Slope		US:	DS:		Outlet:		
ERM Description:						Coordinate System:					
Photo Numbers:			USC: 64	USF: 63		DSF: 65	DSC: 66		DSL 67 DSR 68	069	
Additional Info:	dirt road, standing water										
File Name:											

PROFILE VIEW:
(Left to Right looking Downstream)

passenger U.S

PLAN VIEW:

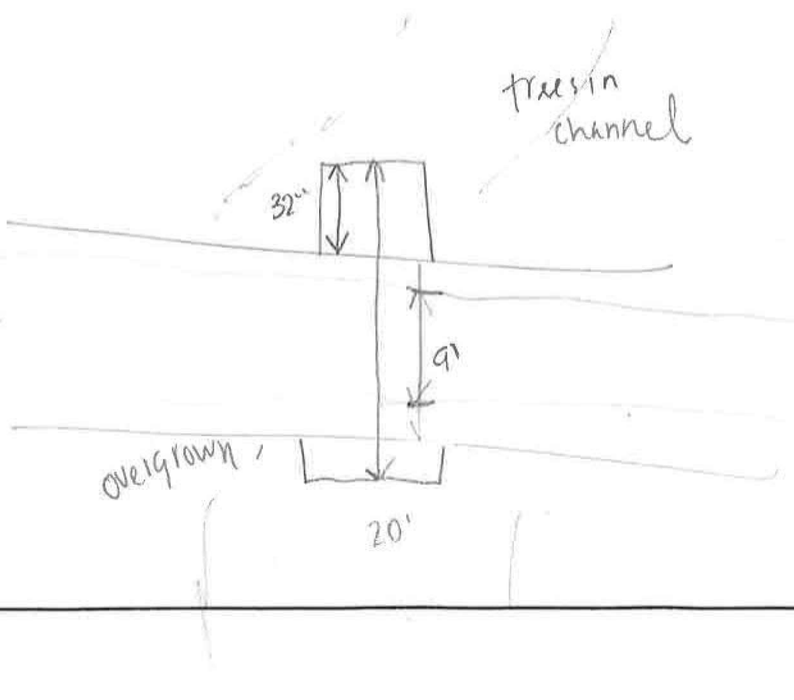


	Photo ID: Coordinates: Description:	AC_T8_STR_200_USC 30.175297, -97.205168 Upstream channel
	Photo ID: Coordinates: Description:	AC_T8_STR_200_USF 30.175297, -97.205168 Upstream face

	Photo ID: Coordinates: Description:	AC_T8_STR_200_DSF 30.175297, -97.205168 Downstream face
	Photo ID: Coordinates: Description:	AC_T8_STR_200_DSC 30.175297, -97.205168 Downstream channel

	Photo ID: Coordinates: Description:	AC_T8_STR_200_DSL 30.175297, -97.205168 Downstream left
	Photo ID: Coordinates: Description:	AC_T8_STR_200_DSR 30.175297, -97.205168 Downstream right

	Photo ID: Coordinates: Description:	AC_T8_STR_200_OVERVIEW 30.175297, -97.205168 Overview

HALFF

Survey Field Sheet

PROJECT: Bastrop FPP AVO 35837 SURVEY NAME:

STREAM NAME: Alum Creek Trib 8 DATE: 04-17-19

LOCATION: Ponderosa Ln, AC-T8, STR-300, C23 CREW: KS+ML

TYPE: BR( ) CUL(X) DAM( ) XS( ) ERM ELEV.: ERM ID: GEOID:

BRIDGE: Rail Height: Deck: 45" Width: 20' skew Pier(s): @ Pier Shape:

CULVERT: Number: 3 Shape: arch cmp Length: 39' skew Height: below Width: below Skew: 45°

CULVERT: I/O Type: Material: metal Wingwall Angle

DAM: Top Width: Side Slope Side Slope US: DS: Outlet:

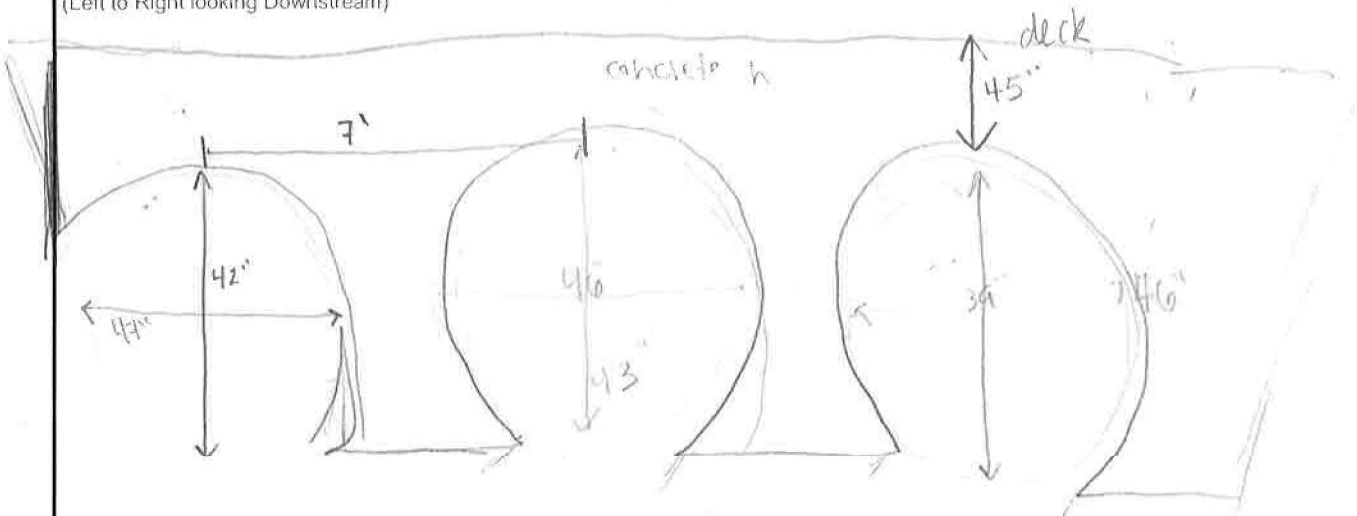
ERM Description: Coordinate System:

Photo Numbers: USC: 15 USF: 16 DSF: 17 DSC: 18 DSL 19 DSR 20 021

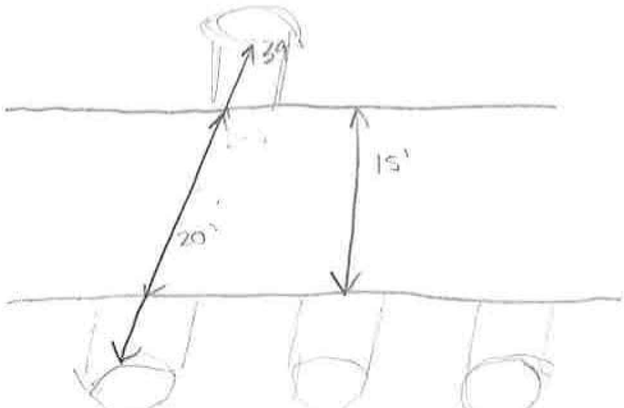
Additional Info: severe skew, grapevines on US culverts, not alot of big trees

File Name:

PROFILE VIEW:
(Left to Right looking Downstream)



PLAN VIEW:



245 Ponderosa
US end road cut off
during events
cars parked @ high point
since the fire

	Photo ID: Coordinates: Description:	AC_T8_STR_300_USC 30.182169, -97.209641 Upstream channel
	Photo ID: Coordinates: Description:	AC_T8_STR_300_USF 30.182169, -97.209641 Upstream face

	Photo ID: Coordinates: Description:	AC_T8_STR_300_DSF 30.182169, -97.209641 Downstream face
	Photo ID: Coordinates: Description:	AC_T8_STR_300_DSC 30.182169, -97.209641 Downstream channel

	Photo ID: Coordinates: Description:	AC_T8_STR_300_DSL 30.182169, -97.209641 Downstream left
	Photo ID: Coordinates: Description:	AC_T8_STR_300_DSR 30.182169, -97.209641 Downstream right

	Photo ID: Coordinates: Description:	AC_T8_STR_300_OVERVIEW 30.182169, -97.209641 Overview

HALFF **Survey Field Sheet**

PROJECT: Alum Creek SURVEY NAME: ______

STREAM NAME: Alum Creek Tributary 8 DATE: 6/14/19

LOCATION: AC_T8-STR-400 CREW: ______

TYPE: BR( ) CUL(X) DAM( ) XS( ) ERM ELEV.: ______ ERM ID: ______ GEOID: ______

BRIDGE: Rail Height: ______ Deck: ______ Width: ______ Pier(s): ______ @ ______ Pier Shape: ______

CULVERT: Number: 3 Shape: Round Length: 37'7" Height: 42" Width: ______ Skew: yes

CULVERT: I/O Type: ______ Material: CMP Wingwall Angle ______

DAM: Top Width: ______ Side Slope Side Slope US: ______ DS: ______ Outlet: ______

ERM Description: ______ Coordinate System: ______

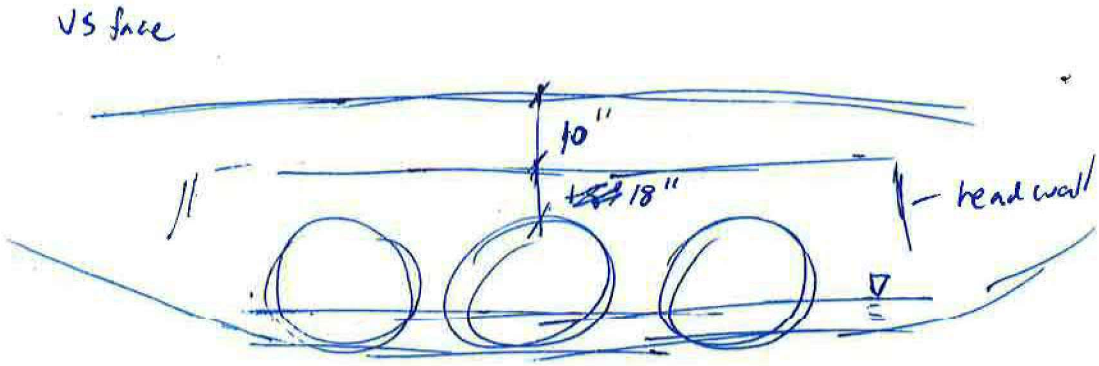
Photo Numbers: USC: 1 USF: 2-3 DSF: 4-6 DSC: 7 LOB 8 ROB 9

Additional Info: standing water, a little sediment on US side, lots of vegitation overview

File Name: left culvert looking DS slightly crushed

overall picture after pics from AC_UN_STR-1000

PROFILE VIEW:
(Left to Right looking Downstream)



PLAN VIEW:

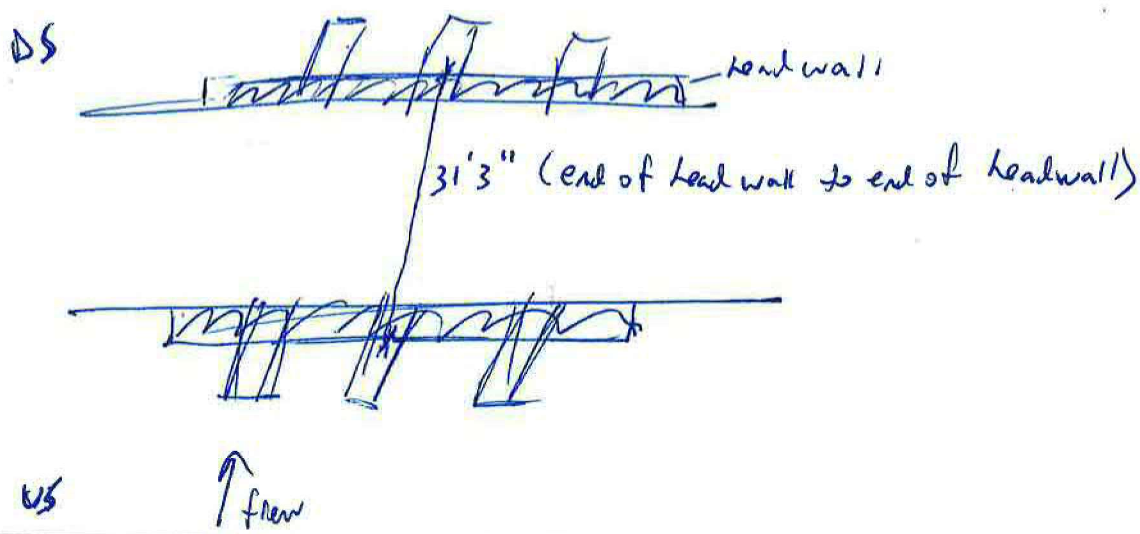


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	Photo ID: Coordinates: Description:	AC_T8_STR_400_USF_1 30.184773, -97.211646 Upstream face

	Photo ID: Coordinates: Description:	AC_T8_STR_400_USF_2 30.184773, -97.211646 Upstream face
	Photo ID: Coordinates: Description:	AC_T8_STR_400_DSF_1 30.184773, -97.211646 Downstream face

	Photo ID: Coordinates: Description:	AC_T8_STR_400_DSF_2 30.184773, -97.211646 Downstream face
	Photo ID: Coordinates: Description:	AC_T8_STR_400_DSF_3 30.184773, -97.211646 Downstream face

	Photo ID: Coordinates: Description:	AC_T8_STR_400_DSC 30.184773, -97.211646 Downstream channel
	Photo ID: Coordinates: Description:	AC_T8_STR_400_LOB 30.184773, -97.211646 Left overbank, looking downstream

	Photo ID: Coordinates: Description:	AC_T8_STR_400_ROB 30.184773, -97.211646 Right overbank, looking downstream
	Photo ID: Coordinates: Description:	AC_T8_STR_400_OVERVIEW 30.184773, -97.211646 Overview

HALFF

Survey Field Sheet

PROJECT: Bastrop FPP AVO 35837 SURVEY NAME:

STREAM NAME: AC Trib 9 AC_T9_STR-100 DATE: 04-15-19

LOCATION: Cluster 1, #2 McBride CREW: KS + ML

TYPE: BR( ) CUL(X) DAM( ) XS( ) ERM ELEV.: ERM ID: GEOID:

BRIDGE: Rail Height: NA Deck: NA Width: 14' Pier(s): @ Pier Shape:

CULVERT: Number: 1 Shape: O Length: 20.25' Height: 30" Width: 30" Skew: Small

CULVERT: I/O Type: Material: CMP Wingwall Angle

DAM: Top Width: Side Slope Side Slope US: DS: Outlet:

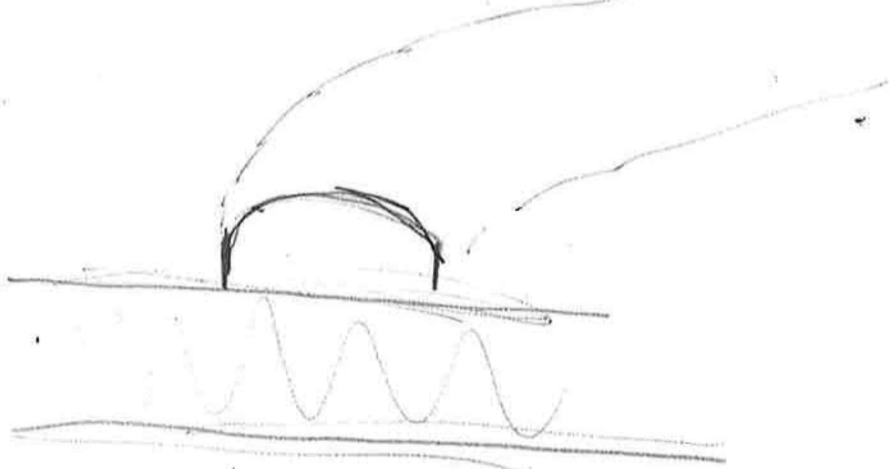
ERM Description: Coordinate System:

Photo Numbers: USC: 8 USF: 9 DSF: 10 DSC: 11 DSL12 DSR13 O14

Additional Info: lots of debris, depth of road over culvert = 6"

File Name:

PROFILE VIEW:
(Left to Right looking Downstream)



PLAN VIEW:

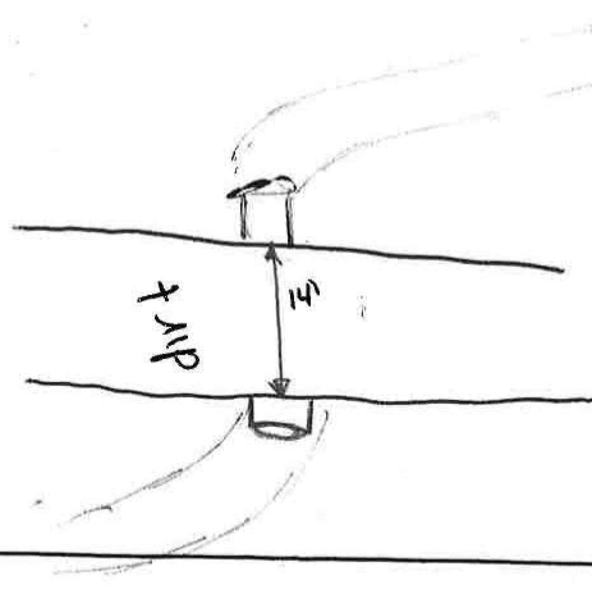


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	Photo ID: Coordinates: Description:	AC_T9_STR_100_DSF 30.196041, -97.189149 Downstream face

	Photo ID: Coordinates: Description:	AC_T9_STR_100_DSC 30.196041, -97.189149 Downstream channel
	Photo ID: Coordinates: Description:	AC_T9_STR_100_DSL 30.196041, -97.189149 Downstream left

	Photo ID: Coordinates: Description:	AC_T9_STR_100_DSR 30.196041, -97.189149 Downstream right
	Photo ID: Coordinates: Description:	AC_T9_STR_100_OVERVIEW 30.196041, -97.189149 Overview

HALFF

Survey Field Sheet

PROJECT: Bastrop FPP AVO 35837 SURVEY NAME:

STREAM NAME: Alum Creek Trib 9, AC-T9-SIR -200 DATE: 04-15-19

LOCATION: Cluster 1, #1, Old Potato CREW: KS + ML

TYPE: BR( ) CUL(X) DAM( ) XS( ) ERM ELEV.: ERM ID: GEOID:

BRIDGE: Rail Height: 26.5" Deck: 20" Width: 8' Pier(s): N/A @ Pier Shape:

CULVERT: Number: 2 Shape: □ Length: 24' Height: Width: Skew:

CULVERT: I/O Type: Material: RCB Wingwall Angle

DAM: Top Width: Side Slope Side Slope US: DS: Outlet:

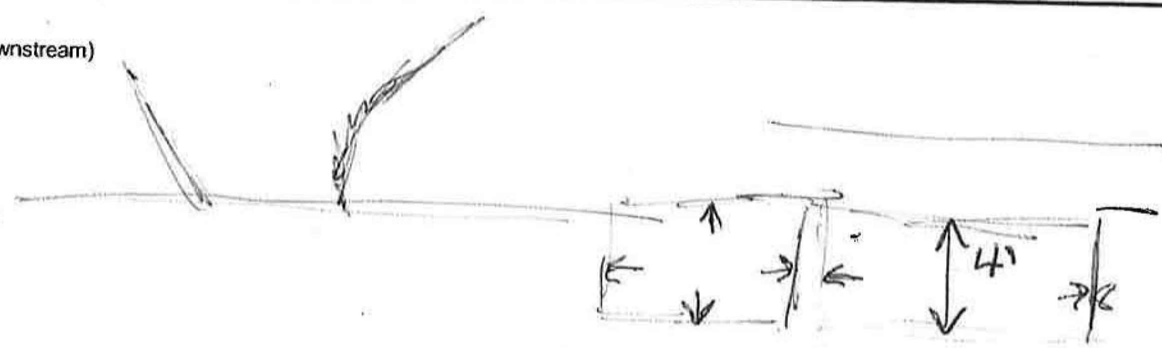
ERM Description: Coordinate System:

Photo Numbers: USC: 185 USF: 186 DSF: 187 DSC: 18 DSL19 DS R20 O22

Additional Info: marshy, reeds, standing water

File Name:

PROFILE VIEW:
(Left to Right looking Downstream)



PLAN VIEW:

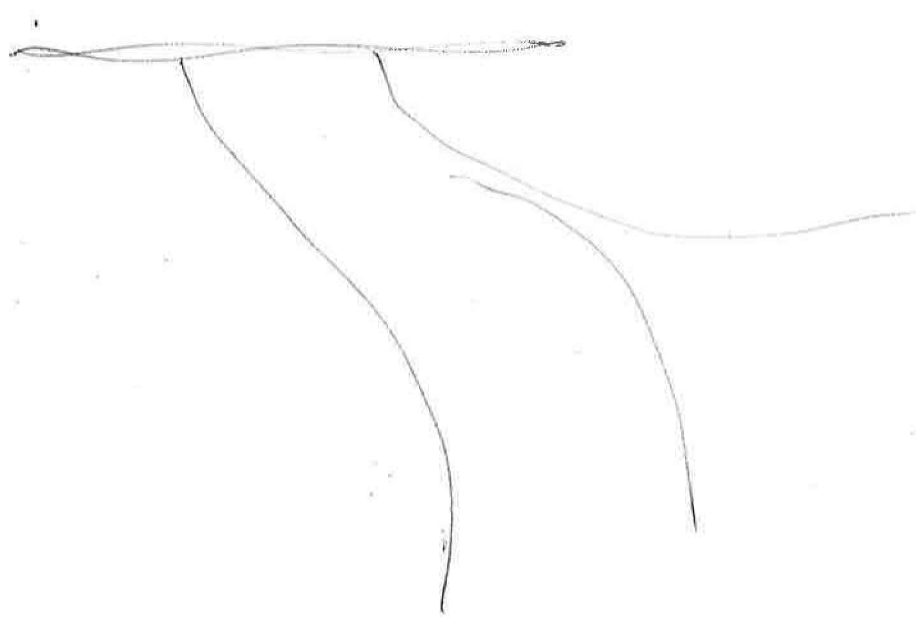


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	Photo ID: Coordinates: Description:	AC_T9_STR_200_DSF 30.198811, -97.188835 Downstream face
	Photo ID: Coordinates: Description:	AC_T9_STR_200_DSC 30.198811, -97.188835 Downstream channel

	Photo ID: Coordinates: Description:	AC_T9_STR_200_DSL 30.198811, -97.188835 Downstream left
	Photo ID: Coordinates: Description:	AC_T9_STR_200_DSR 30.198811, -97.188835 Downstream right

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Coordinates:
Description:</td>
<td>AC_T9_STR_200_OVERVIEW
30.198811, -97.188835
Overview</td>
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</table>

AC-T10-STR-100 ✓

HALFF

Survey Field Sheet

PROJECT: Bastrop FPP AVO 35837 SURVEY NAME:

STREAM NAME: Alum Creek Trib 10, AC-T10-STR-100, DATE: 04-15-19

LOCATION: Old Potato Rd ,C1 CREW: KS+ML

TYPE: BR(X) CUL( ) DAM( ) XS( ) ERM ELEV.: ERM ID: GEOID:

BRIDGE: Rail Height: 27" Deck: 26" Width: 8' Pier(s): N/A @ Pier Shape:

CULVERT: Number: Shape: Length: Height: Width: Skew:

CULVERT: I/O Type: Material: Wingwall Angle

DAM: Top Width: Side Slope Side Slope US: DS: Outlet:

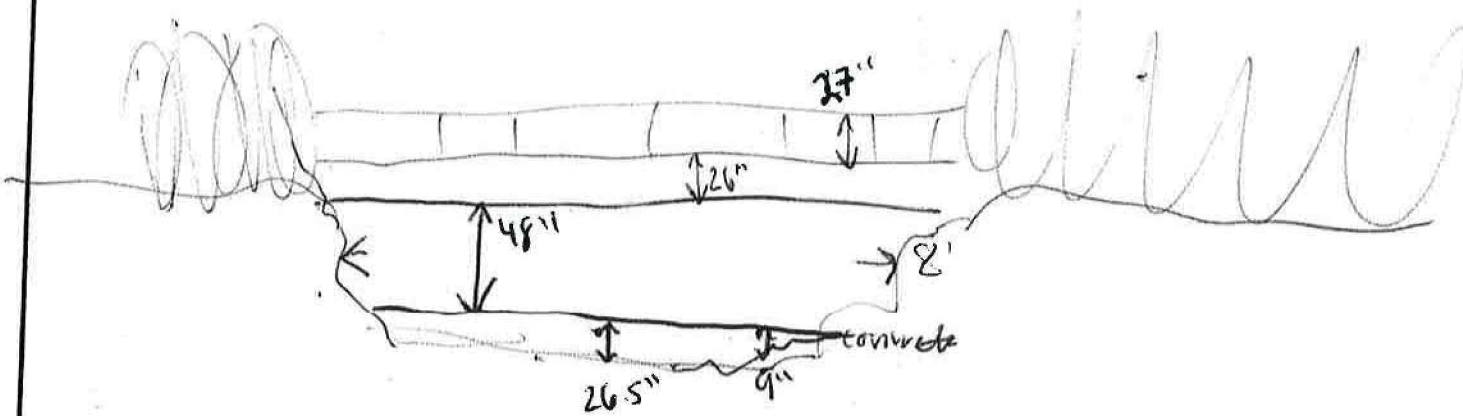
ERM Description: Coordinate System:

Photo Numbers: USC: 1 USF: 2 DSF: 3 DSC: 4 DSL5 DSR6 7

Additional Info: concrete chnl bottom, thickness of gravel = 3"

File Name:

PROFILE VIEW:
(Left to Right looking Downstream)



PLAN VIEW:

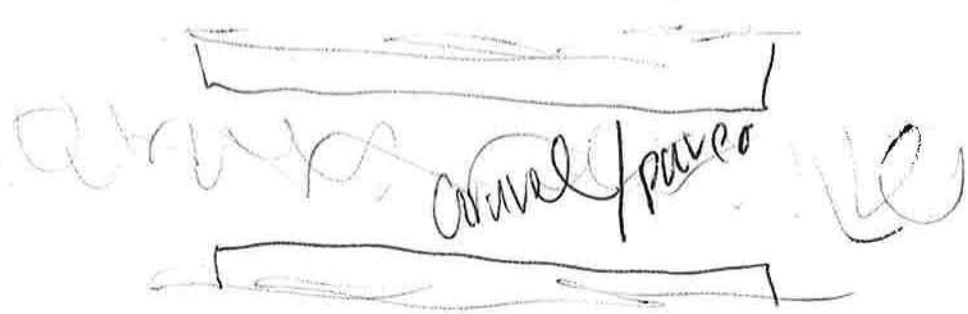


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	Photo ID: Coordinates: Description:	AC_T10_STR_100_USF 30.193841, -97.184882 Upstream face

	Photo ID: Coordinates: Description:	AC_T10_STR_100_DSF 30.193841, -97.184882 Downstream face
	Photo ID: Coordinates: Description:	AC_T10_STR_100_DSC 30.193841, -97.184882 Downstream channel

	Photo ID: Coordinates: Description:	AC_T10_STR_100_DSL 30.193841, -97.184882 Downstream left
	Photo ID: Coordinates: Description:	AC_T10_STR_100_DSR 30.193841, -97.184882 Downstream right

Photo ID:	AC_T10_STR_100_OVERVIEW
Coordinates:	30.193841, -97.184882
Description:	Overview

HALFF — Survey Field Sheet

PROJECT: Bastrop FPP AVO 35837 SURVEY NAME:

STREAM NAME: Alum Creek Trib. 11 DATE: 04-17-19

LOCATION: Cardinal Dr, AC-T11_STR-100 CREW: KJ + ML
C22

TYPE: BR( ) CUL(X) DAM( ) XS( ) ERM ELEV.: ERM ID: GEOID:

BRIDGE: Rail Height: N/A Deck: 2' Width: 13' Pier(s): @ Pier Shape:

CULVERT: Number: 4 Shape: CMP Length: 24 Height: 18" Width: Skew:

CULVERT: I/O Type: mitered to slope Material: metal Wingwall Angle

DAM: Top Width: Side Slope Side Slope US: DS: Outlet:

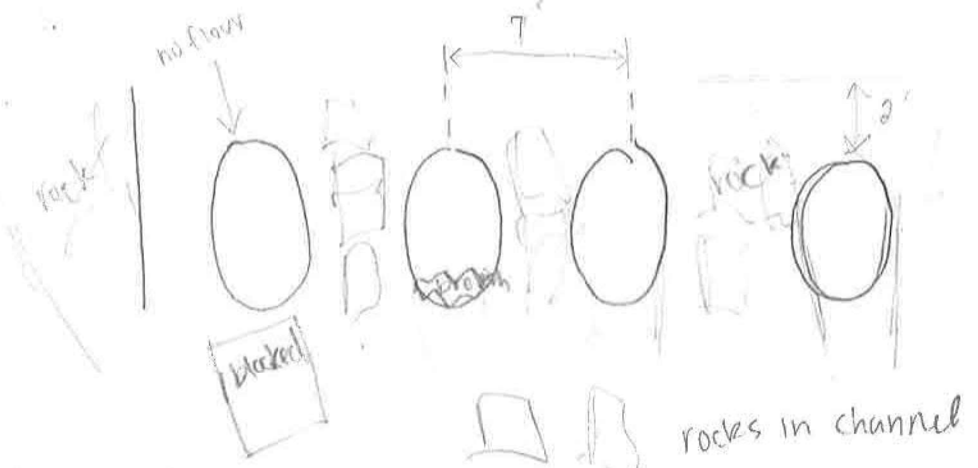
ERM Description: Coordinate System:

Photo Numbers: USC: 1 USF: 2 DSF: 3 DSC: 4 DSL 5 DSR 6 07

Additional Info: woody, 1 culv. does not receive flow in nonevents, dead fish

File Name:

PROFILE VIEW:
(Left to Right looking Downstream)



PLAN VIEW:

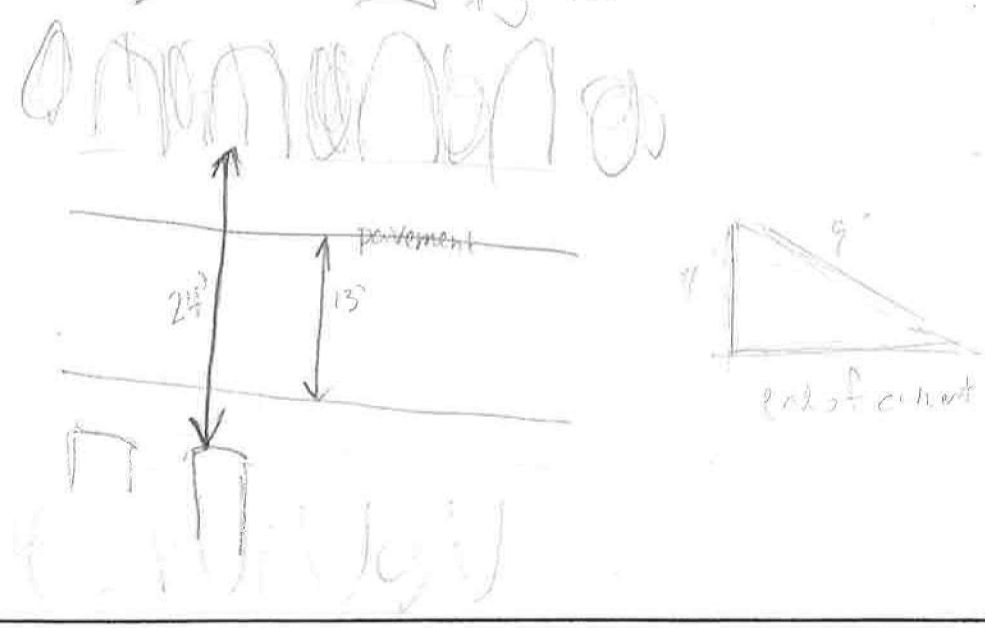


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	Photo ID: Coordinates: Description:	AC_T11_STR_100_USF 30.191374, -97.202126 Upstream face

	Photo ID: Coordinates: Description:	AC_T11_STR_100_DSF 30.191374, -97.202126 Downstream face
	Photo ID: Coordinates: Description:	AC_T11_STR_100_DSC 30.191374, -97.202126 Downstream channel

	Photo ID: Coordinates: Description:	AC_T11_STR_100_DSL 30.191374, -97.202126 Downstream left
	Photo ID: Coordinates: Description:	AC_T11_STR_100_DSR 30.191374, -97.202126 Downstream right

	Photo ID: Coordinates: Description:	AC_T11_STR_100_OVERVIEW 30.191374, -97.202126 Overview

HALFF

Survey Field Sheet

PROJECT: Alum Creek SURVEY NAME:

STREAM NAME: Alum creek Tributary 173 DATE: 6/14/19

LOCATION: AC_UN_STR_050 CREW:

TYPE: BR( ) CUL( ) DAM( ) XS( ) ERM ELEV.: ERM ID: GEOID:

BRIDGE: Rail Height: Deck: Width: Pier(s): @ Pier Shape:

CULVERT: Number: 2 Shape: round Length: 25.5' Height: 5' Width: Skew:

CULVERT: I/O Type: Material: CMP coated Wingwall Angle N/A

DAM: Top Width: Side Slope Side Slope US: DS: Outlet:

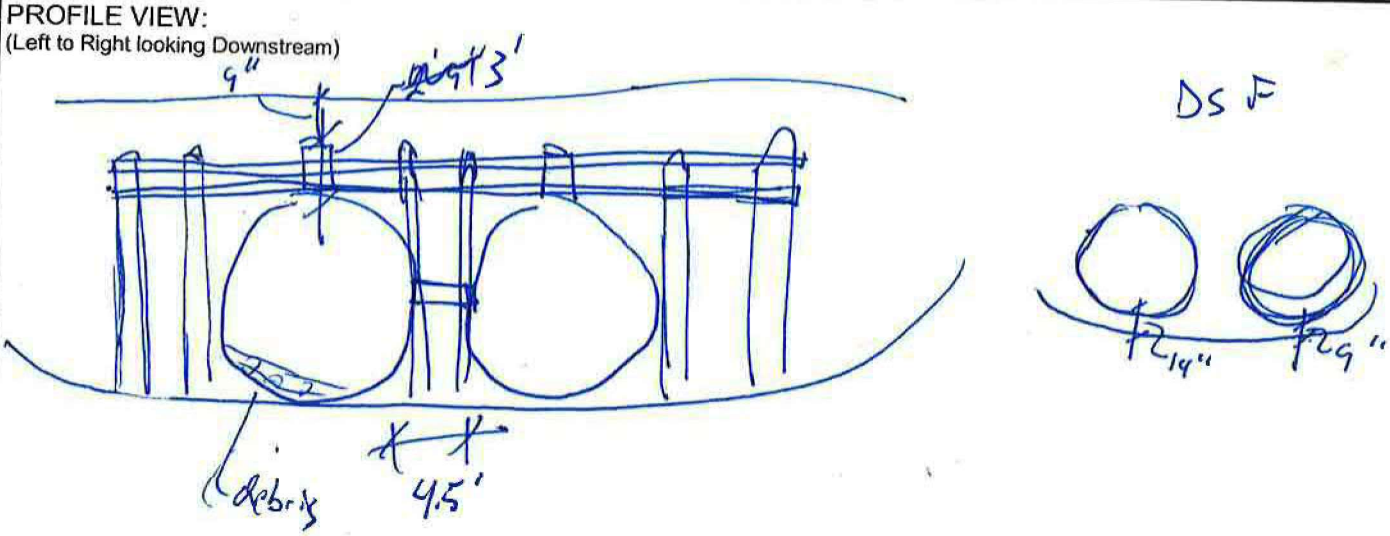
ERM Description: Coordinate System:

Photo Numbers: USC: 4 USF: 1-2 DSF: 3-4 DSC: 5-6 LOB: 7 ROB: 8 overview 9

Additional Info: some debris @ Left culvert

File Name:

PROFILE VIEW:
(Left to Right looking Downstream)



PLAN VIEW:

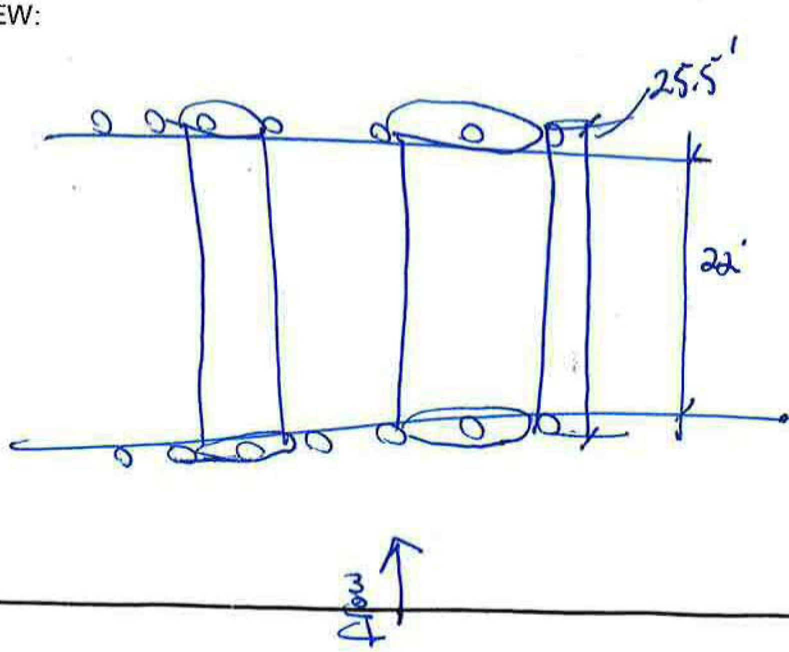


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	Photo ID: Coordinates: Description:	AC_UN_STR_050_USF_2 30.085057, -97.258299 Upstream face
	Photo ID: Coordinates: Description:	AC_UN_STR_050_DSF_1 30.085057, -97.258299 Downstream face

	Photo ID: Coordinates: Description:	AC_UN_STR_050_DSF_2 30.085057, -97.258299 Downstream face
	Photo ID: Coordinates: Description:	AC_UN_STR_050_DSC_1 30.085057, -97.258299 Downstream channel

	Photo ID: Coordinates: Description:	AC_UN_STR_050_DSC_2 30.085057, -97.258299 Downstream channel
	Photo ID: Coordinates: Description:	AC_UN_STR_050_LOB 30.085057, -97.258299 Left overbank, looking downstream

	Photo ID: Coordinates: Description:	AC_UN_STR_050_ROB 30.085057, -97.258299 Right overbank, looking downstream
	Photo ID: Coordinates: Description:	AC_UN_STR_050_OVERVIEW 30.085057, -97.258299 Overview

HALFF — Survey Field Sheet

PROJECT: Bastrop FPP AVO 35837 SURVEY NAME:

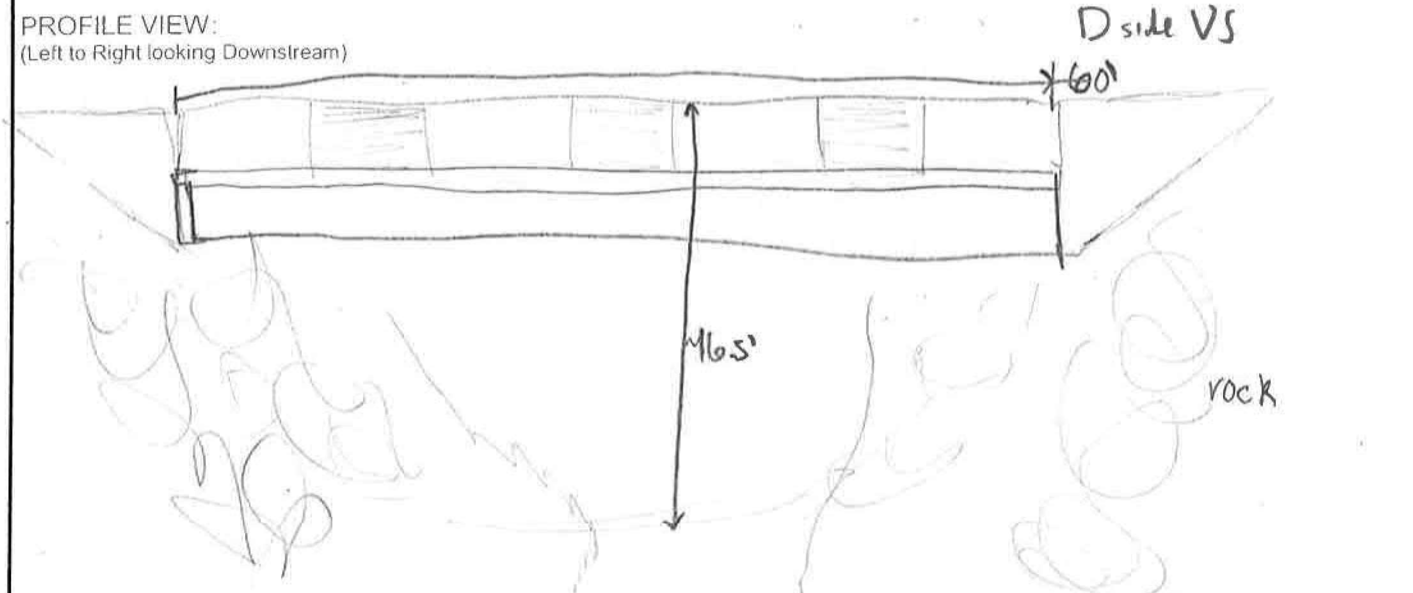
STREAM NAME: Alum Creek Unnamed DATE: 04-23-19

LOCATION: Alum Creek Rd., AC-UN-STR.200, C102 CREW: KS & ML

TYPE: BR(X) CUL( ) DAM( ) XS( ) ERM ELEV.: ERM ID: GEOID:

BRIDGE:	Rail Height:	31"	Deck:	9"	Width:	26'	Pier(s):	No	@		Pier Shape:
CULVERT:	Number:		Shape:		Length:		Height:		Width:		Skew:
CULVERT:	I/O Type:				Material:		Wingwall Angle				
DAM:	Top Width:		Side Slope		Side Slope		US:		DS:		Outlet:
ERM Description:							Coordinate System:				
Photo Numbers:			USC:	1	USF:	2	DSF:	3	DSC:	4	DSL DSR ⑩
Additional Info:											
File Name:											

PROFILE VIEW:
(Left to Right looking Downstream)



PLAN VIEW:

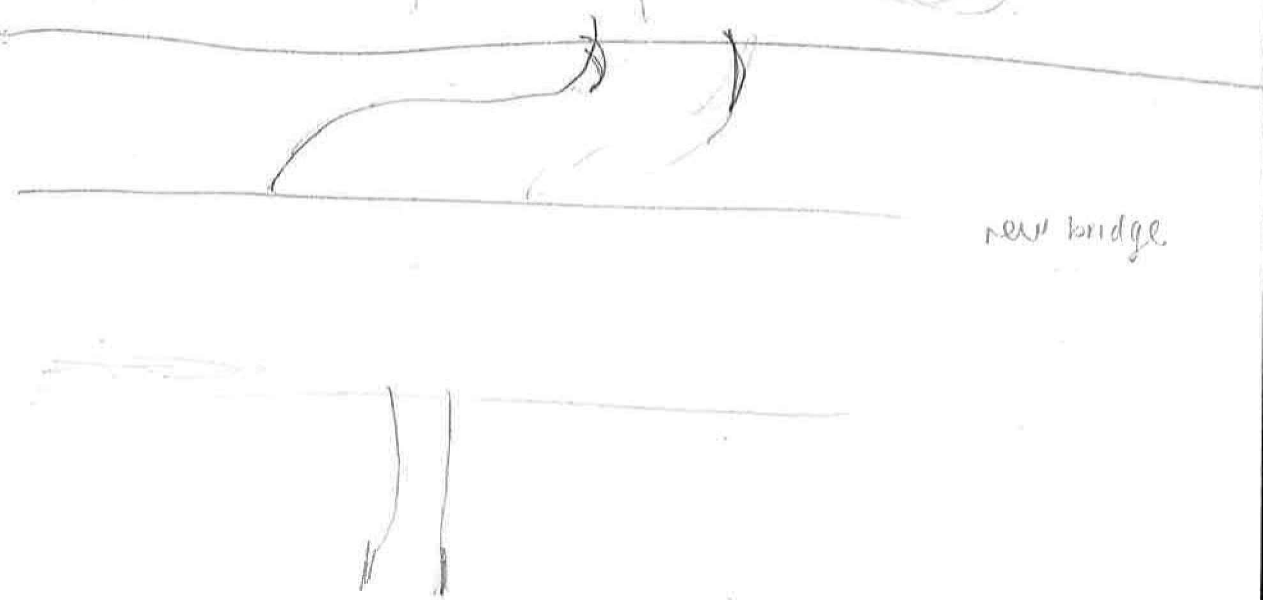


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	Photo ID: Coordinates: Description:	AC_UN_STR_100_DSF 30.090987, -97.222557 Downstream face
	Photo ID: Coordinates: Description:	AC_UN_STR_100_DSC 30.090987, -97.222557 Downstream channel

	Photo ID: Coordinates: Description:	AC_UN_STR_100_DSL 30.090987, -97.222557 Downstream left
	Photo ID: Coordinates: Description:	AC_UN_STR_100_DSR 30.090987, -97.222557 Downstream right

HALFF Survey Field Sheet

PROJECT: Bastrop FPP AVO 35837 SURVEY NAME:

STREAM NAME: Alum Creek Unnamed DATE: 04-23-19

LOCATION: Park Rd 1C, AC-UN-STR-200, C103 CREW: KS+ML

TYPE: BR( ) CUL(X) DAM( ) XS( ) ERM ELEV.: ERM ID: GEOID:

BRIDGE: Rail Height: Deck: Width: Pier(s): @ Pier Shape:

CULVERT: Number: 1 Shape: arch Length: Height: 43" Width: 42" Skew: Y

CULVERT: I/O Type: projecting from fill Material: metal Wingwall Angle

DAM: Top Width: Side Slope Side Slope US: DS: Outlet:

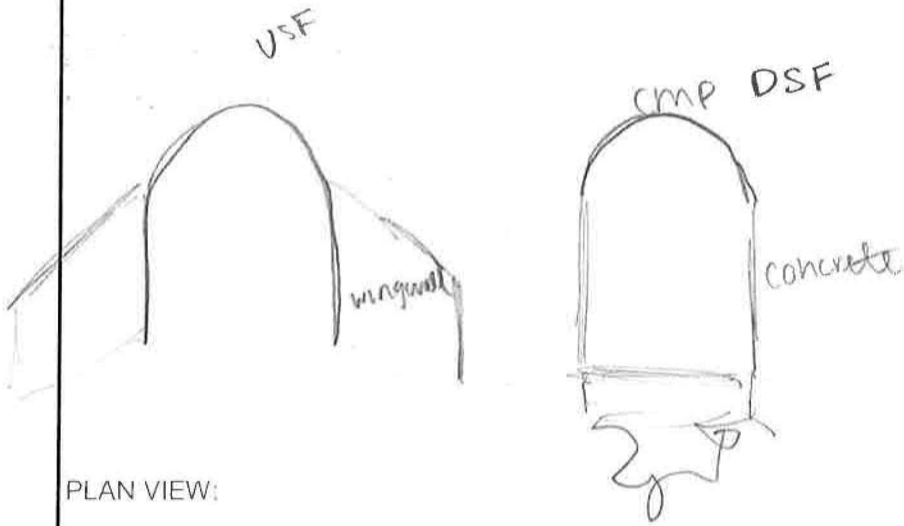
ERM Description: Coordinate System:

Photo Numbers: USC: 1 USF: 2 DSF: 3 DSC: 4 DSL 5 DSR 6

Additional Info: brushy banks, flowing water, water scours under US

File Name:

PROFILE VIEW:
(Left to Right looking Downstream)



PLAN VIEW:

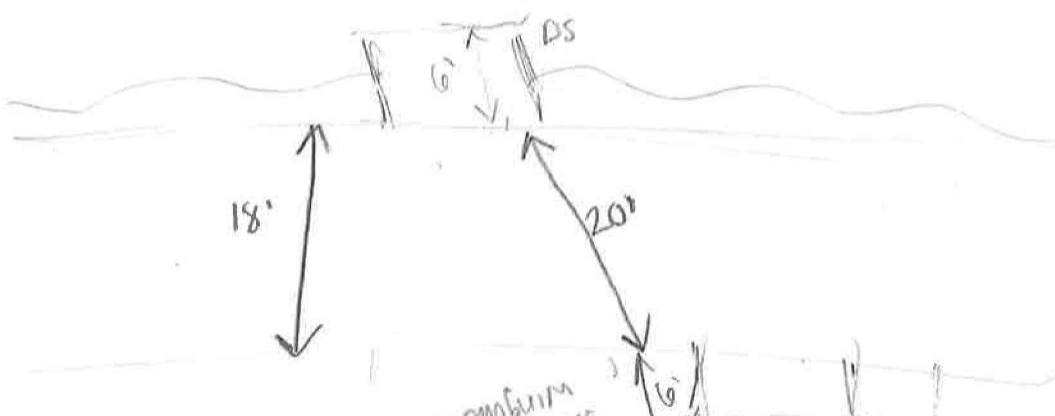


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	Photo ID: Coordinates: Description:	AC_UN_STR_200_DSF 30.094661, -97.211550 Downstream face
	Photo ID: Coordinates: Description:	AC_UN_STR_200_DSC 30.094661, -97.211550 Downstream channel

	Photo ID: Coordinates: Description:	AC_UN_STR_200_DSL 30.094661, -97.211550 Downstream left
	Photo ID: Coordinates: Description:	AC_UN_STR_200_DSR 30.094661, -97.211550 Downstream right

	Photo ID: Coordinates: Description:	AC_UN_STR_200_OVERVIEW 30.094661, -97.211550 Overview

HALFF — Survey Field Sheet

PROJECT: Bastrop FPP AVO 35837 SURVEY NAME: ______

STREAM NAME: AC Unnamed Trib. DATE: 04-15-19

LOCATION: Hwy 21, AC-UN-STR.300, Cluster 5 #2 CREW: KS+ML

TYPE: BR( ) CUL(X) DAM( ) XS( ) ERM ELEV.: ______ ERM ID: ______ GEOID: ______

BRIDGE: Rail Height: N/A Deck: 3' Width: GIS Pier(s): ______ @ ______ Pier Shape: ______

CULVERT: Number: 2 Shape: BOX Length: ______ Height: ______ Width: ______ Skew: ______

CULVERT: I/O Type: mitered Material: RCB Wingwall Angle ______

DAM: Top Width: ______ Side Slope ______ Side Slope ______ US: ______ DS: ______ Outlet: ______

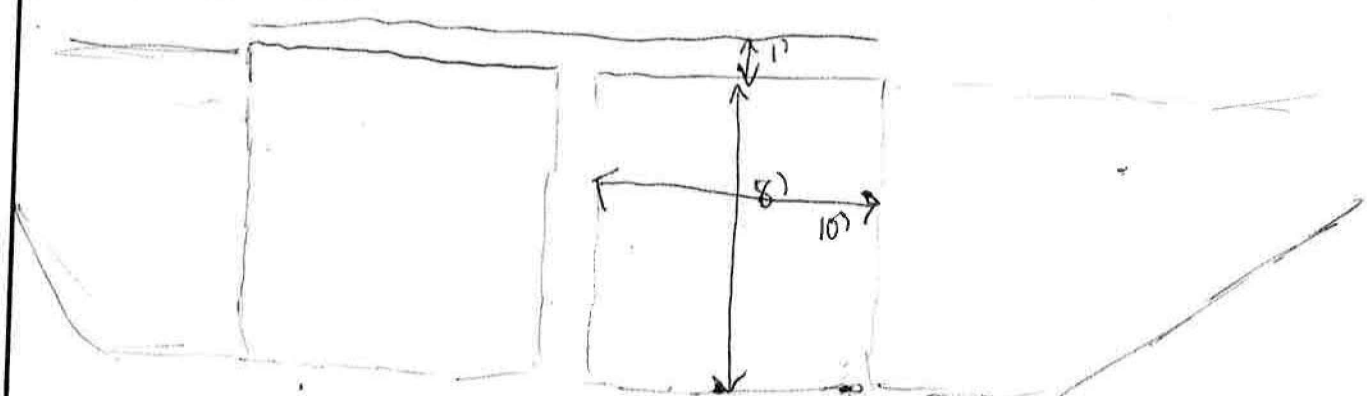
ERM Description: ______ Coordinate System: ______

Photo Numbers: USC: 1,2 USF: 3 DSF: 4 DSC: 5

Additional Info: Standing water DS

File Name: ______

PROFILE VIEW:
(Left to Right looking Downstream)



PLAN VIEW:

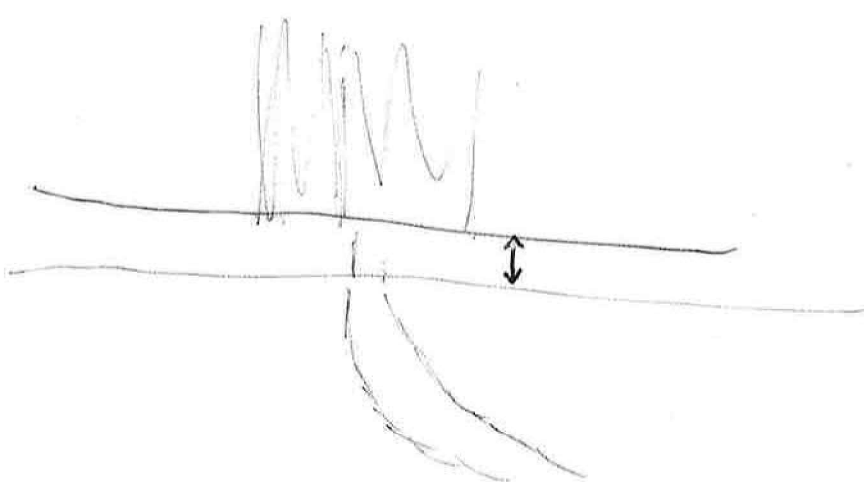


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	Photo ID: Coordinates: Description:	AC_UN_STR_300_USC2 30.162199, -97.207645 Upstream channel

	Photo ID: Coordinates: Description:	AC_UN_STR_300_USF 30.162199, -97.207645 Upstream face
	Photo ID: Coordinates: Description:	AC_UN_STR_300_DSF 30.162199, -97.207645 Downstream face

	Photo ID: Coordinates: Description:	AC_UN_STR_300_DSC 30.162199, -97.207645 Downstream channel

HALFF

Survey Field Sheet

PROJECT: Bastrop FPP AVO 35837 SURVEY NAME:

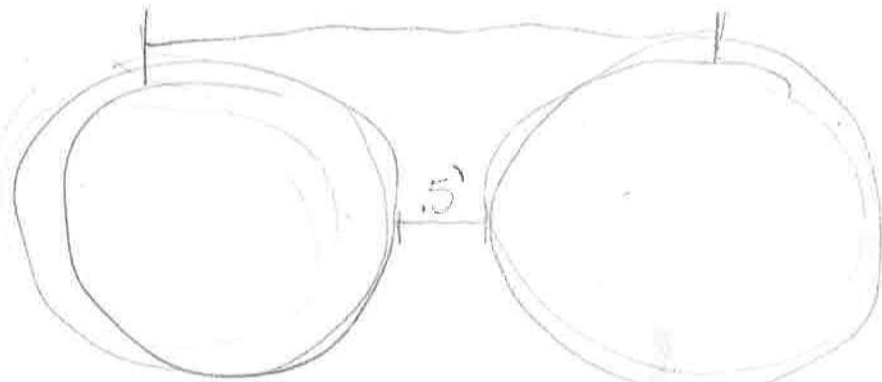
STREAM NAME: Alum Creek Unnamed DATE: 04-17-19

LOCATION: Cardinal Dr., AC. UN. STR-400,041 CREW: KS+ML

TYPE: BR( ) CUL(X) DAM( ) XS( ) ERM ELEV.: ERM ID: GEOID:

BRIDGE:	Rail Height:		Deck: 3)	Width: 22 ft	Pier(s):	@		Pier Shape:	
CULVERT:	Number:	2	Shape: CMP	Length: 51 ft	Height: 48"	Width: 48"		Skew: y	
CULVERT:	I/O Type:	projected from fill		Material: metal		Wingwall Angle			
DAM:	Top Width:		Side Slope	Side Slope	US:	DS:		Outlet:	
ERM Description:						Coordinate System:			
Photo Numbers:			USC: 43	USF: 44	DSF: 45	DSC: 46	DSL 47 DSR 48	049	
Additional Info:									
File Name:		Pictures 816-822		IMG.4866 → IMG.4872					

PROFILE VIEW:
(Left to Right looking Downstream)



PLAN VIEW:

high pt
V brushy channel

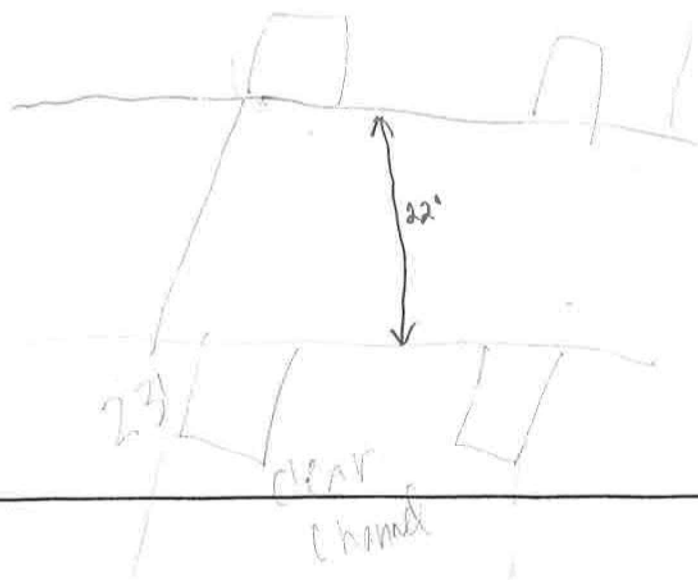


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	Photo ID: Coordinates: Description:	AC_UN_STR_400_USF 30.164859, -97.212748 Upstream face

	Photo ID: Coordinates: Description:	AC_UN_STR_400_DSF 30.164859, -97.212748 Downstream face
	Photo ID: Coordinates: Description:	AC_UN_STR_400_DSC 30.164859, -97.212748 Downstream channel

	Photo ID: Coordinates: Description:	AC_UN_STR_400_DSL 30.164859, -97.212748 Downstream left
	Photo ID: Coordinates: Description:	AC_UN_STR_400_DSR 30.164859, -97.212748 Downstream right

	Photo ID: Coordinates: Description:	AC_UN_STR_400_OVERVIEW 30.164859, -97.212748 Overview

HALFF **Survey Field Sheet**

PROJECT: Bastrop FPP AVO 35837 SURVEY NAME:

STREAM NAME: Alum Creek Unnamed DATE: 04-17-19

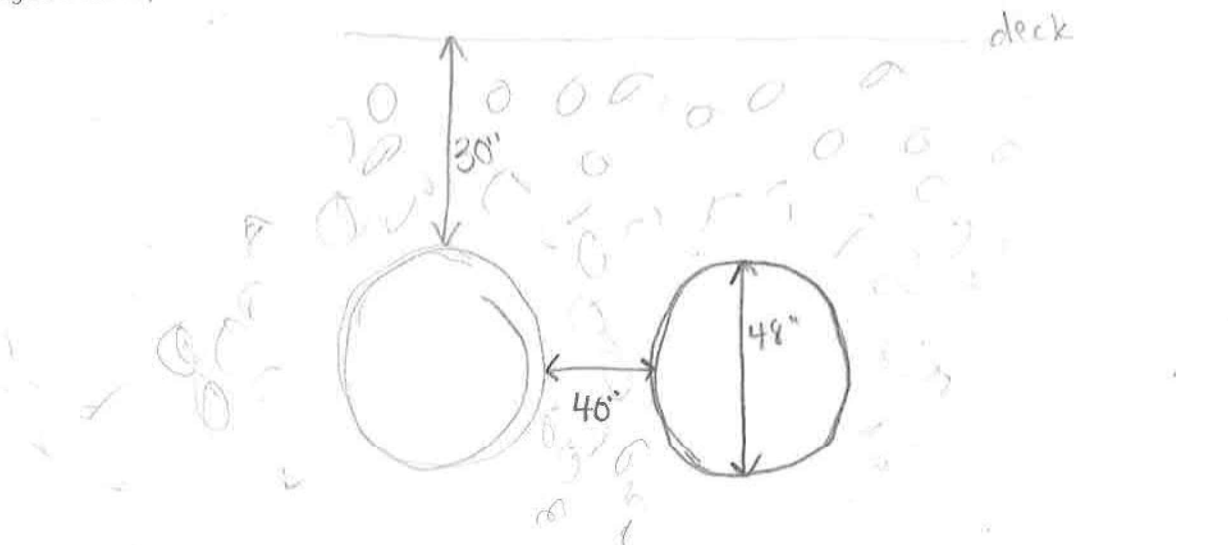
LOCATION: Cardinal Loop, AC-UN-STR-500, C42 CREW: KS+ML

TYPE: BR( ) CUL(X) DAM( ) XS( ) ERM ELEV.: ERM ID: GEOID:

BRIDGE:	Rail Height:		Deck:	30"	Width:	24'	Pier(s):		@		Pier Shape:
CULVERT:	Number:	2	Shape:	CMP	Length:	60' skew	Height:	48"	Width:	48"	Skew: Y, 30°
CULVERT:	I/O Type:				Material:	coated metal	Wingwall Angle				
DAM:	Top Width:		Side Slope		Side Slope		US:		DS:		Outlet:
ERM Description:							Coordinate System:				
Photo Numbers:			USC:	29	USF:	30	DSF:	31	DSC:	32	DSL33 DSR34 035
Additional Info:	dry channel DS, rock headwalls, marshy US										
File Name:											

128 Cardinal Loop

PROFILE VIEW:
(Left to Right looking Downstream)



PLAN VIEW:

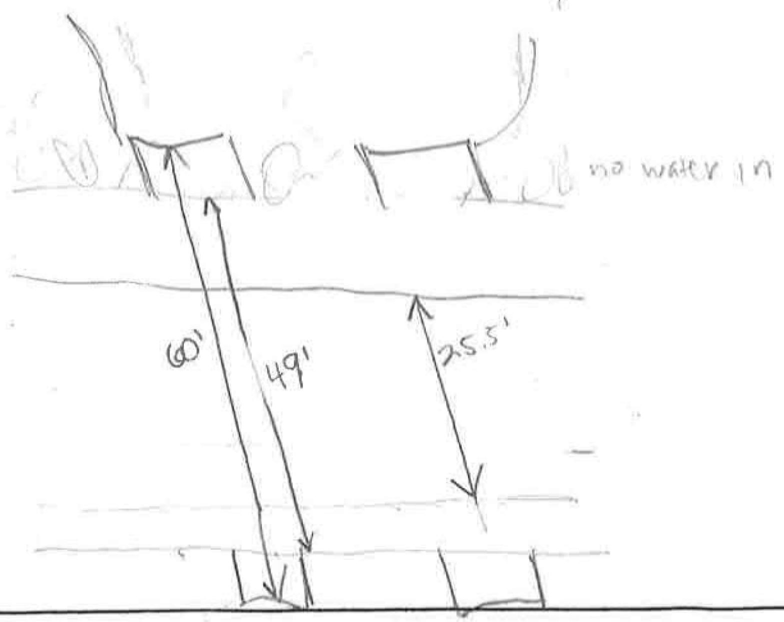


	Photo ID: Coordinates: Description:	AC_UN_STR_500_USC 30.164245, -97.216440 Upstream channel
	Photo ID: Coordinates: Description:	AC_UN_STR_500_USF 30.164245, -97.216440 Upstream face

	Photo ID: Coordinates: Description:	AC_UN_STR_500_DSF 30.164245, -97.216440 Downstream face
	Photo ID: Coordinates: Description:	AC_UN_STR_500_DSC 30.164245, -97.216440 Downstream channel

	Photo ID: Coordinates: Description:	AC_UN_STR_500_DSL 30.164245, -97.216440 Downstream left
	Photo ID: Coordinates: Description:	AC_UN_STR_500_DSR 30.164245, -97.216440 Downstream right

	Photo ID: Coordinates: Description:	AC_UN_STR_500_OVERVIEW 30.164245, -97.216440 Overview

HALFF

Survey Field Sheet

PROJECT: Bastrop FPP AVO 35837

SURVEY NAME:

STREAM NAME: Alum Creek Unnamed

DATE: 04-17-19

LOCATION: Jim Bowie Dr, AC-UN-STR.600, C43

CREW: KS+ML

TYPE: BR( ) CUL(X) DAM( ) XS( ) ERM ELEV.: ERM ID: GEOID:

BRIDGE: Rail Height: Deck: 4.5' Width: 45' skew Pier(s): @ Pier Shape:

CULVERT: Number: 2 Shape: CMP Length: 60' skew Height: 48" Width: 48" Skew: Y

CULVERT: I/O Type: Material: metal Wingwall Angle

DAM: Top Width: Side Slope Side Slope US: DS: Outlet:

ERM Description: Coordinate System:

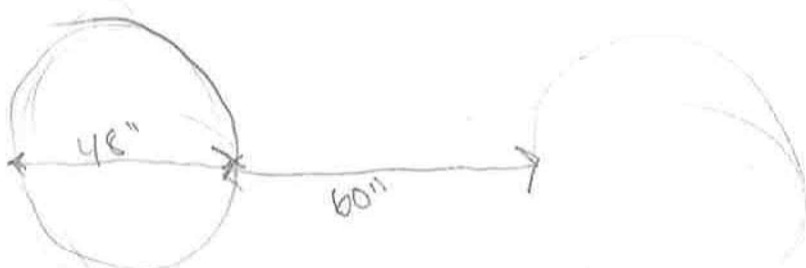
Photo Numbers: USC: 36 USF: 37 DSF: 38 DSC: 39 DSL 40 DSR 41 042

Additional Info: ~~DS proj. 17"~~

File Name:

PROFILE VIEW:
(Left to Right looking Downstream)

pier w/ wood wall slats



PLAN VIEW:

culv to culv 45
wood wall to wood wall 29.5 } along skew

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	Photo ID: Coordinates: Description:	AC_UN_STR_600_USF 30.169524, -97.213777 Upstream face

	Photo ID: Coordinates: Description:	AC_UN_STR_600_DSF 30.169524, -97.213777 Downstream face
	Photo ID: Coordinates: Description:	AC_UN_STR_600_DSC 30.169524, -97.213777 Downstream channel

	Photo ID: Coordinates: Description:	AC_UN_STR_600_DSL 30.169524, -97.213777 Downstream left
	Photo ID: Coordinates: Description:	AC_UN_STR_600_DSR 30.169524, -97.213777 Downstream right

	Photo ID: Coordinates: Description:	AC_UN_STR_600_OVERVIEW 30.169524, -97.213777 Overview

HALFF — Survey Field Sheet

PROJECT: Bastrop FPP AVO 35837 SURVEY NAME:

STREAM NAME: Alum Creek Unnamed DATE: 04-17-19

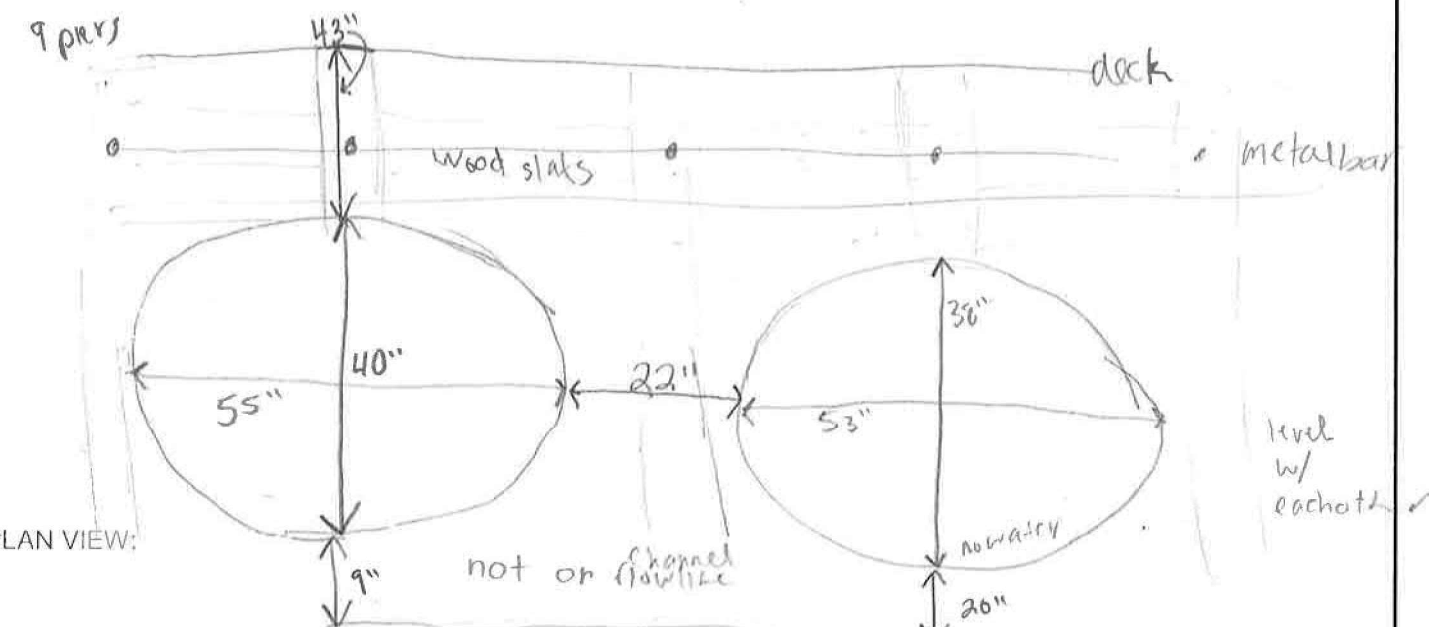
LOCATION: Cardinal Dr, AC-UN-STR-700, C24 CREW: KS + ML

TYPE: BR( ) CUL(X) DAM( ) XS( ) ERM ELEV.: ERM ID: GEOID:

BRIDGE:	Rail Height:		Deck:	43"	Width:	29' short	Pier(s):	@		Pier Shape:
CULVERT:	Number:	2	Shape:	arch	Length:	36'	Height: below	Width: below		Skew: small
CULVERT:	I/O Type:				Material:	CMP corrod	Wingwall Angle			
DAM:	Top Width:		Side Slope		Side Slope		US:	DS:		Outlet:
ERM Description:							Coordinate System:			
Photo Numbers:			USC:	22	USF:	23	DSF: 24	DSC: 25	DSL 26 DSR 27	O 28
Additional Info:	DS culv projecting, sandy soil, rock lining channel sides									
File Name:										

PROFILE VIEW:
(Left to Right looking Downstream)

408 Cardinal Ln



PLAN VIEW:

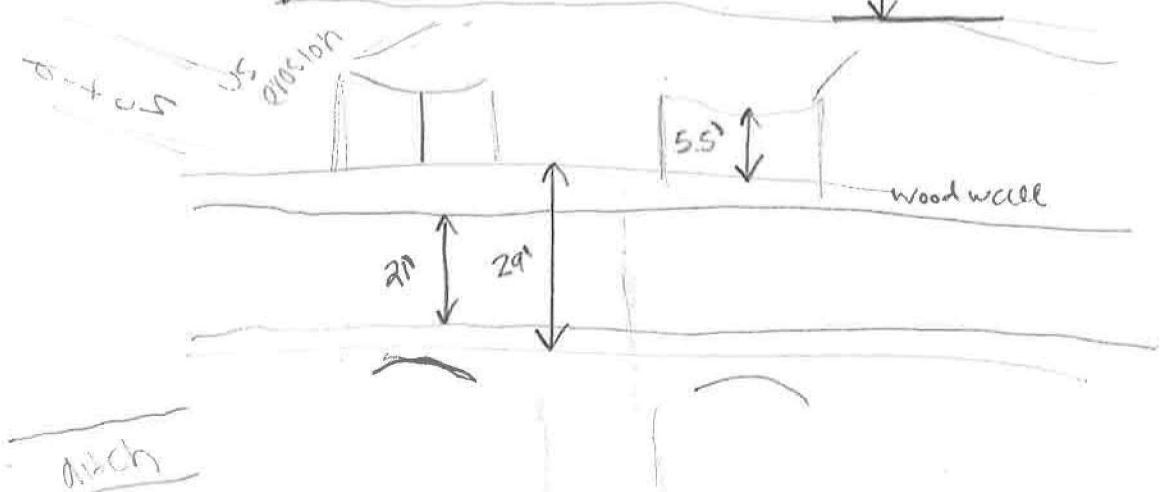


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	Photo ID: Coordinates: Description:	AC_UN_STR_700_USF 30.176346, -97.221533 Upstream face

	Photo ID: Coordinates: Description:	AC_UN_STR_700_DSF 30.176346, -97.221533 Downstream face
	Photo ID: Coordinates: Description:	AC_UN_STR_700_DSC 30.176346, -97.221533 Downstream channel

	Photo ID: Coordinates: Description:	AC_UN_STR_700_DSL 30.176346, -97.221533 Downstream left
	Photo ID: Coordinates: Description:	AC_UN_STR_700_DSR 30.176346, -97.221533 Downstream right

	Photo ID: Coordinates: Description:	AC_UN_STR_700_OVERVIEW 30.176346, -97.221533 Overview

HALFF | **Survey Field Sheet**

PROJECT: Bastrop FPP AVO 35837 SURVEY NAME:

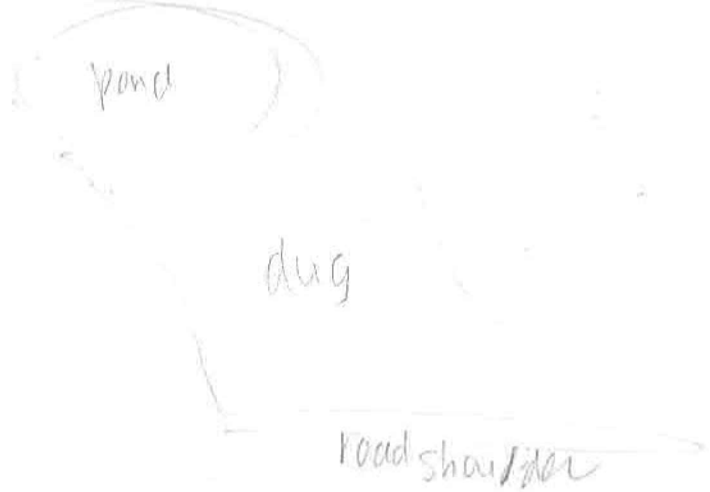
STREAM NAME: Alum Creeked Unnamed DATE: 04-17-19

LOCATION: Peaceful Ln., AC_UN_STR.800,C34 CREW: KS+ML

TYPE: BR( ) CUL(X) DAM( ) XS( ) ERM ELEV.: ERM ID: GEOID:

BRIDGE:	Rail Height:		Deck:	2"	Width:		Pier(s):		@		Pier Shape:
CULVERT:	Number:	1	Shape:	arch	Length:	56"x24.5'	Height:	20"	Width:	24"	Skew:
CULVERT:	I/O Type:				Material:	metal	Wingwall Angle				
DAM:	Top Width:		Side Slope		Side Slope		US:		DS:		Outlet:
ERM Description:							Coordinate System:				
Photo Numbers:			USC:	57	USF:	behind fence	DSF:	58	DSC:	59	DSL 60 DSR 61 0 62
Additional Info:	dirt road + private property										
File Name:											

PROFILE VIEW:
(Left to Right looking Downstream)



PLAN VIEW:

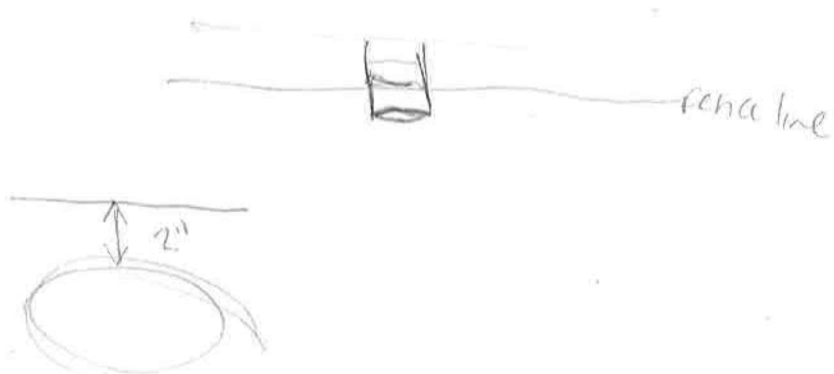


	Photo ID: Coordinates: Description:	AC_UN_STR_800_USC 30.173390, -97.208365 Upstream channel
Unable to access	Photo ID: Coordinates: Description:	AC_UN_STR_800_USF 30.173390, -97.208365 Upstream face

	Photo ID: Coordinates: Description:	AC_UN_STR_800_DSF 30.173390, -97.208365 Downstream face
	Photo ID: Coordinates: Description:	AC_UN_STR_800_DSC 30.173390, -97.208365 Downstream channel

	Photo ID: Coordinates: Description:	AC_UN_STR_800_DSL 30.173390, -97.208365 Downstream left
	Photo ID: Coordinates: Description:	AC_UN_STR_800_DSR 30.173390, -97.208365 Downstream right

HALFF — **Survey Field Sheet**

PROJECT: Bastrop FPP AVO 35837 SURVEY NAME:

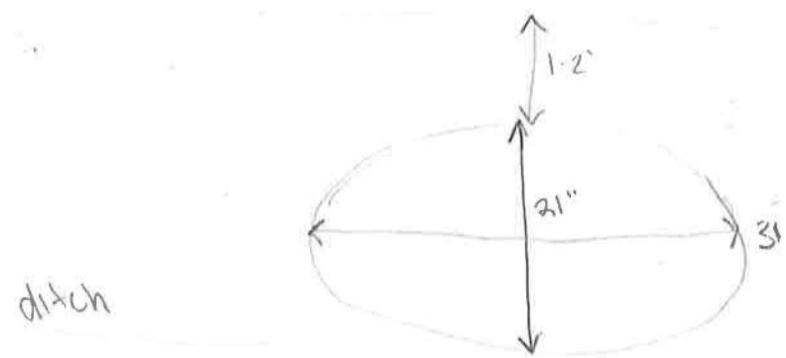
STREAM NAME: Alum Creek Unnamed DATE: 04-17-19

LOCATION: Quiet Dr, AC-UN_STR.900,C35 CREW: KS + ML

TYPE: BR( ) CUL(X) DAM( ) XS( ) ERM ELEV.: ERM ID: GEOID:

BRIDGE:	Rail Height:		Deck: 1-2'	Width: 12'	Pier(s):		@		Pier Shape:	
CULVERT:	Number:	1	Shape: arch	Length: 30'	Height: 21"		Width: 3'		Skew: Y, small	15°
CULVERT:	I/O Type:	projecting from fill		Material: metal	Wingwall Angle					
DAM:	Top Width:		Side Slope	Side Slope	US:		DS:		Outlet:	
ERM Description:					Coordinate System:					
Photo Numbers:			USC: 50	USF: 51	DSF: 52		DSC: 53		DSL 54 DSR 55	056
Additional Info:		standing water, marshy, in burn zone. resident said didn't know this was a trib.								
File Name:										

PROFILE VIEW:
(Left to Right looking Downstream)



PLAN VIEW:

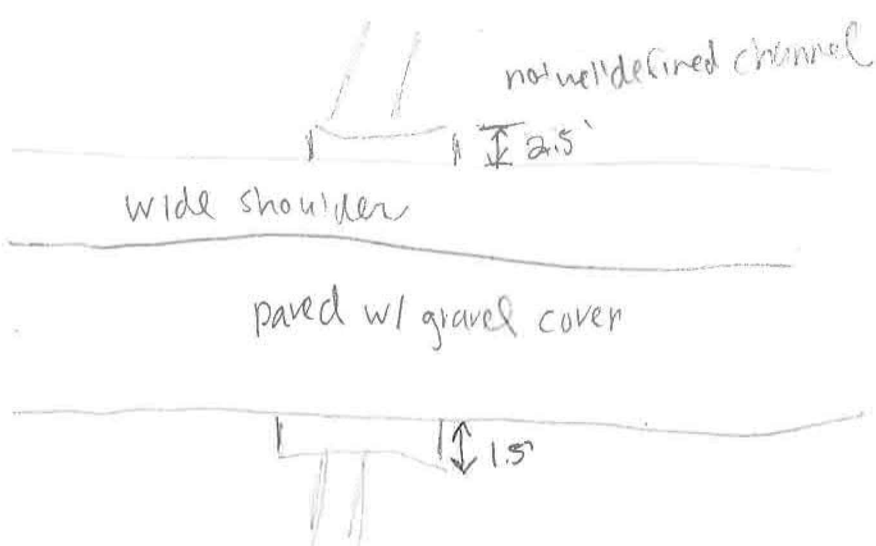


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	Photo ID: Coordinates: Description:	AC_UN_STR_900_USF 30.175180, -97.211702 Upstream face

	Photo ID: Coordinates: Description:	AC_UN_STR_900_DSF 30.175180, -97.211702 Downstream face
	Photo ID: Coordinates: Description:	AC_UN_STR_900_DSC 30.175180, -97.211702 Downstream channel

	Photo ID: Coordinates: Description:	AC_UN_STR_900_DSL 30.175180, -97.211702 Downstream left
	Photo ID: Coordinates: Description:	AC_UN_STR_900_DSR 30.175180, -97.211702 Downstream right

	Photo ID: Coordinates: Description:	AC_UN_STR_900_OVERVIEW 30.175180, -97.211702 Overview

HALFF

Survey Field Sheet

PROJECT: Alum Creek SURVEY NAME: ______

STREAM NAME: Alum Creek Tributary 129 DATE: 6/14/19

LOCATION: AC-UN-STR-1000 CREW: ______

TYPE: BR( ) CUL( ) DAM( ) XS( ) ERM ELEV.: ______ ERM ID: ______ GEOID: ______

BRIDGE: Rail Height: ______ Deck: ______ Width: ______ Pier(s): ______ @ ______ Pier Shape: ______

CULVERT: Number: 1 Shape: round Length: 39' Height: ______ Width: ______ Skew: ______

CULVERT: I/O Type: ______ Material: CMP Wingwall Angle ______

DAM: Top Width: ______ Side Slope Side Slope US: ______ DS: ______ Outlet: ______

ERM Description: ______ Coordinate System: ______

Photo Numbers: USC: 1 USF: 2-3 DSF: 4-5 DSC: 6-7 LOB 8 ROB: 9 overall 10

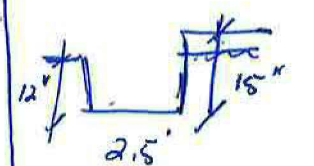
Additional Info:

File Name:

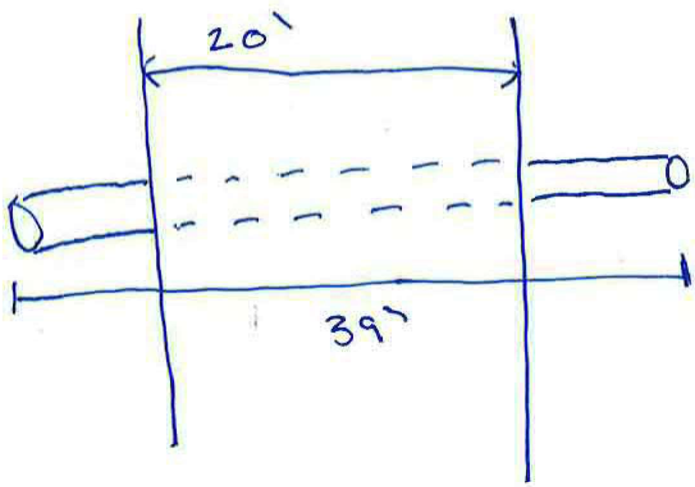
Upstream side appears to be torn. Downstream side is slightly crushed

PROFILE VIEW:
(Left to Right looking Downstream)

Cross Section A



PLAN VIEW:



DS Plan view

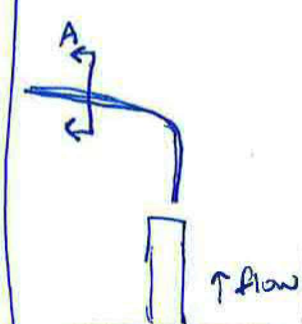


	Photo ID: Coordinates: Description:	AC_UN_STR_1000_USC 30.178965, -97.213802 Upstream channel
	Photo ID: Coordinates: Description:	AC_UN_STR_1000_USF_1 30.178965, -97.213802 Upstream face

	Photo ID: Coordinates: Description:	AC_UN_STR_1000_USF_2 30.178965, -97.213802 Upstream face
	Photo ID: Coordinates: Description:	AC_UN_STR_1000_DSF_1 30.178965, -97.213802 Downstream face

	Photo ID: Coordinates: Description:	AC_UN_STR_1000_DSF_2 30.178965, -97.213802 Downstream face
	Photo ID: Coordinates: Description:	AC_UN_STR_1000_DSC_1 30.178965, -97.213802 Downstream channel

<table>
<tr><td></td><td>Photo ID:
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Description:</td><td>AC_UN_STR_1000_DSC_2
30.178965, -97.213802
Downstream channel</td></tr>
<tr><td></td><td>Photo ID:
Coordinates:
Description:</td><td>AC_UN_STR_1000_LOB
30.178965, -97.213802
Left overbank, looking downstream</td></tr>
</table>

	Photo ID: Coordinates: Description:	AC_UN_STR_1000_ROB 30.178965, -97.213802 Right overbank, looking downstream
	Photo ID: Coordinates: Description:	AC_UN_STR_1000_OVERVIEW 30.178965, -97.213802 Overview

HALFF Survey Field Sheet

PROJECT: Alum Creek SURVEY NAME:

STREAM NAME: Alum Creek Tributary 129 DATE: 6/4/19

LOCATION: AC-UN-STR-1190 CREW:

TYPE: BR( ) CUL( ) DAM( ) XS( ) ERM ELEV.: ERM ID: GEOID:

BRIDGE: Rail Height: Deck: Width: Pier(s): @ Pier Shape:

CULVERT: Number: Shape: Length: Height: Width: Skew:

CULVERT: I/O Type: Material: Wingwall Angle

DAM: Top Width: Side Slope Side Slope US: DS: Outlet:

ERM Description: Coordinate System:

Photo Numbers: USC: ~~4~~ 2 USF: ~~3~~ 1 DSF: 1 DSC: 2 LOB: 3 ROB: 4

Additional Info: no structure picture 0 is sheet overview: 5

File Name:

PROFILE VIEW:
(Left to Right looking Downstream)

~~no~~

no defined creek

PLAN VIEW:

	Photo ID: Coordinates: Description:	AC_UN_STR_1100_USC 30.180641, -97.216771 Upstream channel
	Photo ID: Coordinates: Description:	AC_UN_STR_1100_USF 30.180641, -97.216771 Upstream face, no structure identified

	Photo ID: Coordinates: Description:	AC_UN_STR_1100_DSF 30.180641, -97.216771 Downstream face, no structure identified
	Photo ID: Coordinates: Description:	AC_UN_STR_1100_DSC 30.180641, -97.216771 Downstream channel

	Photo ID: Coordinates: Description:	AC_UN_STR_1100_LOB 30.180641, -97.216771 Left overbank, looking downstream
	Photo ID: Coordinates: Description:	AC_UN_STR_1100_ROB 30.180641, -97.216771 Right overbank, looking downstream

	Photo ID: Coordinates: Description:	AC_UN_STR_1100_OVERVIEW 30.180641, -97.216771 Overview

Appendix D: Environmental Constraints

Environmental Constraints Analysis

Introduction

Bastrop County (County) is conducting hydrologic and hydraulic studies within the Alum Creek Watershed as part of the Texas Water Development Board (TWDB) Flood Protection Plan (FPP) grant (see **Appendix A, Figures 1** and **2**). To support the County's studies, Halff Associates, Inc. (Halff) has prepared this desktop analysis to identify potential environmental constraints and permitting requirements for the proposed project.

