TECHNICAL MEMORANDUM

Shoal Creek Conservancy
Shoal Creek Debris and Sediment Inventory
15th Street to Lady Bird Lake
Project Summary

Project No.: 3151-001-01

Date: October 11, 2016

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In July, 2016, the Shoal Creek Conservancy (SCC) contracted with Alan Plummer Associates, Inc. (APAI) to assess the flood reduction benefits of removing debris, sediment, gravel, and in-creek vegetation in Shoal Creek from 15th Street downstream to Lady Bird Lake. The study area is about 7,000 feet in length, includes multiple bridges and the outfall into the Lake.

The scope of the study includes four tasks.

1. Perform field review with City and SCC staff to assess sediment and debris areas. The task includes taking measurements to illustrate the sediment deposition where it was noted in the creek to be included in the floodplain model.

2. Perform floodplain modeling to assess the benefits of sediment/debris management. The City of Austin FEMA Floodplain Model, 2016 was used to compare water surface elevations.

3. Prepare a technical memorandum summarizing study findings.

4. Meet with City staff and the SCC Board/stakeholders to share findings.

FIELD REVIEW

On July 13, 2016, a field review was performed with City and SCC staff, beginning upstream of 15th Street and continuing downstream to West Avenue. Downstream of West Avenue, the Shoal Creek stream slope becomes much steeper and flows across a rock outcrop before discharging to Lady Bird Lake. In this steep slope area, little evidence of sedimentation was noted and upstream floodplain benefits are not anticipated due to the bridge constriction at West Avenue that increases flood levels. This is evident in the FEMA floodplain profile.

The focus of the field work was on the bridges that contained deposition within or near the structures and in the channel upstream of 5th Street and downstream of Lamar Boulevard. Measurements were taken to define the approximate depth and area of deposition above the "normal" channel bottom. Please see the photographs and the Creek Walk Summary in the Appendix.

FLOODPLAIN MODELING

APAI obtained the latest Shoal Creek floodplain models from the City of Austin. These models are the basis of the 2016 Federal Emergency Management Agency (FEMA) Flood Maps, thus, the model is up-to-date and was correlated with a complex two-dimensional model to define floodplain boundaries on Shoal Creek.

Using the creek data obtained from the field review, APAI modified the cross sections in the floodplain model to reflect the current sediment and gravel bars within the creek. It was noted from the field measurements that the floodplain model cross sections are similar in area to observations in the field. This can indicate that the current effective FEMA floodplain model includes input data that resembles the typical sediment/debris accumulation in the creek. Key areas of identified sedimentation were at:

- Lamar Boulevard bridge and downstream of Lamar
- 12th Street bridge
- 10th Street bridge
- East channel bank upstream of 9th Street
- 6th Street bridge
- 5th Street bridge
- West Avenue (channel under construction)

APAI obtained the 1997 Shoal Creek Erosion Inventory and compared photographs from that study to the current channel conditions observed in the field in the summer of 2016. Study photographs from 5th Street to Lamar Boulevard are included in the Appendix. It was noted that sediment deposition from that time period is consistent with field findings in July, 2016. This includes the bridges, between 9th and 10th Streets, and downstream of Lamar Boulevard. One observed difference from 1997 is that there are currently more and larger trees on the creek bank and in the floodplain (outside the channel) from 5th Street to 12th Street. This study did not evaluate creek-bank and out of channel tree clearing as a means to reduce floodplain levels and is further discussed below and in the Appendix.

A floodplain model run was conducted with the measured sediment data to define a “revised floodplain elevation” based on the current channel conditions. Reviewing the range of studied storms, from the 2-year to the 100-year events, the revised floodplain model indicated that floodplain elevations were about one to three inches higher than the base model at several locations. Floodplain depths range from 12 feet to 25 feet based on the storm event and location in the creek.

A second floodplain model was created by performing a “sediment management” practice of removing the gravel bars and associated small vegetation from affected cross sections and bridges. In this effort, APAI modified the cross-section geometry to model the anticipated creek shape in the event of an ongoing sediment management program. APAI did not model clearing vegetation from the creek bank as there are a considerable number of mature trees and other established vegetation that maintain creek bank integrity. Removal of this vegetation would likely generate significant creek bank erosion challenges and could threaten existing buildings and infrastructure near the creek. Please see the example in the Appendix that illustrates the sediment management approach.

Review of the sediment management floodplain model found that the maximum floodplain reduction occurred at Lamar Boulevard for the 10-year flood. The floodplain reduction was modeled to be 0.44 feet. Thus, the floodplain depth reduced from 15.6 feet to 15.16 feet, or about a 5 inch reduction. This led to a 10-year floodplain width reduction of about 52 feet which occurred primarily in the parking lot south of the House Park Stadium as this is the lower side of the creek. For the 100-year storm at this location, the floodplain width was reduced by about 2.5 feet. Other bridges in the study experienced floodplain width reductions ranging from 0 to 25 feet based on water surface elevation decreases on the order of 3 inches or less. For comparison purposes, typical floodplain management projects can reduce flood depths on the order of several feet or more to generate measureable benefits to improve road safety and eliminate flooding from building and residences for the selected design storm (e.g. 100-year).

In general, it has been noted in streams during smaller flow events that there is the potential for deposition around bridges and obstructions. However, high flow events are anticipated to produce scour that degrades the bottom during the peak of the storm. When the flood waters recede, the mobilized gravel and sediment can settle along the stream bed. Thus, creeks and rivers are a dynamic system that can experience significant change during floods and the deposited sediment after a flood may not reflect channel conditions during the flood.

