BARTON SPRINGS ROAD BRIDGE OVER BARTON CREEK

BRIDGE CONCEPT ENGINEERING REPORT

OCTOBER 2023

CIP ID #5873.031

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OVER BARTON CREEK PROJECT

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AUSTIN, TEXAS
OCTOBER 2023

PREPARED FOR
The City of Austin

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Executive Summary

This report summarizes the logistical process and technical findings related to the recommendation of the preferred bridge alternative for the new Barton Springs Road Bridge over Barton Creek in Austin, Texas.

The purpose and need for this project is centered on safety-related bridge improvements that address existing conditions such as the age of the existing bridge structure and structural deterioration, as well as insufficient bike/pedestrian paths. The body of this report discusses the inputs and outcomes related to the bridge decision making process.

The original project scope included consideration of two bridge rehabilitation options and three options for bridge replacement. The bridge alternatives were developed and then evaluated as a result of the collaboration of key City departmental stakeholders through a series of meetings. The outcome of this process was the recommended Bridge Replacement Option 3 - a replacement bridge consisting of a three-span concrete girder structure supported by two lines of custom "Y" Piers which flank the center channel of Barton Creek. Figures E-1 and E-2 are renderings of the recommended bridge option from different vantage points.

Figure ES-1. Bridge Rendering View Looking North

Figure ES-2. Bridge Rendering View North and East Under Bridge

As part of the project, a combination in-person and virtual public open house was held in April 2023 and solicited public feedback on the proposed design alternatives. Public sentiment was mixed and varied from making no changes, to voicing favor for both rehabilitation and replacement alternatives.

The recommended design limits in-water obstructions for users while maximizing the views through and under the bridge. The bridge piers are oriented transversely to the structure which helps to create the greatest sense of openness when viewed from Barton Creek below. The western abutment for the bridge has been relocated to the west. This is important on the park side of the bridge because it increases the amount of usable space underneath the bridge and along the creek, accommodating new multi-use paths and the Zilker Eagle train.

The pedestrian and bicycle accommodations on the deck of the bridge are significantly enhanced from the existing condition. The new bridge will have very wide sidewalks and mixed-use paths on either side that can accommodate the significant crowds during key park events. The project will reconnect bike and pedestrian facilities to connect to existing Zilker Park facilities.

The Barton Springs Rd./Azie Morton Rd. intersection will be revised to accommodate the additional Azie Morton right-turn lane, as well as the revised roadway and bike lane layouts. The existing Umlauf Garden retaining wall at Azie Morton Rd will be replaced, addressing the hillside instability adjacent to Umlauf Gardens.

Utilities in the immediate vicinity of the bridge and intersection will be either replaced, relocated, or potentially upsized/improved during the construction.

Preliminary project cost estimates were prepared. The overall preliminary project cost estimate is $36,660,000.

1 Project Summary

1.1 Background

The City of Austin is evaluating design for rehabilitation or replacement of the Barton Springs Road Bridge over Barton Creek. The location of the bridge, at the entrance to Zilker Park, is a focal point of key community events such as the Austin City Limits Music Festival, South by Southwest Conference and Music Festival (SXSW), Barton Springs, Trail of Lights, and Blues on the Green. Barton Creek and nearby Barton Springs are key community locations and focal points of environmental and social sensitivity within the context of many events. Barton Springs Rd. and the associated bridge is also a key connection for vehicular, bike, and pedestrian access linking Mopac to downtown and the South Lamar/Congress corridors, as well as providing the primary northern entrance to the Zilker and Barton Hills neighborhoods via Azie Morton Rd., located immediately east of the bridge.

The three-span open spandrel concrete arch bridge was originally built in 1925 and was expanded to the north in 1946. The current bridge is 212' long and 58'-8" wide. The age of the structure has warranted progressively more detailed inspection and condition assessments over time. In addition, the bridge geometry is functionally obsolete with respect to bikes and pedestrians, and the roadway west of Azie Morton is un-aligned with the roadway east of Azie Morton. The City's preliminary bridge deck concept approximately doubles the width of the bridge deck to accommodate wider sidewalks on either side of the bridge, two bicycle lanes, four travel lanes, and a median to match the cross section of Barton Springs Road established by a previous reconstruction of that roadway east of Azie Morton.

The bridge is currently a bottleneck, with congestion for all modes of travel at the Barton Springs Road/Azie Morton intersection. The proximity of the bridge and Azie Morton intersection (including structural cantilevered sidewalk) specifies the two features are integral to one another. For that reason, in addition to the evaluation of the bridge structure, the City is interested in understanding the potential for reducing congestion at this intersection and entrance to Zilker Park via assessment of potential improvements to the combination of roadway, bridge, and intersection. Reducing congestion will provide future benefits to the local neighborhoods, commuters (all travel modes), local businesses, as well as Zilker Park users and event attendees.

1.2 Project Objectives

The purpose and need for this project is centered on safety-related bridge improvements that address the following items:

- Age of structure/structural deterioration;
- Insufficient bike/pedestrian paths (functionally obsolete);
- Bridge roadway lanes not aligned with lanes east of Azie Morton;
- Hillside instability (rock fall) and obsolete retaining wall on Azie Morton east side of intersection;
- Elevated/overhanging sidewalk integral to intersection – past movement/cracking; and
- Bridge/intersection congestion.

In addition to the project objectives, the bridge alternatives needed to provide the following performance features:

- Four (4) traffic lanes, per the historic bridge layout.
- Roadway geometry and alignment improvements.
- Intersection improvements to decrease traffic delays.
- Two (2) new, dedicated bike lanes.
- Two (2) pedestrian sidewalks, with significant width increases beyond the existing.
- Varying bridge configurations that cross Barton Creek.
- Provisions for maintaining and/or improving the various existing modes of travel from the existing sidewalks, pathways, and hike/bike trails adjacent to and under the bridge.
- A 75-year design life.
- Context-sensitive aesthetic design solutions sympathetic to stakeholder guidance and input.

1.3 Description of the Bridge Project Process

The overall process for the Barton Springs Rd. Bridge project will follow the general phases listed below:

- Preliminary Selection and Concept Engineering. This phase assesses the feasibility of bridge rehabilitation or replacement. The evaluations will consist of assessments such as bridge structural engineering, architectural, roadway, and bike/ped mobility, as well as environmental feasibility. These options will be developed and analyzed, and the evaluations vetted by City of Austin stakeholder departments and management. Public involvement will be conducted. The result of the Preliminary Selection phase will be a vetted/recommended bridge design option; this phase will be documented in this Bridge Concept Engineering Report (BCER). The approved/confirmed design option will then proceed to the design phase.

- Preliminary (30%) Design. This phase consists of the 30% Design and the Preliminary Engineering Report. The primary outcomes of this phase include obtaining detailed design information from onsite topographic and bathymetric surveying, engineering field investigations, and environmental field investigations. This detailed information will allow for preliminary engineering of the total project, including bridge, roadway, retaining walls, utilities, and remaining wall work within the identified limits of construction. It will also allow for early coordination with federal, state, and local permitting agencies to vet the design and determine the available strategies for obtaining permits/approvals of the design to support later construction efforts.
- Final Design and Permitting. Includes detailed design for all disciplines, and obtaining permits and approvals from all federal, state, and City agencies and departments.

  Within this phase, detailed design calculations, drawings, specifications (instructions to contractors on materials, testing, and performance requirements), and estimated construction costs are developed and submitted to the City for review and vetting. The design is submitted and vetted in the 60%, 90%, and 100 phases.

  During each of these phases various design disciplines develop the details of their respective designs, as well as coordinate between designs for the overall project objectives. Some of the design disciplines include bridge/structural; retaining walls; roadway/traffic engineering; signalization/signage/pavement marking; drainage and water quality; environmental and landscape disciplines for tree and overall environmental protection; and utility design for relocation or replacement of existing utilities in conflict with construction. All the work will undergo permit applications and related discussions with agencies for the various permits and approvals that are anticipated and that are discussed later in this report.
- Bidding and Construction. This phase includes soliciting and obtaining bids from construction contractors; reviewing and recommending the bids for approval; and City approval of the bids for contracting. This phase will then include City contracting with the construction contractor; and then managing the construction process to completion.

1.4 Project and Report Scope

The original project scope for the concept phase included consideration of two potential bridge rehabilitation options and three options for bridge replacement. A general description of these options is:

- Rehabilitation Option 1: This option has a focus to rehabilitate but preserve the existing structure. This option includes consideration of a retrofit bridge railing system to upgrade the substandard existing railings. This option also includes consideration and

feasibility of a complementary structure or other means to adequately address additional capacity desired for bike and pedestrian traffic on both sides of the bridge.

- Rehabilitation Option 2: This option focuses on rehabilitating the existing structure and enhancing the deck by widening it to incorporate wider sidewalks and a bike lane on both sides. The deck would either be placed on the existing substructure or a widened, expanded substructure, as necessary.
- Replacement Options: Three options were originally set aside to address complete reconstruction of the bridge, to be designed to modern structural codes and to include a wider bridge deck to allow for realigning the Barton Springs Road intersection for improved safety, bike lanes on both sides, and wider ADA compliant sidewalks. As the project developed, the following three replacement options were identified:
  - Replacement Option 1 – Single Span Concrete Arch, generally spanning the entire creek.
  - Replacement Option 2 – Two-Span structure with piers located in centerline of Barton Creek.
  - Replacement Option 3 – Three-Span structure with piers located in the general vicinity of the current/existing bridge piers.

This report summarizes the development and evaluation of the above bridge alternatives. It includes the design work and the input and outcomes of the decision-making processes resulting in the conceptual development of a recommended bridge option.

2 Project Area

The Barton Springs Road bridge project is located where Barton Springs Road crosses over Barton Creek. The limits of the project are shown in Figure 2-1, and include the bridge over Barton Creek, the transitional roadway from the bridge west into Zilker Park at Lou Neff Road, the Azie Morton/Barton Springs intersection, and the transitional roadway and sidewalks along Azie Morton immediately south of the intersection.

Figure 2-1. Project Limits

3 Existing Conditions

3.1 Bridge Cultural/Historical Conditions

The original Barton Springs Road bridge was built in 1925 and widened to its current configuration in 1945. The bridge is located adjacent to Zilker Park, which is listed in the National Register of Historic Places (NRHP); the bridge is considered a contributing resource to the Park. The Barton Springs Archeological and Historical District (formed in 1985) is also located within the Zilker Historic District and the downstream boundary of this district is in close proximity to the bridge.

It is understood that all planning and design work will also include coordination and discussions with key cultural/historic preservation stakeholders such as the Texas Historic Commission (THC). Appendix A-1 includes the Section 106 Technical Guidance Memo, which was provided early in the project, to identify the level of effort to conduct coordination with agencies. Section 106 refers to Section 106 of the National Historic Preservation Act of 1966 (NHPA), providing guidance to agencies to consider the effects on projects on historic properties.

3.2 Bridge Structural Condition

A detailed bridge inspection was performed in 2016, including an arms-length inspection of most structural members, via snooper truck. The Bridge Inspection and Condition Assessment Report for Barton Springs Road Bridge (included in Appendix A-2) was submitted in January 2017. The condition assessment report indicated that the overall bridge was in fair condition; however, the deck (with integral longitudinal joint), floor beams, and spandrel columns had exhibited the most degradation, although all structural components had exhibited degradation.

Figure 3-1. Deterioration of Longitudinal Beam

As a result, any rehabilitation desiring increased service life would need to remove the deck, floor beams, and spandrel columns, essentially stripping the structure down to the arch ribs as a starting point. As indicated in the report, these results, by definition, removed the original Rehabilitation Option 1 (as described in Section 1.2) as a feasible alternative, since the intent of that option was a "low-impact", "preserve-structure" rehabilitation option from visual, construction, and cost standpoints. Based on the above, the team focused on Rehabilitation Option 2 and on potential bridge replacement options moving forward.

3.2.1 Traffic Conditions

A Traffic study and memo was submitted in January 2018 (Appendix A-3). Traffic counts and modeling were conducted to analyze existing levels of service and to perform an intersection analysis to reduce congestion and delays in the intersection. This was done to help guide decisions on how to treat the Azie Morton/Barton Springs intersection; due to the proximity of the intersection to the bridge, the intersection and bridge concepts needed to be treated together.

The traffic study recommended adding a right turn lane from Barton Springs Rd. to Azie Morton and another right turn lane from Azie Morton to Barton Springs Rd. This was vetted with ATD in 2017-18 and incorporated into the conceptual plans at that time.

3.2.2 Preliminary Environmental Conditions

A conceptual boundary of the limits of the project area impacts were developed and used to identify proximate environmental resources and considerations. At this stage there was no distinction made between bridge rehabilitation and replacement alternatives since their limits of construction operations are so similar.

Figure 3-2 was developed based on the preliminary findings; this figure shows some of the anticipated environmental constraints in and around the project area. This map or similar maps will be developed and updated as future, more detailed investigations are conducted.

Table 3-1 provides a preliminary list of environmental permits and approvals that have been identified as potentially applicable, and which will be further vetted in the design phase of the project. Further investigations and data collection may show that some of these potential requirements are not applicable.

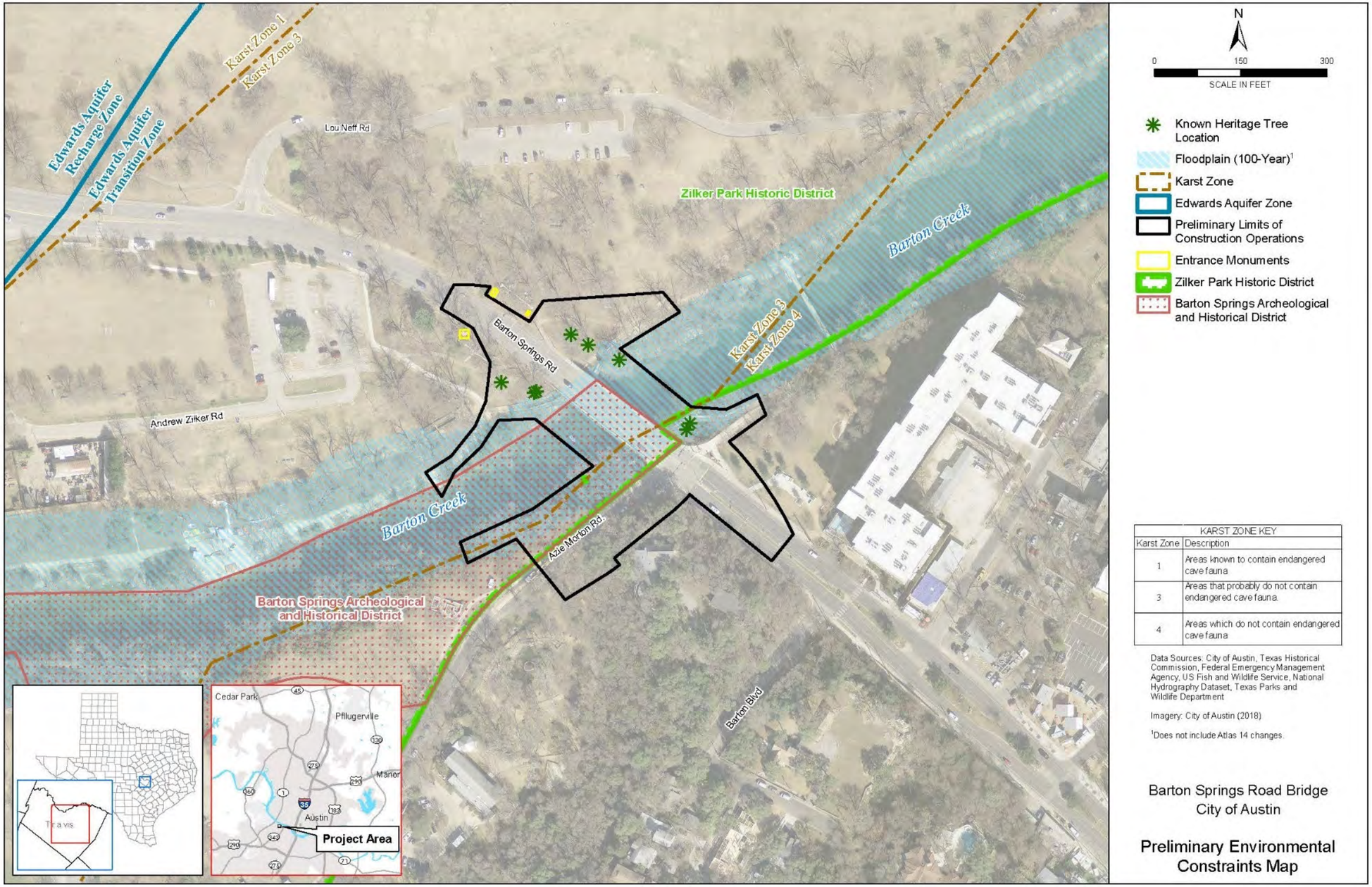

Figure 3-2. Preliminary Environmental Constraints Map

Table 3-1. Preliminary Federal/State/City of Austin Permits and Approvals for the Barton Springs Road Bridge Project