For the purpose of the environmental constraints review, the study area includes a 34,674-acre area that includes Alum Creek. The study area is within Bastrop County, east of City of Bastrop and extends from US 290 to south of State Highway (SH) 95. Numerous sources were reviewed to identify potential environmental constraints in the study area, including: socioeconomic data from the U.S. Census Bureau (USCB), Texas Parks and Wildlife Department (TPWD) threatened and endangered species by county and Element of Occurrence locations, U.S. Fish and Wildlife Service (USFWS) critical habitats and National Wetlands Inventory (NWI) maps, Texas Commission on Environmental Quality (TCEQ) hazardous materials, and cultural resources data from the Texas Historical Commission (THC).

Study Area Description

Topographic Map Description

The U.S. Geological Survey (USGS) quadrangle maps for "Lake Bastrop, Bastrop, Smithville NW, Smithville, Paige, and Winchester, Texas" (see **Appendix A**, **Figure A-1**) depict the study area as mixed urban development and undeveloped land. Urban development within the study area is primarily concentrated adjacent to SH 21 and SH 95. The remainder of the study area consists of undeveloped land. Numerous tributaries and aquatic resources are depicted throughout the study area.

Aerial Photo Description

Aerial imagery maps for 1996 and 2018 (see **Appendix A**, **Figures A-2** and **A-3**) were reviewed and compared to other background resources within the study area. The aerial imagery maps depict the study area as consistent with the topographic map. However, the 2018 aerial imagery map depicts the northern portion of the study area as having been subjected to agricultural production.

Geology

Surface geology, derived from the USGS Texas Geology[1] database, was reviewed to identify rock units within the study area. The database identified nine rock units within the study area (see **Appendix A**, **Figure A-4**), further identified as: Carrizo sand (Ec), Cook Mountain formation (EcM), Queen City sand (Eqc), Reklaw formation (Er), Sparta sand (Es), Weches formation (Ew), alluvium (Qal), high gravel deposits (Qhg), and fluviatile terrace deposits (Qt).

Soil Survey

Soil data for the study area was obtained from the Natural Resource Conservation Service (NRCS) Web Soil Survey, which is derived from the U.S. Department of Agriculture (USDA) Soil Survey for Bastrop County, Texas. The soil units derived from the USDA Geographic Information System (GIS) data are shown atop recent aerial imagery in **Appendix A**, **Figures A-5** to **A-5.3**. **Table 1** provides key characteristics for these soil types.

Table 1. Soil Units within the Study Area

Soil Unit	Topography	Farmland Classification
AfA – Axtell fine sandy loam	0-1% Slopes	Farmland of Statewide Importance
AfC – Edge fine sandy loam	1-5% Slopes	Farmland of Statewide Importance
AfC2 – Edge fine sandy loam	2-5% Slopes, moderately eroded	Not Prime Farmland
AfE2 – Edge fine sandy loam	5-12% Slopes, eroded	Not Prime Farmland
AtD – Edge gravelly fine sandy loam	3-8% Slopes	Not Prime Farmland
BaA – Bastrop fine sandy loam	0-1% Slopes	All Areas are Prime Farmland
BaB – Bastrop fine sandy loam	1-3% Slopes	All Areas are Prime Farmland
BaC2 – Bastrop fine sandy loam	3-5% Slopes, eroded	Not Prime Farmland
BeB – Behring clay loam	1-3% Slopes	All Areas are Prime Farmland
BeC2 – Behring clay loam	3-5% Slopes, eroded	Not Prime Farmland
Bo – Bosque loam	0-1% Slopes, occasionally flooded	Not Prime Farmland
CfB – Crockett fine sandy loam	1-3% Slopes	Farmland of Statewide Importance
CsC2 – Crockett fine sandy loam	2-5% Slopes, eroded	Not Prime Farmland
CsD3 – Crockett fine sandy loam	3-8% Slopes, severely eroded	Not Prime Farmland
CsE2 – Crockett fine sandy loam	5-10% Slopes	Not Prime Farmland

[1] https://txpub.usgs.gov/txgeology/

Soil Unit	Topography	Farmland Classification
DeC – Robco-Tanglewood complex	1-5% Slopes	Farmland of Statewide Importance, if drained
Dm – Robco loamy fine sand	0-2% Slopes	Farmland of Statewide Importance, if drained
DoB – Dutek loamy fine sand	0-3% Slopes	Not Prime Farmland
DoD – Dutek loamy fine sand	3-8% Slopes	Not Prime Farmland
FeF2 – Ferris clay	5-20% Slopes, eroded	Not Prime Farmland
GP – Gravel pit	-	-
Gs – Whitesboro clay loam	0-1% Slopes, frequently flooded	Not Prime Farmland
HeB – Heiden clay	1-3% Slopes	All Areas are Prime Farmland
HeC2 – Heiden clay	3-5% Slopes, eroded	Not Prime Farmland
JeF – Jedd gravelly fine sandy loam	5-20% Slopes	Not Prime Farmland
KrA – Krum silty clay	0-1% Slopes	All Areas are Prime Farmland
Ls – Gad fine sand	0-1% Slopes, occasionally flooded	Not Prime Farmland
MaA – Mabank loam	0-1% Slopes	Farmland of Statewide Importance
MaB – Mabank loam	1-3% Slopes	Farmland of Statewide Importance
No – Weswood silty clay loam	0-1% Slopes, rarely flooded	All Areas are Prime Farmland
PaE – Padina fine sand	1-12% Slopes	Not Prime Farmland
RoB – Rosanky fine sandy loam	1-3% Slopes	All Areas are Prime Farmland
RoD – Rosanky fine sandy loam	3-8% Slopes	Not Prime Farmland
Sa – Sayers fine sandy loam	0-1% Slopes, occasionally flooded	Not Prime Farmland
Sb – Sayers fine sandy loam	0-1 % Slopes, frequently flooded	Not Prime Farmland
SeD2 – Shep clay loam	3-8% Slopes, eroded	Not Prime Farmland
Sg – Ships silty clay	0-1% Slopes, occasionally flooded	Not Prime Farmland
SkC – Silstid loamy fine sand	1-5% Slopes	Not Prime Farmland
Sm – Smithville fine sandy loam	0-1% Slopes	All Areas are Prime Farmland
TfA – Tabor fine sandy loam	0-1% Slopes	Farmland of Statewide Importance
TfB – Tabor fine sandy loam	1-3% Slopes	Farmland of Statewide Importance
Uh – Uhland clay loam	0-1% Slopes, frequently flooded	Not Prime Farmland

Soil Unit	Topography	Farmland Classification
VeD – Vernia very gravelly loamy sand	1-8% Slopes	Not Prime Farmland
W – Water	-	-
WsA – Wilson clay loam	0-1% Slopes	Farmland of Statewide Importance
WsB – Wilson clay loam	1-3% Slopes	Farmland of Statewide Importance

Water Resources

Potential water resource constraints including surface water features[2] (wetlands, tributaries, rivers, impoundments, and other potential waters of the United States), floodplains[3], and groundwater features were evaluated along the proposed study area to identify local, state, and/or federal permitting requirements that may be associated with construction of the proposed project.

Floodplains

Based on the Federal Emergency Management Agency (FEMA) National Flood Hazard Layer (NFHL)[4] (see **Appendix A, Figure A-6**), Alum Creek and its tributaries' floodplains are classified as Zone A, areas subject to inundation by 1 percent annual chance flood hazards with undetermined base flood elevations (BFE). Similarly, tributaries of the Colorado River located along the southern boundary of the study area are also classified as Zone A; however, the Colorado River is classified as Zone AE within the regulatory floodway. Zone AE are areas subject to inundation by 1 percent annual chance flood hazards with determined BFE. Additionally, property adjacent to the Colorado River are classified as Zone X, areas of moderate flooding by 0.2 percent annual chance flood hazards. The remainder of the study area is classified as Zone X, areas of minimal flood hazard which is outside of the 1 and 0.2 percent annual chance of flood hazard zones.

National Wetlands Inventory

Wetlands are identified as those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Based on the review of the NWI data and the National Hydrography Dataset (NHD), surface water features within the study area include 10 freshwater forested/shrub wetlands, 33 freshwater

[2] Pursuant to EO 11990, Section 404 of the Clean Water Act (CWA), Section 401 of the CWA, Section 303(d) of the CWA, and Sections 9 and 10 of the Rivers and Harbors Act
[3] Pursuant to Executive Order (EO) 11988
[4] https://www.fema.gov/national-flood-hazard-layer-nfhl

emergent wetlands, 305 freshwater ponds, 1 lake, and 314 riverine features (see **Appendix A**, **Figures A-7** to **A-7.3**).

Section 303(d)

According to the Draft 2020 Texas Section 303(d) list[5], Alum Creek, from its confluence with the Colorado River upstream to its headwaters near US 290 approximately 3.5 km southwest of McDade, is identified as an impaired waterbody due to bacterial pollutants/conditions that affect water quality standards for recreational use.

Biological Resources

Review of the USFWS Information for Planning and Consultation (IPaC) report identified eight federally-listed species that should be considered in an effects analysis for the study area. The report also identified one critical habitat located wholly or partially within the study area. Critical habitats are specific geographic areas that contain features essential for the conservation of a threatened or endangered species and that may require special management and protection. The majority of the study area is located within the USFWS designated critical habitat for the federally endangered Houston toad (*Bufo houstonensis*) (see **Appendix A**, **Figure A-8**).

Review of the TPWD county list identified 18 state-listed species for Bastrop County. Database search for protected species was also conducted using the Texas Natural Diversity Database (TXNDD) on January 16, 2020. The TXNDD search revealed 22 Element of Occurrence Records (records of sightings of rare or endangered species) or managed areas within a two-mile radius of the study area (see **Appendix A**, **Figure A-9**). These Element Occurrence records include the Houston toad (Element Occurrence IDs [EOIDs] 12828, 4685, 2733, and 344), timber rattlesnake (*Crotalis horridus* [EOIDs 9387 and 9386]), Texas garter snake (*Thamnophis sirtalis annectens* [EOID 5791]), Texas beebalm (*Monarda viridissima* [EOIDs 10486, 10338, 10178, 10063, and 9979]), post oak-blackjack oak series (EOIDs 6800, 4758, and 1345), loblolly pine-post oak-blackjack oak/farkleberry forest (EOIDs 5403, 2703, 2690, 2179, and 893), sphagnum-beakrush series (EOID 4812), and Navasota ladies'-tresses (EOID 8806).

Given the small proportion of public versus private land in Texas, the TXNDD does not include a representative inventory of rare resources in the state. Although it is based on the TPWD's best available data regarding rare species, the data cannot provide a definitive statement as to the presence, absence, or condition of special status species, natural communities, or other significant features in any area. The data cannot substitute for on-site evaluation by qualified biologists. The TXNDD information is intended to assist users in avoiding harm to rare and special species or significant ecological features. Refer all requests back to the TXNDD to obtain the most

[5] https://www.tceq.texas.gov/assets/public/waterquality/swqm/assess/20txir/2020_303d.pdf

current information. A field visit by a qualified biologist is recommended prior to construction to determine the presence or absence of suitable habitat for protected species.

Socioeconomic/Environmental Justice

Executive order (EO) 12898 "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" requires each federal agency to "make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies and activities on minority populations and low-income populations."

The USCB Quick Facts[6] demographic data was reviewed to determine if minority or low-income persons have the potential to be adversely affected by the proposed project. According to the Quick Facts statistics, Bastrop County had a population estimate of 86,976 in 2018 and approximately 32.2 percent of the population was composed of minorities. The American Community Survey (ACS) 5-year average income and poverty data for 2014-2018 indicates that the median household income for Bastrop County is $62,947. Review of the United States Department of Health and Human Services (USDHHS) 2019 poverty guideline indicates that the annual income for a household of four is $25,750. Based on this data, the median household income for Bastrop County in 2018 is greater than the 2019 USDHHS poverty guideline; however, approximately 12.6 percent of Bastrop County are considered to be in poverty.

Although minority and low-income persons are located within the study area, the proposed project is not expected to have adverse or disproportionate impacts on minority or low-income populations. The benefits of the flood studies are expected to equally benefit all residents in Bastrop County. Public outreach planning for any future public involvement activities should take into consideration low-income and minority populations.

Hazardous Materials

A database search for regulated hazardous materials sites located within the detention pond footprint (see **Appendix A**, **Figure A-10**) was provided by GeoSearch in February 2020 (see **Appendix B**). The *GeoSearch Radius Report* did not identify any hazardous material records within a 1-mile search radius of the detention pond footprint.

Based on a preliminary review of data provided by the Railroad Commission of Texas, oil and gas facilities, including wells and pipelines, were identified within 0.5 mile of the project area.

[6] https://www.census.gov/quickfacts/fact/table/bastropcountytexas/INC110218

Cultural Resources

As a political subdivision of the State, projects undertaken by Bastrop County are subject to the *Antiquities Code of Texas*. In addition, given the number of surface water features within the study area that could fall under jurisdiction of USACE, the project could be considered a federal undertaking, requiring compliance with Section 106 of the National Historic Preservation Act (NHPA). Therefore, a Cultural Resources Background Review was conducted to evaluate the potential for the proposed project to impact cultural resources.

A review of the *Texas Archeological Sites Atlas* (Atlas) identified numerous cultural resources sites within the study area, including prehistoric and historic age archeological sites, one National Register of Historic Places (NRHP) District, one historical marker and four cemeteries. The physiographic settings along the alluvial terraces of Alum Creek and its tributaries are considered conducive to the preservation of cultural resources in the study area. In addition, the presence of several previously documented cultural resources sites in the study area indicates that cultural resource coordination under Texas Antiquities Code and potentially, Section 106 of the NHPA will likely be required should ground disturbing activity be proposed within the study area.

Conclusions and Recommendations

Based on the assessment of potential environmental constraints for the proposed project, additional actions regarding potential environmental impacts may be required, including:

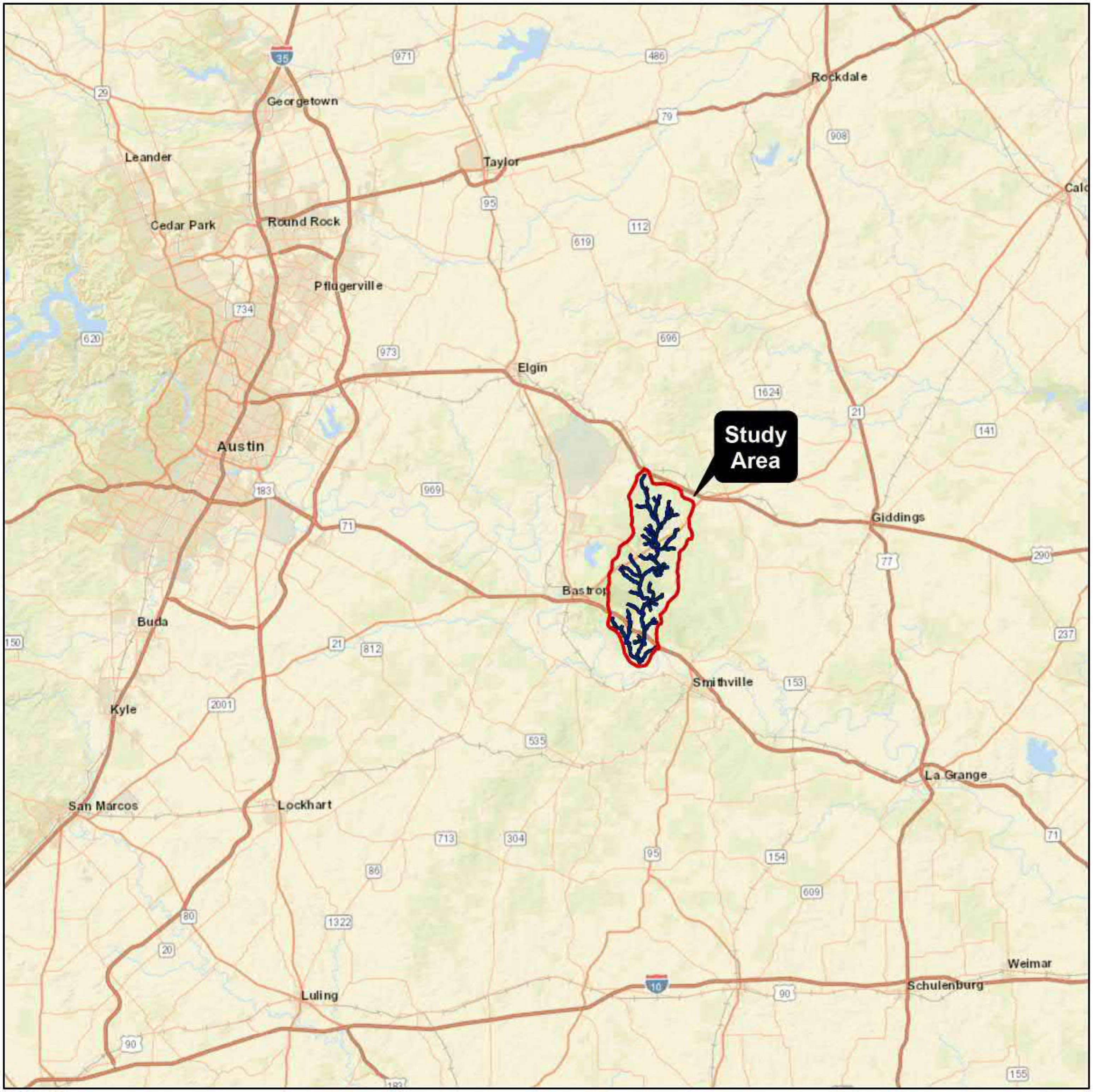
- As a political subdivision of the State, the County must notify the THC prior to commencing any project on public land and/or affecting publicly-owned buildings that will involve 5 or more acres of ground disturbance, 5,000 or more cubic yards of earth moving, will occur within a historic district, or will affect a recorded archeological site.
- Construction of the proposed project may result in a discharge of fill material into a water of the United States (Alum Creek, tributaries of Alum Creek, and the Colorado River), thereby requiring authorization from the United States Army Corps of Engineers under a Section 404 permit. Additional investigation into these issues should be conducted during the schematic/design phase for this project.
- Construction of the proposed project may impact critical habitat for the Houston toad. Field reconnaissance of the study area is recommended prior to construction to determine the presence or absence of suitable habitat for protected species. Additionally, federal actions (e.g. Section 404 permit) would require Section 7 Consultation with the USFWS.
- Based on a review of preliminary project details, archeological surveys are recommended if any of the following criterion are met:
    - the project is on public land and/or would impact publicly-owned buildings,

- the project will involve 5 or more acres of ground disturbance or 5,000 or more cubic yards of earth moving,
- the project will occur within a historic district, or will affect a recorded archeological site.

Furthermore, should deep impacts be proposed near any tributary crossings (i.e., installation of bridge columns) or additional right-of-way is required, additional surveys and mechanized trenching (i.e., deep testing) may be warranted.

- Based on a review of the *GeoSearch Radius Report*, no hazardous material sites were identified within 0.5 mile of the detention pond footprint. However, a Phase I Environmental Site Assessment is recommended if property acquisition is anticipated for the detention pond.

FIGURES



0 5 10 20

Miles

Legend

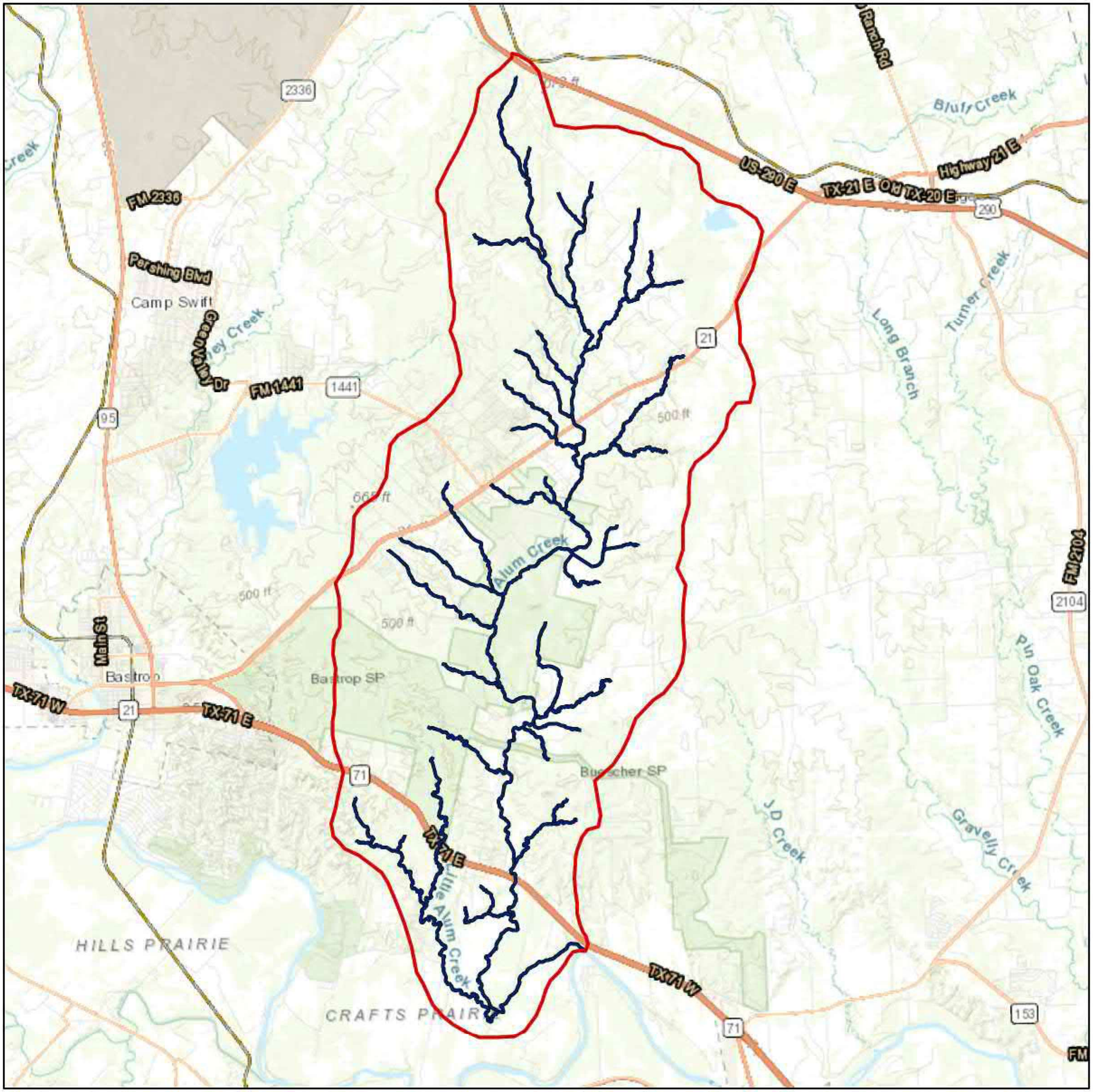
Study Area

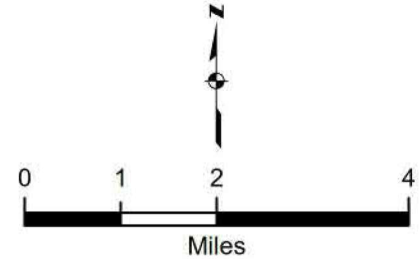
Study Stream Centerlines

Notes:
1. LAT: 30.1635°, LONG: -97.3384°
2.Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c)

Alum Creek Watershed Study Bastrop County, Texas
Project Number: N/A
Date: 4/2/2020 AVO: 35837
Location Map
Figure 1

HALFF





Legend

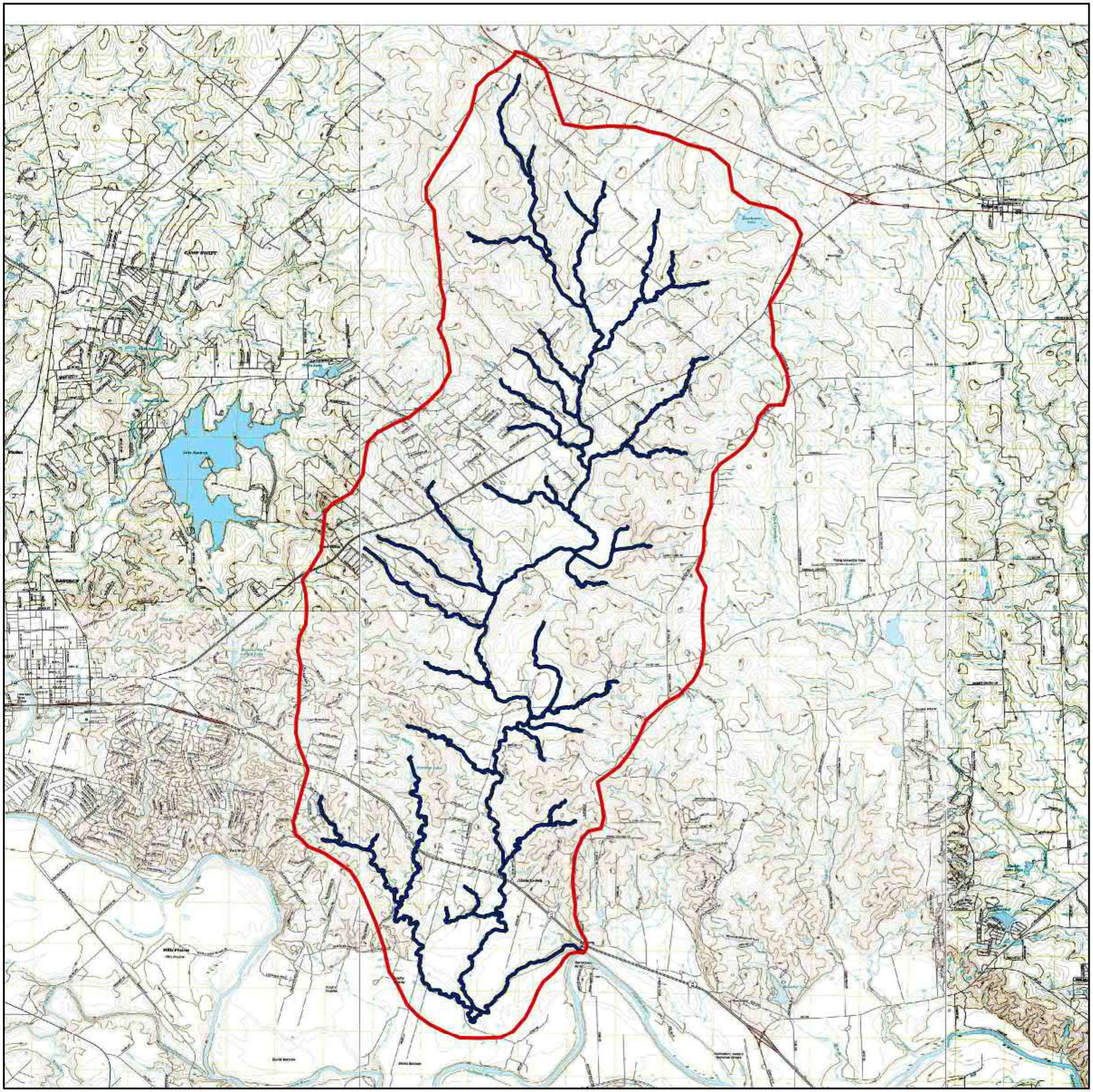
- Study Area
- Study Stream Centerlines

Notes:
1. LAT: 30.1389°, LONG: -97.2103°
2. Service Layer Credits: Esri, HERE, Garmin, (c) OpenStreetMap contributors
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO,

Alum Creek Watershed Study Bastrop County, Texas
Project Number: N/A
Date: 4/2/2020 AVO: 35837
Vicinity Map
Figure 2
HALFF

APPENDIX A

Supporting Documentation



Legend

Study Area

Study Stream Centerlines

Notes:
1. LAT: 30.1389°, LONG: -97.2102°
2. USGS TopoView Maps

Alum Creek Watershed Study
Bastrop County, Texas

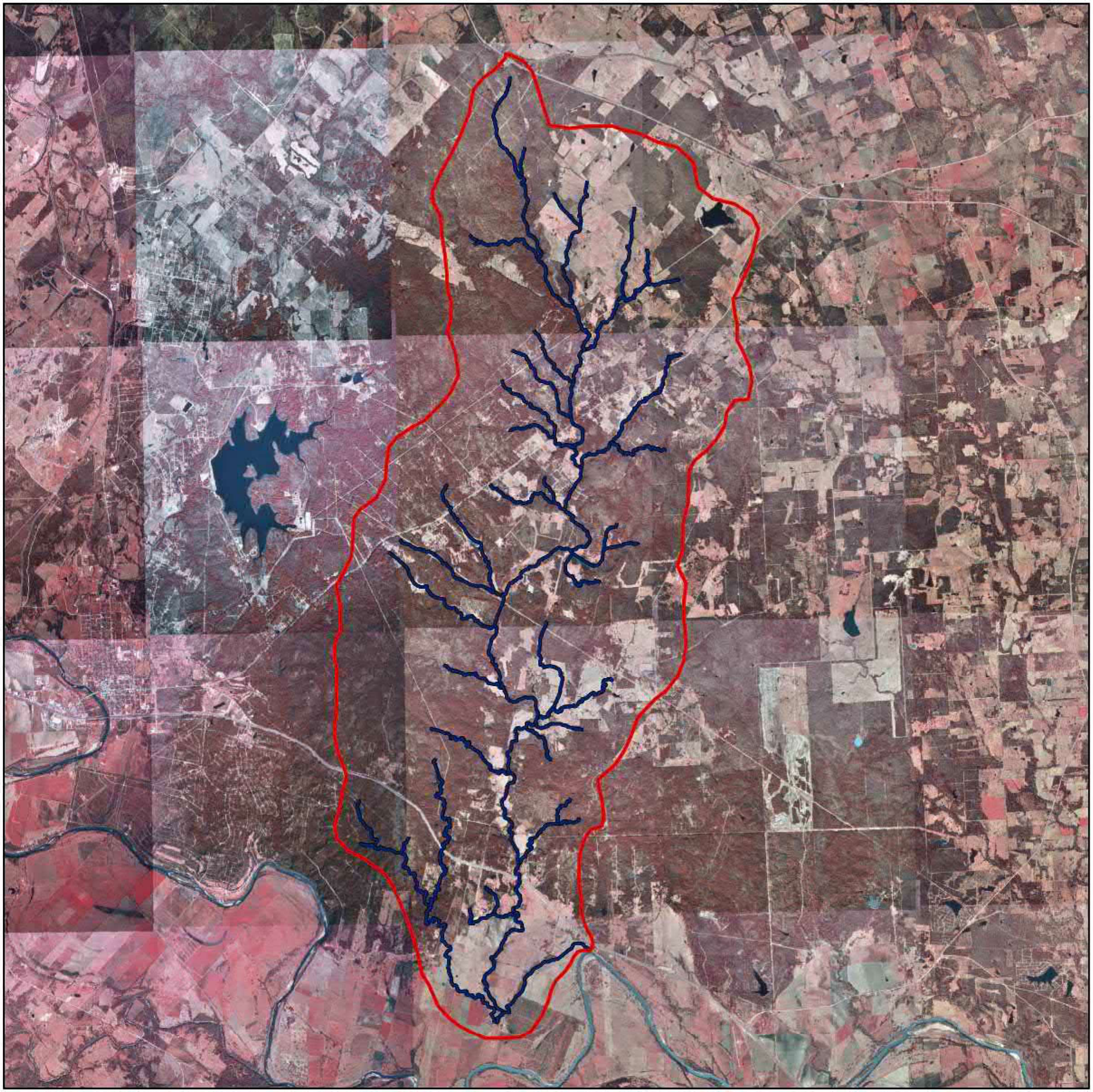
Project Number: N/A

Date: 4/2/2020 AVO: 35837

USGS Topographic Map

Figure A-1

HALFF



Legend

Study Area

Study Stream Centerlines

Notes:
1. LAT: 30.1389°, LONG: -97.2103°
2. TNRIS - Texas TOP Imagery 1996

Alum Creek Watershed Study
Bastrop County, Texas

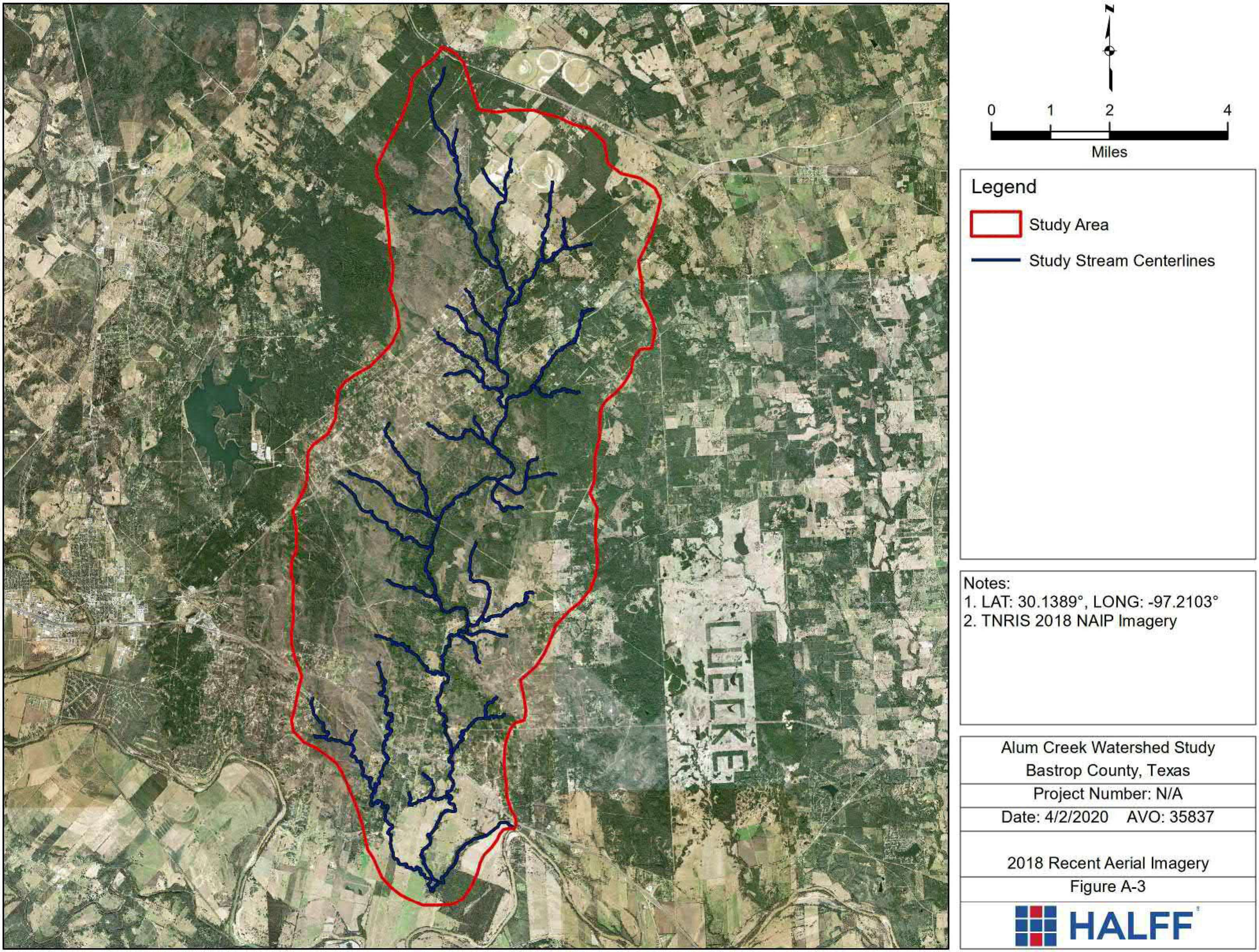
Project Number: N/A

Date: 4/2/2020 AVO: 35837

1996 Aerial Imagery Map

Figure A-2

HALFF



Alum Creek Watershed Study
Bastrop County, Texas

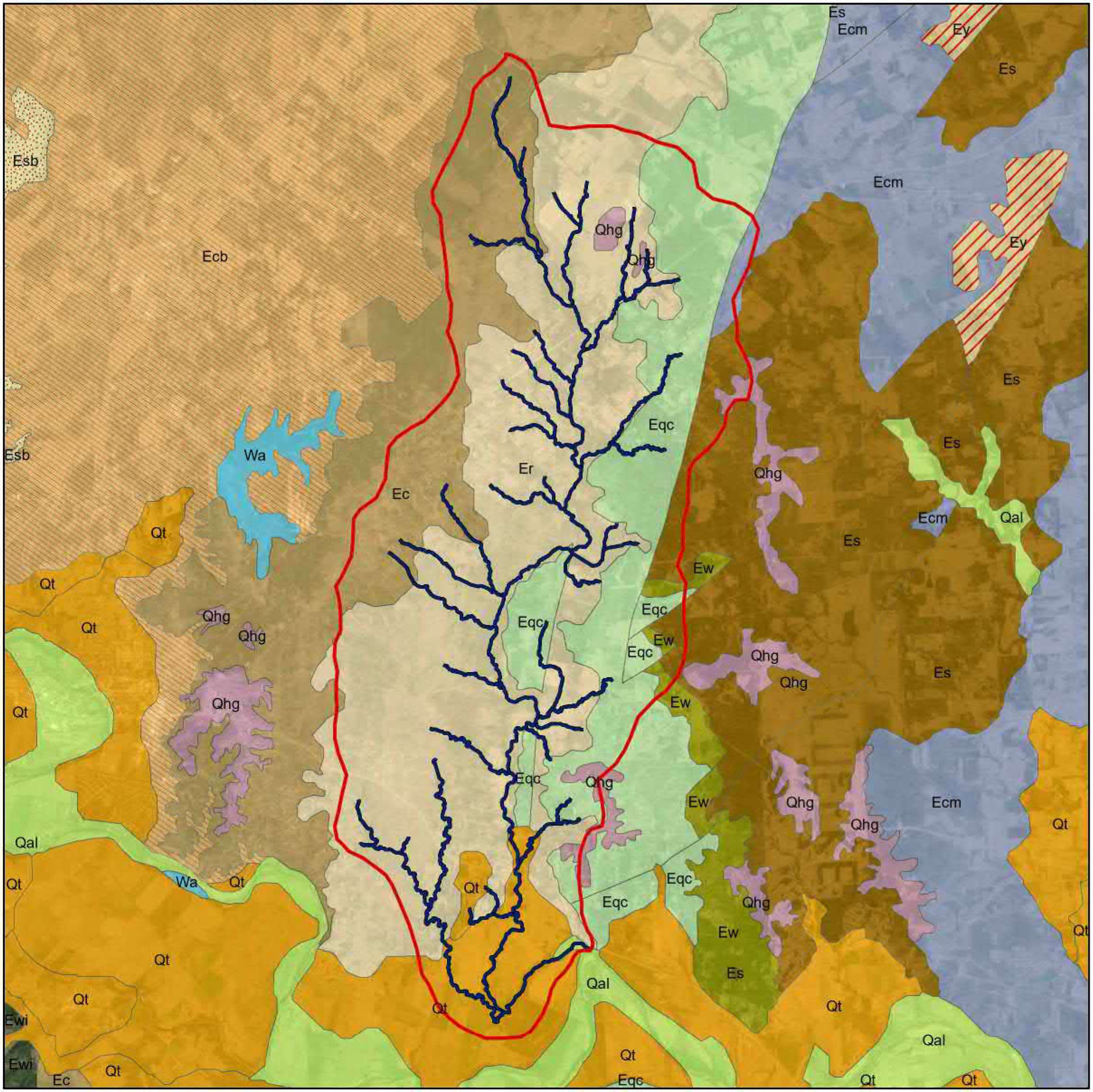
Project Number: N/A

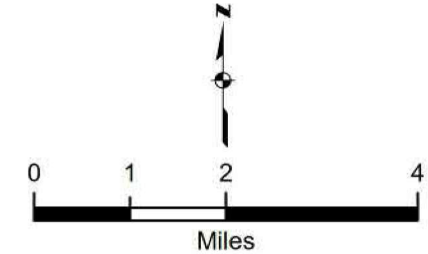
Date: 4/2/2020 AVO: 35837

2018 Recent Aerial Imagery

Figure A-3

HALFF





Legend

- Study Area
- Study Stream Centerlines

USGS Geologic Rock Units

- Ec - Carrizo Sand
- Ecb - Calvert Bluff
- Ecm - Cook Mountain Formation
- Eqc - Queen City Sand
- Er - Reklaw Formation
- Es - Sparta Sand
- Esb - Simsboro Formation
- Ew - Weches Formation
- Ey - Yegua Formation
- Qal - Alluvium
- Qhg - High Gravel Deposits
- Qt - Fluviatile Terrace Deposits
- Wa - Water

Notes:
1. LAT: 30.1389°, LONG: -97.2103°
2.Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
3. TNRIS 2014 USGS Texas Geology

Alum Creek Watershed Study
Bastrop County, Texas

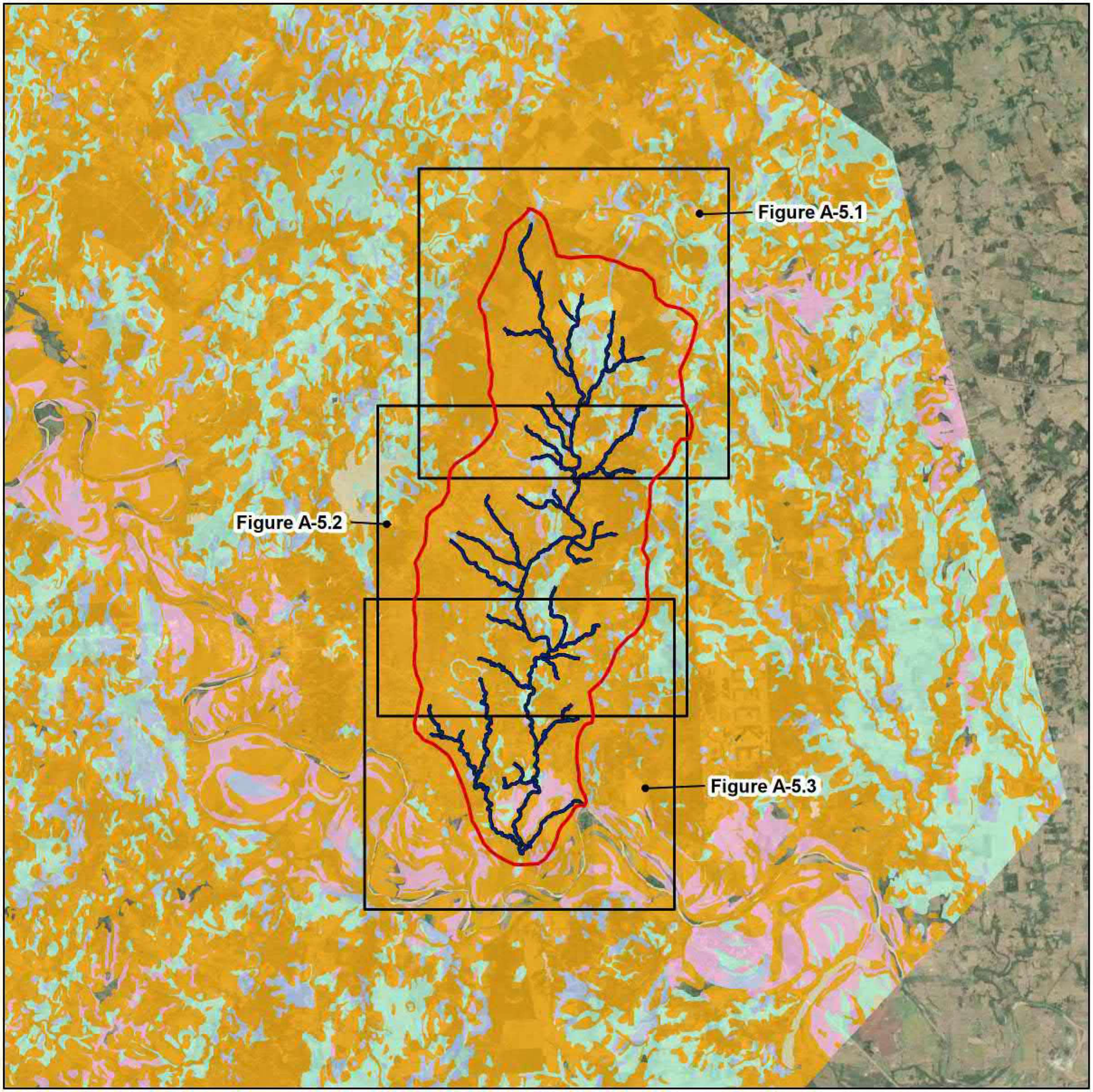
Project Number: N/A

Date: 4/2/2020 AVO: 35837

USGS Geology Map

Figure A-4

HALFF



N

0 1.5 3 6
Miles

Legend

Study Area

Study Stream Centerlines

NRCS Soil Survey

Farmland of Statewide Importance

Not Prime Farmland

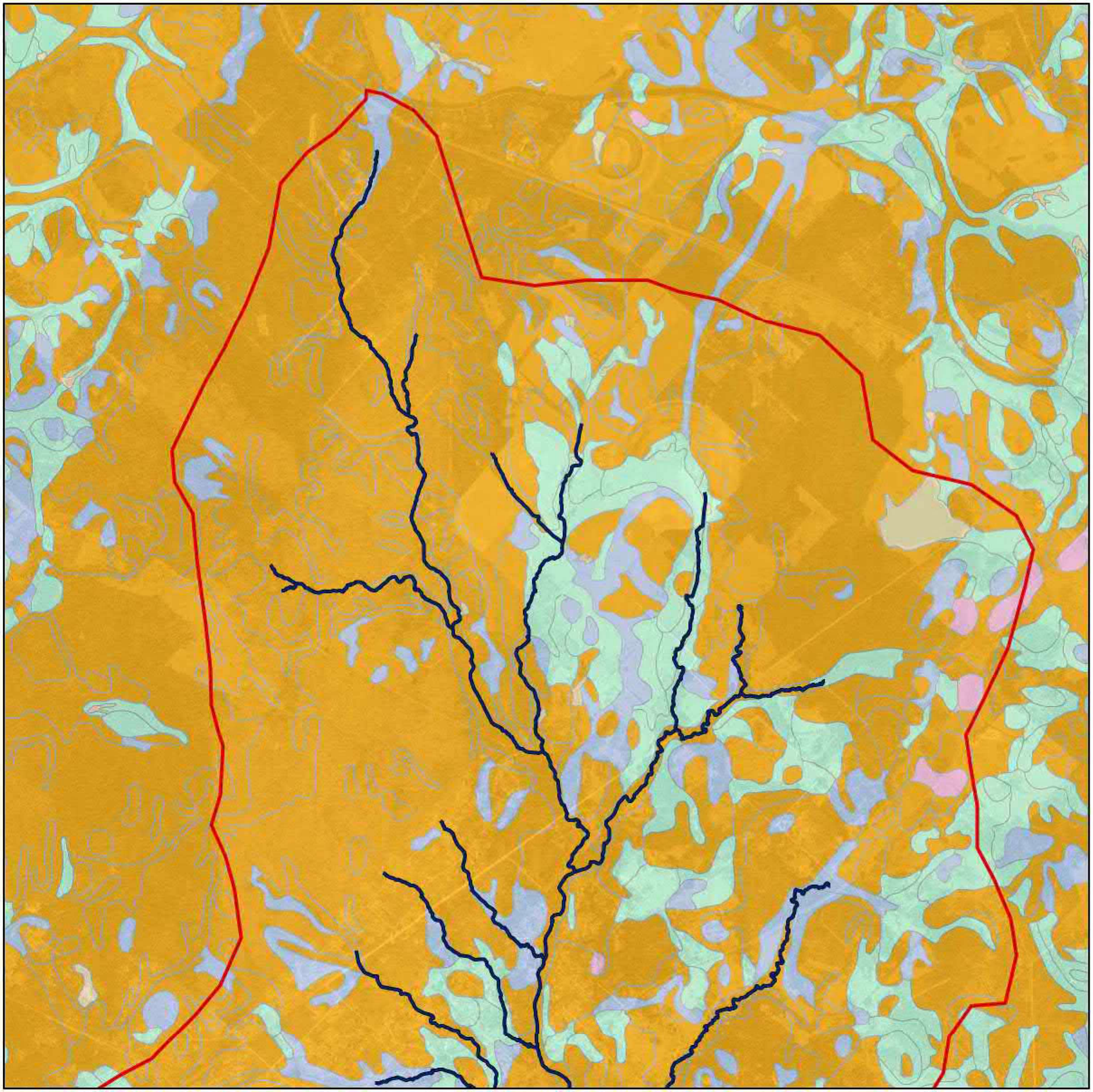
All Areas are Prime Farmland

Farmland of Statewide Importance, if drained

No Farmland Classification

Notes:
1. LAT: 30.1358°, LONG: -97.2136°
2. Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
3. USDA Web Soil Survey NRCS SSURGO

Alum Creek Watershed Study Bastrop County, Texas
Project Number: N/A
Date: 4/2/2020 AVO: 35837
NRCS SSURGO Overview Map
Figure A-5
HALFF



Legend

Study Area

Study Stream Centerlines

NRCS Soil Survey

Farmland of Statewide Importance

Not Prime Farmland

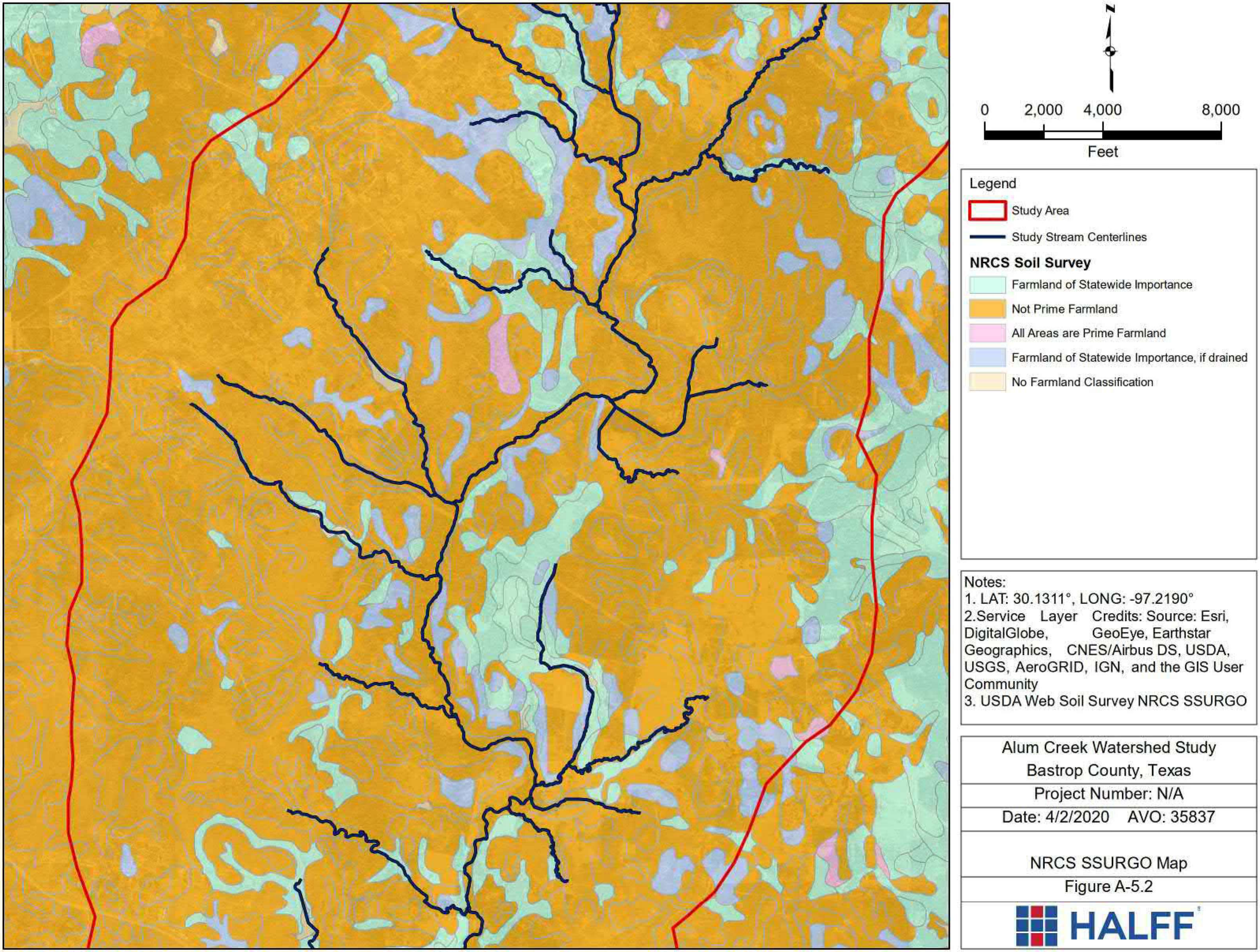
All Areas are Prime Farmland

Farmland of Statewide Importance, if drained

No Farmland Classification

Notes:
1. LAT: 30.2071°, LONG: -97.2012°
2. Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
3. USDA Web Soil Survey NRCS SSURGO

Alum Creek Watershed Study Bastrop County, Texas
Project Number: N/A
Date: 4/2/2020 AVO: 35837
NRCS SSURGO Map
Figure A-5.1
HALFF



Notes:
1. LAT: 30.1311°, LONG: -97.2190°
2. Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
3. USDA Web Soil Survey NRCS SSURGO

Alum Creek Watershed Study
Bastrop County, Texas

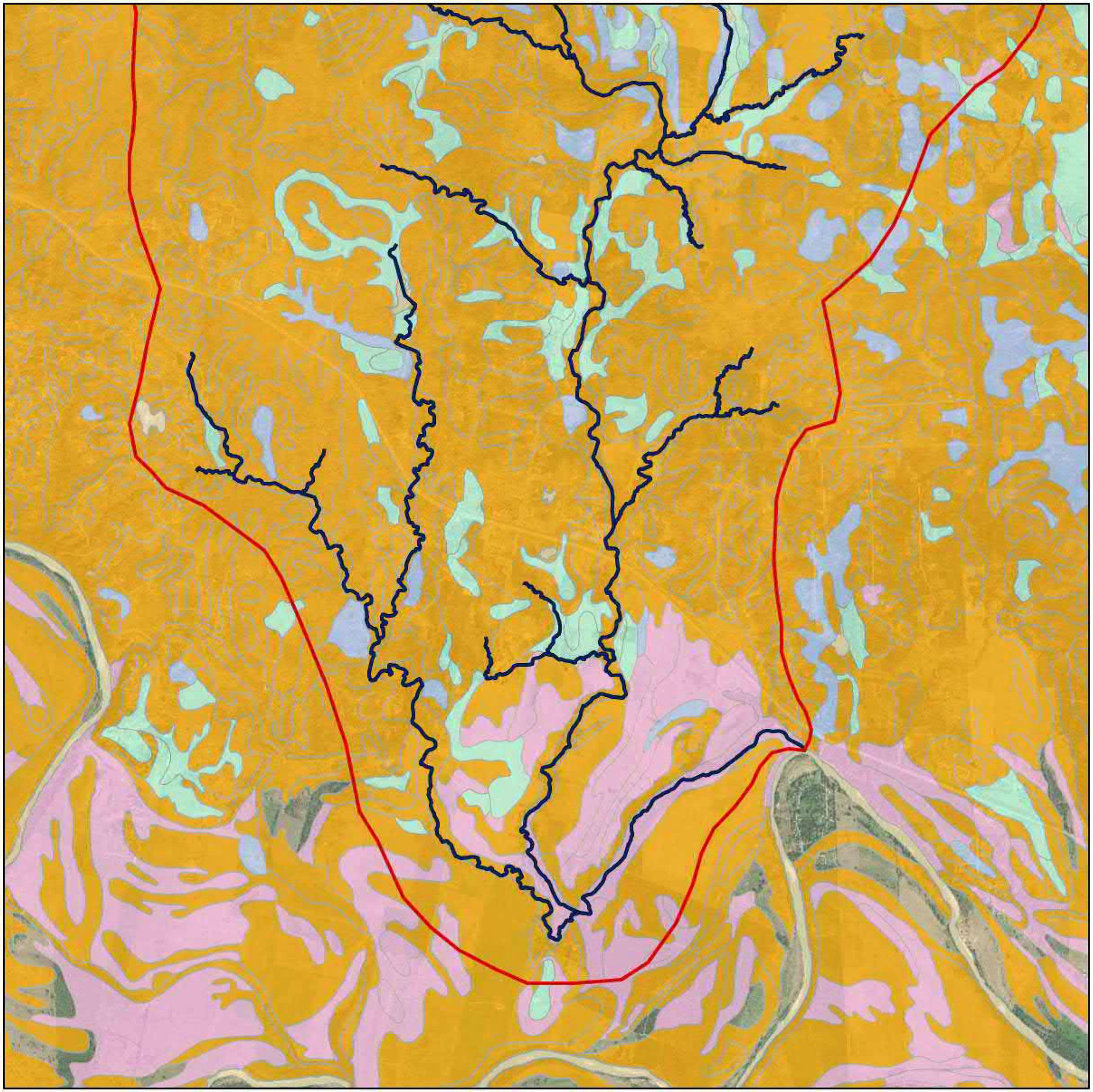
Project Number: N/A

Date: 4/2/2020 AVO: 35837

NRCS SSURGO Map

Figure A-5.2

HALFF



0 2,000 4,000 8,000

Feet

Legend

Study Area

Study Stream Centerlines

NRCS Soil Survey

Farmland of Statewide Importance

Not Prime Farmland

All Areas are Prime Farmland

Farmland of Statewide Importance, if drained

No Farmland Classification

Notes:
1. LAT: 30.0693°, LONG: -97.2257°
2. Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
3. USDA Web Soil Survey NRCS SSURGO

Alum Creek Watershed Study
Bastrop County, Texas

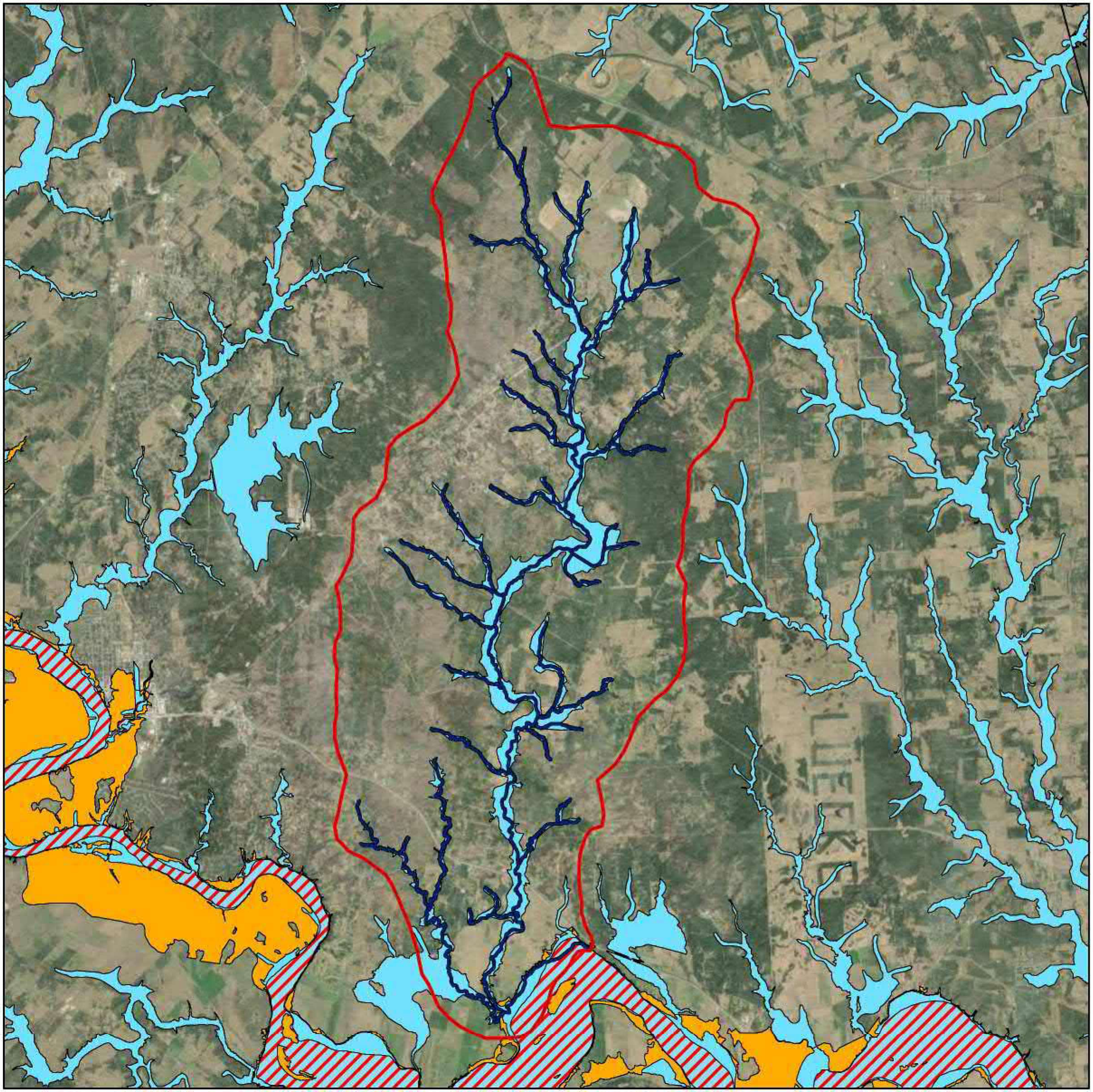
Project Number: N/A

Date: 4/2/2020 AVO: 35837

NRCS SSURGO Map

Figure A-5.3

HALFF



0 1 2 4

Miles

Legend

- Study Area
- Study Stream Centerlines
- 1% Annual Chance Flood Hazard
- 0.2% Annual Chance Flood Hazard
- Area of Minimal Flood Hazard
- Regulatory Floodway

Notes:
1. LAT: 30.1389°, LONG: -97.2103°
2. Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
3. FEMA NFHL

Alum Creek Watershed Study

Bastrop County, Texas

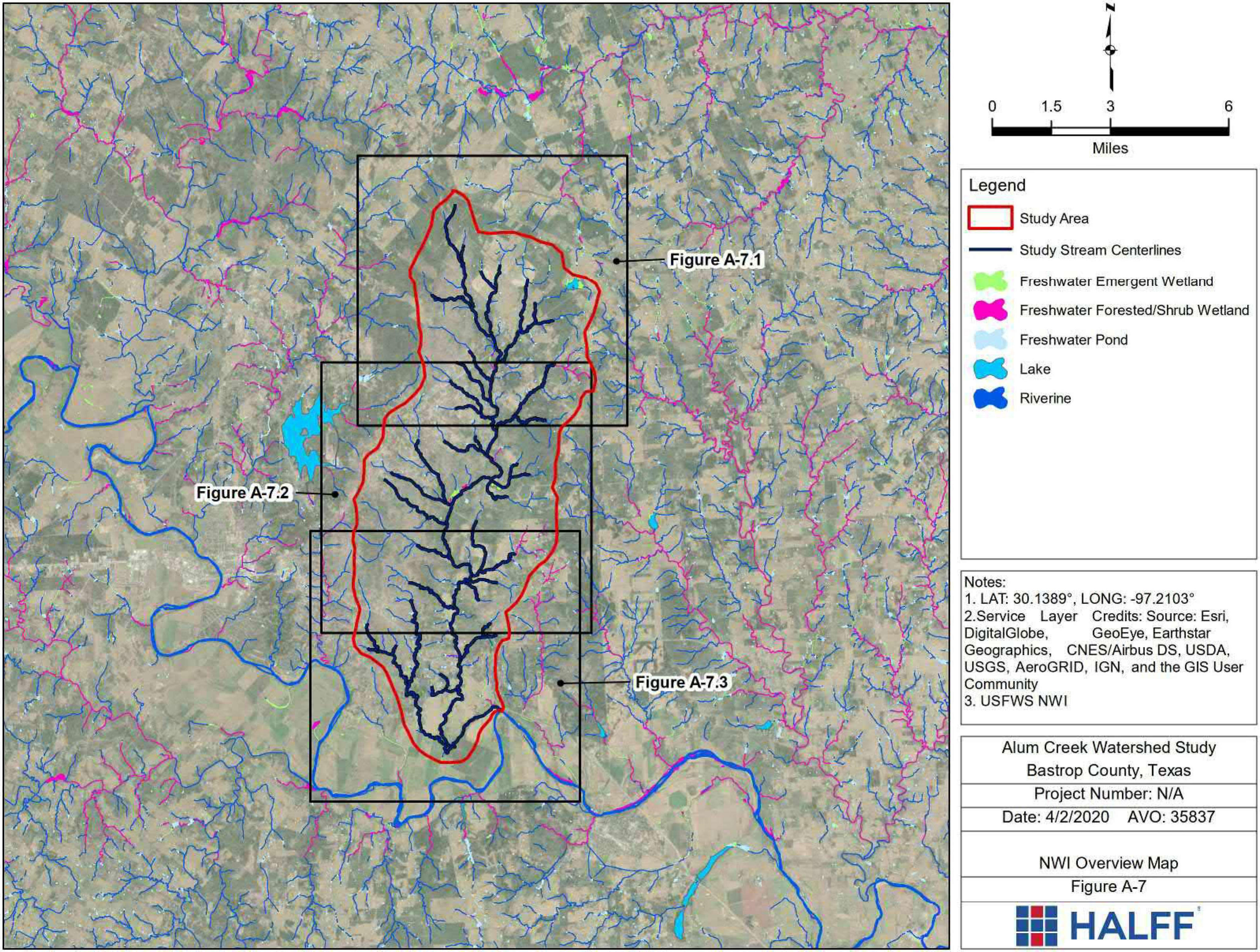
Project Number: N/A

Date: 4/2/2020 AVO: 35837

FEMA National Flood Hazard Layer Map

Figure A-6

HALFF



Notes:
1. LAT: 30.1389°, LONG: -97.2103°
2. Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
3. USFWS NWI

Alum Creek Watershed Study
Bastrop County, Texas

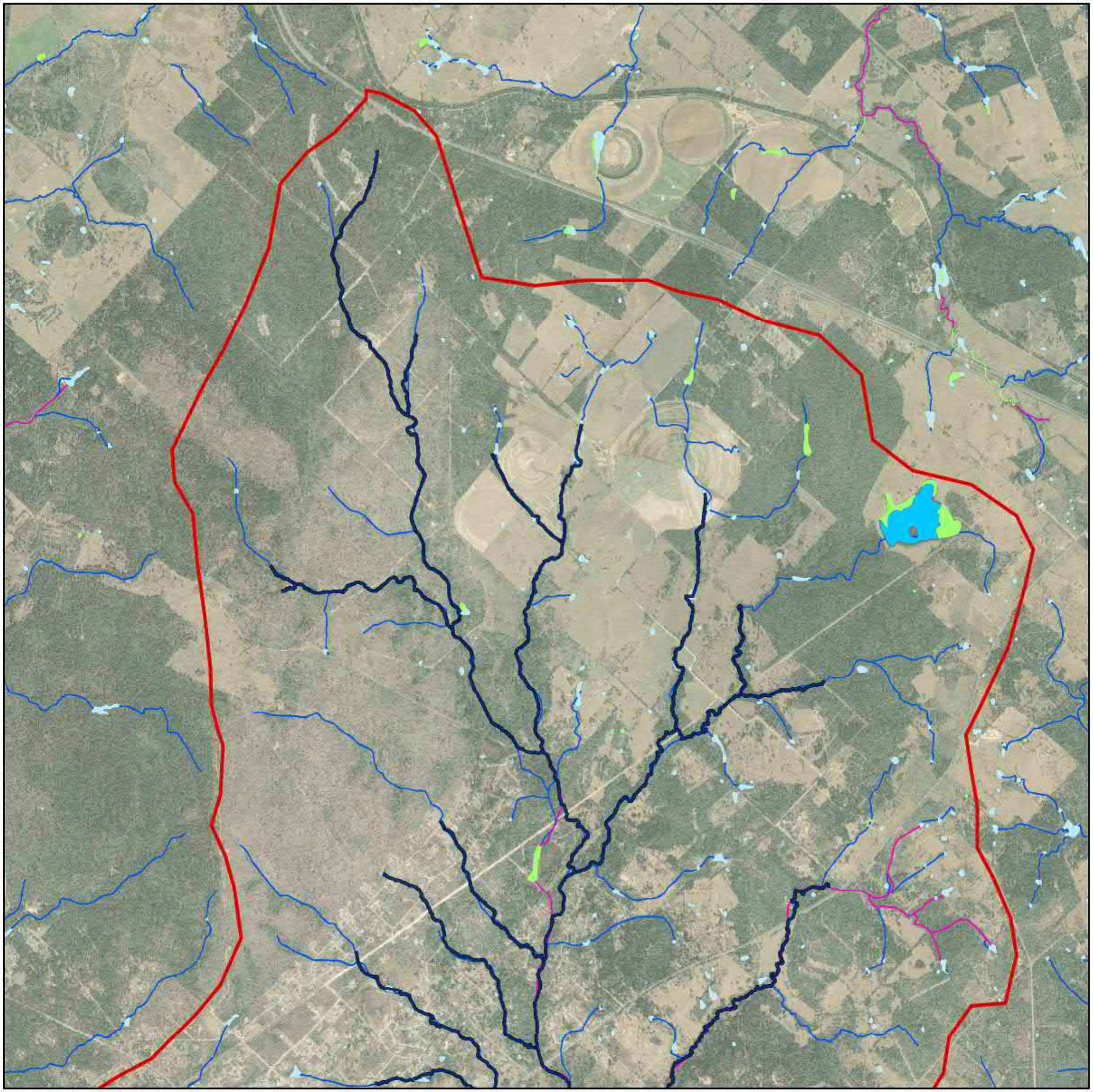
Project Number: N/A

Date: 4/2/2020 AVO: 35837

NWI Overview Map

Figure A-7

HALFF



Notes:
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2. Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
3. USFWS NWI

Alum Creek Watershed Study
Bastrop County, Texas

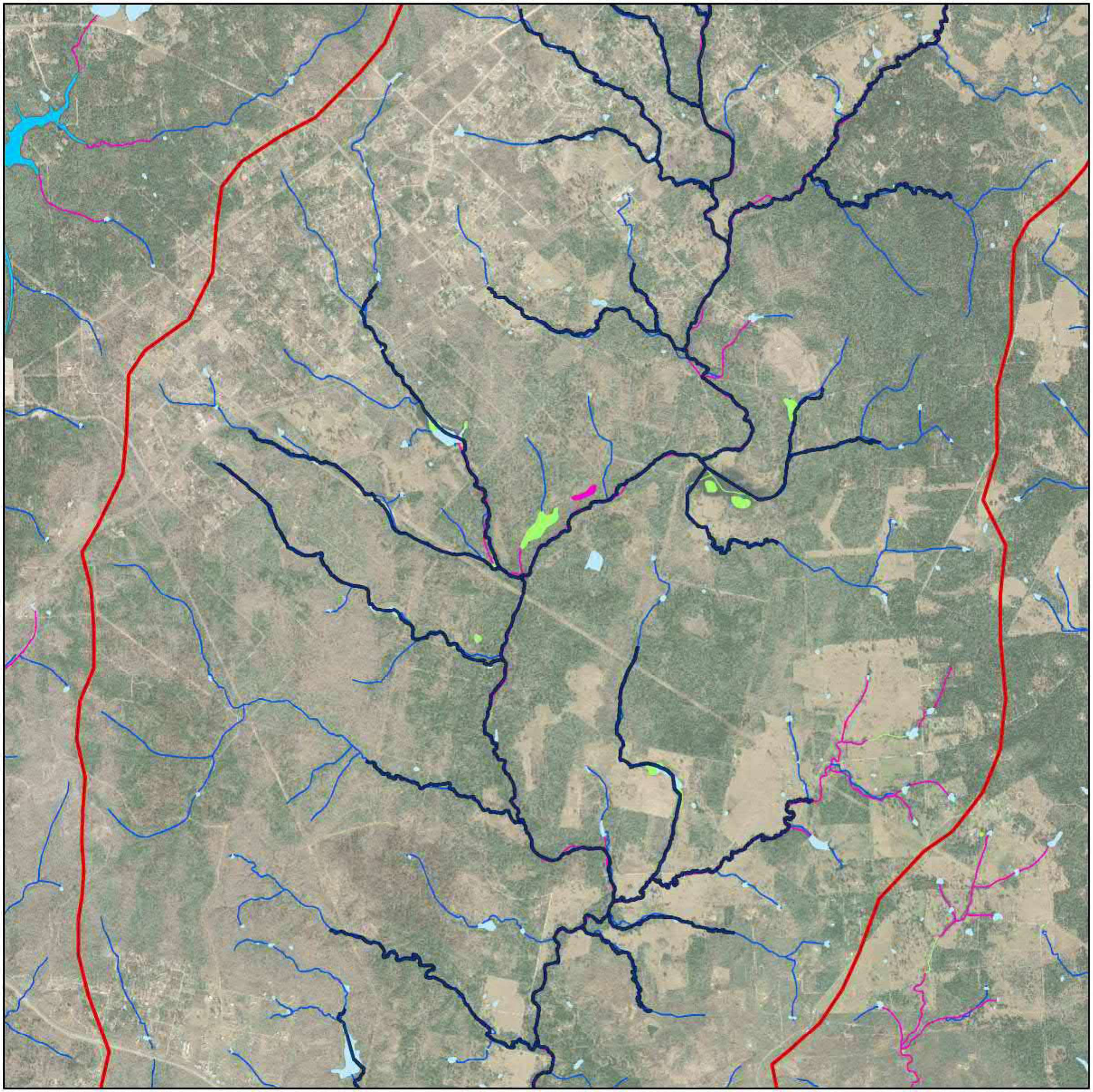
Project Number: N/A

Date: 4/2/2020 AVO: 35837

NWI Map

Figure A-7.1

HALFF



Legend

Study Area

Study Stream Centerlines

Freshwater Emergent Wetland

Freshwater Forested/Shrub Wetland

Freshwater Pond

Lake

Riverine

Notes:
1. LAT: 30.1311°, LONG: -97.2190°
2. Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
3. USFWS NWI

Alum Creek Watershed Study
Bastrop County, Texas

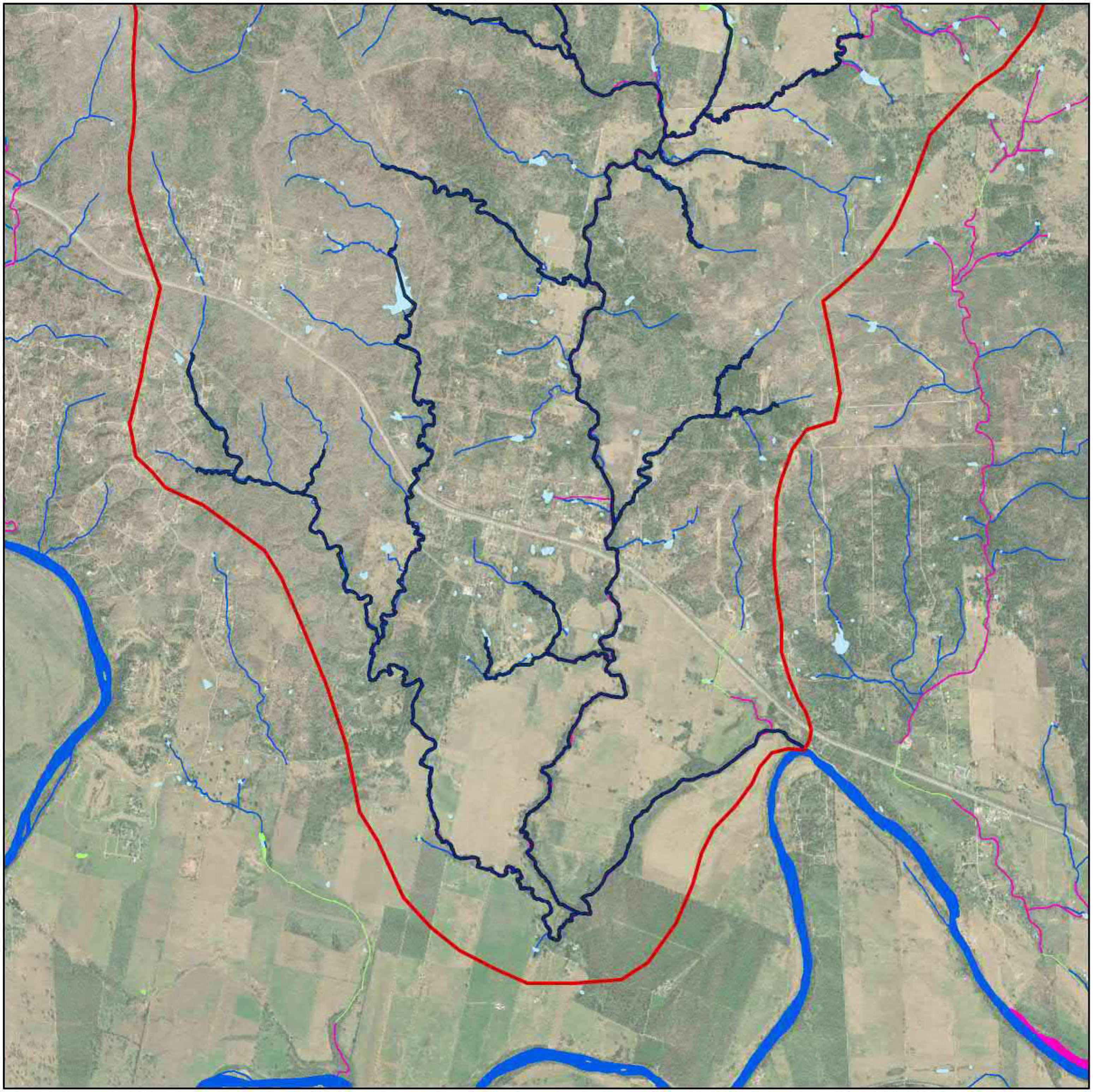
Project Number: N/A

Date: 4/2/2020 AVO: 35837

NWI Map

Figure A-7.2

HALFF



Legend

Study Area

Study Stream Centerlines

Freshwater Emergent Wetland

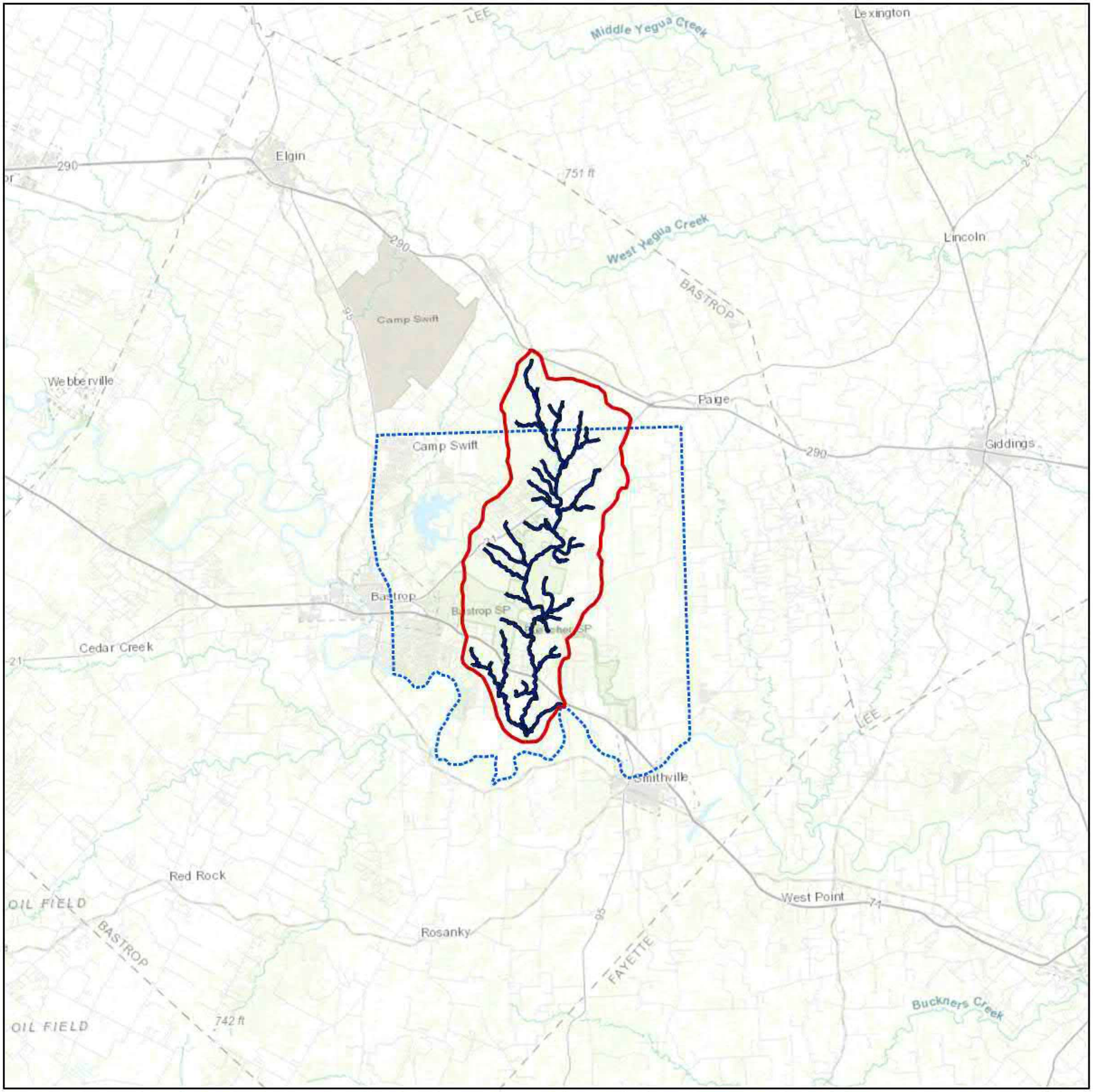
Freshwater Forested/Shrub Wetland

Freshwater Pond

Riverine

Notes:
1. LAT: 30.0693°, LONG: -97.2257°
2. Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
3. USFWS NWI

Alum Creek Watershed Study Bastrop County, Texas
Project Number: N/A
Date: 4/2/2020 AVO: 35837
NWI Map
Figure A-7.3
HALFF



N

0 2.5 5 10

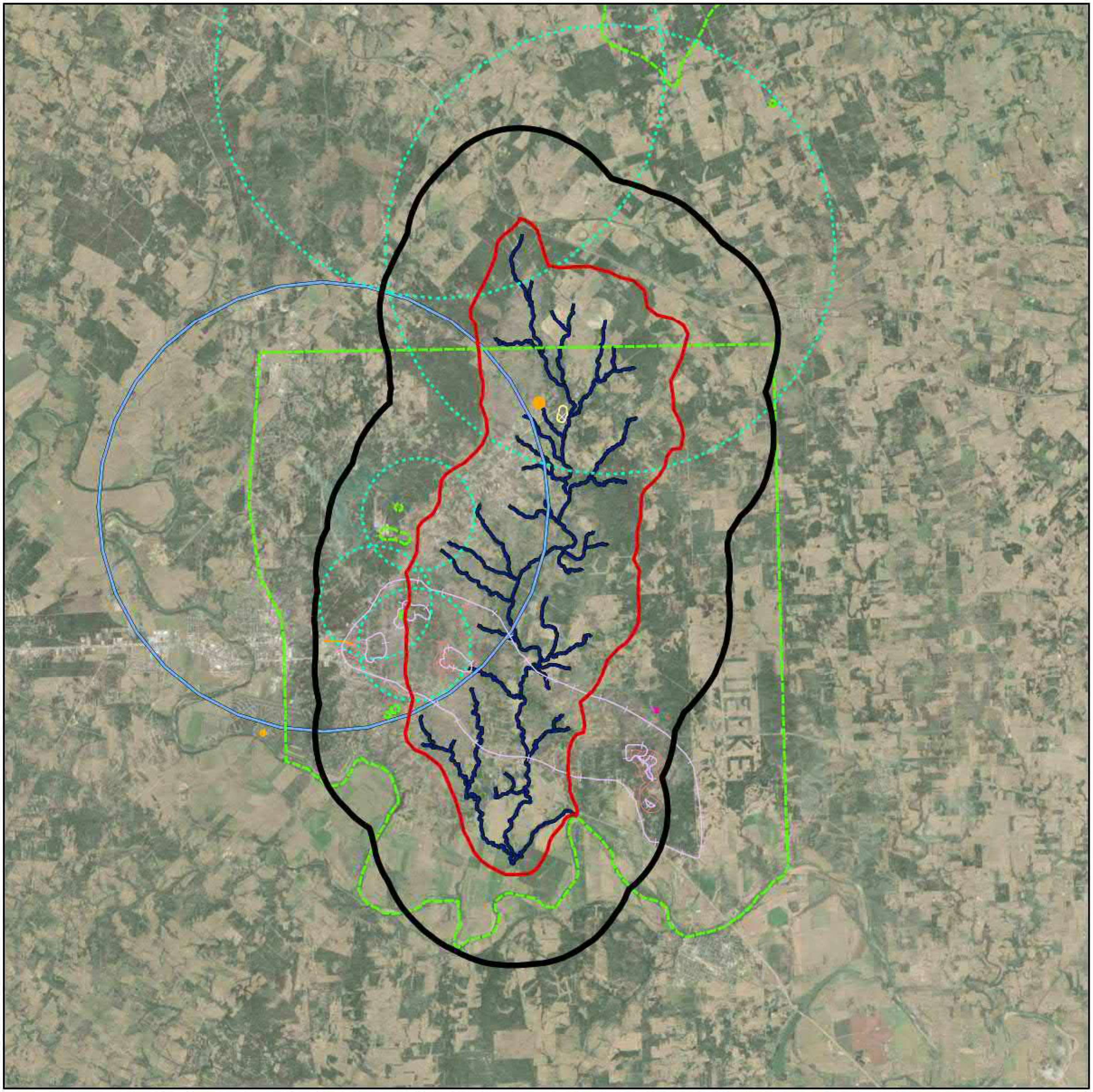
Miles

Legend

- Study Area
- Study Stream Centerlines
- Houston toad Critical Habitat

Notes:
1. LAT: 30.1389°, LONG: -97.2103°
2. Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap

Alum Creek Watershed Study Bastrop County, Texas
Project Number: N/A
Date: 4/2/2020 AVO: 35837
USFWS Critical Habitat Map
Figure A-8
HALFF



Legend

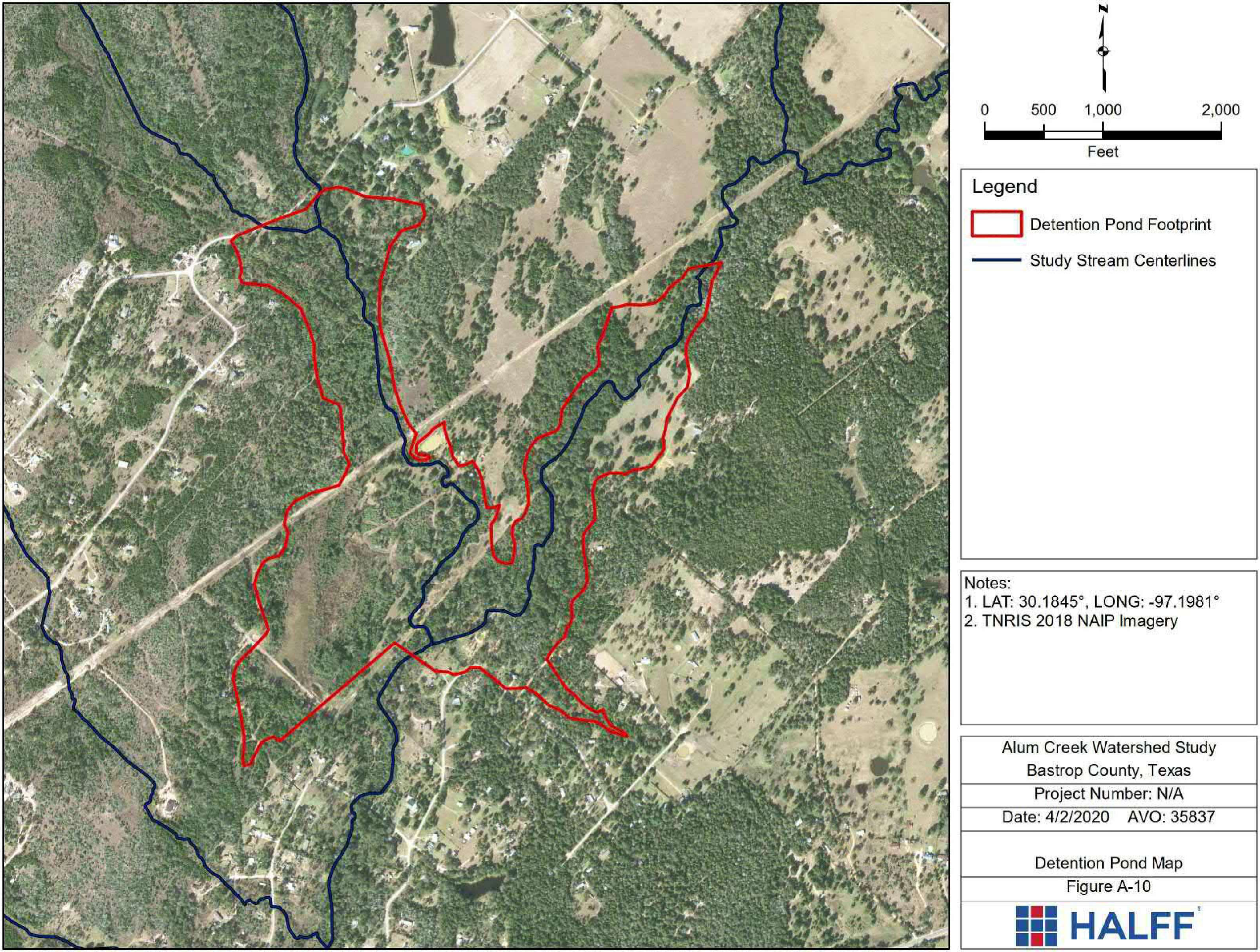
- Study Area
- 2-mile Buffer
- Study Stream Centerlines

TXNDD Element of Occurrences

- Houston toad
- Loblolly Pine-post Oak-blackjack Oak/farkleberry Forest
- Navasota ladies'-tresses
- Sphagnum-beakrush Series
- Texas beebalm
- Texas garter snake
- timber (canebrake) rattlesnake
- Post Oak-blackjack Oak Series

Notes:
1. LAT: 30.1389°, LONG: -97.2103°
2. Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
3. TPWD Texas Natural Diversity Database

Alum Creek Watershed Study Bastrop County, Texas
Project Number: N/A
Date: 4/2/2020 AVO: 35837
TPWD TXNDD Map
Figure A-9
HALFF


N
0
500
1,000
2,000
Feet
Legend
Detention Pond Footprint
Study Stream Centerlines
Notes:
1. LAT: 30.1845°, LONG: -97.1981°
2. TNRIS 2018 NAIP Imagery
Alum Creek Watershed Study
Bastrop County, Texas
Project Number: N/A
Date: 4/2/2020 AVO: 35837
Detention Pond Map
Figure A-10
HALFF

APPENDIX B

GeoSearch Radius Report

GeoSearch
On time. On target. In touch.™

Radius Report

GeoLens by GeoSearch

Target Property:

Alum Creek Watershed Study
County, Texas

Prepared For:

Halff & Associates Houston

Order #: 141849
Job #: 338409
Project #: 35837.001
Date: 02/13/2020

Table of Contents

Disclaimer

This report was designed by GeoSearch to meet or exceed the records search requirements of the All Appropriate Inquiries Rule (40 CFR ï¿½312.26) and the current version of the ASTM International E1527, Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process or, if applicable, the custom requirements requested by the entity that ordered this report. The records and databases of records used to compile this report were collected from various federal,state and local governmental entities. It is the goal of GeoSearch to meet or exceed the 40 CFR ï¿½312.26 and E1527 requirements for updating records by using the best available technology. GeoSearch contacts the appropriate governmental entities on a recurring basis. Depending on the frequency with which a record source or database of records is updated by the governmental entity, the data used to prepare this report may be updated monthly, quarterly, semi-annually, or annually.