Water Surface Elevation (WSEL) Change Due to Sediment Management

Creek Station	Road Crossing	Top of Road Elevation +/-	2-Year WSEL Sediment Management	2- Year WSEL Difference (Sed. Mgmt - Revised) (feet)	5-Year WSEL Difference (Sed. Mgmt - Revised) (feet)	10-Year WSEL Difference (Sed. Mgmt - Revised) (feet)	25-Year WSEL Difference (Sed. Mgmt - Revised) (feet)	100-Year WSEL Difference (Sed. Mgmt - Revised) (feet)
7082	N. Lamar Blvd	477.5	473.08	-0.33	-0.25	-0.44	-0.15	-0.32
6876	Downstream of Lamar	N/A	471.33	0.03	-0.17	-0.1	-0.07	-0.09
6815	Downstream of Lamar	N/A	471.2	0.04	-0.28	-0.12	-0.07	-0.08
6405	W 12th St	477.5	470.64	0.08	-0.33	-0.31	-0.04	-0.07
5599	W 10th St	471	468.3	-0.28	-0.06	-0.02	-0.01	-0.01
5357	Between 9th and 10th	N/A	467.42	0	-0.03	0.01	0.01	0
5203	Between 9th and 10th	N/A	467.59	-0.01	-0.02	0	0	0
5036	9th St	469	466.97	0	-0.03	0	0	0
3819	6th St	466.5	462.8	-0.05	-0.1	-0.03	-0.04	0.01
3343	W 5th St	460	461.52	-0.07	-0.13	-0.06	-0.04	0.04
2956	Pedestrian Bridge	469	456.54	-0.05	-0.13	-0.07	-0.07	0.01
2552	West Avenue	457.5	455.83	-0.03	-0.13	-0.07	-0.06	0.03

Floodplain Top Width Change Due to Sediment Management

River Station	Road Crossing	2- Year Topwidth Sediment Management (feet)	2- Year Difference (Sed. Mgmt - Revised) (feet)	5-Year Difference (Sed. Mgmt - Revised) (feet)	10-Year Difference (Sed. Mgmt - Revised) (feet)	25-Year Difference (Sed. Mgmt - Revised) (feet)	100-Year Difference (Sed. Mgmt - Revised) (feet)
7082	N. Lamar Blvd	135.07	-0.08	-30.73	-51.93	-6.09	-2.45
6876	Downstream of Lamar	95.03	0.37	-2.19	-42.07	0	-3.94
6815	Downstream of Lamar	104.79	0.23	-5.19	0	-21.47	-10.77
6405	W 12th St	99.85	0.03	-0.11	-24.69	-8.3	-5.08
5599	W 10th St	407.46	-25.34	-0.42	-0.08	-0.06	-0.04
5357	Between 9th and 10th	405.73	0	-0.16	0.01	0.01	0.01
5203	Between 9th and 10th	504.94	-0.02	-0.1	0	0.01	0.03
5036	9th St	359.96	-0.17	-0.31	0	0	0
3819	6th St	172.23	-2.75	-13.07	-2.78	-1.45	0.31
3343	W 5th St	343.74	-12.61	-4.57	-2.91	-1.72	0.52
2956	Pedestrian Bridge	79.07	0.95	-1.41	-0.36	-0.26	0.04
2552	West Avenue	89.18	-0.09	-11.18	-1.77	-2.15	6.75

FINDINGS

As shown above, the largest reduction in the floodplain elevation occurs during a 10-year storm at Lamar Boulevard. Other floodplain reductions are on the order of 0 to 3 inches. From a review of the flood profile that is included in the Appendix, the existing bridges backup water during all the studied flood events. This “backwater” effect creates a higher water surface elevation at the bridge and extends upstream. Thus, one could excavate large quantities of sediment from the channel but when the water level is controlled, or held higher by downstream constraints, there is limited benefit to sediment removal. As noted in the flood profile in the Appendix, a higher water surface elevation can be viewed upstream of the bridges, this is called the “backwater” generated by the bridge.

Just upstream at 9th Street, the creek channel turns abruptly to the left and then bends to the right to convey flow below the bridge. These sharp meander bends slow down the creek flow which can cause the water surface elevation to increase. When the stream velocity is reduced, the suspended sediment and gravel can sink to the bottom of the creek and often accumulate on the inside of the bend. This is called the point bar and is common in natural streams where the inside portion of the bend accumulates sediment while the outside bend can erode and widen during the natural evolutionary process of rivers and creeks. The Shoal Creek Erosion Inventory of 1997 includes photographs illustrating the deposition on the point bar just upstream of 9th Street. The same point bar can be found today.

There appears to be a steady supply of sand, gravel, and cobble in Shoal Creek and it can be anticipated to continue to move through the channel system. Above Lamar Boulevard, Shoal Creek continues for almost 9 miles to upstream of U.S. Highway 183. The channel continues to erode, and while more stable today than a few decades ago, the natural process, even in undeveloped watersheds is for the continuous movement of bed material down the creek or river system. Potential flood mitigation projects should include design features that continue to convey the bed material through lower Shoal Creek to not induce new sediment deposition.

RECOMMENDATIONS

Due to the slight floodplain reductions (on the order of 0 to 3 inches) at several locations in the study area, the floodplain modeling found that the removal of sediment bars and accompanying vegetation did not provide a consistent and measurable floodplain benefit. Therefore, an ongoing sediment management maintenance plan is not recommended.

Floodplain models do not consider floating debris moving down the stream, thus, when debris snags in trees or in bridges, water surface elevations can rise. While not shown in the modeling effort, to minimize snags and potential localized flood level increases, APAI recommends the removal of several small trees and woody debris at the location noted below.

The Lamar Boulevard Bridge should be closely monitored as debris blockage could significantly increase sediment levels and decrease flow conveyance. At the time of the creek walk, there was large woody debris and several small trees growing on the downstream side of the bridge. The woody debris and small trees should be removed to prevent retention of additional debris during high flow events.

Note woody debris and china berry trees at the bridge pier. Suggest removal.

Between 6th and 9th Street, several small willow trees are growing on the creek bottom and adjacent to the hike and bike trail. These trees should be monitored since as they begin to mature they could retain flood debris. The creek is shaded by trees on both creek banks so limited habitat impacts are anticipated if these trees are removed in the future.

Note the willow trees in the channel just to the right of the trail. Monitor tree growth.