Regulatory Agency	Regulation/Guidance	Permitting Trigger/ Permit Type	Field Surveys and/or Deliverables Requirements
U.S. Army Corps of Engineers (USACE), Fort Worth District	Section 404 of the Clean Water Act (CWA), Section 10 of the Rivers and Harbors Act	Barton Creek is considered a potentially jurisdictional "water of the U.S.;" therefore, is regulated by the USACE. Pre-application meeting held with the USACE Ft. Worth District (SWF-2022-00392 USACE Project Manager Brian Bartels) Per Nationwide Permit (NWP) 14 – Linear Transportation Projects, a Pre-Construction Notification (PCN) to the USACE Fort Worth District is required if: (1) the loss of waters of the U.S. exceeds 1/10-acre; or (2) there is a discharge in a special aquatic site, including wetlands. If permanent impacts to waters of the U.S. are less than 1/10-acre, no wetlands are impacted, and all NWP general conditions are met, than formal notification is not required. An Individual Permit (IP) is required if the loss of waters of the U.S. exceeds 0.50 acre. This project is not anticipated to exceed this impact threshold; therefore, no IP submittal is anticipated.	**Field Survey** – Waters of the U.S. and Wetlands Delineation **Deliverable** – Determination of Potentially Jurisdictional Waters of the U.S. and Wetlands Report – Section 404 of the Clean Water Act Permitting Memo that quantifies impacts to potentially jurisdictional waters of the U.S. from project activities. **As-Needed** – Meetings with the USACE Ft. Worth District to discuss project – Nationwide Permit 14 PCN Application submittal with applicable attachments
Texas Historical Commission (THC)	Section 106 of the National Historic Preservation Act of 1966, Antiquities Code of Texas	The Barton Springs Road Bridge is a contributing resource to the Zilker Park Historic District, which is listed on the National Register of Historic Places (NRHP); and in proximity to the Barton Springs Archeological and Historic District; therefore, coordination with the THC will be a continuing part of the overall project design/construction process. In addition, compliance is required as part of the Section 404 process. As part of this THC coordination, an intensive cultural resources field survey will be performed in compliance with the Antiquities Code of Texas. And coordination with THC will continue throughout the design process.	**Field Survey** – Intensive Cultural Resources Field Survey **Deliverable** – THC Consultation Letter – Antiquities Permit Application – Cultural Resources Survey and Report

Regulatory Agency	Regulation/Guidance	Permitting Trigger/ Permit Type	Field Surveys and/or Deliverables Requirements
U.S. Fish and Wildlife Service (USFWS)	Federal Endangered Species Act (ESA)	Potential habitat for federally listed threatened or endangered species is identified near the Barton Springs Road Bridge; therefore, coordination with the USFWS will be a part of the overall project design/construction process. In addition, compliance is required as part of the Section 404 process. The USFWS coordination process will be inclusive to all species listed as federal or threatened within Travis County; therefore, field surveys/studies will encompass listed terrestrial, aquatic, and karst invertebrate species.	**Field Survey** – Federal and State Listed Species Survey and Habitat Assessment – Karst Feature Survey (encompassing Karst Zone 3) – Salamander Habitat Assessment **Deliverable** – USFWS Informal Consultation letter – Federal and State Listed Threatened and Endangered Species Assessment Report – As-Needed: – Migratory Bird Nesting Surveys – Federally Listed Aquatic Species/Mussel Surveys – Salamander Presence/Absence Surveys
Texas Parks and Wildlife Department (TPWD)	Chapters 67 (Nongame Species) and 68 (Endangered Species) of the Texas Parks and Wildlife (TPW) Code and Sections 65.171 - 65.176 (Threatened and Endangered Nongame Species) of Title 31 of the Texas Administrative Code (T.A.C.)	TPWD prohibits the take, possession, transportation, or sale of any of the animal species designated by state law as endangered or threatened without the issuance of a permit. As such, due diligence will be performed to determine if state listed threatened or endangered species have the potential to occur within the limits of construction. Field investigations will also be conducted to determine potential presence or absence of preferred habitat types. If needed, coordination with TPWD will be performed during the overall project design/construction process.	**Field Survey** – Federal and State Listed Species Survey and Habitat Assessment **Deliverable** – Federal and State Listed Threatened and Endangered Species Assessment Report **As-Needed** – State Listed Mussel Surveys – Aquatic Resource Relocation Plan (ARRP) for Dewatering Events

Regulatory Agency	Regulation/Guidance	Permitting Trigger/ Permit Type	Field Surveys and/or Deliverables Requirements
TPWD	Marl, Sand, Gravel, Shell or Mudshell Permits-Chapter 86, subtitle F, of the Texas Parks and Wildlife Code	Barton Creek is perennial and greater than 30' in width; therefore, is potentially subject to this permit because construction activities may be required within the bed and bank of Barton Creek for bridge piers/piling. The State claims the bed and the sand and gravel within in it as State-owned if the stream is perennial and greater than 30' in width. A Permit from TPWD is required to "disturb or take" streambed materials from a streambed claimed by the State.	**As-Needed** – General Permit (31 TAC § 69.115) – disturbance or removal of less than 1,000 cubic yards of sedimentary material. – Individual Permit (31 TAC §69.105) - disturbance or removal of greater than 1,000 cubic yards of sedimentary material or executive director finds adverse impacts to natural resources.
Texas Commission of Environmental Quality (TCEQ)	Edwards Aquifer Protection Program-Edwards Aquifer Rules, Title 30 Texas Administrative Code (TAC) Chapter 213	The limits of construction are located above the Edwards Aquifer Transition Zone. An Edwards Aquifer protection plan (EAPP) is required for construction activities on the recharge, transition, or contributing zones of the Edwards Aquifer. The plan will outline the best management practices that will be implemented and maintained, both during and after construction activities, to prevent contaminants found in storm water from reaching the Edwards Aquifer.	**Field Survey** – Geologic Assessment – Deliverable – Edwards Aquifer Protection Plan with BMPs and Stormwater Pollution Prevent Plan **As-Needed** – Recharge and Transition Zone Exception Request Form and associated attachments – Construction monitoring for sensitive geologic features – Water Pollution Abatement Plan (WPAP)

4 Alternative Development and Selection Process

As indicated in Section 3, several studies were performed (circa 2016-2018) to identify existing conditions of the bridge structure as well as the existing traffic and environmental/permitting issues. These were precursor studies to allow for further alternative development and evaluation. Sections 4.1 to 4.3 present summaries of these additional evaluations, studies, and meetings which comprised the process used to develop, evaluate, and recommend the preferred bridge alternative.

City Departmental stakeholders assisted in the evaluation of designs and provided guidance from a broad range of perspectives. The City's participant team members included:

- City of Austin – Transportation and Public Works (TPW)
- City of Austin – Parks and Recreation Department (PARD)
- City of Austin – Austin Water (AW)
- City of Austin – Austin Energy (AE)
- City of Austin – Watershed Protection Department (WPD)
- City of Austin – Historic Preservation Office (HPO)

Other stakeholders have had input into the design, either directly with team member meetings and discussions, or from participation in public engagement efforts. Some of these additional stakeholders include:

- U.S. Army Corps of Engineers (USACE)
- U.S. Fish and Wildlife Service (USFWS)
- Texas Historic Commission (THC)
- Texas Commission on Environmental Quality (TCEQ)
- Save our Springs Alliance (SOS)
- City of Austin citizens through in-person and virtual Open House

4.1 Initial Assessments (2018-2019)

4.1.1 Early Geometric Concepts

Appendix B-1 includes preliminary plan views of the bridge and roadway geometries for Rehabilitation and Replacement bridge options. These were developed in February 2018 and discussed with City TPW at the time.

4.1.2 Bridge Rehabilitation Feasibility

In 2018, structural modeling was done to determine the feasibility of the Rehabilitation Option 2. In May 2018, preliminary results of the rehabilitation structural modeling were discussed with TPW. Appendix B-2 provides the presentation slides from that meeting. The outcome was that a feasible rehabilitation solution was available.

4.1.3 Bridge Replacement Concepts

In Summer of 2018 early bridge replacement option concepts were developed vetted with TPW staff. This included preliminary development of a Maintenance of Traffic plan, which was developed to ensure that four lanes of traffic were able to be maintained during construction. In July 2018, a briefing was provided to TPW to update on the status; Appendix B-3 includes the slides from the briefing, with topics including project overview; bridge inspection; rehabilitation feasibility; maintenance of traffic during construction, and conceptual sketches for bridge replacement. In September 2018 bridge replacement option renderings were developed and discussed with TPW staff. Appendix B-4 includes a copy of the renderings developed.

4.1.4 Design Reviews and Funding Pause

A draft of an Interim Bridge Status Memorandum was developed in late 2018 and vetted with the City in January 2019.

During the first months of 2019, various tasks were discussed and explored for moving the project forward, including:

- Potential for CAMPO funding (in May 2019 it was determined that TxDOT had utilized those funds);
- Potential for federal BUILD Grant funding; and
- Potential for early public input and strategy and cost for public involvement.

In July 2019, the project was paused due to a lack of further funding, to complete the remainder of the Concept Engineering and Public Involvement.

4.2 Bridge Alternative Development (2021-2022)

The design team performed additional structural modeling in late 2021 to provide a similar level of structural vetting for the replacement options, as had been performed for the rehabilitation option in 2019. The modeling and associated renderings were discussed with Public Works management team in November 2021. Appendix C-1 includes a copy of the slides from this meeting.

The draft Interim Bridge Status Memorandum (referenced in Section 4.1.4) was finished in draft form in February 2022, and was distributed to the City's stakeholder departments/groups in advance of the Design Charrette. Appendix C-2 includes a copy of this memorandum.

4.2.1 Design Charrette

A Design Charrette was held March 2022, and was attended by multiple City stakeholder departments. The meeting oriented the group and reviewed the background and history, and the process for selecting an alternative for the bridge. The design team recommended a bridge replacement for the general project direction. Appendix C-3 includes a copy of the agenda and the slide deck from that meeting.

The meeting provided general input from various departments, and it was understood that additional input would be provided as the slides were studied more in depth. One outcome was the decision to contact the Texas Historical Commission (THC) for general orientation and to obtain their initial input into general project direction.

4.2.2 City Department Vetting and Alternative Refinement

Various additional meetings were held with City Departments in Spring and Summer 2022. The primary outcome of these meetings was a revision to the geometry for both the rehab and replacement options. ATD comments resulted in the following primary alternative revisions:

- The right-turn lane from Barton Springs to Azie Morton was removed;
- Road lanes were narrowed; and
- Bike lanes and pedestrian paths were widened.

4.2.3 Initial Agency Vetting

In June 2022, the design team met with THC and presented the project, after incorporating the general revisions to alternatives from departmental input. Appendix D-1 includes the slide deck from this meeting. The outcome from this meeting was that THC requested that the U.S. Army Corps of Engineers (USACE) be contacted for consultation (as lead federal agency). The THC also requested some additional documentation in memorandum form for their review, prior to public outreach, to review the feasibility of both rehab and replacement options.

4.2.4 Bridge Alternatives (Comparison of Options)

As a result of the input from City stakeholders and THC, the rehab and replacement alternatives underwent additional review and comparisons. The Rehab vs. Replacement Memorandum was developed (August 2022 draft and finalized September 2022) to provide documentation and a matrix of the comparisons between all alternatives, and highlighting

which alternatives were at an advantage over the others. Appendix C-4 includes this memorandum.

The three bridge replacement options were compared to each other. Table 4-1 includes a summary of the bridge replacement options and comparisons/advantages of each.

Table 4-1. Comparison of Bridge Replacement Options

	Option 1 - Single Arch	**Option 2 - "Y" Pier Longitudinal**	**Option 3 - "Y" Pier Transverse**
Description	Option 1 is comprised of four arch ribs bearing on thrust block at either side of the creek. The form the arch makes creates a contemporary reference to the existing bridge form.	Option 2 consists of four "Y" piers located at the center of creek that create an arch-like appearance. There are two bearing points on the "Y" pier with a longitudinal tie to accom-modate the tension in the top of the pier.	Option 3 utilizes eight "Y" piers arched in the transverse direction. The piers are located near the third-points of the structure and maintain an open center channel in the creek
Structural Complexity	This option utilizes a complex post-tensioning system in the main arches and large scale thrust block to transfer load from the bridge to the ground. The superstructure girders and intermediate diaphragms are post-tensioned.	The "Y" piers utilize post-tensioning tendons to pre-compress a tie at the top of the pier to resist the longitudinal forces created by the bearing points of the structure. The piers rest on conventional foundations located in the creek. The superstructure girders and intermediate diaphragms are post-tensioned.	Advantage Post-tensioning bars are used to pre-compress a transverse tie at the top of the pier. These piers rest on conventional foundations in the creek. The superstructure girders are post-tensioned.
Visual Openness	The bold forms of the arches create the highest level of visual obstruction. The arches provide direct views along the centerline of the creek when seen from the water.	The "Y" piers create more openness than Option 1. However, the location of the piers in the center of the creek obstructs the views down the centerline of the creek.	Advantage Option 3 provides more visual openness than Options 1 and 2. The pier placement also creates unobstructed views along the center of the creek.

	Option 1 - Single Arch	**Option 2 - "Y" Pier Longitudinal**	**Option 3 - "Y" Pier Transverse**
Constructability	Option 1 requires temporary piers and complex falsework to form the arches. It is the most complex to build.	Option 2 utilizes conventional construction techniques and has the fewest number of foundations in the water. However, the tension ties at the top of the piers will require specialty construction techniques including complex falsework.	Advantage Option 3 generally uses conventional construction techniques and should not pose any unusual problems for a bridge of this type and scale. The tension ties at the top of the piers will require some specialty construction techniques.
Initial Const. Cost	$19.7M	$15.3M	$12.9M Advantage

Based on this comparison, the recommended alternative for bridge replacement was Option 3; this option utilizes a concrete beam superstructure with two lines of "Y" piers oriented parallel to the channel and at a slight skew to the bridge's beam elements. This option maximizes the views through the bridge and maintains an open center channel in Barton Creek below.

This recommended bridge replacement option was then compared with the bridge rehabilitation option. A summary and comparison of various features and components of both rehabilitation and replacement bridge concepts are provided in Table 4-2.

Table 4-2. Comparison of Bridge Rehabilitation/Replacement Concepts

Highlighted Boxes Represent Benefit Over Other Option

Feature/Component	Bridge Rehabilitation Concept	Recommended Bridge Replacement Concept (Option 3)
Renderings		
	 Rendering showing removal of superstructure	 *Rendering of Option 3 looking north*

Feature/Component	Bridge Rehabilitation Concept	Recommended Bridge Replacement Concept (Option 3)
	Rendering showing completed, widened rehabilitation	*Rendering of Option 3 under the west bank*
Roadway Geometry		
Azie Morton Road Extended Right Turn lane onto Barton Springs Road	Included	Included
Barton Springs Road Alignment	Barton Springs Rd. will be improved but still unaligned; the required "zig zag" by west bound traffic will be much less abrupt. Rehabilitation requires the new structure to be built on the existing centerline alignment.	Advantage Barton Springs Rd. will have the point of inflection removed from the alignment. The result will be a straight intersection, with no conflict in east- or westbound traffic and no "zig zag."
Park Amenities/Improvements		
Zilker Eagle Train	The train will have to be replaced under the bridge, in a similar configuration to current layout.	Advantage Moving the western abutment further west provides additional horizontal space. The train can be replaced similar to the current layout, or relocated with additional space for rider room and safety.
West Bank Hike/Bike Trail Pedestrian Bridge Under Barton Springs Rd	The pedestrian bridge will need to be removed and replaced in a similar manner to existing layout.	Advantage The pedestrian bridge will need to be removed. It can either be replaced similar to current layout, or it may be able to be relocated as a path on the additional space allowed by moving the western abutment.

Feature/Component	Bridge Rehabilitation Concept	Recommended Bridge Replacement Concept (Option 3)
Hike/Bike Trail Passage below the Bridge	Passage length under bridge will be roughly twice as wide as existing. Passage space and headroom will be similar to existing layout.	Advantage Passage length will be similar to rehab length. Passage space will see combination of new structures and abutments to allow opportunity for added vertical and horizontal open space underneath bridge.
Bridge Structure		
Bridge Architecture and Aesthetics	Existing arches and foundations will be preserved and remain. Remaining structures will undergo cathodic protection including concrete and condition mitigation and re-surface work. Rehab concept will add new arches upstream and downstream. New arches will be complementary to but not a replicate of the existing arches, depending upon aesthetic coordination with Texas Historical Commission. Visibility of new arches will be predominant. Substructure to consist of 8 arch lines	Existing arches will be removed. Replacement concepts will include 4 arch lines. New bridge aesthetic can be complementary to the existing bridge (3 span) type/span arrangement. Replacement concept to consist of 4 substructure elements at two locations in lieu of 8 continuous elements providing more open view sheds.
Impacts to Historic Structure	Advantage Rehabilitation of the existing bridge preserves some of the existing historic bridge elements.	Replacement removes the existing historic elements and relies on mitigation strategies to offset impacts.
Bridge Length and Abutment Locations	For rehab, existing abutment locations will remain, and will expand or widen to the north and to the south to accommodate the additional arches for a wider bridge, in a similar geometric arrangement to existing.	Advantage Replacement concept will shift the west abutment to the west, to provide more space and safety for pedestrian trail and the Zilker Eagle train on the West Bank.