The information provided in this report was obtained from a variety of public sources. GeoSearch cannot ensure and makes no warranty or representation as to the accuracy, reliability, quality, errors occurring from data conversion or the customer's interpretation of this report. This report was made by GeoSearch for exclusive use by its clients only. Therefore, this report may not contain sufficient information for other purposes or parties. GeoSearch and its partners, employees, officers And independent contractors cannot be held liable For actual, incidental, consequential, special or exemplary damages suffered by a customer resulting directly or indirectly from any information provided by GeoSearch.

Target Property Summary

Target Property Information

Alum Creek Watershed Study
Texas

Coordinates
Area centroid (-97.198843, 30.1844381)
461 feet above sea level

USGS Quadrangle
Smithville Nw, TX

Geographic Coverage Information

County/Parish: Bastrop (TX)
ZipCode(s):
Bastrop TX: 78602
Mc Dade TX: 78650
Paige TX: 78659

FEDERAL LISTING

Standard Environmental Records

Database	Acronym	Locatable	Unlocatable	Search Radius (miles)
EMERGENCY RESPONSE NOTIFICATION SYSTEM	ERNSTX	0	0	TP/AP
FEDERAL ENGINEERING INSTITUTIONAL CONTROL SITES	EC	0	0	TP/AP
LAND USE CONTROL INFORMATION SYSTEM	LUCIS	0	0	TP/AP
RCRA SITES WITH CONTROLS	RCRASC	0	0	TP/AP
RESOURCE CONSERVATION & RECOVERY ACT - GENERATOR	RCRAGR06	0	0	0.1250
RESOURCE CONSERVATION & RECOVERY ACT - NON-GENERATOR	RCRANGR06	0	0	0.1250
BROWNFIELDS MANAGEMENT SYSTEM	BF	0	0	0.5000
DELISTED NATIONAL PRIORITIES LIST	DNPL	0	0	0.5000
NO LONGER REGULATED RCRA NON-CORRACTS TSD FACILITIES	NLRRCRAT	0	0	0.5000
RESOURCE CONSERVATION & RECOVERY ACT - NON-CORRACTS TREATMENT, STORAGE & DISPOSAL FACILITIES	RCRAT	0	0	0.5000
SUPERFUND ENTERPRISE MANAGEMENT SYSTEM	SEMS	0	0	0.5000
SUPERFUND ENTERPRISE MANAGEMENT SYSTEM ARCHIVED SITE INVENTORY	SEMSARCH	0	0	0.5000
NATIONAL PRIORITIES LIST	NPL	0	0	1.0000
NO LONGER REGULATED RCRA CORRECTIVE ACTION FACILITIES	NLRRCRAC	0	0	1.0000
PROPOSED NATIONAL PRIORITIES LIST	PNPL	0	0	1.0000
RESOURCE CONSERVATION & RECOVERY ACT - CORRECTIVE ACTION FACILITIES	RCRAC	0	0	1.0000
RESOURCE CONSERVATION & RECOVERY ACT - SUBJECT TO CORRECTIVE ACTION FACILITIES	RCRASUBC	0	0	1.0000
SUB-TOTAL		0	0	

Additional Environmental Records

Database	Acronym	Locatable	Unlocatable	Search Radius (miles)
AEROMETRIC INFORMATION RETRIEVAL SYSTEM / AIR FACILITY SUBSYSTEM	AIRSAFS	0	0	TP/AP
BIENNIAL REPORTING SYSTEM	BRS	0	0	TP/AP
CERCLIS LIENS	SFLIENS	0	0	TP/AP
CLANDESTINE DRUG LABORATORY LOCATIONS	CDL	0	0	TP/AP
EPA DOCKET DATA	DOCKETS	0	0	TP/AP
ENFORCEMENT AND COMPLIANCE HISTORY INFORMATION	ECHOR06	0	0	TP/AP
FACILITY REGISTRY SYSTEM	FRSTX	0	1	TP/AP

Database Summary

Database	Acronym	Locatable	Unlocatable	Search Radius (miles)
HAZARDOUS MATERIALS INCIDENT REPORTING SYSTEM	HMIRSR06	0	0	TP/AP
INTEGRATED COMPLIANCE INFORMATION SYSTEM (FORMERLY DOCKETS)	ICIS	0	0	TP/AP
INTEGRATED COMPLIANCE INFORMATION SYSTEM NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM	ICISNPDES	0	0	TP/AP
MATERIAL LICENSING TRACKING SYSTEM	MLTS	0	0	TP/AP
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM	NPDESR06	0	0	TP/AP
PCB ACTIVITY DATABASE SYSTEM	PADS	0	0	TP/AP
PERMIT COMPLIANCE SYSTEM	PCSR06	0	0	TP/AP
SEMS LIEN ON PROPERTY	SEMSLIENS	0	0	TP/AP
SECTION SEVEN TRACKING SYSTEM	SSTS	0	0	TP/AP
TOXIC SUBSTANCE CONTROL ACT INVENTORY	TSCA	0	0	TP/AP
TOXICS RELEASE INVENTORY	TRI	0	0	TP/AP
ALTERNATIVE FUELING STATIONS	ALTFUELS	0	0	0.2500
FEMA OWNED STORAGE TANKS	FEMAUST	0	0	0.2500
HISTORICAL GAS STATIONS	HISTPST	0	0	0.2500
INTEGRATED COMPLIANCE INFORMATION SYSTEM DRYCLEANERS	ICISCLEANERS	0	0	0.2500
MINE SAFETY AND HEALTH ADMINISTRATION MASTER INDEX FILE	MSHA	0	0	0.2500
MINERAL RESOURCE DATA SYSTEM	MRDS	0	0	0.2500
OPEN DUMP INVENTORY	ODI	0	0	0.5000
SURFACE MINING CONTROL AND RECLAMATION ACT SITES	SMCRA	0	0	0.5000
URANIUM MILL TAILINGS RADIATION CONTROL ACT SITES	USUMTRCA	0	0	0.5000
DEPARTMENT OF DEFENSE SITES	DOD	0	0	1.0000
FORMER MILITARY NIKE MISSILE SITES	NMS	0	0	1.0000
FORMERLY USED DEFENSE SITES	FUDS	0	0	1.0000
FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM	FUSRAP	0	0	1.0000
RECORD OF DECISION SYSTEM	RODS	0	0	1.0000

SUB-TOTAL		0	1	

Database Summary

STATE (TX) LISTING

Standard Environmental Records

Database	Acronym	Locatable	Unlocatable	Search Radius (miles)
STATE INSTITUTIONAL/ENGINEERING CONTROL SITES	SIEC01	0	0	TP/AP
PETROLEUM STORAGE TANKS	PST	0	0	0.2500
BROWNFIELDS SITE ASSESSMENTS	BSA	0	0	0.5000
CLOSED & ABANDONED LANDFILL INVENTORY	CALF	0	0	0.5000
LEAKING PETROLEUM STORAGE TANKS	LPST	0	0	0.5000
MUNICIPAL SOLID WASTE LANDFILL SITES	MSWLF	0	0	0.5000
RAILROAD COMMISSION VCP AND BROWNFIELD SITES	RRCVCP	0	0	0.5000
VOLUNTARY CLEANUP PROGRAM SITES	VCP	0	0	0.5000
STATE SUPERFUND SITES	SF	0	0	1.0000
SUB-TOTAL		0	0	

Additional Environmental Records

Database	Acronym	Locatable	Unlocatable	Search Radius (miles)
GROUNDWATER CONTAMINATION CASES	GWCC	0	0	TP/AP
HISTORIC GROUNDWATER CONTAMINATION CASES	HISTGWCC	0	0	TP/AP
LAND APPLICATION PERMITS	LANDAPP	0	0	TP/AP
MUNICIPAL SETTING DESIGNATIONS	MSD	0	0	TP/AP
NOTICE OF VIOLATIONS	NOV	0	0	TP/AP
SPILLS LISTING	SPILLS	0	0	TP/AP
TCEQ LIENS	LIENS	0	0	TP/AP
TIER I I CHEMICAL REPORTING PROGRAM FACILITIES	TIERII	0	0	TP/AP
DRY CLEANER REGISTRATION DATABASE	DCR	0	0	0.2500
INDUSTRIAL AND HAZARDOUS WASTE SITES	IHW	0	0	0.2500
PERMITTED INDUSTRIAL HAZARDOUS WASTE SITES	PIHW	0	0	0.2500
AFFECTED PROPERTY ASSESSMENT REPORTS	APAR	0	0	0.5000
DRY CLEANER REMEDIATION PROGRAM SITES	DCRPS	0	0	0.5000
INNOCENT OWNER / OPERATOR DATABASE	IOP	0	0	0.5000
RADIOACTIVE WASTE SITES	RWS	0	0	0.5000
RECYCLING FACILITIES	WMRF	0	0	0.5000
SALT CAVERNS FOR PETROLEUM STORAGE	STCV	0	0	0.5000
INDUSTRIAL AND HAZARDOUS WASTE CORRECTIVE ACTION SITES	IHWCA	0	0	1.0000

Database Summary

SUB-TOTAL		0	0	

TRIBAL LISTING

Standard Environmental Records

Database	Acronym	Locatable	Unlocatable	Search Radius (miles)
UNDERGROUND STORAGE TANKS ON TRIBAL LANDS	USTR06	0	0	0.2500
LEAKING UNDERGROUND STORAGE TANKS ON TRIBAL LANDS	LUSTR06	0	0	0.5000
OPEN DUMP INVENTORY ON TRIBAL LANDS	ODINDIAN	0	0	0.5000
SUB-TOTAL		0	0	

Additional Environmental Records

Database	Acronym	Locatable	Unlocatable	Search Radius (miles)
INDIAN RESERVATIONS	INDIANRES	0	0	1.0000
SUB-TOTAL		0	0	

TOTAL		0	1	

Database Radius Summary

FEDERAL LISTING

Standard environmental records are displayed in ***bold****.*

Acronym	Search Radius (miles)	TP/AP (0 - 0.02)	1/8 Mile (> TP/AP)	1/4 Mile (> 1/8)	1/2 Mile (> 1/4)	1 Mile (> 1/2)	> 1 Mile	Total
AIRSAFS	0.0200	0	NS	NS	NS	NS	NS	0
BRS	0.0200	0	NS	NS	NS	NS	NS	0
CDL	0.0200	0	NS	NS	NS	NS	NS	0
DOCKETS	0.0200	0	NS	NS	NS	NS	NS	0
EC	**0.0200**	**0**	**NS**	**NS**	**NS**	**NS**	**NS**	**0**
ECHOR06	0.0200	0	NS	NS	NS	NS	NS	0
ERNSTX	**0.0200**	**0**	**NS**	**NS**	**NS**	**NS**	**NS**	**0**
FRSTX	0.0200	0	NS	NS	NS	NS	NS	0
HMIRSR06	0.0200	0	NS	NS	NS	NS	NS	0
ICIS	0.0200	0	NS	NS	NS	NS	NS	0
ICISNPDES	0.0200	0	NS	NS	NS	NS	NS	0
LUCIS	**0.0200**	**0**	**NS**	**NS**	**NS**	**NS**	**NS**	**0**
MLTS	0.0200	0	NS	NS	NS	NS	NS	0
NPDESR06	0.0200	0	NS	NS	NS	NS	NS	0
PADS	0.0200	0	NS	NS	NS	NS	NS	0
PCSR06	0.0200	0	NS	NS	NS	NS	NS	0
RCRASC	**0.0200**	**0**	**NS**	**NS**	**NS**	**NS**	**NS**	**0**
SEMSLIENS	0.0200	0	NS	NS	NS	NS	NS	0
SFLIENS	0.0200	0	NS	NS	NS	NS	NS	0
SSTS	0.0200	0	NS	NS	NS	NS	NS	0
TRI	0.0200	0	NS	NS	NS	NS	NS	0
TSCA	0.0200	0	NS	NS	NS	NS	NS	0
RCRAGR06	**0.1250**	**0**	**0**	**NS**	**NS**	**NS**	**NS**	**0**
RCRANGR06	**0.1250**	**0**	**0**	**NS**	**NS**	**NS**	**NS**	**0**
ALTFUELS	0.2500	0	0	0	NS	NS	NS	0
FEMAUST	0.2500	0	0	0	NS	NS	NS	0
HISTPST	0.2500	0	0	0	NS	NS	NS	0
ICISCLEANERS	0.2500	0	0	0	NS	NS	NS	0
MRDS	0.2500	0	0	0	NS	NS	NS	0
MSHA	0.2500	0	0	0	NS	NS	NS	0
BF	**0.5000**	**0**	**0**	**0**	**0**	**NS**	**NS**	**0**
DNPL	**0.5000**	**0**	**0**	**0**	**0**	**NS**	**NS**	**0**
NLRRCRAT	**0.5000**	**0**	**0**	**0**	**0**	**NS**	**NS**	**0**
ODI	0.5000	0	0	0	0	NS	NS	0
RCRAT	**0.5000**	**0**	**0**	**0**	**0**	**NS**	**NS**	**0**

Database Radius Summary

Acronym	Search Radius (miles)	TP/AP (0 - 0.02)	1/8 Mile (> TP/AP)	1/4 Mile (> 1/8)	1/2 Mile (> 1/4)	1 Mile (> 1/2)	> 1 Mile	Total
SEMS	**0.5000**	**0**	**0**	**0**	**0**	**NS**	**NS**	**0**
SEMSARCH	**0.5000**	**0**	**0**	**0**	**0**	**NS**	**NS**	**0**
SMCRA	0.5000	0	0	0	0	NS	NS	0
USUMTRCA	0.5000	0	0	0	0	NS	NS	0
DOD	1.0000	0	0	0	0	0	NS	0
FUDS	1.0000	0	0	0	0	0	NS	0
FUSRAP	1.0000	0	0	0	0	0	NS	0
NLRRCRAC	**1.0000**	**0**	**0**	**0**	**0**	**0**	**NS**	**0**
NMS	1.0000	0	0	0	0	0	NS	0
NPL	**1.0000**	**0**	**0**	**0**	**0**	**0**	**NS**	**0**
PNPL	**1.0000**	**0**	**0**	**0**	**0**	**0**	**NS**	**0**
RCRAC	**1.0000**	**0**	**0**	**0**	**0**	**0**	**NS**	**0**
RCRASUBC	**1.0000**	**0**	**0**	**0**	**0**	**0**	**NS**	**0**
RODS	1.0000	0	0	0	0	0	NS	0
SUB-TOTAL		0	0	0	0	0	0	0

Database Radius Summary

STATE (TX) LISTING

Standard environmental records are displayed in ***bold***.

Acronym	Search Radius (miles)	TP/AP (0 - 0.02)	1/8 Mile (> TP/AP)	1/4 Mile (> 1/8)	1/2 Mile (> 1/4)	1 Mile (> 1/2)	> 1 Mile	Total
GWCC	0.0200	0	NS	NS	NS	NS	NS	0
HISTGWCC	0.0200	0	NS	NS	NS	NS	NS	0
LANDAPP	0.0200	0	NS	NS	NS	NS	NS	0
LIENS	0.0200	0	NS	NS	NS	NS	NS	0
MSD	0.0200	0	NS	NS	NS	NS	NS	0
NOV	0.0200	0	NS	NS	NS	NS	NS	0
SIEC01	**0.0200**	**0**	**NS**	**NS**	**NS**	**NS**	**NS**	**0**
SPILLS	0.0200	0	NS	NS	NS	NS	NS	0
TIERII	0.0200	0	NS	NS	NS	NS	NS	0
DCR	0.2500	0	0	0	NS	NS	NS	0
IHW	0.2500	0	0	0	NS	NS	NS	0
PIHW	0.2500	0	0	0	NS	NS	NS	0
PST	**0.2500**	**0**	**0**	**0**	**NS**	**NS**	**NS**	**0**
APAR	0.5000	0	0	0	0	NS	NS	0
BSA	**0.5000**	**0**	**0**	**0**	**0**	**NS**	**NS**	**0**
CALF	**0.5000**	**0**	**0**	**0**	**0**	**NS**	**NS**	**0**
DCRPS	0.5000	0	0	0	0	NS	NS	0
IOP	0.5000	0	0	0	0	NS	NS	0
LPST	**0.5000**	**0**	**0**	**0**	**0**	**NS**	**NS**	**0**
MSWLF	**0.5000**	**0**	**0**	**0**	**0**	**NS**	**NS**	**0**
RRCVCP	**0.5000**	**0**	**0**	**0**	**0**	**NS**	**NS**	**0**
RWS	0.5000	0	0	0	0	NS	NS	0
STCV	0.5000	0	0	0	0	NS	NS	0
VCP	**0.5000**	**0**	**0**	**0**	**0**	**NS**	**NS**	**0**
WMRF	0.5000	0	0	0	0	NS	NS	0
IHWCA	1.0000	0	0	0	0	0	NS	0
SF	**1.0000**	**0**	**0**	**0**	**0**	**0**	**NS**	**0**
SUB-TOTAL		0	0	0	0	0	0	0

TRIBAL LISTING

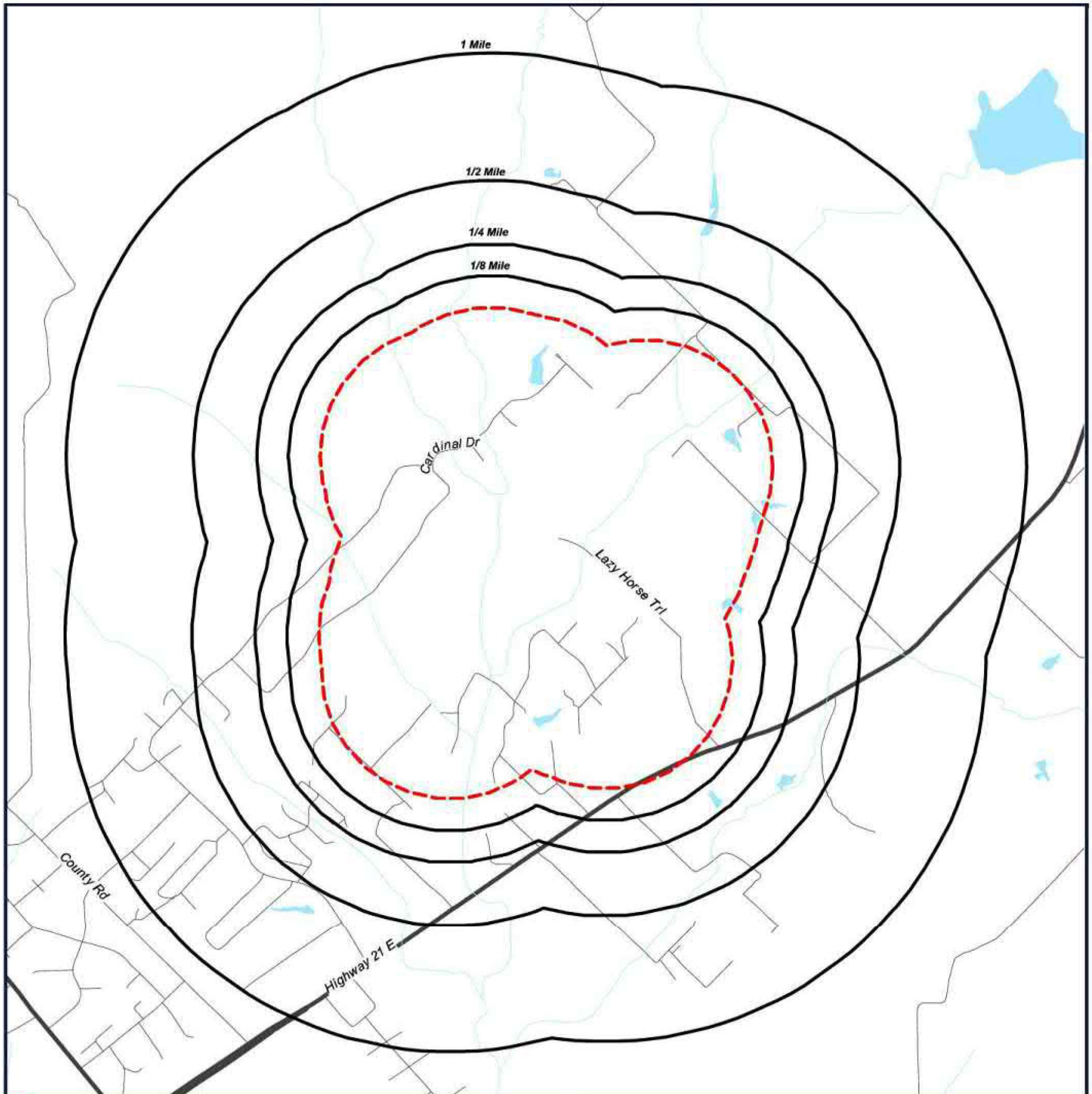
*Standard environmental records are displayed in **bold**.*

Acronym	Search Radius (miles)	TP/AP (0 - 0.02)	1/8 Mile (> TP/AP)	1/4 Mile (> 1/8)	1/2 Mile (> 1/4)	1 Mile (> 1/2)	> 1 Mile	Total
USTR06	**0.2500**	**0**	**0**	**0**	**NS**	**NS**	**NS**	**0**
LUSTR06	**0.5000**	**0**	**0**	**0**	**0**	**NS**	**NS**	**0**
ODINDIAN	**0.5000**	**0**	**0**	**0**	**0**	**NS**	**NS**	**0**
INDIANRES	1.0000	0	0	0	0	0	NS	0
SUB-TOTAL		0	0	0	0	0	0	0

TOTAL		0	0	0	0	0	0	0

NOTES:
NS = NOT SEARCHED
TP/AP = TARGET PROPERTY/ADJACENT PROPERTY

Radius Map 1



Target Property (TP)

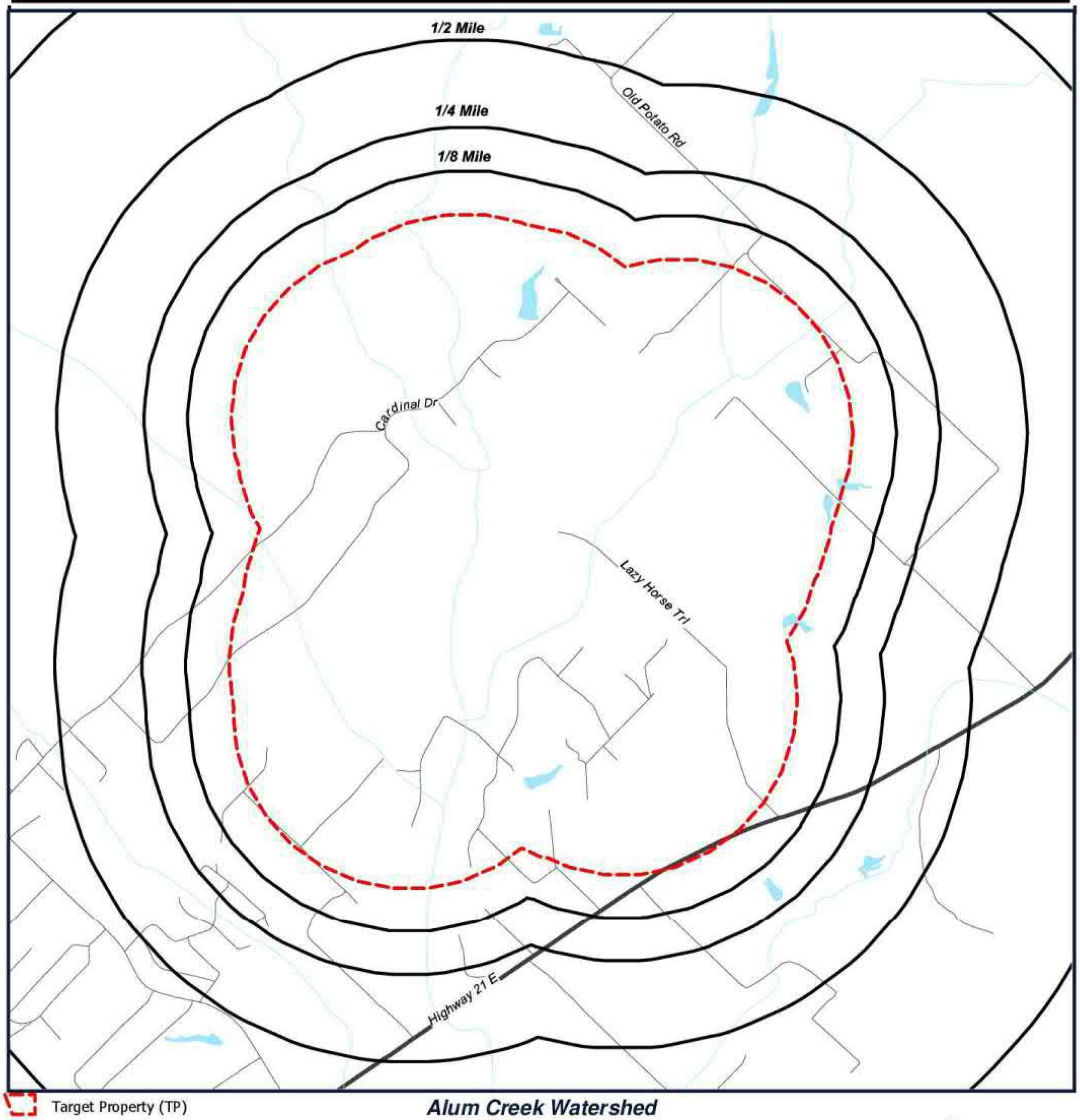
Alum Creek Watershed
Study
County, Texas

N
W E
S

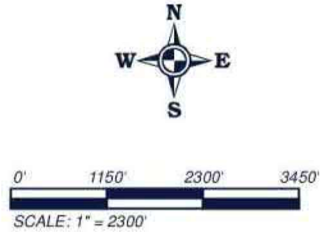
0' 1600' 3200' 4800'
SCALE: 1" = 3200'

[Click here to access Satellite view]

Radius Map 2

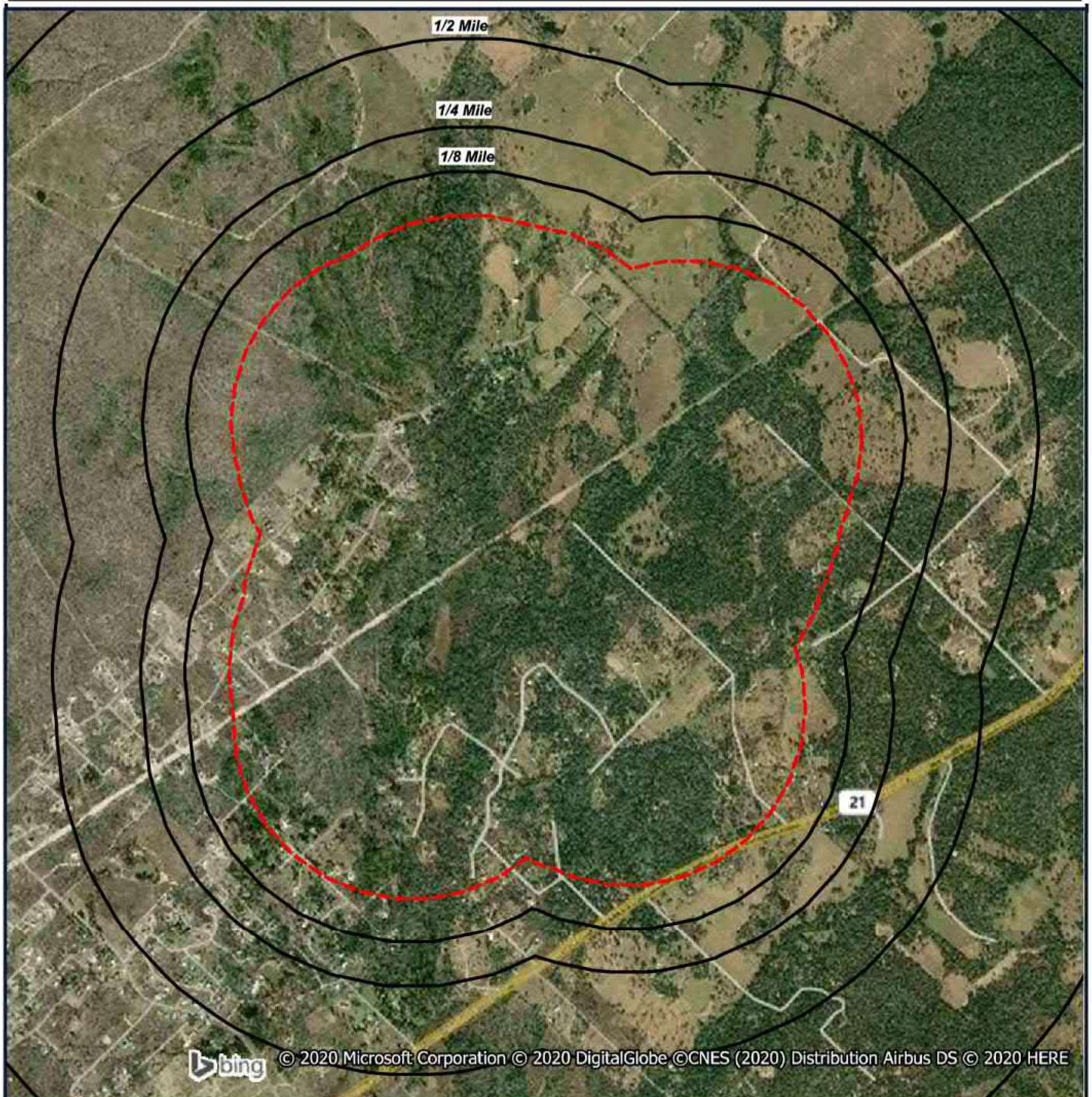


Alum Creek Watershed Study County, Texas



[Click here to access Satellite view]

Ortho Map



Target Property (TP)

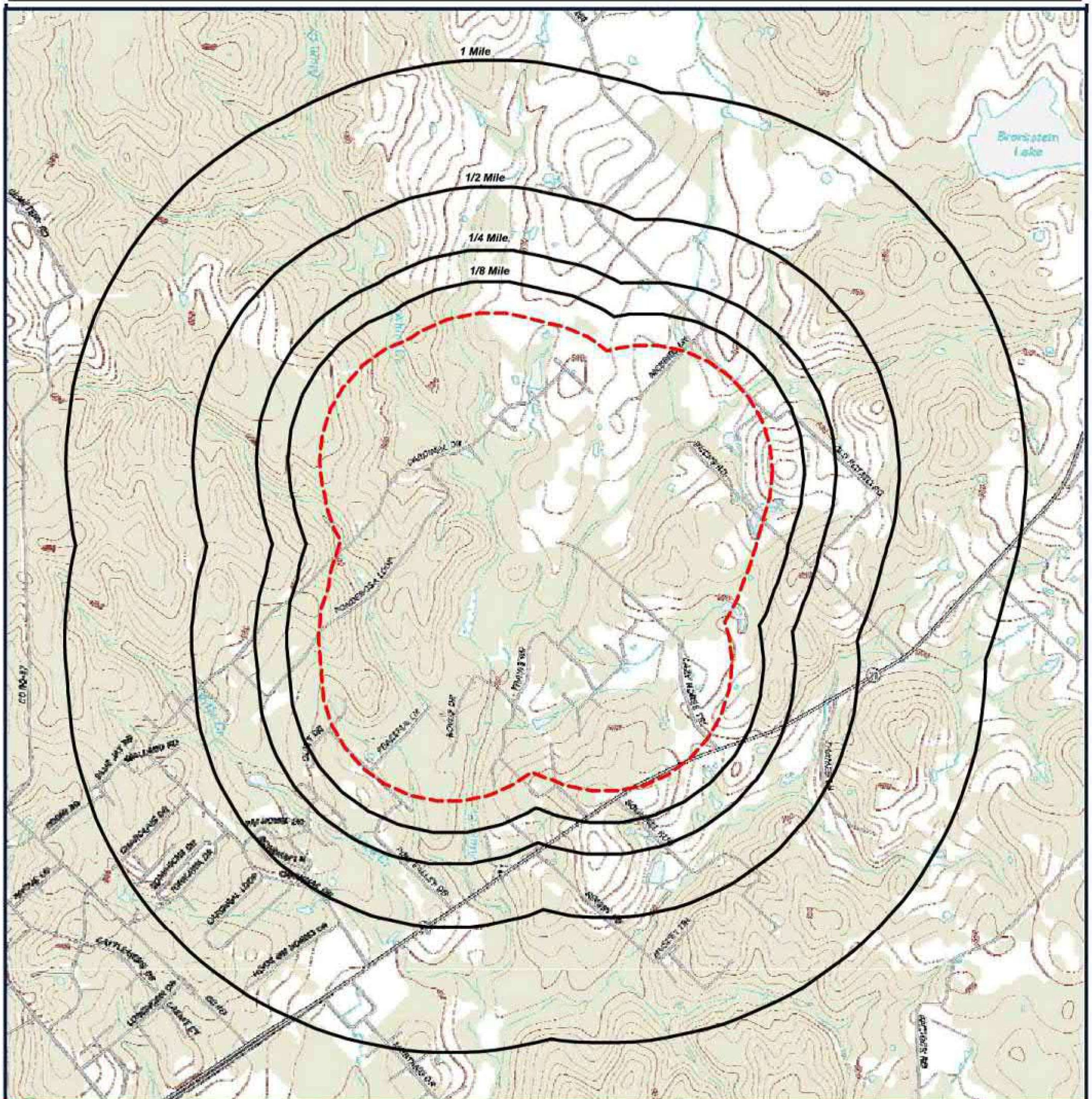
Quadrangle(s):
Smithville Nw
Alum Creek Watershed Study
County, Texas

N W E S

0' 1150' 2300' 3450'
SCALE: 1" = 2300'

Click here to access Satellite view

Topographic Map



Target Property (TP)

Quadrangle(s):
Smithville Nw
Source: USGS,
12/20/2012
Alum Creek Watershed
Study
County, Texas

N
W E
S

0' 1600' 3200' 4800'
SCALE: 1" = 3200'

[Click here to access Satellite view]

Located Sites Summary

No Records Found.

Elevation Summary

Elevations are collected from the USGS 3D Elevation Program 1/3 arc-second (approximately 10 meters) layer hosted at the NGTOC. .

Target Property Elevation: 461 ft.

*NOTE: Standard environmental records are displayed in **bold**.*

No Records Found.

Unlocated Sites Summary

This list contains sites that could not be mapped due to limited or incomplete address information.

Database Name	Site ID#	Site Name	Address	City/State/Zip/County
FRSTX	110070281980	BURLIN POWER LINE, LLC	HWY 21	PAIGE 78659 Bastrop

AIRSAFS Aerometric Information Retrieval System / Air Facility Subsystem

VERSION DATE: 10/20/14

The United States Environmental Protection Agency (EPA) modified the Aerometric Information Retrieval System (AIRS) to a database that exclusively tracks the compliance of stationary sources of air pollution with EPA regulations: the Air Facility Subsystem (AFS). Since this change in 2001, the management of the AIRS/AFS database was assigned to EPA's Office of Enforcement and Compliance Assurance.

BRS Biennial Reporting System

VERSION DATE: 12/31/15

The United States Environmental Protection Agency (EPA), in cooperation with the States, biennially collects information regarding the generation, management, and final disposition of hazardous wastes regulated under the Resource Conservation and Recovery Act of 1976 (RCRA), as amended. The Biennial Report captures detailed data on the generation of hazardous waste from large quantity generators and data on waste management practices from treatment, storage and disposal facilities. Currently, the EPA states that data collected between 1991 and 1997 was originally a part of the defunct Biennial Reporting System and is now incorporated into the RCRAInfo data system.

CDL Clandestine Drug Laboratory Locations

VERSION DATE: 11/26/19

The U.S. Department of Justice ("the Department") provides this information as a public service. It contains addresses of some locations where law enforcement agencies reported they found chemicals or other items that indicated the presence of either clandestine drug laboratories or dumpsites. In most cases, the source of the entries is not the Department, and the Department has not verified the entry and does not guarantee its accuracy. Members of the public must verify the accuracy of all entries by, for example, contacting local law enforcement and local health departments. The Department does not establish, implement, enforce, or certify compliance with clean-up or remediation standards for contaminated sites; the public should contact a state or local health department or environmental protection agency for that information.

DOCKETS EPA Docket Data

VERSION DATE: 12/22/05

The United States Environmental Protection Agency Docket data lists Civil Case Defendants, filing dates as far back as 1971, laws broken including section, violations that occurred, pollutants involved, penalties assessed and superfund awards by facility and location. Please refer to ICIS database as source of current data.

EC Federal Engineering Institutional Control Sites

VERSION DATE: 12/19/19

This database includes site locations where Engineering and/or Institutional Controls have been identified as part of a selected remedy for the site as defined by United States Environmental Protection Agency official remedy decision documents. The data displays remedy component information for Superfund decision documents issued in fiscal years 1982-2017, and it includes final and deleted NPL sites as well as sites with a Superfund Alternative Approach (SAA) agreement in place. The only sites included that are not on the NPL, proposed for NPL, or removed from proposed NPL, are those with an SAA Agreement in place. A site listing does not indicate that the institutional and engineering controls are currently in place nor will be in place once the remedy is complete; it only indicates that the decision to include either of them in the remedy is documented as of the completed date of the document. Institutional controls are actions, such as legal controls, that help minimize the potential for human exposure to contamination by ensuring appropriate land or resource use. Engineering controls include caps, barriers, or other device engineering to prevent access, exposure, or continued migration of contamination.

ECHOR06 Enforcement and Compliance History Information

VERSION DATE: 10/27/19

The U.S. Environmental Protection Agency's Enforcement and Compliance History Online (ECHO) database, provides compliance and enforcement information for facilities nationwide. This database includes facilities regulated as Clean Air Act stationary sources, Clean Water Act direct dischargers, Resource Conservation and Recovery Act hazardous waste handlers, Safe Drinking Water Act public water systems along with other data, such as Toxics Release Inventory releases.

ERNSTX Emergency Response Notification System

VERSION DATE: 10/06/19

This National Response Center database contains data on reported releases of oil, chemical, radiological, biological, and/or etiological discharges into the environment anywhere in the United States and its territories. The data comes from spill reports made to the U.S. Environmental Protection Agency, U.S. Coast Guard, the National Response Center and/or the U.S. Department of Transportation.

FRSTX Facility Registry System

VERSION DATE: 10/09/19

The United States Environmental Protection Agency's Office of Environmental Information (OEI) developed the Facility Registry System (FRS) as the centrally managed database that identifies facilities, sites or places subject to environmental regulations or of environmental interest. The Facility Registry System replaced the Facility Index System or FINDS database.

HMIRSR06 Hazardous Materials Incident Reporting System

VERSION DATE: 11/20/19

The HMIRS database contains unintentional hazardous materials release information reported to the U.S. Department of Transportation located in EPA Region 6. This region includes the following states: Arkansas, Louisiana, New Mexico, Oklahoma, and Texas.

ICIS Integrated Compliance Information System (formerly DOCKETS)

VERSION DATE: 09/21/19

ICIS is a case activity tracking and management system for civil, judicial, and administrative federal Environmental Protection Agency enforcement cases. ICIS contains information on federal administrative and federal judicial cases under the following environmental statutes: the Clean Air Act, the Clean Water Act, the Resource Conservation and Recovery Act, the Emergency Planning and Community Right-to-Know Act - Section 313, the Toxic Substances Control Act, the Federal Insecticide, Fungicide, and Rodenticide Act, the Comprehensive Environmental Response, Compensation, and Liability Act, the Safe Drinking Water Act, and the Marine Protection, Research, and Sanctuaries Act.

ICISNPDES Integrated Compliance Information System National Pollutant Discharge Elimination System

VERSION DATE: 07/09/17

Authorized by the Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. This database is provided by the U.S. Environmental Protection Agency.

LUCIS Land Use Control Information System

VERSION DATE: 09/01/06

The LUCIS database is maintained by the U.S. Department of the Navy and contains information for former Base Realignment and Closure (BRAC) properties across the United States.

MLTS Material Licensing Tracking System

VERSION DATE: 06/29/17

MLTS is a list of approximately 8,100 sites which have or use radioactive materials subject to the United States Nuclear Regulatory Commission (NRC) licensing requirements. Disclaimer: Due to agency regulations and policies, this database contains applicant/licensee location information which may or may not be related to the physical location per MLTS site.

NPDESR06 National Pollutant Discharge Elimination System

VERSION DATE: 04/01/07

Authorized by the Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. The NPDES database was collected from the U.S. Environmental Protection Agency (EPA) from December 2002 through April 2007. Refer to the PCS and/or ICIS-NPDES database as source of current data. This database includes permitted facilities located in EPA Region 6. This region includes the following states: Arkansas, Louisiana, New Mexico, Oklahoma, and Texas.

PADS PCB Activity Database System

VERSION DATE: 09/14/18

PADS Identifies generators, transporters, commercial storers and/or brokers and disposers of Polychlorinated Biphenyls (PCB) who are required to notify the U.S. Environmental Protection Agency of such activities.

PCSR06 Permit Compliance System

VERSION DATE: 08/01/12

The Permit Compliance System is used in tracking enforcement status and permit compliance of facilities controlled by the National Pollutant Discharge Elimination System (NPDES) under the Clean Water Act and is maintained by the United States Environmental Protection Agency's Office of Compliance. PCS is designed to support the NPDES program at the state, regional, and national levels. This database includes permitted facilities located in EPA Region 6. This region includes the following states: Arkansas, Louisiana, New Mexico, Oklahoma, and Texas. PCS has been modernized, and no longer exists. National Pollutant Discharge Elimination System (ICIS-NPDES) data can now be found in Integrated Compliance Information System (ICIS).

RCRASC RCRA Sites with Controls

VERSION DATE: 11/22/19

The Resource Conservation and Recovery Act (RCRA) gives the U.S. Environmental Protection Agency (EPA) the authority to control hazardous waste from the "cradle-to-grave." This includes the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA also set forth a framework for the management of non-hazardous solid wastes. The 1986 amendments to RCRA enabled EPA to address environmental problems that could result from underground tanks storing petroleum and other hazardous substances. This listing refers to facilities with institutional controls in place.

SEMSLIENS SEMS Lien on Property

VERSION DATE: 08/13/18

The U.S. Environmental Protection Agency's (EPA) Office of Solid Waste and Emergency Response, Office of Superfund Remediation and Technology Innovation (OSRTI), has implemented The Superfund Enterprise Management System (SEMS), formerly known as CERCLIS (Comprehensive Environmental Response, Compensation and Liability Information System) to track and report on clean-up and enforcement activities taking place at Superfund sites. SEMS represents a joint development and ongoing collaboration between Superfund's Remedial, Removal, Federal Facilities, Enforcement and Emergency Response programs. This is a listing of SEMS sites with a lien on the property.

SFLIENS CERCLIS Liens

VERSION DATE: 06/08/12

A Federal CERCLA ("Superfund") lien can exist by operation of law at any site or property at which United States

Environmental Protection Agency has spent Superfund monies. These monies are spent to investigate and address releases and threatened releases of contamination. CERCLIS provides information as to the identity of these sites and properties. This database contains those CERCLIS sites where the Lien on Property action is complete. Please refer to the SEMSLIENS database as source of current data.

SSTS Section Seven Tracking System

VERSION DATE: 02/01/17

The United States Environmental Protection Agency tracks information on pesticide establishments through the Section Seven Tracking System (SSTS). SSTS records the registration of new establishments and records pesticide production at each establishment. The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) requires that production of pesticides or devices be conducted in a registered pesticide-producing or device-producing establishment. ("Production" includes formulation, packaging, repackaging, and relabeling.)

TRI Toxics Release Inventory

VERSION DATE: 12/31/17

The Toxics Release Inventory, provided by the United States Environmental Protection Agency, includes data on toxic chemical releases and waste management activities from certain industries as well as federal and tribal facilities. This inventory contains information about the types and amounts of toxic chemicals that are released each year to the air, water, and land as well as information on the quantities of toxic chemicals sent to other facilities for further waste management.

TSCA Toxic Substance Control Act Inventory

VERSION DATE: 12/31/12

The Toxic Substances Control Act (TSCA) was enacted in 1976 to ensure that chemicals manufactured, imported, processed, or distributed in commerce, or used or disposed of in the United States do not pose any unreasonable risks to human health or the environment. TSCA section 8(b) provides the United States Environmental Protection Agency authority to "compile, keep current, and publish a list of each chemical substance that is manufactured or processed in the United States." This TSCA Chemical Substance Inventory contains non-confidential information on the production amount of toxic chemicals from each manufacturer and importer site.

RCRAGR06 Resource Conservation & Recovery Act - Generator

VERSION DATE: 12/30/19

The Resource Conservation and Recovery Act (RCRA) gives the U.S. Environmental Protection Agency (EPA) the authority to control hazardous waste from the "cradle-to-grave." This includes the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA also set forth a framework for the management of non-hazardous solid wastes. The 1986 amendments to RCRA enabled EPA to address environmental problems that could result from underground tanks storing petroleum and other hazardous substances. This listing refers to facilities currently generating hazardous waste. EPA region 6 includes the following states: Arkansas, Louisiana, New Mexico, Oklahoma, and Texas.

RCRANGR06	Resource Conservation & Recovery Act - Non-Generator
VERSION DATE: 12/30/19	

The Resource Conservation and Recovery Act (RCRA) gives the U.S. Environmental Protection Agency (EPA) the authority to control hazardous waste from the "cradle-to-grave." This includes the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA also set forth a framework for the management of non-hazardous solid wastes. The 1986 amendments to RCRA enabled EPA to address environmental problems that could result from underground tanks storing petroleum and other hazardous substances. This listing refers to facilities classified as non-generators. Non-Generators do not presently generate hazardous waste. EPA Region 6 includes the following states: Arkansas, Louisiana, New Mexico, Oklahoma, and Texas.

ALTFUELS	Alternative Fueling Stations
VERSION DATE: 09/24/19	

Nationwide list of alternative fueling stations made available by the U.S. Department of Energy's Office of Energy Efficiency & Renewable Energy. Includes Bio-diesel stations, Ethanol (E85) stations, Liquefied Petroleum Gas (Propane) stations, Ethanol (E85) stations, Natural Gas stations, Hydrogen stations, and Electric Vehicle Supply Equipment (EVSE).

FEMAUST	FEMA Owned Storage Tanks
VERSION DATE: 12/01/16	

This is a listing of FEMA owned underground and aboveground storage tank sites. For security reasons, address information is not released to the public according to the U.S. Department of Homeland Security.

HISTPST	Historical Gas Stations
VERSION DATE: NR	

This historic directory of service stations is provided by the Cities Service Company. The directory includes Cities Service filling stations that were located throughout the United States in 1930.

ICISCLEANERS	Integrated Compliance Information System Drycleaners
VERSION DATE: 09/21/19	

This is a listing of drycleaner facilities from the Integrated Compliance Information System (ICIS). The U.S. Environmental Protection Agency (EPA) tracks facilities that possess NAIC and SIC codes that classify businesses as drycleaner establishments. The following Primary SIC Codes are included in this data: 7211, 7212, 7213, 7215, 7216, 7217, 7218, and/or 7219; the following Primary NAICS Codes are included in this data: 812320, 812331, and/or 812332.

MRDS Mineral Resource Data System

VERSION DATE: 03/15/16

MRDS (Mineral Resource Data System) is a collection of reports describing metallic and nonmetallic mineral resources throughout the world. Included are deposit name, location, commodity, deposit description, geologic characteristics, production, reserves, resources, and references. This database contains the records previously provided in the Mineral Resource Data System (MRDS) of USGS and the Mineral Availability System/Mineral Industry Locator System (MAS/MILS) originated in the U.S. Bureau of Mines, which is now part of USGS.

MSHA Mine Safety and Health Administration Master Index File

VERSION DATE: 09/20/19

The Mine dataset lists all Coal and Metal/Non-Metal mines under MSHA's jurisdiction since 1/1/1970. It includes such information as the current status of each mine (Active, Abandoned, NonProducing, etc.), the current owner and operating company, commodity codes and physical attributes of the mine. Mine ID is the unique key for this data. This information is provided by the United States Department of Labor - Mine Safety and Health Administration (MSHA).

BF Brownfields Management System

VERSION DATE: 10/15/19

Brownfields are real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant. Cleaning up and reinvesting in these properties takes development pressures off of undeveloped, open land, and both improves and protects the environment. The United States Environmental Protection Agency maintains this database to track activities in the various brown field grant programs including grantee assessment, site cleanup and site redevelopment. This database included tribal brownfield sites.

DNPL Delisted National Priorities List

VERSION DATE: 01/27/20

This database includes sites from the United States Environmental Protection Agency's Final National Priorities List (NPL) where remedies have proven to be satisfactory or sites where the original analyses were inaccurate, and the site is no longer appropriate for inclusion on the NPL, and final publication in the Federal Register has occurred.

NLRRCRAT No Longer Regulated RCRA Non-CORRACTS TSD Facilities

VERSION DATE: 12/30/19

This database includes RCRA Non-Corrective Action TSD facilities that are no longer regulated by the United States Environmental Protection Agency or do not meet other RCRA reporting requirements. This listing includes facilities that formerly treated, stored or disposed of hazardous waste.

ODI Open Dump Inventory

VERSION DATE: 06/01/85

The open dump inventory was published by the United States Environmental Protection Agency. An "open dump" is defined as a facility or site where solid waste is disposed of which is not a sanitary landfill which meets the criteria promulgated under section 4004 of the Solid Waste Disposal Act (42 U.S.C. 6944) and which is not a facility for disposal of hazardous waste. This inventory has not been updated since June 1985.

RCRAT Resource Conservation & Recovery Act - Non-CORRACTS Treatment, Storage & Disposal Facilities

VERSION DATE: 12/30/19

The Resource Conservation and Recovery Act (RCRA) gives the U.S. Environmental Protection Agency (EPA) the authority to control hazardous waste from the "cradle-to-grave." This includes the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA also set forth a framework for the management of non-hazardous solid wastes. The 1986 amendments to RCRA enabled EPA to address environmental problems that could result from underground tanks storing petroleum and other hazardous substances. This listing refers to facilities recognized as hazardous waste treatment, storage, and disposal sites (TSD).

SEMS Superfund Enterprise Management System

VERSION DATE: 01/27/20

The U.S. Environmental Protection Agency's (EPA) Office of Solid Waste and Emergency Response, Office of Superfund Remediation and Technology Innovation (OSRTI), has implemented The Superfund Enterprise Management System (SEMS), formerly known as CERCLIS (Comprehensive Environmental Response, Compensation and Liability Information System) to track and report on clean-up and enforcement activities taking place at Superfund sites. SEMS represents a joint development and ongoing collaboration between Superfund's Remedial, Removal, Federal Facilities, Enforcement and Emergency Response programs.

SEMSARCH Superfund Enterprise Management System Archived Site Inventory

VERSION DATE: 01/27/20

The U.S. Environmental Protection Agency's (EPA) Superfund Enterprise Management System Archived Site Inventory (List 8R Archived) replaced the CERCLIS NFRAP reporting system in 2015. This listing reflects sites at which the EPA has determined that assessment has been completed and no further remedial action is planned under the Superfund program.

SMCRA Surface Mining Control and Reclamation Act Sites

VERSION DATE: 11/26/19

An inventory of land and water impacted by past mining (primarily coal mining) is maintained by the Office of Surface Mining Reclamation and Enforcement (OSMRE) to provide information needed to implement the Surface Mining Control and Reclamation Act of 1977 (SMCRA). The inventory contains information on the location, type, and extent of AML impacts, as well as, information on the cost associated with the reclamation of those problems. The inventory is based upon field surveys by State, Tribal, and OSMRE program officials. It is dynamic to the extent that it is modified as new problems are identified and existing problems are reclaimed.

USUMTRCA Uranium Mill Tailings Radiation Control Act Sites

VERSION DATE: 03/04/17

The Legacy Management Office of the Department of Energy (DOE) manages radioactive and chemical waste, environmental contamination, and hazardous material at over 100 sites across the U.S. The L.M. Office manages this database of sites registered under the Uranium Mill Tailings Control Act (UMTRCA).

DOD Department of Defense Sites

VERSION DATE: 12/01/14

This information originates from the National Atlas of the United States Federal Lands data, which includes lands owned or administered by the Federal government. Army DOD, Army Corps of Engineers DOD, Air Force DOD, Navy DOD and Marine DOD areas of 640 acres or more are included.

FUDS Formerly Used Defense Sites

VERSION DATE: 06/01/15

The Formerly Used Defense Sites (FUDS) inventory includes properties previously owned by or leased to the United States and under Secretary of Defense Jurisdiction, as well as Munitions Response Areas (MRAs). The remediation of these properties is the responsibility of the Department of Defense. This data is provided by the U.S. Army Corps of Engineers (USACE), the boundaries/polygon data are based on preliminary findings and not all properties currently have polygon data available. DISCLAIMER: This data represents the results of data collection/processing for a specific USACE activity and is in no way to be considered comprehensive or to be used in any legal or official capacity as presented on this site. While the USACE has made a reasonable effort to insure the accuracy of the maps and associated data, it should be explicitly noted that USACE makes no warranty, representation or guaranty, either expressed or implied, as to the content, sequence, accuracy, timeliness or completeness of any of the data provided herein. For additional information on Formerly Used Defense Sites please contact the USACE Public Affairs Office at (202) 528-4285.

FUSRAP Formerly Utilized Sites Remedial Action Program

VERSION DATE: 03/04/17

The U.S. Department of Energy (DOE) established the Formerly Utilized Sites Remedial Action Program (FUSRAP) in 1974 to remediate sites where radioactive contamination remained from the Manhattan Project and early U.S. Atomic Energy Commission (AEC) operations. The DOE Office of Legacy Management (LM) established long-term surveillance and maintenance (LTS&M) requirements for remediated FUSRAP sites. DOE evaluates the final site conditions of a remediated site on the basis of risk for different future uses. DOE then confirms that LTS&M requirements will maintain protectiveness.

NLRRCRAC	No Longer Regulated RCRA Corrective Action Facilities
VERSION DATE: 12/30/19	

This database includes RCRA Corrective Action facilities that are no longer regulated by the United States Environmental Protection Agency or do not meet other RCRA reporting requirements.

NMS	Former Military Nike Missile Sites
VERSION DATE: 12/01/84	

This information was taken from report DRXTH-AS-IA-83A016 (Historical Overview of the Nike Missile System, 12/1984) which was performed by Environmental Science and Engineering, Inc. for the U.S. Army Toxic and Hazardous Materials Agency Assessment Division. The Nike system was deployed between 1954 and the mid-1970's. Among the substances used or stored on Nike sites were liquid missile fuel (JP-4); starter fluids (UDKH, aniline, and furfuryl alcohol); oxidizer (IRFNA); hydrocarbons (motor oil, hydraulic fluid, diesel fuel, gasoline, heating oil); solvents (carbon tetrachloride, trichloroethylene, trichloroethane, stoddard solvent); and battery electrolyte. The quantities of material a disposed of and procedures for disposal are not documented in published reports. Virtually all information concerning the potential for contamination at Nike sites is confined to personnel who were assigned to Nike sites. During deactivation most hardware was shipped to depot-level supply points. There were reportedly instances where excess materials were disposed of on or near the site itself at closure. There was reportedly no routine site decontamination.

NPL	National Priorities List
VERSION DATE: 01/27/20	

This database includes United States Environmental Protection Agency (EPA) National Priorities List sites that fall under the EPA's Superfund program, established to fund the cleanup of the most serious uncontrolled or abandoned hazardous waste sites identified for possible long-term remedial action.

PNPL	Proposed National Priorities List
VERSION DATE: 01/27/20	

This database contains sites proposed to be included on the National Priorities List (NPL) in the Federal Register. The United States Environmental Protection Agency investigates these sites to determine if they may present long-term threats to public health or the environment.

RCRAC	Resource Conservation & Recovery Act - Corrective Action Facilities
VERSION DATE: 12/30/19	

The Resource Conservation and Recovery Act (RCRA) gives the U.S. Environmental Protection Agency (EPA) the authority to control hazardous waste from the "cradle-to-grave." This includes the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA also set forth a framework for the management of non-hazardous solid wastes. The 1986 amendments to RCRA enabled EPA to address environmental problems that could result from underground tanks storing petroleum and other hazardous substances. This listing refers to facilities with corrective action activity.

RCRASUBC	Resource Conservation & Recovery Act - Subject to Corrective Action Facilities
VERSION DATE: 12/30/19	

The Resource Conservation and Recovery Act (RCRA) gives the U.S. Environmental Protection Agency (EPA) the authority to control hazardous waste from the "cradle-to-grave." This includes the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA also set forth a framework for the management of non-hazardous solid wastes. The 1986 amendments to RCRA enabled EPA to address environmental problems that could result from underground tanks storing petroleum and other hazardous substances. This listing refers to facilities subject to corrective actions.

RODS	Record of Decision System
VERSION DATE: 01/27/20	

These decision documents maintained by the United States Environmental Protection Agency describe the chosen remedy for NPL (Superfund) site remediation. They also include site history, site description, site characteristics, community participation, enforcement activities, past and present activities, contaminated media, the contaminants present, and scope and role of response action.

GWCC Groundwater Contamination Cases

VERSION DATE: 12/31/18

This is a Joint Groundwater Monitoring and Contamination Report provided by the Texas Commission on Environmental Quality (TCEQ). The annual report describes the status of groundwater monitoring activities conducted or required by each agency at regulated facilities or associated with regulated activities. The report provides a general overview of groundwater monitoring by participating members on a program by program basis. Groundwater contamination is broadly defined in the report as any detrimental alteration of the naturally occurring quality of groundwater.

HISTGWCC Historic Groundwater Contamination Cases

VERSION DATE: 12/31/17

This is a Joint Groundwater Monitoring and Contamination Report provided by the Texas Commission on Environmental Quality (TCEQ) that includes historic groundwater contamination cases reported since 1994. These cases have been closed by a program area or agency, such as the TCEQ, the Railroad Commission of Texas, and/or the Texas Alliance of Groundwater Districts. According to the TCEQ report, although enforcement actions may be closed on these cases, the Activity Status Code descriptions allow that groundwater contamination may still be present at the site and may therefore be of interest to regulatory agencies and the general public.

LANDAPP Land Application Permits

VERSION DATE: 06/03/19

Texas Land Application Permits are a requirement from the Texas Commission on Environmental Quality for any domestic facility that disposes of treated effluent by land application such as surface irrigation, evaporation, drainfields or subsurface land application.

LIENS TCEQ Liens

VERSION DATE: 06/06/18

Liens filed upon State and/or Federal Superfund Sites by the Texas Commission on Environmental Quality.

MSD Municipal Setting Designations

VERSION DATE: 01/16/19

The Texas Commission on Environmental Quality (TCEQ) defines an MSD as an official state designation given to property within a municipality or its extraterritorial jurisdiction that certifies that designated groundwater at the property is not used as potable water, and is prohibited from future use as potable water because that groundwater is contaminated in excess of the applicable potable-water protective concentration level. The prohibition must be in the form of a city ordinance, or a restrictive covenant that is enforceable by the city and filed in the property records. The MSD property can be a single property, multi-property, or a portion of property.

TCEQ Disclaimer: This data is for informational purposes and may not have been prepared for or be suitable for legal, engineering, or surveying purposes. It does not represent an on-the-ground survey and represents only the approximate relative location of property boundaries.

NOV Notice of Violations

VERSION DATE: 02/24/16

This database containing Notice of Violations (NOV) is maintained by the Texas Commission on Environmental Quality. An NOV is a written notification that documents and communicates violations observed during an inspection to the business or individual inspected.

SIEC01 State Institutional/Engineering Control Sites

VERSION DATE: 11/20/19

The Texas Risk Reduction Program (TRRP) requires the placement of institutional controls (e.g., deed notices or restrictive covenants) on affected property in different circumstances as part of completing a response action. In its simplest form, an institutional control (IC) is a legal document that is recorded in the county deed records. In certain circumstances, local zoning or ordinances can serve as an IC. This listing may also include locations where Engineering Controls are in effect, such as a cap, barrier, or other engineering device to prevent access, exposure, or continued migration of contamination. The sites included on this list are regulated by various programs of the Texas Commission on Environmental Quality (TCEQ).

SPILLS Spills Listing

VERSION DATE: 09/19/19

This Texas Commission on Environmental Quality database includes releases of hazardous or potentially hazardous materials into the environment.

TIERII Tier I I Chemical Reporting Program Facilities

VERSION DATE: 12/31/12

The Texas Tier II Chemical Reporting Program in the Department of State Health Services (DSHS) is the state repository for EPCRA-required Emergency Planning Letters (EPLs), which are one-time notifications to the state from facilities that have certain extremely hazardous chemicals in specified amounts. The Program is also the state repository for EPCRA/state-required hazardous chemical inventory reports called Texas Tier Two Reports. This data contains those facility reports for the 2005 through the 2012 calendar years. Please contact the Texas Commission on Environmental Quality Tier II Chemical Reporting Division as the current source for this data, due to confidentiality and safety reasons details such as the location and capacity of on-site hazardous chemicals is only available to local emergency planning agencies, fire departments, and/or owners.

DCR Dry Cleaner Registration Database

VERSION DATE: 10/01/19

The database includes dry cleaning drop stations and facilities registered with the Texas Commission on Environmental Quality.

IHW	Industrial and Hazardous Waste Sites
VERSION DATE: 05/02/19	

Owner and facility information is included in this database of permitted and non-permitted industrial and hazardous waste sites. Industrial waste is waste that results from or is incidental to operations of industry, manufacturing, mining, or agriculture. Hazardous waste is defined as any solid waste listed as hazardous or possesses one or more hazardous characteristics as defined in federal waste regulations. The IHW database is maintained by the Texas Commission on Environmental Quality.

PIHW	Permitted Industrial Hazardous Waste Sites
VERSION DATE: 05/02/19	

Owner and facility information is included in this database of all permitted industrial and hazardous waste sites. Industrial waste is waste that results from or is incidental to operations of industry, manufacturing, mining, or agriculture. Hazardous waste is defined as any solid waste listed as hazardous or possesses one or more hazardous characteristics as defined in federal waste regulations. Permitted IHW facilities are regulated under 30 Texas Administrative Code Chapter 335 in addition to federal regulations. The IHW database is maintained by the Texas Commission on Environmental Quality.

PST	Petroleum Storage Tanks
VERSION DATE: 10/01/19	

The Petroleum Storage Tank database is administered by the Texas Commission on Environmental Quality (TCEQ). Both Underground storage tanks (USTs) and Aboveground storage tanks (ASTs) are included in this report. Petroleum Storage Tank registration has been a requirement with the TCEQ since 1986.

APAR	Affected Property Assessment Reports
VERSION DATE: 04/05/19	

As regulated by the Texas Commission on Environmental Quality, an Affected Property Assessment Report is required when a person is addressing a release of chemical of concern (COC) under 30 TAC Chapter 350, the Texas Risk Reduction Program (TRRP). The purpose of the APAR is to document all relevant affected property information to identify all release sources and COCs, determine the extent of all COCs, identify all transport/exposure pathways, and to determine if any response actions are necessary. The Texas Administrative Code Title 30 §350.4(a)(1) defines affected property as the entire area (i.e. on-site and off-site; including all environmental media) which contains releases of chemicals of concern at concentrations equal to or greater than the assessment level applicable for residential land use and groundwater classification.

BSA Brownfields Site Assessments

VERSION DATE: 11/04/19

The Brownfields Site Assessments database is maintained by the Texas Commission on Environmental Quality (TCEQ). The TCEQ, in close partnership with the U.S. Environmental Protection Agency (EPA) and other federal, state, and local redevelopment agencies, and stakeholders, is facilitating cleanup, transferability, and revitalization of brownfields through the development of regulatory, tax, and technical assistance tools.

CALF Closed & Abandoned Landfill Inventory

VERSION DATE: 11/01/05

The Texas Commission on Environmental Quality, under a contract with Texas State University, and in cooperation with the 24 regional Council of Governments (COGs) in the State, has located over 4,000 closed and abandoned municipal solid waste landfills throughout Texas. This listing contains "unauthorized sites". Unauthorized sites have no permit and are considered abandoned. The information available for each site varies in detail and this historical information is not updated. Please refer to the specific regional COG for the most current information.

DCRPS Dry Cleaner Remediation Program Sites

VERSION DATE: 09/01/19

This list of DCRP sites is provided by the Texas Commission on Environmental Quality (TCEQ). According to the TCEQ, the Dry Cleaner Remediation Program (DCRP) establishes a prioritization list of dry cleaner sites and administers the Dry Cleaning Remediation fund to assist with remediation of contamination caused by dry cleaning solvents.

IOP Innocent Owner / Operator Database

VERSION DATE: 08/20/19

Texas Innocent Owner / Operator (IOP), created by House Bill 2776 of the 75th Legislature, provides a certificate to an innocent owner or operator if their property is contaminated as a result of a release or migration of contaminants from a source or sources not located on the property, and they did not cause or contribute to the source or sources of contamination. The IOP database is maintained by the Texas Commission on Environmental Quality.

LPST Leaking Petroleum Storage Tanks

VERSION DATE: 12/13/19

The Leaking Petroleum Storage Tank listing is derived from the Petroleum Storage Tank (PST) database and is maintained by the Texas Commission on Environmental Quality. This listing includes aboveground and underground storage tank facilities with reported leaks.

MSWLF Municipal Solid Waste Landfill Sites

VERSION DATE: 12/06/19

The municipal solid waste landfill database is provided by the Texas Commission on Environmental Quality. This database includes active landfills and inactive landfills, where solid waste is treated or stored.

RRCVCP Railroad Commission VCP and Brownfield Sites

VERSION DATE: 11/14/19

According to the Railroad Commission of Texas, their Voluntary Cleanup Program (RRC-VCP) provides an incentive to remediate Oil & Gas related pollution by participants as long as they did not cause or contribute to the contamination. Applicants to the program receive a release of liability to the state in exchange for a successful cleanup.

RWS Radioactive Waste Sites

VERSION DATE: 07/11/06

This Texas Commission on Environmental Quality database contains all sites in the State of Texas that have been designated as Radioactive Waste sites.

STCV Salt Caverns for Petroleum Storage

VERSION DATE: 09/01/06

The salt caverns for petroleum storage database is provided by the Railroad Commission of Texas.

VCP Voluntary Cleanup Program Sites

VERSION DATE: 11/20/19

The Texas Voluntary Cleanup Program (VCP) provides administrative, technical, and legal incentives to encourage the cleanup of contaminated sites in Texas. Since all non-responsible parties, including future lenders and landowners, receive protection from liability to the state of Texas for cleanup of sites under the VCP, most of the constraints for completing real estate transactions at those sites are eliminated. As a result, many unused or underused properties may be restored to economically productive or community beneficial uses. The VCP database is maintained by the Texas Commission on Environmental Quality.

WMRF Recycling Facilities

VERSION DATE: 11/01/12

This listing of recycling facilities is provided by the Texas Commission on Environmental Quality's Recycle Texas Online service. The company information provided in this database is self-reported. Since recyclers post their own information, a facility or company appearing on the list does not imply that it is in compliance with TCEQ regulations or other applicable laws. This database is no longer maintained and includes the last compilation of the program participants before the Recycle Texas Online program was closed.

IHWCA Industrial and Hazardous Waste Corrective Action Sites

VERSION DATE: 07/09/19

This database is provided by the Texas Commission on Environmental Quality (TCEQ). According to the TCEQ, the mission of the industrial and hazardous waste corrective action program is to oversee the cleanup of sites contaminated from industrial and municipal hazardous and industrial nonhazardous wastes. The goals of this program are to: Ensure that sites are assessed and remediated to levels that protect human health and the environment; Verify that waste management units or facilities are taken out of service and closed properly; and to Facilitate revitalization of contaminated properties.

SF State Superfund Sites

VERSION DATE: 01/16/19

The state Superfund program mission is to remediate abandoned or inactive sites within the state that pose an unacceptable risk to public health and safety or the environment, but which do not qualify for action under the federal Superfund program (NPL - National Priority Listing). As required by the Texas Solid Waste Disposal Act, Texas Health and Safety Code, Chapter 361, the Texas Commission on Environmental Quality identifies and evaluates these facilities for inclusion on the state Superfund registry. This listing includes any recent developments and the anticipated action for these sites as documented in the annual state Superfund registry publication of the Texas Register as well as the Superfund Webpage on the TCEQ website.

USTR06 Underground Storage Tanks On Tribal Lands

VERSION DATE: 10/01/19

This database, provided by the United States Environmental Protection Agency (EPA), contains underground storage tanks on Tribal lands located in EPA Region 6. This region includes the following states: Arkansas, Louisiana, New Mexico, Oklahoma, and Texas.

LUSTR06 Leaking Underground Storage Tanks On Tribal Lands

VERSION DATE: 10/01/19

This database, provided by the United States Environmental Protection Agency (EPA), contains leaking underground storage tanks on Tribal lands located in EPA Region 6. This region includes the following states: Arkansas, Louisiana, New Mexico, Oklahoma, and Texas.

ODINDIAN Open Dump Inventory on Tribal Lands

VERSION DATE: 11/08/06

This Indian Health Service database contains information about facilities and sites on tribal lands where solid waste is disposed of, which are not sanitary landfills or hazardous waste disposal facilities, and which meet the criteria promulgated under section 4004 of the Solid Waste Disposal Act (42 U.S.C. 6944).

INDIANRES Indian Reservations

VERSION DATE: 01/01/00

The Department of Interior and Bureau of Indian Affairs maintains this database that includes American Indian Reservations, off-reservation trust lands, public domain allotments, Alaska Native Regional Corporations and Recognized State Reservations.