The City of Austin entered into creek maintenance agreements with Austin City Lofts and the Monarch Apartments in the vicinity of 5th Street. While this study did not show significant floodplain reductions with sediment management, this practice should continue until other alternatives are defined to minimize excessive sediment bar growth. The City will continue to coordinate with the owners to ensure sediment removal occurs per the agreement requirements.

During the development of the Preliminary Engineering Report (PER) for the Hike and Bike Trail from 5th Street to 15th Street, we recommend the inclusion of creek maintenance access ramps downstream of Lamar Boulevard to facilitate access if necessary to remove flood debris or other material. The PER should design the trail crossings, stream restoration, and stabilization measures to minimize the retention of sediment, gravel, cobble, and boulders that move through the creek system as bed load during stormwater runoff events. This connects to the design goal of maximizing flow conveyance so that potential trail improvements will not adversely affect flood levels. This includes smooth transitions and low roughness materials to enhance sediment and water movement in Shoal Creek.

The PER should also address the gabion mattress downstream of 9th Street that is damaged and needs to be repaired or replaced. This should be done in conjunction with the potential removal of the existing infrastructure beneath the bridge to ensure future channel stability and that the existing pool below 9th Street remains to serve as riparian habitat during dry weather conditions and provide storm flow velocity dissipation.

Alternatives to continuously dredging sediment and gravel from the creek include floodproofing existing buildings and structures to minimize flood water entrance. FEMA produced a manual titled "Floodproofing Non-Residential Buildings, July 2013" that offers insights into enhanced flood warning and measures such as impermeable walls, shields for doors and windows, valves, pumps, and berms to name a few. These options can provide measurable protection and be permanent in nature depending upon the site or installed by business owners in a relatively short time period. Thus, flood warning works hand-in-hand with floodproofing.

It has been noted that during floods, dumpsters from upland areas can float and eventually become trapped in trees or bridge openings and increase flood levels. Business owners should evaluate their current dumpster locations and consider alternative locations to minimize flotation and movement during high flow events. This could include relocating the dumpsters to higher ground or constructing low flow diversion walls on the upstream side that do not increase flood levels and minimize direct velocity impact that can generate dumpster movement.

The upcoming Shoal Creek Floodplain Mitigation Assessment by the City of Austin will evaluate larger scale projects to significantly reduce flooding along lower Shoal Creek. The Shoal Creek Conservancy and stakeholders should actively participate in this process.

APPENDIX A

Creek Walk Summary (provided by the City of Austin) and photographs

Shoal Creek Conservancy – Creek Walk Summary
On July 13, 2016, City staff met with Shoal Creek Conservancy (SCC) representatives to walk Shoal Creek from Pease Park (15th Street) to 5th Street to discuss areas of concern along the creek, and areas which may be better maintained/managed by the Conservancy. Representatives from the City included staff from Stream Bank Restoration, Policy and Planning, Riparian Habitat Implementation, and Floodplain. This summary is written from a Floodplain Management standpoint.

First and foremost, any potential projects along Shoal Creek must not cause an adverse impact from a flooding standpoint. The City of Austin Land Development Code defines "adverse flooding impact" as an increase in flood risk or hazards. The Drainage Criteria Manual section 1.2.2.A states that "Stormwater runoff peak flow rates for the 2, 10, 25, and 100-year frequency storms shall not cause increased inundation of any building or roadway surface or create any additional adverse flooding impacts." As all attendees are aware, there is significant road and structure flooding in the area which was walked. The SCC has contracted with Alan Plummer Associates (APAI) to analyze whether there are any small scale projects/maintenance activities that could be spearheaded and managed by the SCC which could improve Riparian Habitat and Stream Stability while not causing an adverse impact to flooding potential or even potentially reducing the flood impacts.

From a floodplain standpoint, the areas of concern that may affect flooding potential are as follows:

- Lamar: Sediment underneath the bridge, and large sediment sand bar downstream of the bridge.
- 10th Street: Sediment underneath the bridge.
- 9th Street: The pedestrian trail which passes underneath 9th Street creates a significant blockage; however, the removal of the trail is a larger project than the SCC is capable of undertaking. There is also sediment build up underneath 9th Street, but because of the pedestrian trail crossing, the removal of the sediment is unlikely to reduce the flood depth and sediment is likely to be deposited again in the area during the next storm event that causes significant flow in Shoal Creek. There is a large sediment bar downstream of the gabion mat; however, because there is little vegetation on this bar, it is likely recently placed and may migrate with subsequent storm events.
- 6th Street: Sediment underneath bridge; especially on the right (west) side adjacent to the pedestrian trail, and on the downstream left (east) side culvert.
- 5th Street: Sediment underneath the bridge. This area is currently under a maintenance agreement with the Austin City Lofts to perform sediment abatement activities when the sediment is above the footer bump-out on the bridge piers. Currently, there are some areas which are above this elevation and there are areas which are lower. It is very likely that the sediment, if spread out in this immediate area, would be below the point of requiring maintenance.
- There are a few areas of erosion noted and any projects done to mitigate the erosion will need to be analyzed to ensure no adverse flooding impact. These areas include:
    - Just downstream of Lamar on the left bank

- Just downstream of 10th Street on the right bank (by the 7-11)
- Just upstream of 9th Street on the right bank (by the Shoal Creek Saloon)
- Just downstream of 9th Street on the left bank
- Failing gabion mattresses downstream of 9th Street

Based on the above observations, the SCC should evaluate if removal or leveling of sediment has an identifiable impact on the flooding potential of structures/roadways and, if so, come up with a cost/benefit ratio to maintain the sediment removal/leveling activities before deciding to undertake maintenance of the areas.

From a water quality and riparian health perspective, this stretch of Shoal Creek generally has good cover and distribution of mature riparian vegetation. Bank slopes and flood benches in the channel should be avoided to maintain shade and bank stability. There are a variety of deeper, perennial pools that are important refuge areas for aquatic communities and should be avoided with respect to any channel or active bank work. Any periodic or routine maintenance dealing with sediment or channel form would degrade this system on a scale directly proportional to the area and frequency of the disturbance.