Feature/Component	Bridge Rehabilitation Concept	Recommended Bridge Replacement Concept (Option 3)
Bridge Foundation Work in Barton Creek	Work on existing foundations in the creek will include cathodic protection and concrete mitigation and concrete re-surface work. Includes construction of 8 new foundations (for 4 new arch lines each with two piers), in Barton Creek.	The existing arches and foundations would likely be removed, down to the creek bed. Replacement concept includes 8 foundations – for 4 substructure elements at 2 locations.
Temporary Construction in Barton Creek	Extensive foundations for temporary works will be required	Advantage Assuming bridge can be constructed by barge mounted cranes, foundations for temporary works will not be required.
Bicycle Elements on Bridge	Includes 10 ft-wide bike lanes on each side, to accommodate 2-way bike operations on either side of the bridge.	Includes 10 ft-wide bike lanes on each side, to accommodate 2-way bike operations on either side of the bridge.
Pedestrian Elements on Bridge	Includes a 14 ft-wide sidewalk on the south side and 18 ft wide sidewalk on the north side.	Includes a 14 ft-wide sidewalk on the south side and 18 ft wide sidewalk on the north side.
Service Life	Target Service Life extension of 50-75 years This is dependent upon results from additional sampling/testing of the existing bridge materials.	Advantage Target Service Life of 75 years This can be extended to 100 years with durability enhancements to the design basis and prescribed materials. This would entail an increase in cost of roughly 10% or more.
Bridge Maintenance	Increased long term maintenance cost and requirements	Advantage Less maintenance cost and staffing labor required
Engineer's Preliminary Estimate of Bridge Construction Cost *(range indicating initial and maximum cost including 50% inflation over course of design and bidding of the project)*	$14.8M - $22.4M	Advantage $12.8M – 19.2M

Feature/Component	Bridge Rehabilitation Concept	Recommended Bridge Replacement Concept (Option 3)
Constructability/Risk	Constructability more difficult due to the requirement for precision-demolition, and the need to protect existing structures to remain, while constructing new work on or adjacent. Subject to greater project risk with unknown material conditions of existing structures and subsurface foundation conditions.	Advantage Comparatively less construction and project risk.

Both rehabilitation and replacement can accommodate the transportation needs in a similar fashion. The bridge replacement option offers numerous additional benefits (highlighted cells in the above table) including better accommodations of the Zilker Eagle mini-train and enhanced trails underneath the bridge.

The most significant differences between the rehabilitation option and the replacement option are cost and risk. The recommended replacement bridge option is not the least expensive design possible; it includes enhanced features such as unique piers and upgraded abutments. Even with these enhancements, the cost of the replacement bridge is significantly less than the rehabilitation option. Furthermore, ongoing maintenance cost and labor requirements are less with the replacement option. There is also a great deal of risk associated with the rehabilitation option. While the bridge condition survey was thorough, there are many things that could increase the cost of rehabilitation once the initial demolition exposes all of the "hidden" elements of the bridge.

It was noted that, if the bridge is rehabilitated, very little of the existing structure will remain and those remaining elements will be almost entirely concealed by the new construction. This fact coupled with the significant increase in cost and risk led to the recommendation of the Replacement Option 3 as the path forward.

TPW staff reviewed the documentation and information with various City departments and management; a memorandum from the Staff to City Council was developed in November 2022, and is included in Appendix C-5.

Construction Cost Estimates for each Bridge Option were updated to 2023 cost. These costs are reflected in the tables above and are included in Appendix C-6. In parallel with the alternative reviews, geotechnical investigations had occurred in the Spring of 2022. The Geotechnical Data

report was developed in draft in October 2022, and is included in Appendix C-7, and provides additional information on subsurface conditions in and around the bridge.

4.2.5 Additional Agency Vetting

The Rehab vs Replacement Memorandum was submitted to both the THC and USACE in November 2022. A meeting with USACE was held in November 2022 to discuss the project and initiate consultation. Meeting notes from this call are included in Appendix D-2.

In addition to the memorandum, a Section 106 Evaluation was developed to provide the THC more information on the implications and effects of both alternatives on historic properties. The memorandum was developed in draft form in December 2022 and submitted to THC in January 2023. It is included in Appendix D-3.

The THC responded to the memorandum in an email in March 2023, agreeing with the Section 106 Evaluation, and indicating that the project could proceed with either rehab or replacement options and that both options had similar cultural/archeological impacts. The email from THC is included in Appendix D-4.

4.3 Public Involvement

The design team began preparations for the city-wide open house in late summer 2022. The targeted time frame for the Open House was November 2022. During the course of coordination with other departments, it was requested that the bridge Open House be delayed allowing for the progress of other studies and public outreach in progress at the time. The bridge open house was postponed to Spring 2023.

4.3.1 Open House

The Open House was held April 2023 (originally scheduled event in March was cancelled by a severe storm the day of). The open house was a combined in-person open house, and virtual open house. The virtual session began in early March and continued through roughly the middle of April 2023. Appendix E-1 contains both a copy of the boards that were present in the in-person open house, as well as the slide deck that was provided for the virtual open house.

4.3.2 Public Comment Summary

Public comments were gathered in two ways: on paper during the in-person meeting and online as part of the virtual public meeting. Overall there were 1,677 views of the public meeting; 189 participated in the online survey. Overall sentiment varied with the major sentiment categories of either favoring rehabilitation, favoring replacement, or not wanting any changes. A public meeting summary was developed and is included in Appendix E-2.

4.3.3 Post Open House Discussions

Various additional discussions have taken place with City management in the time frame after the public engagement process. Public Works management provided a briefing to the City's Mobility Committee in May 2023. Appendix E-3 includes the slide deck from the presentation.

5 Proposed Improvements

The recommended Bridge Replacement Option 3 is a three-span concrete girder structure supported by two lines of custom "Y" Piers which flank the center channel of Barton Creek. Figures 5-1 and 5-2 are renderings of the recommended bridge type from different vantage points.

Figure 5-1. Bridge Rendering View Looking North

Figure 5-2. Bridge Rendering View North and East Under Bridge

The following sections provide additional information on the recommended alternative. Figure 5-3 below includes an overall view of the proposed project with the proposed bridge and additional key ancillary project components.

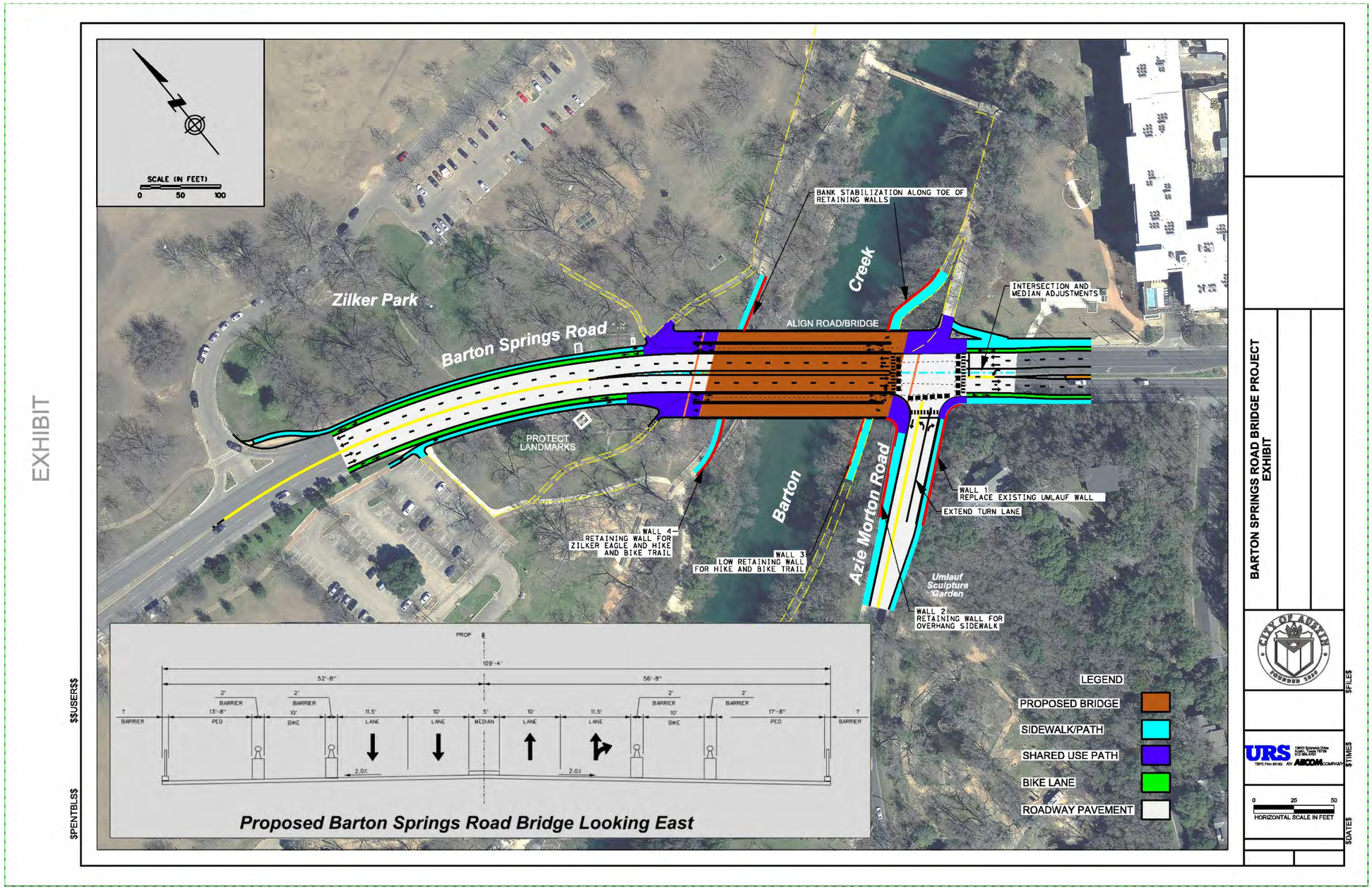

Figure 5-3. Proposed Project and Key Components

5.1 Bridge Cross-Section

The proposed cross-section for the Barton Springs Road Bridge over Barton Creek was developed after consultation with City's transportation engineers and bike/pedestrian coordinators, and consists of:

1. One (1) – 5-ft. center median;
2. Two (2) – 10-ft. inside lanes;
3. Two (2) – 10-ft. outside lanes with 1.5-ft. striped shoulder;
4. Two (2) – Traffic barriers assumed to be nominal 2-ft. wide;
5. Two (2) – 10-ft. bike lanes;
6. Two (2) – Interior pedestrian barriers that separate bikes and pedestrians, assumed 2-ft. nominal width;
7. A 13.66-ft. multi-use path on the North side of the bridge and a 17.66-ft. multi-use path on the south side of the bridge; and
8. Two (2) – Exterior pedestrian barriers, assumed 1-ft. nominal width.

The proposed bridge typical sections are shown in Figure 2.1. The roadway utilizes a standard crown section with 2 percent cross slopes to facilitate drainage. The deck will drain via the gutter line to inlets located at either end of the bridge. The overall deck width is derived from the needs of Maintenance of Traffic (described in more detail in Section 6.3). That is to say that the overall deck width is needed to ensure that four lanes of traffic stay operational during construction.

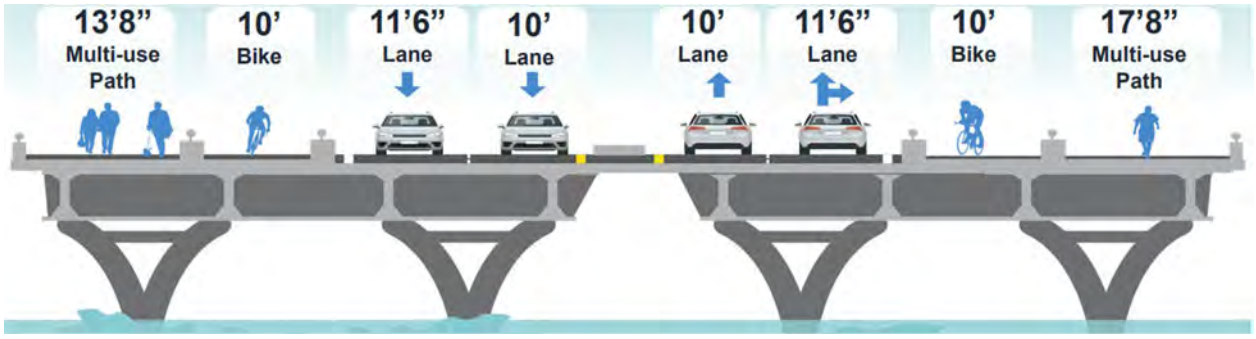

Figure 5-4. Typical Cross-Section

5.2 Bridge Aesthetic Design

The design for the recommended bridge is a three-span concrete girder structure supported by two lines of custom "Y" Piers which flank the center channel of Barton Creek. This design limits in-water obstructions for users while maximizing the views through and under the bridge. The bridge piers are oriented transversely to the structure which helps to create the greatest sense of openness when viewed from the river below. In addition, a large number of users will be

beneath the bridge and on the trail system. These users will experience views of the bridge from an oblique angle. The orientation of the piers provides the greatest amount of visual interest for users at these different vantage points. The forms of the piers utilize curved and arching shapes which pay homage to the existing bridge.

The western abutment for the bridge has been pushed back slightly. This is especially important on the park side of the bridge because it increases the amount of usable space underneath the bridge and along the creek, accommodating new multi-use paths and the Zilker Eagle train.

The pedestrian and bicycle accommodations on the deck of the bridge are significantly enhanced from the existing condition. The new bridge will have very wide sidewalks and mixed-use paths on either side that can accommodate seating areas with integral planters, custom railing systems, and adequate lighting. Barriers separating the travel lanes from the shared use path along with a raised and planted center median will help to create a more pedestrian and urban experience.

5.3 Roadway Design

Roadway design for the bridge approach was derived from allowable geometry around physical constraints in the environment. There are two significant constraints on either side of the Barton Springs Bridge. On the East side is the intersection with Azie Morton. Barton Springs Road, westbound, has a left turn lane for traffic turnings south onto Azie Morton. The same turn lane must be tapered away before the bridge begins. To do this, the turn lane was centered on the proposed alignment. This allowed both the East and West approaching lane to share the taper and decrease the lane shift for each direction of traffic across the intersection. The second significant constraint on the West side of the bridge is the two Zilker Park Monuments.

Figure 5-5. Example of Zilker Park Monuments

These monuments are historical in nature and must be avoided in the development of this project. One monument is on the North side of the road and there is another on the South side of the road. The geometry used to preserve these monuments was chosen to facilitate the desires of this project and meet the city's design criteria.

5.4 Park Area Design

A review of opportunities for park/pedestrian improvements were developed in the Interim Bridge Status memo (see Appendix C-2 for more detail).

5.4.1 Structure/Tree Protection and Mitigation

Key historic structures such as the existing park monuments and the pecan grove picnic area will be protected from disturbance during the work; these important facilities are part of the historical character of the park. Heritage trees that have the potential to be in conflict with the bridge construction have been assessed; these trees can be moved/re-located to mitigate

potential damage or alternatively can be stabilized and protected depending upon the degree of conflict. These aspects of the work will be coordinated with City stakeholders throughout future design efforts.

5.4.2 Zilker Park – Zilker Eagle

The preliminary plan includes the provision of additional space for the Zilker Eagle track. The plan will be vetted and coordinated with the Parks Department and the overall planning needs for Zilker Park. After the project construction, new tracks will need to be placed in/around the bridge abutment and reconnected with the existing track at some determined distance from the bridge.

The proposed design provides a shift of the abutment to the west and provides an opportunity for more horizontal and vertical space for the train and riders, as well as pedestrians.

5.4.3 Zilker Park Hike/Bike Trail

The hike/bike trail immediately under the proposed bridge will likely be in conflict with the bridge construction; as a result, it will likely require replacement in the vicinity of the bridge.

In addition to potential construction conflict, the existing east-side trail underneath the bridge has also exhibited erosion/undercutting from Barton Creek. As a result, the proposed project will also likely include bank stabilization in these areas, in coordination with ongoing efforts from the WPD.

The existing west-side trail underneath the bridge includes a pedestrian bridge that is located to avoid the existing arches. For the recommended design, the pedestrian path will be able to be re-located onto the bank adjacent to a re-located west abutment, with the additional space made available on this side. This will require a retaining wall and additional bank stabilization at the toe of the wall, as is likely on the east bank.

5.4.4 Umlauf Garden Retaining Wall

The Umlauf Sculpture Garden and Museum is part of the City's Parks and Recreation Department. The existing Umlauf Garden retaining wall and hillside on the east side of Azie Morton at the southeast corner of the Barton Springs Rd. intersection has exhibited instability in the recent past. This hillside is directly below the Umlauf home and workshop. The enhancement of the right-turn lane at Azie Morton will be combined with the construction of a replacement retaining wall to stabilize this hillside. Construction of these elements early in the project's construction sequence will also allow for Azie Morton roadway to shift to the east, maintaining traffic flow for the neighborhood while also providing additional construction space near the bridge.

5.5 Structural Design

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

5.6 Utility Design

Existing utilities on the bridge consist of the following:

- 6″ coated steel gas line; and
- 6″ cast iron water line.

In addition to the utilities connected to the bridge, there are various overhead utilities for energy and communications spanning Barton Creek. Additionally, there are underground and overhead lines adjacent to Azie Morton Rd.