Appendix E: Hydrologic Model Analysis

E-1 Soil Type Table

Alum Creek Watershed, Bastrop, TX Soil Type		
Soil Name	**Soil Series**	**Hydrologic Soil Group**
Axtell	AfA	D
	AfC	D
	AfC2	D
	AfE2	D
	AtD	D
Bastrop	BaA	B
	BaB	B
	BaC2	B
Behring	BeB	C
	BeC2	C
Bosque	Bo	B
Crockett	CfB	D
	CsC2	D
	CsD3	D
	CsE2	D
Demona	DeC	A
Demona Variant	Dm	A
Dougherty	DoB	B
	DoD	A
Ferris	FeF2	D
Gravel Pit	GP	D
Gowen	Gs	B
Heiden	HeB	D
	HeC2	D
Jedd	JeF	C
Krum	KrA	C
Lincoln	Ls	A
	Lw	A
Mabank	MaA	D
	MaB	D
Norwood	Nd	B
	No	B
Patilo	PaE	A
Rosanky	RoB	C
	RoD	C
Sayers	Sa	A
	Sb	A
Shep	SeD2	B
Ships	Sg	D
Silstid	SkC	B
Smithville	Sm	B
Tabor	TfA	D
	TfB	D
Uhland	Uh	C
Vernia	VeD	A
Water	W	D
Wilson	WsA	D
	WsB	D

E-1 Soil Type Table

Appendix E: Hydrologic Model Analysis

E-2 Curve Number

CN and Landuse Classification, Fail Soil Condition

Landuse Classification	TR 55 Table	TR55 Classification	NLCD	CN for HSG			
				A	B	C	D
Open Water		-	11	100	100	100	100
Developed, Open Space	2-2a	Open space, Good condition	21	39	61	74	80
Developed, Low Intensity	2-2a	Open space, Good condition	22	39	61	74	80
Developed, Medium Intensity	2-2a	Open space, Fair condition	23	49	69	79	84
Developed, High Intensity	2-2a	Open space, Poor condition	24	68	79	86	89
Barren Land (Rock/Sand/Clay)	2-2b	Bare soil	31	77	86	91	94
Deciduous Forest	2-2c	Woods-Grass combo (Fair)	41	43	65	76	82
Evergreen Forest	2-2c	Woods-Grass combo (Fair)	42	43	65	76	82
Mixed Forest	2-2c	Woods-Grass combo (Fair)	43	43	65	76	82
Shrub/Scrub	2-2c	Brush-brush-weed-grass (Fair)	52	35	56	70	77
Grassland/Herbaceous	2-2c	Pasture, grassland, range (Fair)	71	49	69	79	84
Pasture/Hay	2-2c	Pasture, grassland, range (Fair)	81	49	69	79	84
Cultivated Crops	2-2b	Fallow, Crop residue cover **(Good)**	82	74	83	88	90
Woody Wetlands	2-2d	Herbaceous - mix of grass, weeds and low-growing brush (Fair)	90	90	90	90	90
Emergent Herbaceous Wetlands	2-2d	Herbaceous - mix of grass, weeds and low-growing brush (Fair)	95	90	90	90	90

CN and Landuse Classification, Poor Soil Condition

Landuse Classification	TR 55 Table	TR55 Classification	NLCD	CN for HSG			
				A	B	C	D
Open Water		-	11	100	100	100	100
Developed, Open Space	2-2a	Open space, Good condition	21	68	79	86	89
Developed, Low Intensity	2-2a	Open space, Good condition	22	68	79	86	89
Developed, Medium Intensity	2-2a	Open space, Fair condition	23	68	79	86	89
Developed, High Intensity	2-2a	Open space, Poor condition	24	68	79	86	89
Barren Land (Rock/Sand/Clay)	2-2b	Bare soil	31	77	86	91	94
Deciduous Forest	2-2c	Woods-Grass combo (Poor)	41	57	73	82	86
Evergreen Forest	2-2c	Woods-Grass combo (Poor)	42	57	73	82	86
Mixed Forest	2-2c	Woods-Grass combo (Poor)	43	57	73	82	86
Shrub/Scrub	2-2c	Brush-brush-weed-grass (Poor)	52	48	67	77	83
Grassland/Herbaceous	2-2c	Pasture, grassland, range (Poor)	71	68	79	86	89
Pasture/Hay	2-2c	Pasture, grassland, range (Poor)	81	68	79	86	89
Cultivated Crops	2-2b	Fallow, Crop residue cover (Poor)	82	76	85	90	93
Woody Wetlands	2-2d	Herbaceous - mix of grass, weeds and low-growing brush (Poor)	90	90	90	90	90
Emergent Herbaceous Wetlands	2-2d	Herbaceous - mix of grass, weeds and low-growing brush (Poor)	95	90	90	90	90

NLCD Land Cover Classification Legend

- 11 Open Water
- 12 Perennial Ice/ Snow
- 21 Developed, Open Space
- 22 Developed, Low Intensity
- 23 Developed, Medium Intensity
- 24 Developed, High Intensity
- 31 Barren Land (Rock/Sand/Clay)
- 41 Deciduous Forest
- 42 Evergreen Forest
- 43 Mixed Forest
- 51 Dwarf Scrub*
- 52 Shrub/Scrub
- 71 Grassland/Herbaceous
- 72 Sedge/Herbaceous*
- 73 Lichens*
- 74 Moss*
- 81 Pasture/Hay
- 82 Cultivated Crops
- 90 Woody Wetlands
- 95 Emergent Herbaceous Wetlands

* Alaska only

Alum Creek Watershed, Bastrop, TX Curve Number Loss		
Basin	Curve Number	Impervious (%)
AC_10	44	1.15
AC_20	49	0.05
AC_30	63	0.02
AC_40	59	0.74
AC_50	71	1.45
AC_60	62	2.71
AC_70	60	1.8
AC_80	67	3.44
AC_90	62	0.09
AC_100	60	2.03
AC_110	62	0
AC_120	77	0.11
AC_130	69	0.58
AC_140	73	0.01
AC_150	73	0
AC_160	74	0.55
AC_170	71	1.91
AC_180	81	1.75
AC_190	83	0.6
AC_200	81	1.18
AC_210	78	5.67
AC_220	81	2.69
AC_230	79	0
AC_240	73	0.03
AC_250	74	1.92
AC_260	73	0.03
ACT1_10	75	0.17
ACT1_20	74	0.7
ACT1_30	75	0.85
ACT2_10	79	0.97
ACT2_20	75	0.95
ACT3_10	69	0.48
ACT3_20	67	1.04
ACT3_30	72	0.24
ACT3_40	79	0.75
ACT4_10	68	3.82
ACT4_20	66	4.22
ACT4_30	60	2.58
ACT4_40	63	4.87
ACT4_50	60	5.11
ACT4_60	65	0.16
ACT5_10	61	3.95

Alum Creek Watershed, Bastrop, TX Curve Number Loss		
Basin	Curve Number	Impervious (%)
ACT5_20	66	0.52
ACT6_10	74	0.55
ACT6_20	71	0.12
ACT7_10	78	1.05
ACT7_20	54	1.4
ACT7_30	65	0.28
ACT7_40	58	1.76
ACT7_50	67	0.19
ACT8_10	65	0
ACT8_20	60	0.73
ACT8_30	57	1.92
ACT9_10	62	0.83
ACT9_20	59	0.67
ACT9_30	66	0.7
ACT10_10	59	8.64
ACT10_20	54	0
ACT10_30	61	1.12
ACT11_10	64	0.75
ACT11_20	79	0.92
ACT11_30	72	0.9
ACT067_10	72	1.15
ACT067_20	77	0.81
ACT087_10	66	5.78
ACT087_20	64	7.03
ACT093_10	68	0.63
ACT093_20	63	1.21
ACT107_10	55	0.01
ACT107_20	61	0
ACT107_30	61	0.12
ACT107A_10	65	0
ACT110_10	49	0.15
ACT110_20	60	0.03
ACT124_10	57	0.38
ACT124_20	67	0.95
ACT129_10	59	0.67
ACT129_20	62	2.52
ACT129_30	76	2.44
ACT131_10	67	0.48
ACT131_20	49	0.36
ACT137_10	60	6.37
ACT137_20	72	0.77
ACT138_10	65	3.85

Alum Creek Watershed, Bastrop, TX Curve Number Loss		
Basin	Curve Number	Impervious (%)
ACT138_20	62	1.81
ACT143_10	59	0.28
ACT143_20	62	0.01
ACT148_10	67	7.38
ACT148_20	67	0.85
ACT148_30	71	0.03
ACT160_10	78	2.18
ACT160_20	80	1.39
ACT162_10	84	0.27
ACT162_20	82	0.65
ACT166_10	77	0.89
ACT166_20	83	0.07
ACT166_30	73	0.59
ACT167_10	76	1.27
ACT167_20	80	0.68
ACT168_10	85	5.98
ACT168_20	87	0.54
ACT169_10	86	2.4
ACT169_20	83	0.81
ACT169_30	84	0
ACT173_10	69	3.11
ACT173_20	74	3.56
ACT173_30	65	0.3
ACT173_40	74	0.28
ACT174_10	72	4
ACT174_20	73	0.49
ACT175_10	83	0.88
ACT175_20	82	0
LAC_10	85	1.63
LAC_20	80	4.42
LAC_30	80	1.66
LAC_40	72	0.72
LAC_50	74	1.35
LAC_60	81	0.24
PC_10	60	0.85
PC_20	59	4.09
PC_30	66	5
PC_40	57	1.12

Appendix E: Hydrologic Model Analysis

E-3 Lag Times

Alum Creek Watershed, Bastrop, TX Time of Concentration															
Variable	Variable description	Unit	Subbasin AC_20	Subbasin ACT110_20	Subbasin ACT9_20	Subbasin ACT124_20	Subbasin AC_30	Subbasin ACT10_20	Subbasin ACT107_30	Subbasin ACT93_20	Subbasin ACT10_30	Subbasin AC_40	Subbasin AC_50	Subbasin AC_60	Subbasin ACT7_20
	Sheet Flow [eq. 3-3]														
n	Manning's roughness coefficient (table 3-1)	n/a	0.4	0.13	0.4	0.4	0.4	0.13	0.15	0.15	0.13	0.4	0.13	0.4	0.15
L	flow length	ft	99.3	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
P_2	2-year, 24-hour rainfall	in	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17
s	slope of hydraulic grade line (land slope)	ft/ft	0.014	0.030	0.011	0.014	0.010	0.010	0.019	0.038	0.042	0.026	0.024	0.023	0.016
T_t	travel time	hr	0.36	0.11	0.40	0.36	0.42	0.17	0.15	0.11	0.09	0.28	0.12	0.29	0.16
	Shallow Concentrated Flow [eq. 3-1]														
L	flow length	ft	4139.06	2586.29	4726.59	1644.47	5387.61	492.93	2214.62	3972.11	5941.79	5050.19	7284.61	4752.81	6335.00
s	slope of hydraulic grade line (watercourse slope)	ft/ft	0.022	0.023	0.014	0.043	0.021	0.048	0.039	0.017	0.015	0.023	0.009	0.017	0.012
n/a	surface (Unpaved, Paved)	n/a	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved
V	average velocity	ft/s	2.37	2.46	1.91	3.34	2.34	3.54	3.19	2.12	1.97	2.44	1.53	2.08	1.78
T_t	travel time	hr	0.485	0.292	0.688	0.137	0.640	0.039	0.193	0.520	0.838	0.576	1.322	0.635	0.987
	Channel Flow [eq. 3-4 and eq. 3-1]														
L	flow length	ft	6477.74	1547.02	11280.99	2962.60	6862.63	2910.25	5920.23	563.51	1696.04	2909.06	3749.66	640.24	2634.34
a	cross sectional flow area	ft^2	194.11	76.75	174.28	99.02	23.67	75.82	60.09	39.66	153.42	76.30	114.08	70.69	58.70
p_w	wetted perimeter	ft	63.98	39.43	63.66	39.59	24.58	48.44	39.37	27.09	44.73	68.91	66.18	22.26	31.08
r	hydraulic radius = a/p_w	ft	3.03	1.95	2.74	2.50	0.96	1.57	1.53	1.46	3.43	1.11	1.72	3.17	1.89
s	slope of hydraulic grade line (channel slope)	ft/ft	0.005	0.009	0.007	0.006	0.004	0.005	0.007	0.005	0.005	0.005	0.003	0.000	0.005
n	Manning's roughness coefficient for open channel flow	n/a	0.04	0.04	0.045	0.045	0.04	0.05	0.045	0.055	0.055	0.04	0.045	0.045	0.055
V	average velocity	ft/s	5.46	5.57	5.24	4.80	2.38	2.72	3.65	2.47	4.36	2.93	2.47	1.38	3.04
T_t	travel time	hr	0.329	0.077	0.598	0.171	0.800	0.297	0.451	0.063	0.108	0.276	0.421	0.129	0.241
	Total Travel Time (Tt)	hr	1.17	0.48	1.68	0.67	1.86	0.50	0.79	0.69	1.04	1.13	1.86	1.06	1.39
	Time of Concentration (TOC_min)	min	**70.43**	**28.61**	**100.89**	**40.30**	**111.55**	**30.27**	**47.40**	**41.66**	**62.47**	**67.98**	**111.76**	**63.56**	**83.11**
	Lag Time	min	**42.26**	**17.17**	**60.54**	**24.18**	**66.93**	**18.16**	**28.44**	**25.00**	**37.48**	**40.79**	**67.06**	**38.13**	**49.87**

Alum Creek Watershed, Bastrop, TX Time of Concentration															
Variable	Variable description	Unit	Subbasin ACT9_30	Subbasin ACT7_30	Subbasin AC_70	Subbasin ACT7_40	Subbasin ACT129_30	Subbasin AC_80	Subbasin ACT87_20	Subbasin ACT7_50	Subbasin ACT131_20	Subbasin PC_40	Subbasin ACT138_20	Subbasin AC_90	Subbasin AC_100
	Sheet Flow [eq. 3-3]														
n	Manning's roughness coefficient (table 3-1)	n/a	0.15	0.4	0.4	0.4	0.15	0.24	0.24	0.24	0.4	0.15	0.15	0.4	0.4
L	flow length	ft	100.0	99.4	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
P_2	2-year, 24-hour rainfall	in	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17
s	slope of hydraulic grade line (land slope)	ft/ft	0.010	0.006	0.015	0.061	0.018	0.021	0.037	0.041	0.033	0.022	0.026	0.027	0.026
T_t	travel time	hr	0.19	0.51	0.35	0.20	0.15	0.20	0.16	0.16	0.26	0.14	0.13	0.28	0.28
	Shallow Concentrated Flow [eq. 3-1]														
L	flow length	ft	3067.64	5173.98	1977.30	4412.44	1397.41	4100.60	3792.28	3487.16	6497.28	823.27	2034.82	2681.15	1584.56
s	slope of hydraulic grade line (watercourse slope)	ft/ft	0.021	0.012	0.014	0.018	0.026	0.021	0.026	0.019	0.015	0.030	0.016	0.019	0.057
n/a	surface (Unpaved, Paved)	n/a	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved
V	average velocity	ft/s	2.33	1.77	1.90	2.18	2.62	2.34	2.58	2.23	2.00	2.79	2.05	2.23	3.84
T_t	travel time	hr	0.365	0.813	0.289	0.562	0.148	0.486	0.409	0.434	0.901	0.082	0.276	0.334	0.115
	Channel Flow [eq. 3-4 and eq. 3-1]														
L	flow length	ft	5431.76	4113.58	2438.57	4877.26	2239.14	3046.48	3252.16	1919.81	2263.82	2851.72	1581.19	1694.67	3178.17
a	cross sectional flow area	ft^2	103.40	148.09	67.67	152.97	165.77	125.66	17.32	105.15	84.79	64.36	14.60	203.77	205.11
p_w	wetted perimeter	ft	41.21	38.41	37.63	38.77	57.74	53.08	20.90	28.79	23.27	30.93	15.14	38.40	54.91
r	hydraulic radius = a/p_w	ft	2.51	3.86	1.80	3.95	2.87	2.37	0.83	3.65	3.64	2.08	0.96	5.31	3.74
s	slope of hydraulic grade line (channel slope)	ft/ft	0.002	0.008	0.001	0.003	0.006	0.002	0.008	0.002	0.006	0.005	0.004	0.001	0.002
n	Manning's roughness coefficient for open channel flow	n/a	0.05	0.06	0.045	0.045	0.045	0.045	0.045	0.045	0.06	0.05	0.045	0.045	0.045
V	average velocity	ft/s	2.20	5.46	1.70	4.68	5.01	2.28	2.56	3.04	4.40	3.29	2.04	3.02	3.19
T_t	travel time	hr	0.686	0.209	0.399	0.290	0.124	0.372	0.352	0.175	0.143	0.240	0.215	0.156	0.277
	Total Travel Time (Tt)	hr	1.24	1.53	1.04	1.05	0.42	1.06	0.93	0.77	1.30	0.46	0.62	0.77	0.68
	Time of Concentration (TOC_min)	min	**74.56**	**91.86**	**62.33**	**63.10**	**25.25**	**63.71**	**55.51**	**45.98**	**78.04**	**27.62**	**37.16**	**46.07**	**40.52**
	Lag Time	min	**44.74**	**55.12**	**37.40**	**37.86**	**15.15**	**38.23**	**33.30**	**27.59**	**46.82**	**16.57**	**22.30**	**27.64**	**24.31**

Alum Creek Watershed, Bastrop, TX Time of Concentration															
Variable	Variable description	Unit	Subbasin ACT137_20	Subbasin AC_110	Subbasin ACT143_20	Subbasin ACT5_20	Subbasin ACT6_20	Subbasin AC_130	Subbasin ACT4_60	Subbasin AC_140	Subbasin ACT1_20	Subbasin ACT148_30	Subbasin AC_150	Subbasin ACT3_40	Subbasin ACT3_20
Sheet Flow [eq. 3-3]															
n	Manning's roughness coefficient (table 3-1)	n/a	0.24	0.4	0.4	0.4	0.24	0.4	0.4	0.4	0.4	0.4	0.25	0.4	0.4
L	flow length	ft	100.0	100.2	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
P_2	2-year, 24-hour rainfall	in	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17
s	slope of hydraulic grade line (land slope)	ft/ft	0.033	0.029	0.015	0.010	0.026	0.046	0.028	0.109	0.109	0.022	0.028	0.011	0.123
T_t	travel time	hr	0.17	0.27	0.35	0.41	0.19	0.23	0.27	0.16	0.16	0.30	0.19	0.39	0.15
Shallow Concentrated Flow [eq. 3-1]															
L	flow length	ft	1474.30	3035.15	5403.92	2508.71	4161.66	2267.12	1914.51	2814.61	4970.34	4698.25	1873.04	4893.40	5661.31
s	slope of hydraulic grade line (watercourse slope)	ft/ft	0.028	0.026	0.022	0.027	0.026	0.016	0.037	0.034	0.022	0.021	0.031	0.023	0.020
n/a	surface (Unpaved, Paved)	n/a	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved
V	average velocity	ft/s	2.68	2.60	2.37	2.65	2.60	2.01	3.12	2.97	2.40	2.31	2.85	2.45	2.25
T_t	travel time	hr	0.153	0.324	0.634	0.263	0.444	0.314	0.170	0.263	0.574	0.565	0.183	0.554	0.698
Channel Flow [eq. 3-4 and eq. 3-1]															
L	flow length	ft	7920.48	10157.47	2288.83	9643.33	5691.95	5662.98	4603.08	2164.78	5919.87	3200.89	5393.53	4339.19	4333.22
a	cross sectional flow area	ft^2	20.04	21.77	82.55	69.37	93.13	39.94	38.28	189.72	77.52	128.10	461.55	214.87	152.87
p_w	wetted perimeter	ft	18.04	26.48	36.37	36.40	39.98	27.45	27.21	59.62	54.29	45.26	64.06	44.73	43.91
r	hydraulic radius = a/p_w	ft	1.11	0.82	2.27	1.91	2.33	1.45	1.41	3.18	1.43	2.83	7.21	4.80	3.48
s	slope of hydraulic grade line (channel slope)	ft/ft	0.006	0.003	0.008	0.009	0.004	0.008	0.006	0.003	0.004	0.008	0.003	0.008	0.009
n	Manning's roughness coefficient for open channel flow	n/a	0.04	0.045	0.045	0.05	0.065	0.05	0.045	0.05	0.05	0.05	0.05	0.05	0.04
V	average velocity	ft/s	3.02	1.64	5.05	4.25	2.48	3.87	3.19	3.29	2.27	6.00	5.78	7.35	7.94
T_t	travel time	hr	0.730	1.716	0.126	0.631	0.637	0.406	0.400	0.183	0.725	0.148	0.259	0.164	0.152
Total Travel Time (Tt)		hr	1.05	2.31	1.11	1.30	1.27	0.94	0.84	0.61	1.46	1.01	0.63	1.11	1.00
Time of Concentration (TOC_min)		min	**63.21**	**138.69**	**66.62**	**78.26**	**76.17**	**56.68**	**50.65**	**36.31**	**87.52**	**60.80**	**37.82**	**66.66**	**60.07**
Lag Time		min	**37.93**	**83.21**	**39.97**	**46.96**	**45.70**	**34.01**	**30.39**	**21.78**	**52.51**	**36.48**	**22.69**	**39.99**	**36.04**

Alum Creek Watershed, Bastrop, TX Time of Concentration															
Variable	Variable description	Unit	Subbasin ACT3_10	Subbasin ACT2_20	Subbasin ACT1_30	Subbasin AC_160	Subbasin AC_170	Subbasin ACT67_20	Subbasin AC_180	Subbasin LAC_30	Subbasin AC_190	Subbasin AC_200	Subbasin ACT166_30	Subbasin ACT173_30	Subbasin AC_220
Sheet Flow [eq. 3-3]															
n	Manning's roughness coefficient (table 3-1)	n/a	0.4	0.4	0.13	0.4	0.4	0.24	0.4	0.24	0.24	0.41	0.4	0.15	0.15
L	flow length	ft	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
P_2	2-year, 24-hour rainfall	in	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17
s	slope of hydraulic grade line (land slope)	ft/ft	0.089	0.025	0.018	0.011	0.031	0.062	0.150	0.059	0.097	0.108	0.055	0.013	0.007
T_t	travel time	hr	0.17	0.29	0.13	0.40	0.26	0.13	0.14	0.14	0.11	0.16	0.21	0.17	0.22
Shallow Concentrated Flow [eq. 3-1]															
L	flow length	ft	2699.96	4386.24	283.00	3887.20	1695.21	5890.51	7746.42	4525.86	4894.35	6961.05	1109.08	3365.32	3046.51
s	slope of hydraulic grade line (watercourse slope)	ft/ft	0.030	0.032	0.082	0.018	0.034	0.025	0.019	0.025	0.030	0.019	0.066	0.030	0.031
n/a	surface (Unpaved, Paved)	n/a	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved
V	average velocity	ft/s	2.78	2.88	4.62	2.16	2.98	2.57	2.23	2.57	2.79	2.24	4.15	2.79	2.83
T_t	travel time	hr	0.270	0.423	0.017	0.500	0.158	0.636	0.965	0.490	0.486	0.863	0.074	0.335	0.299
Channel Flow [eq. 3-4 and eq. 3-1]															
L	flow length	ft	5851.28	8824.57	1696.05	5448.16	1580.93	654.49	4670.16	6540.40	3121.26	4932.99	5620.54	2177.20	4105.73
a	cross sectional flow area	ft^2	23.12	449.07	169.48	243.28	298.70	15.73	180.51	30.82	276.61	212.19	110.29	103.47	178.91
p_w	wetted perimeter	ft	15.65	72.35	34.50	48.86	50.96	12.34	44.63	27.31	49.37	43.75	31.98	28.27	34.23
r	hydraulic radius = a/p_w	ft	1.48	6.21	4.91	4.98	5.86	1.27	4.04	1.13	5.60	4.85	3.45	3.66	5.23
s	slope of hydraulic grade line (channel slope)	ft/ft	0.012	0.005	0.005	0.002	0.001	0.008	0.004	0.005	0.002	0.002	0.008	0.006	0.003
n	Manning's roughness coefficient for open channel flow	n/a	0.05	0.05	0.05	0.055	0.055	0.05	0.05	0.04	0.05	0.05	0.04	0.05	0.05
V	average velocity	ft/s	4.16	6.83	6.09	3.53	2.78	3.15	4.97	2.77	4.90	4.03	7.46	6.24	4.49
T_t	travel time	hr	0.390	0.359	0.077	0.428	0.158	0.058	0.261	0.656	0.177	0.340	0.209	0.097	0.254
Total Travel Time (Tt)		hr	0.83	1.07	0.23	1.33	0.58	0.83	1.37	1.28	0.77	1.37	0.49	0.60	0.77
Time of Concentration (TOC_min)		min	**49.99**	**64.10**	**13.72**	**79.61**	**34.82**	**49.62**	**81.96**	**76.89**	**46.46**	**81.95**	**29.53**	**36.15**	**46.13**
Lag Time		min	**30.00**	**38.46**	**8.23**	**47.77**	**20.89**	**29.77**	**49.18**	**46.13**	**27.88**	**49.17**	**17.72**	**21.69**	**27.68**

Alum Creek Watershed, Bastrop, TX Time of Concentration															
Variable	Variable description	Unit	Subbasin ACT173_40	Subbasin AC_250	Subbasin LAC_50	Subbasin AC_230	Subbasin AC_240	Subbasin AC_260	Subbasin LAC_60	Subbasin ACT169_30	Subbasin ACT160_10	Subbasin ACT107_20	Subbasin AC_210	Subbasin ACT173_20	Subbasin ACT174_10
	Sheet Flow [eq. 3-3]														
n	Manning's roughness coefficient (table 3-1)	n/a	0.4	0.15	0.13	0.13	0.17	0.13	0.13	0.15	0.4	0.4	0.15	0.4	0.4
L	flow length	ft	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.1	101.4
P_2	2-year, 24-hour rainfall	in	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17
s	slope of hydraulic grade line (land slope)	ft/ft	0.037	0.017	0.004	0.010	0.003	0.009	0.007	0.014	0.020	0.081	0.054	0.075	0.019
T_t	travel time	hr	0.24	0.15	0.25	0.17	0.33	0.18	0.20	0.17	0.31	0.18	0.10	0.19	0.33
	Shallow Concentrated Flow [eq. 3-1]														
L	flow length	ft	3953.87	1558.07	4543.78	779.64	4319.80	740.45	7082.32	1449.30	2847.22	578.34	4793.39	3429.28	2836.63
s	slope of hydraulic grade line (watercourse slope)	ft/ft	0.028	0.047	0.004	0.025	0.006	0.051	0.005	0.009	0.027	0.088	0.034	0.024	0.022
n/a	surface (Unpaved, Paved)	n/a	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved
V	average velocity	ft/s	2.68	3.51	0.97	2.55	1.21	3.64	1.12	1.50	2.67	4.79	2.99	2.52	2.37
T_t	travel time	hr	0.410	0.123	1.304	0.085	0.994	0.056	1.760	0.269	0.296	0.034	0.445	0.378	0.333
	Channel Flow [eq. 3-4 and eq. 3-1]														
L	flow length	ft	5429.45	9270.13	5812.84	10625.18	6587.38	231.42	1734.89	1609.86	1037.22	853.30	364.67	4410.00	860.40
a	cross sectional flow area	ft^2	107.68	76.11	204.35	271.88	879.94	910.83	185.58	108.21	16.91	281.03	323.45	102.58	43.55
p_w	wetted perimeter	ft	39.06	33.88	47.95	57.69	115.25	91.54	36.77	31.46	15.05	55.75	76.86	33.67	21.72
r	hydraulic radius = a/p_w	ft	2.76	2.25	4.26	4.71	7.64	9.95	5.05	3.44	1.12	5.04	4.21	3.05	2.00
s	slope of hydraulic grade line (channel slope)	ft/ft	0.006	0.016	0.003	0.002	0.002	0.000	0.006	0.006	0.013	0.012	0.002	0.008	0.019
n	Manning's roughness coefficient for open channel flow	n/a	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.045	0.05	0.05	0.05	0.05	0.05
V	average velocity	ft/s	4.87	7.14	5.00	3.75	5.17	2.54	7.42	5.94	4.06	9.68	3.86	6.22	6.55
T_t	travel time	hr	0.310	0.361	0.323	0.788	0.354	0.025	0.065	0.075	0.071	0.024	0.026	0.197	0.037
	Total Travel Time (Tt)	hr	0.96	0.64	1.88	1.04	1.68	0.26	2.02	0.51	0.68	0.24	0.57	0.76	0.70
	Time of Concentration (TOC_min)	min	**57.88**	**38.22**	**112.54**	**62.51**	**100.87**	**15.44**	**121.35**	**30.65**	**40.80**	**14.24**	**34.04**	**45.61**	**41.72**
	Lag Time	min	**34.73**	**22.93**	**67.52**	**37.50**	**60.52**	**9.26**	**72.81**	**18.39**	**24.48**	**8.55**	**20.42**	**27.36**	**25.03**

Alum Creek Watershed, Bastrop, TX Time of Concentration														
Variable	Variable description	Unit	Subbasin LAC_40	Subbasin AC_120	Subbasin ACT8_10	Subbasin ACT8_30	Subbasin ACT162_20	Subbasin ACT1_10	Subbasin ACT11_30	Subbasin ACT107A_10	Subbasin PC_10	Subbasin ACT11_20	Subbasin ACT11_10	Subbasin ACT93_10
Sheet Flow [eq. 3-3]														
n	Manning's roughness coefficient (table 3-1)	n/a	0.4	0.4	0.4	0.24	0.4	0.4	0.13	0.15	0.4	0.13	0.15	0.08
L	flow length	ft	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
P_2	2-year, 24-hour rainfall	in	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17
s	slope of hydraulic grade line (land slope)	ft/ft	0.067	0.031	0.039	0.040	0.011	0.085	0.010	0.019	0.040	0.034	0.023	0.050
T_t	travel time	hr	0.19	0.26	0.24	0.16	0.40	0.18	0.17	0.15	0.24	0.10	0.14	0.06
Shallow Concentrated Flow [eq. 3-1]														
L	flow length	ft	2088.86	5896.47	3022.74	3427.78	3332.14	4932.86	2006.74	3510.49	1649.84	3531.49	6319.44	5959.70
s	slope of hydraulic grade line (watercourse slope)	ft/ft	0.043	0.013	0.030	0.024	0.027	0.020	0.022	0.025	0.041	0.017	0.010	0.012
n/a	surface (Unpaved, Paved)	n/a	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved
V	average velocity	ft/s	3.35	1.85	2.78	2.51	2.64	2.28	2.37	2.56	3.28	2.11	1.57	1.76
T_t	travel time	hr	0.173	0.887	0.302	0.379	0.350	0.601	0.235	0.381	0.140	0.465	1.116	0.941
Channel Flow [eq. 3-4 and eq. 3-1]														
L	flow length	ft	6777.22	570.80	3673.19	3584.69	9390.54	1493.36	7635.21	1294.81	4934.38	3426.77	2856.08	2482.91
a	cross sectional flow area	ft^2	208.66	57.73	135.93	37.43	79.23	1.41	61.01	190.39	184.41	175.68	98.47	53.89
p_w	wetted perimeter	ft	45.32	25.09	48.65	24.35	30.79	14.92	27.68	43.34	42.38	58.03	105.10	27.58
r	hydraulic radius = a/p_w	ft	4.60	2.30	2.79	1.54	2.57	0.09	2.20	4.39	4.35	3.03	0.94	1.95
s	slope of hydraulic grade line (channel slope)	ft/ft	0.003	0.003	0.009	0.008	0.008	0.004	0.004	0.016	0.014	0.005	0.004	0.004
n	Manning's roughness coefficient for open channel flow	n/a	0.05	0.045	0.05	0.04	0.05	0.05	0.05	0.045	0.05	0.045	0.04	0.055
V	average velocity	ft/s	4.76	3.11	5.48	4.30	5.10	0.41	3.01	11.09	9.46	4.90	2.17	2.78
T_t	travel time	hr	0.395	0.051	0.186	0.232	0.512	1.010	0.705	0.032	0.145	0.194	0.366	0.248
Total Travel Time (Tt)		hr	0.76	1.20	0.73	0.77	1.26	1.79	1.11	0.56	0.52	0.76	1.62	1.25
Time of Concentration (TOC_min)		min	**45.71**	**72.02**	**43.75**	**46.17**	**75.71**	**107.22**	**66.62**	**33.58**	**31.36**	**45.72**	**97.03**	**74.95**
Lag Time		min	**27.43**	**43.21**	**26.25**	**27.70**	**45.43**	**64.33**	**39.97**	**20.15**	**18.82**	**27.43**	**58.22**	**44.97**

Alum Creek Watershed, Bastrop, TX Time of Concentration

Variable	Variable description	Unit	Subbasin ACT4_50	Subbasin ACT4_10	Subbasin ACT4_20	Subbasin ACT4_40	Subbasin ACT4_30	Subbasin ACT3_30	Subbasin ACT2_10	Subbasin ACT8_20	Subbasin ACT5_10	Subbasin ACT9_10	Subbasin ACT173_10	Subbasin LAC_20	Subbasin LAC_10	Subbasin ACT110_10
	Sheet Flow [eq. 3-3]															
n	Manning's roughness coefficient (table 3-1)	n/a	0.15	0.4	0.24	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.28
L	flow length	ft	100.0	100.0	99.3	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	101.0	100.0	100.0
P_2	2-year, 24-hour rainfall	in	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17
s	slope of hydraulic grade line (land slope)	ft/ft	0.040	0.043	0.040	0.011	0.041	0.013	0.030	0.019	0.066	0.011	0.045	0.021	0.012	0.060
T_t	travel time	hr	0.11	0.23	0.16	0.40	0.24	0.37	0.27	0.32	0.19	0.40	0.23	0.31	0.38	0.15
	Shallow Concentrated Flow [eq. 3-1]															
L	flow length	ft	7141.31	3093.11	6211.74	4058.58	2208.99	4100.57	3419.29	1160.52	2616.52	7795.54	4679.73	6510.52	3580.36	4993.79
s	slope of hydraulic grade line (watercourse slope)	ft/ft	0.022	0.028	0.015	0.024	0.040	0.027	0.018	0.047	0.046	0.005	0.016	0.014	0.016	0.021
n/a	surface (Unpaved, Paved)	n/a	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved
V	average velocity	ft/s	2.41	2.70	1.97	2.49	3.23	2.65	2.18	3.50	3.48	1.15	2.03	1.90	2.07	2.32
T_t	travel time	hr	0.823	0.318	0.876	0.453	0.190	0.430	0.435	0.092	0.209	1.879	0.639	0.951	0.481	0.598
	Channel Flow [eq. 3-4 and eq. 3-1]															
L	flow length	ft	2212.76	8669.86	1258.00	1070.06	275.83	3614.36	8325.38	3694.55	2660.96	901.83	3771.56	7133.71	2428.96	751.73
a	cross sectional flow area	ft^2	DAM	200.52	57.71	59.26	19.11	140.97	136.10	130.64	57.35	0.28	247.17	27.93	90.15	9.05
p_w	wetted perimeter	ft	DAM	49.59	45.11	27.94	32.91	38.30	35.47	54.23	30.61	5.94	52.29	30.31	39.98	20.99
r	hydraulic radius = a/p_w	ft	DAM	4.04	1.28	2.12	0.58	3.68	3.84	2.41	1.87	0.05	4.73	0.92	2.26	0.43
s	slope of hydraulic grade line (channel slope)	ft/ft	-0.004	0.008	0.004	0.005	0.001	0.006	0.009	0.006	0.016	0.005	0.011	0.003	0.013	0.008
n	Manning's roughness coefficient for open channel flow	n/a	0.045	0.045	0.045	0.045	0.045	0.05	0.05	0.05	0.05	0.04	0.04	0.05	0.04	0.045
V	average velocity	ft/s	DAM	7.42	2.56	3.90	0.88	5.36	6.77	4.18	5.75	0.33	10.90	1.69	7.30	1.67
T_t	travel time	hr	0.000	0.324	0.137	0.076	0.087	0.187	0.341	0.245	0.129	0.749	0.096	1.174	0.092	0.125
	Total Travel Time (Tt)	hr	0.93	0.87	1.17	0.93	0.51	0.99	1.04	0.66	0.53	3.03	0.96	2.43	0.96	0.87
	Time of Concentration (TOC_min)	min	**55.91**	**52.42**	**70.14**	**55.90**	**30.76**	**59.55**	**62.57**	**39.49**	**31.91**	**181.67**	**57.76**	**146.05**	**57.35**	**52.47**
	Lag Time	min	**33.55**	**31.45**	**42.09**	**33.54**	**18.46**	**35.73**	**37.54**	**23.69**	**19.14**	**109.00**	**34.66**	**87.63**	**34.41**	**31.48**

Alum Creek Watershed, Bastrop, TX Time of Concentration															
Variable	Variable description	Unit	Subbasin ACT10_10	Subbasin ACT137_10	Subbasin ACT138_10	Subbasin PC_30	Subbasin PC_20	Subbasin ACT143_10	Subbasin ACT6_10	Subbasin ACT67_10	Subbasin ACT175_20	Subbasin ACT175_10	Subbasin ACT169_20	Subbasin ACT169_10	Subbasin ACT168_20
Sheet Flow [eq. 3-3]															
n	Manning's roughness coefficient (table 3-1)	n/a	0.011	0.24	0.24	0.24	0.4	0.4	0.4	0.13	0.4	0.24	0.4	0.4	0.13
L	flow length	ft	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.8	100.0
P_2	2-year, 24-hour rainfall	in	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17
s	slope of hydraulic grade line (land slope)	ft/ft	0.056	0.039	0.022	0.019	0.042	0.013	0.036	0.060	0.072	0.019	0.058	0.022	0.011
T_t	travel time	hr	0.01	0.16	0.20	0.21	0.23	0.37	0.25	0.08	0.19	0.21	0.21	0.30	0.16
Shallow Concentrated Flow [eq. 3-1]															
L	flow length	ft	3387.75	1457.34	1585.05	902.07	2696.55	2096.27	2329.76	4931.29	1701.79	2089.57	4457.14	1914.55	1717.49
s	slope of hydraulic grade line (watercourse slope)	ft/ft	0.016	0.030	0.025	0.041	0.031	0.030	0.020	0.020	0.054	0.020	0.024	0.032	0.025
n/a	surface (Unpaved, Paved)	n/a	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved
V	average velocity	ft/s	2.01	2.78	2.53	3.27	2.83	2.80	2.28	2.30	3.73	2.28	2.52	2.86	2.57
T_t	travel time	hr	0.468	0.146	0.174	0.077	0.265	0.208	0.284	0.596	0.127	0.254	0.492	0.186	0.186
Channel Flow [eq. 3-4 and eq. 3-1]															
L	flow length	ft	11151.89	3484.65	10645.41	4383.47	3426.93	4097.50	8145.45	954.22	1310.47	3590.05	297.50	1028.26	2357.01
a	cross sectional flow area	ft^2	282.45	56.61	30.30	16.84	234.01	325.60	48.26	26.08	47.39	67.01	11.28	62.04	61.23
p_w	wetted perimeter	ft	67.12	25.25	36.01	21.08	53.50	59.61	27.95	18.33	18.63	22.12	18.01	39.24	30.87
r	hydraulic radius = a/p_w	ft	4.21	2.24	0.84	0.80	4.37	5.46	1.73	1.42	2.54	3.03	0.63	1.58	1.98
s	slope of hydraulic grade line (channel slope)	ft/ft	0.004	0.011	0.006	0.008	0.012	0.011	0.007	0.006	0.010	0.019	0.004	0.003	0.009
n	Manning's roughness coefficient for open channel flow	n/a	0.05	0.05	0.05	0.05	0.05	0.045	0.05	0.045	0.05	0.045	0.04	0.05	0.045
V	average velocity	ft/s	5.09	5.38	2.34	2.32	8.62	10.72	3.61	3.13	6.26	9.43	1.68	2.10	4.90
T_t	travel time	hr	0.608	0.180	1.263	0.524	0.110	0.106	0.626	0.085	0.058	0.106	0.049	0.136	0.134
Total Travel Time (Tt)		hr	1.09	0.49	1.64	0.81	0.61	0.69	1.16	0.76	0.37	0.57	0.75	0.62	0.48
Time of Concentration (TOC_min)		min	**65.30**	**29.10**	**98.27**	**48.77**	**36.54**	**41.11**	**69.45**	**45.76**	**22.36**	**34.37**	**44.82**	**37.48**	**28.76**
Lag Time		min	**39.18**	**17.46**	**58.96**	**29.26**	**21.93**	**24.67**	**41.67**	**27.46**	**13.42**	**20.62**	**26.89**	**22.49**	**17.26**

Alum Creek Watershed, Bastrop, TX Time of Concentration														
Variable	Variable description	Unit	Subbasin ACT168_10	Subbasin ACT162_10	Subbasin ACT148_20	Subbasin ACT148_10	Subbasin ACT87_10	Subbasin ACT7_10	Subbasin ACT129_20	Subbasin ACT129_10	Subbasin ACT166_20	Subbasin ACT166_10	Subbasin ACT167_20	Subbasin ACT167_10
Sheet Flow [eq. 3-3]														
n	Manning's roughness coefficient (table 3-1)	n/a	0.24	0.24	0.24	0.4	0.4	0.4	0.4	0.4	0.4	0.24	0.24	0.4
L	flow length	ft	100.7	100.0	100.6	100.0	100.0	100.9	100.0	100.0	100.0	100.0	101.3	100.0
P_2	2-year, 24-hour rainfall	in	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17
s	slope of hydraulic grade line (land slope)	ft/ft	0.022	0.045	0.039	0.094	0.009	0.018	0.028	0.012	0.008	0.024	0.051	0.009
T_t	travel time	hr	0.20	0.15	0.16	0.17	0.44	0.33	0.28	0.39	0.46	0.19	0.14	0.43
Shallow Concentrated Flow [eq. 3-1]														
L	flow length	ft	2872.71	2570.75	4061.95	2069.40	2834.13	6139.97	6247.92	2741.66	2527.95	3115.21	3205.77	2783.79
s	slope of hydraulic grade line (watercourse slope)	ft/ft	0.024	0.026	0.017	0.030	0.022	0.011	0.023	0.030	0.047	0.027	0.033	0.033
n/a	surface (Unpaved, Paved)	n/a	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved
V	average velocity	ft/s	2.52	2.61	2.10	2.81	2.37	1.67	2.45	2.79	3.50	2.64	2.94	2.94
T_t	travel time	hr	0.317	0.273	0.536	0.204	0.333	1.022	0.709	0.273	0.201	0.328	0.303	0.263
Channel Flow [eq. 3-4 and eq. 3-1]														
L	flow length	ft	2021.88	3675.56	4621.46	538.37	2178.78	2787.08	463.70	202.21	1664.15	981.75	1041.51	177.43
a	cross sectional flow area	ft^2	65.25	45.77	133.19	117.72	32.29	70.65	8.56	1.42	26.86	79.23	65.67	32.20
p_w	wetted perimeter	ft	21.32	19.36	43.87	37.37	18.39	21.04	20.95	5.90	18.66	30.79	36.40	15.49
r	hydraulic radius = a/p_w	ft	3.06	2.36	3.04	3.15	1.76	3.36	0.41	0.24	1.44	2.57	1.80	2.08
s	slope of hydraulic grade line (channel slope)	ft/ft	0.016	0.012	0.008	0.016	0.015	0.003	0.006	0.010	0.011	0.013	0.014	0.014
n	Manning's roughness coefficient for open channel flow	n/a	0.05	0.04	0.04	0.045	0.05	0.055	0.04	0.04	0.045	0.045	0.045	0.045
V	average velocity	ft/s	7.90	7.30	7.03	8.89	5.28	3.27	1.60	1.42	4.33	7.20	5.85	6.38
T_t	travel time	hr	0.071	0.140	0.183	0.017	0.115	0.237	0.080	0.040	0.107	0.038	0.049	0.008
Total Travel Time (Tt)		hr	0.59	0.56	0.88	0.39	0.88	1.59	1.07	0.70	0.77	0.56	0.50	0.70
Time of Concentration (TOC_min)		min	**35.40**	**33.87**	**52.79**	**23.41**	**52.97**	**95.24**	**63.92**	**42.09**	**46.00**	**33.63**	**29.83**	**42.05**
Lag Time		min	**21.24**	**20.32**	**31.67**	**14.04**	**31.78**	**57.14**	**38.35**	**25.25**	**27.60**	**20.18**	**17.90**	**25.23**

Alum Creek Watershed, Bastrop, TX Time of Concentration								
Variable	Variable description	Unit	Subbasin ACT131_10	Subbasin ACT107_10	Subbasin AC_10	Subbasin ACT124_10	Subbasin ACT174_20	Subbasin ACT160_20
	Sheet Flow [eq. 3-3]							
n	Manning's roughness coefficient (table 3-1)	n/a	0.4	0.4	0.4	0.24	0.4	0.4
L	flow length	ft	100.0	101.0	101.4	99.8	101.3	100.0
P_2	2-year, 24-hour rainfall	in	4.17	4.17	4.17	4.17	4.17	4.17
s	slope of hydraulic grade line (land slope)	ft/ft	0.016	0.020	0.009	0.048	0.028	0.072
T_t	travel time	hr	0.34	0.32	0.44	0.15	0.28	0.19
	Shallow Concentrated Flow [eq. 3-1]							
L	flow length	ft	5060.97	4537.21	3117.18	6343.15	1309.88	4918.29
s	slope of hydraulic grade line (watercourse slope)	ft/ft	0.015	0.018	0.015	0.017	0.063	0.018
n/a	surface (Unpaved, Paved)	n/a	unpaved	unpaved	unpaved	unpaved	unpaved	unpaved
V	average velocity	ft/s	1.96	2.17	1.97	2.10	4.04	2.16
T_t	travel time	hr	0.716	0.581	0.440	0.838	0.090	0.631
	Channel Flow [eq. 3-4 and eq. 3-1]							
L	flow length	ft	779.67	2598.86	751.35	2336.36	773.06	981.55
a	cross sectional flow area	ft^2	25.32	196.74	110.55	185.19	24.27	33.70
p_w	wetted perimeter	ft	15.63	42.35	63.23	47.75	21.14	12.86
r	hydraulic radius = a/p_w	ft	1.62	4.65	1.75	3.88	1.15	2.62
s	slope of hydraulic grade line (channel slope)	ft/ft	0.004	0.012	0.008	0.007	0.012	0.013
n	Manning's roughness coefficient for open channel flow	n/a	0.06	0.055	0.045	0.045	0.045	0.05
V	average velocity	ft/s	2.08	8.26	4.16	7.07	3.94	6.48
T_t	travel time	hr	0.104	0.087	0.050	0.092	0.054	0.042
	Total Travel Time (Tt)	hr	1.16	0.99	0.93	1.08	0.42	0.86
	Time of Concentration (TOC_min)	min	**69.88**	**59.19**	**55.81**	**64.54**	**25.24**	**51.67**
	Lag Time	min	**41.93**	**35.52**	**33.49**	**38.73**	**15.14**	**31.00**

Appendix E: Hydrologic Model Analysis

E-4 Routing – Modified Puls

Alum Creek Modified Puls Routing Step Calculations								
							Time Step (min) =	2
Creek/River	HEC-HMS Reach Name	Upstream	Downstream	Length	Channel Velocity[1]	Floodwave Velocity[2]	# Subreaches for Mod Puls[3]	# Subreaches for Mod Puls[4]
ALUM CREEK	R_AC20	110630	101447	9183	5.8	8.6	8.9	10
	R_AC30	101447	93786	7661	4.7	7.1	9.1	10
	R_AC40	93786	88575	5211	3.1	4.6	9.3	10
	R_AC50	88575	84471	4104	3.6	5.5	6.3	7
	R_AC60	84471	80446	4025	2.6	3.9	8.5	9
	R_AC70	80446	77859	2587	3.3	4.9	4.4	5
	R_AC80	77859	75022	2837	3.3	4.9	4.8	5
	R_AC90	75022	72301	2721	3.0	4.5	5.1	6
	R_AC100	72301	68707	3594	3.3	4.9	6.1	7
	R_AC110	68707	62845	5862	3.7	5.5	8.9	9
	R_AC120	62844	58678	4166	3.2	4.8	7.2	8
	R_AC130	58678	56080	2598	2.8	4.2	5.2	6
	R_AC140	56080	53037	3043	3.5	5.2	4.9	5
	R_AC150	53037	46845	6192	5.3	7.9	6.5	7
	R_AC160	46845	42035	4810	3.3	4.9	8.2	9
	R_AC170	42035	39400	2635	3.3	4.9	4.5	5
	R_AC180	39400	35952	3448	3.1	4.7	6.1	7
	R_AC190	35952	31214	4738	4.6	6.9	5.8	6
	R_AC200	31214	26699	4515	4.3	6.5	5.8	6
	R_AC210	26699	25354	1345	6.3	9.4	1.2	2
	R_AC220	25354	21091	4263	4.5	6.7	5.3	6
	R_AC230	21091	10172	10919	4.2	6.4	14.3	15
	R_AC240	10172	1372	8800	5.2	7.8	9.3	10
	R_AC260	1372	542	830	6.9	10.3	0.7	1
ALUM CREEK TRIBUTARY 1	R_ACT1_20	10514	2082	8432	3.0	4.4	15.8	16
	R_ACT1_30	2082	463	1619	5.0	7.5	1.8	2
ALUM CREEK TRIBUTARY 2	R_ACT2_20	8299	898	7401	6.0	9.1	6.8	7
ALUM CREEK TRIBUTARY 3	R_ACT3_40	6069	1642	4427	7.1	10.7	3.4	4
ALUM CREEK TRIBUTARY 4	R_ACT4_30	11456	10249	1207	2.6	3.9	2.6	3
	R_ACT4_40	10249	7729	2520	2.2	3.3	6.4	7
	R_ACT4_50	7729	5048	2681	1.8	2.6	8.5	9
	R_ACT4_60	5048	653	4395	3.7	5.6	6.6	7
ALUM CREEK TRIBUTARY 5	R_ACT5_20	9233	237	8996	4.9	7.4	10.2	11

Alum Creek Modified Puls Routing Step Calculations								
							Time Step (min) =	2
Creek/River	HEC-HMS Reach Name	Upstream	Downstream	Length	Channel Velocity[1]	Floodwave Velocity[2]	# Subreaches for Mod Puls[3]	# Subreaches for Mod Puls[4]
ALUM CREEK TRIBUTARY 6	R_ACT6_20	6134	1817	4317	2.9	4.3	8.4	9
ALUM CREEK TRIBUTARY 7	R_ACT7_20	16107	13455	2652	4.0	6.0	3.7	4
	R_ACT7_30	13455	11436	2019	4.1	6.1	2.8	3
	R_ACT7_40	11436	4146	7290	4.4	6.6	9.3	10
	R_ACT7_50	4146	1537	2609	4.5	6.8	3.2	4
ALUM CREEK TRIBUTARY 8	R_ACT8_30	5879	444	5435	3.3	5.0	9.1	10
ALUM CREEK TRIBUTARY 9	R_ACT9_20	14583	6370	8213	3.2	4.8	14.4	15
	R_ACT9_30	6370	1058	5312	2.9	4.3	10.2	11
ALUM CREEK TRIBUTARY 10	R_ACT10_20	6658	3209	3449	3.7	5.5	5.2	6
	R_ACT10_30	3209	87	3122	3.3	5.0	5.2	6
ALUM CREEK TRIBUTARY 11	R_ACT11_20	11432	7603	3829	3.9	5.9	5.4	6
	R_ACT11_30	7603	71	7532	3.1	4.6	13.7	14
ALUM CREEK TRIBUTARY 67	R_ACT067_20	4406	2748	1658	3.7	5.6	2.5	3
ALUM CREEK TRIBUTARY 87	R_ACT087_20	4149	215	3934	3.9	5.8	5.6	6
ALUM CREEK TRIBUTARY 93	R_ACT093_20	2924	431	2493	2.4	3.7	5.7	6
ALUM CREEK TRIBUTARY 107	R_ACT107_20	7256	6494	762	6.6	10.0	0.6	1
	R_ACT107_30	6494	1136	5358	5.0	7.6	5.9	6
ALUM CREEK TRIBUTARY 107A	R_ACT107A_10	604	175	429	8.7	13.1	0.3	1
ALUM CREEK TRIBUTARY 110	R_ACT110_20	2520	642	1878	3.9	5.9	2.7	3
ALUM CREEK TRIBUTARY 124	R_ACT124_20	3474	171	3303	4.7	7.1	3.9	4
ALUM CREEK TRIBUTARY 129	R_ACT129_20	8110	3166	4944	3.4	5.1	8.0	9
	R_ACT129_30	3166	974	2192	4.3	6.5	2.8	3
ALUM CREEK TRIBUTARY 131	R_ACT131_20	7022	561	6461	2.7	4.0	13.4	14
ALUM CREEK TRIBUTARY 137	R_ACT137_20	7797	543	7254	3.9	5.9	10.3	11
ALUM CREEK TRIBUTARY 138	R_ACT138_20	2336	124	2212	2.7	4.1	4.5	5

Alum Creek Modified Puls Routing Step Calculations								
							Time Step (min) =	2
Creek/River	HEC-HMS Reach Name	Upstream	Downstream	Length	Channel Velocity[1]	Floodwave Velocity[2]	# Subreaches for Mod Puls[3]	# Subreaches for Mod Puls[4]
ALUM CREEK TRIBUTARY 143	R_ACT143_20	3046	1050	1996	5.4	8.2	2.0	3
ALUM CREEK TRIBUTARY 148	R_ACT148_20	12191	4204	7987	6.0	9.1	7.3	8
	R_ACT148_30	4204	1107	3097	6.0	8.9	2.9	3
ALUM CREEK TRIBUTARY 160	R_ACT160_20	4688	17	4671	5.6	8.4	4.6	5
ALUM CREEK TRIBUTARY 162	R_ACT162_20	9725	336	9389	5.6	8.4	9.3	10
ALUM CREEK TRIBUTARY 166	R_ACT166_20	9140	5792	3348	5.0	7.6	3.7	4
	R_ACT166_30	5792	1133	4659	4.1	6.2	6.3	7
ALUM CREEK TRIBUTARY 167	R_ACT167_20	2464	98	2366	5.2	7.7	2.5	3
ALUM CREEK TRIBUTARY 168	R_ACT168_20	3040	200	2840	4.6	7.0	3.4	4
ALUM CREEK TRIBUTARY 169	R_ACT169_20	5917	2695	3222	3.7	5.5	4.9	5
	R_ACT169_30	2695	622	2073	4.2	6.3	2.7	3
ALUM CREEK TRIBUTARY 173	R_ACT173_20	13553	8991	4562	5.9	8.8	4.3	5
	R_ACT173_30	8991	6474	2517	5.3	8.0	2.6	3
	R_ACT173_40	6474	656	5818	5.0	7.5	6.4	7
ALUM CREEK TRIBUTARY 174	R_ACT174_20	1400	62	1338	4.4	6.6	1.7	2
ALUM CREEK TRIBUTARY 175	R_ACT175_20	1733	182	1551	5.2	7.8	1.7	2
LITTLE ALUM CREEK	R_LAC_20	35309	24602	10707	4.1	6.2	14.4	15
	R_LAC_30	24602	18161	6441	5.8	8.7	6.2	7
	R_LAC_40	18161	10374	7787	4.6	6.9	9.4	10
	R_LAC_50	10374	1468	8906	4.2	6.3	11.8	12
	R_LAC_60	1468	54	1414	5.8	8.7	1.4	2
PRICE CREEK	R_PC_20	9949	7635	2314	6.7	10.0	1.9	2
	R_PC_30	7635	2817	4818	5.6	8.4	4.8	5
	R_PC_40	2817	1229	1588	5.4	8.1	1.6	2

Notes:

[1] Average channel velocity calculated in RAS Routing Model (V2)

[2] Flood Wave Velocity = 1.5 * average channel velocity

[3] Number of Routing Steps = (River Length / Flood Wave Velocity) * (1 / 60 min/s) / Time Step, where Flood Wave Velocity = 1.5 * average channel velocity

[4] Rounded Steps = the number of routing steps rounded up

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek

R_AC20	
From_RS	to_RS
110630	101447
Volume (acre-ft)	Q Total (cfs)
0	0
24.61	500
40.63	1000
73.66	2000
111.21	3000
148.96	4000
187.99	5000
223.34	6000
290.84	8000
415.78	12000
543.51	16000
661.11	20000
775.1	24000

R_AC30	
From_RS	to_RS
101447	93786
Volume (acre-ft)	Q Total (cfs)
0	0
32.42	500
54.86	1000
92.14	2000
126.05	3000
157.36	4000
186.2	5000
213.06	6000
265.45	8000
364.34	12000
459.58	16000
552.5	20000
640.59	24000

R_AC40	
From_RS	to_RS
93786	88575
Volume (acre-ft)	Q Total (cfs)
0	0
48.65	500
78.43	1000
115.97	2000
152.26	3000
186.22	4000
215.36	5000
245.6	6000
302.23	8000
406.12	12000
502.16	16000
593.9	20000
683.24	24000

R_AC50	
From_RS	to_RS
88575	84471
Volume (acre-ft)	Q Total (cfs)
0	0
34.61	500
60.49	1000
104.1	2000
140.19	3000
174.41	4000
206.92	5000
238.43	6000
300.15	8000
421.1	12000
540.39	16000
659.51	20000
771.22	24000

R_AC60	
From_RS	to_RS
84471	80446
Volume (acre-ft)	Q Total (cfs)
0	0
51.25	500
90.49	1000
244.69	3000
398.45	5000
591.8	8000
1033.4	16000
1401.13	24000
1594.47	28000
1889.82	35000
2103.97	42000
2284.57	49000
2465.74	56000

R_AC70	
From_RS	to_RS
80446	77859
Volume (acre-ft)	Q Total (cfs)
0	0
22.15	500
41.34	1000
106.58	3000
201.36	5000
272.41	8000
412.22	16000
555.28	24000
632.83	28000
763.67	35000
855.74	42000
970.36	49000
1066.5	56000

R_AC80	
From_RS	to_RS
77859	75022
Volume (acre-ft)	Q Total (cfs)
0	0
26.64	500
59.81	1000
97.78	3000
144.82	5000
203.23	8000
326.99	16000
451.51	24000
515.55	28000
639.06	35000
748.52	42000
844.56	49000
937.82	56000

R_AC90	
From_RS	to_RS
75022	72301
Volume (acre-ft)	Q Total (cfs)
0	0
19.82	500
40.73	1000
115.1	3000
177.43	5000
260.66	8000
450.31	16000
612.48	24000
687.75	28000
810.8	35000
925.98	42000
1028.02	49000
1125.33	56000

R_AC100	
From_RS	to_RS
72301	68707
Volume (acre-ft)	Q Total (cfs)
0	0
28.81	500
70.61	1000
146.04	3000
198.86	5000
272.8	8000
439.73	16000
584.46	24000
655.18	28000
756.15	35000
857.81	42000
944.56	49000
1034.71	56000

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek (Continued)

R_AC110	
From_RS	to_RS
68707	62845
Volume (acre-ft)	Q Total (cfs)
0	0
131.12	500
222.88	1000
505.39	3000
731.82	5000
1022.06	8000
1702.46	16000
2304.7	24000
2587.17	28000
3043.27	35000
3482.23	42000
3905.14	49000
4320.06	56000

R_AC120	
From_RS	to_RS
62845	58678
Volume (acre-ft)	Q Total (cfs)
0	0
47.58	500
82.54	1000
164.23	3000
234.12	5000
323.85	8000
518.74	16000
682.01	24000
756.72	28000
878.85	35000
994.94	42000
1106.69	49000
1215.56	56000

R_AC130	
From_RS	to_RS
58678	56080
Volume (acre-ft)	Q Total (cfs)
0	0
42.99	500
75.3	1000
161.97	3000
234.83	5000
327.28	8000
521.97	16000
681.31	24000
752.97	28000
870.07	35000
978.99	42000
1082.22	49000
1180.64	56000

R_AC140	
From_RS	to_RS
56080	53037
Volume (acre-ft)	Q Total (cfs)
0	0
11.95	500
35.1	1000
136.29	3000
217.8	5000
297.8	8000
475.25	16000
615.81	24000
678.57	28000
780.56	35000
875.01	42000
1129.68	63000
1361.95	84000

R_AC150	
From_RS	to_RS
53037	46845
Volume (acre-ft)	Q Total (cfs)
0	0
29.42	500
54.9	1000
171.59	3000
262.56	5000
422.76	8000
781.53	16000
1099.55	24000
1231.85	28000
1473.58	35000
1702.33	42000
2330.41	63000
2907.43	84000

R_AC160	
From_RS	to_RS
46845	42035
Volume (acre-ft)	Q Total (cfs)
0	0
26.53	500
73.8	1000
204.26	3000
301.47	5000
445.89	8000
787.82	16000
1079.76	24000
1212.47	28000
1429.42	35000
1628.73	42000
2163.54	63000
2634.1	84000

R_AC170	
From_RS	to_RS
42035	39400
Volume (acre-ft)	Q Total (cfs)
0	0
13.58	500
24.78	1000
62.96	3000
105.59	5000
168.26	8000
324.15	16000
471.63	24000
534.9	28000
640.33	35000
738.77	42000
1006.39	63000
1245.88	84000

R_AC180	
From_RS	to_RS
39400	35952
Volume (acre-ft)	Q Total (cfs)
0	0
22.07	500
35.54	1000
77.57	3000
122.73	5000
203.2	8000
438.37	16000
644.71	24000
718.14	28000
840.73	35000
951.77	42000
1241.62	63000
1489.04	84000

R_AC190	
From_RS	to_RS
35952	31214
Volume (acre-ft)	Q Total (cfs)
0	0
16.82	500
33.01	1000
100.72	3000
153.59	5000
228.16	8000
438.66	16000
609.59	24000
692.64	28000
831.55	35000
962.24	42000
1315.04	63000
1644.46	84000

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek (Continued)

R_AC200	
From_RS	to_RS
31214	26699
Volume (acre-ft)	Q Total (cfs)
0	0
18.14	500
33.6	1000
93.89	3000
142.27	5000
208.42	8000
451.43	16000
669.16	24000
800.56	28000
936.51	35000
1065.88	42000
1399.73	63000
1690.87	84000

R_AC210	
From_RS	to_RS
26699	25354
Volume (acre-ft)	Q Total (cfs)
0	0
11.22	500
26.59	1000
86.9	3000
131.69	5000
163.21	8000
363.26	16000
515.08	24000
683.51	28000
725.02	35000
767.06	42000
880.43	63000
985.61	84000

R_AC220	
From_RS	to_RS
25354	21091
Volume (acre-ft)	Q Total (cfs)
0	0
16.24	500
36.9	1000
107.24	3000
163.04	5000
243.6	8000
535.67	16000
735.96	24000
882.83	28000
1060.69	35000
1244.65	42000
1837.06	63000
2334.96	84000

R_AC230	
From_RS	to_RS
21091	10172
Volume (acre-ft)	Q Total (cfs)
0	0
44.27	500
76.15	1000
206.08	3000
320.85	5000
497.15	8000
1030.31	16000
1702.05	24000
2068.12	28000
2710.46	35000
3370.4	42000
5314.85	63000
7096.8	84000

R_AC240	
From_RS	to_RS
10172	1372
Volume (acre-ft)	Q Total (cfs)
0	0
36.98	500
61.27	1000
143.48	3000
228.23	5000
461.5	8000
1123.39	16000
1793.17	24000
2229.02	28000
3010.95	35000
3617.83	42000
5334.73	63000
6476.61	84000

R_AC260	
From_RS	to_RS
1372	542
Volume (acre-ft)	Q Total (cfs)
0	0
2.78	500
4.64	1000
10.41	3000
15.22	5000
21.66	8000
48.13	16000
80.32	24000
97.63	28000
125.74	35000
157.04	42000
257.56	63000
317.24	84000

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek Tributary 1

R_ACT1_20	
From_RS	to_RS
10514	2082
Volume (acre-ft)	Q Total (cfs)
0	0
57.35	500
96.4	1000
131.85	1500
166.14	2000
200.01	2500
301.31	4000
394.64	5500
470.74	7000
547.76	8700
618.99	10400
684.64	12000
744.98	13500

R_ACT1_30	
From_RS	to_RS
2082	463
Volume (acre-ft)	Q Total (cfs)
0	0
4.43	500
8.77	1000
14.97	1500
21.22	2000
27.2	2500
44.7	4000
58.27	5500
70.55	7000
82.73	8700
93.84	10400
103.59	12000
112.2	13500

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek Tributary 2

R_ACT2_20	
From_RS	to_RS
8299	898
Volume (acre-ft)	Q Total (cfs)
0	0
10.61	200
22.29	530
33.88	850
43.49	1180
52.96	1500
75.46	2300
97.61	3100
110.49	3570
128.27	4100
168.52	5450
202.99	6750
252.04	8800

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek Tributary 3

R_ACT3_40	
From_RS	to_RS
6069	1642
Volume (acre-ft)	Q Total (cfs)
0	0
11.15	500
21.5	1000
33.87	1500
64.75	2500
94.65	3500
134.81	5000
160.49	6000
185.82	7000
211.83	8000
235.65	9000
261.29	10000
285.18	11000

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek Tributary 4

R_ACT4_30	
From_RS	to_RS
11456	10249
Volume (acre-ft)	Q Total (cfs)
0	0
2.25	100
4.77	350
6.36	500
38.26	1000
44.11	1500
49.46	2000
53.7	2500
56.38	3000
61.2	4000
65.96	5000
72.14	6500
75.76	7500

R_ACT4_40	
From_RS	to_RS
10249	7729
Volume (acre-ft)	Q Total (cfs)
0	0
5.05	100
27.21	350
48.32	500
130.79	1000
147.91	1500
160.57	2000
170.38	2500
177.26	3000
188.84	4000
199.95	5000
213.8	6500
221.97	7500

R_ACT4_50	
From_RS	to_RS
7729	5048
Volume (acre-ft)	Q Total (cfs)
0	0
131.48	100
202.7	350
234.93	500
281.46	1000
316.27	1500
333.73	2000
346.3	2500
356.75	3000
373.8	4000
388.05	5000
406.15	6500
417.52	7500

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek Tributary 4 (Continued)

R_ACT4_60	
From_RS	to_RS
5048	653
Volume (acre-ft)	Q Total (cfs)
0	0
41.62	100
56.77	350
66.79	500
89.52	1000
104.04	1500
117.58	2000
129.72	2500
141.36	3000
162.01	4000
181.1	5000
207.27	6500
223.49	7500

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek Tributary 5

R_ACT5_20	
From_RS	to_RS
9233	237
Volume (acre-ft)	Q Total (cfs)
0	0
16.9	200
27.9	430
37.35	650
46.01	870
54.23	1090
76.64	1675
97.15	2260
108.12	2585
119.26	2910
151.55	3865
182.23	4820
227.18	6270

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek Tributary 6

R_ACT6_20	
From_RS	to_RS
6134	1817
Volume (acre-ft)	Q Total (cfs)
0	0
2.64	50
4.42	100
7.84	200
11.12	300
14.29	400
17.39	500
31.36	1000
43.27	1500
54.6	2000
64.82	2500
74.3	3000
83.47	3500

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek Tributary 7

R_ACT7_20	
From_RS	to_RS
16107	13455
Volume (acre-ft)	Q Total (cfs)
0	0
17.46	500
28.69	1000
38.05	1450
52.93	2300
61.42	2800
82.28	4055
103.88	5310
114.44	5920
125.51	6530
166.4	8335
211.33	10470
267.4	13620

R_ACT7_30	
From_RS	to_RS
13455	11436
Volume (acre-ft)	Q Total (cfs)
0	0
7.18	500
17.1	1000
24.04	1450
32.65	2300
37.78	2800
49.64	4055
60.38	5310
65.22	5920
69.94	6530
82.63	8335
96.81	10470
117.66	13620

R_ACT7_40	
From_RS	to_RS
11436	4146
Volume (acre-ft)	Q Total (cfs)
0	0
25.41	500
62.22	1000
87.07	1450
126.56	2300
148.45	2800
197.63	4055
243.03	5310
263.86	5920
284.16	6530
340.74	8335
403.34	10470
490.38	13620

R_ACT7_50	
From_RS	to_RS
4146	1537
Volume (acre-ft)	Q Total (cfs)
0	0
17.28	500
35.2	1000
46.61	1450
69.27	2300
81.08	2800
108.63	4055
133.43	5310
144.98	5920
156.57	6530
188.7	8335
226.15	10470
278.62	13620

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek Tributary 8

R_ACT8_30	
From_RS	to_RS
5879	444
Volume (acre-ft)	Q Total (cfs)
0	0
6.28	100
10.05	200
17.02	400
22.58	600
29.01	850
34.99	1100
46.16	1600
56.43	2100
64.3	2500
73.63	3000
91.22	4000
107.67	5000
115.62	5500

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek Tributary 9

R_ACT9_20	
From_RS	to_RS
14583	6370
Volume (acre-ft)	Q Total (cfs)
0	0
21.95	200
48.08	500
89.56	1000
150.14	1800
196.66	2500
293.04	4100
374.35	5600
420.03	6500
459.84	7300
582.81	10000
690.91	12500
769.86	14400

R_ACT9_30	
From_RS	to_RS
6370	1058
Volume (acre-ft)	Q Total (cfs)
0	0
24.48	200
45.01	500
71.81	1000
109.43	1800
139.49	2500
200.9	4100
252.6	5600
281.67	6500
306.9	7300
389.5	10000
462.33	12500
512.7	14400

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek Tributary 10

R_ACT10_20	
From_RS	to_RS
6658	3209
Volume (acre-ft)	Q Total (cfs)
0	0
8.08	200
24.13	800
31.04	1200
38.28	1600
46.99	2000
61.69	2700
81.29	3800
91.63	4400
99.92	4900
123.88	6550
146.38	8200
162.32	9450

R_ACT10_30	
From_RS	to_RS
3209	87
Volume (acre-ft)	Q Total (cfs)
0	0
6.23	200
23.43	800
32	1200
38.78	1600
45.45	2000
56.44	2700
71.08	3800
79.04	4400
85.37	4900
104.91	6550
122.75	8200
136.41	9450

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek Tributary 11

R_ACT11_20	
From_RS	to_RS
11432	7603
Volume (acre-ft)	Q Total (cfs)
0	0
8.87	200
19.87	600
28.6	1000
37.05	1400
45.47	1800
66.08	2800
85.81	3800
97.79	4400
109.53	5000
141.03	6750
170.18	8500
191.06	9800

R_ACT11_30	
From_RS	to_RS
7603	71
Volume (acre-ft)	Q Total (cfs)
0	0
19.7	200
50.16	600
74.82	1000
96.53	1400
117.15	1800
163.75	2800
206.64	3800
232.23	4400
256.47	5000
323.75	6750
390.69	8500
438.67	9800

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek Tributary 67

R_ACT067_20	
From_RS	to_RS
4406	2748
Volume (acre-ft)	Q Total (cfs)
0	0
3.22	200
6.49	400
10.15	700
13.38	1000
15.39	1200
18.17	1500
21.55	1900
24.73	2300
28.49	2800
31.28	3200
35.36	3800
39.29	4400

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek Tributary 87

R_ACT87_20	
From_RS	to_RS
4149	215
Volume (acre-ft)	Q Total (cfs)
0	0
4.31	100
8.26	200
11.15	300
13.17	400
16.72	600
21.69	900
26.44	1200
29.53	1400
33.32	1650
37.2	1900
40.69	2110
45.66	2400

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek Tributary 93

R_ACT93_20	
From_RS	to_RS
2924	431
Volume (acre-ft)	Q Total (cfs)
0	0
3.9	100
7.14	200
12.15	400
17.18	600
22.73	900
30.86	1350
38.14	1800
41.25	2000
45.74	2300
55.4	3000
61.75	3500
67.76	4000

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek Tributary 107

R_ACT107_20	
From_RS	to_RS
7256	6494
Volume (acre-ft)	Q Total (cfs)
0	0
0.68	200
1.3	500
1.95	900
2.75	1400
3.73	2000
4.54	2500
5.38	3000
6.27	3500
7.26	4000
8.55	4500
9.81	5000
11.41	5600

R_ACT107_30	
From_RS	to_RS
6494	1136
Volume (acre-ft)	Q Total (cfs)
0	0
6.72	200
12.71	500
19.2	900
26.69	1400
35.15	2000
41.98	2500
48.74	3000
55.29	3500
62.02	4000
68.5	4500
75	5000
83.04	5600

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek Tributary 107_A

R_ACT107A_10	
From_RS	to_RS
604	175
Volume (acre-ft)	Q Total (cfs)
0	0
0.06	20
0.09	40
0.12	60
0.15	80
0.18	100
0.25	160
0.32	220
0.35	250
0.38	280
0.46	362.5
0.53	445
0.61	534

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek Tributary 110

R_ACT110_20	
From_RS	to_RS
2520	642
Volume (acre-ft)	Q Total (cfs)
0	0
1.94	100
3.22	200
4.26	300
5.7	450
7	600
9.32	900
11.46	1200
13.53	1500
15.51	1800
17.39	2100
19.28	2400
21.19	2700

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek Tributary 124

R_ACT124_20	
From_RS	to_RS
3474	171
Volume (acre-ft)	Q Total (cfs)
0	0
6.1	150
9.17	300
11.61	450
13.26	600
15.02	750
19.21	1100
23.8	1500
27.05	1800
31.95	2200
36.96	2600
41.48	3000
47.31	3450

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek Tributary 129

R_ACT129_20	
From_RS	to_RS
8110	3166
Volume (acre-ft)	Q Total (cfs)
0	0
3.82	50
6.08	100
8.19	150
9.94	200
13.34	300
16.31	400
19.27	500
25.65	750
31.48	1000
36.99	1250
42.44	1500
46.6	1700

R_ACT129_30	
From_RS	to_RS
3166	974
Volume (acre-ft)	Q Total (cfs)
0	0
1.47	50
2.34	100
3.13	150
3.79	200
5.05	300
6.23	400
7.48	500
10.39	750
13.16	1000
15.82	1250
18.44	1500
20.55	1700

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek Tributary 131

R_ACT131_20	
From_RS	to_RS
7022	561
Volume (acre-ft)	Q Total (cfs)
0	0
22.93	200
35.66	400
45.9	600
54.38	800
62.2	1000
80.41	1525
96.25	2050
104.15	2325
111.67	2600
133.73	3450
153.13	4300
172.01	5160

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek Tributary 137

R_ACT137_20	
From_RS	to_RS
7797	543
Volume (acre-ft)	Q Total (cfs)
0	0
11.64	150
18.05	300
24.02	450
34.44	750
43.35	1000
58.71	1400
81.64	2000
98.59	2500
114.59	3000
130.44	3500
163.71	4500
193.83	5500

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek Tributary 138

R_ACT138_20	
From_RS	to_RS
2336	124
Volume (acre-ft)	Q Total (cfs)
0	0
3.4	120
5.53	240
7.26	360
8.79	480
10.92	660
14.48	975
17.97	1290
19.78	1455
21.56	1620
26.45	2090
31.08	2560
36.01	3072

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek Tributary 143

R_ACT143_20	
From_RS	to_RS
3046	1050
Volume (acre-ft)	Q Total (cfs)
0	0
2.1	120
3.36	240
4.42	360
5.32	480
6.3	620
8.18	920
9.79	1220
10.69	1385
11.59	1550
13.99	2000
16.62	2450
19.3	2940

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek Tributary 148

R_ACT148_20	
From_RS	to_RS
12191	4204
Volume (acre-ft)	Q Total (cfs)
0	0
12.32	250
20.07	500
27.46	750
34.74	1000
42.05	1250
61.72	1925
81.67	2600
93.14	3000
104.87	3400
135.8	4550
166.26	5700
203.13	7125

R_ACT148_30	
From_RS	to_RS
4204	1107
Volume (acre-ft)	Q Total (cfs)
0	0
4.8	250
8.04	500
11.3	750
14.76	1000
17.86	1250
23.81	1925
29.62	2600
33.17	3000
36.53	3400
45.85	4550
54.96	5700
66.11	7125

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek Tributary 160

R_ACT160_20	
From_RS	to_RS
4688	17
Volume (acre-ft)	Q Total (cfs)
0	0
2.72	90
5.59	180
7.45	270
9.11	360
10.68	450
14.29	655
17.98	860
20	970
24.14	1200
29.4	1500
32.89	1700
38.11	2000

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek Tributary 162

R_ACT162_20	
From_RS	to_RS
9725	336
Volume (acre-ft)	Q Total (cfs)
0	0
11.18	200
18.57	400
25.66	600
32.47	800
41.59	1100
51.73	1450
61.89	1800
70.57	2100
79.01	2400
96.56	3000
119.77	3800
136.05	4370

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek Tributary 166

R_ACT166_20	
From_RS	to_RS
9140	5792
Volume (acre-ft)	Q Total (cfs)
0	0
4.1	200
7.51	400
10.47	600
13.08	800
15.59	1000
21.1	1500
26.78	2100
29.39	2400
31.91	2700
39.12	3600
46.02	4500
49.61	5000

R_ACT166_30	
From_RS	to_RS
5792	1133
Volume (acre-ft)	Q Total (cfs)
0	0
6.55	200
11.08	400
15.63	600
20.14	800
24.7	1000
34.27	1500
44.69	2100
49.4	2400
54	2700
67.18	3600
80	4500
86.58	5000

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek Tributary 167

R_ACT167_20	
From_RS	to_RS
2464	98
Volume (acre-ft)	Q Total (cfs)
0	0
1.54	100
2.59	200
4.27	400
5.7	600
7.29	800
9.11	1000
10.86	1200
13.87	1500
15.58	1750
17.76	2000
18.44	2100
19.11	2200

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek Tributary 168

R_ACT168_20	
From_RS	to_RS
3040	200
Volume (acre-ft)	Q Total (cfs)
0	0
1.25	50
2.31	100
4.09	200
6.14	300
7.73	400
9.19	500
10.59	600
11.93	700
13.93	850
15.77	1000
18.15	1200
19.31	1300

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek Tributary 169

R_ACT169_20	
From_RS	to_RS
5917	2695
Volume (acre-ft)	Q Total (cfs)
0	0
6.68	200
11.27	400
15.62	600
19.19	800
22.9	1000
27.32	1250
31.86	1500
40.23	2000
47.69	2500
54.55	3000
61.03	3500
67.3	4000

R_ACT169_30	
From_RS	to_RS
2695	622
Volume (acre-ft)	Q Total (cfs)
0	0
4.5	200
7.2	400
10.1	600
13.14	800
16.12	1000
20.05	1250
24.04	1500
31.67	2000
38.75	2500
45.64	3000
52.91	3500
61.1	4000

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek Tributary 173

R_ACT173_20	
From_RS	to_RS
13553	8991
Volume (acre-ft)	Q Total (cfs)
0	0
3.32	100
10.08	400
19.32	900
26.78	1400
34.42	1900
42.78	2500
55.99	3500
64.46	4200
75.51	5100
97.86	7100
107.7	8000
123.21	9200

R_ACT173_30	
From_RS	to_RS
8991	6474
Volume (acre-ft)	Q Total (cfs)
0	0
2.14	100
5.93	400
12.3	900
18.83	1400
24.59	1900
30.96	2500
40.3	3500
46.63	4200
54.28	5100
69.92	7100
76.7	8000
85.58	9200

R_ACT173_40	
From_RS	to_RS
6474	656
Volume (acre-ft)	Q Total (cfs)
0	0
5.35	100
15.76	400
30.8	900
44.78	1400
58.93	1900
75.25	2500
98.88	3500
115.89	4200
136.95	5100
180.02	7100
197.87	8000
221.21	9200

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek Tributary 174

R_ACT174_20	
From_RS	to_RS
1400	62
Volume (acre-ft)	Q Total (cfs)
0	0
0.64	60
1.11	120
1.52	180
1.9	240
2.28	300
3.05	425
3.81	550
4.16	612.5
4.5	675
5.41	847.5
6.31	1020
7.38	1224

Modified Puls Routing Reaches
Storage Outflow Tables - Alum Creek Tributary 175

R_ACT175_20	
From_RS	to_RS
1733	182
Volume (acre-ft)	Q Total (cfs)
0	0
0.9	100
1.51	200
2.11	300
2.79	400
3.77	500
5.75	705
7.45	910
8.36	1030
9.25	1150
11.42	1475
13.62	1800
15.96	2200

Modified Puls Routing Reaches
Storage Outflow Tables - Little Alum Creek

R_LAC_20	
From_RS	to_RS
35309	24602
Volume (acre-ft)	Q Total (cfs)
0	0
188.41	500
243.73	1000
274.12	1500
324.19	2500
369.62	3500
446.52	5000
528.48	7200
557.14	8000
606.32	9500
650.93	11000
680.85	12000
735.59	14000

R_LAC_30	
From_RS	to_RS
24602	18161
Volume (acre-ft)	Q Total (cfs)
0	0
18.58	500
34.71	1000
48.37	1500
72.06	2500
94.42	3500
126.2	5000
172.26	7200
187.42	8000
215.08	9500
241.59	11000
258.6	12000
291.4	14000

R_LAC_40	
From_RS	to_RS
18161	10374
Volume (acre-ft)	Q Total (cfs)
0	0
52.72	500
102.86	1000
165.52	1500
266.53	2500
346.83	3500
463.87	5000
622.74	7200
681.13	8000
786.82	9500
885.45	11000
951.18	12000
1078.61	14000

R_LAC_50	
From_RS	to_RS
10374	1468
Volume (acre-ft)	Q Total (cfs)
0	0
26.83	500
53.4	1000
92.22	1500
153.52	2500
195.89	3500
258.98	5000
344.56	7200
374.28	8000
428.39	9500
479.66	11000
514.35	12000
582.22	14000

R_LAC_60	
From_RS	to_RS
1468	54
Volume (acre-ft)	Q Total (cfs)
0	0
2.85	500
4.66	1000
6.23	1500
9.2	2500
11.69	3500
20.84	5000
28.57	7200
31.5	8000
36.94	9500
42.7	11000
46.47	12000
55.03	14000

Modified Puls Routing Reaches
Storage Outflow Tables - Price Creek

R_PC_20	
From_RS	to_RS
9949	7635
Volume (acre-ft)	**Q Total (cfs)**
0	0
5.63	200
8.2	350
12.4	600
16.47	900
19.99	1200
27.54	2000
33.64	2700
36.91	3100
40.09	3500
43.95	4000
51.73	5000
56.03	5500

R_PC_30	
From_RS	to_RS
7635	2817
Volume (acre-ft)	**Q Total (cfs)**
0	0
7.02	200
12.42	350
18.79	600
27.56	900
36.81	1200
52.12	2000
62.71	2700
68.32	3100
74.41	3500
81.95	4000
93.8	5000
100.52	5500

R_PC_40	
From_RS	to_RS
2817	1229
Volume (acre-ft)	**Q Total (cfs)**
0	0
2.93	200
5.13	350
8.94	600
12.35	900
15.6	1200
22.49	2000
27.74	2700
30.8	3100
33.93	3500
37.81	4000
43.8	5000
46.94	5500

Appendix E: Hydrologic Model Analysis

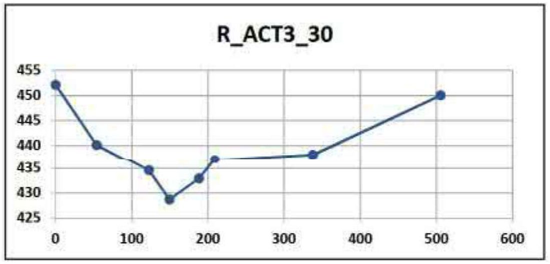
E-5 Routing – Muskingum Cunge

Muskingum-Cunge Routing Reaches							
Reach	Length (FT)	Slope (FT/FT)	Channel Manning's n	Shape	LOB Manning's n	ROB Manning's n	Cross Section Table
R_ACT3_30	7815	0.0170	0.05	Eight Point	0.08	0.08	R_ACT3_30
R_ACT8_20	4955	0.0160	0.05	Eight Point	0.08	0.08	R_ACT8_20

Reach	R_ACT3_30	
Point	Station	Elevation
1	0.00	452.12
2	53.80	440.10
3	122.55	434.57
4	149.46	428.71
5	188.32	432.91
6	209.24	437.01
7	337.77	438.11
8	505.41	450.06

Manning's n		
LOB	Chnl	ROB
0.08	0.05	0.08

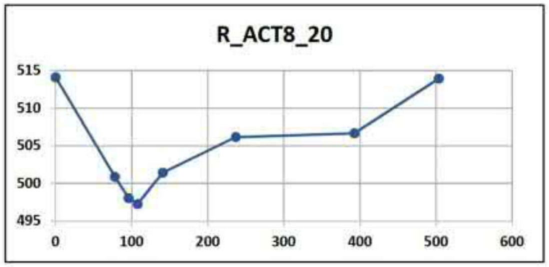
Dimensions		
Segment	Width (ft)	Depth (ft)
XS	505.4	21.35
Channel	86.7	5.9



Reach	R_ACT8_20	
Point	Station	Elevation
1	0.00	514.11
2	77.95	500.89
3	95.94	498.03
4	107.93	497.26
5	140.91	501.43
6	236.86	506.14
7	392.76	506.66
8	503.69	513.93

Manning's n		
LOB	Chnl	ROB
0.08	0.05	0.08

Dimensions		
Segment	Width (ft)	Depth (ft)
XS	503.7	16.7
Channel	63.0	3.6



Appendix E: Hydrologic Model Analysis

E-6 Hydrology Results – Computed Peak Discharge Existing

Alum Creek Watershed		Existing Flows (cfs)						
Hydrologic Element	DA (Sq. Miles)	50% ACE	20% ACE	10% ACE	4% ACE	2% ACE	1% ACE	0.2% ACE
J_AC_10	0.17	6	24	49	100	150	206	371
J_AC_20	1.35	84	250	464	850	1210	1614	2771
J_AC_30	2.65	285	640	1108	1905	2606	3376	5546
J_AC_30_ACT107_30	3.92	471	968	1617	2813	3865	4998	8215
J_AC_40	4.5	468	1044	1763	3054	4239	5554	9181
J_AC_40_ACT11_30	6.92	921	1966	3219	5262	7145	9221	14749
J_AC_50	7.46	1000	2079	3446	5648	7637	9826	15685
J_AC_50_ACT9_30	12.9	1951	3805	6168	9941	13236	16856	26666
J_AC_60	13.31	1858	3623	5808	9545	12810	16372	26292
J_AC_60_ACT8_30	14.49	1929	3742	6010	9920	13310	17056	27499
J_AC_70	14.6	1902	3632	5884	9845	13246	16945	27376
J_AC_70_ACT129_30	15.23	1934	3685	5982	10025	13491	17275	27960
J_AC_80	15.53	1937	3681	5913	10014	13513	17310	28059
J_AC_80_PC_40	16.87	1994	3777	6090	10362	14009	17952	29161
J_AC_90	17	1968	3751	5954	10182	13881	17860	29105
J_AC_90_ACT7_50	21.11	2275	4319	7026	12071	16384	21112	34441
J_AC_100	21.33	2254	4318	6959	11960	16339	21078	34485
J_AC_100_ACT137_20_ACT138_20	22.79	2310	4422	7129	12289	16821	21737	35657
J_AC_110	23.84	2148	4303	6710	11386	15860	20993	35421
J_AC_110_ACT6_20_ACT143_20	25.64	2196	4390	6842	11623	16202	21488	36422
J_AC_120	26.18	2196	4394	6840	11616	16206	21523	36609
J_AC_130	26.8	2185	4382	6817	11575	16140	21511	36747
J_AC_130_ACT4_60_ACT5_20	30.57	2261	4512	7525	12777	17495	23214	39311
J_AC_140	30.88	2244	4488	7480	12733	17471	23190	39355
J_AC_140_ACT148_30	32.15	2269	4535	7555	12865	17656	23446	39881
J_AC_150	32.59	2260	4524	7454	12727	17531	23275	39782
J_AC_150_ACT3_40	35.44	2363	4627	7613	13014	17938	23828	40939
J_AC_160	36.03	2311	4626	7571	12941	17885	23767	41008
J_AC_160_ACT1_30_ACT067_20	40.29	3340	5649	7815	13388	18537	24657	42902
J_AC_170	40.41	3316	5581	7797	13351	18491	24621	42888
J_AC_170_ACT160_20	40.71	3363	5657	7854	13378	18531	24674	42995
J_AC_180	41.45	3475	5784	8077	13360	18532	24737	43209
J_AC_180_ACT162_20	42.38	3643	6033	8451	13441	18653	24901	43540
J_AC_190	42.96	3707	6087	8540	13452	18671	24935	43680
J_AC_20_ACT110_20	1.82	127	363	667	1207	1705	2258	3835
J_AC_200	43.73	3880	6212	8664	13432	18662	24833	43872
J_AC_200_ACT166_30	44.65	4048	6343	8848	13499	18760	24971	44160
J_AC_210	45.04	3998	6376	8808	13378	18663	24626	44253
J_AC_220	45.32	4000	6388	8789	13313	18629	24577	44156
J_AC_220_ACT169_30	46.28	4110	6516	8945	13381	18726	24704	44444
J_AC_230	46.9	4117	6542	8928	13298	18467	24513	43874
J_AC_230_LAC_60	52.91	5593	8896	11747	15502	19452	25937	46502
J_AC_240	53.49	5538	8784	11576	15470	19230	25519	46024
J_AC_240_AC_250	54.45	5575	8843	11660	15579	19375	25614	46199
J_AC_250	0.96	802	1236	1629	2179	2607	3035	4123
J_AC_260	54.48	5576	8842	11661	15580	19376	25607	46185
J_ACT1_10	0.55	246	384	510	692	837	987	1388
J_ACT1_20	1.58	515	820	1108	1532	1878	2242	3261
J_ACT1_20_ACT2_20	3.45	1672	2626	3456	4648	5590	6555	9056
J_ACT1_30	3.47	1644	2573	3394	4607	5548	6521	9057
J_ACT2_10	1.12	862	1268	1624	2118	2502	2886	3883
J_ACT2_20	1.87	1157	1807	2350	3123	3718	4318	5842
J_ACT3_10	1.07	588	978	1345	1877	2302	2736	3861

Alum Creek Watershed		Existing Flows (cfs)						
Hydrologic Element	DA (Sq. Miles)	50% ACE	20% ACE	10% ACE	4% ACE	2% ACE	1% ACE	0.2% ACE
J_ACT3_10_ACT3_20	1.72	861	1448	2004	2815	3467	4136	5877
J_ACT3_20	0.65	284	487	680	966	1199	1437	2063
J_ACT3_30	2.38	1218	2026	2793	3894	4781	5685	7986
J_ACT3_40	2.84	1416	2233	3031	4250	5258	6276	8883
J_ACT4_10	0.84	448	740	1016	1417	1740	2071	2930
J_ACT4_20	0.71	286	487	681	968	1203	1446	2091
J_ACT4_30	1.64	463	735	986	1365	1668	2009	4599
J_ACT4_40	1.87	423	634	830	1116	1609	2226	5034
J_ACT4_50	2.57	229	423	708	1087	1442	2021	5896
J_ACT4_60	2.74	95	369	657	1088	1412	1956	5452
J_ACT5_10	0.35	162	300	437	644	815	992	1450
J_ACT5_20	1.04	299	549	891	1360	1737	2126	3137
J_ACT6_10	0.76	437	683	906	1225	1476	1730	2398
J_ACT6_20	1.04	536	856	1143	1574	1906	2250	3155
J_ACT7_10	0.83	465	696	903	1196	1427	1662	2285
J_ACT7_20	1.38	504	831	1128	1577	1942	2344	3397
J_ACT7_30	2.05	650	1088	1538	2236	2789	3386	4975
J_ACT7_40	2.69	645	1070	1577	2376	3048	3791	5755
J_ACT7_40_ACT131_20	3.78	797	1330	1997	3071	3988	5026	7802
J_ACT7_50	4.11	797	1347	1998	3111	4065	5155	8116
J_ACT8_10	0.65	300	536	765	1106	1383	1667	2408
J_ACT8_20	0.9	367	673	981	1438	1803	2179	3165
J_ACT8_30	1.18	379	733	1090	1642	2094	2547	3778
J_ACT9_10	0.7	103	196	293	448	582	730	1148
J_ACT9_20	1.83	202	408	630	994	1319	1678	2765
J_ACT9_20_ACT10_30	4.55	921	1741	2603	3957	5069	6265	9695
J_ACT9_30	5.43	983	1893	2889	4483	5831	7246	11275
J_ACT10_10	1.28	401	719	1044	1545	1967	2412	3615
J_ACT10_20	1.42	396	715	1071	1590	2009	2474	3762
J_ACT10_20_ACT093_20	2.35	698	1236	1795	2673	3359	4103	6166
J_ACT10_30	2.72	722	1335	1974	2967	3758	4596	6982
J_ACT11_10	0.69	181	330	479	707	896	1097	1641
J_ACT11_20	1.18	465	695	913	1240	1568	1883	2765
J_ACT11_20_ACT124_20	1.86	569	885	1203	1889	2473	3008	4515
J_ACT11_30	2.42	618	1048	1528	2338	3061	3786	5700
J_ACT067_10	0.42	287	456	610	831	1005	1181	1631
J_ACT067_20	0.79	556	868	1158	1565	1880	2199	3026
J_ACT087_10	0.23	113	189	261	369	455	544	778
J_ACT087_20	0.48	174	302	446	685	876	1060	1537
J_ACT093_10	0.65	262	444	618	876	1085	1300	1871
J_ACT093_20	0.93	302	521	734	1083	1352	1632	2404
J_ACT107_10	0.6	98	226	370	603	805	1024	1619
J_ACT107_20	0.62	100	232	378	617	823	1045	1654
J_ACT107_20_ACT107A_10	0.74	140	308	490	784	1034	1302	2030
J_ACT107_30	1.27	254	564	896	1434	1882	2347	3611
J_ACT107A_10	0.12	66	118	169	243	303	365	524
J_ACT110_10	0.33	26	79	148	269	379	502	844
J_ACT110_20	0.47	58	125	220	396	553	720	1203
J_ACT124_10	0.51	99	212	335	530	698	877	1365
J_ACT124_20	0.68	116	266	436	716	936	1162	1785
J_ACT129_10	0.11	34	70	106	162	210	260	392
J_ACT129_20	0.52	135	251	378	605	797	995	1513
J_ACT129_30	0.63	160	296	436	679	890	1111	1691
J_ACT131_10	0.43	169	291	409	583	725	872	1259
J_ACT131_20	1.09	154	304	514	861	1184	1531	2488