Photographs

Lamar Bridge

Channel downstream of Lamar

12th Street Bridge, East Span

10th Street Bridge, looking upstream

Downstream of 10th Street – West bank

Bank erosion at the Shoal Creek Saloon

Looking upstream from the 9th Street Bridge

Downstream of 9th Street – Damaged gabion mattress

Looking upstream towards 9th Street, note line of willow trees in the channel

6th Street Bridge, downstream side

5th Street Bridge, east span, looking downstream

Looking upstream at 5th Street

APPENDIX B

Shoal Creek, City-wide Erosion Assessments, 1997. Creek Photos

HECRAS Model Cross Section Location Map

Example Cross Section Highlighting Model Sediment Management

Shoal Creek Floodplain Profile, FEMA, 2016

Photo 15. Looking U/S at West 5th Street; island forming in channel and bridge; aggrading section.

Photo 16. Structure just U/S of 6th Street on right bank with exposed columns.

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Photo 17. Washout behind hike & bike trail on left bank 200 feet U/S of 6th Street bridge looking D/S; notice crib wall across creek on outside of bend.

Photo 18. Approximately 200 feet D/S of West 9th Street; right bank with exposed roots; alluvial layers.

SHOAL CREEK

CITY WIDE WATERSHED EROSION ASSESSMENTS
CITY OF AUSTIN
TRAVIS COUNTY, TEXAS

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SHEET 9	DATE: March, 1997	JOB : 225

Photo 19. Gabion mattress in channel bed looking D/S from 9th Street bridge.

Photo 20. Looking U/S at 10th Street bridge; bankfull section 3-A.

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SHEET 10	DATE: March, 1997	JOB : 225

Photo 21. Point bar with avalanche face looking U/S from 9th Street.

Photo 22. New gabions along west bank looking U/S from 10th Street bridge.

SHOAL CREEK

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SHEET 11	DATE: March, 1997	JOB : 225

Photo 23. Looking U/S at 12th Street bridge.

Photo 24. Left bank just downstream of Lamar Boulevard; type 2 erosion problem.

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Photo 25. Photo looking U/S at Lamar Boulevard during small storm event; aggradation at Lamar bridge.