The gas line and water line on the bridge will be replaced. In preliminary discussions with Austin Water (AW), the 6″ line will be replaced by an upsized 12″ line. Preliminary discussions with Texas Gas indicated that they would self-perform a gas line replacement and bore under the creek. Additional discussions and coordination with Texas Gas will be conducted during the design phase.

The roadway and bridge work will require existing electric lines to be relocated. Austin Energy (AE) will design the relocation of their own poles and overhead transmission and/or

distribution lines. The design team will coordinate same with project construction phasing. It is also typical for Austin Energy to coordinate the use of their overhead power poles for communication line purposes. This will be coordinated and confirmed during the design phase as well.

6 Construction Phases and Methods

6.1 Construction Phases

[redacted]

[redacted]

[redacted]

6.2 Foundation and Substructure Construction

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

6.3 Superstructure Construction

[redacted]

[redacted]

6.4 Construction Sequence/Maintenance of Traffic

Extensive effort was expended to thoroughly consider Maintenance of Traffic (MOT) within the preliminary design of this project. MOT on this key arterial street will be critical during the construction of this bridge project. A preliminary construction sequence and phasing plan was developed with the intent of maintaining all four lanes of traffic operational during construction. The sequencing and lane management are important to avoid overloading existing structures and sequentially accommodating the new foundations.

6.4.1 Phase 1

Phase 1 is described in Figure 6-2, looking to the East.

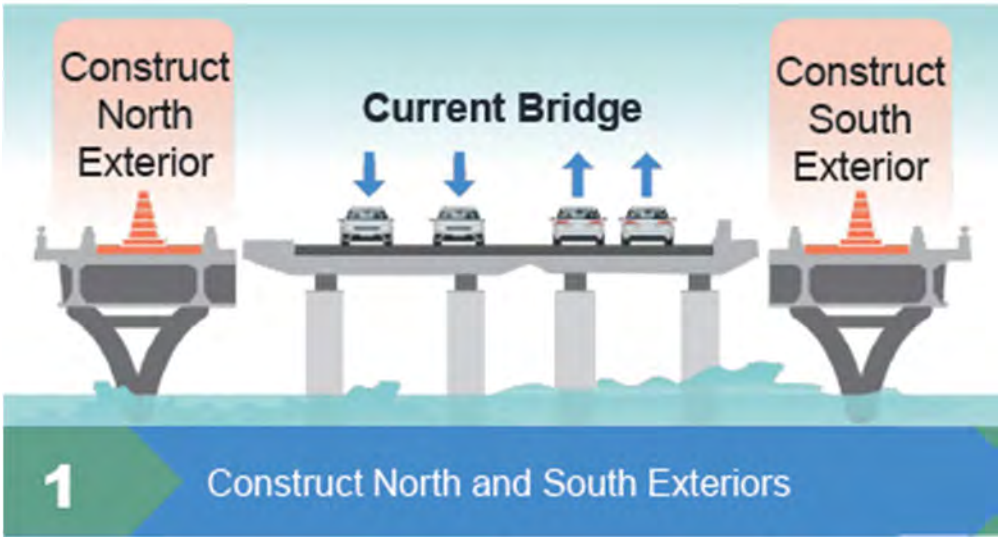

Figure 6-2. Phase 1 Cross-Section, Looking East

Step 1.

- Maintain traffic along Barton Springs Road generally in existing locations with appropriate protections (concrete barriers and advanced warning devices) installed to inform and protect traveling public and to protect construction workers, materials, and equipment.
- The initial bridge work consists of constructing new bridge foundations, superstructure, and decking north and south of the existing bridge. The existing traffic would continue as normal while these new bridge elements are constructed offline.
- Construct north and south portions of Barton Springs Road bridge/approach pavement with appropriate permanent and temporary barriers as well as retaining wall and pavement cantilevered sidewalk along east side of Azie Morton Road.

Step 2.

- The west and east ends of both new bridge segments will be connected to the existing roadway and sidewalk network. This will require some temporary traffic routing.

6.4.2 Phase 2

Phase 2 is described in Figure 6-3.

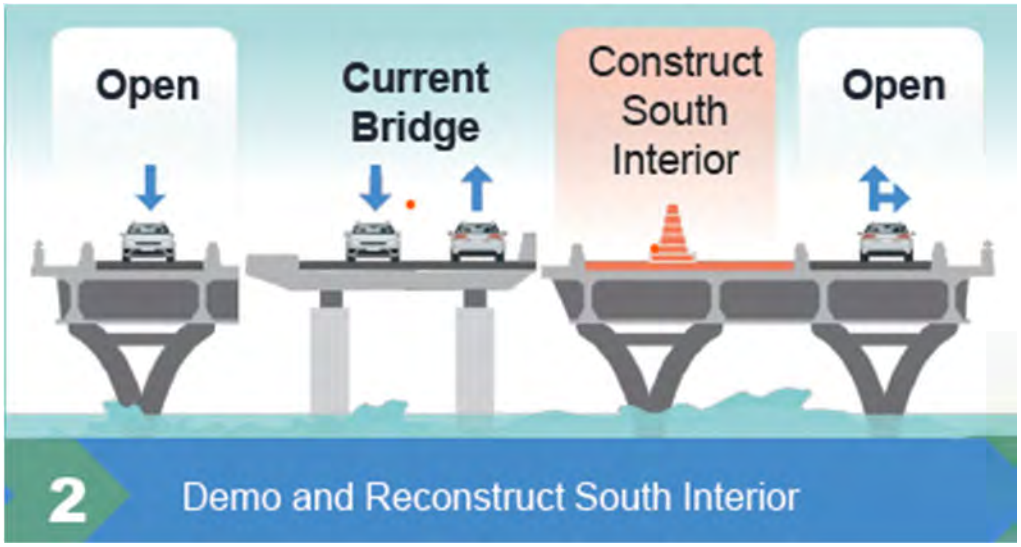

Figure 6-3. Phase 2 Cross-Section, Looking East

- Update MOT signs, structures, and devices to facilitate Phase 2 work.
- Split west-bound (WB) traffic along Barton Springs Road. One lane will be routed onto the new bridge constructed during Phase 1, and the other lane will be routed down the existing outside lane of WB traffic.
- Split east-bound (EB) traffic along Barton Springs Road. One lane will be diverted to what was the inside lane of WB traffic, and the other will be routed onto the new bridge constructed in Phase 1. The EB lane will be able to turn right onto Azie Morton or straight on Barton Springs Road.
- Shift EB pedestrian traffic from the existing bridge to the new bridge constructed in Phase 1.
- Demolish southern half of bridge. This is the existing EB (and circa 1925) bridge elements.
- Construct southern interior portion of proposed Barton Springs Road bridge and approach pavement. Splice together girder and decking with previous decking from Phase 1.

6.4.3 Phase 3

Phase 3 is described in Figure 6-4.

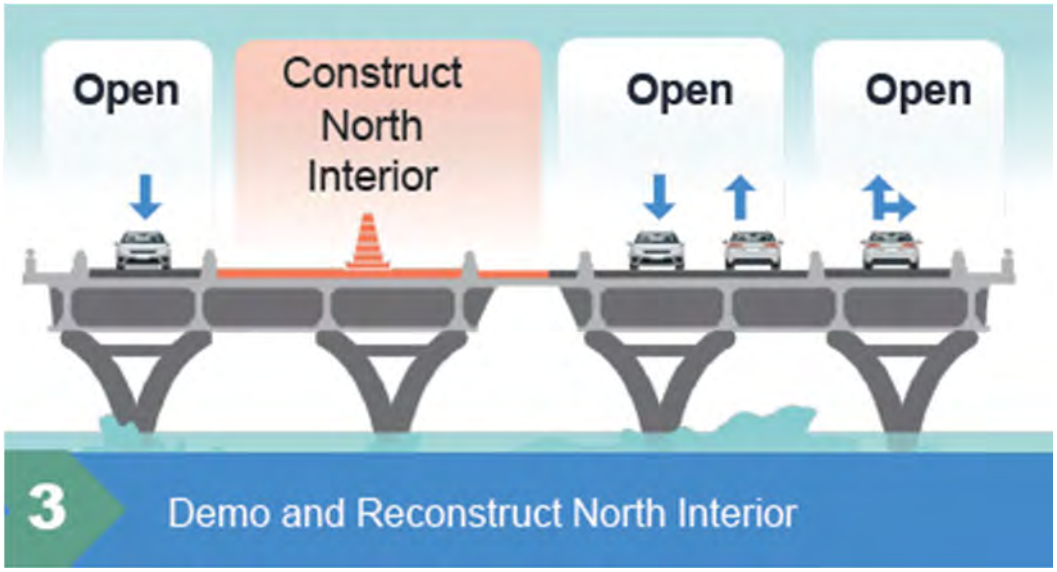

Figure 6-4. Phase 3 Cross-Section, Looking East

- Update MOT signs, structures, and devices to facilitate Phase 3 work.
- Shift and split WB traffic along Barton Springs Road. One lane will continue on the bridge built in Phase 1. The other lane will be shifted south onto the new bridge built in Phase 2.
- Split EB traffic along Barton Springs Road. One lane will remain on the bridge built in Phase 1. The other lane will be routed onto the bridge built in Phase 2.
- Maintain pedestrian traffic as it was in Phase 2.
- Demolish northern half of bridge. This is the existing WB (and circa 1945) bridge elements.
- Construct northern interior portion of proposed Barton Springs Road bridge and approach pavement.

6.4.4 Final Construction

Final work is described in Figure 6-5.

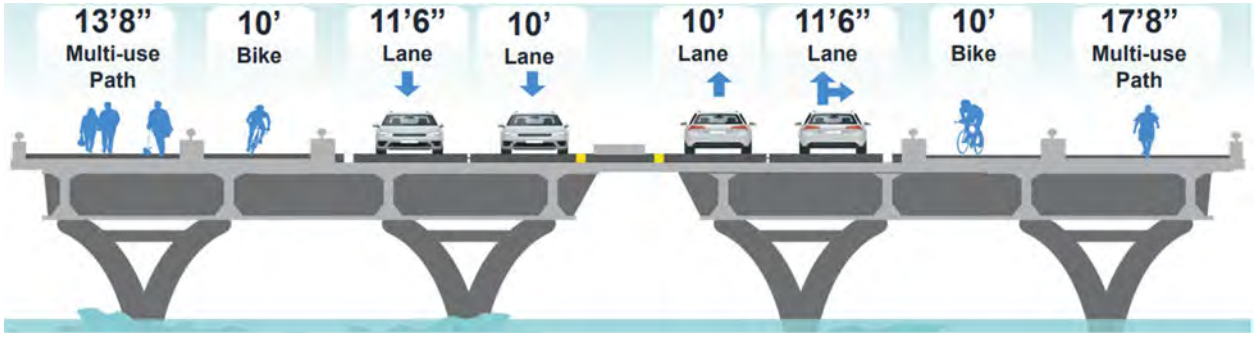

Figure 6-5. Final Completed Cross Section, Looking East

- Update MOT signs, structures, and devices to facilitate final tasks for bridge completion. Remove temporary features no longer needed.
- Route all Barton Springs Road traffic onto permanent approach pavement and bridge completed in previous phases – shift lanes toward median to extent necessary to construct barriers between roadway and pedestrian areas.
- Construct final bike/pedestrian barriers.
- Shift vehicle and pedestrian traffic into final proposed locations after miscellaneous elements are completed.
- Install and complete utilities and finishing works.
- Remove all remaining temporary features and perform final site cleanup for project acceptance by the City.

7 Project Cost

A conceptual project cost estimate has been developed for the Barton Springs Rd. Bridge project. Quantities were estimated from conceptual layouts presented above. As discussed in Section 4.2.4 preliminary construction costs for the bridge and overall project were developed. Unit costs were based on a review of City of Austin and Texas Department of Transportation average low bid unit prices along with past experience of comparable projects. A 25% contingency was applied to construction costs due to the preliminary/conceptual level of the design at this juncture. Construction costs are provided in 2023 dollars and are subject to change. The total construction cost for the proposed Bridge is $27,600,000. The detailed total construction cost is provided in Appendix C-8.

The total construction cost was summarized, and design and management costs added, to provide an overall estimated project cost, provided in Table 7.1.

Table 7-1. Preliminary Overall Project Cost Estimate

Recommended Improvements	Cost
Construction	
Signing & Pavement Markings	$ 25,417
Traffic Signalization	$ 274,500
Structures	$ 11,971,700
Landscaping and Water Quality	$ 240,955
Utilities	$ 690,100
Roadway	$ 1,548,764
Drainage	$ 1,097,040
Relocate Heritage Trees (5 to 6)	$ 1,000,000
Chap 26 PARD Mitigation	$ 1,000,000
Tree Mitigation	$ 200,000
Traffic Control	$ 509,200
Art in Public Places (Est. 2%)	$ 327,200
Maintenance of Traffic (10%)	$ 1,635,800
Mobilization (5%)	$ 817,900
Escalation Est (2 yrs @ 4%)	$ 887,700
Contingency (25%)	$ 5,334,700
	$ 27,561,000
Design and Management	
Engineering and Design (15%)	$ 4,135,000
Construction Engineering and Inspection (10%)	$ 2,757,000
MaterialS Testing (1%)	$ 276,000
Contingency (7%)	$ 1,930,000
	$ 9,098,000
Total Project Costs (2023)	**$ 36,659,000**

austin MOBILITY BONDS

Appendices

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Appendix A - Early Studies

A-1 - Section 106 Report – Sept 2016

BARTON SPRINGS BRIDGE
AUSTIN, TEXAS
SECTION 106 TECHNICAL GUIDANCE MEMO
September 16, 2016

Physical and Locational Description:

The Barton Springs Bridge is a concrete, open spandrel deck arch bridge located in the Zilker Metropolitan Park in Austin, Texas. The bridge has three open spans which sit on concrete piers. The abutments extend into the ground. The decking and sidewalk terminate at the end of the abutments. The total length of the bridge is 212.0 feet and the length of the largest span is 70.0 feet. The deck width is 48.0 feet. The bridge has open spindle handrails positioned between concrete posts.

The Barton Springs Bridge is located within the Zilker Metropolitan Park, a City of Austin recreational area. The Park comprises over 350 acres and has many recreational activities. A hike and bike trail as well as the Zilker Zephry miniature train which runs under the bridge adjacent to the north abutment of the bridge. The Park was listed in the National Register of Historic Places (NRHP) on 1997, and the Barton Springs Bridge, which is a contributing resource to the NRHP, is located within the Park. The Barton Springs Archeological and Historical District are also located within the Zilker NRHP and the boundary is immediately adjacent to the Barton Springs Road Bridge (Exhibit 1 Map of Zilker Park and the NRHP boundary).

History of the Bridge:

Bridge was constructed in 1926 by A.A. Mundy of Austin (Contractor) and The Terrell Bartlett Engineers Inc. of San Antonio, Texas (Exhibit 2). The bridge was widened in 1946 to accommodate more traffic (Exhibit 3).

Proposed Modifications to the Bridge:

Prior to beginning the design for the Barton Springs Bridge, a Bridge Conceptual Engineering Report (BCER) will be prepared. The report, prepared by the Bridge Design Team will address three general design options as defined below

<u>Option 1: Restore Load Capacity and Preserve Existing Structure</u>

The **first option** will be to rehabilitate and preserve the existing structure in accordance with the Secretary of Interiors Standards for Rehabilitation. This option may include among others, consideration of a retrofit, classic-style, bridge railing system to upgrade the substandard existing railings. This option may also include consideration and feasibility of a complimentary structure

or other means to adequately address additional capacity desired for bike and pedestrian traffic on both sides of the bridge. The four goals of Option 1 include:

a) Improve deck and structural superstructure (and substructure if necessary) to accommodate traffic loads;
b) No expansion of sidewalks or deck;
c) Replace railings; and,
d) The design of potential companion bridge(s) for bike/pedestrian use.

The replacement of the classic-style railing and barrier system will need to meet current safety standards. The design of the new barriers should preserve the historical character of the existing railings as closely as possible. This can be accomplished by developing a custom design which would require crash-testing of the system. This can be expensive and time consuming and may not be feasible for a project of this limited scale.

Another approach includes the development of railings and barriers that are based on existing, crash-tested designs which can be modified slightly to preserve the character of the bridge. This approach has been used successfully on other historic bridge restorations include the First Street Viaduct in Los Angeles, CA and the Venetian Causeway in Miami, FL.

A companion bridge(s) may be designed to add additional pedestrian and bicycle capacity. This bridge should complement the existing bridge, while utilizing the most current design techniques and materials to create a new bridge that is clearly of its time

Section 106 Requirements and Review for Option 1:

It is critical that early and continued coordination and discussion be held with the THC in order to keep the project moving in a timely basis. Prior to the creation of any rehabilitation and/or retrofit designs for the Bridge, it is recommended that the City initiate coordination between the Texas Historic Commission (THC) (State Historic Preservation Office - SHPO). Early coordination would consist of:

- Meeting with the THC to discuss City's purpose and need of the project;
- Discussion of rehabilitation and retrofit designs and options for the bridge;
- Discussion of what the THC perceives are the significant elements of the bridge;
- Discussion of any perceived impacts to the NRHP Zilker Park;
- Discussion of any impacts to the Barton Springs Bridge as a result of constructing a companion bridge immediately adjacent to the current bridge; and,
- Discussion of public involvement since the bridge is within the NRHP Listed Zilker Park.