Alum Creek Watershed		Existing Flows (cfs)						
Hydrologic Element	DA (Sq. Miles)	50% ACE	20% ACE	10% ACE	4% ACE	2% ACE	1% ACE	0.2% ACE
J_ACT137_10	0.24	118	216	314	462	585	712	1041
J_ACT137_20	0.8	330	540	839	1253	1582	1907	2713
J_ACT138_10	0.56	169	294	417	603	758	920	1361
J_ACT138_20	0.65	178	313	447	650	819	998	1486
J_ACT143_10	0.45	135	278	425	652	844	1046	1576
J_ACT143_20	0.75	209	425	644	982	1267	1564	2361
J_ACT148_10	0.15	125	202	276	383	468	554	769
J_ACT148_20	0.91	430	729	1013	1466	1869	2255	3252
J_ACT148_30	1.26	596	1000	1378	2000	2515	3026	4344
J_ACT160_10	0.18	169	249	320	416	491	566	756
J_ACT160_20	0.31	248	386	507	669	791	911	1214
J_ACT162_10	0.31	411	571	709	893	1033	1170	1518
J_ACT162_20	0.93	822	1175	1474	1886	2206	2524	3344
J_ACT166_10	0.16	166	248	320	420	497	574	767
J_ACT166_20	0.31	302	444	570	739	876	1008	1347
J_ACT166_20_ACT167_20	0.68	613	909	1183	1546	1832	2123	2849
J_ACT166_30	0.92	686	1025	1358	1803	2168	2520	3481
J_ACT167_10	0.15	133	201	262	347	412	478	644
J_ACT167_20	0.36	328	503	654	864	1020	1177	1582
J_ACT168_10	0.2	268	367	450	562	646	730	942
J_ACT168_20	0.3	348	482	606	773	897	1021	1334
J_ACT169_10	0.12	158	215	263	328	377	425	549
J_ACT169_20	0.58	592	829	1037	1344	1573	1798	2371
J_ACT169_20_ACT168_20	0.88	938	1311	1642	2105	2458	2805	3690
J_ACT169_30	0.96	962	1334	1669	2143	2506	2869	3762
J_ACT173_10	0.8	421	690	941	1308	1603	1904	2686
J_ACT173_20	1.23	616	1029	1394	1975	2404	2838	4026
J_ACT173_20_ACT174_20	1.4	711	1184	1602	2264	2757	3251	4598
J_ACT173_30	1.69	777	1293	1777	2525	3119	3699	5279
J_ACT173_30_ACT175_20	2	980	1582	2158	3034	3744	4457	6300
J_ACT173_40	2.5	1191	1917	2601	3682	4525	5399	7717
J_ACT174_10	0.13	99	154	205	278	334	392	537
J_ACT174_20	0.17	118	187	250	338	408	479	659
J_ACT175_10	0.23	287	403	501	635	737	837	1090
J_ACT175_20	0.32	376	531	664	845	986	1124	1469
J_LAC_10	0.42	426	589	727	914	1057	1199	1570
J_LAC_20	1.3	405	601	780	1042	1254	1478	2578
J_LAC_30	1.71	499	756	988	1331	1627	1925	2927
J_LAC_30_ACT173_40	4.22	1615	2554	3438	4809	5923	7064	10154
J_LAC_40	4.56	1362	2202	3060	4352	5407	6549	9559
J_LAC_50	5.08	1371	2233	3162	4558	5700	6938	10232
J_LAC_60	6.01	1485	2455	3554	5130	6490	7928	11765
J_PC_10	0.35	136	269	403	610	782	960	1422
J_PC_20	0.66	197	392	636	987	1293	1610	2475
J_PC_30	0.82	225	428	708	1070	1371	1808	2868
J_PC_30_ACT087_20	1.29	398	730	1149	1754	2238	2868	4395
J_PC_40	1.34	395	729	1141	1753	2248	2863	4428

E-6 Hydrology Results – Computed Peak Discharge Existing

Appendix E: Hydrologic Model Analysis

E-7 Hydrology Results – Computed Subbasin Discharge Existing

	Alum Creek Watershed		Existing Flows (cfs)						
	Hydrologic Element	DA (Sq. Miles)	50% ACE	20% ACE	10% ACE	4% ACE	2% ACE	1% ACE	0.2% ACE
AC	AC_10	0.17	6	24	49	100	150	206	371
	AC_20	1.18	80	239	441	803	1137	1508	2565
	AC_30	0.83	182	341	503	754	966	1193	1813
	AC_40	0.58	134	270	413	636	827	1028	1574
	AC_50	0.54	197	322	440	613	754	901	1296
	AC_60	0.41	131	242	352	520	660	807	1198
	AC_70	0.11	30	59	88	133	171	211	319
	AC_80	0.3	134	225	312	441	545	653	935
	AC_90	0.14	49	93	137	204	259	317	468
	AC_100	0.22	79	154	230	346	443	544	810
	AC_110	1.06	185	354	530	808	1045	1302	2019
	AC_120	0.54	348	526	684	907	1082	1258	1719
	AC_130	0.62	313	522	717	1003	1232	1465	2075
	AC_140	0.31	251	395	524	710	855	1000	1366
	AC_150	0.45	351	551	735	993	1194	1397	1912
	AC_160	0.59	311	487	647	878	1060	1246	1735
	AC_170	0.11	86	137	184	251	304	357	492
	AC_180	0.73	514	743	942	1220	1435	1653	2227
	AC_190	0.58	621	874	1091	1386	1610	1832	2403
	AC_200	0.76	533	772	980	1269	1493	1720	2318
	AC_210	0.39	426	620	790	1025	1206	1386	1837
	AC_220	0.29	290	414	522	670	782	894	1181
	AC_230	0.62	472	696	893	1166	1378	1590	2140
	AC_240	0.58	247	394	531	730	890	1055	1494
	AC_250	0.96	802	1236	1629	2179	2607	3035	4123
	AC_260	0.03	34	53	71	95	114	133	179
AC_T1	ACT1_10	0.55	246	384	510	692	837	987	1388
	ACT1_20	1.03	507	795	1059	1438	1739	2047	2864
	ACT1_30	0.03	39	60	79	104	124	143	190
AC_T2	ACT2_10	1.12	862	1268	1624	2118	2502	2886	3883
	ACT2_20	0.75	476	732	962	1289	1546	1804	2477
AC_T3	ACT3_10	1.07	588	978	1345	1877	2302	2736	3861
	ACT3_20	0.65	284	487	680	966	1199	1437	2063
	ACT3_30	0.66	378	605	814	1113	1350	1591	2218
	ACT3_40	0.47	344	506	649	848	1002	1157	1561
AC_T4	ACT4_10	0.84	448	740	1016	1417	1740	2071	2930
	ACT4_20	0.71	286	487	681	968	1203	1446	2091
	ACT4_30	0.09	36	69	103	154	196	240	355
	ACT4_40	0.23	91	161	230	334	419	507	742
	ACT4_50	0.7	228	423	620	923	1176	1441	2152
	ACT4_60	0.17	72	128	183	264	331	400	579
AC_T5	ACT5_10	0.35	162	300	437	644	815	992	1450
	ACT5_20	0.69	236	416	590	850	1064	1287	1880
AC_T6	ACT6_10	0.76	437	683	906	1225	1476	1730	2398
	ACT6_20	0.28	130	212	289	400	490	581	821
AC_T7	ACT7_10	0.83	465	696	903	1196	1427	1662	2285
	ACT7_20	0.55	72	163	266	438	589	755	1216
	ACT7_30	0.67	193	347	499	729	920	1121	1662
	ACT7_40	0.64	148	302	464	718	935	1166	1789
	ACT7_50	0.32	165	284	397	563	698	836	1192
AC_T8	ACT8_10	0.65	300	536	765	1106	1383	1667	2408
	ACT8_20	0.25	84	167	252	381	488	602	899
	ACT8_30	0.28	71	149	232	363	473	590	906
AC_T9	ACT9_10	0.7	103	196	293	448	582	730	1148
	ACT9_20	1.13	199	402	618	961	1256	1574	2453
	ACT9_30	0.89	317	556	788	1134	1418	1712	2497
AC_T10	ACT10_10	1.28	401	719	1044	1545	1967	2412	3615
	ACT10_20	0.14	29	73	121	200	268	340	534
	ACT10_30	0.37	106	203	303	454	582	716	1074
AC_T11	ACT11_10	0.69	181	330	479	707	896	1097	1641
	ACT11_20	0.49	456	667	853	1109	1306	1502	2001
	ACT11_30	0.56	300	480	645	883	1073	1265	1768

	Alum Creek Watershed		Existing Flows (cfs)						
	Hydrologic Element	DA (Sq. Miles)	50% ACE	20% ACE	10% ACE	4% ACE	2% ACE	1% ACE	0.2% ACE
AC_T067	ACT067_10	0.42	287	456	610	831	1005	1181	1631
	ACT067_20	0.37	304	456	590	777	922	1067	1439
AC_T087	ACT087_10	0.23	113	189	261	369	455	544	778
	ACT087_20	0.25	110	188	264	376	468	564	815
AC_T093	ACT093_10	0.65	262	444	618	876	1085	1300	1871
	ACT093_20	0.28	118	216	313	458	578	702	1024
AC_T107	ACT107_10	0.6	98	226	370	603	805	1024	1619
	ACT107_20	0.02	14	27	41	61	77	95	138
	ACT107_30	0.53	172	336	501	754	965	1185	1765
AC_T107_A	ACT107A_10	0.12	66	118	169	243	303	365	524
AC_T110	ACT110_10	0.33	26	79	148	269	379	502	844
	ACT110_20	0.14	56	113	170	258	331	407	603
AC_T124	ACT124_10	0.51	99	212	335	530	698	877	1365
	ACT124_20	0.17	97	165	230	325	402	480	682
AC_T129	ACT129_10	0.11	34	70	106	162	210	260	392
	ACT129_20	0.4	129	238	347	513	652	797	1184
	ACT129_30	0.12	132	197	256	336	398	459	613
AC_T131	ACT131_10	0.43	169	291	409	583	725	872	1259
	ACT131_20	0.66	45	129	236	429	606	805	1372
AC_T137	ACT137_10	0.24	118	216	314	462	585	712	1041
	ACT137_20	0.56	309	494	664	909	1103	1300	1814
AC_T138	ACT138_10	0.56	169	294	417	603	758	920	1361
	ACT138_20	0.09	39	72	105	155	196	238	349
AC_T143	ACT143_10	0.45	135	278	425	652	844	1046	1576
	ACT143_20	0.31	88	167	247	370	472	580	867
AC_T148	ACT148_10	0.15	125	202	276	383	468	554	769
	ACT148_20	0.76	363	622	870	1234	1528	1830	2618
	ACT148_30	0.35	187	303	412	568	692	819	1148
AC_T160	ACT160_10	0.18	169	249	320	416	491	566	756
	ACT160_20	0.13	120	173	220	285	334	383	510
AC_T162	ACT162_10	0.31	411	571	709	893	1033	1170	1518
	ACT162_20	0.62	471	674	850	1093	1281	1471	1967
AC_T166	ACT166_10	0.16	166	248	320	420	497	574	767
	ACT166_20	0.15	160	226	282	359	417	474	622
	ACT166_30	0.24	219	342	455	614	738	861	1170
AC_T167	ACT167_10	0.15	133	201	262	347	412	478	644
	ACT167_20	0.21	256	370	470	605	708	809	1063
AC_T168	ACT168_10	0.2	268	367	450	562	646	730	942
	ACT168_20	0.11	168	227	277	342	392	441	564
AC_T169	ACT169_10	0.12	158	215	263	328	377	425	549
	ACT169_20	0.46	505	710	886	1124	1305	1484	1945
	ACT169_30	0.07	102	142	176	221	256	289	375
AC_T173	ACT173_10	0.8	421	690	941	1308	1603	1904	2686
	ACT173_20	0.43	332	508	667	893	1069	1245	1697
	ACT173_30	0.29	147	262	373	536	670	807	1159
	ACT173_40	0.5	323	503	666	898	1081	1265	1740
AC_T174	ACT174_10	0.13	99	154	205	278	334	392	537
	ACT174_20	0.04	36	57	75	101	121	141	192
AC_T175	ACT175_10	0.23	287	403	501	635	737	837	1090
	ACT175_20	0.09	134	190	238	302	350	398	516
LAC	LAC_10	0.42	426	589	727	914	1057	1199	1570
	LAC_20	0.88	401	590	760	1004	1198	1400	1948
	LAC_30	0.41	291	424	541	704	830	957	1291
	LAC_40	0.35	237	378	506	689	834	980	1354
	LAC_50	0.52	216	340	454	620	754	892	1262
	LAC_60	0.93	488	715	916	1201	1425	1655	2275
PC	PC_10	0.35	136	269	403	610	782	960	1422
	PC_20	0.31	116	223	333	500	640	787	1173
	PC_30	0.16	81	136	189	267	330	395	563
	PC_40	0.04	14	29	46	72	93	116	176

Appendix E: Hydrologic Model Analysis

E-8 Hydrology Results – Computed Peak Discharge

All Fair Soil Conditions

Alum Creek Watershed		Existing Flows (cfs), All Fair Soil Conditions						
Hydrologic Element	DA (Sq. Miles)	50% ACE	20% ACE	10% ACE	4% ACE	2% ACE	1% ACE	0.2% ACE
J_AC_10	0.17	6	24	49	100	150	206	371
J_AC_20	1.35	72	227	432	808	1162	1560	2711
J_AC_30	2.65	144	419	783	1510	2180	2916	5059
J_AC_30_ACT107_30	3.92	204	585	1065	2099	3061	4117	7259
J_AC_40	4.5	197	571	1096	2203	3241	4427	7933
J_AC_40_ACT11_30	6.92	591	1253	2235	4165	5856	7771	13239
J_AC_50	7.46	633	1319	2359	4407	6228	8270	14094
J_AC_50_ACT9_30	12.9	1576	3032	4661	8295	11557	15063	24927
J_AC_60	13.31	1477	2861	4519	7941	11171	14647	24620
J_AC_60_ACT8_30	14.49	1514	2947	4642	8183	11561	15166	25661
J_AC_70	14.6	1487	2902	4526	8121	11497	15100	25538
J_AC_70_ACT129_30	15.23	1503	2939	4582	8242	11685	15356	26050
J_AC_80	15.53	1503	2941	4577	8224	11695	15386	26133
J_AC_80_PC_40	16.87	1532	3007	4676	8448	12062	15903	27072
J_AC_90	17	1488	2964	4643	8334	11933	15780	26995
J_AC_90_ACT7_50	21.11	1760	3609	5510	9954	14273	18790	32207
J_AC_100	21.33	1723	3593	5495	9887	14196	18762	32241
J_AC_100_ACT137_20_ACT138_20	22.79	1754	3665	5600	10113	14552	19277	33274
J_AC_110	23.84	1579	3398	5436	9526	13624	18524	32870
J_AC_110_ACT6_20_ACT143_20	25.64	1617	3474	5549	9728	13929	18965	33821
J_AC_120	26.18	1616	3466	5555	9727	13920	18989	33968
J_AC_130	26.8	1603	3434	5538	9692	13865	18956	34056
J_AC_130_ACT4_60_ACT5_20	30.57	1638	3518	5674	9929	14799	20392	36400
J_AC_140	30.88	1621	3481	5661	9925	14733	20360	36434
J_AC_140_ACT148_30	32.15	1637	3514	5718	10028	14884	20578	36906
J_AC_150	32.59	1626	3494	5668	9977	14714	20383	36779
J_AC_150_ACT3_40	35.44	1668	3574	5795	10216	15059	20872	37829
J_AC_160	36.03	1659	3557	5776	10193	14975	20784	37865
J_AC_160_ACT1_30_ACT067_20	40.29	2022	3697	5984	10569	15528	21585	39635
J_AC_170	40.41	2005	3684	5974	10550	15485	21518	39593
J_AC_170_ACT160_20	40.71	2089	3744	5988	10573	15520	21568	39694
J_AC_180	41.45	2284	3906	6004	10580	15507	21558	39871
J_AC_180_ACT162_20	42.38	2606	4138	6106	10653	15612	21710	40187
J_AC_190	42.96	2678	4260	6195	10673	15630	21730	40305
J_AC_20_ACT110_20	1.82	90	293	564	1073	1553	2094	3652
J_AC_200	43.73	2769	4481	6369	10674	15614	21708	40451
J_AC_200_ACT166_30	44.65	2878	4682	6535	10734	15698	21831	40721
J_AC_210	45.04	2788	4656	6588	10652	15563	21691	40800
J_AC_220	45.32	2770	4668	6624	10612	15490	21641	40717
J_AC_220_ACT169_30	46.28	2852	4818	6799	10674	15576	21764	40994
J_AC_230	46.9	2839	4846	6877	10627	15485	21420	40287
J_AC_230_LAC_60	52.91	3821	6549	9448	13193	16314	22743	42724
J_AC_240	53.49	3827	6493	9335	13064	16339	22307	42042
J_AC_240_AC_250	54.45	3858	6540	9405	13177	16473	22396	42205
J_AC_250	0.96	465	832	1186	1717	2151	2596	3745
J_AC_260	54.48	3858	6540	9404	13179	16476	22387	42186
J_ACT1_10	0.55	152	269	384	559	704	857	1272
J_ACT1_20	1.58	311	561	815	1212	1551	1915	2925
J_ACT1_20_ACT2_20	3.45	1189	2012	2783	3940	4877	5858	8466
J_ACT1_30	3.47	1170	1962	2731	3872	4836	5822	8449
J_ACT2_10	1.12	728	1118	1470	1968	2358	2754	3779
J_ACT2_20	1.87	879	1452	1969	2731	3331	3952	5555
J_ACT3_10	1.07	293	596	913	1402	1816	2252	3412

Alum Creek Watershed		Existing Flows (cfs), All Fair Soil Conditions						
Hydrologic Element	DA (Sq. Miles)	50% ACE	20% ACE	10% ACE	4% ACE	2% ACE	1% ACE	0.2% ACE
J_ACT3_10_ACT3_20	1.72	410	854	1324	2060	2689	3353	5142
J_ACT3_20	0.65	123	268	427	681	900	1135	1775
J_ACT3_30	2.38	613	1238	1891	2917	3771	4678	7103
J_ACT3_40	2.84	784	1484	2148	3226	4168	5215	7956
J_ACT4_10	0.84	200	410	636	993	1300	1626	2510
J_ACT4_20	0.71	124	260	413	662	880	1115	1767
J_ACT4_30	1.64	231	432	642	966	1250	1554	3400
J_ACT4_40	1.87	221	402	575	835	1034	1479	3677
J_ACT4_50	2.57	70	164	319	732	1057	1322	3509
J_ACT4_60	2.74	52	94	302	688	1055	1300	3327
J_ACT5_10	0.35	37	100	188	346	491	653	1104
J_ACT5_20	1.04	118	262	430	779	1145	1525	2550
J_ACT6_10	0.76	320	543	755	1067	1321	1581	2268
J_ACT6_20	1.04	369	648	918	1327	1664	2011	2944
J_ACT7_10	0.83	465	696	903	1196	1427	1662	2285
J_ACT7_20	1.38	504	831	1128	1577	1942	2344	3397
J_ACT7_30	2.05	650	1088	1538	2236	2789	3386	4975
J_ACT7_40	2.69	645	1070	1577	2376	3048	3791	5755
J_ACT7_40_ACT131_20	3.78	782	1326	1977	3051	3974	5004	7780
J_ACT7_50	4.11	776	1330	1966	3072	4022	5104	8058
J_ACT8_10	0.65	99	252	429	721	977	1254	2004
J_ACT8_20	0.9	114	300	523	907	1244	1610	2598
J_ACT8_30	1.18	102	304	551	984	1389	1825	3033
J_ACT9_10	0.7	103	196	293	448	582	730	1148
J_ACT9_20	1.83	202	408	630	994	1319	1678	2765
J_ACT9_20_ACT10_30	4.55	921	1741	2603	3957	5069	6265	9695
J_ACT9_30	5.43	978	1886	2878	4469	5815	7230	11258
J_ACT10_10	1.28	401	719	1044	1545	1967	2412	3616
J_ACT10_20	1.42	396	715	1071	1590	2009	2474	3762
J_ACT10_20_ACT093_20	2.35	698	1236	1795	2673	3359	4103	6166
J_ACT10_30	2.72	722	1335	1974	2967	3758	4596	6982
J_ACT11_10	0.69	181	330	479	707	896	1097	1641
J_ACT11_20	1.18	465	695	913	1240	1568	1883	2765
J_ACT11_20_ACT124_20	1.86	529	830	1132	1769	2353	2896	4402
J_ACT11_30	2.42	537	923	1360	2134	2846	3554	5492
J_ACT067_10	0.42	169	311	451	661	834	1014	1484
J_ACT067_20	0.79	343	602	863	1258	1580	1907	2769
J_ACT087_10	0.23	47	97	153	245	326	412	648
J_ACT087_20	0.48	69	143	234	399	563	758	1247
J_ACT093_10	0.65	262	444	618	876	1085	1300	1871
J_ACT093_20	0.93	302	521	734	1083	1352	1632	2404
J_ACT107_10	0.6	37	120	229	427	611	815	1397
J_ACT107_20	0.62	38	122	233	435	623	832	1424
J_ACT107_20_ACT107A_10	0.74	53	159	299	546	776	1028	1742
J_ACT107_30	1.27	75	226	458	876	1273	1711	2944
J_ACT107A_10	0.12	24	60	101	166	223	283	445
J_ACT110_10	0.33	12	49	104	210	312	428	762
J_ACT110_20	0.47	18	66	134	281	422	579	1042
J_ACT124_10	0.51	73	171	284	470	633	809	1294
J_ACT124_20	0.68	84	193	355	607	836	1057	1680
J_ACT129_10	0.11	5	20	41	83	122	167	294
J_ACT129_20	0.52	40	103	182	325	480	662	1177
J_ACT129_30	0.63	94	156	231	400	562	765	1347
J_ACT131_10	0.43	149	266	381	552	694	841	1231
J_ACT131_20	1.09	139	268	481	824	1141	1492	2458

Alum Creek Watershed		Existing Flows (cfs), All Fair Soil Conditions						
Hydrologic Element	DA (Sq. Miles)	50% ACE	20% ACE	10% ACE	4% ACE	2% ACE	1% ACE	0.2% ACE
J_ACT137_10	0.24	31	58	108	209	306	415	730
J_ACT137_20	0.8	181	333	488	734	1033	1376	2251
J_ACT138_10	0.56	54	124	208	355	490	640	1072
J_ACT138_20	0.65	57	130	223	383	531	696	1174
J_ACT143_10	0.45	124	261	405	629	820	1021	1552
J_ACT143_20	0.75	167	364	573	901	1181	1477	2275
J_ACT148_10	0.15	49	103	161	252	332	416	640
J_ACT148_20	0.91	172	375	601	966	1292	1690	2729
J_ACT148_30	1.26	251	547	860	1352	1801	2327	3700
J_ACT160_10	0.18	124	198	266	363	440	518	717
J_ACT160_20	0.31	187	294	420	586	714	840	1158
J_ACT162_10	0.31	342	500	637	828	973	1117	1479
J_ACT162_20	0.93	654	997	1299	1719	2048	2381	3236
J_ACT166_10	0.16	113	187	256	355	435	515	719
J_ACT166_20	0.31	222	350	472	645	780	923	1280
J_ACT166_20_ACT167_20	0.68	427	696	947	1322	1610	1911	2687
J_ACT166_30	0.92	468	769	1053	1511	1869	2240	3237
J_ACT167_10	0.15	85	144	201	284	351	420	596
J_ACT167_20	0.36	222	365	514	724	890	1053	1483
J_ACT168_10	0.2	227	325	410	525	614	701	921
J_ACT168_20	0.3	299	419	546	719	848	978	1302
J_ACT169_10	0.12	128	185	234	302	353	404	534
J_ACT169_20	0.58	455	683	887	1192	1438	1677	2281
J_ACT169_20_ACT168_20	0.88	753	1101	1432	1899	2274	2639	3567
J_ACT169_30	0.96	769	1127	1455	1935	2319	2697	3649
J_ACT173_10	0.8	206	410	623	957	1239	1539	2349
J_ACT173_20	1.23	329	627	964	1457	1916	2360	3568
J_ACT173_20_ACT174_20	1.4	384	728	1114	1678	2201	2714	4087
J_ACT173_30	1.69	411	794	1211	1860	2445	3053	4651
J_ACT173_30_ACT175_20	2	581	1040	1526	2311	2989	3714	5632
J_ACT173_40	2.5	714	1287	1876	2807	3660	4530	6924
J_ACT174_10	0.13	57	103	148	217	273	332	485
J_ACT174_20	0.17	67	124	181	265	335	407	596
J_ACT175_10	0.23	228	341	440	577	683	788	1054
J_ACT175_20	0.32	300	450	583	768	914	1060	1422
J_LAC_10	0.42	356	517	657	850	998	1147	1532
J_LAC_20	1.3	303	481	652	910	1123	1351	2397
J_LAC_30	1.71	375	598	828	1160	1457	1763	2712
J_LAC_30_ACT173_40	4.22	1018	1782	2559	3779	4876	6035	9197
J_LAC_40	4.56	905	1517	2244	3445	4465	5582	8677
J_LAC_50	5.08	949	1548	2310	3632	4734	5953	9333
J_LAC_60	6.01	1099	1715	2595	4155	5431	6891	10831
J_PC_10	0.35	26	91	181	343	491	656	1113
J_PC_20	0.66	43	132	254	517	774	1049	1877
J_PC_30	0.82	62	163	296	588	861	1151	2154
J_PC_30_ACT087_20	1.29	131	307	530	984	1425	1904	3399
J_PC_40	1.34	130	304	525	975	1424	1906	3399

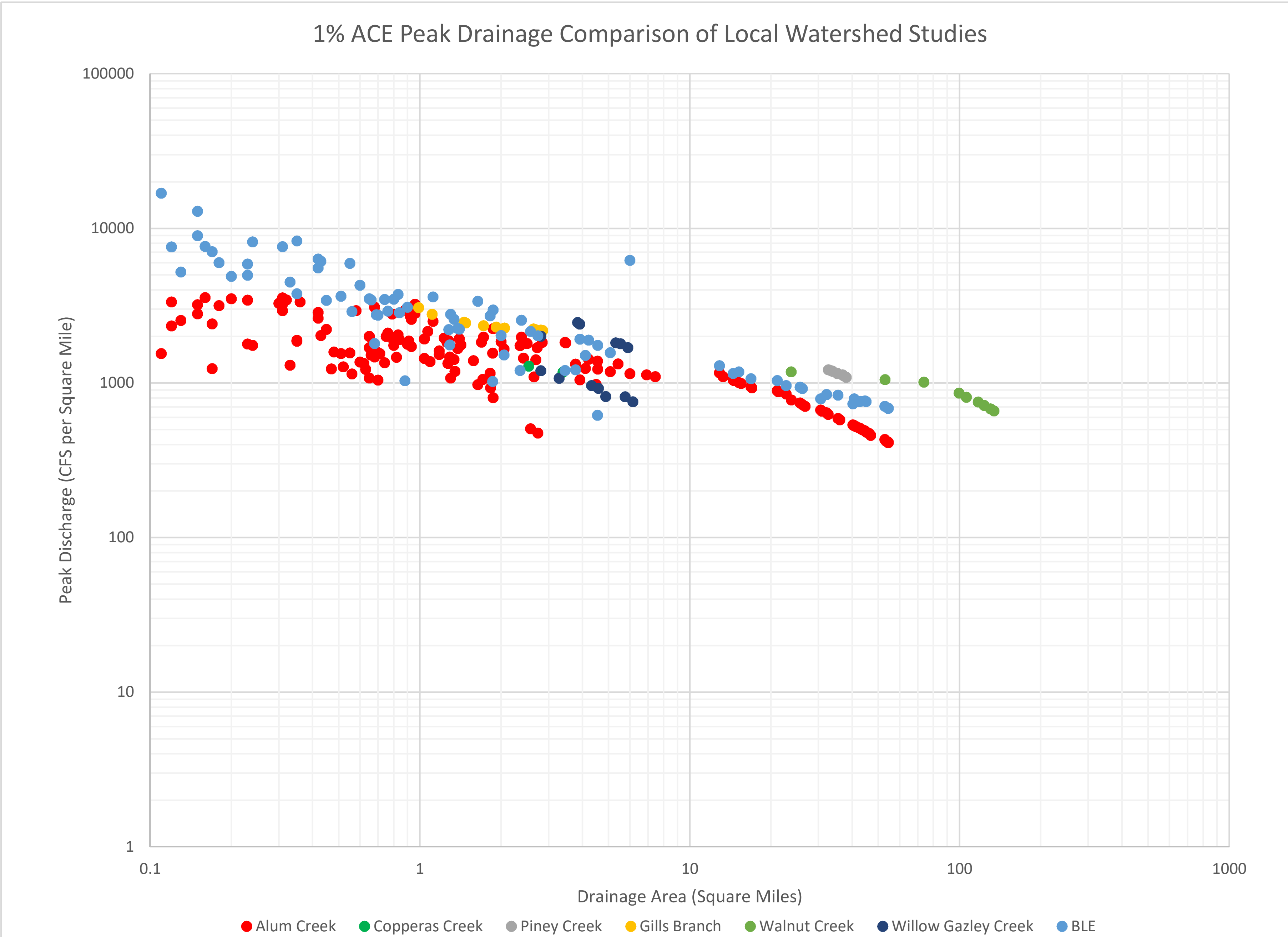
Alum Creek Watershed		Percent Difference (%)						
Hydrologic Element	DA (Sq. Miles)	50% ACE	20% ACE	10% ACE	4% ACE	2% ACE	1% ACE	0.2% ACE
J_AC_10	0.17	0	0	0	0	0	0	0
J_AC_20	1.35	14	9	7	5	4	3	2
J_AC_30	2.65	49	35	29	21	16	14	9
J_AC_30_ACT107_30	3.92	57	40	34	25	21	18	12
J_AC_40	4.5	58	45	38	28	24	20	14
J_AC_40_ACT11_30	6.92	36	36	31	21	18	16	10
J_AC_50	7.46	37	37	32	22	18	16	10
J_AC_50_ACT9_30	12.9	19	20	24	17	13	11	7
J_AC_60	13.31	21	21	22	17	13	11	6
J_AC_60_ACT8_30	14.49	22	21	23	18	13	11	7
J_AC_70	14.6	22	20	23	18	13	11	7
J_AC_70_ACT129_30	15.23	22	20	23	18	13	11	7
J_AC_80	15.53	22	20	23	18	13	11	7
J_AC_80_PC_40	16.87	23	20	23	18	14	11	7
J_AC_90	17	24	21	22	18	14	12	7
J_AC_90_ACT7_50	21.11	23	16	22	18	13	11	6
J_AC_100	21.33	24	17	21	17	13	11	7
J_AC_100_ACT137_20_ACT138_20	22.79	24	17	21	18	13	11	7
J_AC_110	23.84	26	21	19	16	14	12	7
J_AC_110_ACT6_20_ACT143_20	25.64	26	21	19	16	14	12	7
J_AC_120	26.18	26	21	19	16	14	12	7
J_AC_130	26.8	27	22	19	16	14	12	7
J_AC_130_ACT4_60_ACT5_20	30.57	28	22	25	22	15	12	7
J_AC_140	30.88	28	22	24	22	16	12	7
J_AC_140_ACT148_30	32.15	28	23	24	22	16	12	7
J_AC_150	32.59	28	23	24	22	16	12	8
J_AC_150_ACT3_40	35.44	29	23	24	21	16	12	8
J_AC_160	36.03	28	23	24	21	16	13	8
J_AC_160_ACT1_30_ACT067_20	40.29	39	35	23	21	16	12	8
J_AC_170	40.41	40	34	23	21	16	13	8
J_AC_170_ACT160_20	40.71	38	34	24	21	16	13	8
J_AC_180	41.45	34	32	26	21	16	13	8
J_AC_180_ACT162_20	42.38	28	31	28	21	16	13	8
J_AC_190	42.96	28	30	27	21	16	13	8
J_AC_20_ACT110_20	1.82	29	19	15	11	9	7	5
J_AC_200	43.73	29	28	26	21	16	13	8
J_AC_200_ACT166_30	44.65	29	26	26	20	16	13	8
J_AC_210	45.04	30	27	25	20	17	12	8
J_AC_220	45.32	31	27	25	20	17	12	8
J_AC_220_ACT169_30	46.28	31	26	24	20	17	12	8
J_AC_230	46.9	31	26	23	20	16	13	8
J_AC_230_LAC_60	52.91	32	26	20	15	16	12	8
J_AC_240	53.49	31	26	19	16	15	13	9
J_AC_240_AC_250	54.45	31	26	19	15	15	13	9
J_AC_250	0.96	42	33	27	21	17	14	9
J_AC_260	54.48	31	26	19	15	15	13	9
J_ACT1_10	0.55	38	30	25	19	16	13	8
J_ACT1_20	1.58	40	32	26	21	17	15	10
J_ACT1_20_ACT2_20	3.45	29	23	19	15	13	11	7
J_ACT1_30	3.47	29	24	20	16	13	11	7
J_ACT2_10	1.12	16	12	9	7	6	5	3
J_ACT2_20	1.87	24	20	16	13	10	8	5
J_ACT3_10	1.07	50	39	32	25	21	18	12

Alum Creek Watershed		Percent Difference (%)						
Hydrologic Element	DA (Sq. Miles)	50% ACE	20% ACE	10% ACE	4% ACE	2% ACE	1% ACE	0.2% ACE
J_ACT3_10_ACT3_20	1.72	52	41	34	27	22	19	13
J_ACT3_20	0.65	57	45	37	30	25	21	14
J_ACT3_30	2.38	50	39	32	25	21	18	11
J_ACT3_40	2.84	45	34	29	24	21	17	10
J_ACT4_10	0.84	55	45	37	30	25	21	14
J_ACT4_20	0.71	57	47	39	32	27	23	15
J_ACT4_30	1.64	50	41	35	29	25	23	26
J_ACT4_40	1.87	48	37	31	25	36	34	27
J_ACT4_50	2.57	69	61	55	33	27	35	40
J_ACT4_60	2.74	45	75	54	37	25	34	39
J_ACT5_10	0.35	77	67	57	46	40	34	24
J_ACT5_20	1.04	61	52	52	43	34	28	19
J_ACT6_10	0.76	27	20	17	13	11	9	5
J_ACT6_20	1.04	31	24	20	16	13	11	7
J_ACT7_10	0.83	0	0	0	0	0	0	0
J_ACT7_20	1.38	0	0	0	0	0	0	0
J_ACT7_30	2.05	0	0	0	0	0	0	0
J_ACT7_40	2.69	0	0	0	0	0	0	0
J_ACT7_40_ACT131_20	3.78	2	0	1	1	0	0	0
J_ACT7_50	4.11	3	1	2	1	1	1	1
J_ACT8_10	0.65	67	53	44	35	29	25	17
J_ACT8_20	0.9	69	55	47	37	31	26	18
J_ACT8_30	1.18	73	59	49	40	34	28	20
J_ACT9_10	0.7	0	0	0	0	0	0	0
J_ACT9_20	1.83	0	0	0	0	0	0	0
J_ACT9_20_ACT10_30	4.55	0	0	0	0	0	0	0
J_ACT9_30	5.43	1	0	0	0	0	0	0
J_ACT10_10	1.28	0	0	0	0	0	0	0
J_ACT10_20	1.42	0	0	0	0	0	0	0
J_ACT10_20_ACT093_20	2.35	0	0	0	0	0	0	0
J_ACT10_30	2.72	0	0	0	0	0	0	0
J_ACT11_10	0.69	0	0	0	0	0	0	0
J_ACT11_20	1.18	0	0	0	0	0	0	0
J_ACT11_20_ACT124_20	1.86	7	6	6	6	5	4	3
J_ACT11_30	2.42	13	12	11	9	7	6	4
J_ACT067_10	0.42	41	32	26	20	17	14	9
J_ACT067_20	0.79	38	31	25	20	16	13	8
J_ACT087_10	0.23	58	49	41	34	28	24	17
J_ACT087_20	0.48	60	53	48	42	36	28	19
J_ACT093_10	0.65	0	0	0	0	0	0	0
J_ACT093_20	0.93	0	0	0	0	0	0	0
J_ACT107_10	0.6	62	47	38	29	24	20	14
J_ACT107_20	0.62	62	47	38	29	24	20	14
J_ACT107_20_ACT107A_10	0.74	62	48	39	30	25	21	14
J_ACT107_30	1.27	70	60	49	39	32	27	18
J_ACT107A_10	0.12	64	49	40	32	26	22	15
J_ACT110_10	0.33	54	38	30	22	18	15	10
J_ACT110_20	0.47	69	47	39	29	24	20	13
J_ACT124_10	0.51	26	19	15	11	9	8	5
J_ACT124_20	0.68	28	27	19	15	11	9	6
J_ACT129_10	0.11	85	71	61	49	42	36	25
J_ACT129_20	0.52	70	59	52	46	40	33	22
J_ACT129_30	0.63	41	47	47	41	37	31	20
J_ACT131_10	0.43	12	9	7	5	4	4	2
J_ACT131_20	1.09	10	12	6	4	4	3	1

Alum Creek Watershed		Percent Difference (%)						
Hydrologic Element	DA (Sq. Miles)	50% ACE	20% ACE	10% ACE	4% ACE	2% ACE	1% ACE	0.2% ACE
J_ACT137_10	0.24	74	73	66	55	48	42	30
J_ACT137_20	0.8	45	38	42	41	35	28	17
J_ACT138_10	0.56	68	58	50	41	35	30	21
J_ACT138_20	0.65	68	58	50	41	35	30	21
J_ACT143_10	0.45	8	6	5	4	3	2	2
J_ACT143_20	0.75	20	14	11	8	7	6	4
J_ACT148_10	0.15	61	49	42	34	29	25	17
J_ACT148_20	0.91	60	49	41	34	31	25	16
J_ACT148_30	1.26	58	45	38	32	28	23	15
J_ACT160_10	0.18	27	20	17	13	10	8	5
J_ACT160_20	0.31	25	24	17	12	10	8	5
J_ACT162_10	0.31	17	12	10	7	6	5	3
J_ACT162_20	0.93	20	15	12	9	7	6	3
J_ACT166_10	0.16	32	25	20	15	12	10	6
J_ACT166_20	0.31	26	21	17	13	11	8	5
J_ACT166_20_ACT167_20	0.68	30	23	20	14	12	10	6
J_ACT166_30	0.92	32	25	22	16	14	11	7
J_ACT167_10	0.15	36	28	23	18	15	12	7
J_ACT167_20	0.36	32	27	21	16	13	11	6
J_ACT168_10	0.2	15	11	9	7	5	4	2
J_ACT168_20	0.3	14	13	10	7	5	4	2
J_ACT169_10	0.12	19	14	11	8	6	5	3
J_ACT169_20	0.58	23	18	14	11	9	7	4
J_ACT169_20_ACT168_20	0.88	20	16	13	10	7	6	3
J_ACT169_30	0.96	20	16	13	10	7	6	3
J_ACT173_10	0.8	51	41	34	27	23	19	13
J_ACT173_20	1.23	47	39	31	26	20	17	11
J_ACT173_20_ACT174_20	1.4	46	39	30	26	20	17	11
J_ACT173_30	1.69	47	39	32	26	22	17	12
J_ACT173_30_ACT175_20	2	41	34	29	24	20	17	11
J_ACT173_40	2.5	40	33	28	24	19	16	10
J_ACT174_10	0.13	42	33	28	22	18	15	10
J_ACT174_20	0.17	43	34	28	22	18	15	10
J_ACT175_10	0.23	21	15	12	9	7	6	3
J_ACT175_20	0.32	20	15	12	9	7	6	3
J_LAC_10	0.42	16	12	10	7	6	4	2
J_LAC_20	1.3	25	20	16	13	10	9	7
J_LAC_30	1.71	25	21	16	13	10	8	7
J_LAC_30_ACT173_40	4.22	37	30	26	21	18	15	9
J_LAC_40	4.56	34	31	27	21	17	15	9
J_LAC_50	5.08	31	31	27	20	17	14	9
J_LAC_60	6.01	26	30	27	19	16	13	8
J_PC_10	0.35	81	66	55	44	37	32	22
J_PC_20	0.66	78	66	60	48	40	35	24
J_PC_30	0.82	72	62	58	45	37	36	25
J_PC_30_ACT087_20	1.29	67	58	54	44	36	34	23
J_PC_40	1.34	67	58	54	44	37	33	23

Appendix E: Hydrologic Model Analysis

E-9 Area Studies



E-9 Area Studies

Appendix F: Hydraulic Model Analysis

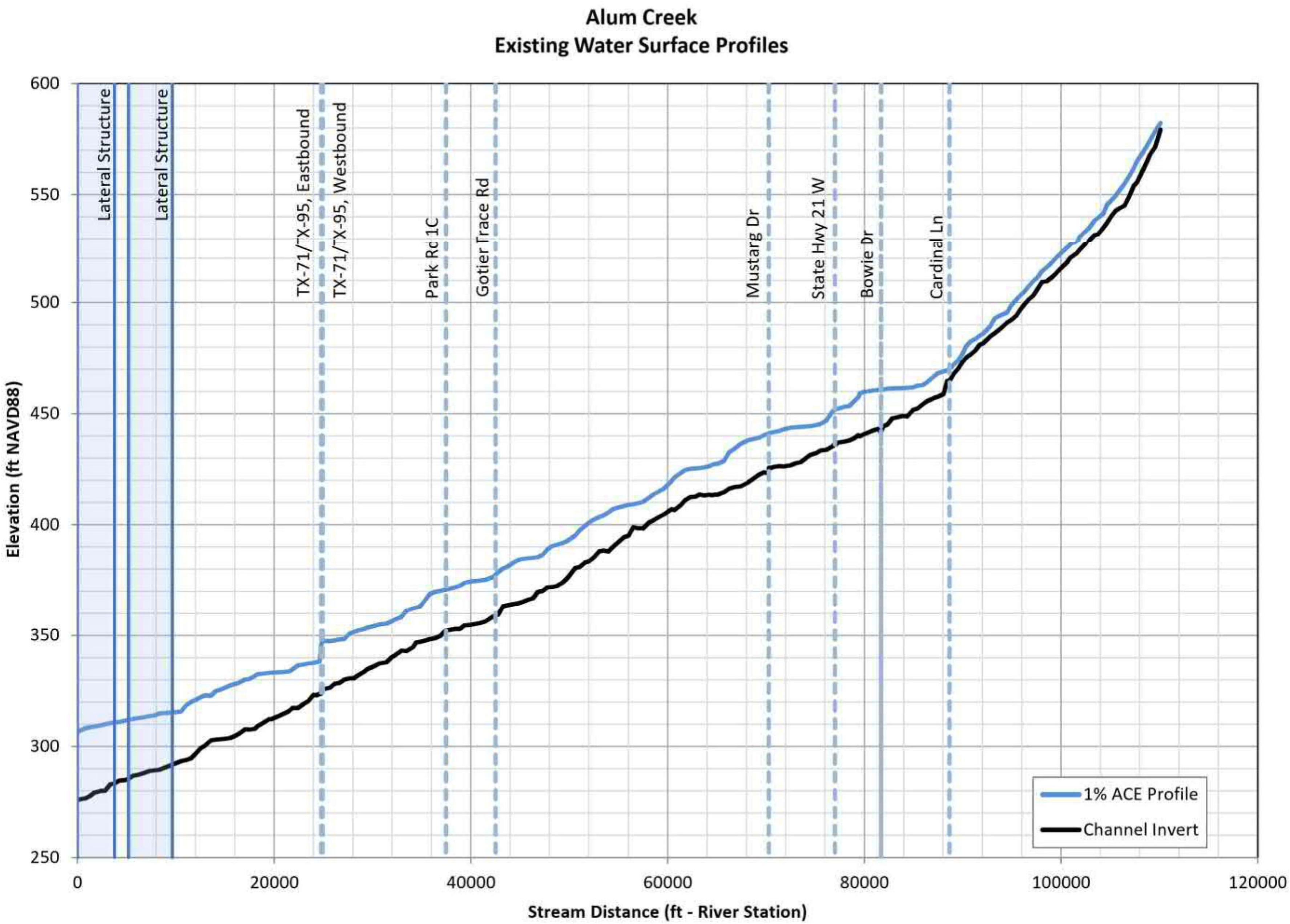
F-1 HEC-RAS Flow Breaks

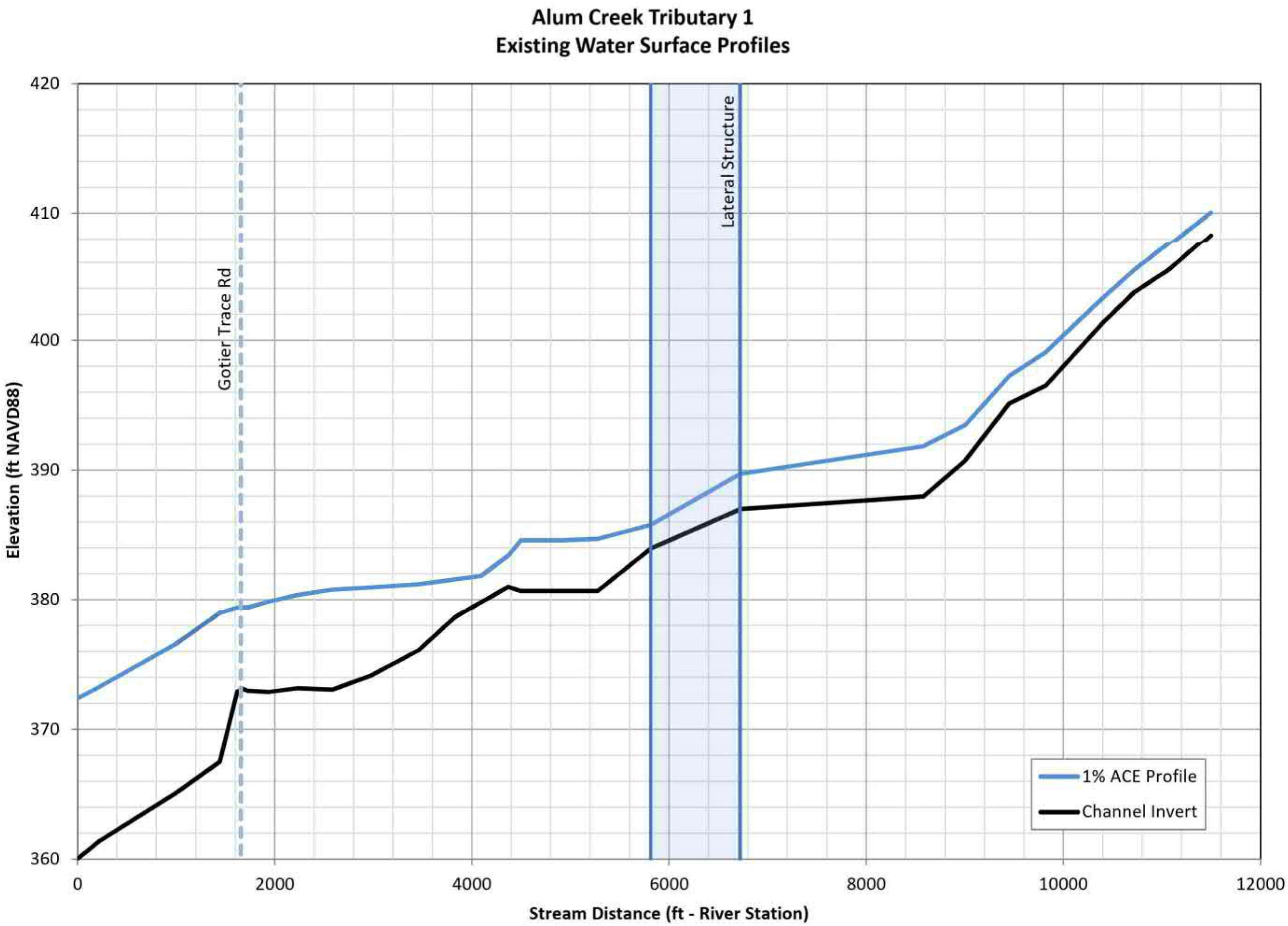
Alum Creek Watershed Flow Breaks								
River	HEC-RAS XS	50%	20%	10%	4%	2%	1%	0.20%
AC	110630	80	250	460	850	1200	1600	2800
	102399	130	360	670	1200	1700	2300	3800
	97225	280	640	1100	1900	2600	3400	5500
	93786	470	970	1600	2800	3900	5000	8200
	90495	470	1000	1800	3100	4200	5600	9200
	88943	920	2000	3200	5300	7100	9200	14700
	86499	1000	2100	3400	5600	7600	9800	15700
	83366	2000	3800	6200	9900	13200	16900	26700
	81990	1900	3600	5800	9500	12800	16400	26300
	80446	1900	3700	6000	9900	13300	17100	27500
	80082	1900	3600	5900	9800	13200	16900	27400
	77859	1900	3700	6000	10000	13500	17300	28000
	76118	1900	3700	5900	10000	13500	17300	28100
	75022	2000	3800	6100	10400	14000	18000	29200
	73028	2000	3800	6000	10200	13900	17900	29100
	72301	2300	4300	7000	12100	16400	21100	34400
	70314	2300	4300	7000	12000	16300	21100	34500
	68707	2300	4400	7100	12300	16800	21700	35700
	66256	2100	4300	6700	11400	15900	21000	35400
	62844	2200	4400	6800	11600	16200	21500	36400
	60115	2200	4400	6800	11600	16200	21500	36600
	56576	2200	4400	6800	11600	16100	21500	36700
	55010	2300	4500	7500	12800	17500	23200	39300
	53588	2200	4500	7500	12700	17500	23200	39400
	52552	2300	4500	7600	12900	17700	23400	39900
	48816	2300	4500	7500	12700	17500	23300	39800
	46845	2400	4600	7600	13000	17900	23800	40900
	43802	2300	4600	7600	12900	17900	23800	41000
	41465	3300	5600	7800	13400	18500	24700	42900
	40415	3300	5600	7800	13400	18500	24600	42900
	39400	3400	5700	7900	13400	18500	24700	43000
	36858	3500	5800	8100	13400	18500	24700	43200
	35369	3600	6000	8500	13400	18700	24900	43500
	32811	3700	6100	8500	13500	18700	24900	43700
	28614	3900	6200	8700	13400	18700	24800	43900
	26699	4000	6300	8800	13500	18800	25000	44200
	26219	4000	6400	8800	13400	18700	24600	44300
	23465	4000	6400	8800	13300	18600	24600	44200
	21091	4100	6500	8900	13400	18700	24700	44400
	14111	4100	6500	8900	13300	18500	24500	43900
	10172	5600	8900	11700	15500	19500	25900	46500
	3898	5500	8800	11600	15500	19200	25500	46000
	919	5600	8800	11700	15600	19400	25600	46200
	542	5600	8800	11700	15600	19400	25600	46200
AC_T1	10514	250	380	510	690	840	990	1400
	3922	520	820	1100	1500	1900	2200	3300
	1464	1700	2600	3500	4600	5600	6600	9100
	681	1600	2600	3400	4600	5500	6500	9100
AC_T2	8299	1200	1800	2400	3100	3700	4300	5800
AC_T3	6069	1200	2000	2800	3900	4800	5700	8000
	1890	1400	2200	3000	4300	5300	6300	8900
AC_T4	11456	450	740	1000	1400	1700	2100	2900
	10458	460	740	990	1400	1700	2000	4600
	8573	420	630	830	1100	1600	2200	5000
	6025	230	420	710	1100	1400	2000	5900
	1567	100	370	660	1100	1400	2000	5500
AC_T5	9233	300	550	890	1400	1700	2100	3100
AC_T6	6134	440	680	910	1200	1500	1700	2400
	2317	540	860	1100	1600	1900	2300	3200
AC_T7	16107	460	700	900	1200	1400	1700	2300
	14134	500	830	1100	1600	1900	2300	3400
	11777	650	1100	1500	2200	2800	3400	5000
	6300	650	1100	1600	2400	3000	3800	5800
	4146	800	1300	2000	3100	4000	5000	7800
	1537	800	1300	2000	3100	4100	5200	8100
AC_T8	5879	370	670	980	1400	1800	2200	3200
	1698	380	730	1100	1600	2100	2500	3800
AC_T9	14583	200	410	630	990	1300	1700	2800
	6370	920	1700	2600	4000	5100	6300	9700
	2326	980	1900	2900	4500	5800	7200	11300

Alum Creek Watershed Flow Breaks								
River	HEC-RAS XS	50%	20%	10%	4%	2%	1%	0.20%
AC_T10	6658	400	720	1000	1500	2000	2400	3600
	4757	400	710	1100	1600	2000	2500	3800
	3209	700	1200	1800	2700	3400	4100	6200
	1970	720	1300	2000	3000	3800	4600	7000
AC_T11	11432	460	690	910	1200	1600	1900	2800
	7310	570	880	1200	1900	2500	3000	4500
	2908	620	1000	1500	2300	3100	3800	5700
AC_T067	4406	290	460	610	830	1000	1200	1600
	1828	560	870	1200	1600	1900	2200	3000
AC_T087	4149	170	300	450	680	880	1100	1500
AC_T093	2924	260	440	620	880	1100	1300	1900
	1099	300	520	730	1100	1400	1600	2400
AC_T107	7256	100	230	380	620	820	1000	1700
	6032	140	310	490	780	1000	1300	2000
	2472	250	560	900	1400	1900	2300	3600
AC_T107_A	604	70	120	170	240	300	370	520
AC_T110	2520	60	120	220	400	550	720	1200
AC_T124	3474	120	270	440	720	940	1200	1800
AC_T129	8110	130	250	380	610	800	990	1500
	1528	160	300	440	680	890	1100	1700
AC_T131	7022	170	290	410	580	730	870	1300
	2407	150	300	510	860	1200	1500	2500
AC_T137	7797	330	540	840	1300	1600	1900	2700
AC_T138	2336	180	310	450	650	820	1000	1500
AC_T143	3046	210	420	640	980	1300	1600	2400
AC_T148	12191	430	730	1000	1500	1900	2300	3300
	1624	600	1000	1400	2000	2500	3000	4300
AC_T160	4688	250	390	510	670	790	910	1200
AC_T162	9725	820	1200	1500	1900	2200	2500	3300
AC_T166	9140	170	250	320	420	500	570	770
	7038	300	440	570	740	880	1000	1300
	5792	610	910	1200	1500	1800	2100	2800
	2361	690	1000	1400	1800	2200	2500	3500
AC_T167	2464	330	500	650	860	1000	1200	1600
AC_T168	3040	270	370	450	560	650	730	940
	932	350	480	610	770	900	1000	1300
AC_T169	5917	160	210	260	330	380	430	550
	3539	590	830	1000	1300	1600	1800	2400
	2244	940	1300	1600	2100	2500	2800	3700
	1039	960	1300	1700	2100	2500	2900	3800
AC_T173	13553	420	690	940	1300	1600	1900	2700
	10658	620	1000	1400	2000	2400	2800	4000
	8991	710	1200	1600	2300	2800	3300	4600
	7476	780	1300	1800	2500	3100	3700	5300
	6474	980	1600	2200	3000	3700	4500	6300
	2613	1200	1900	2600	3700	4500	5400	7700
AC_T174	1400	100	150	210	280	330	390	540
	487	120	190	250	340	410	480	660
AC_T175	1733	290	400	500	640	740	840	1100
	481	380	530	660	850	990	1100	1500
LAC	35309	430	590	730	910	1100	1200	1600
	30532	400	600	780	1000	1300	1500	2600
	21474	500	760	990	1300	1600	1900	2900
	17583	1600	2600	3400	4800	5900	7100	10200
	13552	1400	2200	3100	4400	5400	6500	9600
	4901	1400	2200	3200	4600	5700	6900	10200
	1468	1500	2500	3600	5100	6500	7900	11800
PC	9949	200	390	640	990	1300	1600	2500
	4375	220	430	710	1100	1400	1800	2900
	2547	400	730	1100	1800	2200	2900	4400
	1229	400	730	1100	1800	2200	2900	4400

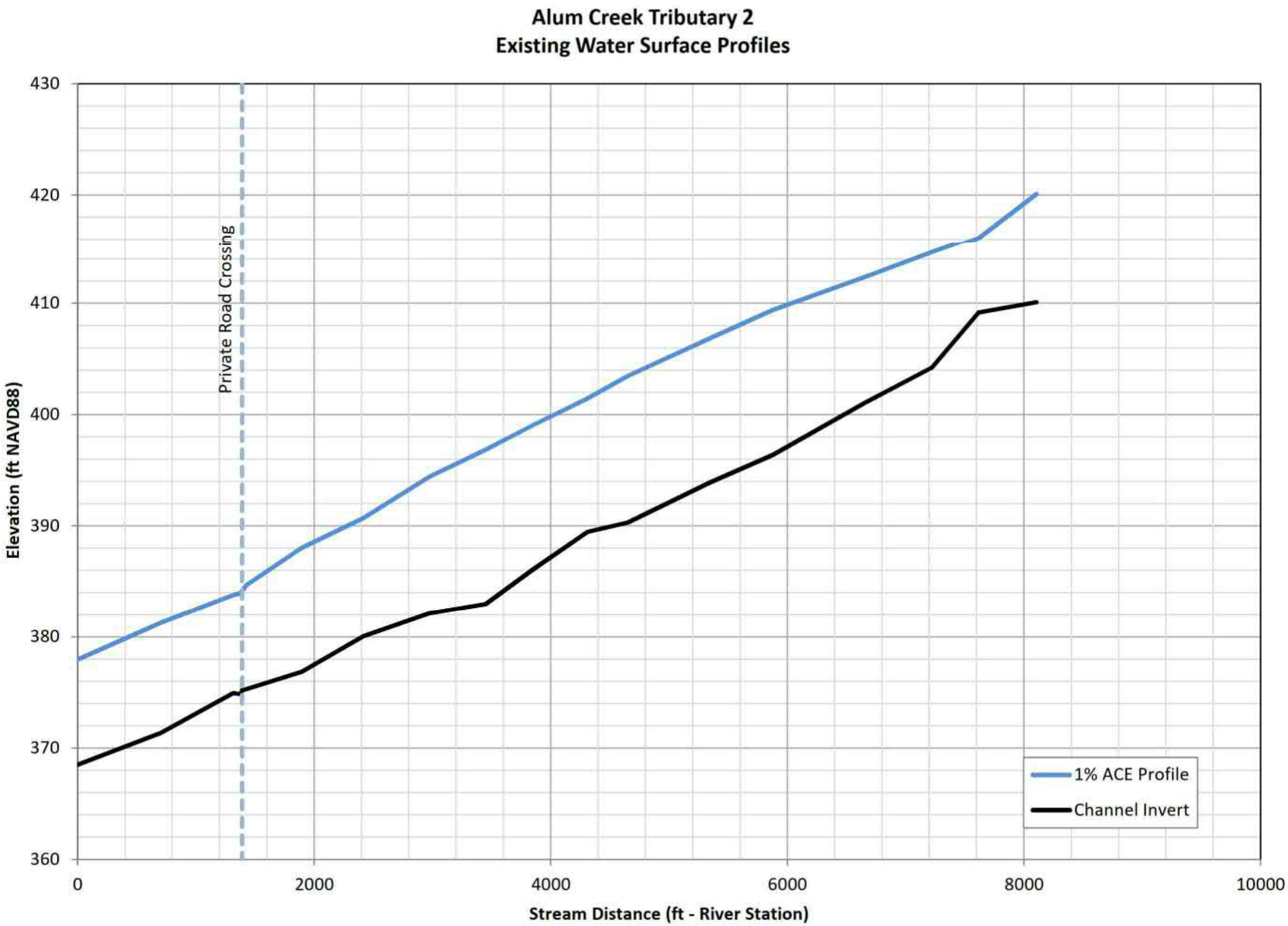
Appendix F: Hydraulic Model Analysis

F-2 Hydraulics Results – HEC-RAS Results

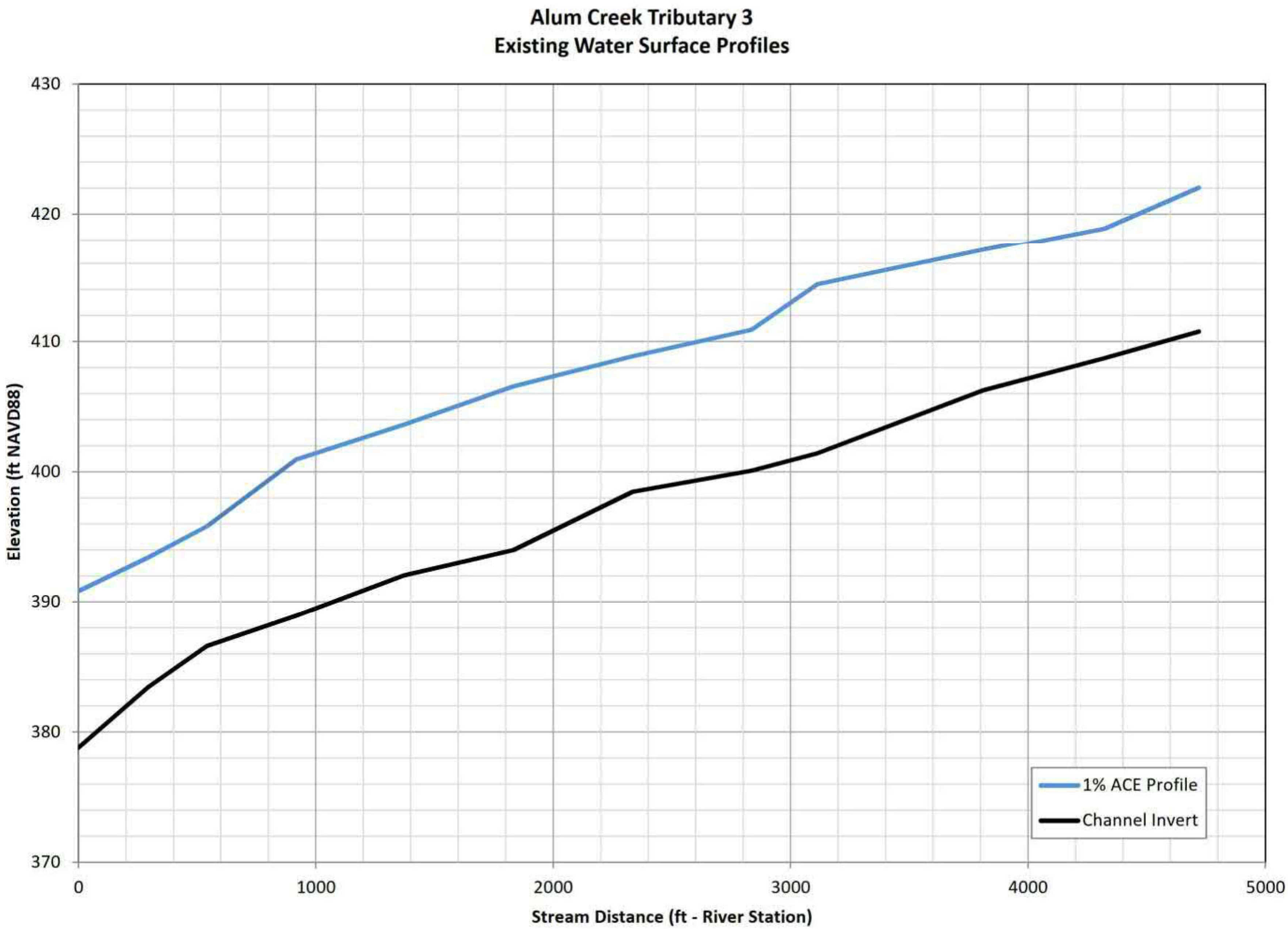

Alum Creek
Existing Water Surface Profiles
Elevation (ft NAVD88)
Stream Distance (ft - River Station)
Lateral Structure
Lateral Structure
TX-71/TX-95, Eastbound
TX-71/TX-95, Westbound
Park Rd 1C
Gotier Trace Rd
Mustarg Dr
State Hwy 21 W
Bowie Dr
Cardinal Ln
1% ACE Profile
Channel Invert
600
550
500
450
400
350
300
250
0
20000
40000
60000
80000
100000
120000

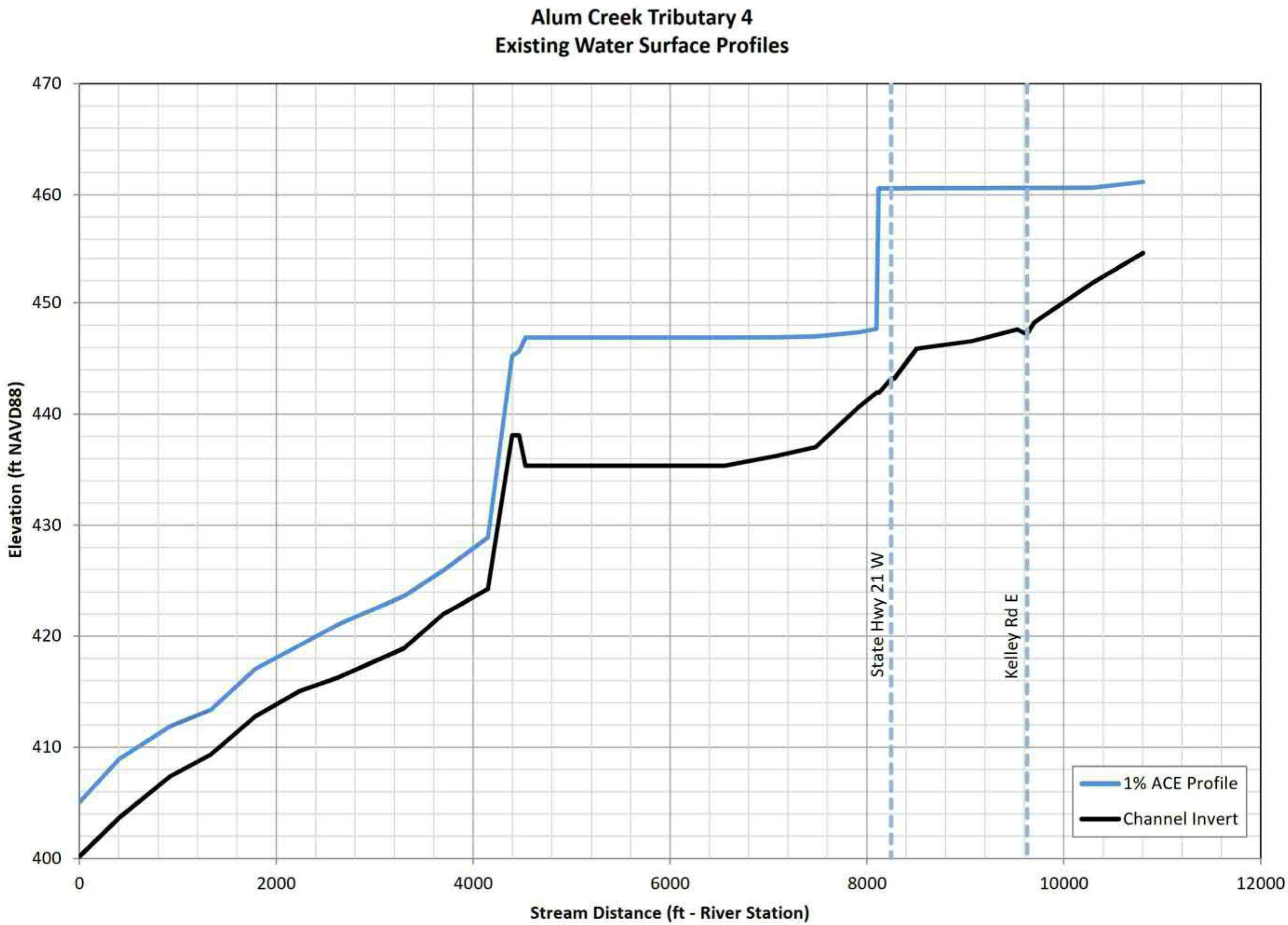


F-2 Hydraulics Results – HEC-RAS Results

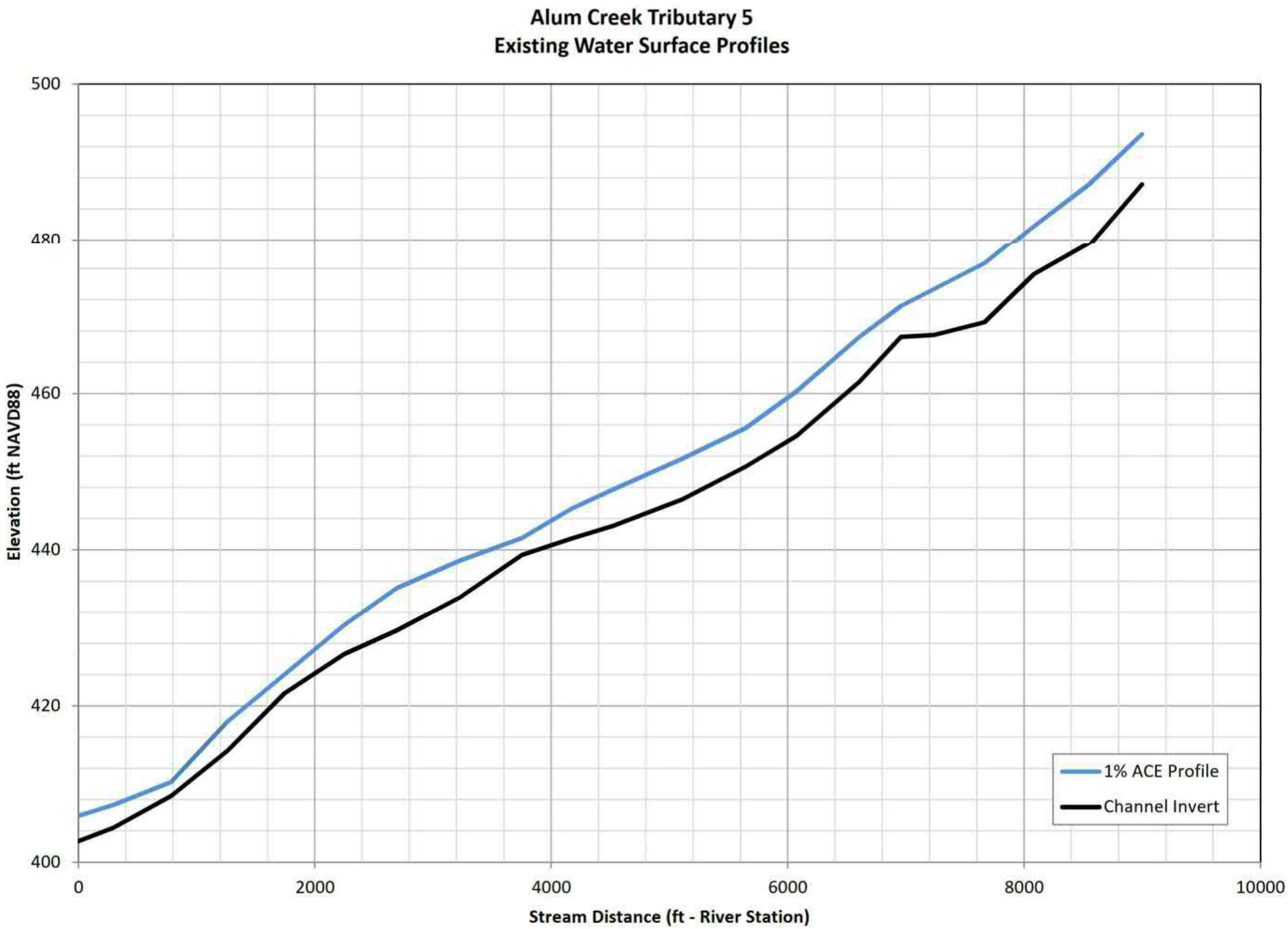


Alum Creek Tributary 2
Existing Water Surface Profiles
Elevation (ft NAVD88)
430
420
410
400
390
380
370
360
Private Road Crossing
0
2000
4000
6000
8000
10000
Stream Distance (ft - River Station)
1% ACE Profile
Channel Invert

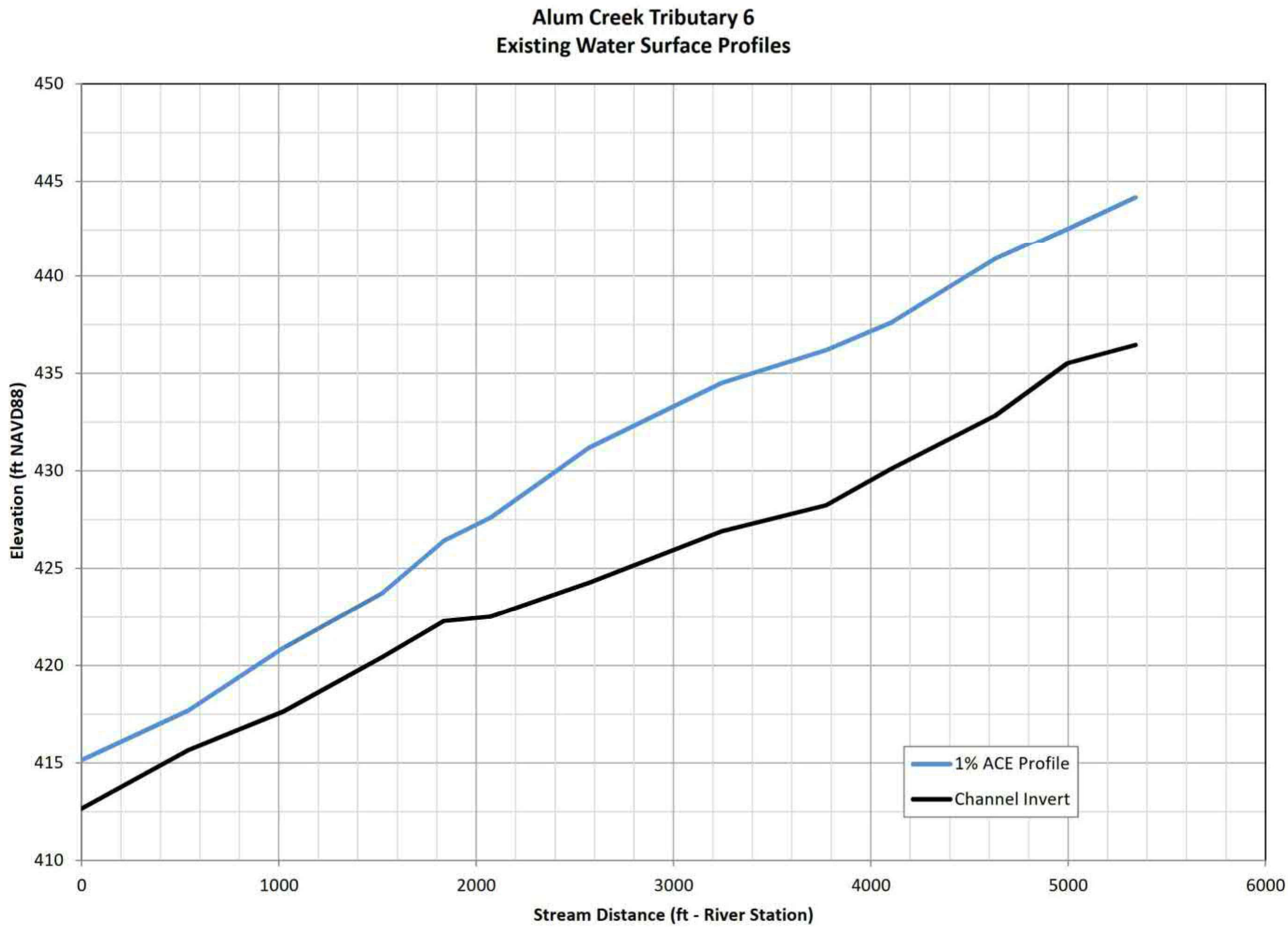

Alum Creek Tributary 3
Existing Water Surface Profiles
430
420
410
400
390
380
370
Elevation (ft NAVD88)
0
1000
2000
3000
4000
5000
Stream Distance (ft - River Station)
1% ACE Profile
Channel Invert

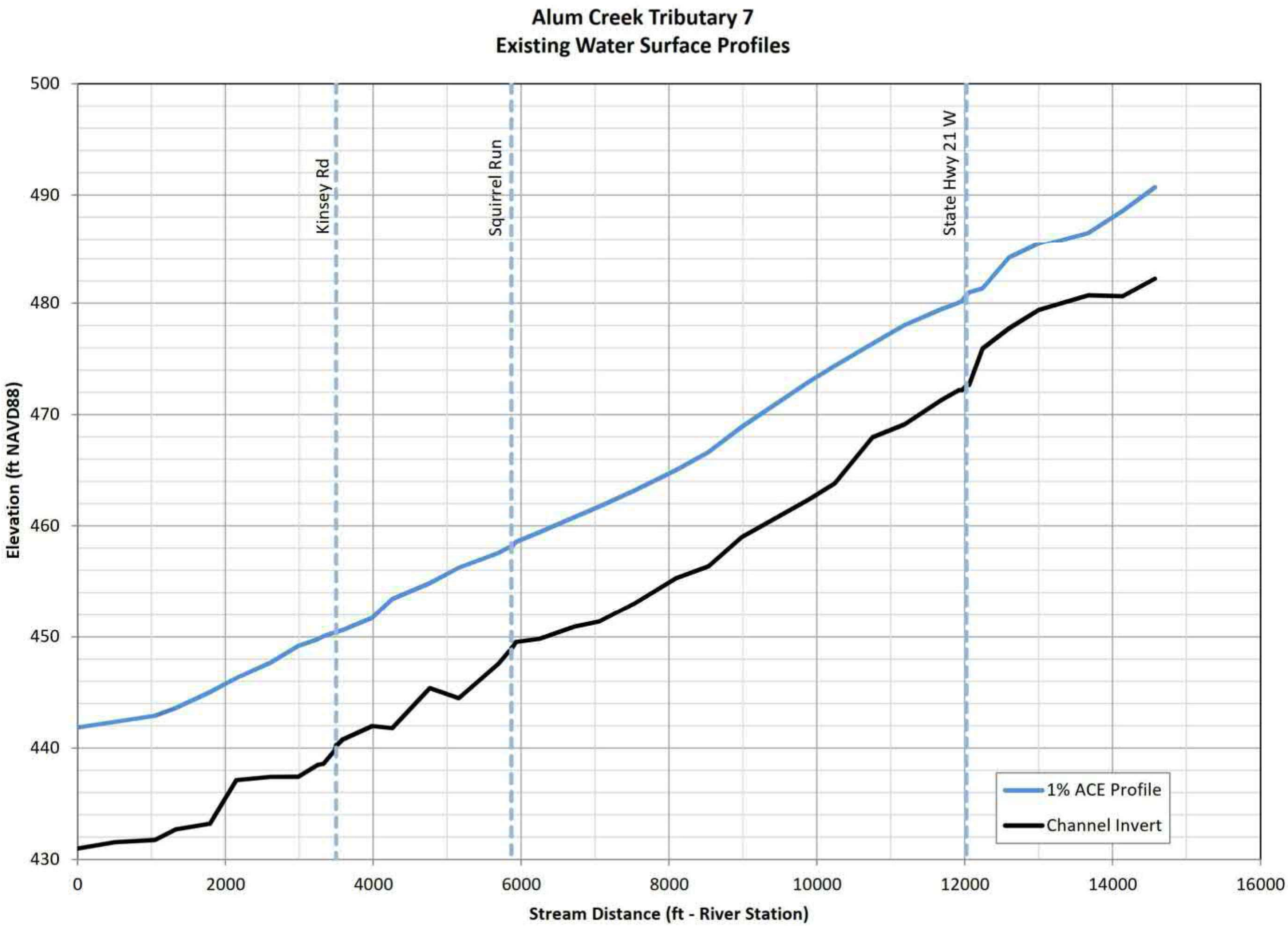


F-2 Hydraulics Results – HEC-RAS Results

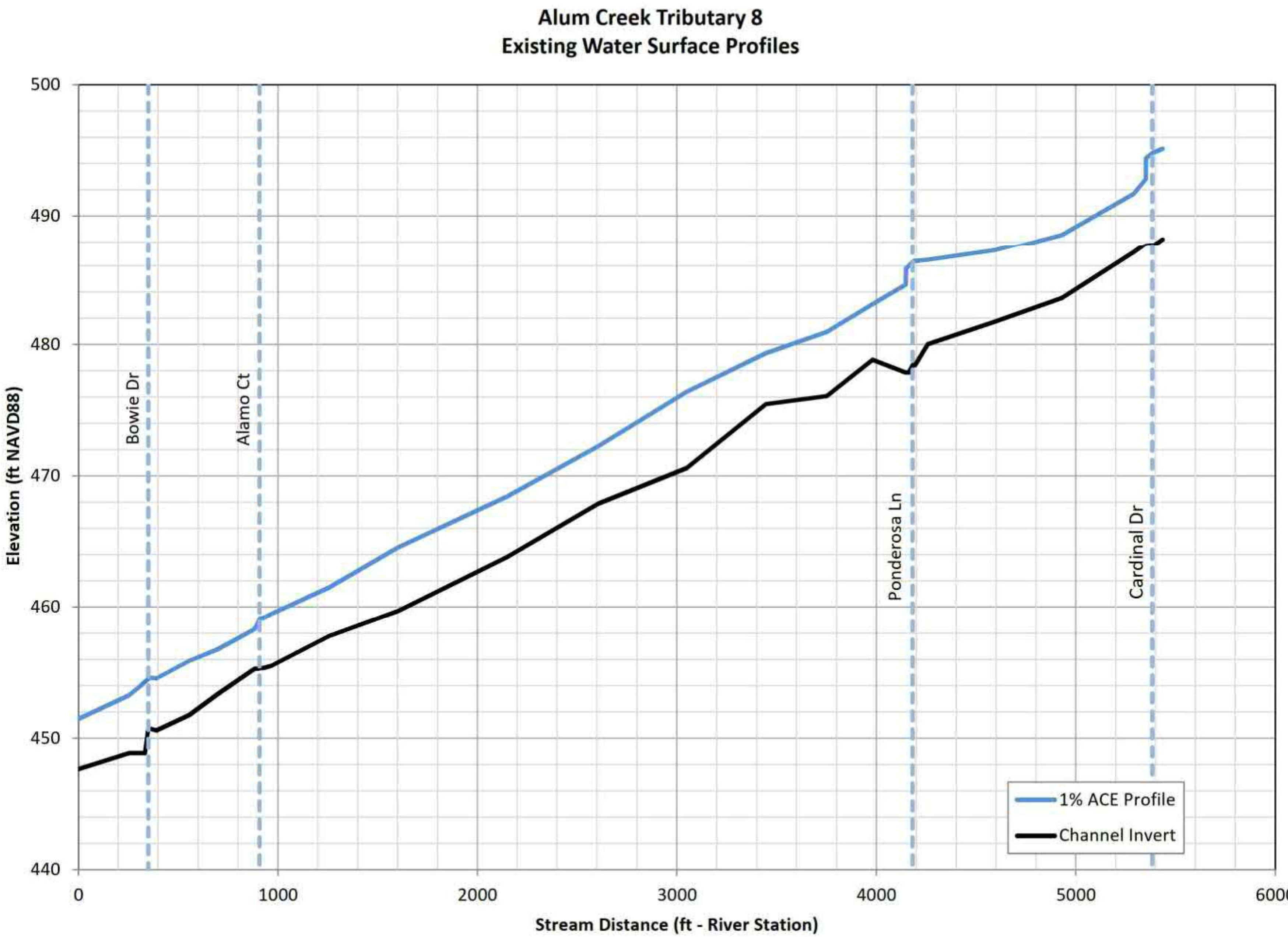


Alum Creek Tributary 5
Existing Water Surface Profiles
Elevation (ft NAVD88)
500
480
460
440
420
400
0
2000
4000
6000
8000
10000
Stream Distance (ft - River Station)
1% ACE Profile
Channel Invert