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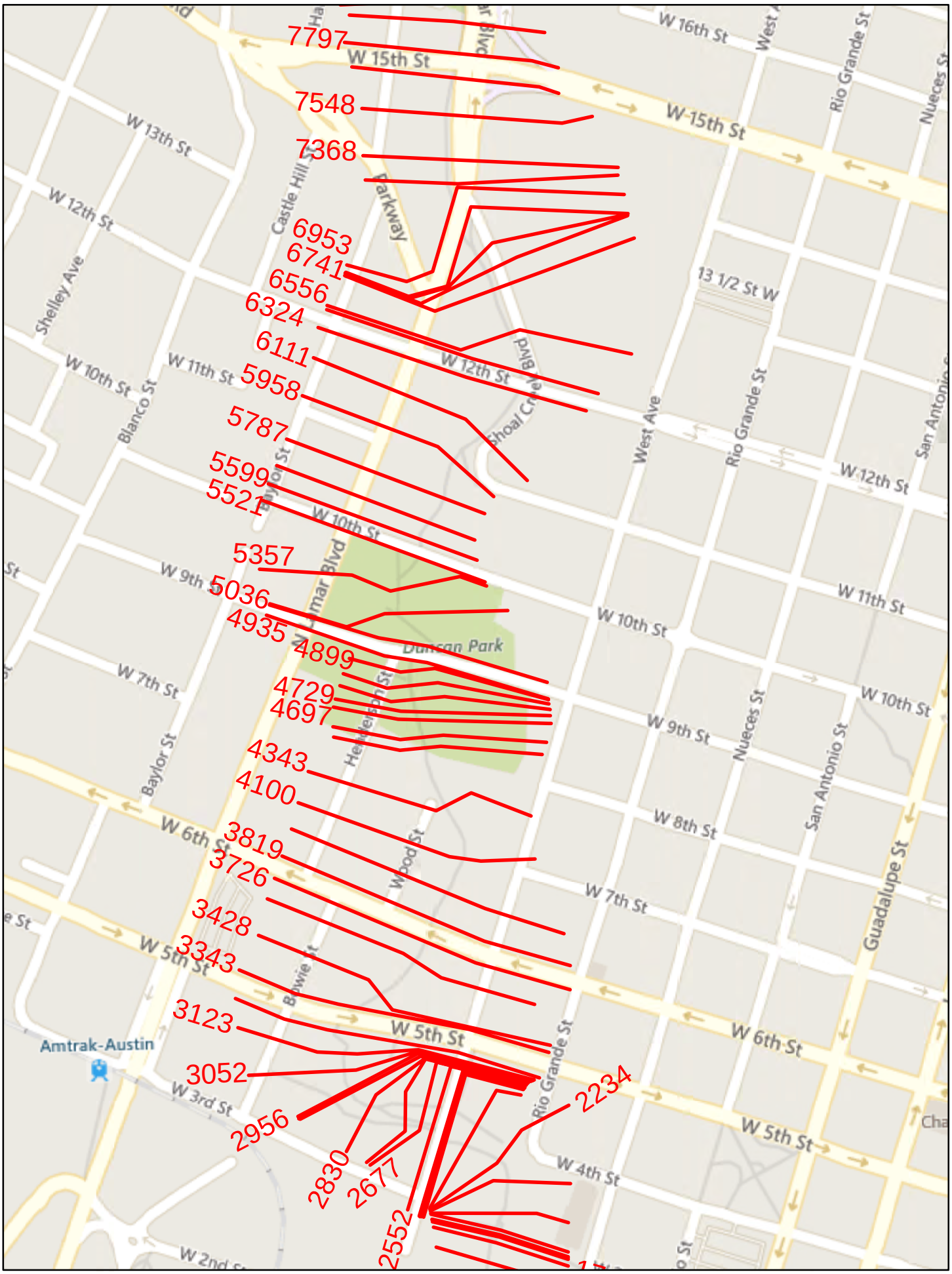
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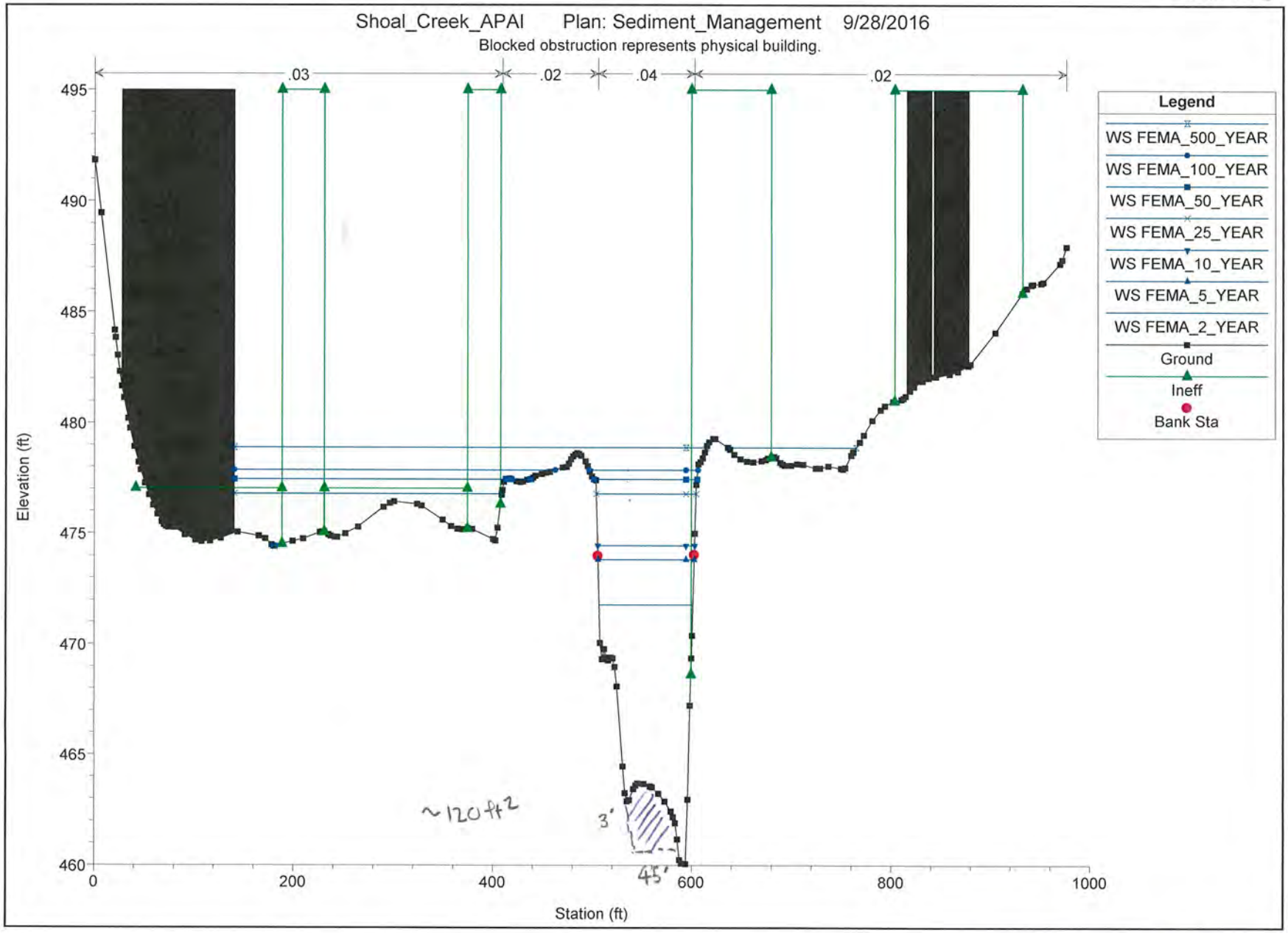
SECTION 6453

"EXISTING CHANNEL"