It is recommended that the attendees for this meeting include City officials overseeing the Bridge project, bridge engineers, bridge architect, and the architectural historian. This meeting will provide the bridge engineers with guidance as to what the THC would prefer in terms of design and materials.

While the Barton Springs Bridge is currently not listed on the NRHP, it is an element within the NRHP listed Zilker Park. Preliminary review of the Bridge and its history would indicate that the

bridge would be individually eligible for listing. During the discussion with the THC, it will be asked whether the THC would like to see a formal Section 106 recording of historic properties report prepared by an architectural historian. At the meeting, the THC will be asked if they (THC) would make the NRHP determination based on their own recommendations, thereby avoiding the process of preparing a historic properties report.

If the THC requests a formal report in order to fulfill the Section 106 recording of historic properties process, a formal report would then be prepared that outlines the history of the area, the construction data of the bridge, the historic significance of the bridge and whether it is eligible, meeting the established four criteria for eligibility for listing on the National Register of Historic Places (NRHP). The report would also discuss any potential impacts to the NRHP Zilker Park as a result of the rehabilitation and/or retrofitting of the bridge. The report will include the design drawings and materials proposed for the rehabilitation and retrofitting. Once the report is submitted to the City, who will then submit to the THC, the THC has 30 days to review the document and provide their comments and/or concurrence. If the THC concurs with the report, then the project can proceed without any further coordination with the THC.

Time Estimate for Concurrence/Clearance:

It is estimated that the process to obtain Section 106 clearance from the THC for this portion of Option 1 will take approximately three months, or 90 days after report is submitted.

Section 106 Requirements and Review for Option 1 – Construction of Companion Bridge:

If the City decides to construct a companion bridge next to the current Barton Springs Bridge, the purpose and need of the proposed bridge, the preliminary design, and proposed construction materials, must be presented in a written report to the THC. The report will also include an assessment as to any impacts (adverse or non-adverse) and any effects (adverse or non-adverse) as required by the Section 106 recording of historic properties process. If the THC concurs that there will be NO impacts or effects to the current bridge, then no mitigation work will be required. However, if the THC determines that there WILL be impacts and/or effects, then mitigation work will be required to document the current bridges condition and to prepare educational information for future use by the public. Section 106 mitigation measures might include a) interpretive signage in the park; b) HABS/HAER documentation of the bridge; and c) educational brochures or information to be added to the Zilker Metropolitan Park website.

Time Estimate for Concurrence/Clearance:

If the THC determines that there will be NO impacts and effects, it is estimated that the process to obtain Section 106 clearance from the THC for this portion of Option 1 will not take any additional time as it will be included within the original submittal of the report.

If the THC determines that there will BE impacts and effects, it is estimated that the process to obtain Section 106 mitigation clearance from the THC for this portion of Option 1 will take an additional four months or 120 days after the THC's initial concurrence of the project (time needed to prepare and complete the mitigation tasks).

Option 2: Rehabilitate and Widen Existing Structure

The **second option** presented will be to rehabilitate the existing structure and enhance the deck by widening it to incorporate wider roads, sidewalks and a bike lane on both sides. This new bridge deck option may either be placed on the existing substructure or a widened, expanded substructure as necessary. All recommended modifications must appropriately protect the character and historical significance of the original structure. This option may also include retrofit, classic-style bridge railings as noted in the first rehabilitation option. The two goals of Option 2 include:

a) Widen deck for expanding roadway, bicycle, and sidewalk/pedestrian needs; and,
b) Include new structural features to include superstructure and may also include additional arches/substructure.

This approach will require close attention to detail, especially where new structural features, such as long outriggers, are added to the bridge to carry the wider deck. The new features should utilize forms and details that fit seamlessly with the existing bridge so that the overall look and feel of the bridge is preserved.

When analyzing this option, consideration should be given to the effect of the change in overall proportions to the existing bridge. The wider deck and additional spandrel arches will change the footprint of the bridge. This change will be most noticeable to the recreational users on the creek and visitors riding on the Zilker Zephry.

Section 106 Requirements and Review for Option 2:

It is critical that early and continued coordination and discussion be held with the THC in order to keep the project moving in a timely basis. Prior to the creation of any designs for the rehabilitation and widening of the bridge, it is recommended that the City initiate coordination between the Texas Historic Commission (THC) (State Historic Preservation Office - SHPO). Early coordination would consist of:

- Meeting with the THC to discuss City's purpose and need of the project;
- Discussion of possible options for the bridge;
- Discussion of what the THC perceives are the significant elements of the bridge;
- Discussion of any perceived impacts to the NRHP Zilker Park;
- Discussion of Section 106 process for mitigation of the resource;
- Discussion of public involvement since the bridge is within the NRHP Listed Zilker Park; and,
- Discussion of public meetings with Preservation Austin and residents of the Zilker neighborhood.

It is recommended that the attendees for this meeting include City officials, overseeing the Bridge project, bridge engineers, bridge architect, and the architectural historian. This meeting will provide the engineers with guidance as to what the THC would prefer in terms of design for the bridge widening as well as materials to be used.

While the Barton Springs Bridge is currently not listed on the NRHP, it is an element within the NRHP listed Zilker Park. Preliminary review of the Bridge and its history would indicate that the bridge would be individually eligible for listing. During the discussion with the THC, it will be asked whether the THC would like to see a formal Section 106 historic properties recording report prepared and presented, or if the THC would make the determination based on their own recommendations.

If the THC requests a formal report in order to fulfill the Section 106 recording of historic properties process, a formal report would then be prepared that outlines the history of the area, the construction data of the bridge, the historic significance of the bridge and whether it is eligible, meeting the established four criteria for eligibility for listing on the National Register of Historic Places (NRHP). The report would also discuss the materials for rehabilitation and the design for widening the existing bridge. Discussion within the report will include any potential impacts to the existing bridge as well as to the NRHP Zilker Park as a result of the rehabilitation and widening of the bridge. Once the report is submitted to the City, who will then submit to the THC, the THC has 30 days to review the document and provide their comments and/or concurrence of the recommendations presented within the report.

The report will also include an assessment as to any impacts (adverse or non-adverse) and any effects (adverse or non-adverse) as required by the Section 106 recording of historic properties process. If the THC concurs that there will be NO impacts or effects to the current bridge, then no mitigation work will be required and the project can proceed without further coordination. However, if the THC determines that there WILL be impacts and/or effects, then mitigation work will be required to document the current bridges condition and to prepare educational information for future use by the public. Section 106 mitigation measures might include a) interpretive signage in the park; b) HABS/HAER documentation of the bridge; and c) educational brochures or information to be added to the Zilker Metropolitan Park website.

Time Estimate for Concurrence /Clearance:

If the THC determines that there will be NO impacts and effects, it is estimated that the process to obtain Section 106 clearance from the THC for this Option will take 90 days.

If the THC determines that there will be impacts and effects, it is estimated that the process to obtain Section 106 review and mitigation clearance from the THC for this Option will take and additional seven months from the THC's initial concurrence.

Option 3: Replacement of the Existing Bridge

The third option would call for the complete replacement of the bridge. The two goals of Option 3 include:

a) Demolition of existing bridge; and
b) Replacing existing bridge with wider bridge to accommodate roadway, bicycle, and sidewalk/pedestrian needs.

Recommendations for Section 106 Review:

It is critical that early and continued coordination and discussion be held with the THC in order to keep the project moving in a timely basis.

Prior to the creation of any designs for the new bridge, it is recommended that the City initiate coordination between the Texas Historic Commission (THC) (State Historic Preservation Office - SHPO). Early coordination would consist of:

- Meeting with the THC to discuss City's purpose and need of the project;
- Discussion of possible options for the bridge;
- Discussion of what the THC perceives are the significant elements of the bridge;
- Discussion of any perceived impacts to the NRHP Zilker Park;
- Discussion of Section 106 process for mitigation of the resource;
- Discussion of public involvement since the bridge is within the NRHP Listed Zilker Park; and,
- Discussion of public meetings with Preservation Austin and residents of the Zilker neighborhood.

It is recommended that the attendees for this meeting include City officials, overseeing the Bridge project, bridge engineers, bridge architect, and the architectural historian. This meeting will also provide the bridge engineers with guidance as to what the THC would prefer in terms of bridge design and materials.

While the Barton Springs Bridge is currently not listed on the NRHP, it is an element within the NRHP listed Zilker Park. Preliminary review of the Bridge and its history would indicate that the bridge would be individually eligible for listing. During the discussion with the THC, it will be asked whether the THC would like to see a formal Section 106 historic properties recording report prepared and presented, or if the THC would make the determination based on their own recommendations.

If the THC requests a formal report in order to fulfill the Section 106 recording of historic properties process, the City is advised to hire an architectural historian who specializes in the Section 106 process. A formal report would then be prepared that outlines the history of the area, the construction data of the bridge, the historic significance of the bridge and whether it is eligible, meeting the established four criteria for eligibility for listing on the National Register of Historic Places (NRHP). The report would also discussion of the design and the materials for the new bridge. Discussion within the report will include any potential impacts to the NRHP Zilker Park as a result of the rehabilitation and widening of the bridge. Once the report is submitted to the City, who will then submit to the THC, the THC has 30 days to review the document and provide their comments and/or concurrence of the recommendations presented within the report.

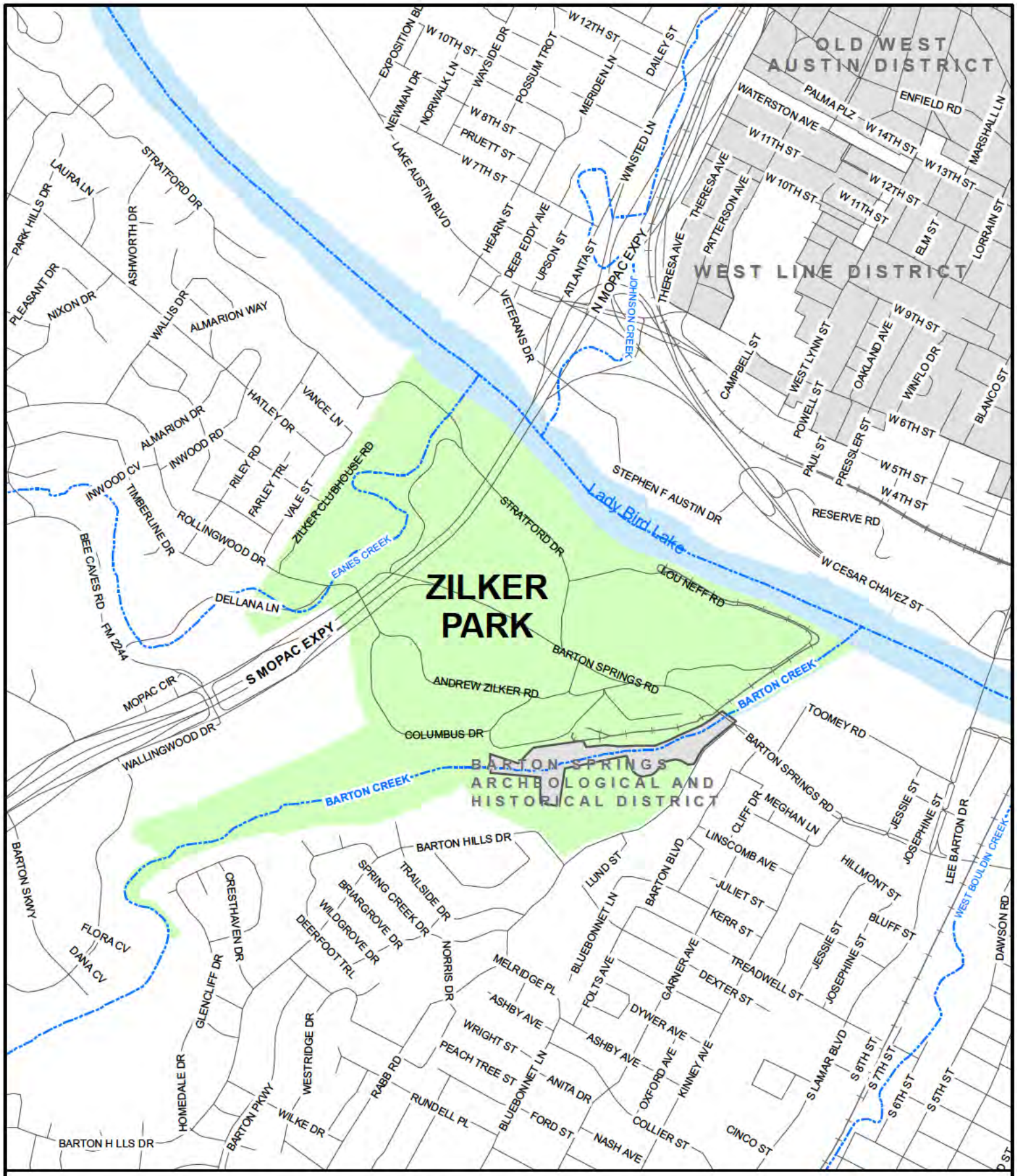
The report will also include an assessment as to any impacts (adverse or non-adverse) and any effects (adverse or non-adverse) as required by the Section 106 recording of historic properties process. If the THC determines that there WILL be impacts and/or effects, then mitigation work

will be required to document the current bridges condition and to prepare educational information for future use by the public. Section 106 mitigation measures might include a) interpretive signage in the park; b) HABS/HAER documentation of the bridge; and c) educational brochures or information to be added to the Zilker Metropolitan Park website.

Time Estimate for Concurrence /Clearance:

Since this option requires the removal and replacement of the bridge, the THC will determine that there will be adverse impacts and effects to both the bridge and the Zilker Park. It is estimated that the process to obtain Section 106 review and mitigation clearance from the THC for this Option will take an additional eight months from the THC's initial concurrence.

Exhibit 1: Zilker Park National Historic Register Boundary Map



NATIONAL REGISTER HISTORIC DISTRICTS

Zilker Park

N
W E
S

0 310 620 1,240 1,860 2,480 Feet

Date Plotted: February 15, 2008

Exhibit 2: 1925 Existing Barton Creek Bridge Plans

Exhibit 3: 1945 Barton Creek Bridge Widening Plans

A-2 - Bridge Inspection Report – Jan 2017

A-3 - Traffic Memo – Jan 2018

URS Corporation

An AECOM Company

To: Paulinda Lanham, PMP
Public Works Department,
Project Management Division
City of Austin

STATE OF TEXAS
SAMUEL HIGGINS
94875
LICENSED
PROFESSIONAL ENGINEER
1/30/18

URS Corporation
9400 Amberglen Boulevard
Austin TX, 78729
aecom.com

Project Name:
Barton Springs Road Bridge

Project Ref:
60493733

Date:
1/30/18

Technical Memorandum

Subject: Barton Springs Road Bridge – Traffic Analysis

This technical memorandum summarizes traffic analysis at the intersection of Barton Springs Road and Robert E Lee Road as part of the Barton Springs Road Bridge project.

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Introduction

On behalf of the City of Austin, URS is conducting a variety of tasks to evaluate the need for rehabilitation or replacement options for the Barton Springs Road Bridge over Barton Creek. The location of the bridge, at the entrance to Zilker Park, is a focal point of key community events and centers such as the Austin City Limits Music Festival, SXSW Conference and Music Festival, Barton Springs, Trail of Lights, and Blues on the Green. Barton Springs Rd and the bridge is also a key commuter corridor and access to Mopac, as well as a key entry/exit to the Zilker and Barton Hills neighborhoods. In addition to the evaluation of the bridge structure, the City is interested in understanding the potential for reducing congestion at this intersection and entrance to Zilker Park. To that end URS has conducted a traffic analysis for the intersection of Barton Springs Road and Robert E Lee Road. The study area is shown in **Figure 1**. The analysis was conducted for the purpose of understanding existing and projected operations at the intersection and to determine if options are available for reducing congestion.