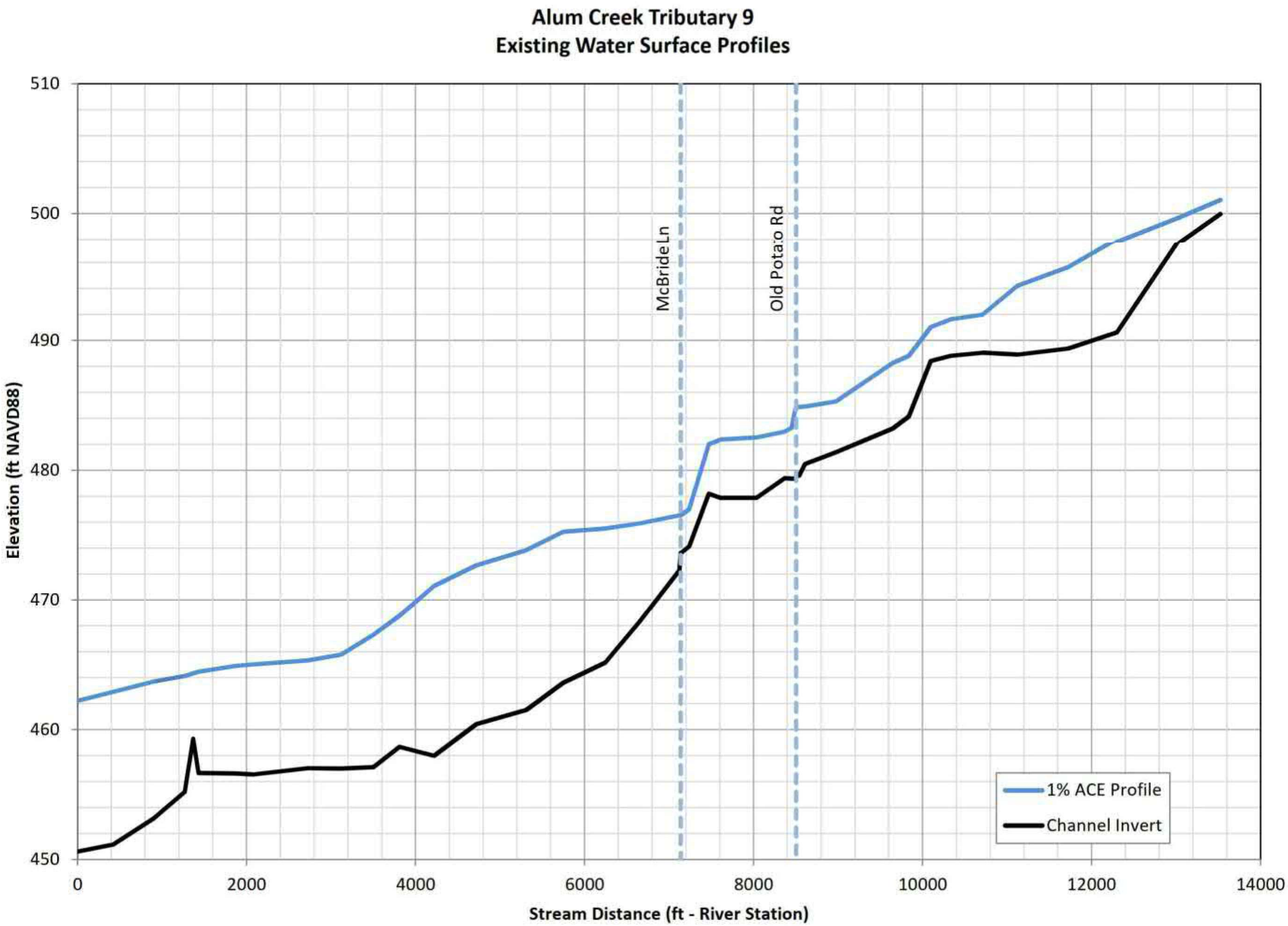

Alum Creek Tributary 6
Existing Water Surface Profiles
450
445
440
435
430
425
420
415
410
Elevation (ft NAVD88)
0
1000
2000
3000
4000
5000
6000
Stream Distance (ft - River Station)
1% ACE Profile
Channel Invert

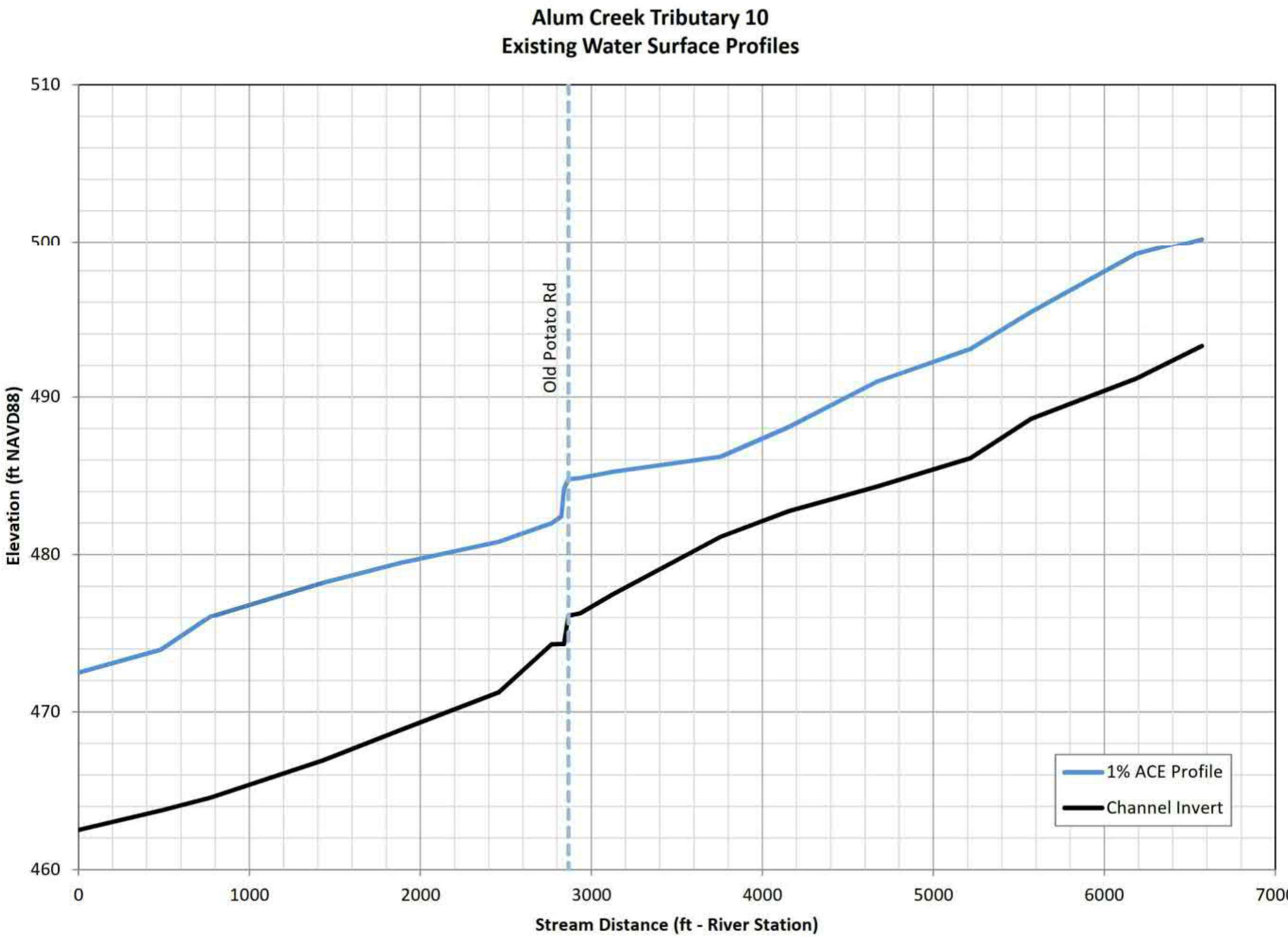


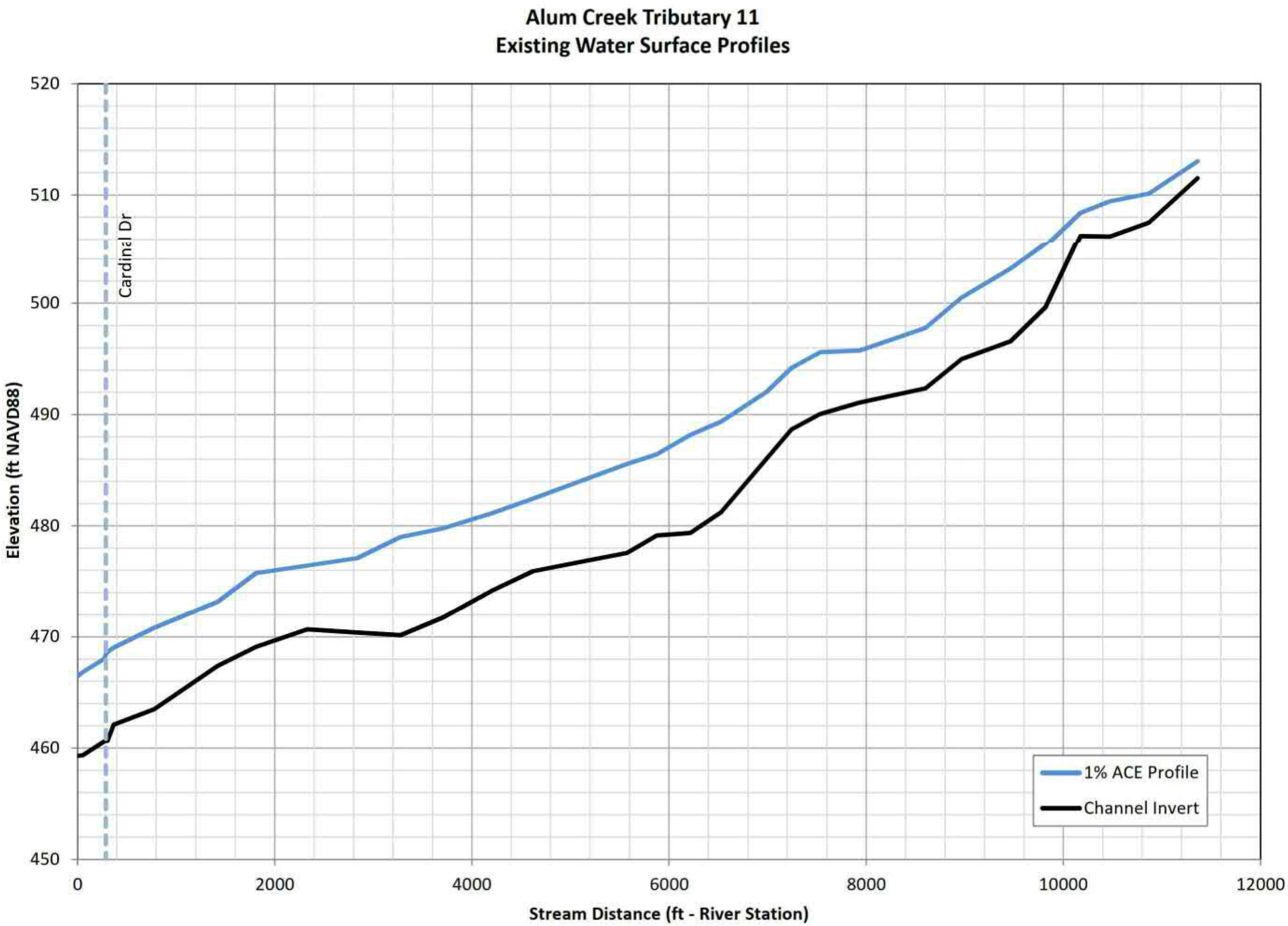
Alum Creek Tributary 7
Existing Water Surface Profiles
Elevation (ft NAVD88)
Stream Distance (ft - River Station)
Kinsey Rd
Squirrel Run
State Hwy 21 W
1% ACE Profile
Channel Invert
500
490
480
470
460
450
440
430
0
2000
4000
6000
8000
10000
12000
14000
16000



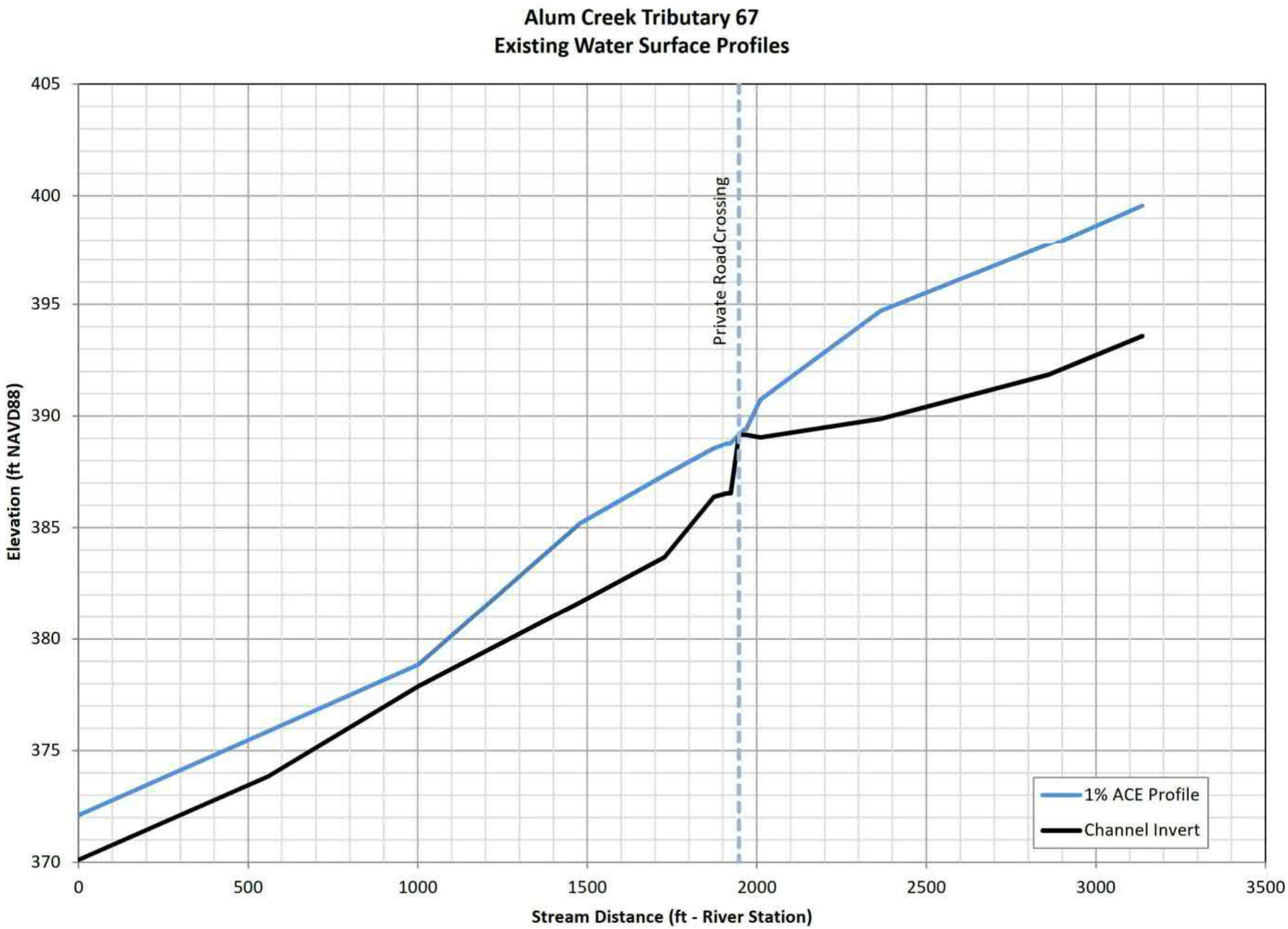
F-2 Hydraulics Results – HEC-RAS Results


Alum Creek Tributary 9
Existing Water Surface Profiles
510
500
490
480
470
460
450
Elevation (ft NAVD88)
0
2000
4000
6000
8000
10000
12000
14000
Stream Distance (ft - River Station)
McBride Ln
Old Potato Rd
1% ACE Profile
Channel Invert

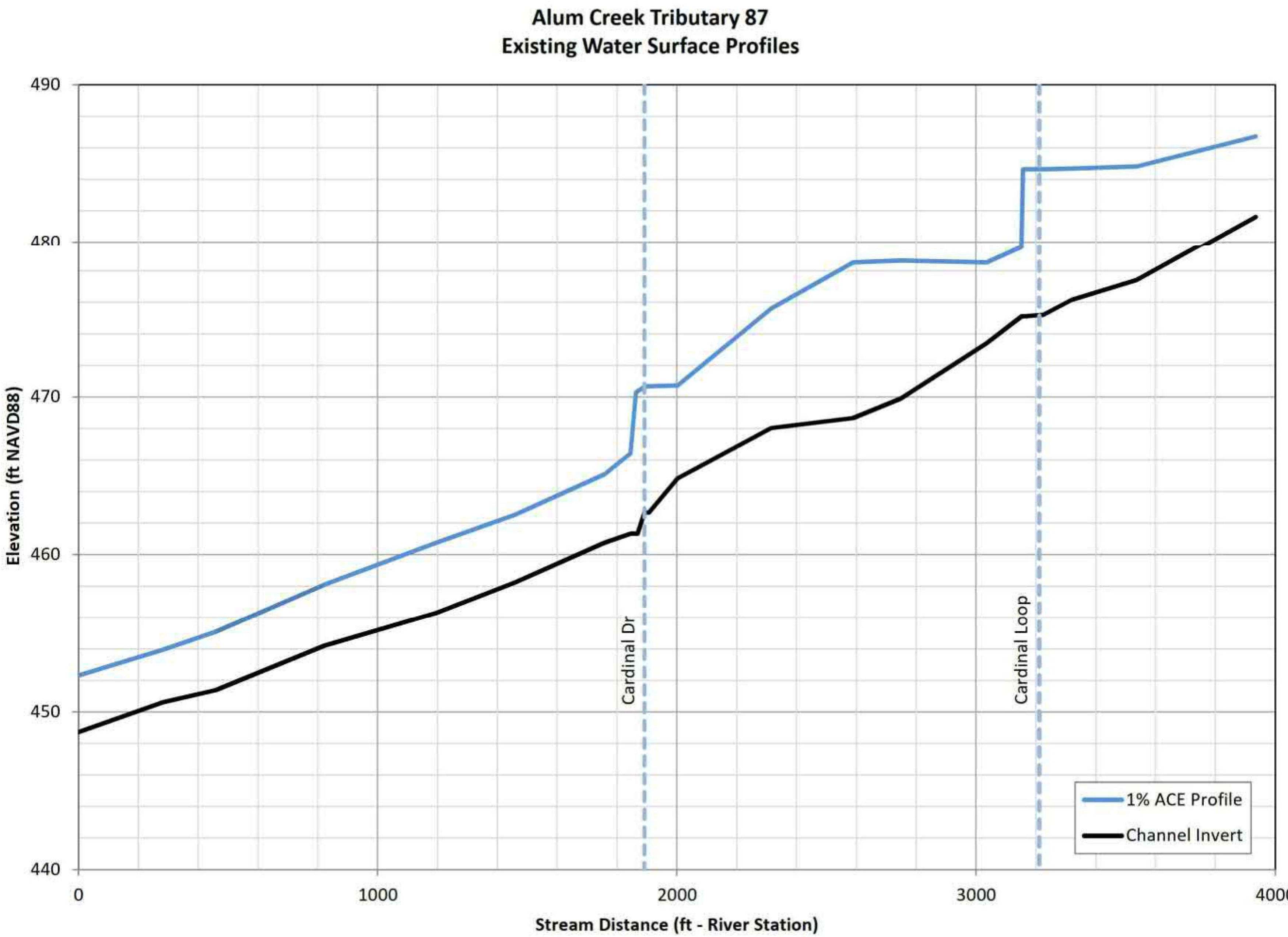

Alum Creek Tributary 10
Existing Water Surface Profiles
Elevation (ft NAVD88)
Stream Distance (ft - River Station)
Old Potato Rd
1% ACE Profile
Channel Invert
510
500
490
480
470
460
0
1000
2000
3000
4000
5000
6000
7000



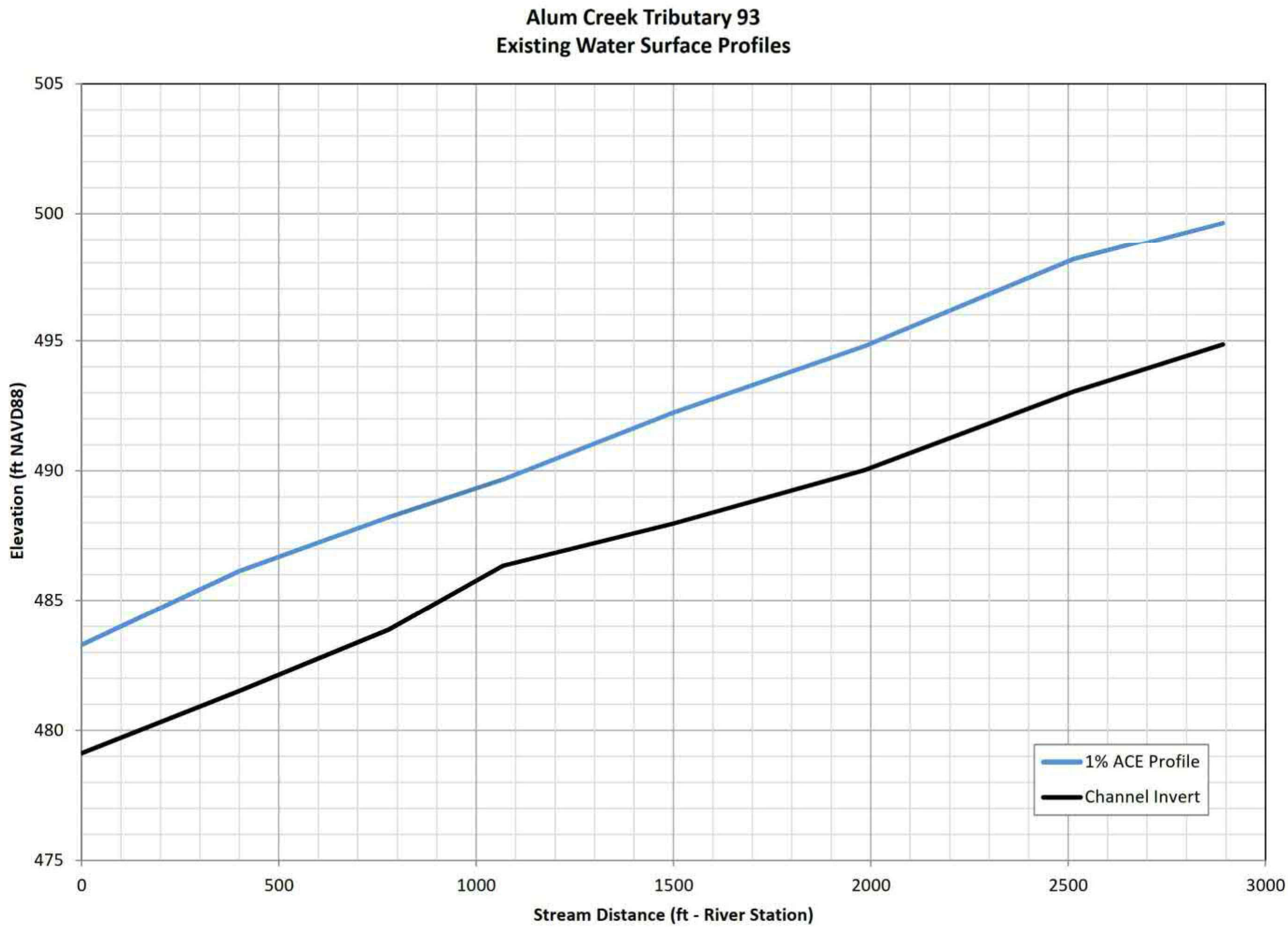
Alum Creek Tributary 11
Existing Water Surface Profiles
Elevation (ft NAVD88)
Stream Distance (ft - River Station)
Cardinal Dr
1% ACE Profile
Channel Invert
520
510
500
490
480
470
460
450
0
2000
4000
6000
8000
10000
12000

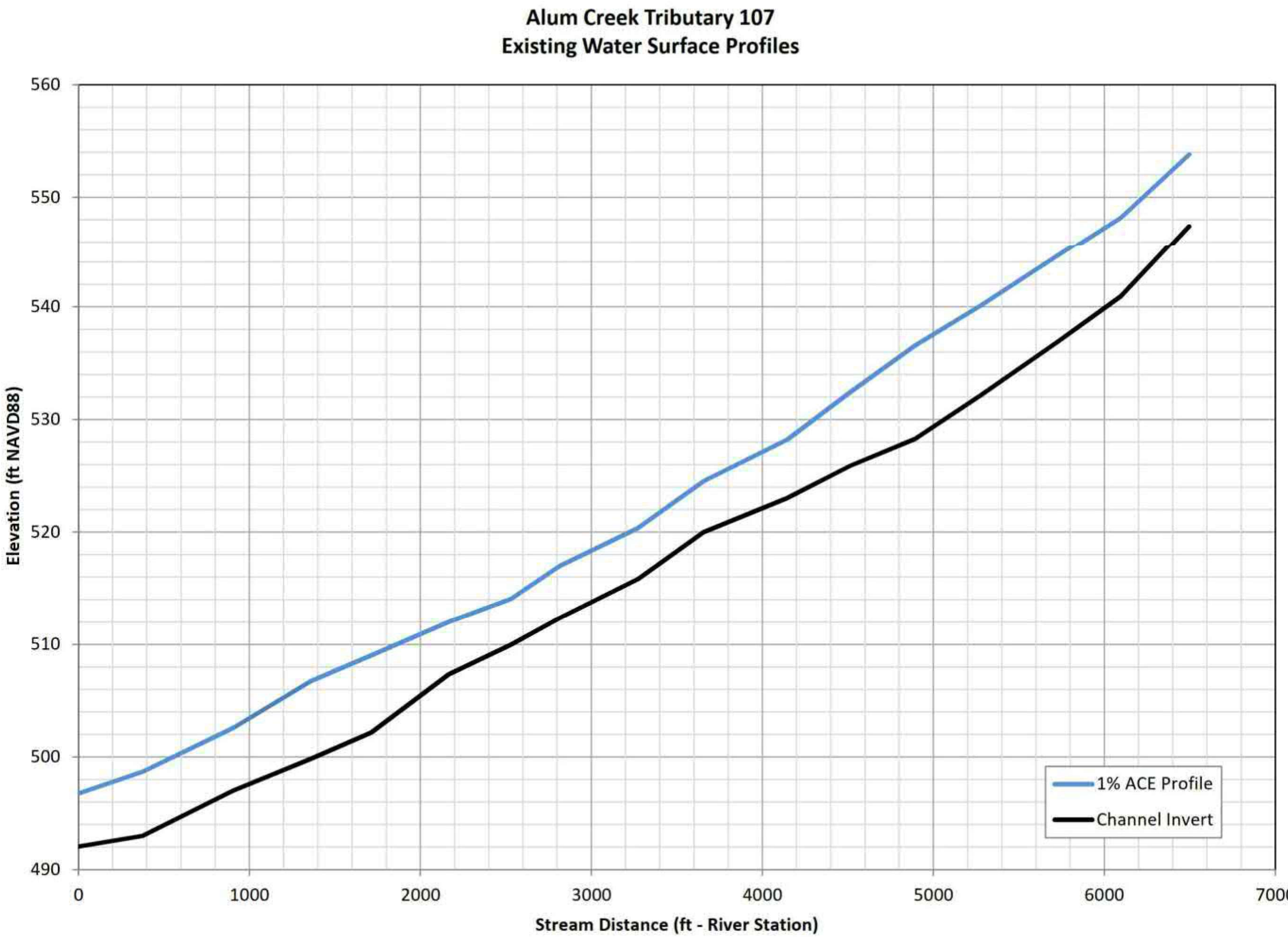


F-2 Hydraulics Results – HEC-RAS Results

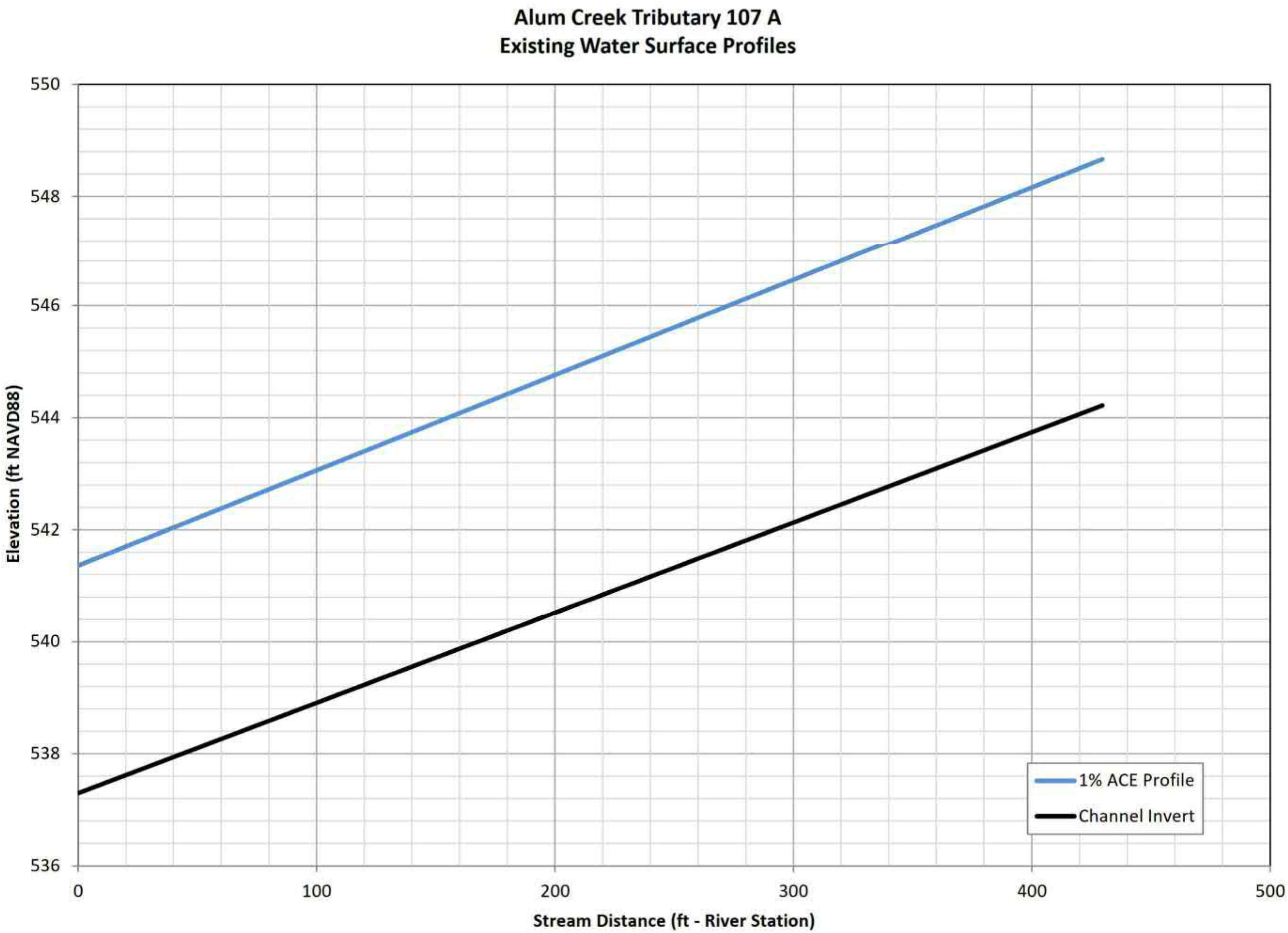


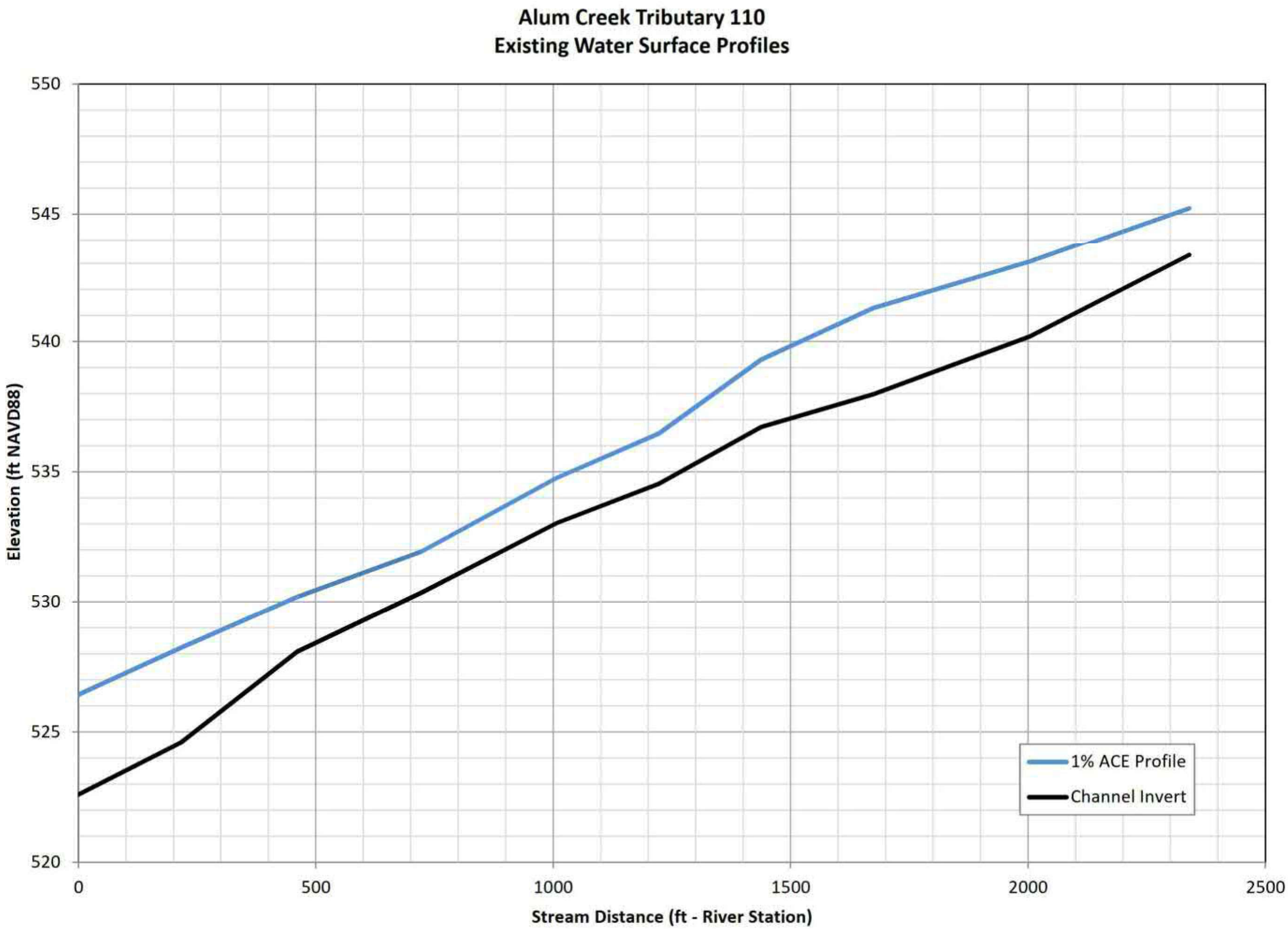
F-2 Hydraulics Results – HEC-RAS Results


Alum Creek Tributary 93
Existing Water Surface Profiles
505
500
495
490
485
480
475
Elevation (ft NAVD88)
0
500
1000
1500
2000
2500
3000
Stream Distance (ft - River Station)
1% ACE Profile
Channel Invert

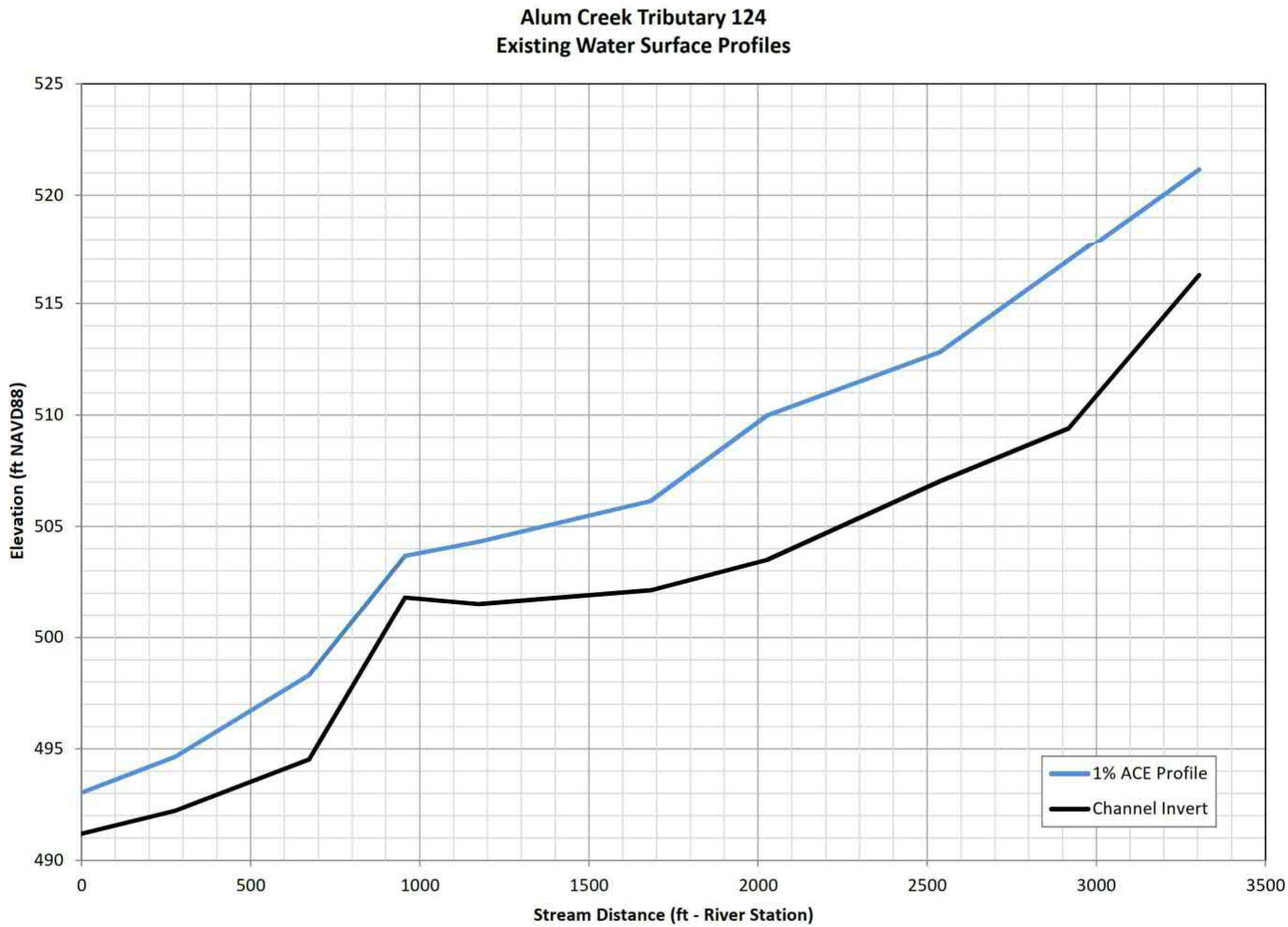


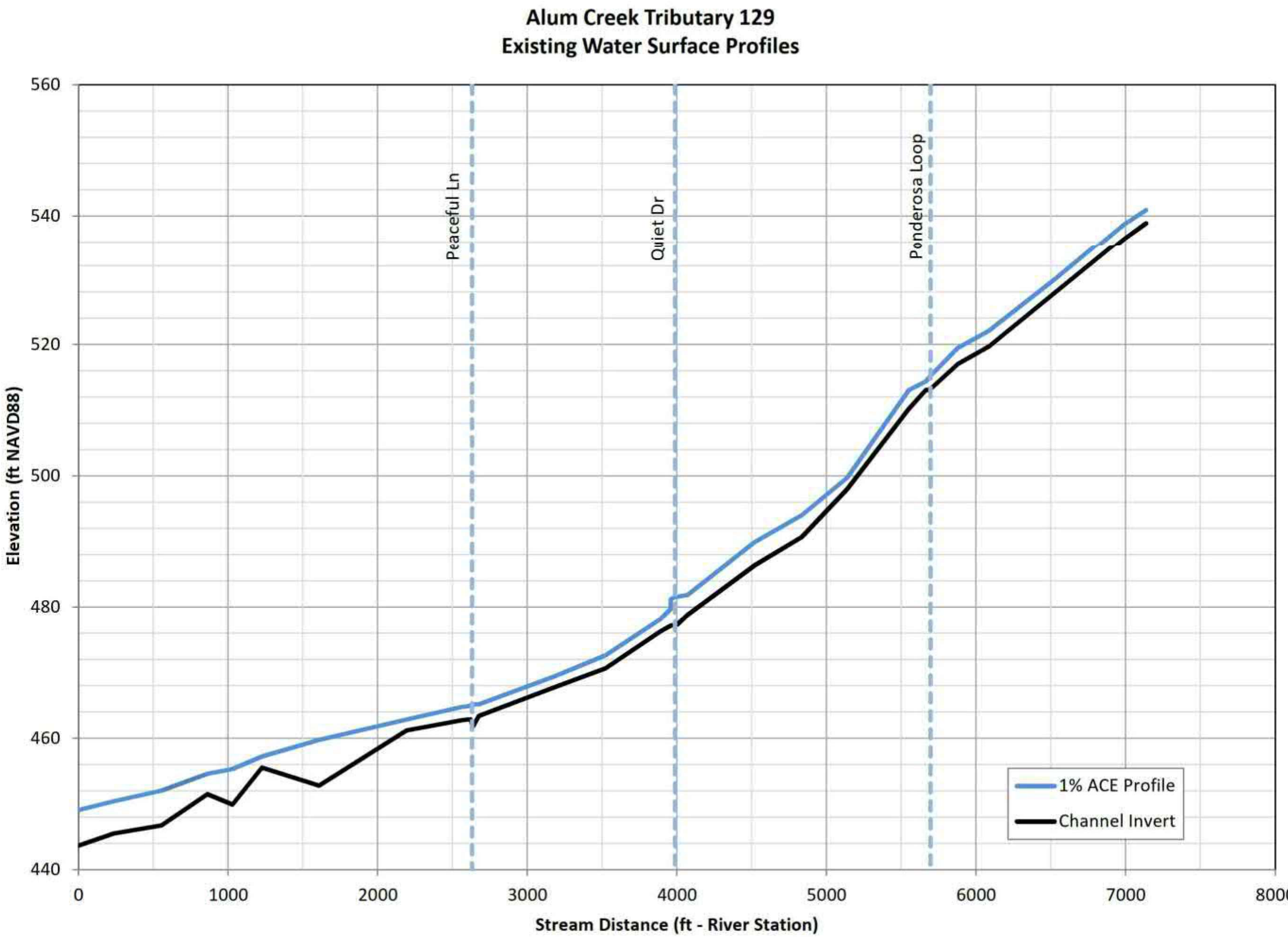
Alum Creek Tributary 107
Existing Water Surface Profiles
560
550
540
530
520
510
500
490
Elevation (ft NAVD88)
0
1000
2000
3000
4000
5000
6000
7000
Stream Distance (ft - River Station)
1% ACE Profile
Channel Invert


Alum Creek Tributary 107 A
Existing Water Surface Profiles
Elevation (ft NAVD88)
550
548
546
544
542
540
538
536
0
100
200
300
400
500
Stream Distance (ft - River Station)
1% ACE Profile
Channel Invert

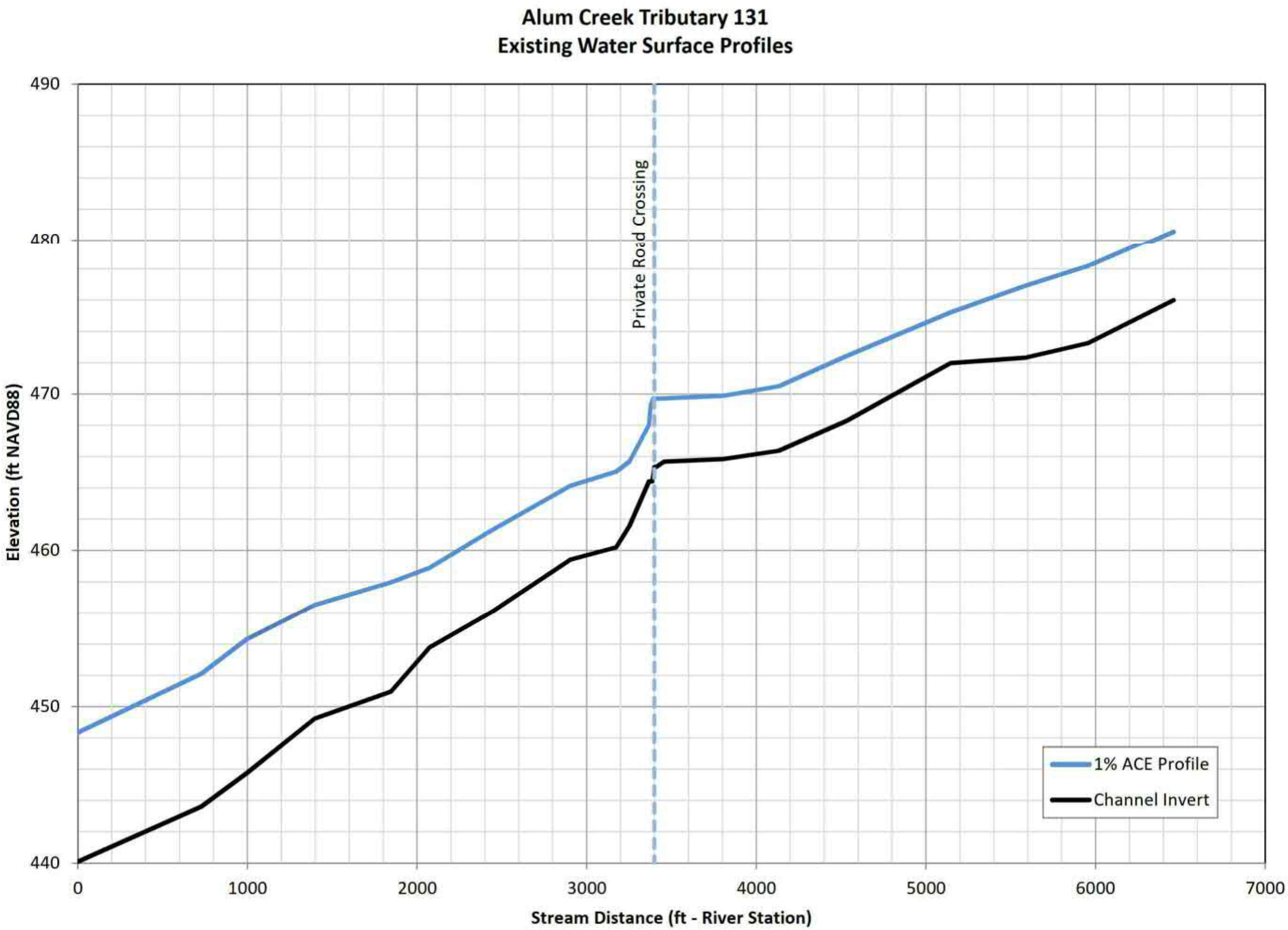


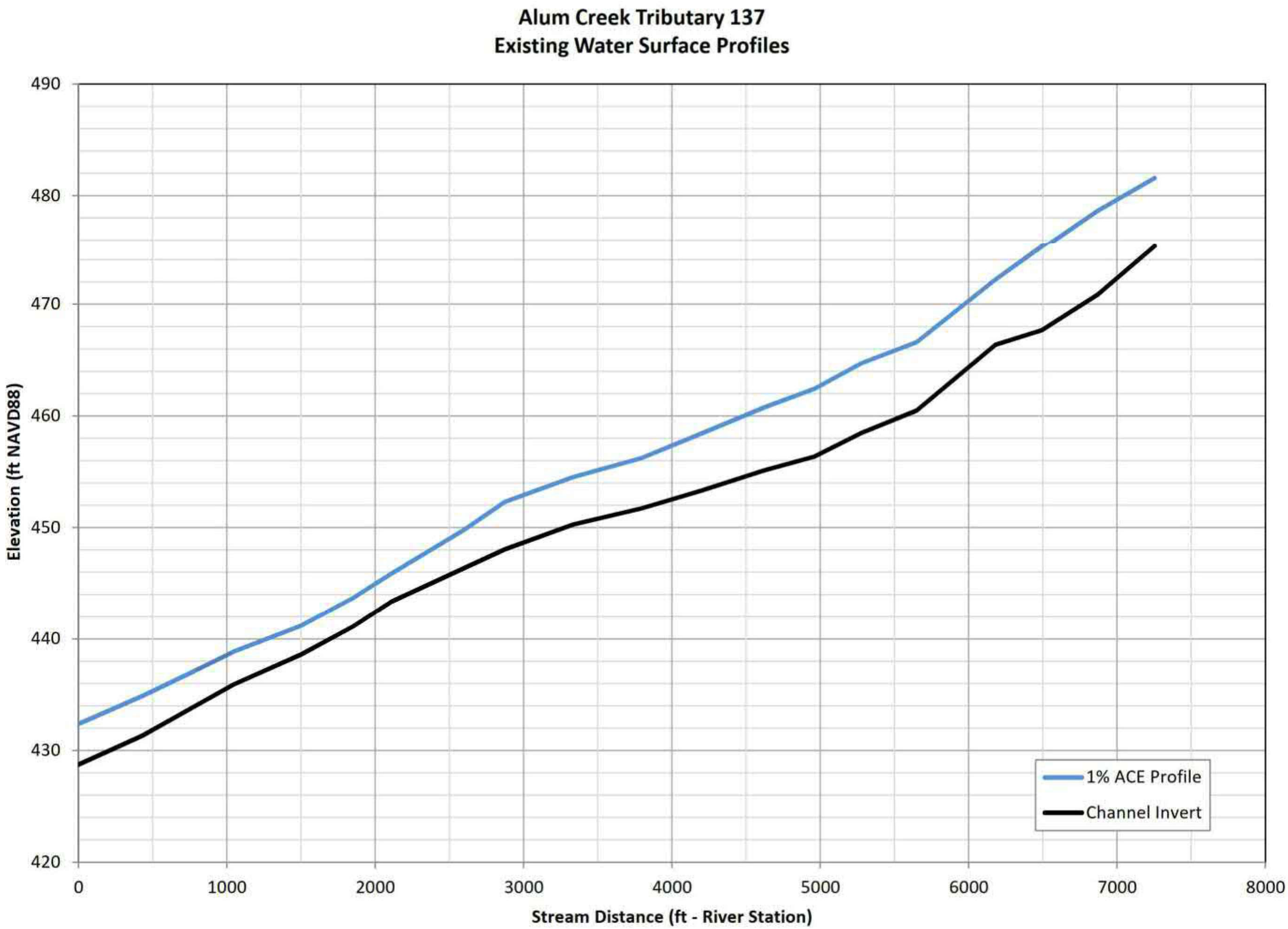
Alum Creek Tributary 110
Existing Water Surface Profiles
550
545
540
535
530
525
520
Elevation (ft NAVD88)
0
500
1000
1500
2000
2500
Stream Distance (ft - River Station)
1% ACE Profile
Channel Invert


Alum Creek Tributary 124
Existing Water Surface Profiles
525
520
515
510
505
500
495
490
Elevation (ft NAVD88)
0
500
1000
1500
2000
2500
3000
3500
Stream Distance (ft - River Station)
1% ACE Profile
Channel Invert

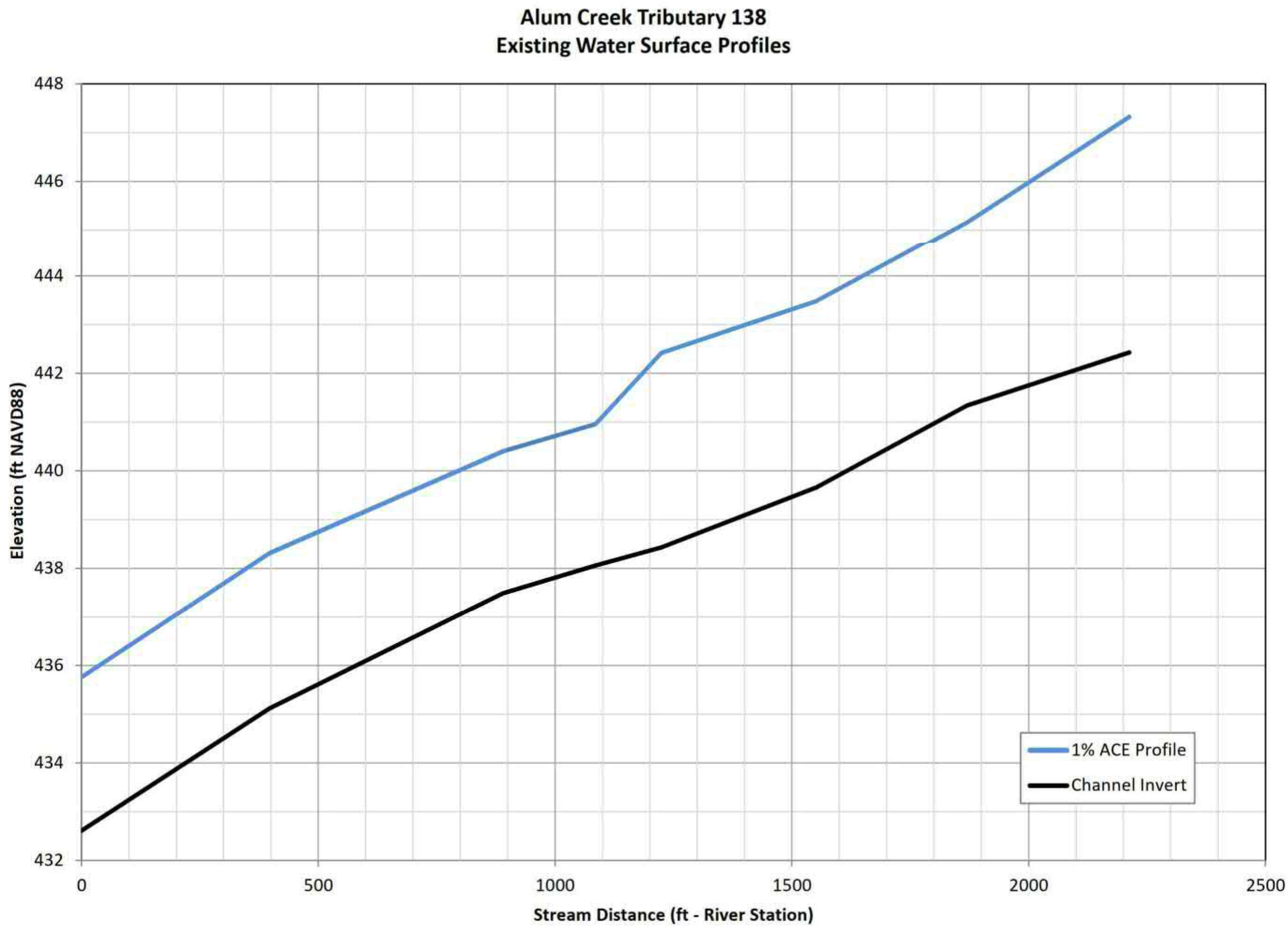


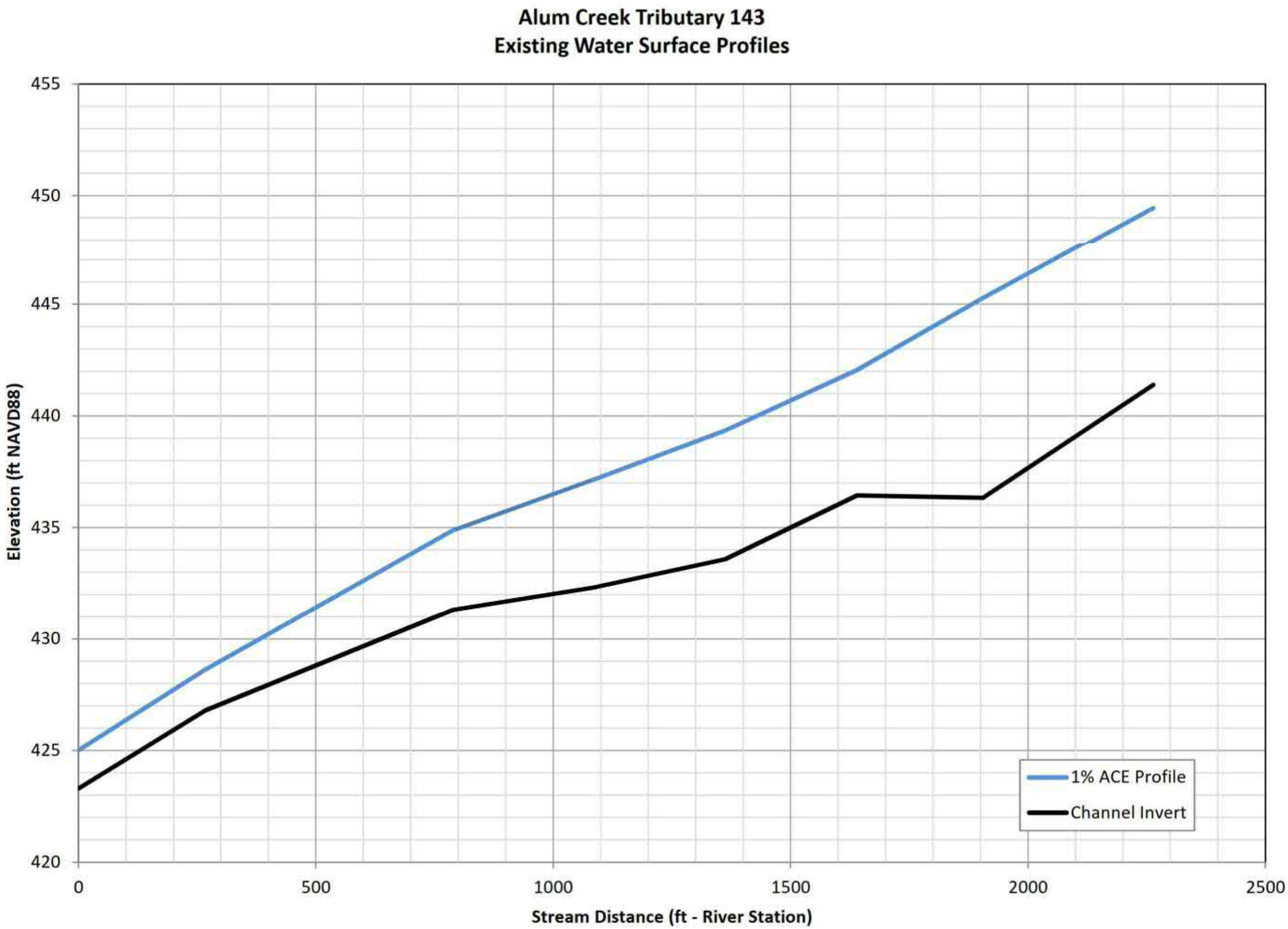
Alum Creek Tributary 129
Existing Water Surface Profiles
Elevation (ft NAVD88)
Stream Distance (ft - River Station)
Peaceful Ln
Quiet Dr
Ponderosa Loop
1% ACE Profile
Channel Invert
560
540
520
500
480
460
440
0
1000
2000
3000
4000
5000
6000
7000
8000

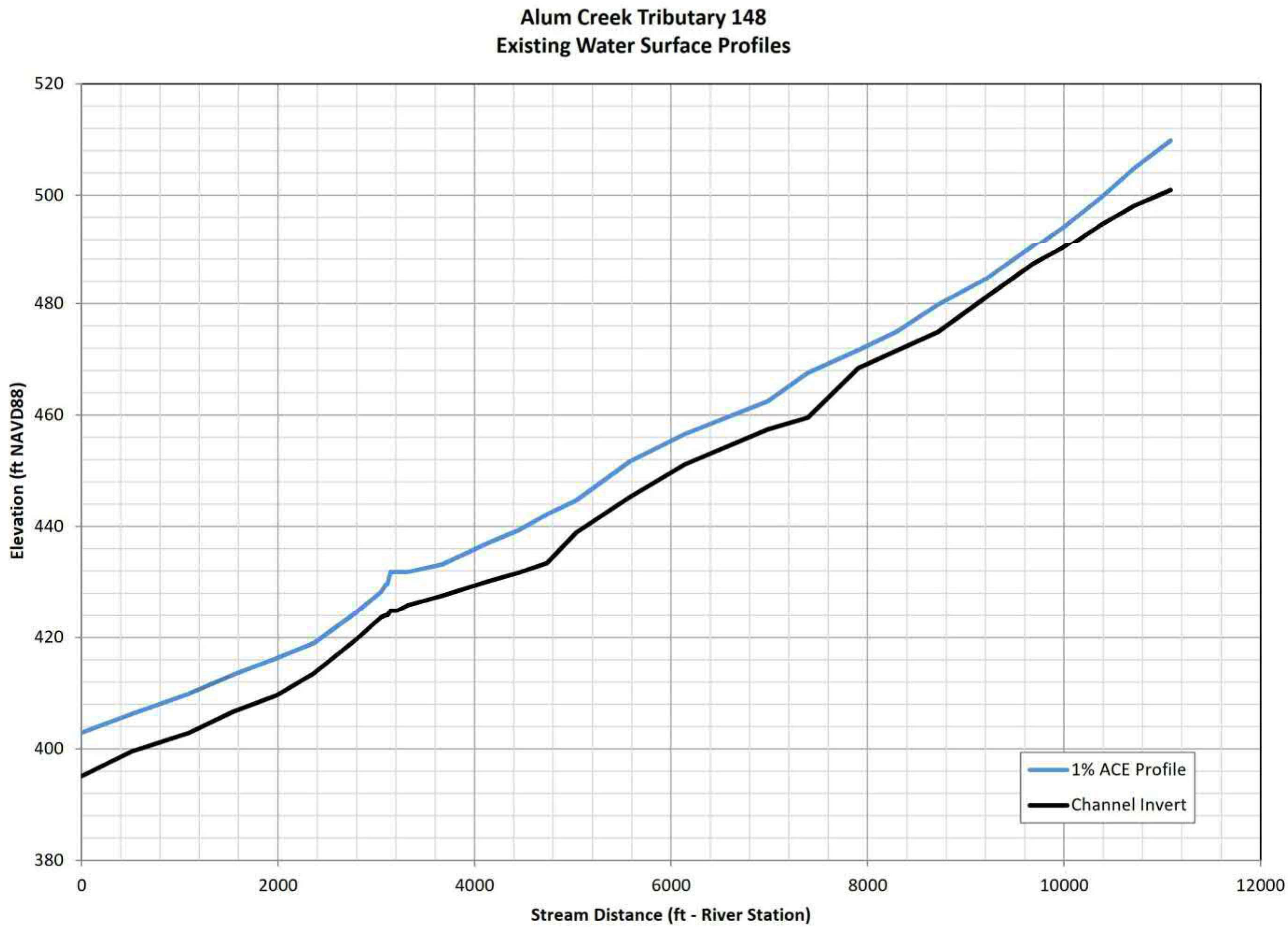

Alum Creek Tributary 131
Existing Water Surface Profiles
Private Road Crossing
1% ACE Profile
Channel Invert
Elevation (ft NAVD88)
Stream Distance (ft - River Station)
490
480
470
460
450
440
0
1000
2000
3000
4000
5000
6000
7000

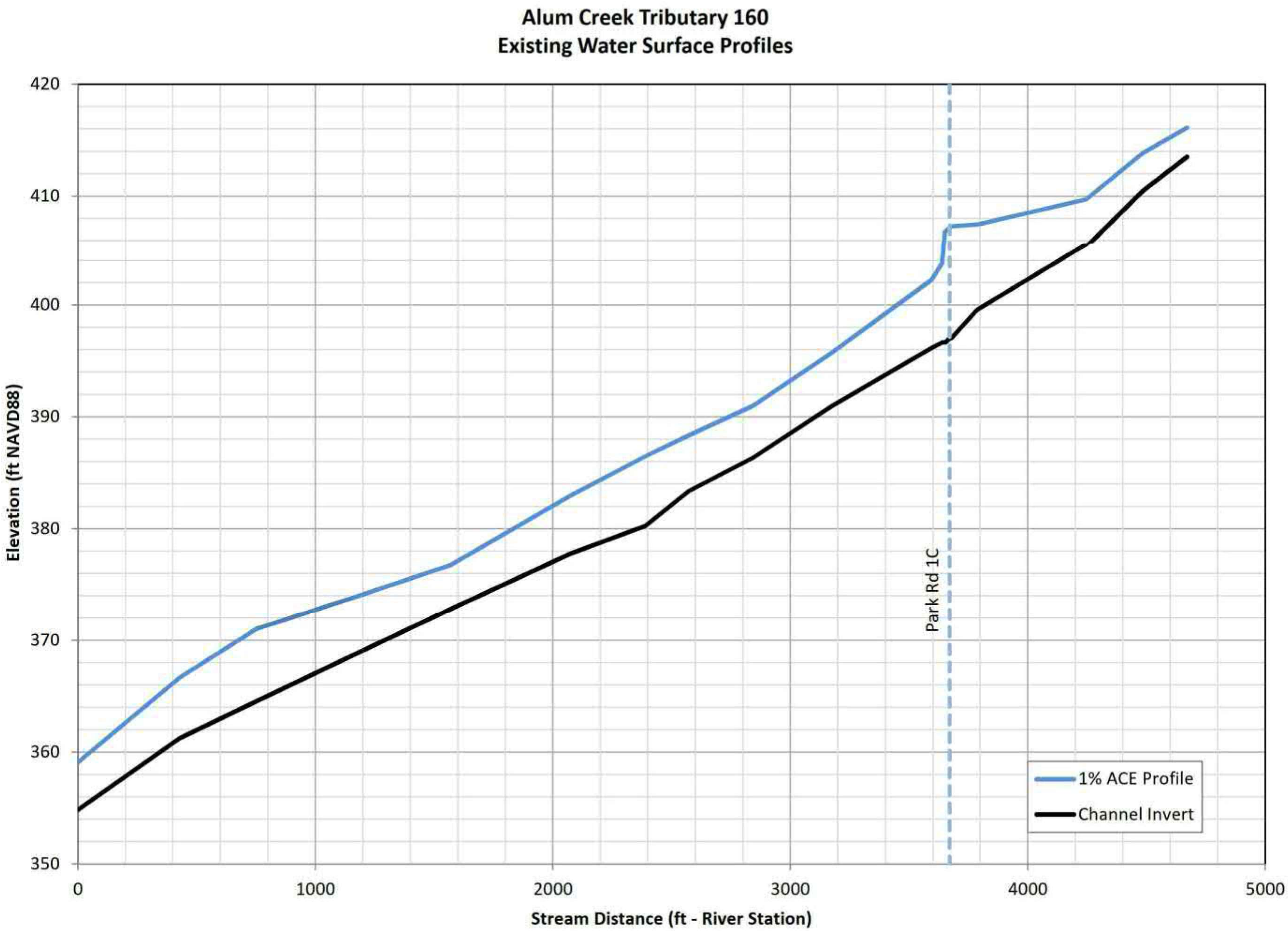


Alum Creek Tributary 137
Existing Water Surface Profiles
490
480
470
460
450
440
430
420
Elevation (ft NAVD88)
0
1000
2000
3000
4000
5000
6000
7000
8000
Stream Distance (ft - River Station)
1% ACE Profile
Channel Invert

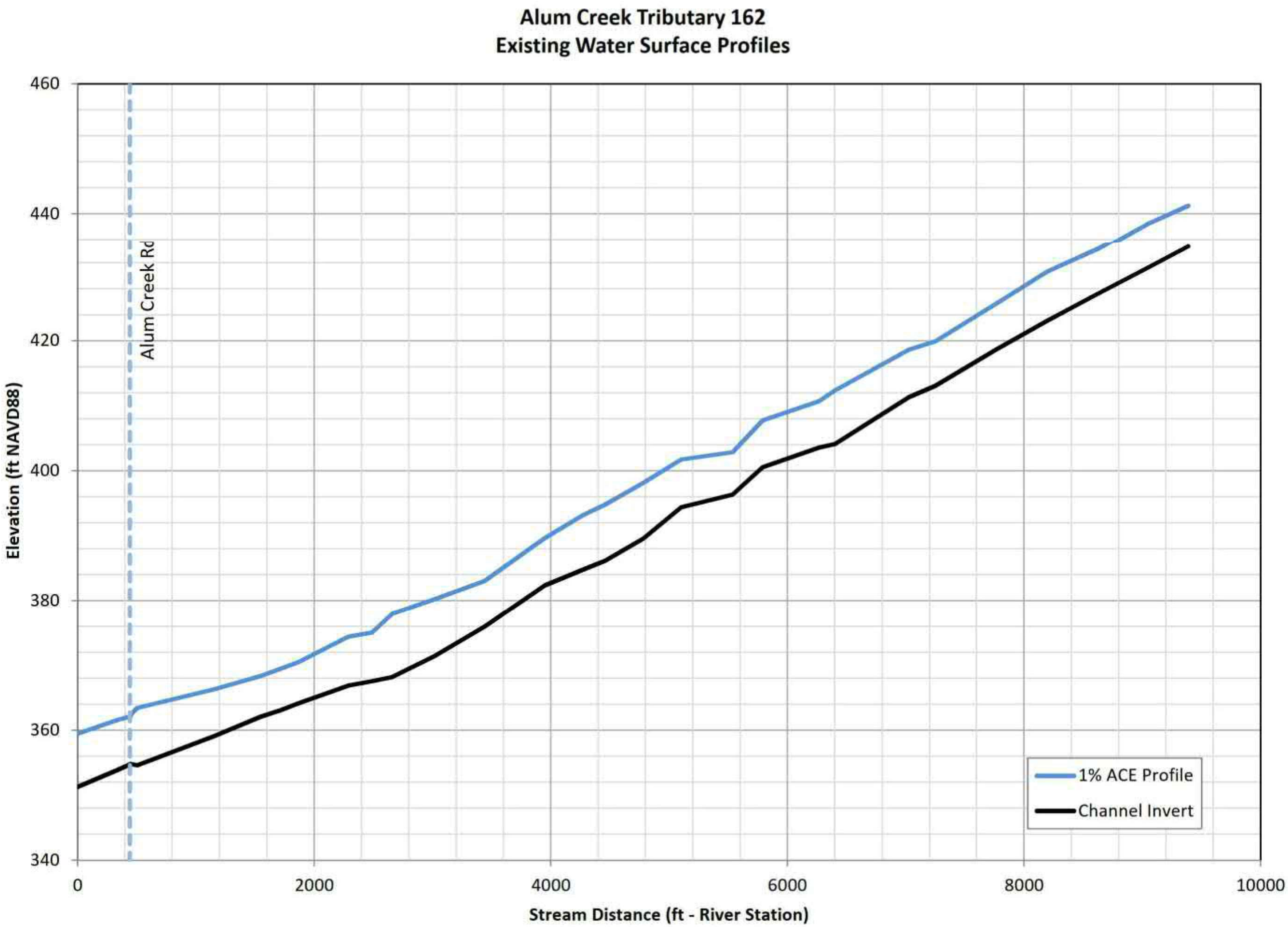

Alum Creek Tributary 138
Existing Water Surface Profiles
448
446
444
442
440
438
436
434
432
0
500
1000
1500
2000
2500
Elevation (ft NAVD88)
Stream Distance (ft - River Station)
1% ACE Profile
Channel Invert

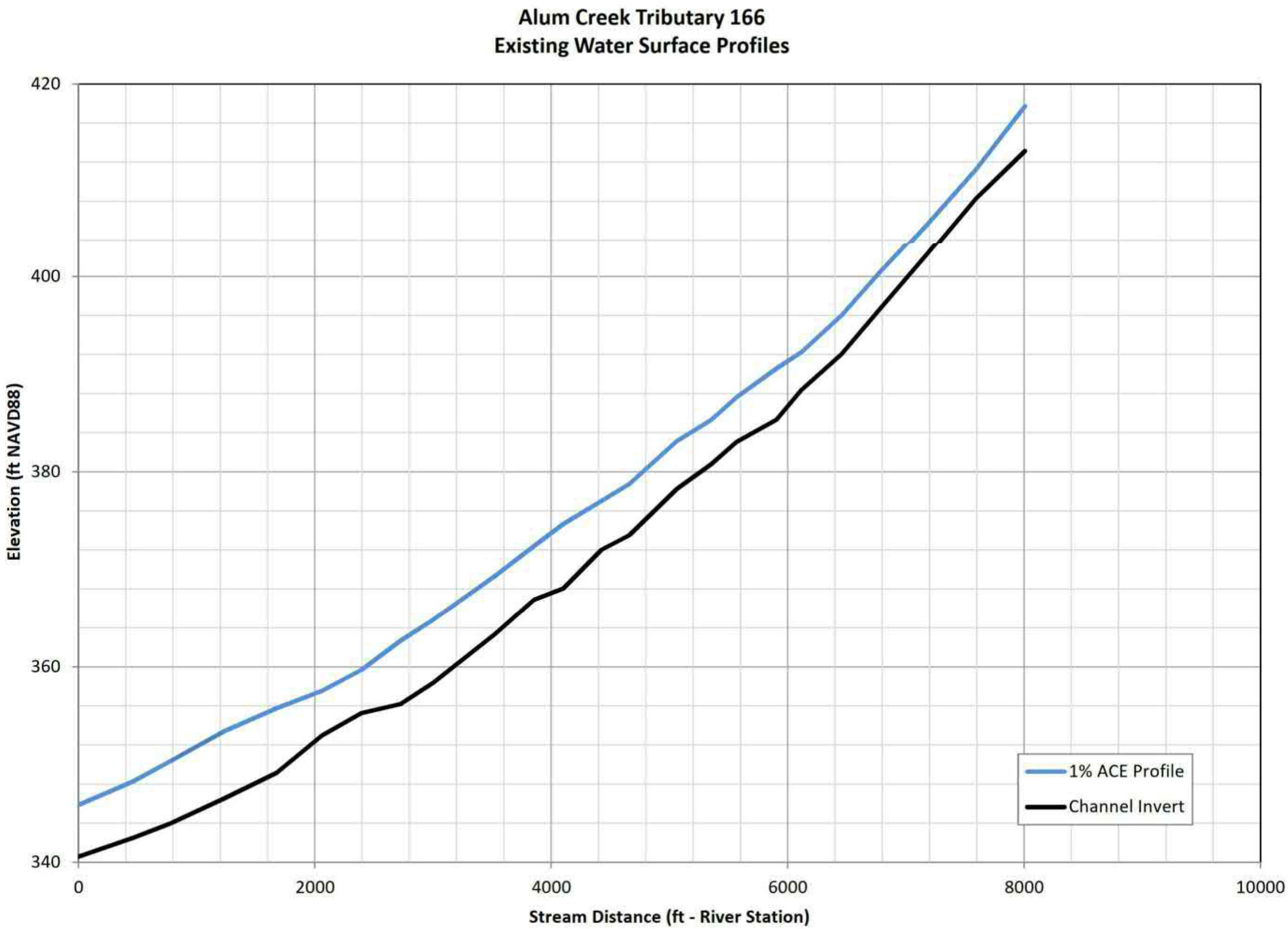

Alum Creek Tributary 143
Existing Water Surface Profiles
455
450
445
440
435
430
425
420
Elevation (ft NAVD88)
0
500
1000
1500
2000
2500
Stream Distance (ft - River Station)
1% ACE Profile
Channel Invert

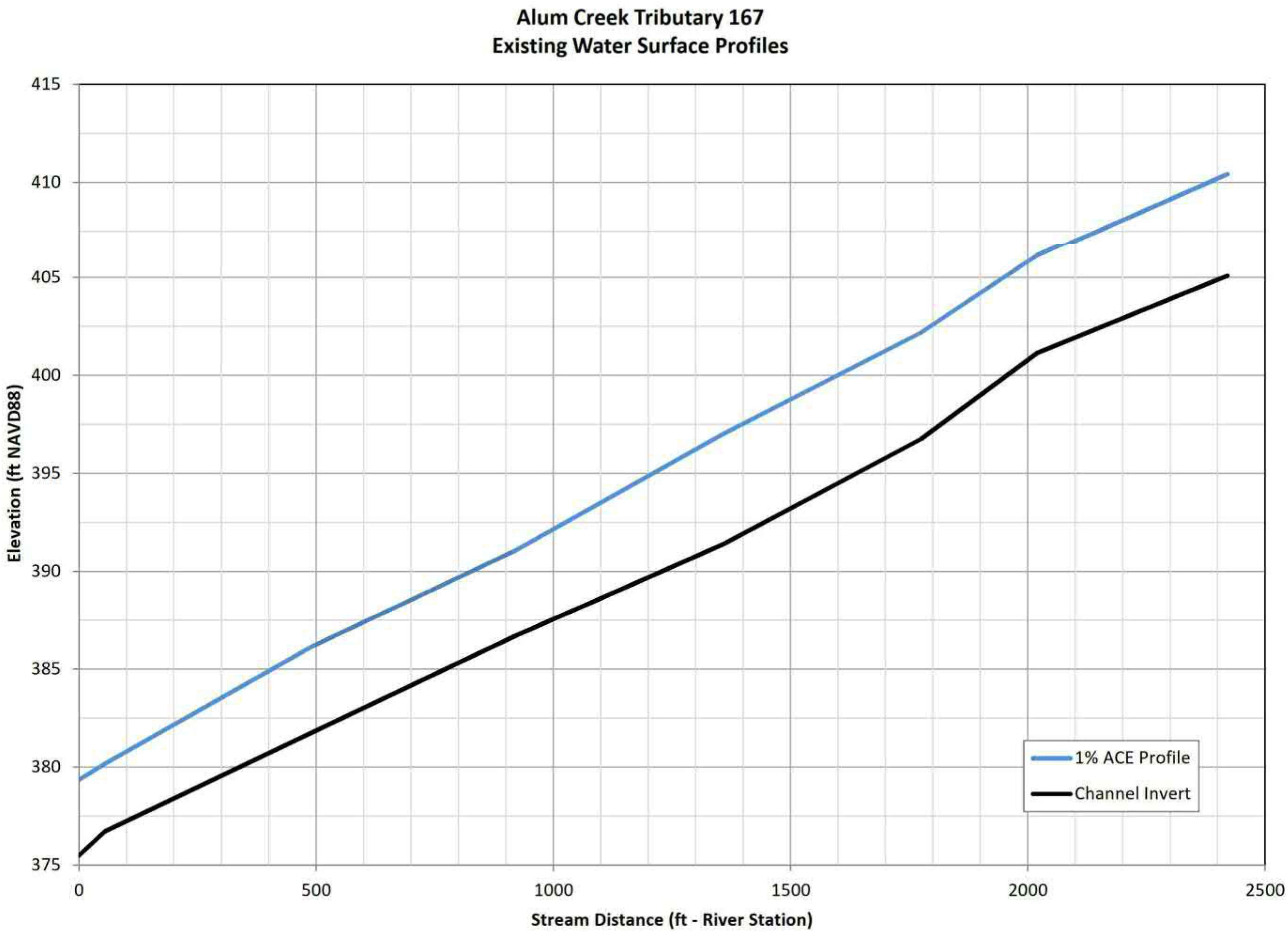

Alum Creek Tributary 148
Existing Water Surface Profiles
520
500
480
460
440
420
400
380
Elevation (ft NAVD88)
0
2000
4000
6000
8000
10000
12000
Stream Distance (ft - River Station)
1% ACE Profile
Channel Invert

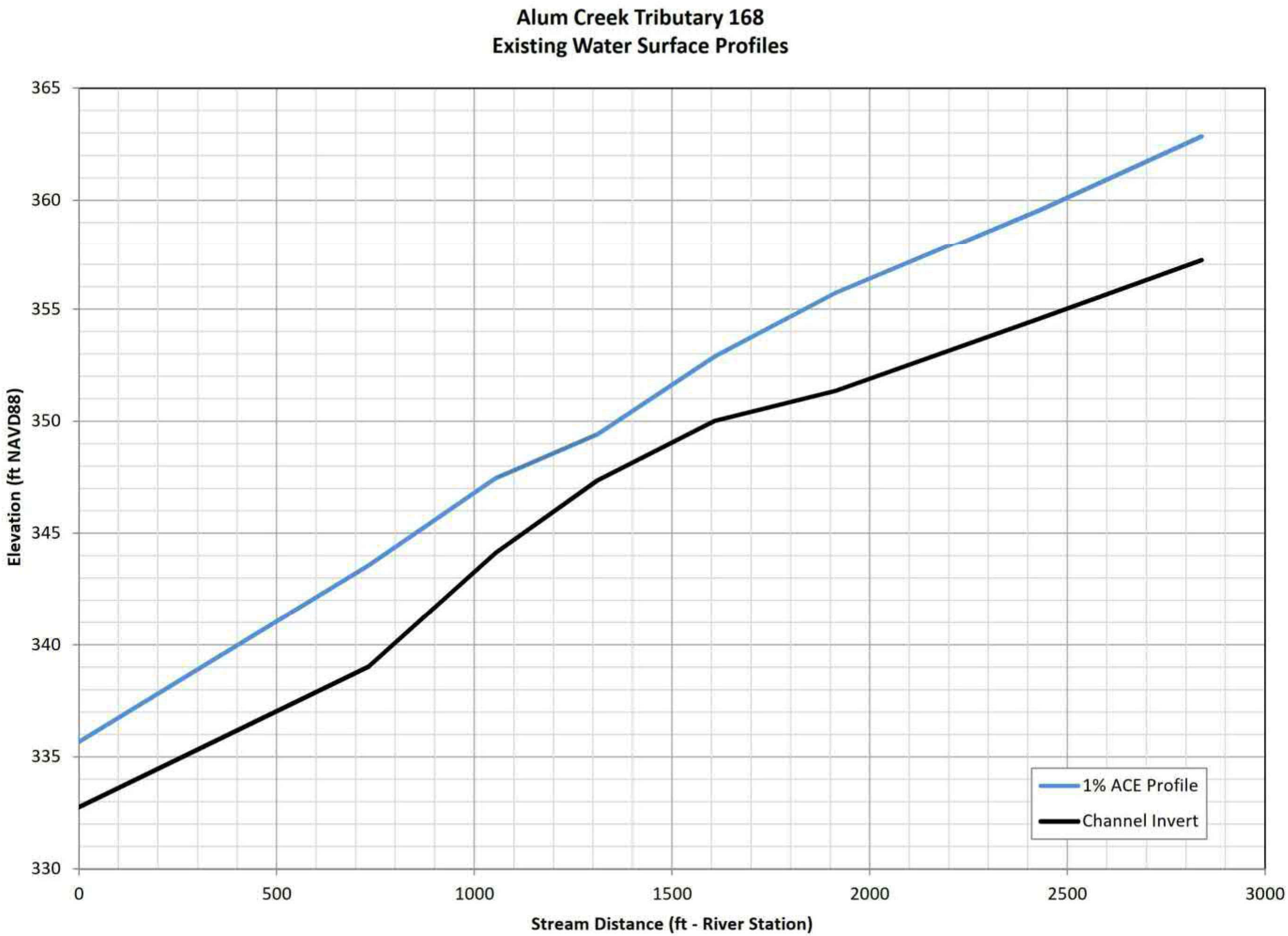


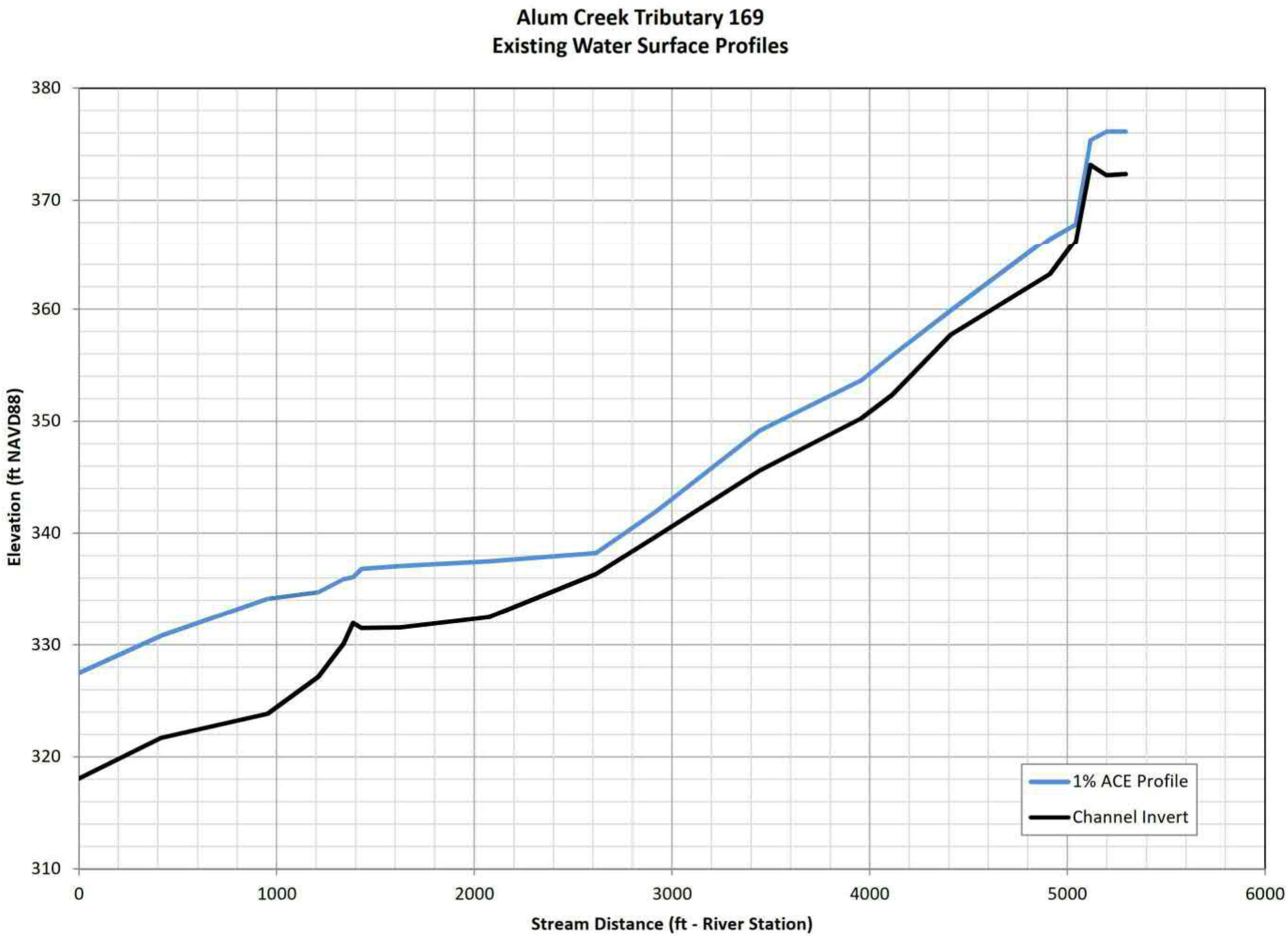
Alum Creek Tributary 160
Existing Water Surface Profiles
Elevation (ft NAVD88)
420
410
400
390
380
370
360
350
0
1000
2000
3000
4000
5000
Stream Distance (ft - River Station)
Park Rd 1C
1% ACE Profile
Channel Invert