Downstream of Lamar Blvd

SECTION 6953

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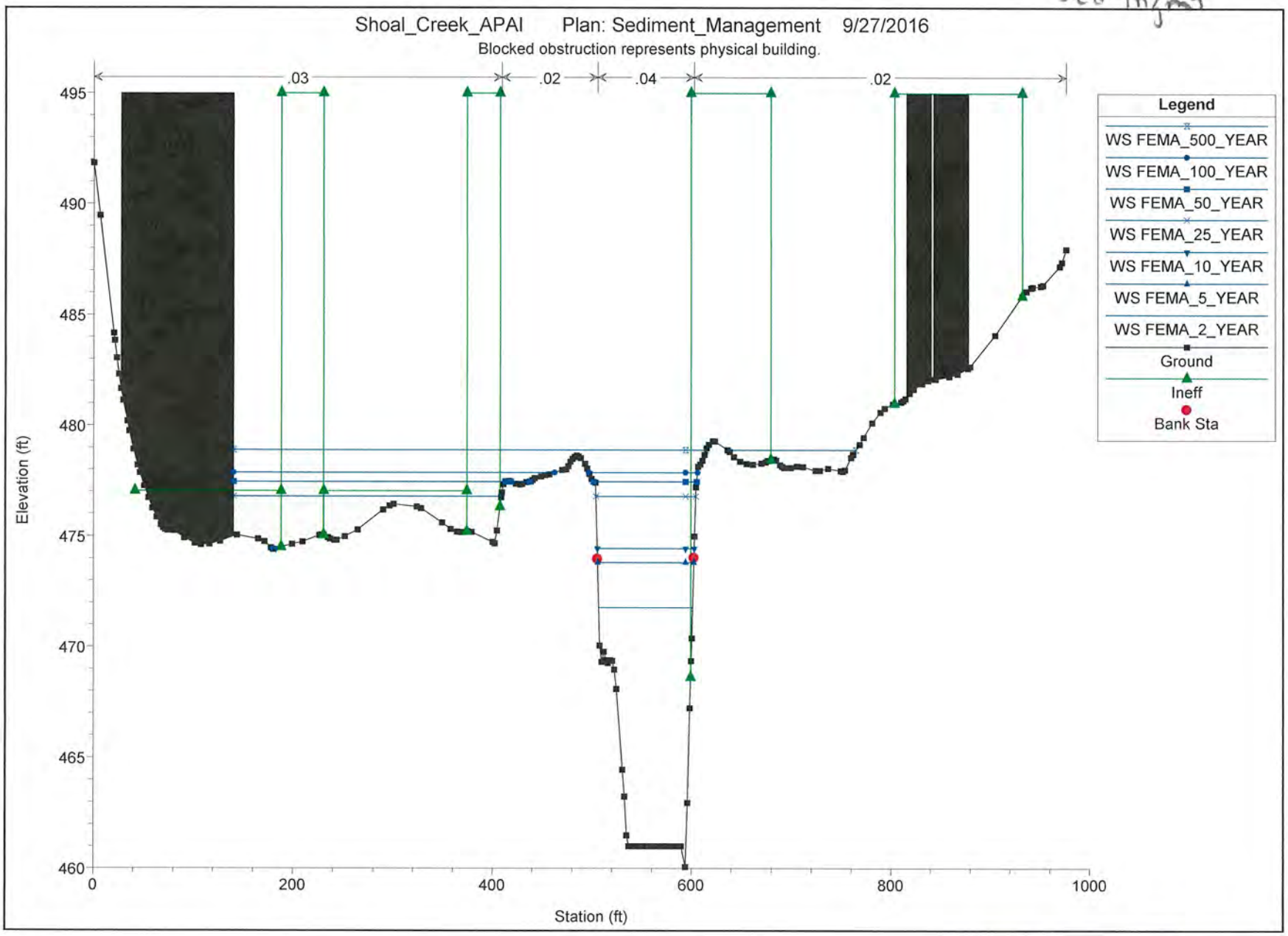

Downstream of Lamar Blvd

SECTION 7082

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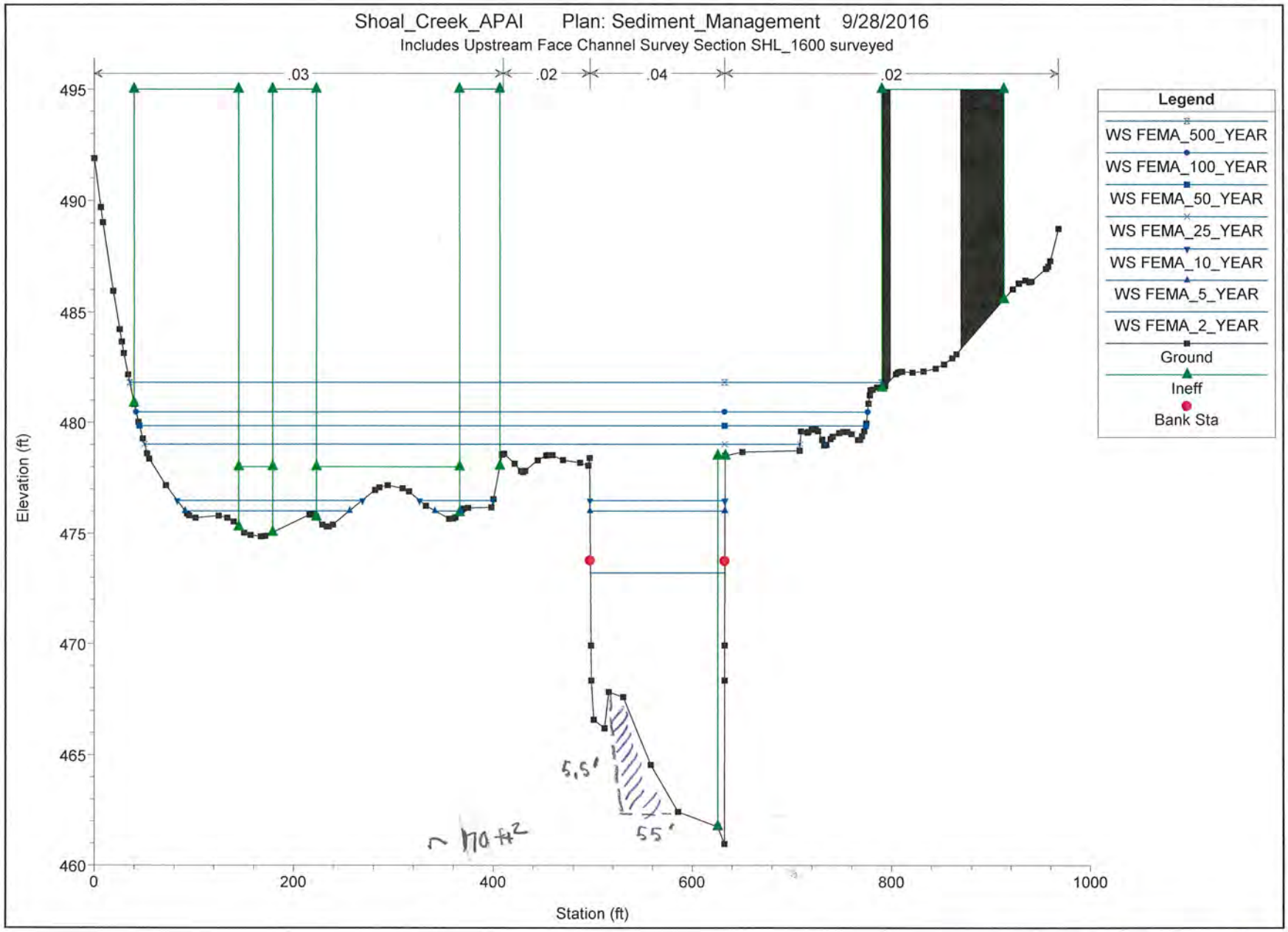