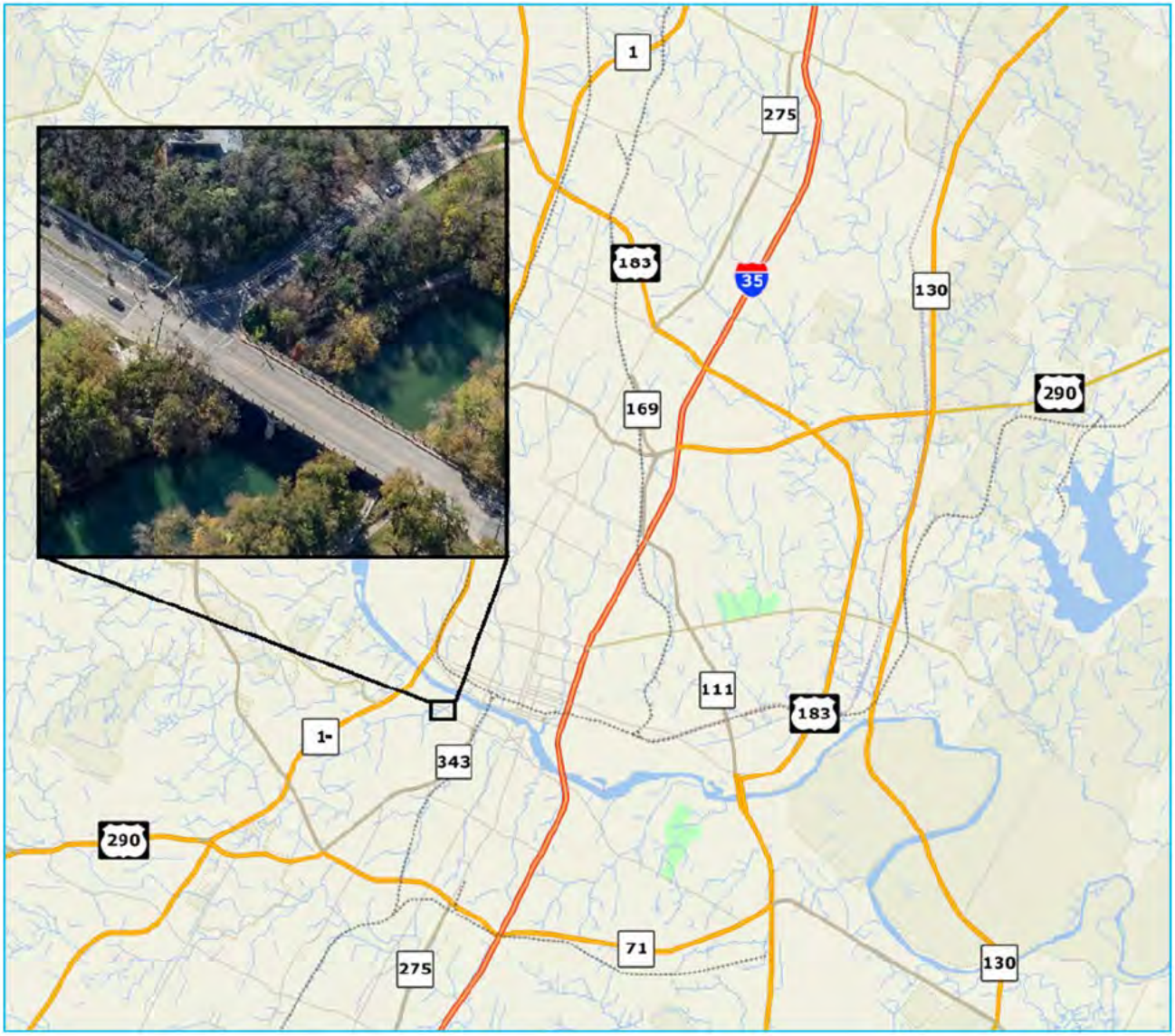


Figure 1: Study Area

Methodology

Traffic Analysis Sequence

URS followed the steps below in conducting the traffic analysis for Barton Springs Road Bridge project.

1. Verify existing intersection geometry.
2. Collect traffic counts from the field and signal timing plans from the City of Austin.
3. Analyze existing level of service (LOS).
4. Develop traffic growth rates.
5. Analyze future year No Build conditions.
6. Develop proposed improvements, and analyze future year Build condition.
7. Develop recommendations.

LOS Description

Signalized intersection LOS is defined in terms of a weighted average control delay for the entire intersection. Control delay quantifies the increase in travel time that a vehicle experiences due to the traffic signal control as well as provides a surrogate measure for driver discomfort. Signalized intersection LOS is stated in terms of average control delay per vehicle (in seconds) during a specified time period (e.g., weekday PM peak hour). Control delay is a complex measure based on many variables, including signal timing and traffic volumes. **Table 1** summarizes the LOS criteria for signalized intersections, as described in the Highway Capacity Manual (Transportation Research Board, 2016). For this project, LOS and delay will also be presented for specific approaches, as the AM and PM have specific problem approaches. Synchro 9 was used to analyze the signalized intersection. The existing signal timing plan for the intersection was obtained from the City of Austin and used for existing year analyses. Future year analyses include optimized signal timing to best highlight the impact from geometric changes.

Table 1: Level of Service for Signalized Intersections

Level of Service	Control Delay per Vehicle (sec/veh)
A	≤10
B	>10-20
C	>20-35
D	>35-55
E	>55-80
F	>80

Traffic Growth Rate

Historical traffic counts from the City of Austin were gathered for Barton Springs Road, and the traffic counts indicate no growth from 2005 to 2015. Thus, a growth rate was determined by comparing the traffic counts collected for this project and the CAMPO Travel Demand Model (TDM) result for 2040 which are presented in **Table 2**. From 2017 to 2040, the estimated growth rate is calculated as 1.80%, and this growth rate will be applied to the existing traffic volumes to develop projected volume estimates for 2020 and 2040 conditions. Projected traffic considered only this intersection and not constraints or impacts from adjacent intersections.

Table 2: Barton Springs Road ADT

Source	Year	ADT
Traffic Counts	2017	21,992
CAMPO TDM	2040	33,134
2017 to 2040 Rate		1.80%

Existing Geometry

The following are the lane configurations for each approach at the T-intersection of Barton Springs Road and Robert E Lee Road:

- Northbound Robert E Lee Road: one left turn lane and one right turn bay with 40’ of storage;
- Eastbound Barton Springs Road: one through lane and one shared through-right turn lane;
- Westbound Barton Springs Road: two through lanes and one left turn bay with 260’ of storage;
- Crosswalks: western and southern legs;
- Sidewalks: west side of southern leg, narrow on both sides of bridge on western leg, standard on both sides of eastern leg; and
- Bicycle: lanes on both sides of eastern leg, no bicycle lanes on southern leg and western leg immediately west of intersection.

Traffic Volumes

Existing turning movement count (TMC) data was collected during the AM and PM peak periods in November 2017. The count reports are in **Appendix A** and also include bicycle and pedestrian counts. On the day of intersection counts, the weather was fair (77°F / no rain), and the typical bicycle and pedestrian traffic did not significantly impact intersection operations. The lane configurations and existing AM and PM traffic counts are shown in **Figure 2** and **Figure 3**. 2020 and 2040 projected traffic counts are presented in **Figure 4** through **Figure 7**.