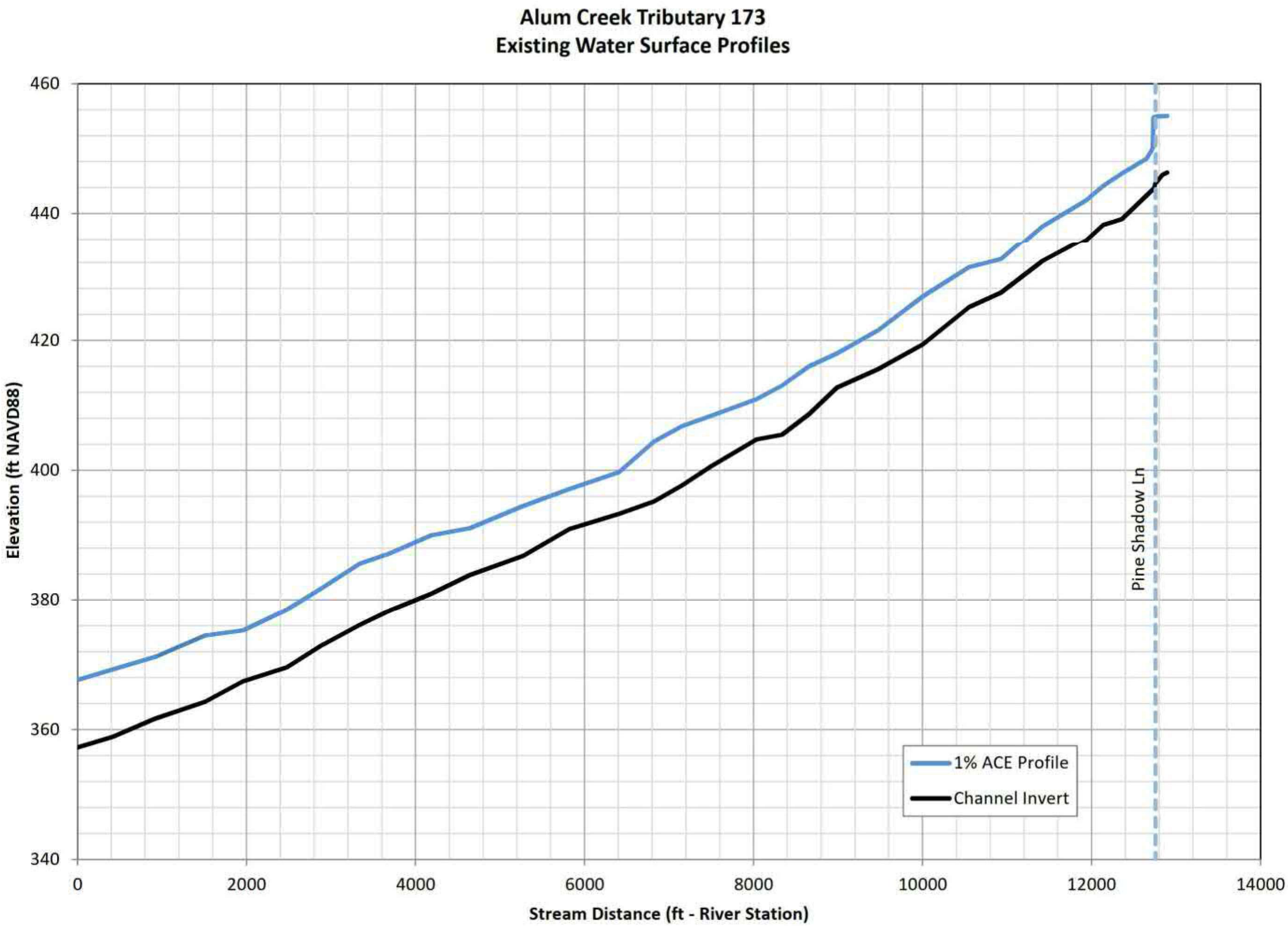

Alum Creek Tributary 162
Existing Water Surface Profiles
460
440
420
400
380
360
340
Elevation (ft NAVD88)
Alum Creek Rd
0
2000
4000
6000
8000
10000
Stream Distance (ft - River Station)
1% ACE Profile
Channel Invert

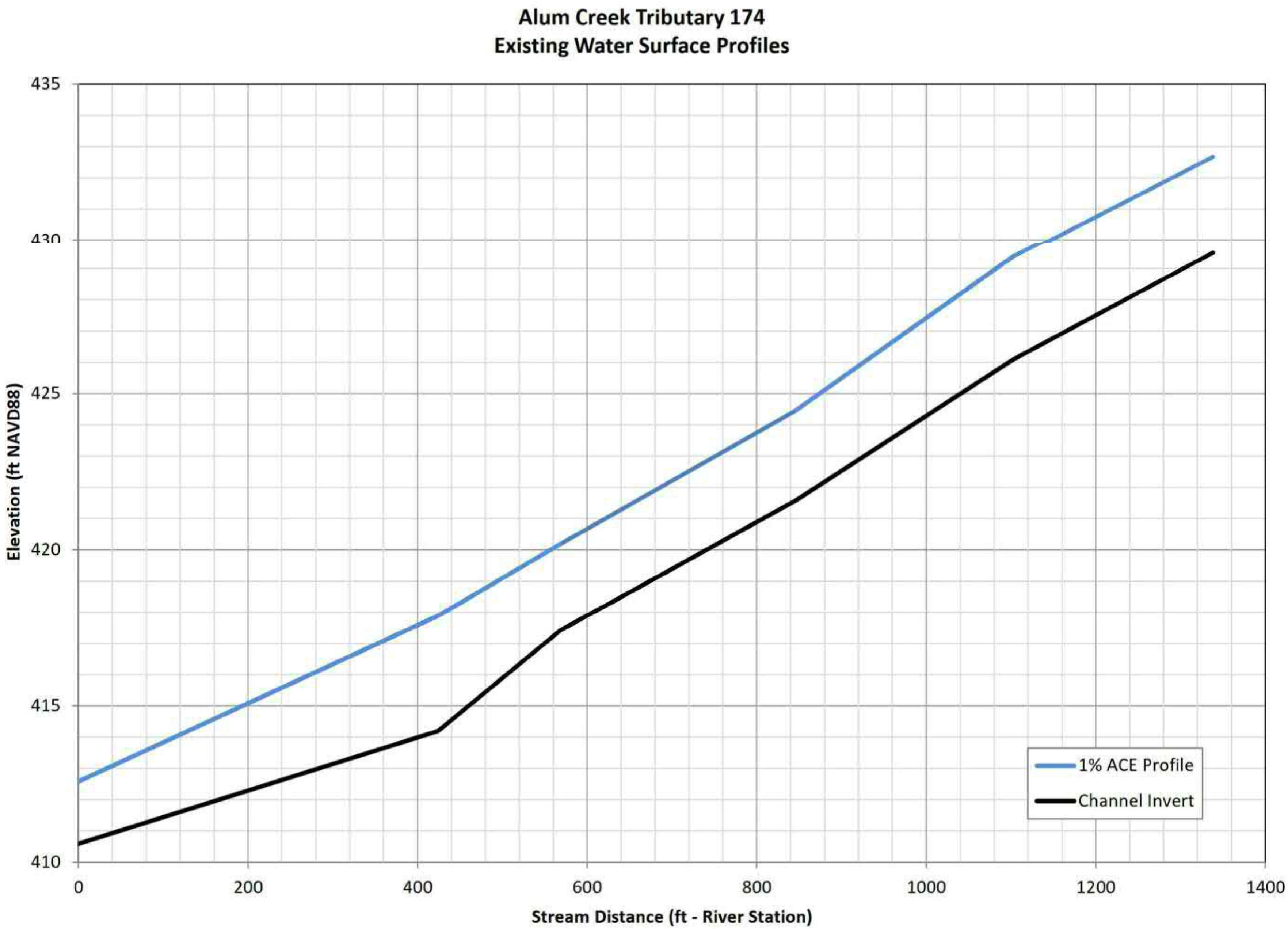

Alum Creek Tributary 166
Existing Water Surface Profiles
420
400
380
360
340
0
2000
4000
6000
8000
10000
Elevation (ft NAVD88)
Stream Distance (ft - River Station)
1% ACE Profile
Channel Invert

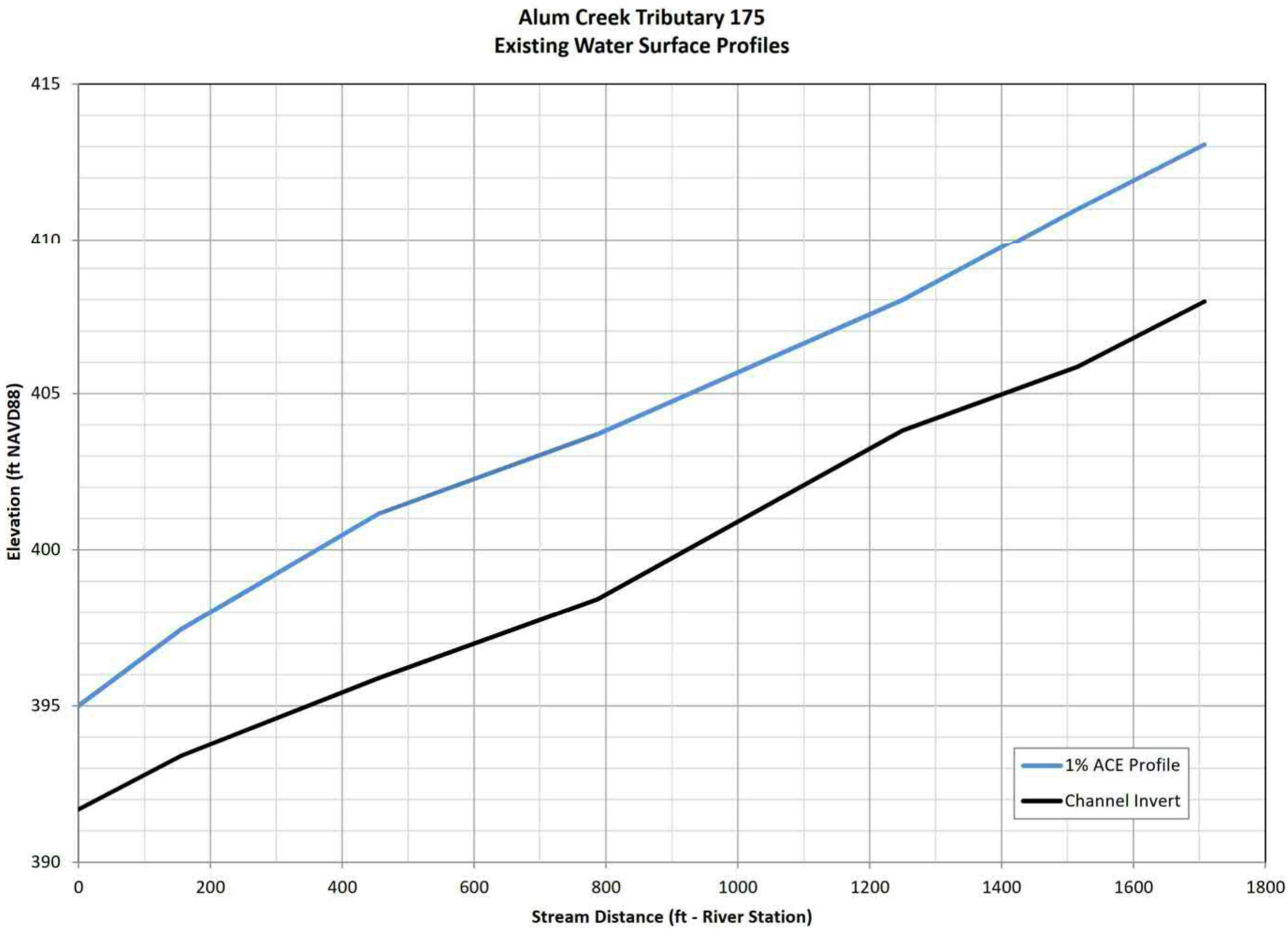

Alum Creek Tributary 167
Existing Water Surface Profiles
415
410
405
400
395
390
385
380
375
Elevation (ft NAVD88)
0
500
1000
1500
2000
2500
Stream Distance (ft - River Station)
1% ACE Profile
Channel Invert

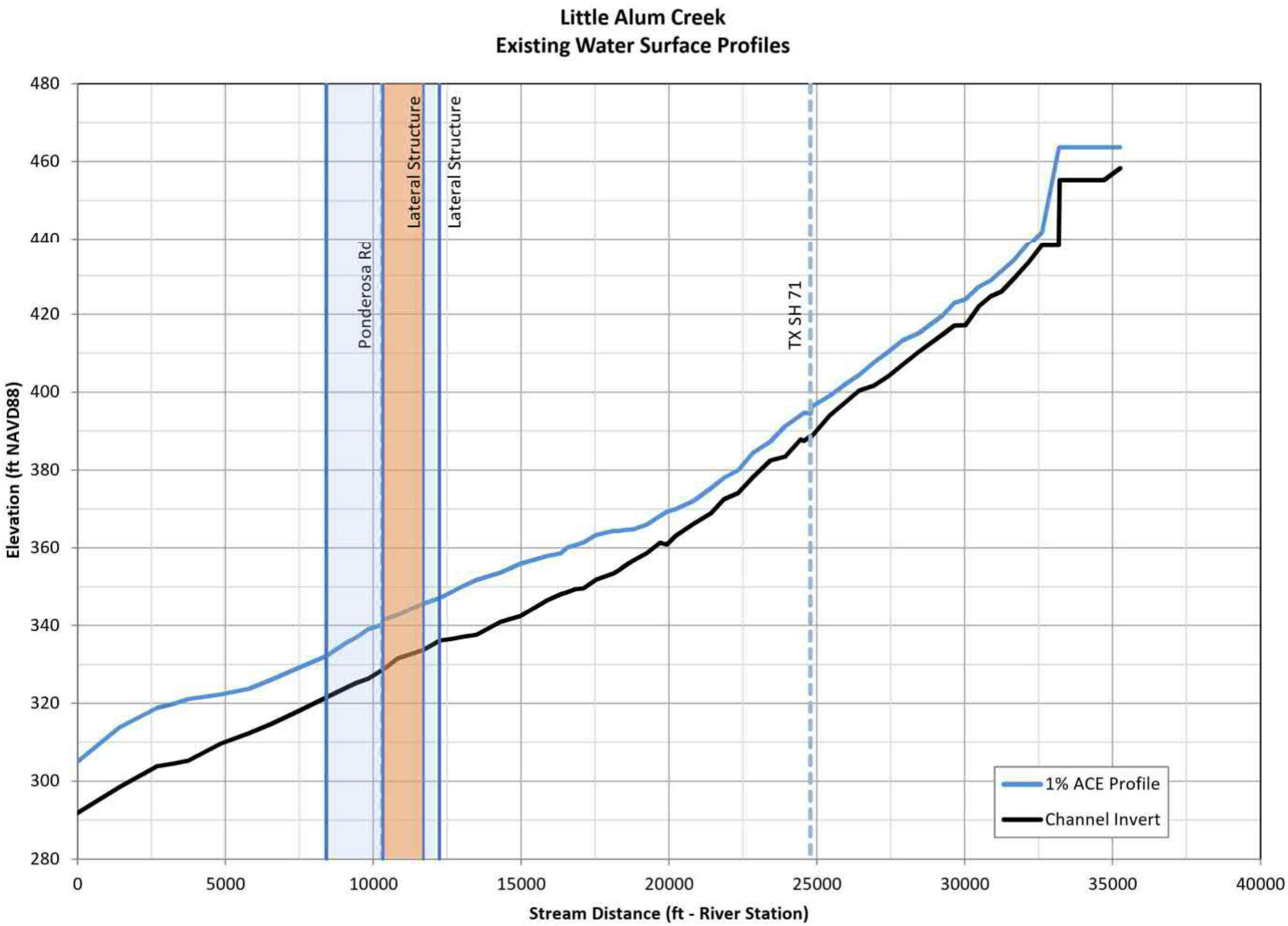

Alum Creek Tributary 168
Existing Water Surface Profiles
Elevation (ft NAVD88)
365
360
355
350
345
340
335
330
0
500
1000
1500
2000
2500
3000
Stream Distance (ft - River Station)
1% ACE Profile
Channel Invert


Alum Creek Tributary 169
Existing Water Surface Profiles
380
370
360
350
340
330
320
310
0
1000
2000
3000
4000
5000
6000
Elevation (ft NAVD88)
Stream Distance (ft - River Station)
1% ACE Profile
Channel Invert

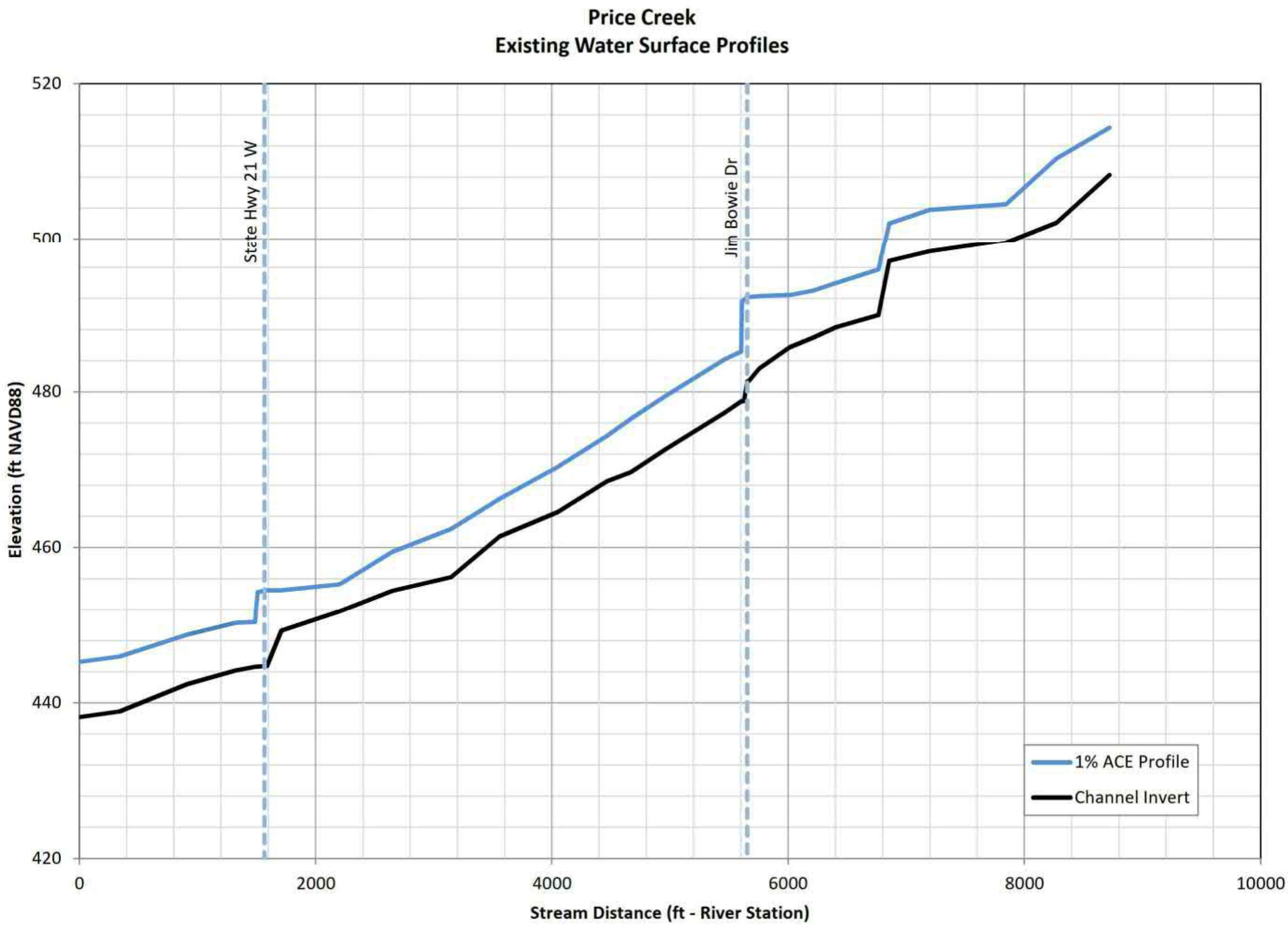

Alum Creek Tributary 173
Existing Water Surface Profiles
Elevation (ft NAVD88)
460
440
420
400
380
360
340
0
2000
4000
6000
8000
10000
12000
14000
Stream Distance (ft - River Station)
Pine Shadow Ln
1% ACE Profile
Channel Invert


Alum Creek Tributary 174
Existing Water Surface Profiles
435
430
425
420
415
410
Elevation (ft NAVD88)
0
200
400
600
800
1000
1200
1400
Stream Distance (ft - River Station)
1% ACE Profile
Channel Invert


Alum Creek Tributary 175
Existing Water Surface Profiles
415
410
405
400
395
390
0
200
400
600
800
1000
1200
1400
1600
1800
Elevation (ft NAVD88)
Stream Distance (ft - River Station)
1% ACE Profile
Channel Invert



Little Alum Creek
Existing Water Surface Profiles
Elevation (ft NAVD88)
Stream Distance (ft - River Station)
Ponderosa Rd
Lateral Structure
Lateral Structure
TX SH 71
1% ACE Profile
Channel Invert
480
460
440
420
400
380
360
340
320
300
280
0
5000
10000
15000
20000
25000
30000
35000
40000


Price Creek
Existing Water Surface Profiles
520
500
480
460
440
420
Elevation (ft NAVD88)
State Hwy 21 W
Jim Bowie Dr
1% ACE Profile
Channel Invert
0
2000
4000
6000
8000
10000
Stream Distance (ft - River Station)

Appendix G: Floodplain Mapping

G-1 Floodplain Work Maps

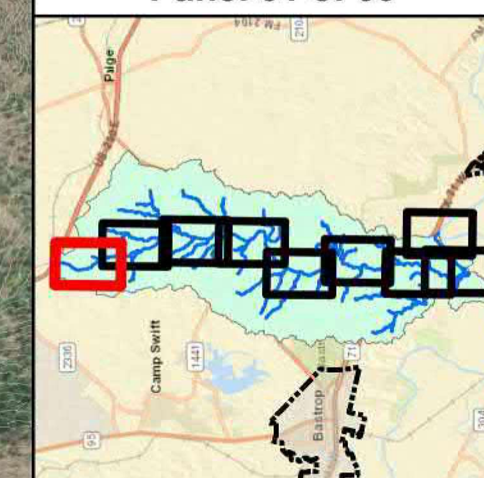
Bastrop County Flood Protection Planning Study

- Roadway Improvements
- Flooded Structures
- Flooded Crossings
- Structures
- Cross Sections
- Limit of Study
- Focused Study Streams
- Other Study Streams
- Index Contour
- Minor Contour
- Roads
- Floodplain

Alum Creek Watershed Hydraulic Work Map

Alum Creek & Tribs 110, 124, 11, 168, 169

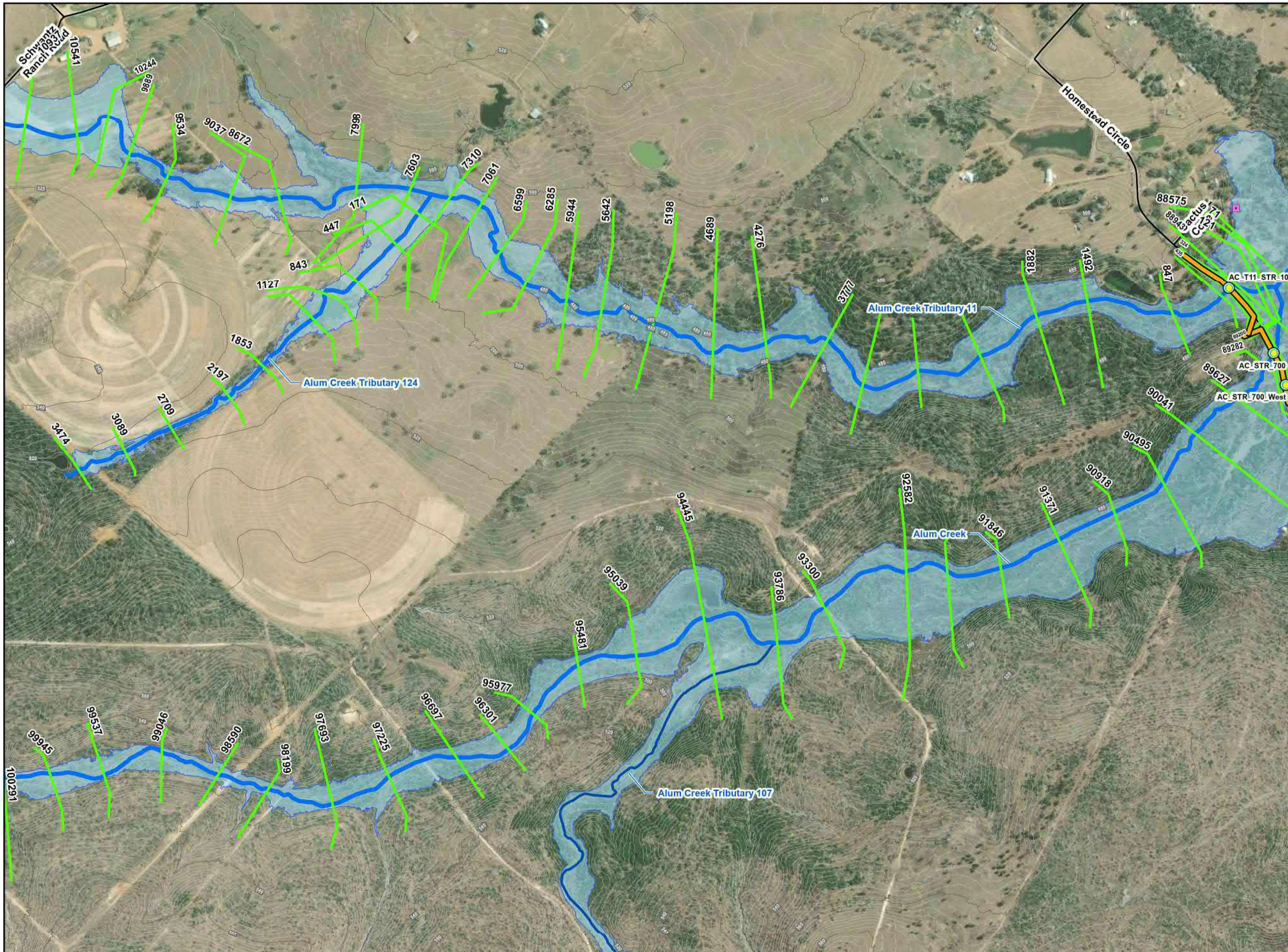
Panel 01 of 09



N

0 700 1,400 Feet

HALFF



THE STATE OF TEXAS COUNTY OF BASTROP

Bastrop County Flood Protection Planning Study

- Roadway Improvements
- Flooded Structures
- Flooded Crossings
- Structures
- Cross Sections
- Limit of Study
- Focused Study Streams
- Other Study Streams
- Index Contour
- Minor Contour
- Roads
- Floodplain

Alum Creek Watershed Hydraulic Work Map

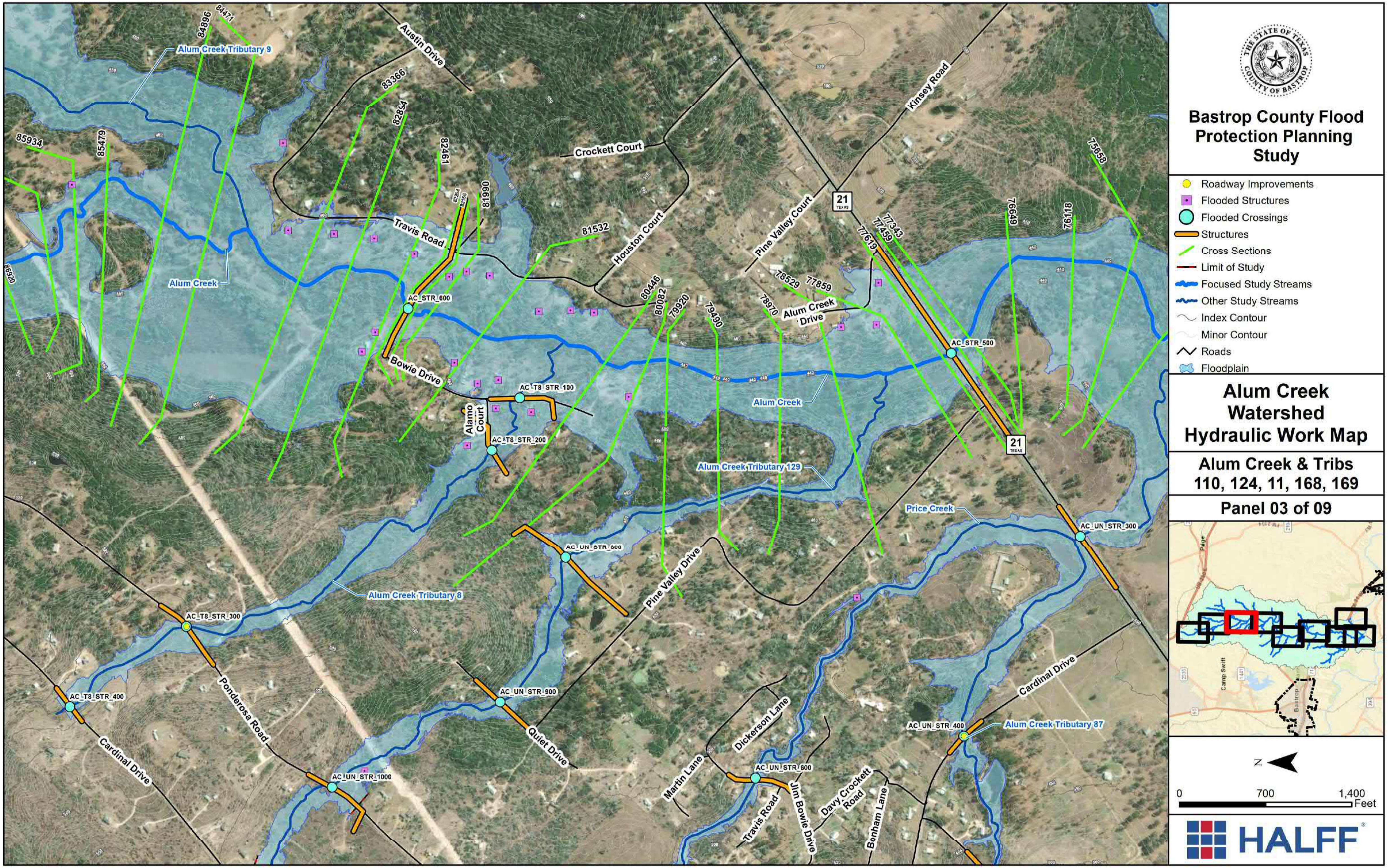
Alum Creek & Tribs 110, 124, 11, 168, 169

Panel 02 of 09

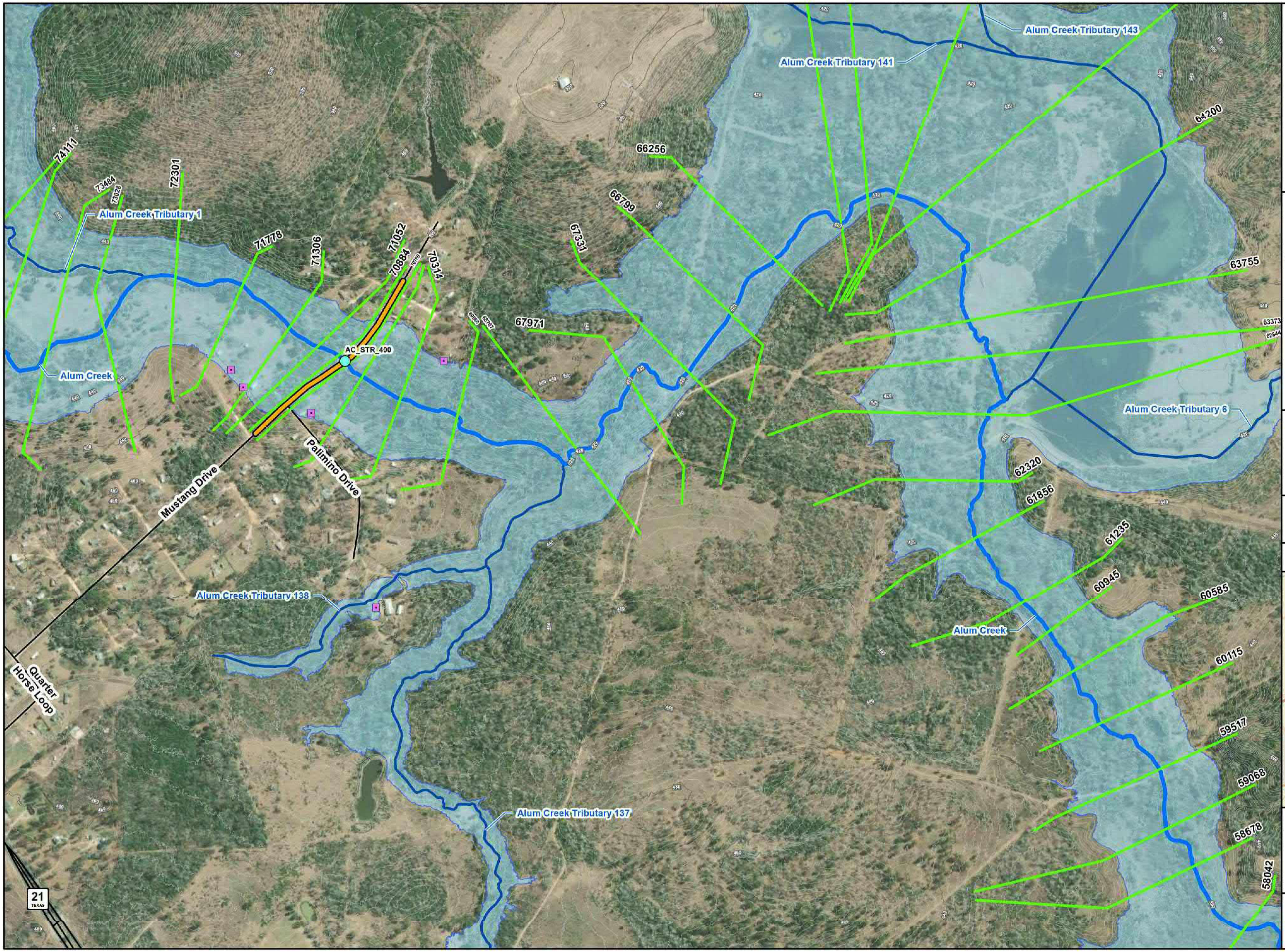
N

0 700 1,400 Feet

HALFF



Bastrop County Flood Protection Planning Study
Roadway Improvements
Flooded Structures
Flooded Crossings
Structures
Cross Sections
Limit of Study
Focused Study Streams
Other Study Streams
Index Contour
Minor Contour
Roads
Floodplain
Alum Creek Watershed Hydraulic Work Map
Alum Creek & Tribs 110, 124, 11, 168, 169
Panel 03 of 09
N
0
700
1,400
Feet
HALFF
Alum Creek Tributary 9
Alum Creek
Alum Creek Tributary 8
Alum Creek Tributary 129
Price Creek
Alum Creek Tributary 87
Austin Drive
Crockett Court
Kinsey Road
Travis Road
Houston Court
Pine Valley Court
Alum Creek Drive
Bowie Drive
Alamo Court
Pine Valley Drive
Ponderosa Road
Cardinal Drive
Quiet Drive
Dickerson Lane
Martin Lane
Travis Road
Jim Bowie Drive
Davy Crockett Road
Bonham Lane
21
AC_STR_600
AC_STR_500
AC_T8_STR_100
AC_T8_STR_200
AC_T8_STR_300
AC_T8_STR_400
AC_UN_STR_300
AC_UN_STR_400
AC_UN_STR_600
AC_UN_STR_900
AC_UN_STR_1000
84471
84896
83366
82854
82461
81990
81532
85934
85479
80446
80082
79920
79490
78970
78529
77859
77619
77459
77343
76649
76118
75658



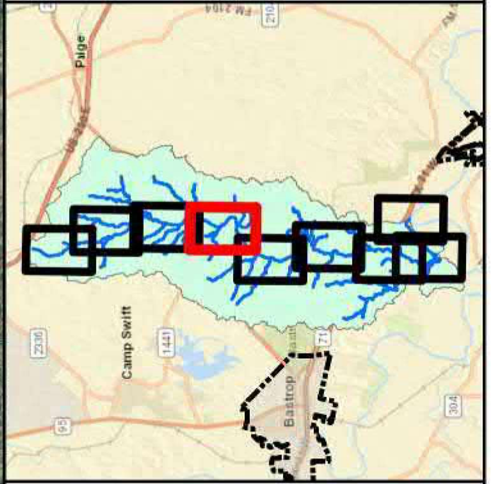
Bastrop County Flood Protection Planning Study

- Roadway Improvements
- Flooded Structures
- Flooded Crossings
- Structures
- Cross Sections
- Limit of Study
- Focused Study Streams
- Other Study Streams
- Index Contour
- Minor Contour
- Roads
- Floodplain

Alum Creek Watershed Hydraulic Work Map

Alum Creek & Tribs 110, 124, 11, 168, 169

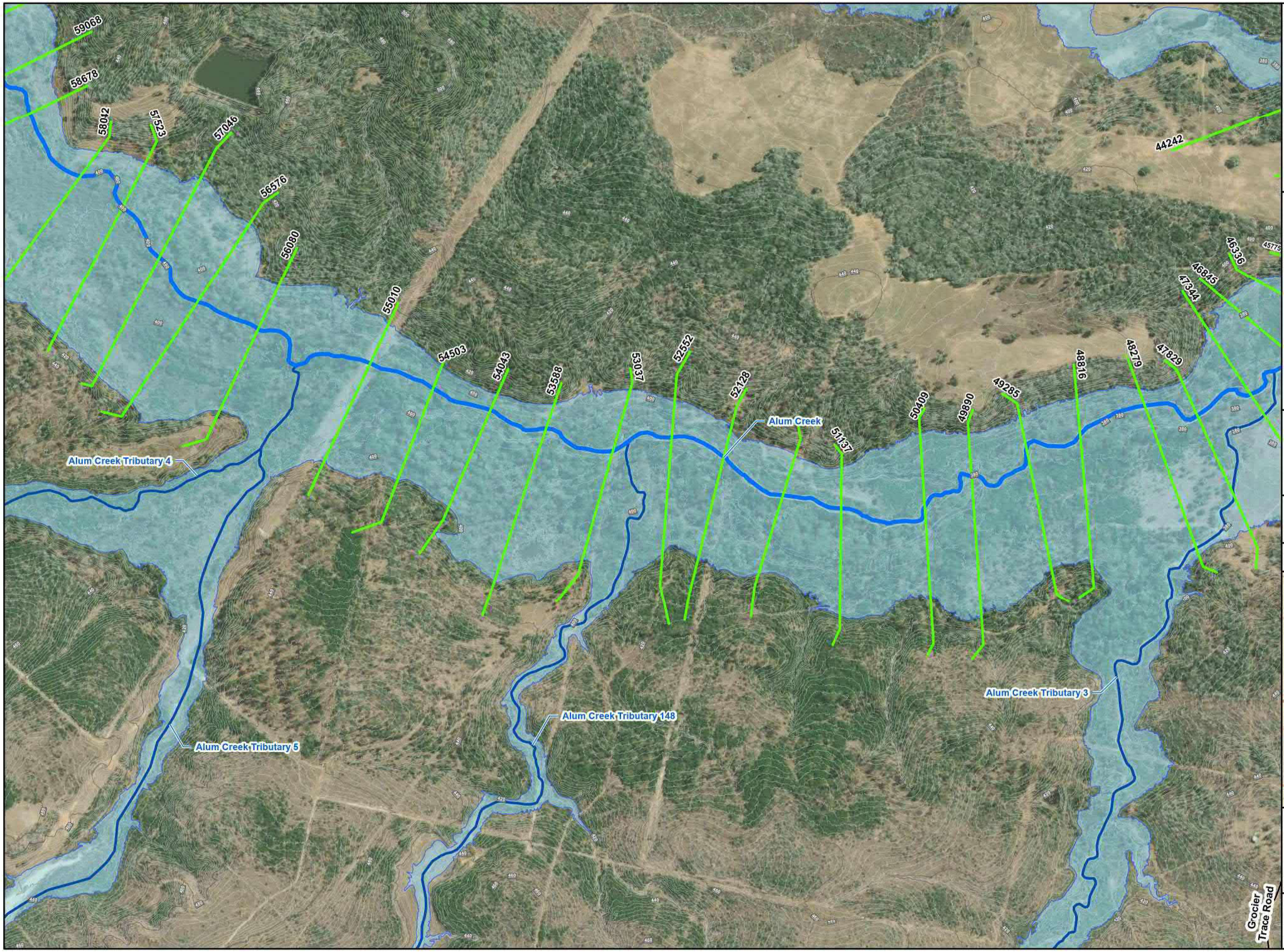
Panel 04 of 09



N

0 700 1,400 Feet

HALFF



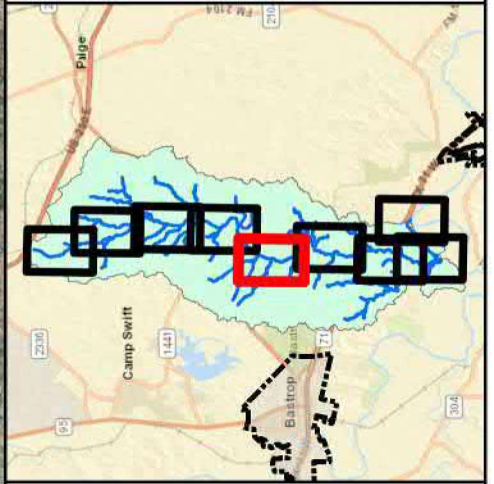
Bastrop County Flood Protection Planning Study

- Roadway Improvements
- Flooded Structures
- Flooded Crossings
- Structures
- Cross Sections
- Limit of Study
- Focused Study Streams
- Other Study Streams
- Index Contour
- Minor Contour
- Roads
- Floodplain

Alum Creek Watershed Hydraulic Work Map

Alum Creek & Tribs 110, 124, 11, 168, 169

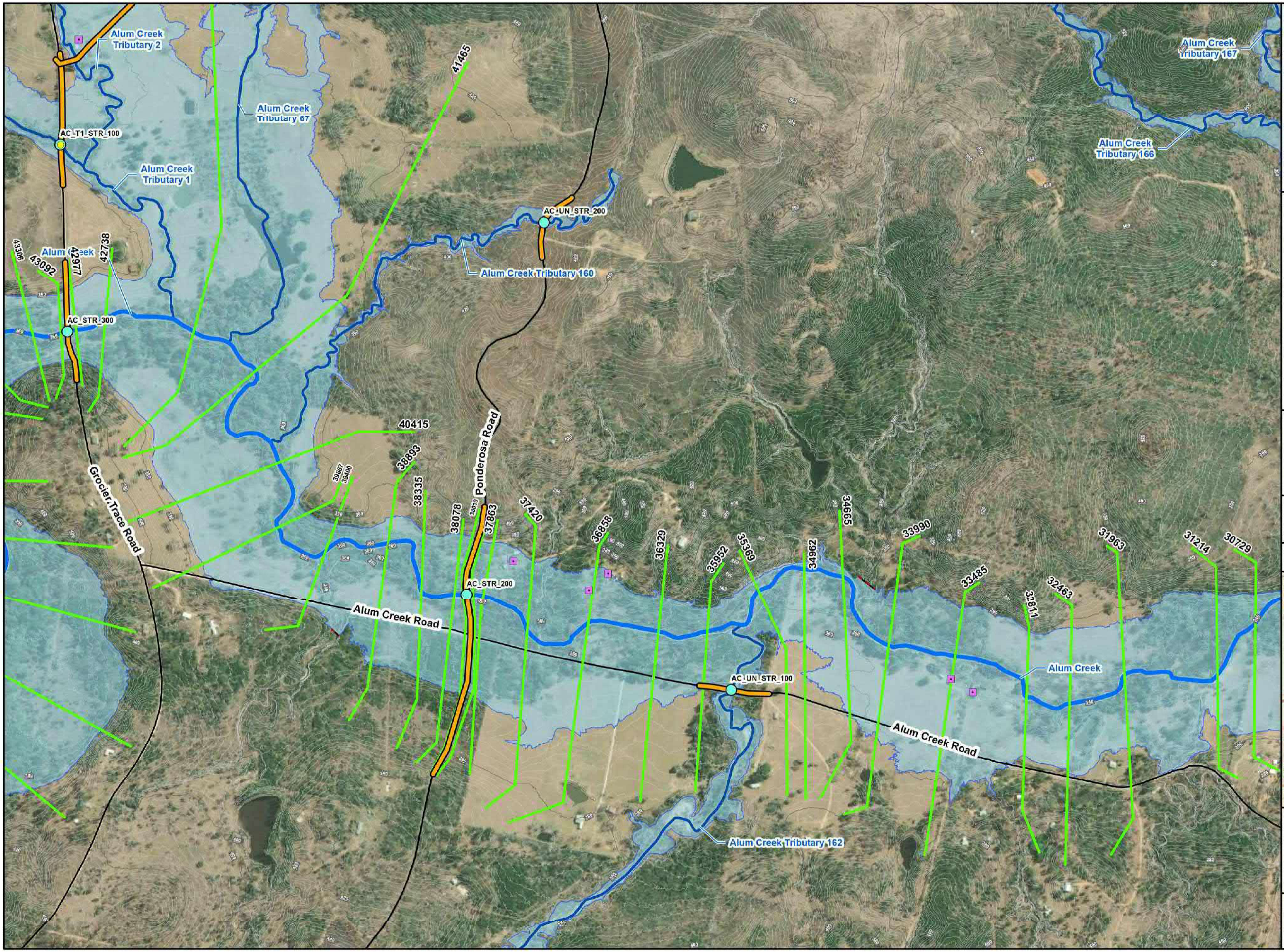
Panel 05 of 09



N

0 700 1,400 Feet

HALFF



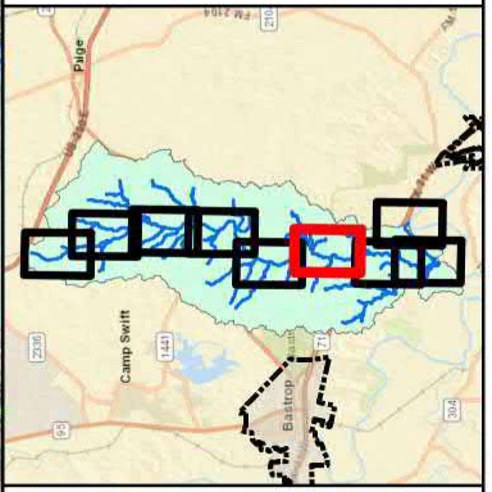
Bastrop County Flood Protection Planning Study

- Roadway Improvements
- Flooded Structures
- Flooded Crossings
- Structures
- Cross Sections
- Limit of Study
- Focused Study Streams
- Other Study Streams
- Index Contour
- Minor Contour
- Roads
- Floodplain

Alum Creek Watershed Hydraulic Work Map

Alum Creek & Tribs 110, 124, 11, 168, 169

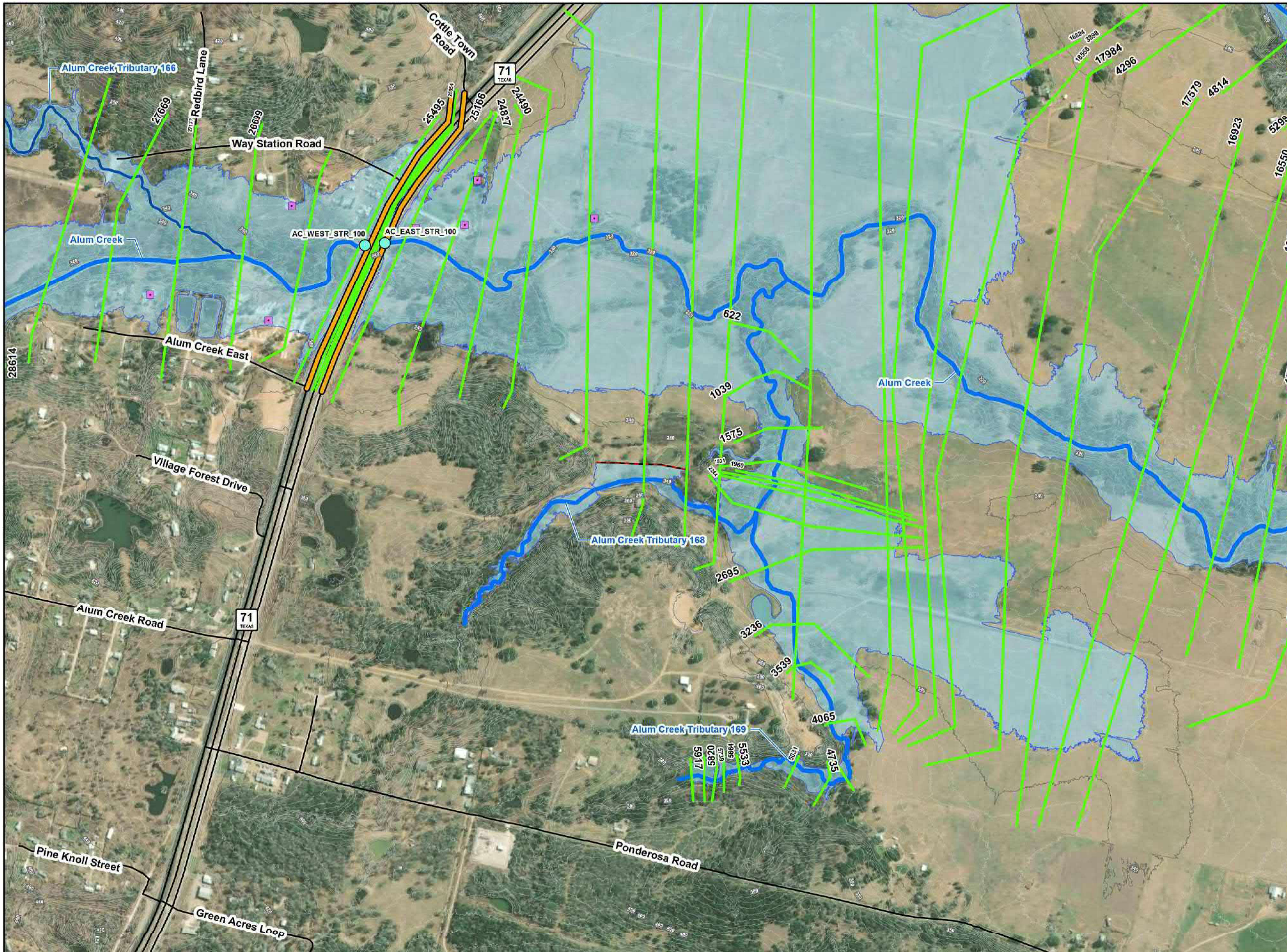
Panel 06 of 09



N

0 700 1,400 Feet

HALFF



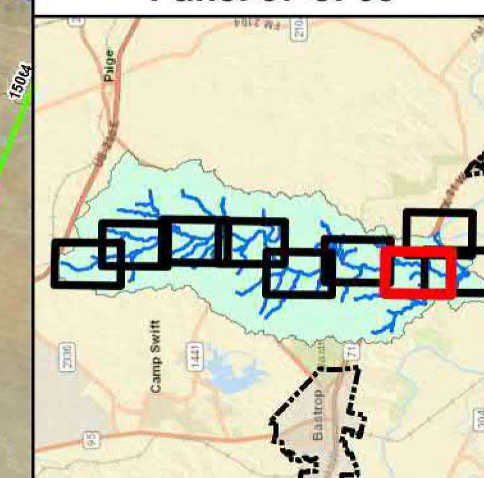
Bastrop County Flood Protection Planning Study

- Roadway Improvements
- Flooded Structures
- Flooded Crossings
- Structures
- Cross Sections
- Limit of Study
- Focused Study Streams
- Other Study Streams
- Index Contour
- Minor Contour
- Roads
- Floodplain

Alum Creek Watershed Hydraulic Work Map

Alum Creek & Tribs 110, 124, 11, 168, 169

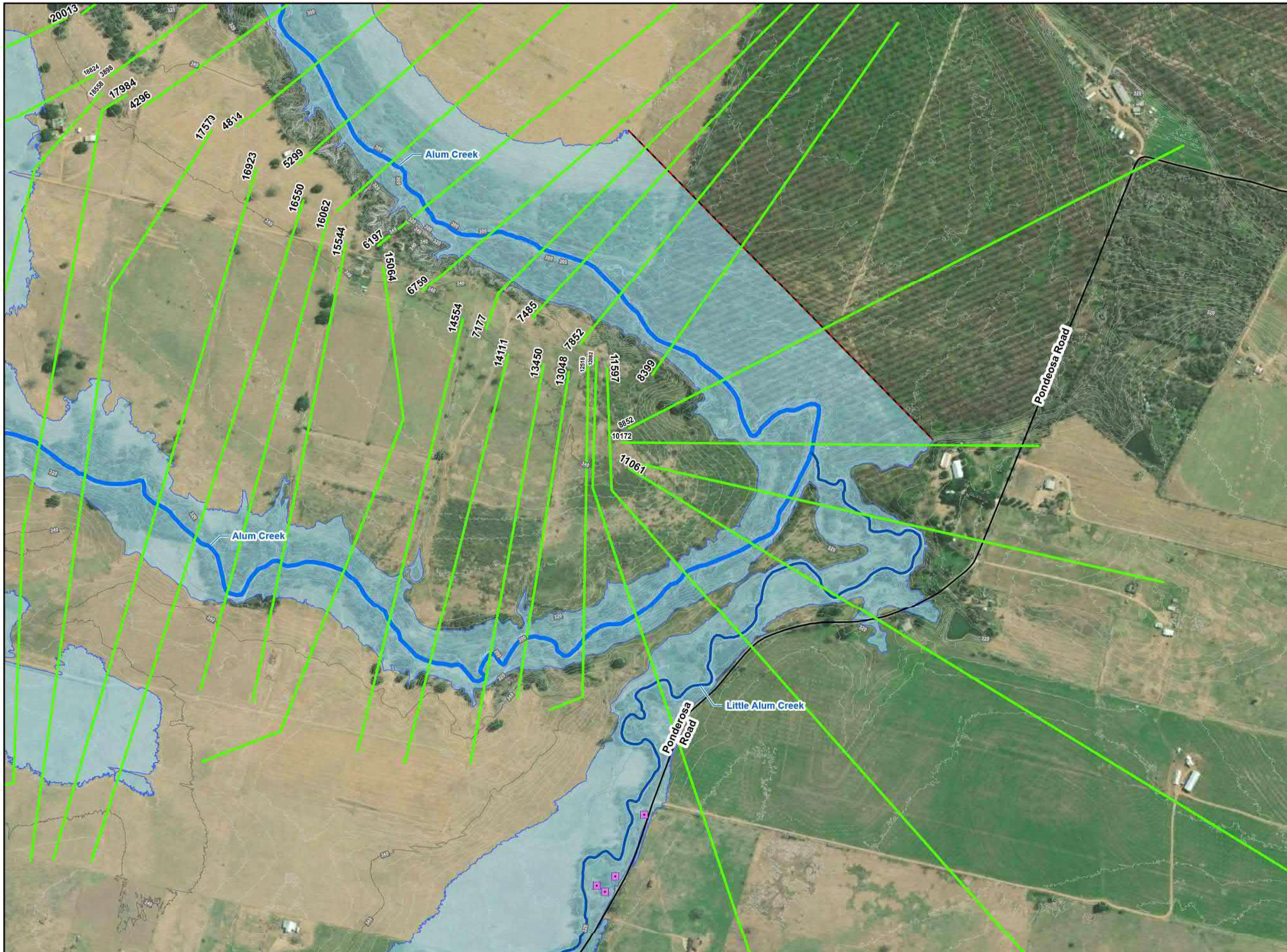
Panel 07 of 09



N

0 700 1,400 Feet

HALFF



Bastrop County Flood Protection Planning Study

- Roadway Improvements
- Flooded Structures
- Flooded Crossings
- Structures
- Cross Sections
- Limit of Study
- Focused Study Streams
- Other Study Streams
- Index Contour
- Minor Contour
- Roads
- Floodplain

Alum Creek Watershed Hydraulic Work Map

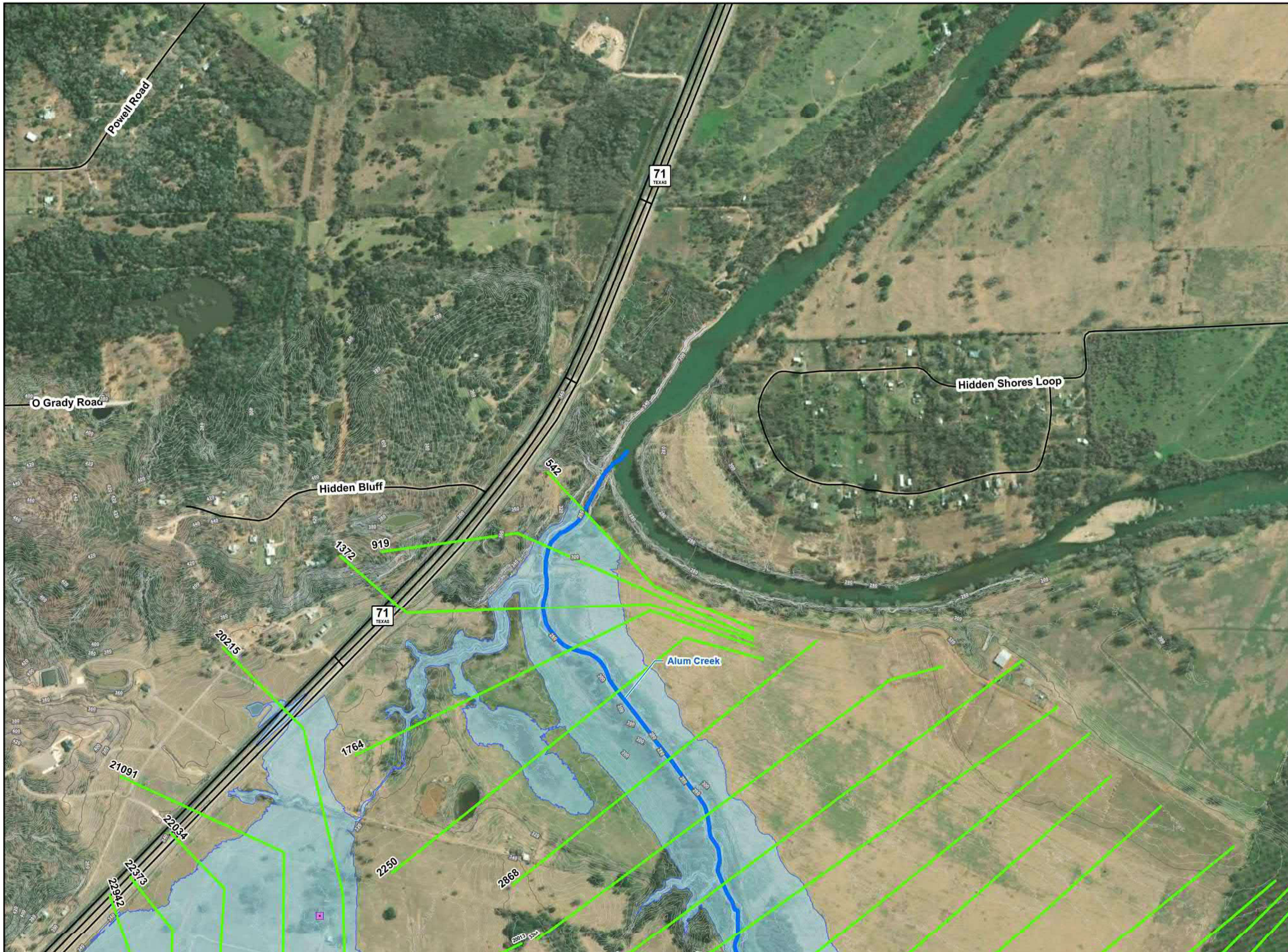
Alum Creek & Tribs 110, 124, 11, 168, 169

Panel 08 of 09

N

0 700 1,400 Feet

HALFF



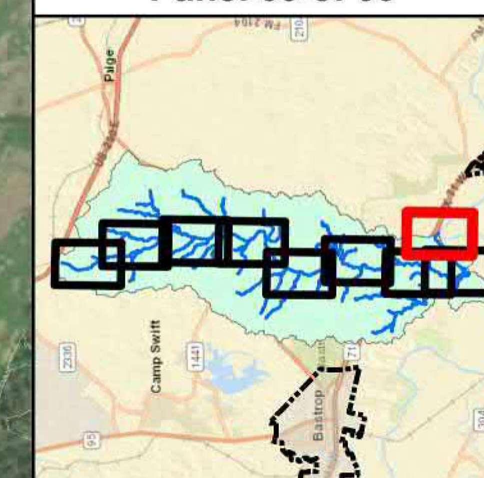
Bastrop County Flood Protection Planning Study

Roadway Improvements
Flooded Structures
Flooded Crossings
Structures
Cross Sections
Limit of Study
Focused Study Streams
Other Study Streams
Index Contour
Minor Contour
Roads
Floodplain

Alum Creek Watershed Hydraulic Work Map

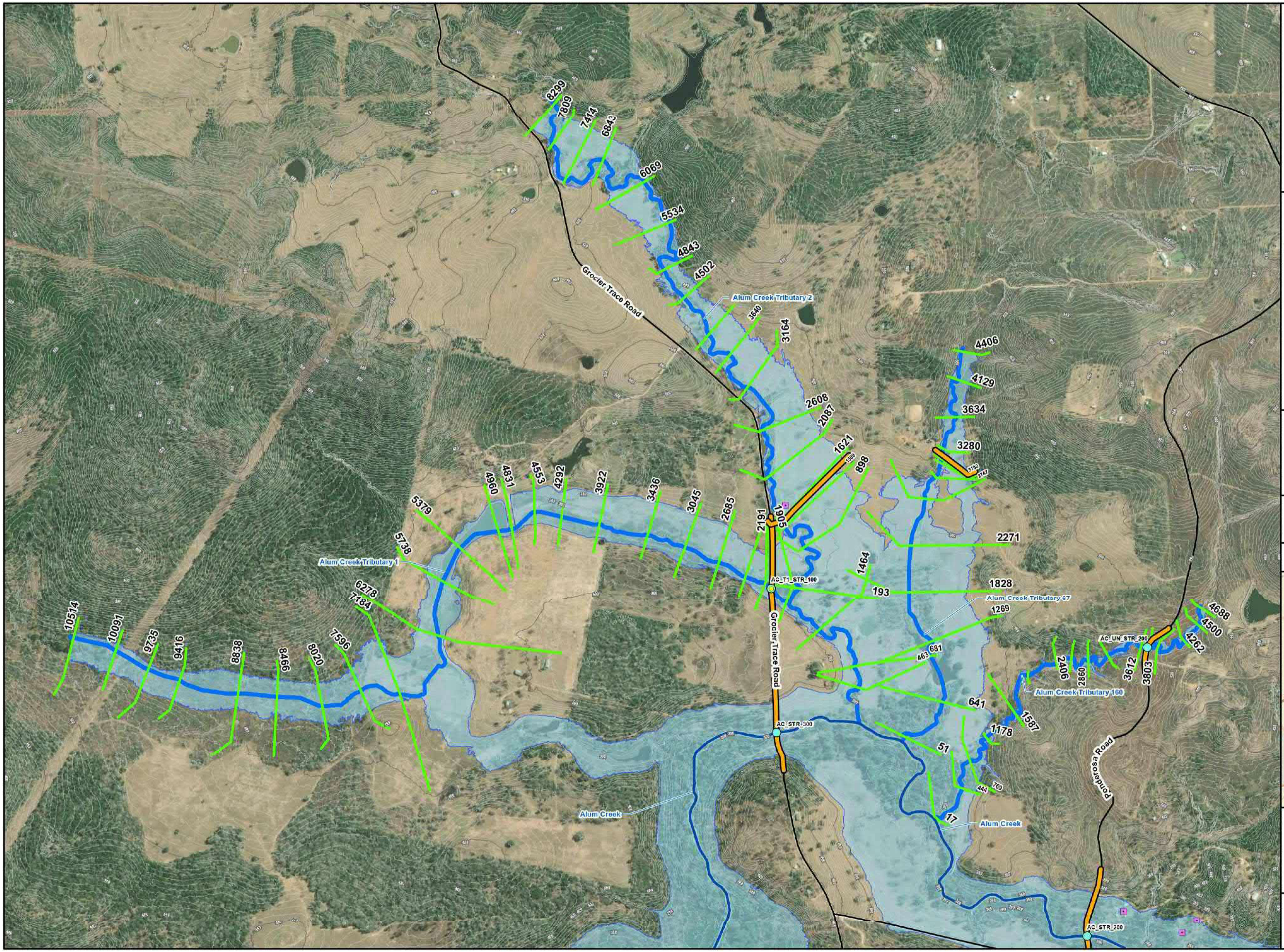
Alum Creek & Tribs 110, 124, 11, 168, 169

Panel 09 of 09



0 700 1,400 Feet

HALFF



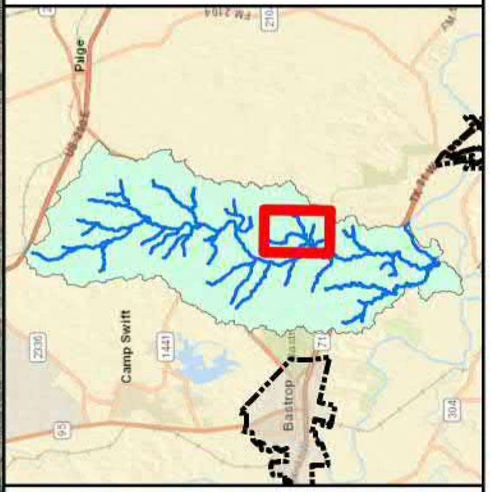
Bastrop County Flood Protection Planning Study

- Roadway Improvements
- Flooded Structures
- Flooded Crossings
- Structures
- Cross Sections
- Limit of Study
- Focused Study Streams
- Other Study Streams
- Index Contour
- Minor Contour
- Roads
- Floodplain

Alum Creek Watershed Hydraulic Work Map

Alum Creek Tribs 1, 2, 67, 160

Panel 01 of 01



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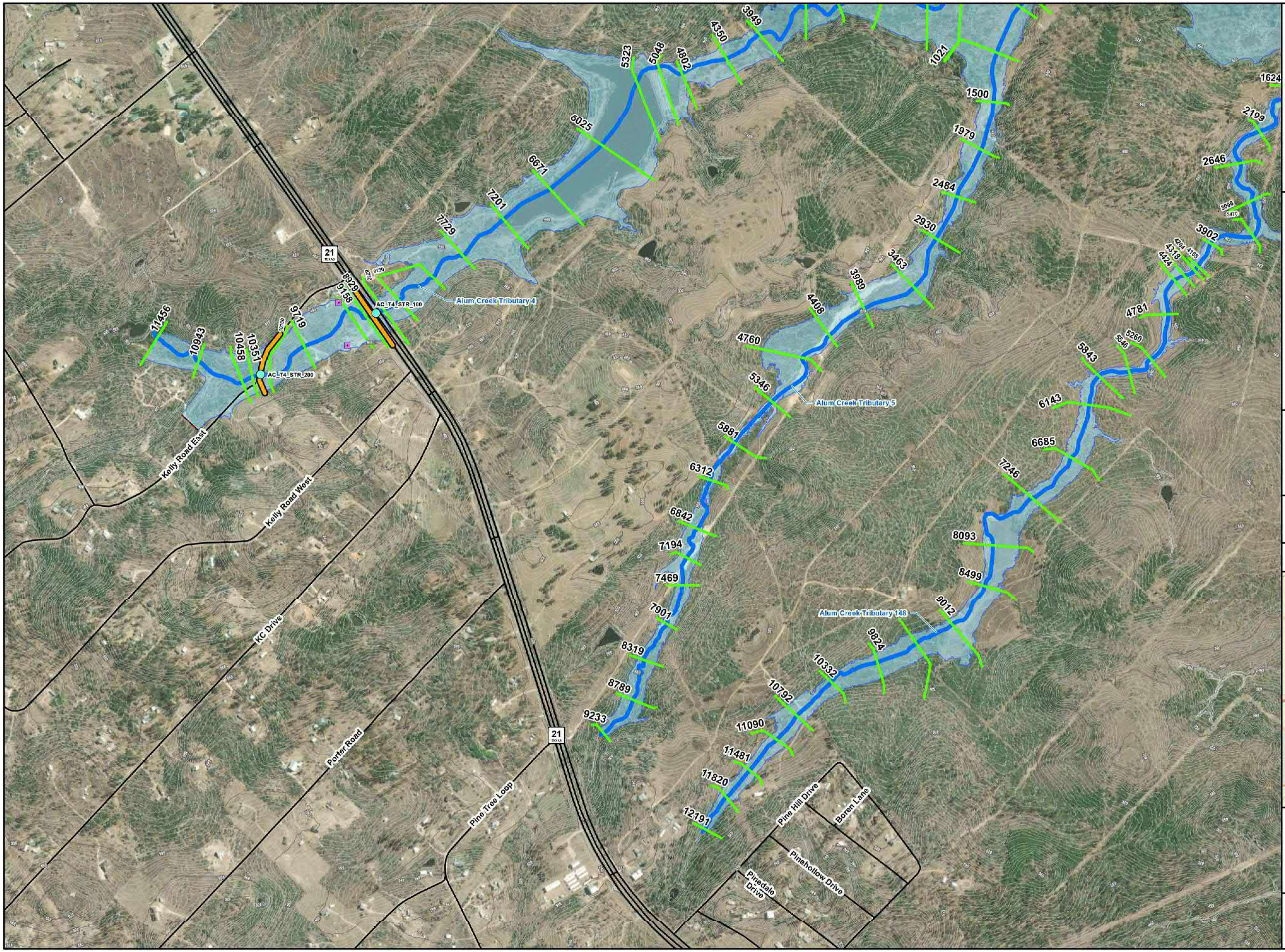


Texas Water Development Board

THE STATE OF TEXAS COUNTY OF BASTROP

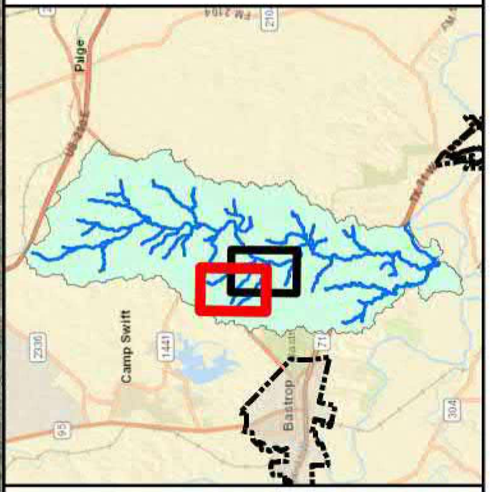
Bastrop County Flood Protection Planning Study

- Roadway Improvements
- Flooded Structures
- Flooded Crossings
- Structures
- Cross Sections
- Limit of Study
- Focused Study Streams
- Other Study Streams
- Index Contour
- Minor Contour
- Roads
- Floodplain

Alum Creek Watershed Hydraulic Work Map

Alum Creek Tribs 3, 4, 5, 148

Panel 01 of 02



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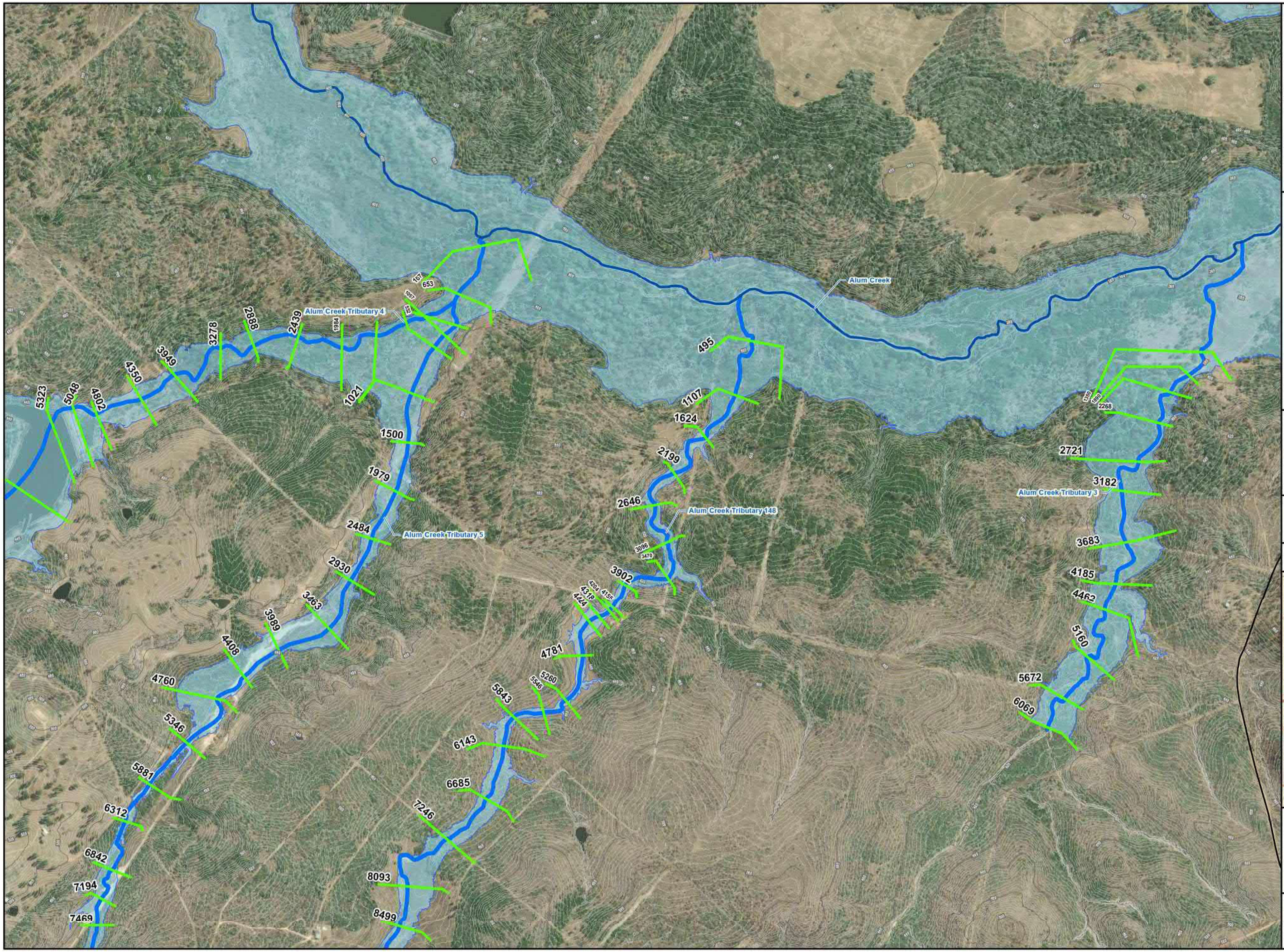

Texas Water Development Board

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Bastrop County Flood Protection Planning Study

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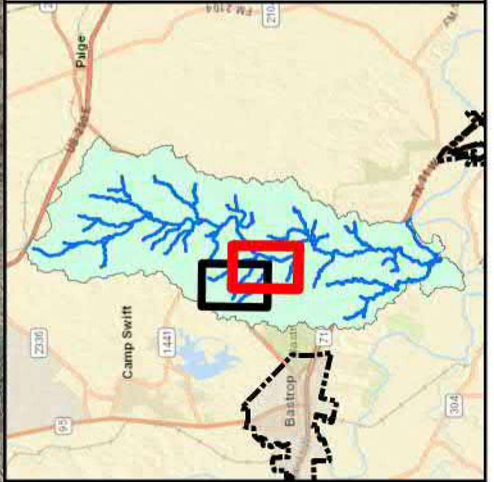
- Floodplain

Alum Creek Watershed Hydraulic Work Map

Alum Creek Tribs 3, 4, 5, 148

Panel 02 of 02



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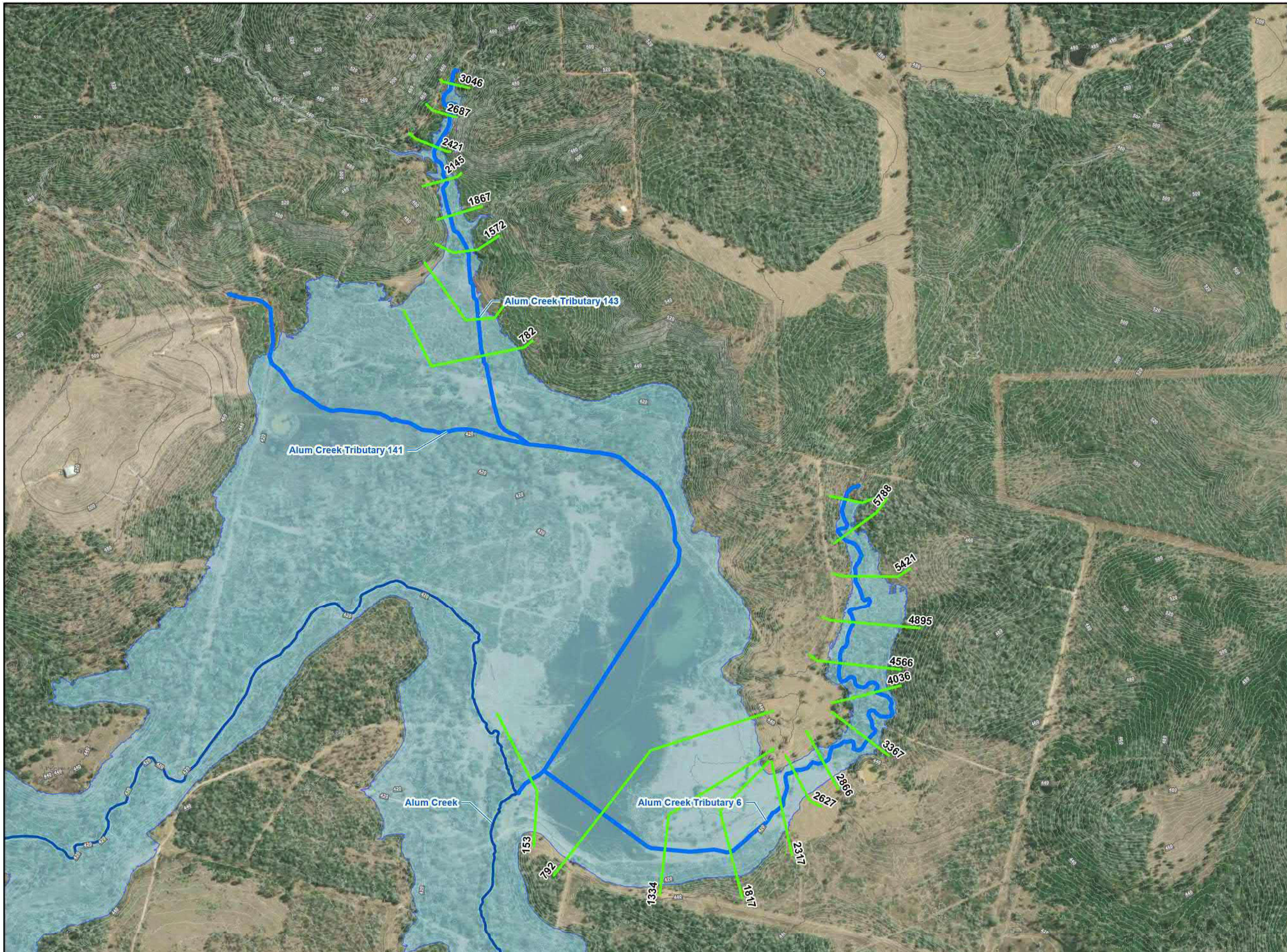

Bastrop County Flood Protection Planning Study

Roadway Improvements
Flooded Structures
Flooded Crossings
Structures
Cross Sections
Limit of Study
Focused Study Streams
Other Study Streams
Index Contour
Minor Contour
Roads
Floodplain

Alum Creek Watershed Hydraulic Work Map

Alum Creek Tribs 143, 141, 6

Panel 01 of 01

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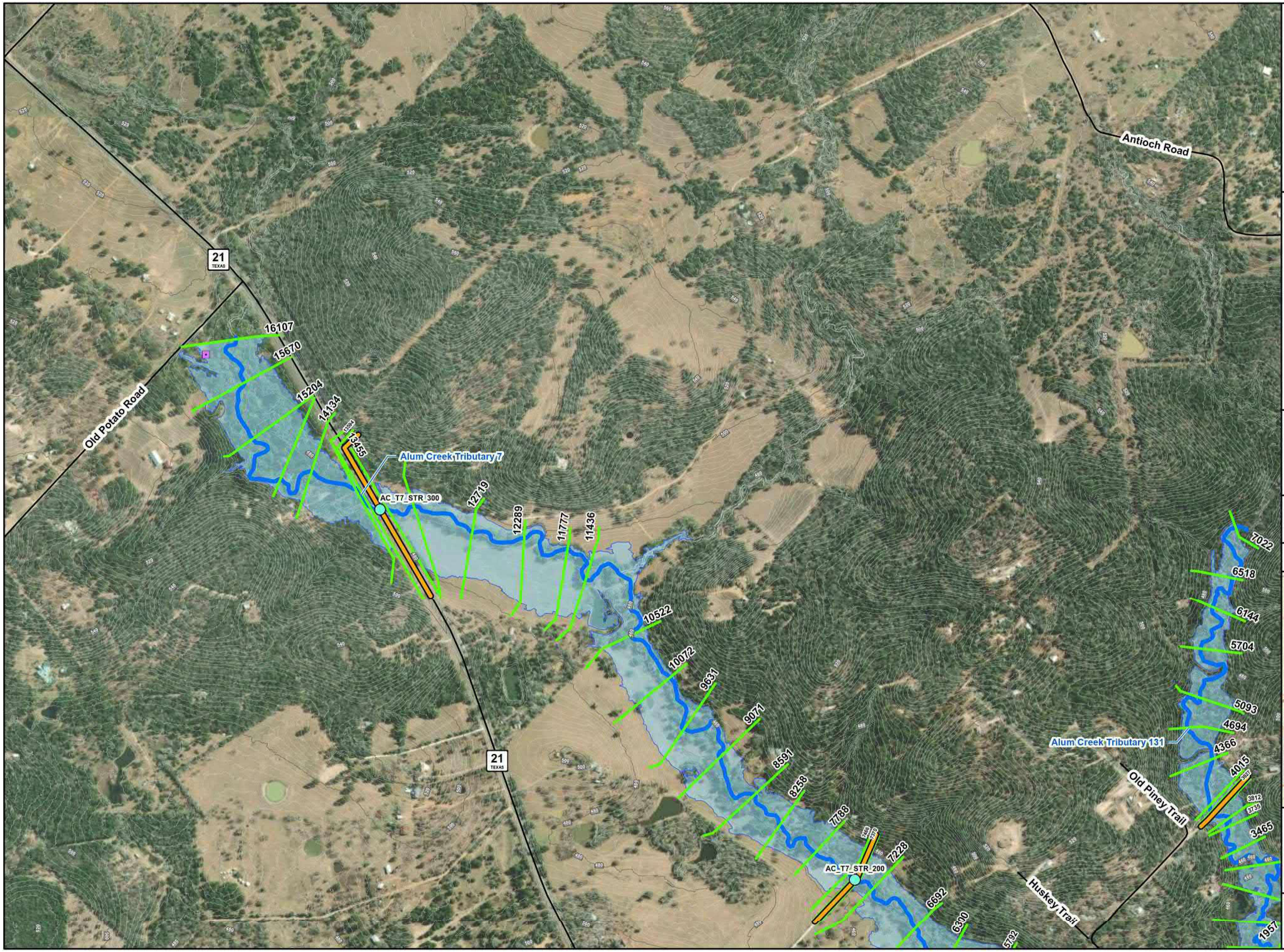

THE STATE OF TEXAS
COUNTY OF BASTROP

Bastrop County Flood Protection Planning Study

- Roadway Improvements
- Flooded Structures
- Flooded Crossings
- Structures
- Cross Sections
- Limit of Study
- Focused Study Streams
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- Minor Contour
- Roads
- Floodplain