Upstream of Lamar Blvd

SECTION 7082

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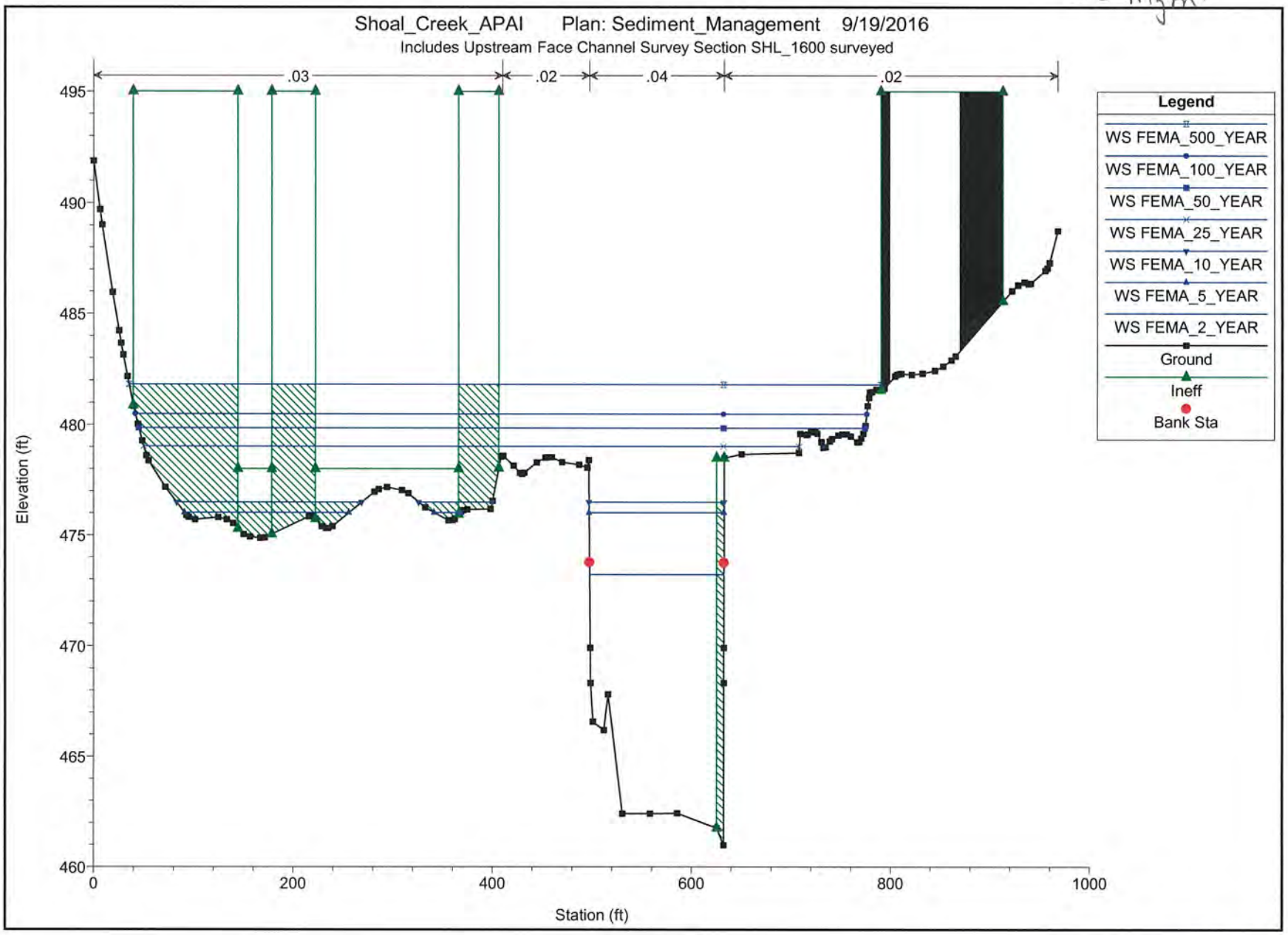

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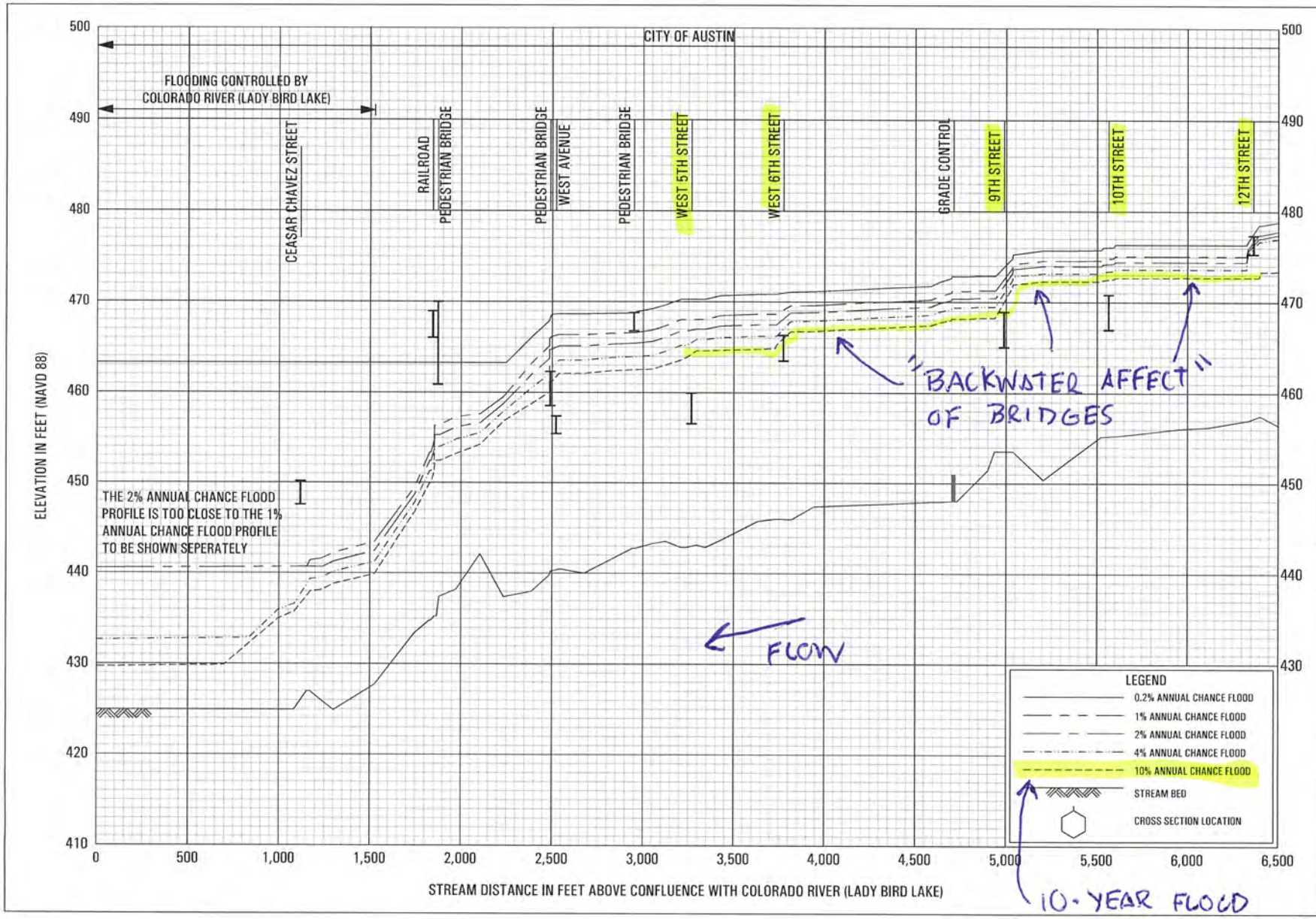