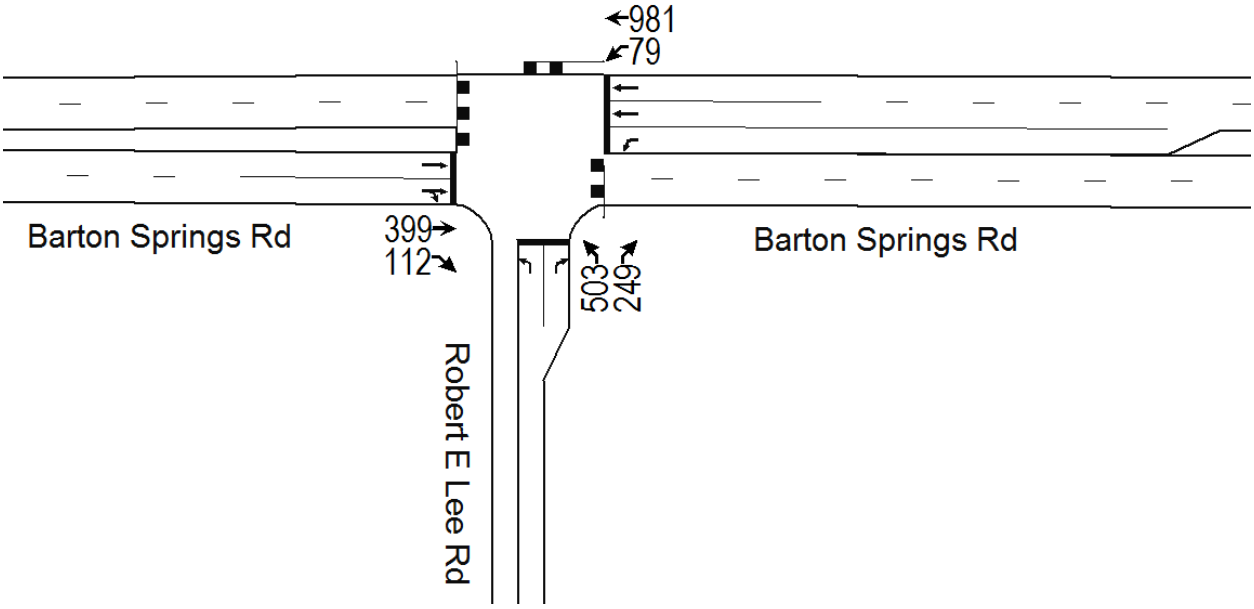


Figure 2: Existing AM Peak Hour Turning Movement Counts

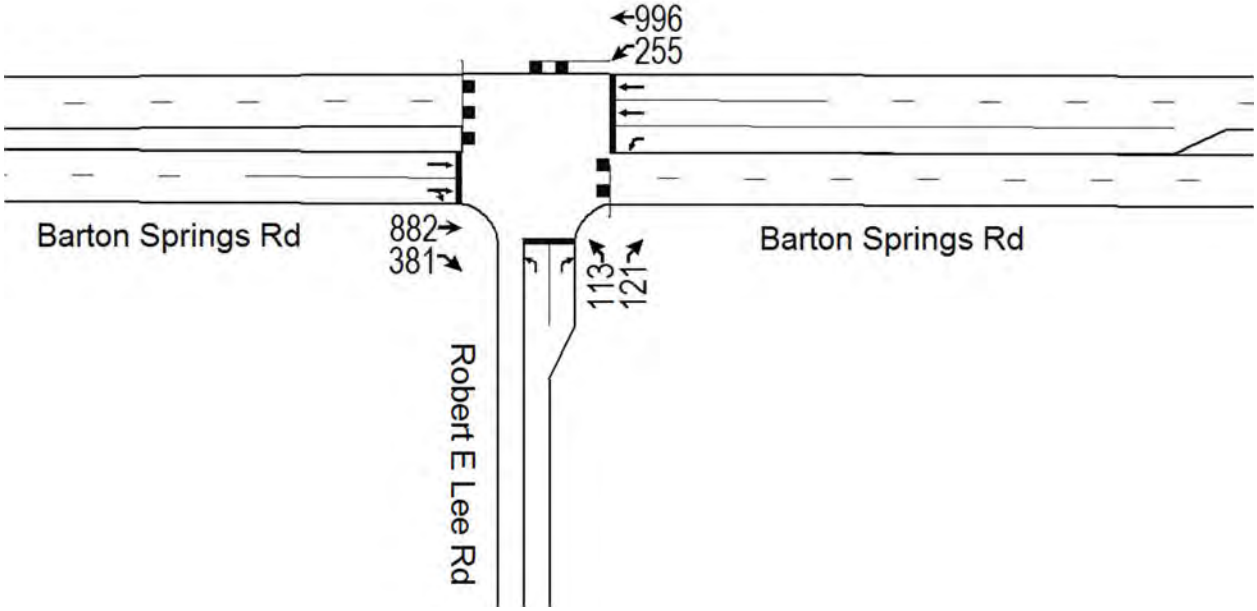


Figure 3: Existing PM Peak Hour Turning Movement Counts

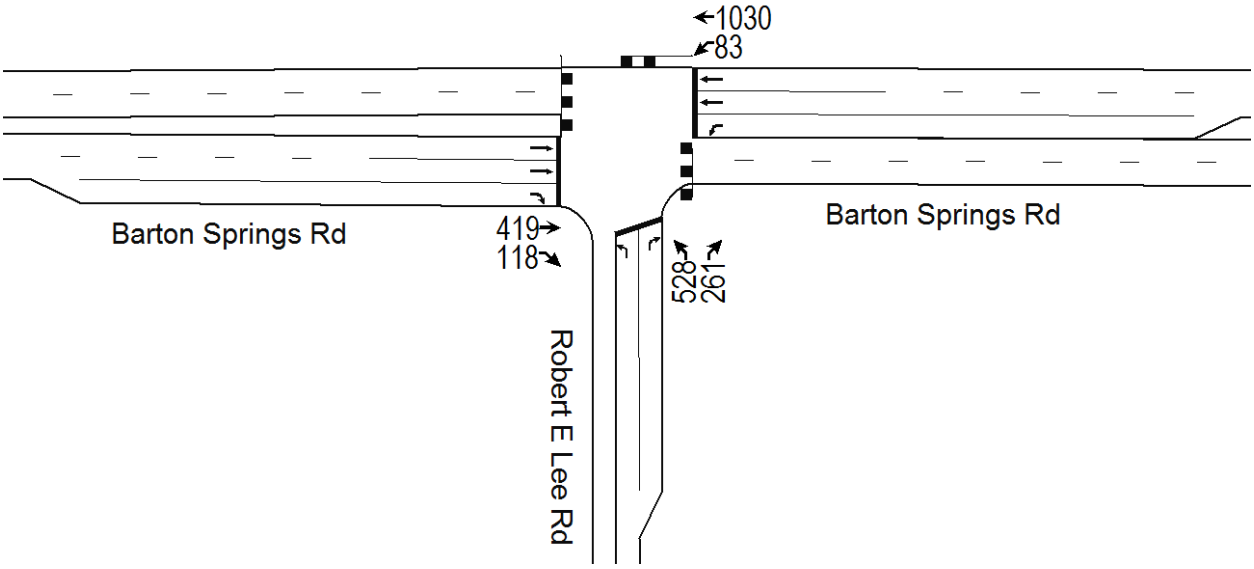


Figure 4: 2020 AM Peak Hour Turning Movement Counts

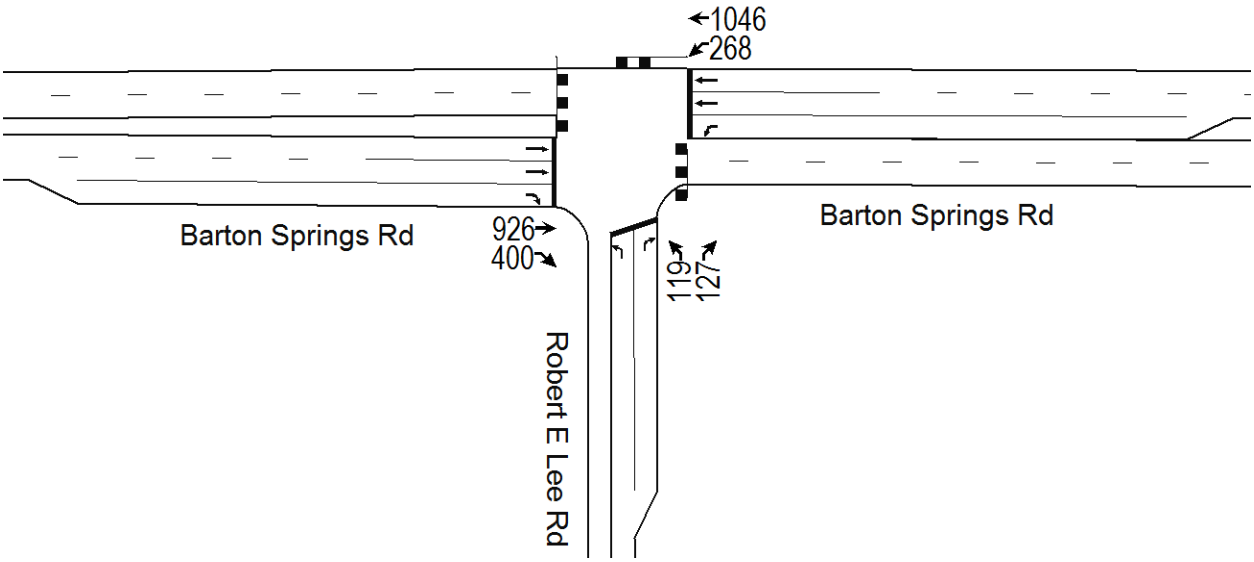


Figure 5: 2020 PM Peak Hour Turning Movement Counts

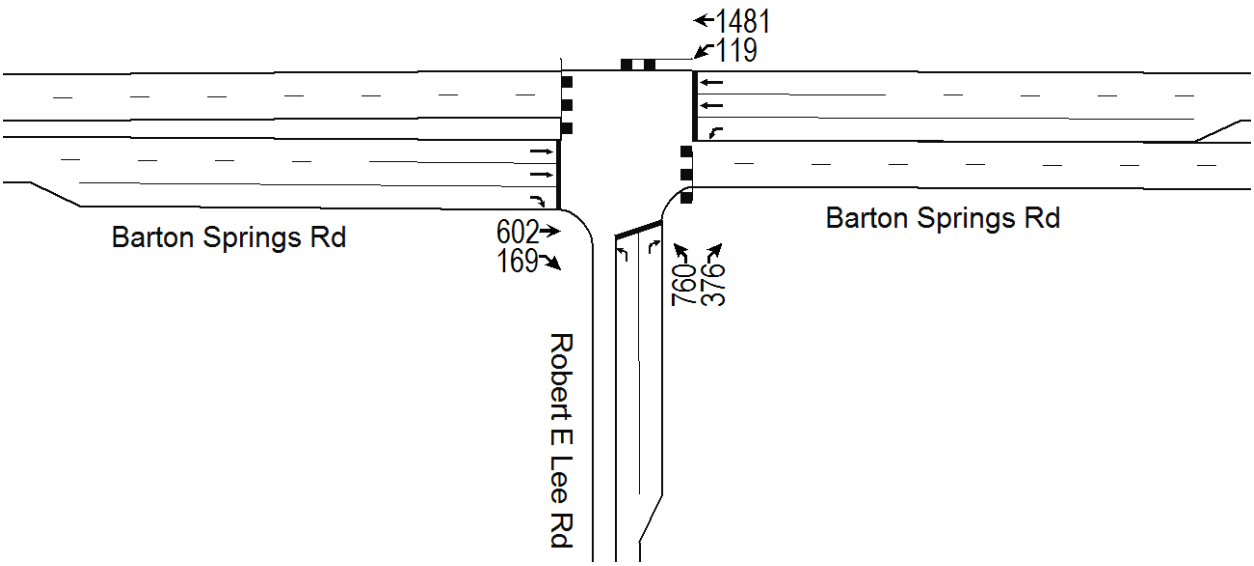


Figure 6: 2040 AM Peak Hour Turning Movement Counts

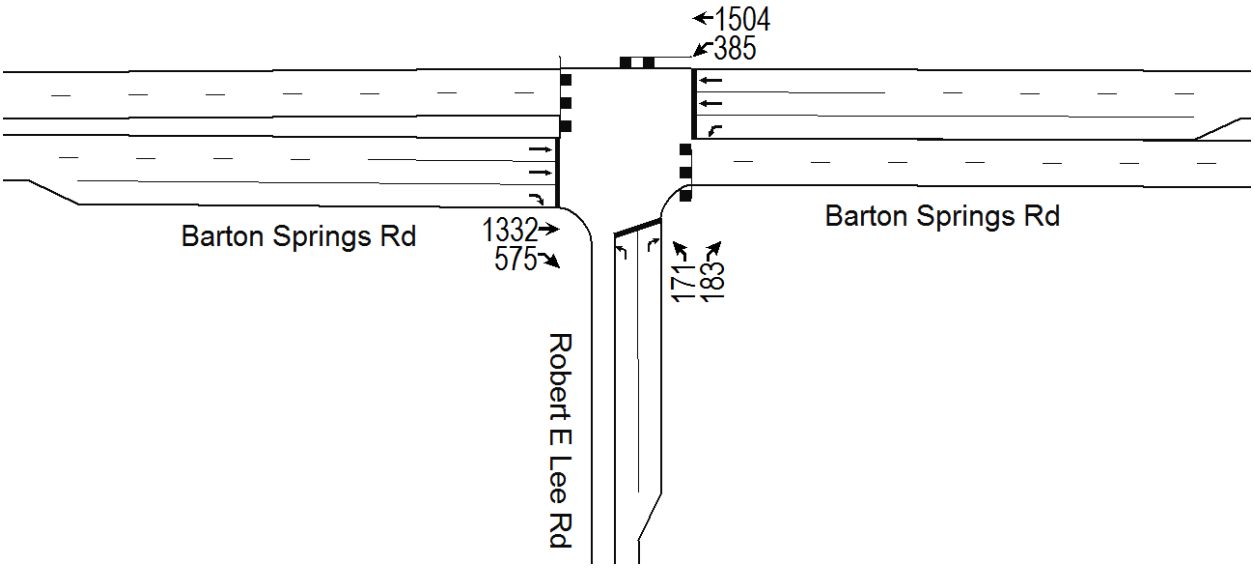


Figure 7: 2040 PM Peak Hour Turning Movement Counts

Intersection LOS Analysis

Existing conditions and No Build and Build conditions for both 2020 and 2040 were analyzed and the overall intersection LOS and delay results are presented in **Table 3** and approach LOS and delay in **Table 4**. Through the course of the analysis, it was determined that the primary sources of congestion are the northbound left turning traffic in the AM peak hour and the eastbound right turning traffic in the PM peak hour. Therefore, the clear alternative for roadway improvements are the addition of turn bays. The Build condition includes a lengthened northbound right turn bay with 130' of storage and an eastbound right turn bay with 250' of storage. The turn bay lengths are based on physical constraints along the approaches. Although storage length for turn bays is often derived from queue lengths in the LOS analysis, this intersection presents several physical constraints including existing trees, driveways, and parking lots. The lengths used are intended to minimize impacts to these constraints while still providing improved vehicle operations. The Synchro reports are provided in **Appendix B**. The Yearly Reduced Vehicle-Hours column in **Table 4** was calculated assuming 250 days per year with peak hour congestion.

Table 3: Intersection LOS and Delay

Year	Peak	No Build		Build	
		LOS	Delay (sec)	LOS	Delay (sec)
2017	AM	C	31.1		
	PM	C	33.5		
2020	AM	C	33.5	C	31.1
	PM	C	22.5	B	17.3
2040	AM	E	64.5	E	59.1
	PM	E	61.6	C	26.5

Table 4: Approach LOS and Delay

Approach	Year	Volume	No Build		Build		Yearly Reduced Veh-Hrs
			LOS	Delay (sec)	LOS	Delay (sec)	
AM Northbound	2017	752	C	29.6			
PM Eastbound		1263	D	49.1			
AM Northbound	2020	790	C	26.1	C	24.3	99
PM Eastbound		1326	C	28.2	C	20.6	700
AM Northbound	2040	1136	E	61.6	E	61.6	0
PM Eastbound		1907	F	89.4	C	29.4	7,946

As seen in the results, the lengthened turn bay on the northbound approach provides small improvement to AM delay in 2020, and by 2040, the approach is too saturated to realize significant benefit from 130' of storage. However, the construction cost of extending the turn bay may be relatively inexpensive. URS has been scoped to design the replacement of the retaining wall along the east side of the approach for increased slope stability, so the only additional costs may be a small amount of additional pavement. Although the addition of an eastbound right turn bay means further widening of the Barton Springs Road Bridge, the travel time benefits in approach delay reduction are 17% in 2020 and 67% in 2040.

For a high-level sketch analysis of benefits vs cost, the yearly vehicle-hour reductions can be monetized to demonstrate 40-year benefits (design life will be much longer). Interpolated delay reduction from 2020-2040 and constant from 2040-2060 are assumed. Using the US DOT value of travel time savings of $13.60, an occupancy of 1.1 persons/vehicle, and a 3% discount rate, the total benefit from delay reduction is $1.9 million. Sketch level costs of the turn bay bridge width are $0.8 million (235' length x 10' width x $350/sq-ft) for construction and $0.1 million (5% of cost every 10 years, 3% discount rate) for maintenance. This yields a benefit-cost ratio of 2.1 ($1.9 million / $0.9 million).

Recommendations

URS recommends construction of both the northbound and eastbound right turn bays at the intersection of Robert E Lee Road and Barton Springs Road. The turn bay storage lengths used in the analysis were 130' for the northbound approach and 250' for the eastbound approach. The turn bays will improve vehicle operations at the intersection by reducing delay for vehicles on those approaches during peak hour traffic. All proposed design for the project will include safe design for bicycle and pedestrian crossings and transitions.

Additional benefits from the right turn bays include additional roadway space for maintenance of traffic during bridge construction and additional pavement and flexibility for special event traffic control operations for the many special events that occur at Zilker Park such as the Austin City Limits Festival and the Trail of Lights. The special event traffic such as buses, special event vehicles, and pedestrian traffic are in extremely high volumes, and the addition of pavement widths around this critical intersection provide more options for how to arrange the traffic patterns.

Appendix A – Traffic Counts

C. J. Hensch & Associates Inc.
5215 Sycamore Ave.

Pasadena, Texas, United States 77503
(281) 487-5417

Count Name: Barton Springs at Robert E Lee
Site Code:
Start Date: 11/01/2017
Page No: 1

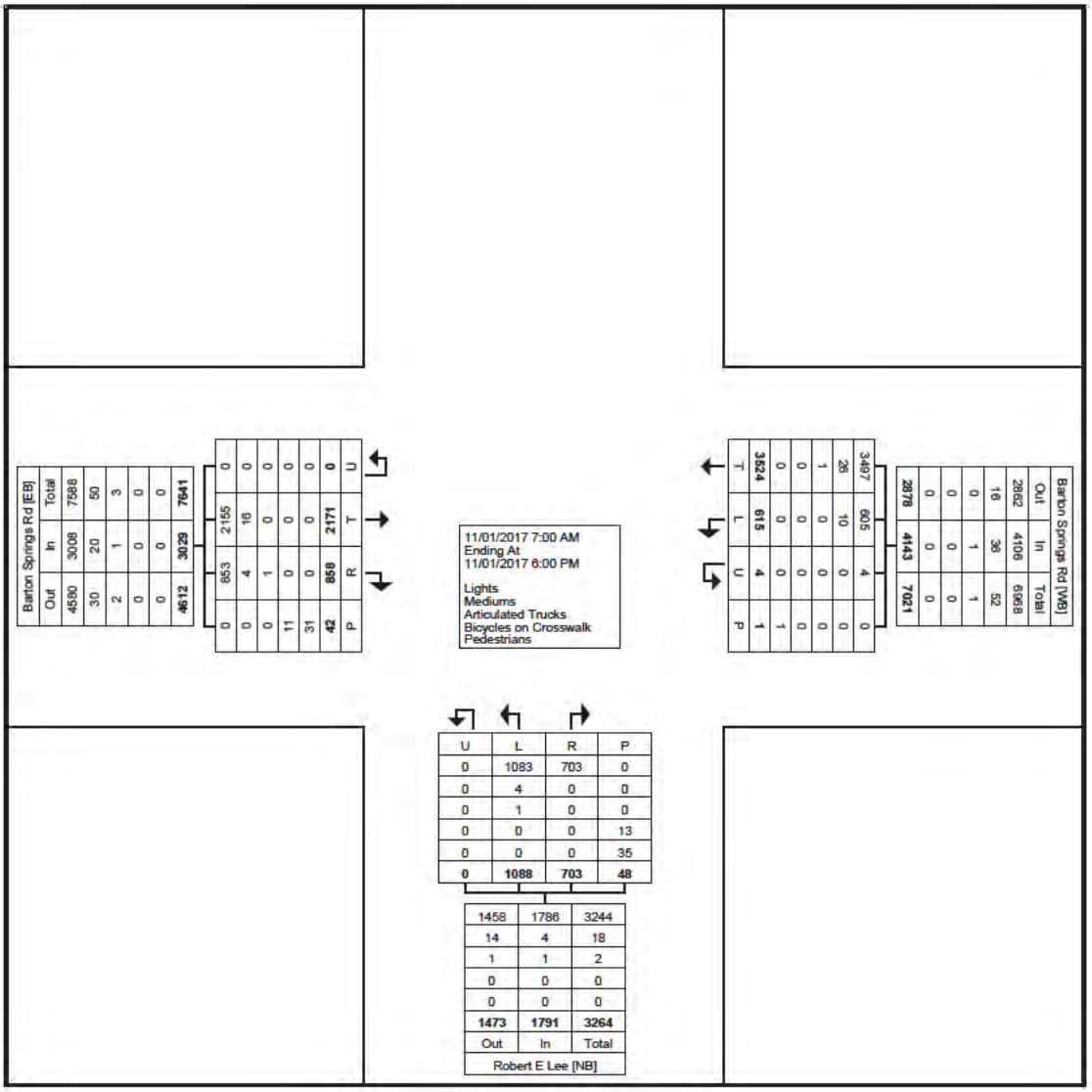
Turning Movement Data

Start Time	Barton Springs Rd Westbound					Robert E Lee Northbound					Barton Springs Rd Eastbound					
	Left	Thru	U-Turn	Peds	App. Total	Left	Right	U-Turn	Peds	App. Total	Thru	Right	U-Turn	Peds	App. Total	Int. Total
7 00 AM	16	61	0	0	77	33	27	0	2	60	57	8	0	1	65	202
7:15 AM	17	115	0	0	132	63	36	0	4	99	63	22	0	1	85	316
7 30 AM	23	167	0	0	190	91	87	0	3	178	69	13	0	0	82	450
7:45 AM	13	224	0	0	237	130	73	0	4	203	88	19	0	0	107	547
Hourly Total	69	567	0	0	636	317	223	0	13	540	277	62	0	2	339	1515
8 00 AM	20	237	0	0	257	108	62	0	0	170	96	19	0	1	115	542
8:15 AM	22	247	1	0	270	158	60	0	0	218	90	21	0	0	111	599
8 30 AM	24	254	0	1	278	108	61	0	3	169	97	37	0	0	134	581
8:45 AM	13	243	0	0	256	129	66	0	4	195	116	35	0	1	151	602
Hourly Total	79	981	1	1	1061	503	249	0	7	752	399	112	0	2	511	2324
*** BREAK ***	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4 00 PM	48	189	0	0	237	22	21	0	3	43	143	57	0	9	200	480
4:15 PM	44	271	0	0	315	50	34	0	4	84	140	64	0	2	204	603
4 30 PM	51	243	0	0	294	49	29	0	2	78	143	86	0	2	229	601
4:45 PM	69	277	0	0	346	34	26	0	1	60	187	96	0	2	283	689
Hourly Total	212	980	0	0	1192	155	110	0	10	265	613	303	0	15	916	2373
5 00 PM	56	234	0	0	290	31	17	0	3	48	209	108	0	5	317	655
5:15 PM	78	253	1	0	332	31	28	0	4	59	193	80	0	9	273	664
5 30 PM	63	264	0	0	327	26	37	0	3	63	237	92	0	4	329	719
5:45 PM	58	245	2	0	305	25	39	0	8	64	243	101	0	5	344	713
Hourly Total	255	996	3	0	1254	113	121	0	18	234	882	381	0	23	1263	2751
Grand Total	615	3524	4	1	4143	1088	703	0	48	1791	2171	858	0	42	3029	8963
Approach %	14.8	85.1	0.1	-	-	60.7	39.3	0 0	-	-	71.7	28 3	0.0	-	-	-
Total %	6.9	39.3	0.0	-	46.2	12.1	7 8	0 0	-	20.0	24 2	9.6	0.0	-	33 8	-
Lights	605	3497	4	-	4106	1083	703	0	-	1786	2155	853	0	-	3008	8900
% Lights	98.4	99.2	100 0	-	99.1	99.5	100.0	-	-	99.7	99 3	99.4	-	-	99 3	99 3
Mediums	10	26	0	-	36	4	0	0	-	4	16	4	0	-	20	60
% Mediums	1.6	0.7	0.0	-	0 9	0.4	0 0	-	-	0 2	0.7	0.5	-	-	0.7	0.7
Articulated Trucks	0	1	0	-	1	1	0	0	-	1	0	1	0	-	1	3
% Articulated Trucks	0.0	0.0	0.0	-	0 0	0.1	0 0	-	-	0.1	0.0	0.1	-	-	0.0	0.0
Bicycles on Crosswalk	-	-	-	0	-	-	-	-	13	-	-	-	-	11	-	-
% Bicycles on Crosswalk	-	-	-	0.0	-	-	-	-	27.1	-	-	-	-	26 2	-	-
Pedestrians	-	-	-	1	-	-	-	-	35	-	-	-	-	31	-	-
% Pedestrians	-	-	-	100 0	-	-	-	-	72.9	-	-	-	-	73 8	-	-

C. J. Hensch & Associates Inc.
5215 Sycamore Ave.

Pasadena, Texas, United States 77503
(281) 487-5417

Count Name: Barton Springs at Robert E Lee
Site Code:
Start Date: 11/01/2017
Page No: 2



Turning Movement Data Plot

C. J. Hensch & Associates Inc.
5215 Sycamore Ave.

Pasadena, Texas, United States 77503
(281) 487-5417

Count Name: Barton Springs at Robert E Lee
Site Code:
Start Date: 11/01/2017

Turning Movement Peak Hour Data (8:00 AM)

Start Time	Barton Springs Rd Westbound					Robert E Lee Northbound					Barton Springs Rd Eastbound					
	Left	Thru	U-Turn	Peds	App. Total	Left	Right	U-Turn	Peds	App. Total	Thru	Right	U-Turn	Peds	App. Total	Int. Total
8 00 AM	20	237	0	0	257	108	62	0	0	170	96	19	0	1	115	542
8:15 AM	22	247	1	0	270	158	60	0	0	218	90	21	0	0	111	599
8 30 AM	24	254	0	1	278	108	61	0	3	169	97	37	0	0	134	581
8:45 AM	13	243	0	0	256	129	66	0	4	195	116	35	0	1	151	602
Total	79	981	1	1	1061	503	249	0	7	752	399	112	0	2	511	2324
Approach %	7.4	92.5	0.1	-	-	66.9	33.1	0 0	-	-	78.1	21 9	0.0	-	-	-
Total %	3.4	42.2	0.0	-	45.7	21.6	10.7	0 0	-	32.4	17 2	4.8	0.0	-	22 0	-
PHF	0.823	0.966	0.250	-	0.954	0.796	0.943	0.000	-	0 862	0 860	0.757	0 000	-	0 846	0 965
Lights	75	970	1	-	1046	501	249	0	-	750	394	109	0	-	503	2299
% Lights	94.9	98.9	100 0	-	98.6	99.6	100.0	-	-	99.7	98.7	97 3	-	-	98.4	98 9
Mediums	4	10	0	-	14	2	0	0	-	2	5	3	0	-	8	24
% Mediums	5.1	1.0	0.0	-	1 3	0.4	0 0	-	-	0 3	1.3	2.7	-	-	1.6	1.0
Articulated Trucks	0	1	0	-	1	0	0	0	-	0	0	0	0	-	0	1
% Articulated Trucks	0.0	0.1	0.0	-	0.1	0 0	0 0	-	-	0 0	0.0	0.0	-	-	0.0	0.0
Bicycles on Crosswalk	-	-	-	0	-	-	-	-	1	-	-	-	-	0	-	-
% Bicycles on Crosswalk	-	-	-	0.0	-	-	-	-	14.3	-	-	-	-	0.0	-	-
Pedestrians	-	-	-	1	-	-	-	-	6	-	-	-	-	2	-	-
% Pedestrians	-	-	-	100 0	-	-	-	-	85.7	-	-	-	-	100.0	-	-