Alum Creek Watershed Hydraulic Work Map

Alum Creek Tribs 7, 131

Panel 01 of 02

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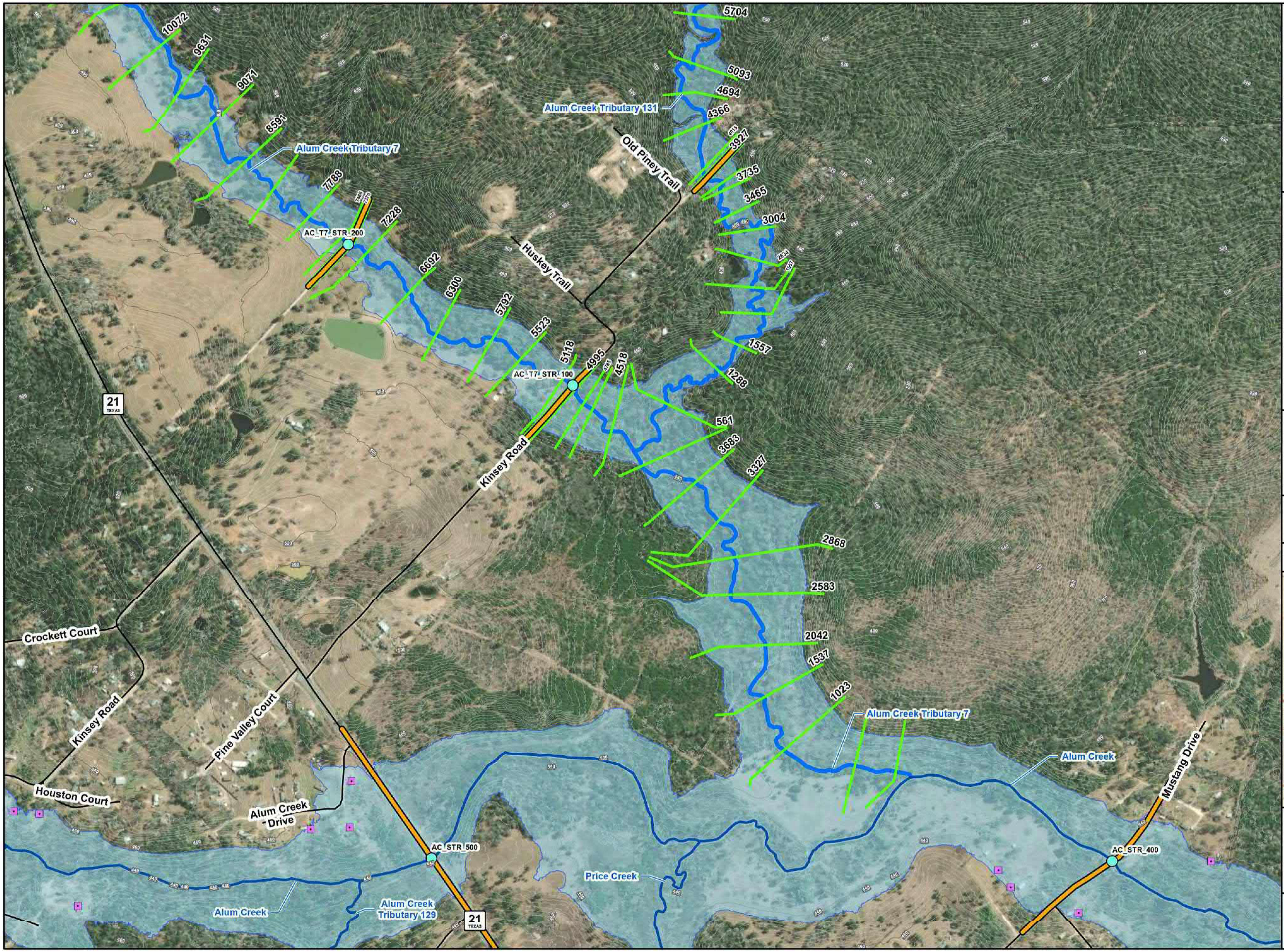


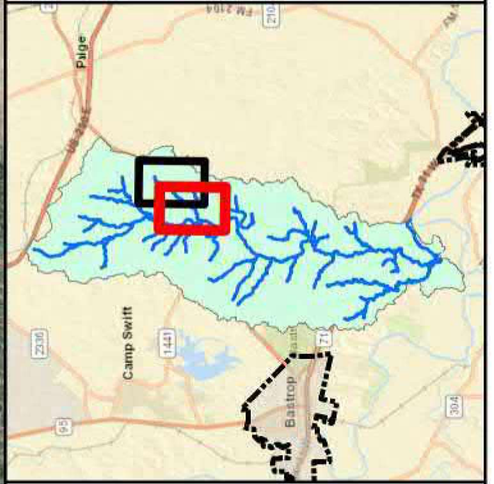
Bastrop County Flood Protection Planning Study

Roadway Improvements
Flooded Structures
Flooded Crossings
Structures
Cross Sections
Limit of Study
Focused Study Streams
Other Study Streams
Index Contour
Minor Contour
Roads
Floodplain

Alum Creek Watershed Hydraulic Work Map

Alum Creek Tribs 7, 131

Panel 02 of 02



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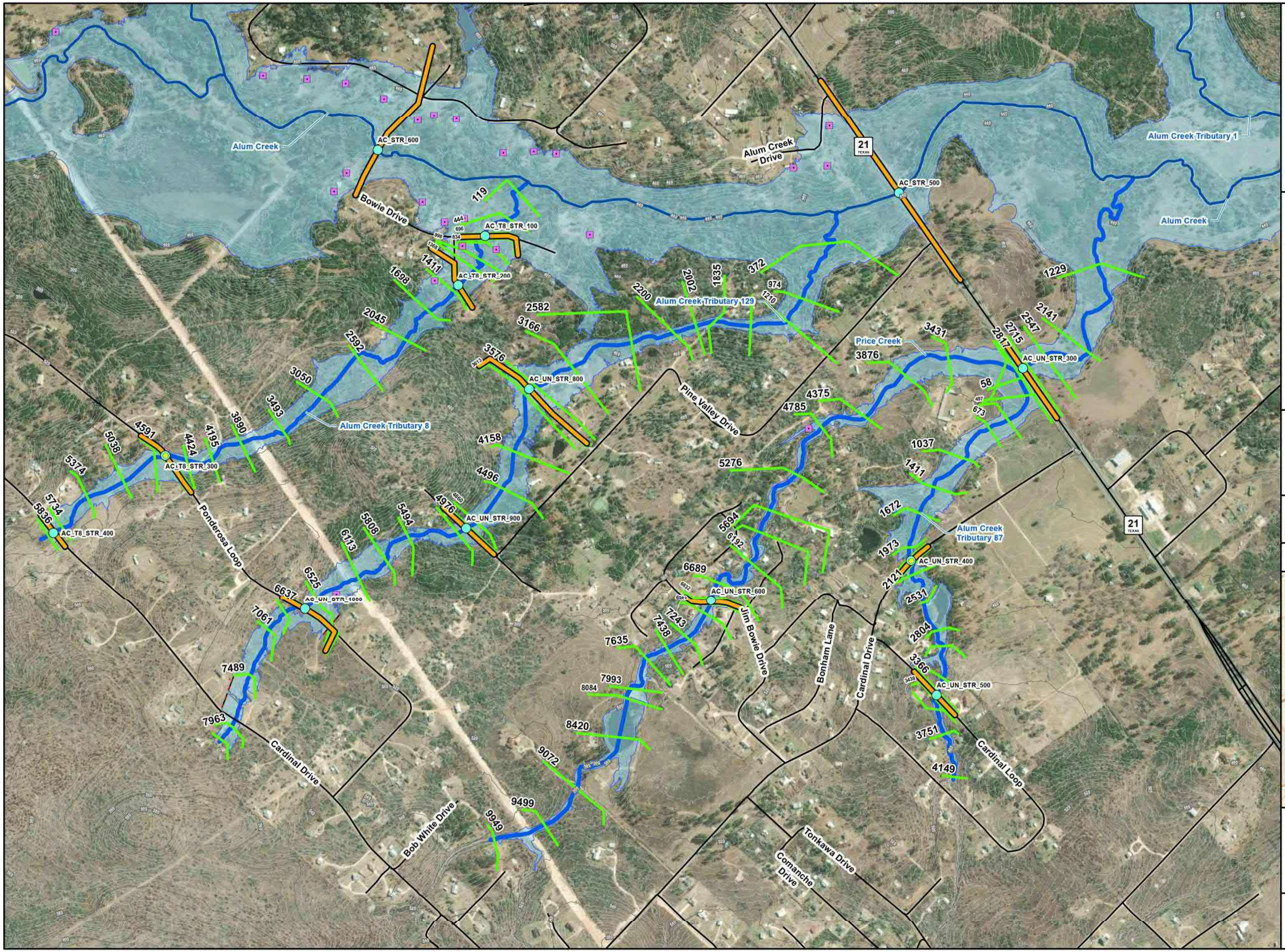


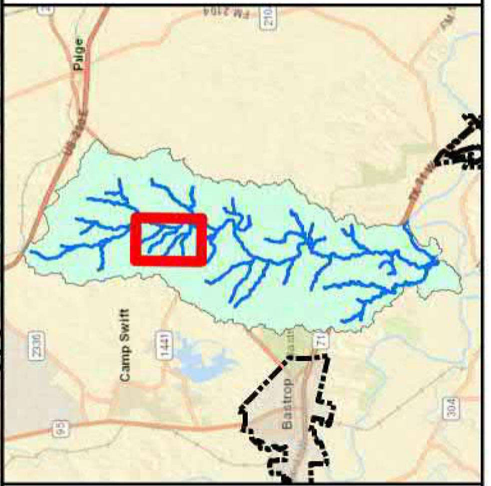
Bastrop County Flood Protection Planning Study

- Roadway Improvements
- Flooded Structures
- Flooded Crossings
- Structures
- Cross Sections
- Limit of Study
- Focused Study Streams
- Other Study Streams
- Index Contour
- Minor Contour
- Roads
- Floodplain

Alum Creek Watershed Hydraulic Work Map

Alum Creek Tribs 8, 129, 87 and Price Creek

Panel 01 of 01



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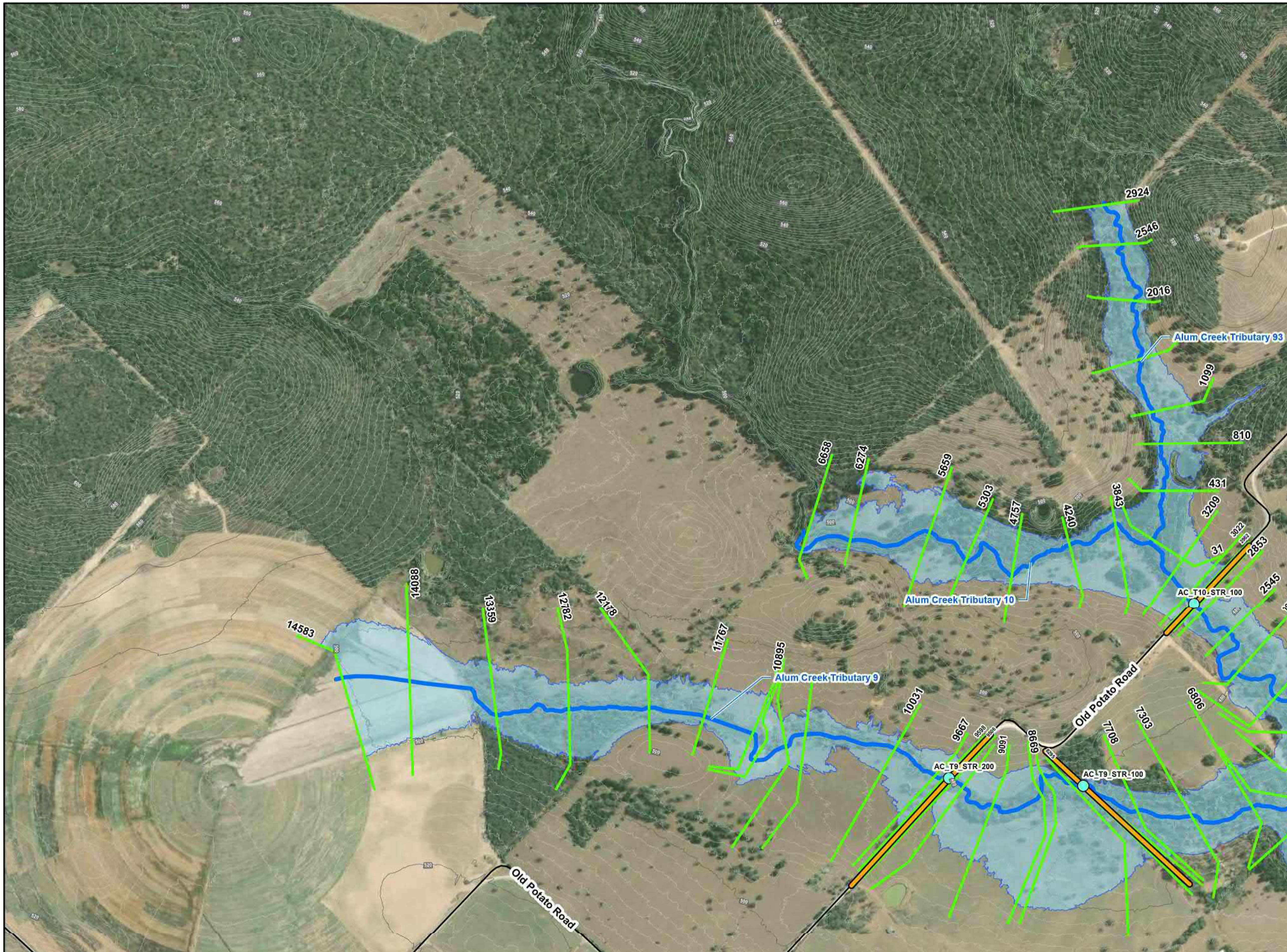

THE STATE OF TEXAS COUNTY OF BASTROP

Bastrop County Flood Protection Planning Study

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- Flooded Structures
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- Structures
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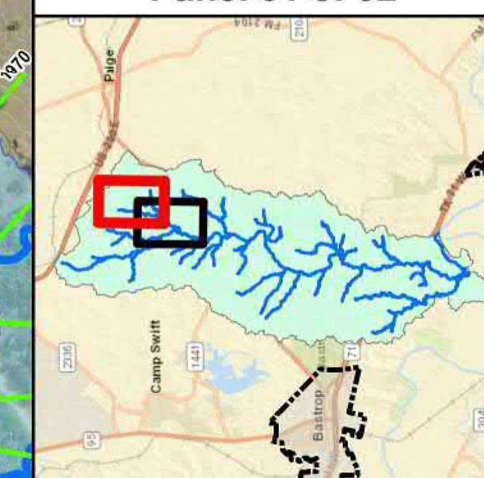
- Floodplain

Alum Creek Watershed Hydraulic Work Map

Alum Creek Tribs 9, 10, 93

Panel 01 of 02



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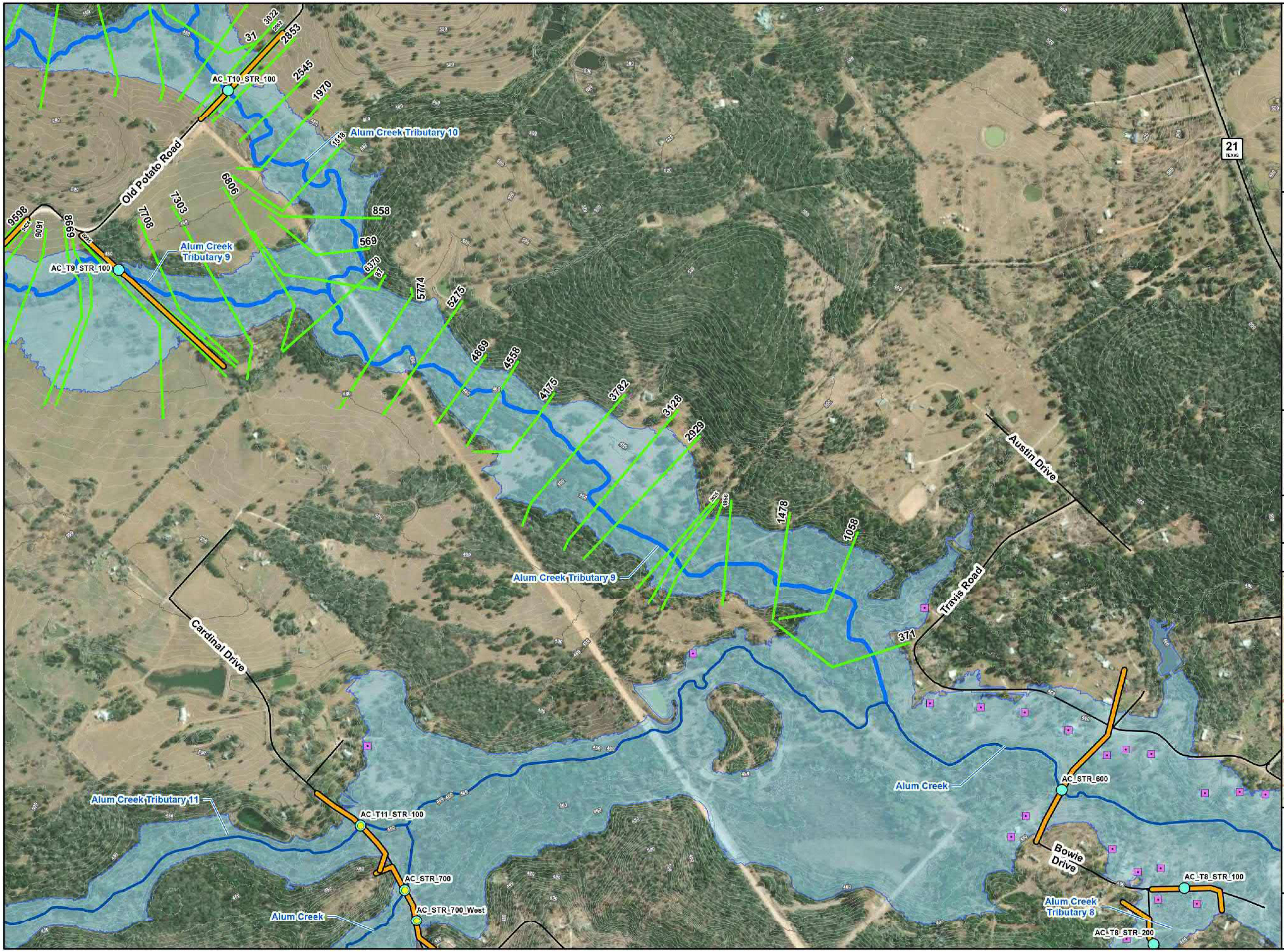

Bastrop County Flood Protection Planning Study

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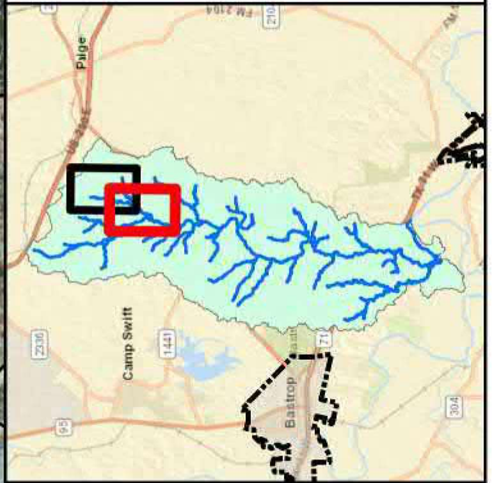
Alum Creek Watershed Hydraulic Work Map

Alum Creek Tribs 9, 10, 93

Panel 02 of 02



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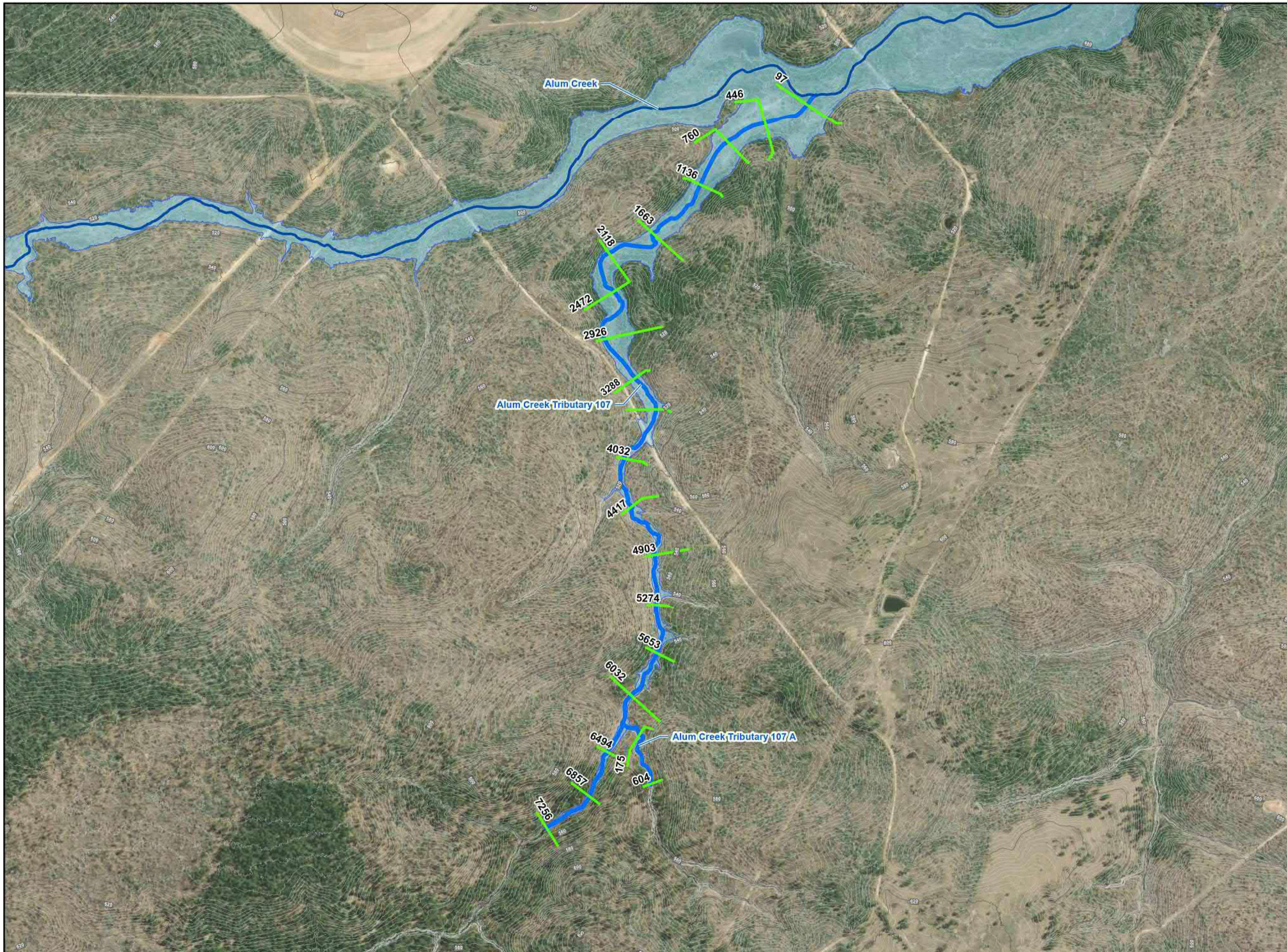


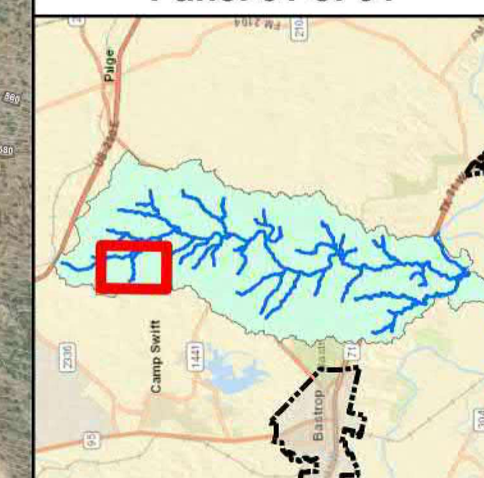
Bastrop County Flood Protection Planning Study

Roadway Improvements
Flooded Structures
Flooded Crossings
Structures
Cross Sections
Limit of Study
Focused Study Streams
Other Study Streams
Index Contour
Minor Contour
Roads
Floodplain

Alum Creek Watershed Hydraulic Work Map

Alum Creek Tribs 107, 107A

Panel 01 of 01



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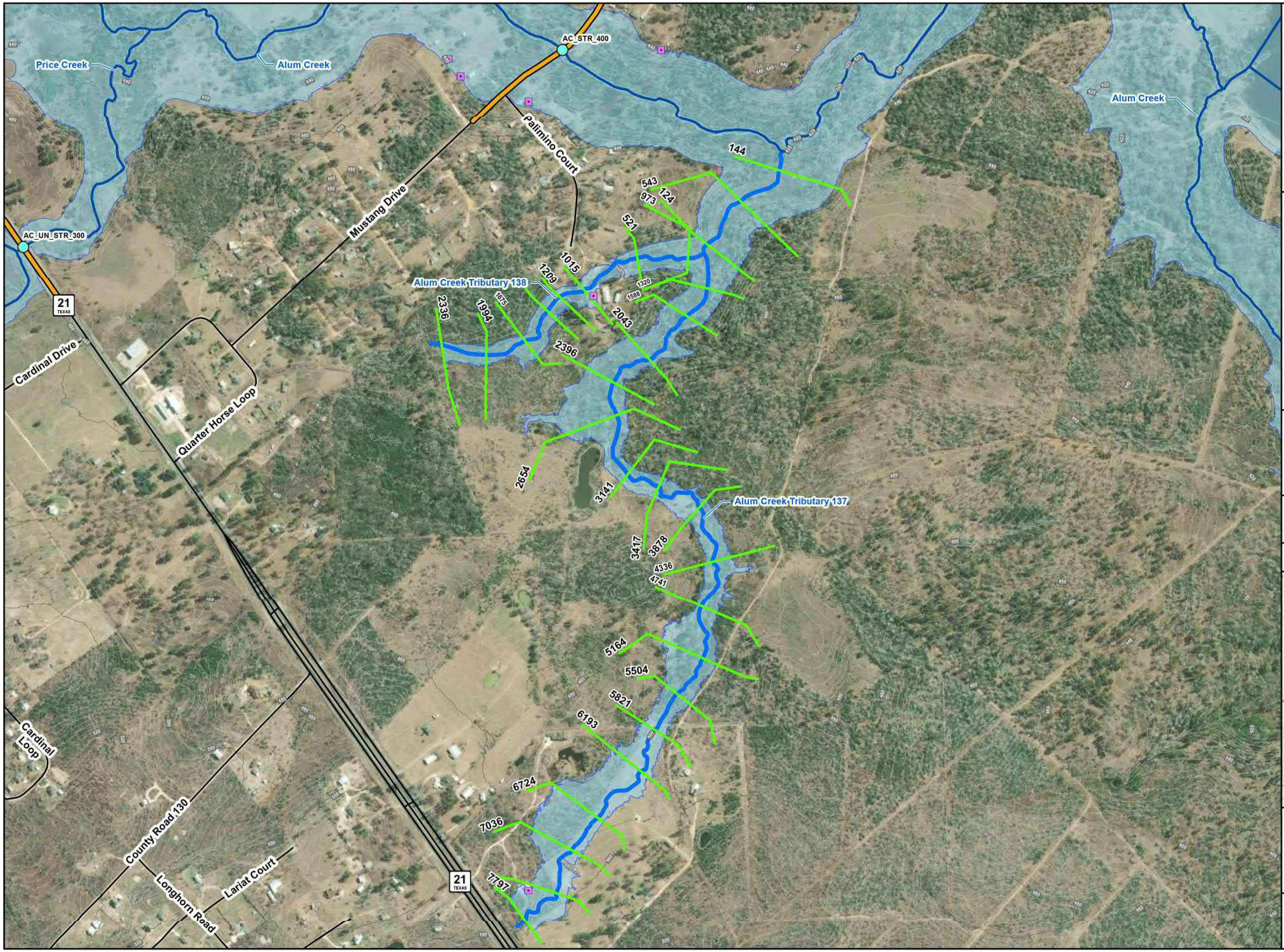

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Bastrop County Flood Protection Planning Study

- Roadway Improvements
- Flooded Structures
- Flooded Crossings
- Structures
- Cross Sections
- Limit of Study
- Focused Study Streams
- Other Study Streams
- Index Contour
- Minor Contour
- Roads
- Floodplain

Alum Creek Watershed Hydraulic Work Map

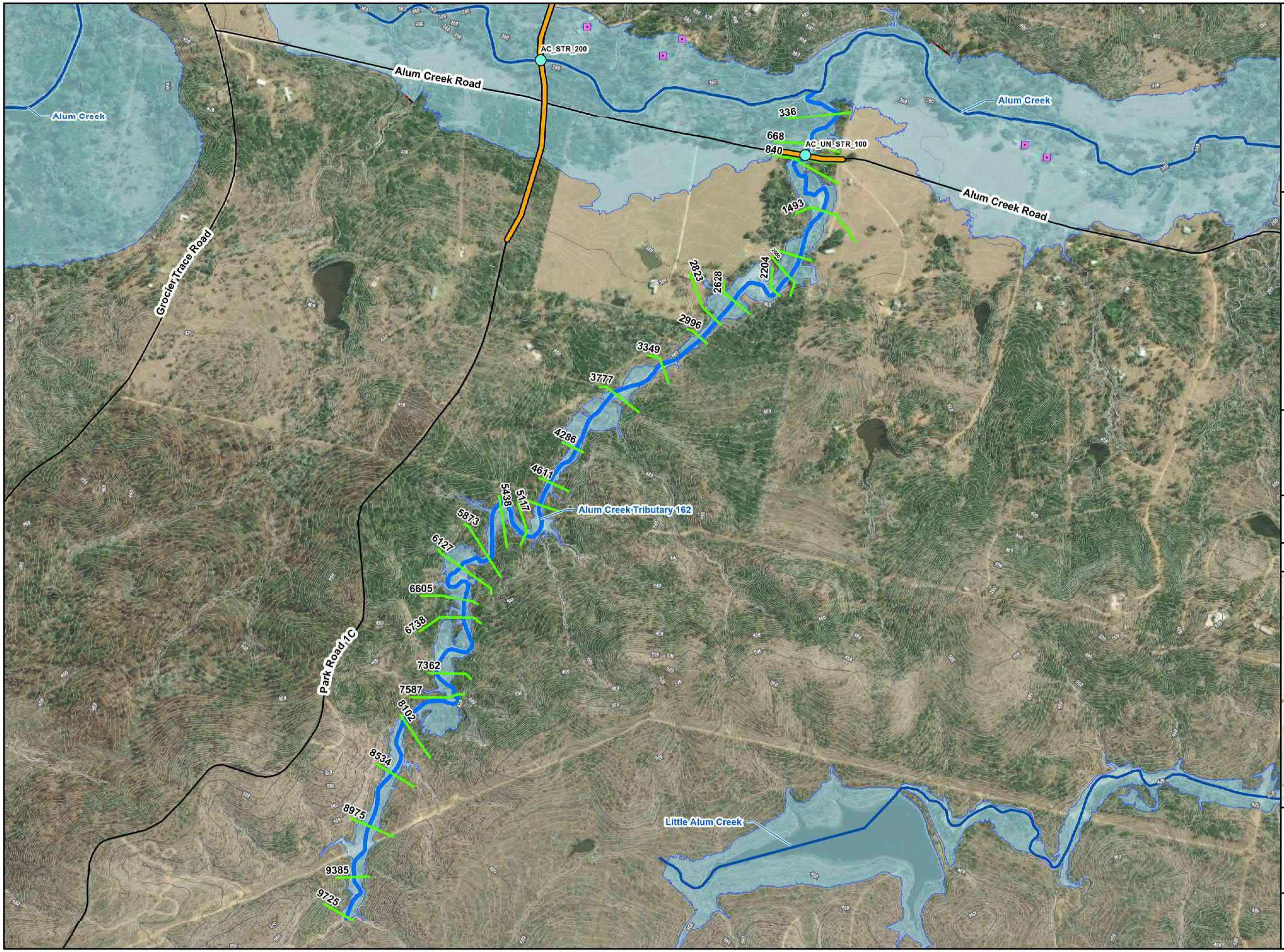
Alum Creek Tribs 137, 138

Panel 01 of 01

N

0 700 1,400 Feet

HALFF



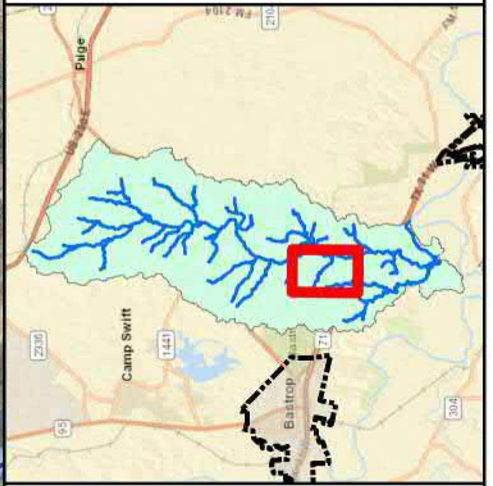
Bastrop County Flood Protection Planning Study

- Roadway Improvements
- Flooded Structures
- Flooded Crossings
- Structures
- Cross Sections
- Limit of Study
- Focused study Streams
- Other Study Streams
- Index Contour
- Minor Contour
- Roads
- Floodplain

Alum Creek Watershed Hydraulic Work Map

Alum Creek Trib 162

Panel 01 of 01



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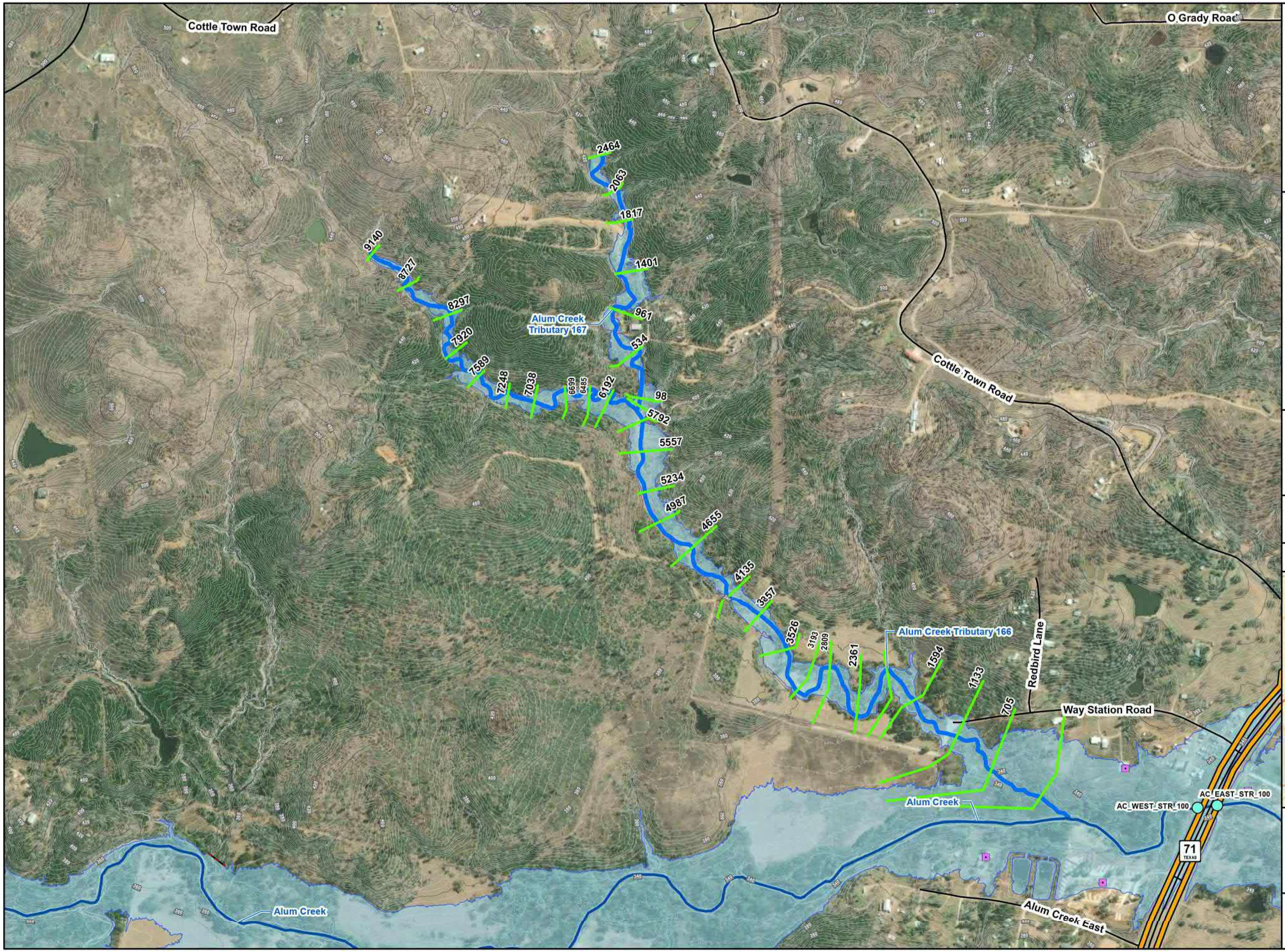
HALFF



THE STATE OF TEXAS COUNTY OF BASTROP

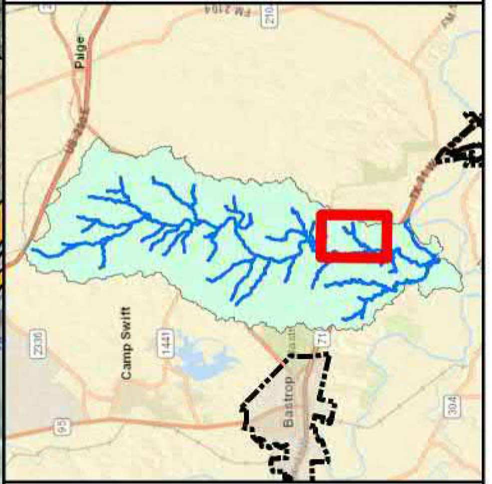
Bastrop County Flood Protection Planning Study

- Roadway Improvements
- Flooded Structures
- Flooded Crossings
- Structures
- Cross Sections
- Limit of Study
- Focused Study Streams
- Other Study Streams
- Index Contour
- Minor Contour
- Roads
- Floodplain

Alum Creek Watershed Hydraulic Work Map

Alum Creek Tribs 166, 167

Panel 01 of 01



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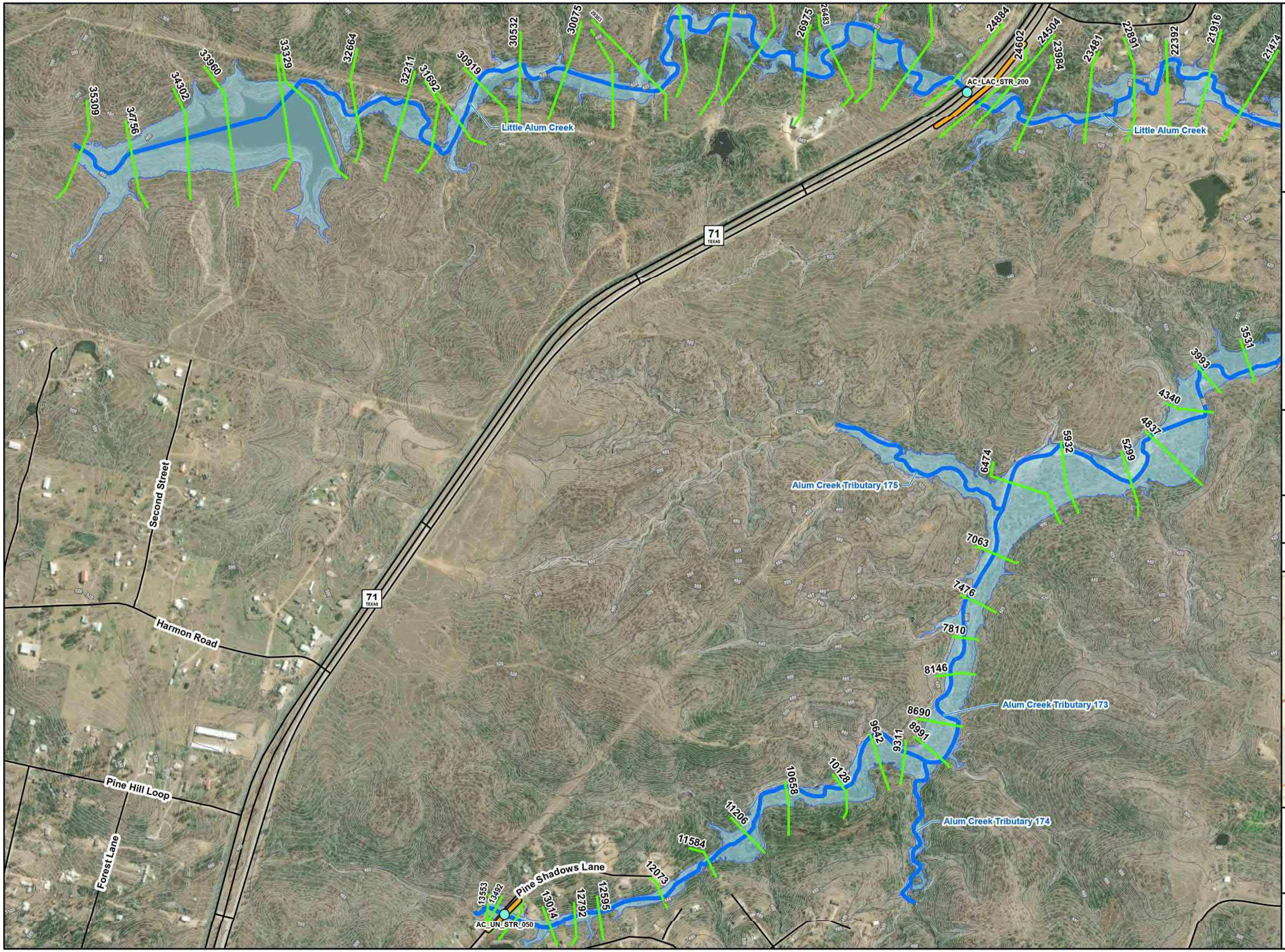


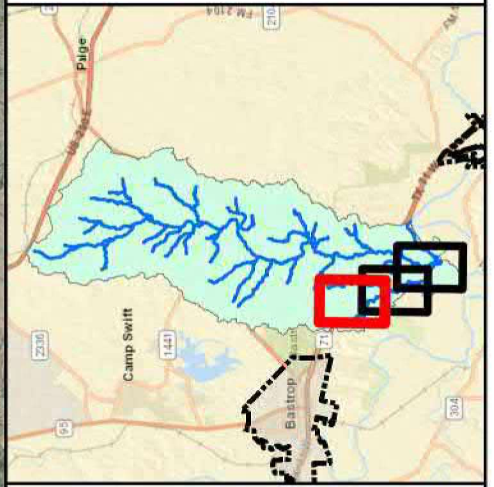
Bastrop County Flood Protection Planning Study

- Roadway Improvements
- Flooded Structures
- Flooded Crossings
- Structures
- Cross Sections
- Limit of Study
- Focused Study Streams
- Other Study Streams
- Index Contour
- Minor Contour
- Roads
- Floodplain

Alum Creek Watershed Hydraulic Work Map

Little Alum Creek & Tribs 175, 174, 173

Panel 01 of 03



N

0 750 1,500 Feet

HALFF

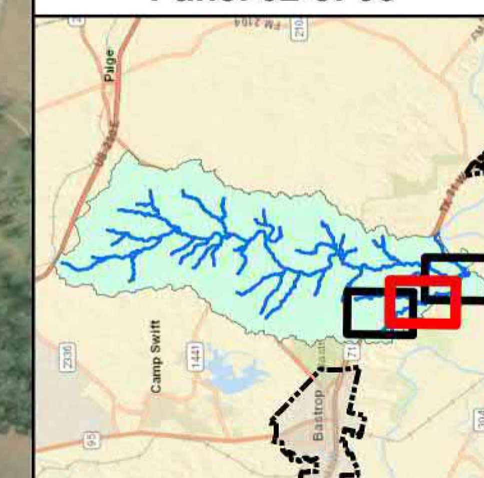
Bastrop County Flood Protection Planning Study

- Roadway Improvements
- Flooded Structures
- Flooded Crossings
- Structures
- Cross Sections
- Limit of Study
- Focused Study Streams
- Other Study Streams
- Index Contour
- Minor Contour
- Roads
- Floodplain

Alum Creek Watershed Hydraulic Work Map

Little Alum Creek & Tribs 175, 174, 173

Panel 02 of 03



N

0 750 1,500 Feet

HALFF

THE STATE OF TEXAS COUNTY OF BASTROP

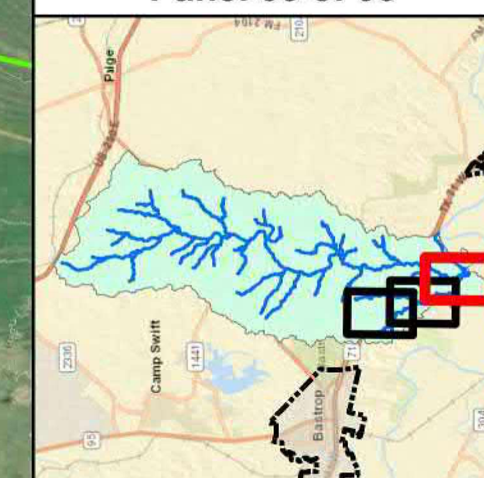
Bastrop County Flood Protection Planning Study

- Roadway Improvements
- Flooded Structures
- Flooded Crossings
- Structures
- Cross Sections
- Limit of Study
- Focused Study Streams
- Other Study Streams
- Index Contour
- Minor Contour
- Roads
- Floodplain

Alum Creek Watershed Hydraulic Work Map

Little Alum Creek & Tribs 175, 174, 173

Panel 03 of 03



N

0 750 1,500 Feet

HALFF

Appendix G: Floodplain Mapping

G-2 Comparison to FEMA Effective Floodplain

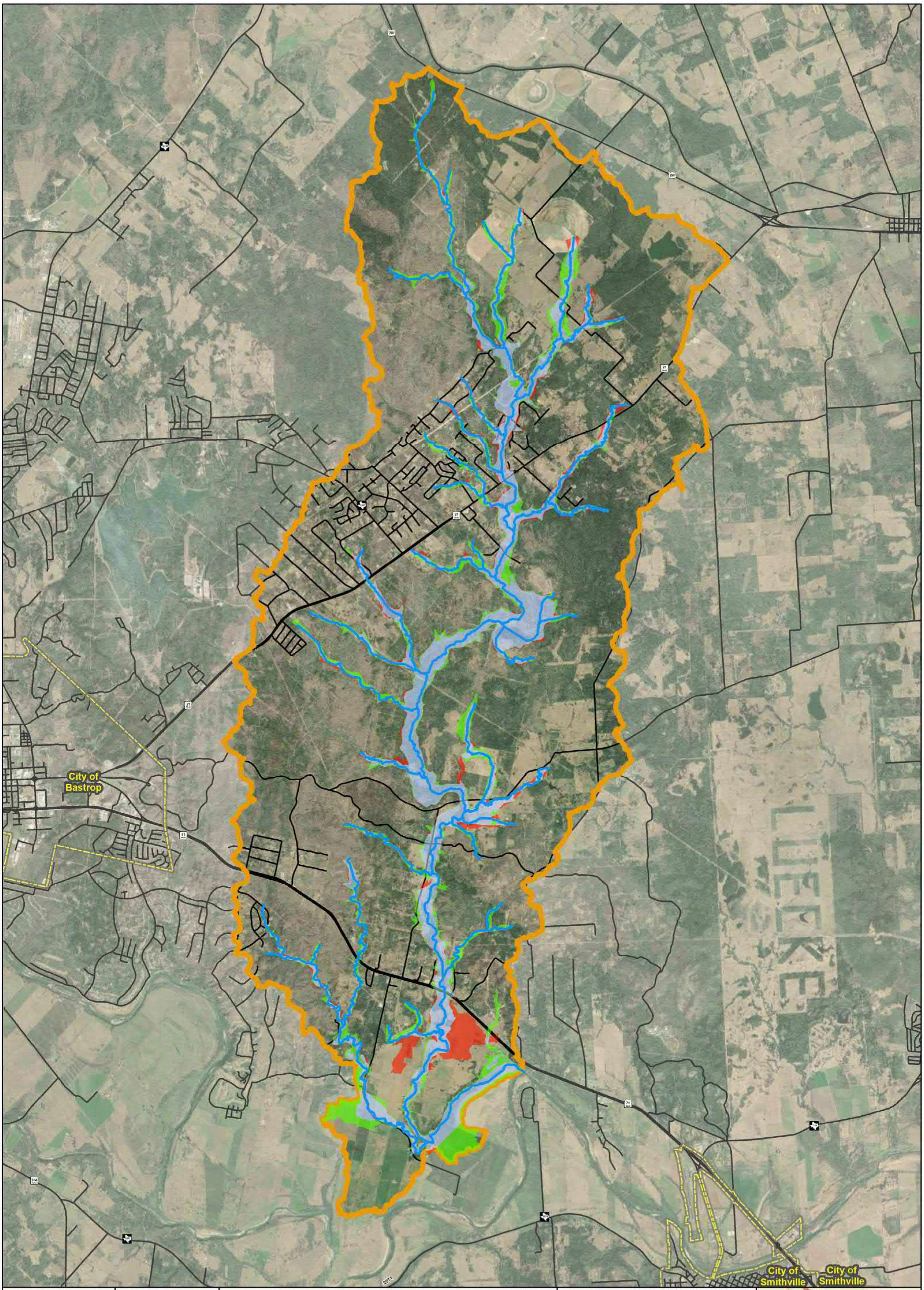
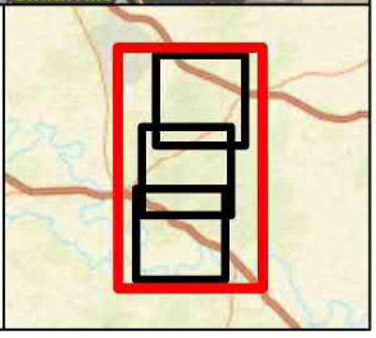


Exhibit G-2 Floodplain Comparison

Overview



Legend

- Stream Centerlines
- Roads
- Alum Creek Watershed
- City Boundary

Floodplain Changes

- Decrease
- Increase
- No Change

N

0 6,000 12,000 Feet

1 inch = 6,000 feet

HALFF

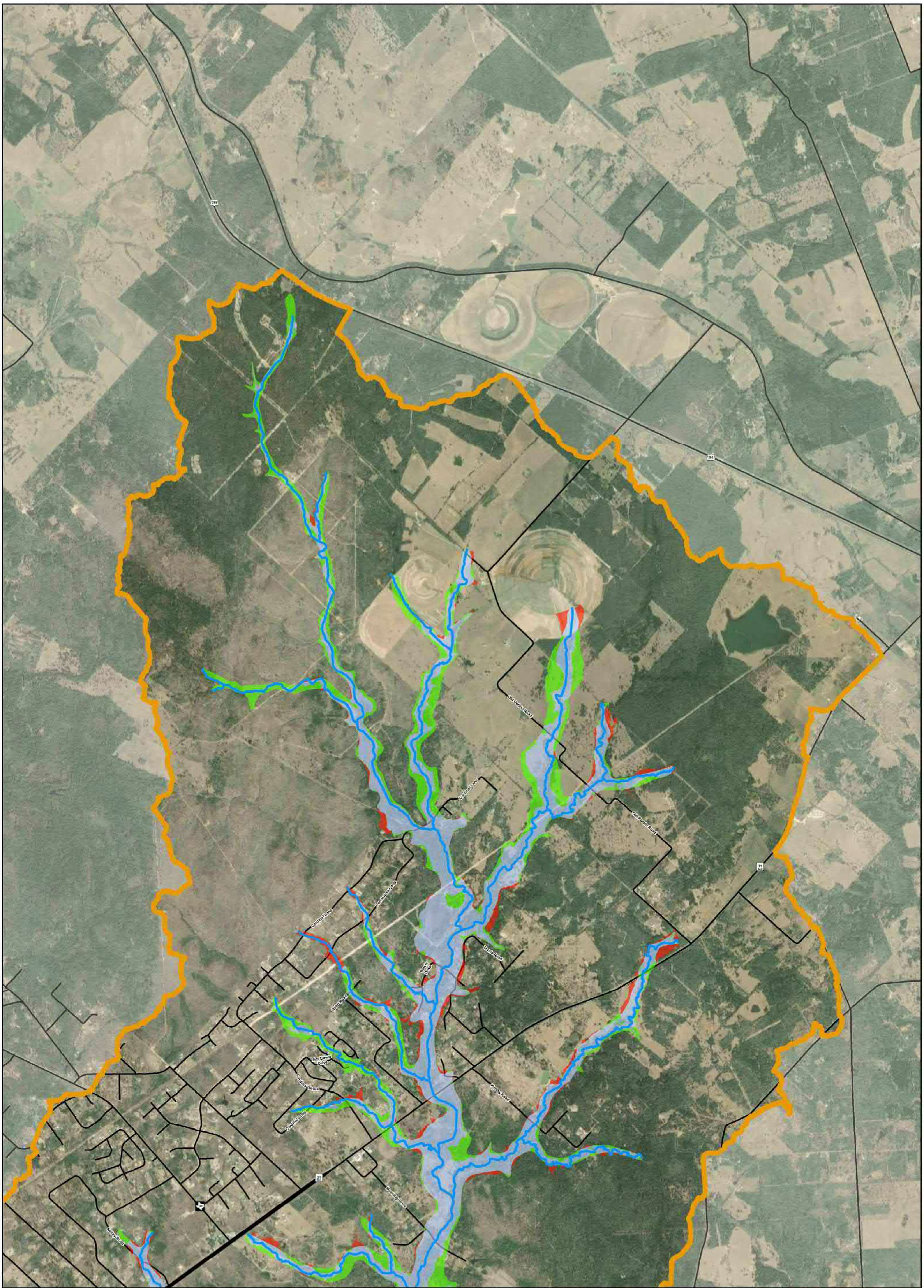


Exhibit G-2 Floodplain Comparison

Upper Watershed

THE STATE OF TEXAS · COUNTY OF BASTROP

HALFF

Legend

Stream Centerlines

Roads

Alum Creek Waterhsed

Floodplain Changes

Decrease

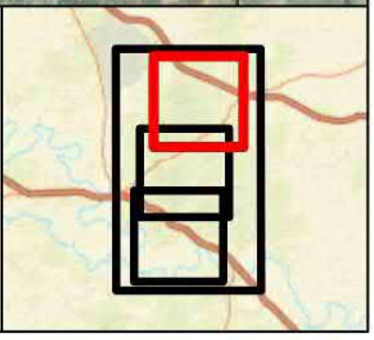
Increase

No Change

N

0 3,000 6,000 Feet

1 inch = 3,000 feet



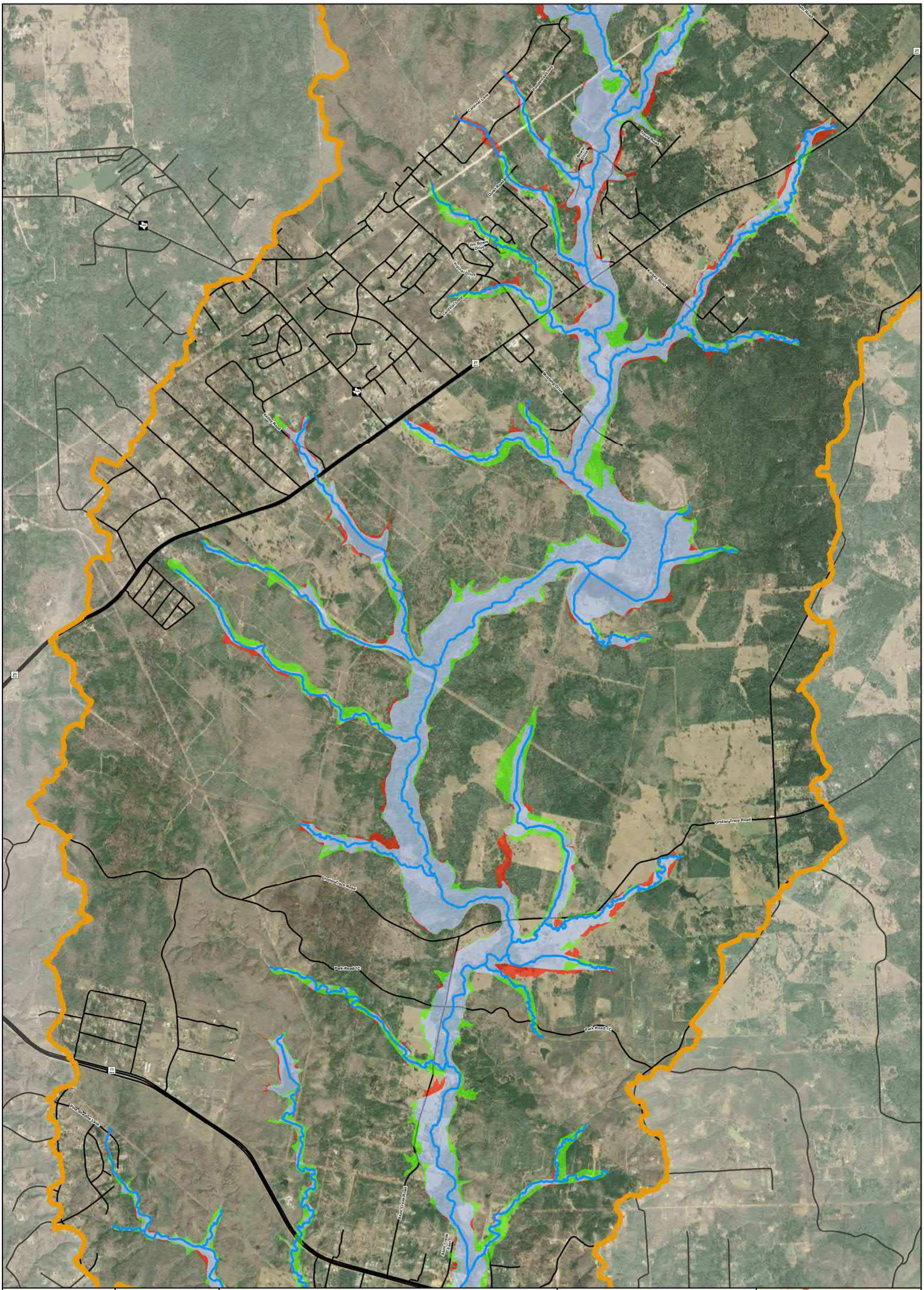


Exhibit G-2
Floodplain Comparison

Mid Watershed

THE STATE OF TEXAS · COUNTY OF BASTROP

HALFF

Legend

- Stream Centerlines
- Roads
- Alum Creek Waterhsed

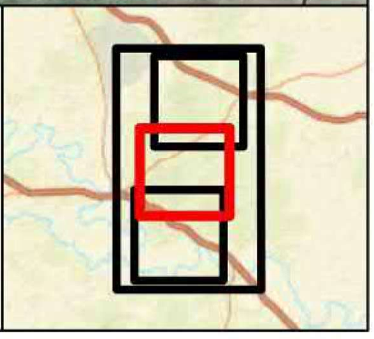
Floodplain Changes

- Decrease
- Increase
- No Change

N

0 3,000 6,000 Feet

1 inch = 3,000 feet



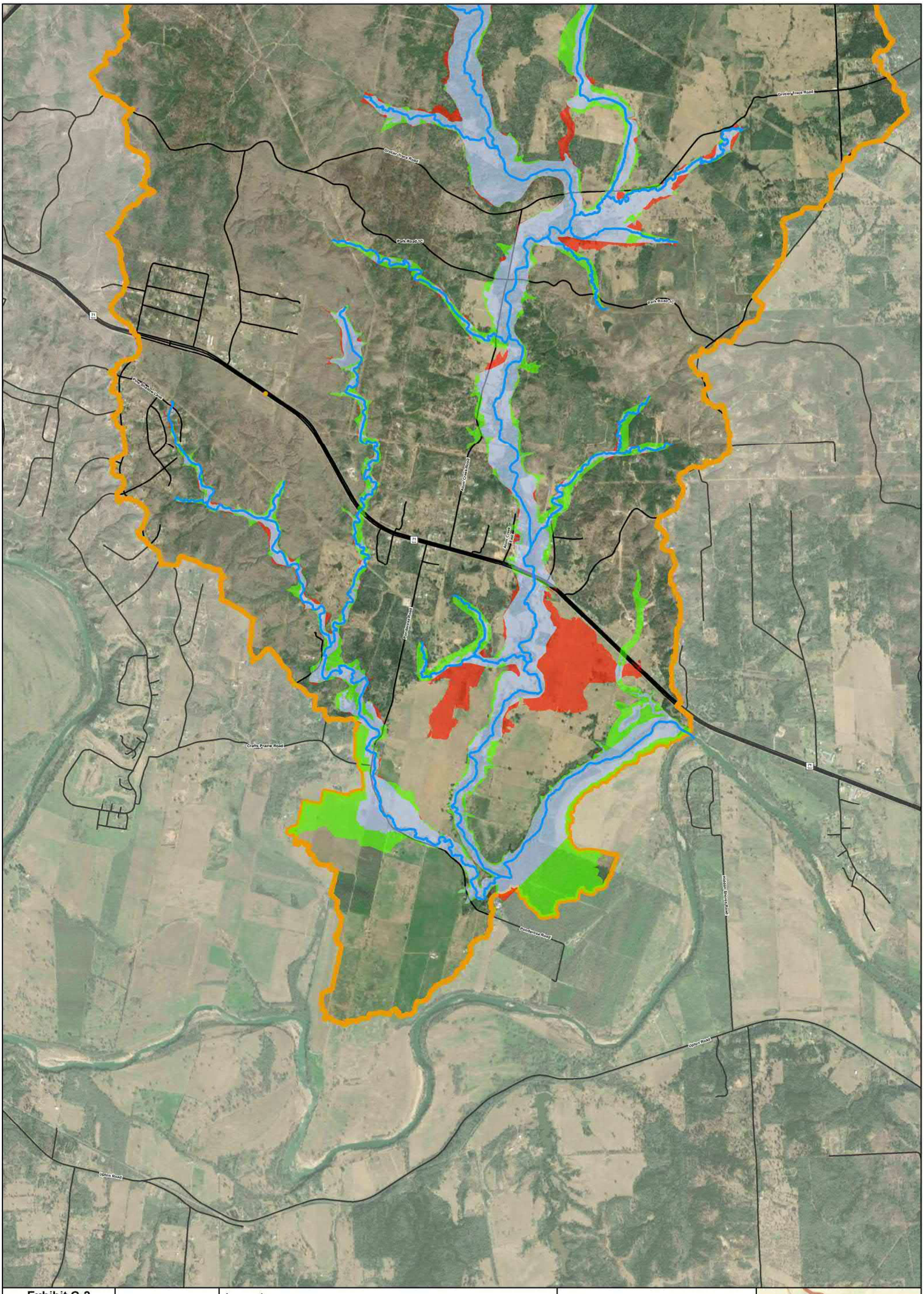


Exhibit G-2 Floodplain Comparison

Lower Watershed

THE STATE OF TEXAS · COUNTY OF BASTROP

HALFF

Legend

Stream Centerlines
Roads
Alum Creek Waterhsed

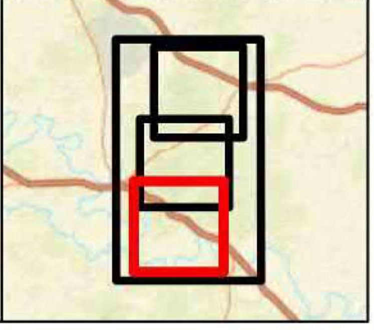
Floodplain Changes

Decrease
Increase
No Change

N

0 3,000 6,000 Feet

1 inch = 3,000 feet



Appendix H: Alternative Evaluation

H-1 Roadway Crossing Urgency Rating

Alum Creek Structure Urgency Ratings

Stream[1]	Structure Station[2]	Road Name[3]	Structure ID	Structure Type[4]	AADT Traffic Count[5]	Minimum TOR Elevation[6]	Frequency Water Surface Elevation[7] (ft)							Annual Chance of Flooding[8]		Flowrate at Structure (Q)[9] (cfs)		Urgency Rating[10]	Risk Rank
	(ft)				(veh/day)		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	Year Event	Percent Chance	25-yr	100-yr	(veh/day/yr)	
AC	77534	State Hwy 21 W	AC_STR_500	Bridge	13385	446.82	444.56	446.86	448.82	450.41	451.23	452.03	454.6	5-yr	20.00%	10000	17300	2677	1
AC_T4	8875	State Hwy 21 W	AC_T4_STR_100	Culverts	13385	458.22	451.87	457.08	459.25	459.97	460.27	460.59	462.02	10-yr	10.00%	1400	2000	1339	2
AC	25421	TX-71/TX-95	AC_WEST_STR_100	Bridge	21970	341.55	337.09	338.64	338.04	344.39	346.15	347.45	351.43	25-yr	4.00%	13400	24600	879	3
AC_T87	2094	Cardinal Dr	AC_UN_STR_400	Culverts	1510	468.78	468.96	469.49	469.83	470.2	470.46	470.68	471.03	2-yr	50.00%	680	1100	755	4
AC	25307	TX-71/TX-96	AC_EAST_STR_100	Bridge	21970	344.73	334.82	336.12	337.28	342.21	344.82	345.86	350.11	50-yr	2.00%	13400	24600	439	5
PC	2767	State Hwy 21 W	AC_UN_STR_300	Culverts	13385	453.61	448.86	449.62	450.71	452.82	453.96	454.48	455.3	50-yr	2.00%	1100	1800	268	6
LAC	10348	Ponderosa Rd	AC_LAC_STR_100	Bridge	390	335.29	336.69	337.99	338.93	340.11	340.62	340.72	341.82	2-yr	50.00%	4400	6500	195	7
AC_T129	6660	Ponderosa Loop	AC_UN_STR_1000	Culverts	320	513.52	514.52	514.7	514.85	515.06	515.24	515.31	515.57	2-yr	50.00%	610	990	160	8
AC_T8	4609	Ponderosa Loop	AC_T8_STR_300	Culverts	230	483.69	484.33	484.96	485.37	485.78	486.09	486.35	486.88	2-yr	50.00%	1400	2200	115	9
AC_T8	5816	Cardinal Dr	AC_T8_STR_400	Culverts	220	491.66	492.62	493.24	493.67	494.16	494.55	494.86	495.52	2-yr	50.00%	1400	2200	110	10
AC_T10	2939	Old Potato Rd	AC_T10_STR_100	Bridge	200	482.33	483.17	483.55	483.84	484.31	484.58	484.8	485.43	2-yr	50.00%	2700	4100	100	11
AC_T4	10272	Kelley Rd E	AC_T4_STR_200	Culverts	180	451.1	452.44	457.13	459.26	459.99	460.29	460.62	462.13	2-yr	50.00%	1400	2000	90	12
AC_T7	7393	Squirrel Run	AC_T7_STR_200	Culverts	180	450.99	455.42	455.81	456.26	457.03	457.57	458.14	459.39	2-yr	50.00%	2200	3400	90	12
AC	89173	Cardinal Dr	AC_STR_700	Culverts	170	466.47	467.6	468.12	468.61	469.27	469.67	470.18	471.53	2-yr	50.00%	3100	5600	85	14
AC	82216	Bowie Dr	AC_STR_600	Culverts	170	448.62	451.66	453.53	455.31	457.62	459.3	460.9	464.31	2-yr	50.00%	9900	16900	85	14
AC_T11	354	Cardinal Dr	AC_T11_STR_100	Culverts	170	465.77	466.73	467.15	467.52	467.98	468.35	468.63	469.22	2-yr	50.00%	3200	3800	85	14
AC	70817	Mustang Dr	AC_STR_400	Bridge	130	431.57	434.64	434.95	436.07	438.18	439.7	441.18	444.5	2-yr	50.00%	12100	21100	65	17
AC_T173	13403	Pine Shadow Ln	AC_UN_STR_050	Culverts	90	451.73	452.35	453.46	453.9	454.38	454.75	454.94	455.6	2-yr	50.00%	1300	1900	45	18
AC_T7	5026	Kinsey Rd	AC_T7_STR_100	Bridge	180	447.49	447.02	448.18	449.05	449.55	449.96	450.47	451.68	5-yr	20.00%	2400	3800	36	19
PC	6872	Jim Bowie Dr	AC_UN_STR_600	Culverts	140	489.7	487.18	490.51	490.79	491.61	491.89	492.19	492.76	5-yr	20.00%	990	1600	28	20
AC	43041	Gotier Trace Rd	AC_STR_300	Bridge	50	369.4	370.75	372.49	373.64	375.34	376.47	377.71	381.03	2-yr	50.00%	13000	23800	25	21
AC_T1	2112	Gotier Trace Rd	AC_T1_STR_100	Culverts	50	375.5	377.28	377.76	378.21	378.7	379.06	379.41	380.13	2-yr	50.00%	1500	2200	25	21
AC_T8	717	Bowie Dr	AC_T8_STR_100	Culverts	50	451.87	453.06	453.45	453.77	454.11	454.39	454.58	455.2	2-yr	50.00%	1600	2500	25	21
AC_T87	3406	Cardinal Loop	AC_UN_STR_500	Culverts	120	482.36	480.54	482.97	483.49	484.06	484.39	484.64	484.99	5-yr	20.00%	680	1100	24	24
AC	37987	Park Rd 1C	AC_STR_200	Culverts	40	357.9	362.38	364.37	365.39	367.41	369.15	370.93	374.75	2-yr	50.00%	13400	24700	20	25
AC_T160	3675	Park Rd 1C	AC_UN_STR_200	Culverts	40	404.76	405.69	406.25	406.57	406.94	407.15	407.3	407.6	2-yr	50.00%	670	910	20	25
AC_T9	9548	Old Potato Rd	AC_T9_STR_200	Culverts	200	483.34	481.47	483.03	483.96	484.33	484.59	484.87	485.35	10-yr	10.00%	990	1700	20	25
AC_T129	4963	Quiet Dr	AC_UN_STR_900	Culverts	30	479.93	480.46	480.76	480.97	481.27	481.46	481.63	482.01	2-yr	50.00%	610	990	15	28
AC_T129	3591	Peaceful Ln	AC_UN_STR_800	Culverts	10	463.71	464.26	464.47	464.62	464.84	465	465.12	465.37	2-yr	50.00%	610	990	5	29
AC_T8	1348	Alamo Ct	AC_T8_STR_200	Culverts	10	456.13	457.8	458.13	458.38	458.66	458.89	459.15	459.58	2-yr	50.00%	1600	2500	5	29
AC_T9	8181	McBride Ln	AC_T9_STR_100	Culverts	10	474.31	475.54	475.73	475.88	476.15	476.28	476.54	477.71	2-yr	50.00%	990	1700	5	29

Notes
1. As designated within HEC-RAS models
2. Stationing begins at the most downstream location of conveyance for the stream
3. As designated within HEC-RAS models
4. AS designated within HEC-RAS models
5. Data interpreted from TxDOT 2018 Austin District Traffic Map
6. Minimum TOR elevation includes surrounding roadways
7. As determined by HEC-RAS models
8. Flood event at which the minimum TOR is overtopped
9. Flowrates taken from adjacent upstream XS
10. Calculated as (AADT Traffic Count)/(Frequency of flooding storm event)

Appendix H: Alternative Evaluation

H-2 Alternative Structures

	Existing				Proposed, Multiple Opening		
	Existing Structure	ACE	WSEL (ft)	Overtopping Depth (ft)	Proposed Improvements	Overtopping Depth (ft)	West Culverts Overtopping Depth (ft)
AC_STR_700 on Cardinal Dr. AC	Two 31" x 41" CMPs (west) & One 1.25' CMP	50%	467.6	1.14	Two 4' x 3' RCBs (west) & Four 4'x2' RCBs, raised road 1'	-1.01	-1.5
		20%	468.12	1.66		-0.24	-0.32
		10%	468.61	2.15		0.32	0.32
		4%	469.27	2.81		0.81	0.81
		2%	469.67	3.21		1.41	1.44
		1%	470.18	3.72		2.06	2.1
		0.20%	471.53	5.07		3.63	3.63

	Existing				Proposed		
	Existing Structure	ACE	WSEL (ft)	Overtopping Depth (ft)	Proposed Improvements	WSEL (ft)	Overtopping Depth (ft)
AC_T1_STR_100 on Gotier Trace. AC_T1	One 2.5' CMP	50%	377.28	1.78	Two 12' x 6' RCBs, raised road 1', channel improvements	377.32	0.37
		20%	377.76	2.26		377.79	0.84
		10%	378.21	2.71		378.22	1.27
		4%	378.7	3.2		378.67	1.72
		2%	379.06	3.56		379.02	2.07
		1%	379.41	3.91		379.36	2.41
		0.20%	380.13	4.63		380.1	3.15
AC_T11_STR_100 on Cardinal Dr. AC_T11	Four 4' CMPs	50%	466.73	0.96	Five 7' x 6' RCBs, raised road 1'	465.77	-1.81
		20%	467.15	1.38		466.38	-1.2
		10%	467.52	1.75		467.4	-0.18
		4%	467.98	2.21		468.17	0.59
		2%	468.35	2.58		468.65	1.07
		1%	468.62	2.85		468.99	1.41
		0.20%	469.23	3.46		469.69	2.11
AC_UN_STR_400 on Cardinal Dr. AC_T087	Two 4' CMPs	50%	468.96	0.18	Three 8' x 6' RCBs, raised road 1'	463.86	-5.97
		20%	469.49	0.71		464.79	-5.04
		10%	469.83	1.05		465.73	-4.1
		4%	470.2	1.42		466.92	-2.91
		2%	470.46	1.68		467.97	-1.86
		1%	470.68	1.9		468.93	-0.9
		0.20%	471.03	2.25		470.2	0.37
AC_T8_STR_300 on Ponderosa Loop AC_T8	Three 4' CMPs	50%	484.33	0.64	Three 8' x 5' RCBs, raised road 1'	481.79	-3.34
		20%	484.96	1.27		482.8	-2.33
		10%	485.37	1.68		484.45	-0.68
		4%	485.78	2.09		485.32	0.19
		2%	486.09	2.4		486.02	0.89
		1%	486.35	2.66		486.29	1.16
		0.20%	486.88	3.19		486.94	1.81

Appendix H: Alternative Evaluation

H-3 Alternative Cost Analysis

Project: Bastrop Co. Flood Protection Planning
Stream: Alum Creek
Crossing: AC_STR_700 on Cardinal Dr.

Engineer's Estimate of Probable Construction Cost
Date: June 8, 2020

PAY ITEM	DESCRIPTION	UNITS	UNIT PRICE	QTY	TOTALS
0100 6002	PREPARING ROW	STA	$2,800	3	$8,680
0110 6001	EXCAVATION (ROADWAY)	CY	$20	159	$3,189
0132 6006	EMBANKMENT (DENSITY, TYPE C)	CY	$35	241	$8,439
0161 6017	COMPOST MANUF TOPSOIL (BOS) (4") AND SEEDING	SY	$15	689	$10,333
0400 6006	CUT & RESTORING PAVEMENT (base and HMAC)	SY	$151	896	$134,915
0402 6001	TRENCH EXCAVATION PROTECTION	LF	$29	105	$3,063
0432 6033	RIPRAP (STONE PROTECTION)(D_{50}=18 IN)	CY	$115	178	$20,444
0432 6033	RIPRAP (STONE PROTECTION)(D_{50}=18 IN)	CY	$115	89	$10,222
0462 6003	CONC BOX CULV (4 FT X 2 FT)	LF	$255	160	$40,800
0462 6004	CONC BOX CULV (4 FT X 3 FT)	LF	$315	80	$25,200
0467 6137	SET (TY I)(S= 4 FT)(HW= 3 FT)(3:1) (C)	EA	$6,000	2	$12,000
04676143	SET (TY I)(S= 4 FT)(HW= 4 FT)(3:1) (C)	EA	$3,100	2	$6,200
0496 6006	REMOV STR (HEADWALL)	EA	$2,000	4	$8,000
0496 6007	REMOV STR (PIPE)	LF	$31	78	$2,430
0500 6001	MOBILIZATION (10%)	LS	$32,300	1	$32,300
0502 6001	BARRICADES, SIGNS AND TRAFFIC HANDLING	MO	$4,500	3	$13,500
0506 6002	EROSION CONTROL	LS	$15,400	1	$15,400
				PROJECT SUBTOTAL	**$355,200**
				30% CONTINGENCY	$106,600
				BASE TOTAL	$461,800
				Environmental Permitting (3%)	$13,900
				Engineering Design (15%)	$69,300
				PROJECT TOTAL	**$545,000**

This statement was prepared utilizing standard cost estimate practices. It is understood and agreed that this is an estimate only, and that Engineer shall not be held liable to Owner or third party for any failure to accurately estimate the cost of the project, or any part thereof. Unit prices are in current dollars and should be adjusted as required when letting schedule for project is determined.

Project: Bastrop Co. Flood Protection Planning
Stream: Alum Creek Tributary 1
Crossing: AC_T1_STR_100 on Gotier Trace

HALFF

Engineer's Estimate of Probable Construction Cost
Date: June 8, 2020

PAY ITEM	DESCRIPTION	UNITS	UNIT PRICE	QTY	TOTALS
0100 6002	PREPARING ROW	STA	$2,790	3	$8,398
0110 6001	EXCAVATION (ROADWAY)	CY	$20	168	$3,362
0110 6002	EXCAVATION (CHANNEL)	CY	$20	463	$9,269
0132 6006	EMBANKMENT (DENSITY, TYPE C)	CY	$35	190	$6,633
0161 6017	COMPOST MANUF TOPSOIL (BOS) (4") AND SEEDING	SY	$15	669	$10,033
0400 6006	CUT & RESTORING PAVEMENT (base and HMAC)	SY	$151	870	$130,999
0402 6001	TRENCH EXCAVATION PROTECTION	LF	$29	34	$992
0432 6033	RIPRAP (STONE PROTECTION)(D_{50}=18 IN)	CY	$114	89	$10,158
0462 6041	CONC BOX CULV (12 FT X 6 FT)	LF	$950	80	$76,000
04676060	SET (TY I)(S=10 FT)(HW=7FT)(3:1)(C)	EA	$11,000	2	$22,000
0496 6006	REMOV STR (HEADWALL)	EA	$2,000	2	$4,000
0496 6007	REMOV STR (PIPE)	LF	$31	26	$810
0500 6001	MOBILIZATION (10%)	LS	$31,100	1	$31,100
0502 6001	BARRICADES, SIGNS AND TRAFFIC HANDLING	MO	$4,500	3	$13,500
0506 6002	EROSION CONTROL	LS	$14,800	1	$14,800
				PROJECT SUBTOTAL	**$342,100**
				30% CONTINGENCY	$102,700
				BASE TOTAL	$444,800
				Environmental Permitting (5%)	$22,300
				Engineering Design (15%)	$66,800
				PROJECT TOTAL	**$533,900**

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Project: Bastrop Co. Flood Protection Planning
Stream: Alum Creek Tributary 11
Crossing: AC_T11_STR_100 on Cardinal Dr.

Engineer's Estimate of Probable Construction Cost
Date: June 8, 2020

PAY ITEM	DESCRIPTION	UNITS	UNIT PRICE	QTY	TOTALS
0100 6002	PREPARING ROW	STA	$2,800	4	$11,200
0110 6001	EXCAVATION (ROADWAY)	CY	$20	213	$4,267
0132 6006	EMBANKMENT (DENSITY, TYPE C)	CY	$35	320	$11,200
0161 6017	COMPOST MANUF TOPSOIL (BOS) (4") AND SEEDING	SY	$15	800	$12,000
0400 6006	CUT & RESTORING PAVEMENT (base and HMAC)	SY	$155	960	$148,800
0402 6001	TRENCH EXCAVATION PROTECTION	LF	$30	120	$3,600
0432 6033	RIPRAP (STONE PROTECTION)(D_{50}=18 IN)	CY	$115	222	$25,556
0462 6017	CONC BOX CULV (7 FT X 6 FT)	LF	$705	200	$141,000
0467 6256	SET (TY I)(S= 7 FT)(HW= 7 FT)(3:1) (C)	EA	$13,500	2	$27,000
0496 6006	REMOV STR (HEADWALL)	EA	$2,000	2	$4,000
0496 6007	REMOV STR (PIPE)	LF	$35	104	$3,640
0500 6001	MOBILIZATION (10%)	LS	$42,600	1	$42,600
0502 6001	BARRICADES, SIGNS AND TRAFFIC HANDLING	MO	$4,500	3	$13,500
0506 6002	EROSION CONTROL	LS	$20,300	1	$20,300
				PROJECT SUBTOTAL	**$468,700**
				30% CONTINGENCY	$140,700
				BASE TOTAL	$609,400
				Environmental Permitting (3%)	$18,300
				Engineering Design (15%)	$91,500
				PROJECT TOTAL	**$719,200**

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Project: Bastrop Co. Flood Protection Planning
Stream: Alum Creek Tributary 87
Crossing: AC_UN_STR_400 on Cardinal Dr.

Engineer's Estimate of Probable Construction Cost
Date: June 8, 2020

PAY ITEM	DESCRIPTION	UNITS	UNIT PRICE	QTY	TOTALS
0100 6002	PREPARING ROW	STA	$2,800	2	$5,600
0110 6001	EXCAVATION (ROADWAY)	CY	$20	33	$652
0132 6006	EMBANKMENT (DENSITY, TYPE C)	CY	$35	77	$2,696
0161 6017	COMPOST MANUF TOPSOIL (BOS) (4") AND SEEDING	SY	$15	231	$3,467
0400 6006	CUT & RESTORING PAVEMENT (base and HMAC)	SY	$151	277	$41,780
0402 6001	TRENCH EXCAVATION PROTECTION	LF	$29	60	$1,750
0432 6033	RIPRAP (STONE PROTECTION)(D_{50}=18 IN)	CY	$115	133	$15,333
0462 6021	CONC BOX CULV (8 FT X 6 FT)	LF	$700	120	$84,000
0467 6283	SET (TY I)(S= 8 FT)(HW= 7 FT)(3:1) (C)	EA	$12,000	2	$24,000
0496 6006	REMOV STR (HEADWALL)	EA	$2,000	2	$4,000
0496 6007	REMOV STR (PIPE)	LF	$35	52	$1,820
0500 6001	MOBILIZATION (10%)	LS	$20,800	1	$20,800
0502 6001	BARRICADES, SIGNS AND TRAFFIC HANDLING	MO	$4,500	3	$13,500
0506 6002	EROSION CONTROL	LS	$9,900	1	$9,900
				PROJECT SUBTOTAL	**$229,300**
				30% CONTINGENCY	$68,800
				BASE TOTAL	$298,100
				Environmental Permitting (3%)	$9,000
				Engineering Design (15%)	$44,800
				PROJECT TOTAL	**$351,900**

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Project: Bastrop Co. Flood Protection Planning
Stream: Alum Creek Tributary 8
Crossing: AC_T8_STR_300 on Ponderosa Loop

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Engineer's Estimate of Probable Construction Cost
Date: June 8, 2020

PAY ITEM	DESCRIPTION	UNITS	UNIT PRICE	QTY	TOTALS
0100 6002	PREPARING ROW	STA	$2,800	2	$5,376
0110 6001	EXCAVATION (ROADWAY)	CY	$20	60	$1,194
0132 6006	EMBANKMENT (DENSITY, TYPE C)	CY	$35	185	$6,471
0161 6017	COMPOST MANUF TOPSOIL (BOS) (4") AND SEEDING	SY	$15	427	$6,400
0400 6006	CUT & RESTORING PAVEMENT (base and HMAC)	SY	$151	555	$83,561
0402 6001	TRENCH EXCAVATION PROTECTION	LF	$29	130	$3,792
0432 6033	RIPRAP (STONE PROTECTION)(D_{50}=18 IN)	CY	$115	133	$15,333
04626020	CONC BOX CULV (8 FT X 5 FT)	LF	$625	120	$75,000
0467 6279	SET (TY I)(S= 8 FT)(HW= 6 FT)(3:1) (C)	EA	$13,000	2	$26,000
0496 6006	REMOV STR (HEADWALL)	EA	$2,000	2	$4,000
0496 6007	REMOV STR (PIPE)	LF	$31	78	$2,430
0500 6001	MOBILIZATION (10%)	LS	$25,500	1	$25,500
0502 6001	BARRICADES, SIGNS AND TRAFFIC HANDLING	MO	$4,500	3	$13,500
0506 6002	EROSION CONTROL	LS	$12,200	1	$12,200
				PROJECT SUBTOTAL	**$280,800**
				30% CONTINGENCY	$84,300
				BASE TOTAL	$365,100
				Environmental Permitting (3%)	$11,000
				Engineering Design (15%)	$54,800
				PROJECT TOTAL	**$430,900**

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Project: Bastrop Co. Flood Protection Planning
Stream: Alum Creek
Alternative: Regional Detention Facility

Engineer's Estimate of Probable Construction Cost
Date: June 8, 2020

PAY ITEM	DESCRIPTION	UNITS	UNIT PRICE	QTY	TOTALS
1	MOBILIZATION (10%)	LS	$267,700	1	$267,700
2	PREPARING ROW	AC	$15,000	5	$76,102
3	EXCAVATION	CY	$20	33,056	$661,111
4	EMBANKMENT	CY	$35	30,000	$1,050,000
5	TOPSOIL AND SEEDING	SY	$12	7,688	$92,253
6	CARE OF WATER	MO	$10,000	12	$120,000
7	SLURRY TRENCH WALL (SEEPAGE CONTROL)	SF	$20	25,500	$510,000
8	OUTFALL STRUCTURE	LS	$50,000	1	$50,000
9	HOUSTON TOAD MONITORING	LS	$40,000	1	$40,000
10	EROSION CONTROL (3%)	LF	$78,000	1	$78,000
				PROJECT SUBTOTAL	**$2,945,200**
				30% CONTINGENCY	$883,600
				BASE TOTAL	$3,828,800
				Environmental Permitting (3%)	$114,900
				Engineering Design (15%)	$574,400
				PROJECT TOTAL	**$4,518,100**

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