FLOOD PROFILES

SHOAL CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TRAVIS COUNTY, TX

AND INCORPORATED AREAS

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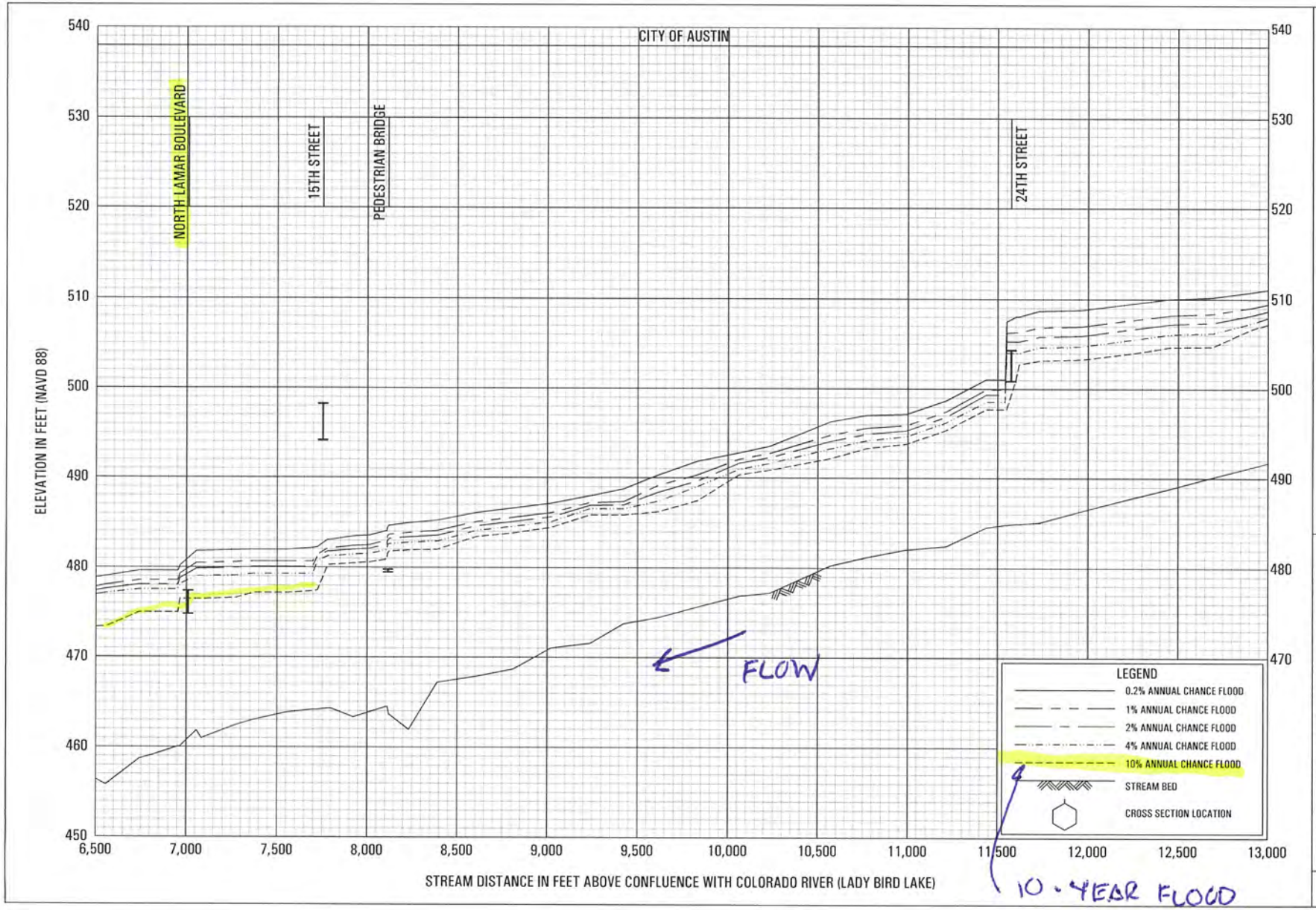
FLOOD PROFILE



FLOOD PROFILES

SHOAL CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TRAVIS COUNTY, TX

AND INCORPORATED AREAS

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FLOOD PROFILE