C. J. Hensch & Associates Inc.
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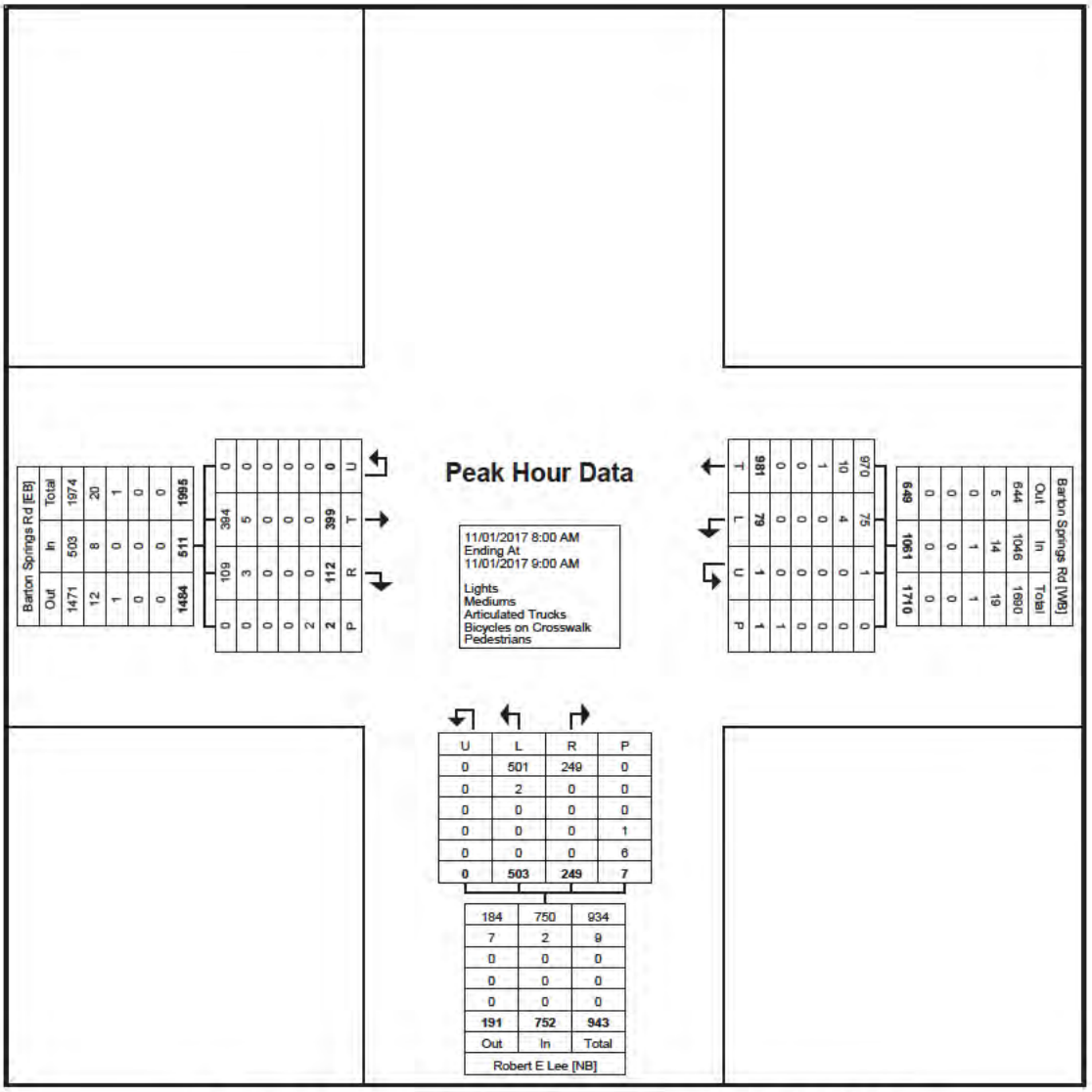
Count Name: Barton Springs at Robert E Lee
Site Code:
Start Date: 11/01/2017
Page No: 4



Turning Movement Peak Hour Data Plot (8:00 AM)

C. J. Hensch & Associates Inc.
5215 Sycamore Ave.

Pasadena, Texas, United States 77503
(281) 487-5417

Count Name: Barton Springs at Robert E Lee
Site Code:
Start Date: 11/01/2017

Turning Movement Peak Hour Data (5:00 PM)

Start Time	Barton Springs Rd Westbound					Robert E Lee Northbound					Barton Springs Rd Eastbound					
	Left	Thru	U-Turn	Peds	App. Total	Left	Right	U-Turn	Peds	App. Total	Thru	Right	U-Turn	Peds	App. Total	Int. Total
5 00 PM	56	234	0	0	290	31	17	0	3	48	209	108	0	5	317	655
5:15 PM	78	253	1	0	332	31	28	0	4	59	193	80	0	9	273	664
5 30 PM	63	264	0	0	327	26	37	0	3	63	237	92	0	4	329	719
5:45 PM	58	245	2	0	305	25	39	0	8	64	243	101	0	5	344	713
Total	255	996	3	0	1254	113	121	0	18	234	882	381	0	23	1263	2751
Approach %	20.3	79.4	0.2	-	-	48.3	51.7	0 0	-	-	69 8	30 2	0.0	-	-	-
Total %	9.3	36.2	0.1	-	45.6	4.1	4.4	0 0	-	8 5	32.1	13 8	0.0	-	45 9	-
PHF	0.817	0.943	0.375	-	0.944	0.911	0.776	0.000	-	0.914	0 907	0 882	0 000	-	0 918	0 957
Lights	253	993	3	-	1249	113	121	0	-	234	880	381	0	-	1261	2744
% Lights	99.2	99.7	100 0	-	99.6	100.0	100.0	-	-	100.0	99 8	100.0	-	-	99 8	99.7
Mediums	2	3	0	-	5	0	0	0	-	0	2	0	0	-	2	7
% Mediums	0.8	0.3	0.0	-	0.4	0 0	0 0	-	-	0 0	0.2	0.0	-	-	0.2	0.3
Articulated Trucks	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0
% Articulated Trucks	0.0	0.0	0.0	-	0 0	0 0	0 0	-	-	0 0	0.0	0.0	-	-	0.0	0.0
Bicycles on Crosswalk	-	-	-	0	-	-	-	-	4	-	-	-	-	4	-	-
% Bicycles on Crosswalk	-	-	-	-	-	-	-	-	22.2	-	-	-	-	17.4	-	-
Pedestrians	-	-	-	0	-	-	-	-	14	-	-	-	-	19	-	-
% Pedestrians	-	-	-	-	-	-	-	-	77.8	-	-	-	-	82 6	-	-

C. J. Hensch & Associates Inc.
5215 Sycamore Ave.

Pasadena, Texas, United States 77503
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Count Name: Barton Springs at Robert E Lee
Site Code:
Start Date: 11/01/2017
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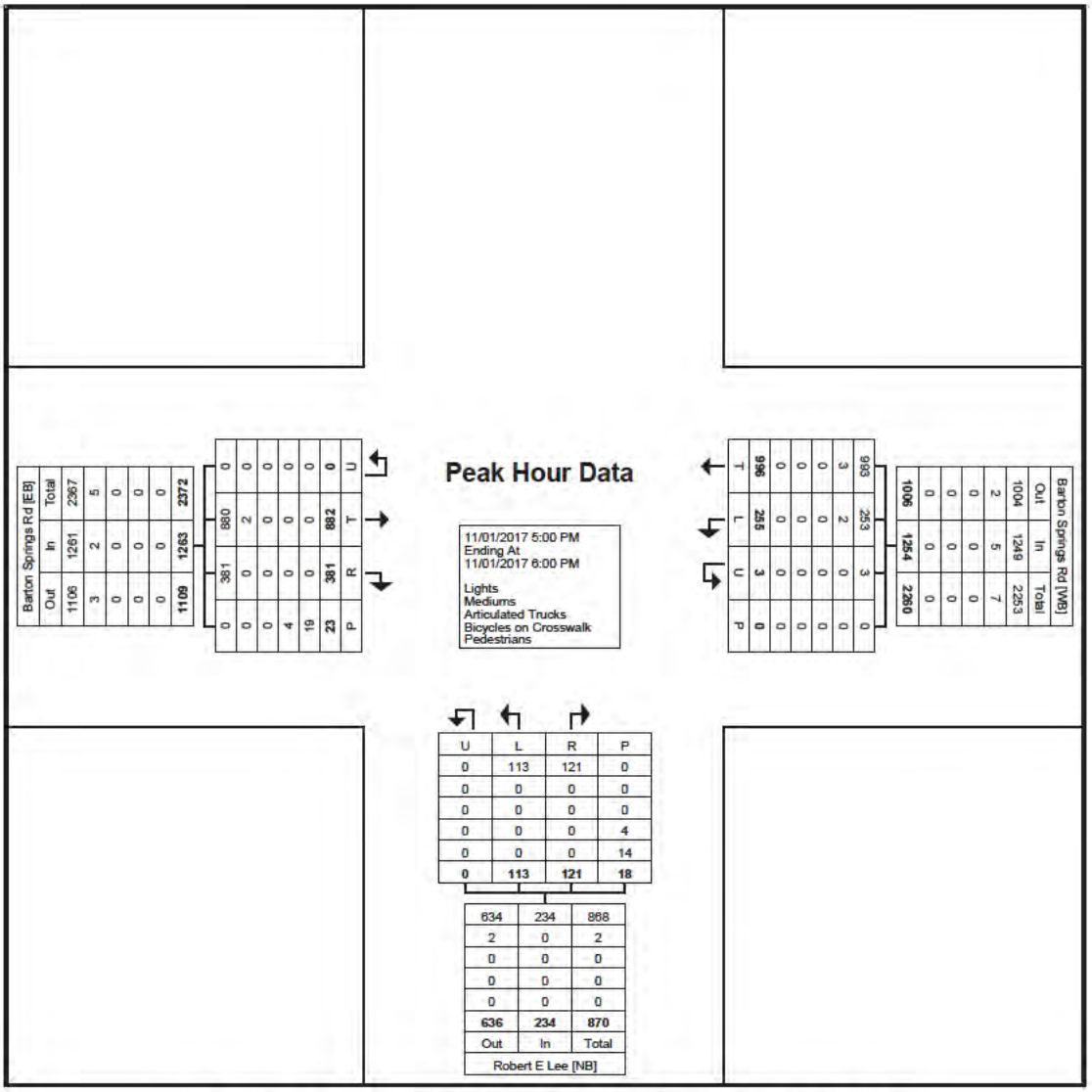


Turning Movement Peak Hour Data Plot (5:00 PM)

Appendix B – Synchro Reports

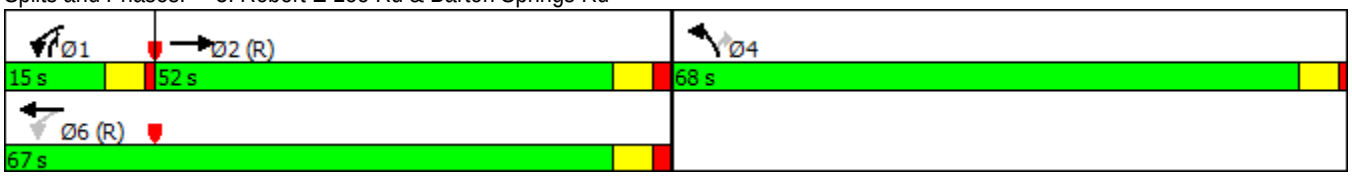
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	399	112	79	981	503	249
Future Volume (vph)	399	112	79	981	503	249
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)		0	260		0	40
Storage Lanes		0	1		1	1
Taper Length (ft)			25		25	
Lane Util. Factor	0.95	0.95	1.00	0.95	1.00	1.00
Ped Bike Factor	0.99		1.00		1.00	0.98
Frt	0.964					0.850
Flt Protected			0.950		0.950	
Satd. Flow (prot)	3391	0	1770	3539	1770	1583
Flt Permitted			0.269		0.950	
Satd. Flow (perm)	3391	0	501	3539	1763	1559
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)	34					64
Link Speed (mph)	35			35	30	
Link Distance (ft)	928			736	1481	
Travel Time (s)	18.1			14.3	33.7	
Confl. Peds. (#/hr)		2	1		6	6
Confl. Bikes (#/hr)						1
Peak Hour Factor	0.86	0.76	0.82	0.97	0.80	0.94
Adj. Flow (vph)	464	147	96	1011	629	265
Shared Lane Traffic (%)						
Lane Group Flow (vph)	611	0	96	1011	629	265
Turn Type	NA		pm+pt	NA	Prot	pm+ov
Protected Phases	2		1	6	4	1
Permitted Phases			6			4
Minimum Split (s)	45.0		10.0	20.0	20.0	10.0
Total Split (s)	52.0		15.0	67.0	68.0	15.0
Total Split (%)	38.5%		11.1%	49.6%	50.4%	11.1%
Maximum Green (s)	46.0		10.0	61.0	63.0	10.0
Yellow Time (s)	4.0		4.0	4.0	4.0	4.0
All-Red Time (s)	2.0		1.0	2.0	1.0	1.0
Lost Time Adjust (s)	0.0		0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0		5.0	6.0	5.0	5.0
Lead/Lag	Lag		Lead			Lead
Lead-Lag Optimize?	Yes		Yes			Yes
Walk Time (s)	7.0					
Flash Dont Walk (s)	16.0					
Pedestrian Calls (#/hr)	0					
Act Effct Green (s)	46.0		62.0	61.0	63.0	73.0
Actuated g/C Ratio	0.34		0.46	0.45	0.47	0.54
v/c Ratio	0.52		0.30	0.63	0.76	0.30
Control Delay	35.4		23.5	30.6	37.2	11.8
Queue Delay	0.0		0.0	0.0	0.0	0.0
Total Delay	35.4		23.5	30.6	37.2	11.8
LOS	D		C	C	D	B
Approach Delay	35.4			30.0	29.6	

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Approach LOS	D			C	C	
Queue Length 50th (ft)	212		47	351	447	82
Queue Length 95th (ft)	256		75	425	499	134
Internal Link Dist (ft)	848			656	1401	
Turn Bay Length (ft)			260			40
Base Capacity (vph)	1177		324	1599	826	874
Starvation Cap Reductn	0		0	0	0	0
Spillback Cap Reductn	0		0	0	0	0
Storage Cap Reductn	0		0	0	0	0
Reduced v/c Ratio	0.52		0.30	0.63	0.76	0.30

Intersection Summary

Area Type: Other
Cycle Length: 135
Actuated Cycle Length: 135
Offset: 62 (46%), Referenced to phase 2:EBT and 6:WBTL, Start of Green
Natural Cycle: 90
Control Type: Pretimed
Maximum v/c Ratio: 0.76
Intersection Signal Delay: 31.1 — Intersection LOS: C
Intersection Capacity Utilization 64.7% — ICU Level of Service C
Analysis Period (min) 15

Splits and Phases: 3: Robert E Lee Rd & Barton Springs Rd



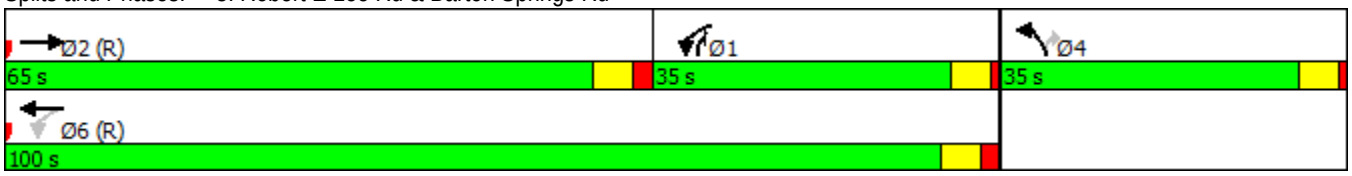
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	882	381	255	996	113	121
Future Volume (vph)	882	381	255	996	113	121
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)		0	260		0	40
Storage Lanes		0	1		1	1
Taper Length (ft)			25		25	
Lane Util. Factor	0.95	0.95	1.00	0.95	1.00	1.00
Ped Bike Factor	0.98				0.98	0.98
Frt	0.954					0.850
Flt Protected			0.950		0.950	
Satd. Flow (prot)	3295	0	1770	3539	1770	1583
Flt Permitted			0.062		0.950	
Satd. Flow (perm)	3295	0	115	3539	1736	1547
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)	67					50
Link Speed (mph)	35			35	30	
Link Distance (ft)	928			736	1481	
Travel Time (s)	18.1			14.3	33.7	
Confl. Peds. (#/hr)		19	1		14	14
Confl. Bikes (#/hr)		4				4
Peak Hour Factor	0.91	0.88	0.82	0.94	0.91	0.78
Adj. Flow (vph)	969	433	311	1060	124	155
Shared Lane Traffic (%)						
Lane Group Flow (vph)	1402	0	311	1060	124	155
Turn Type	NA		pm+pt	NA	Prot	pm+ov
Protected Phases	2		1	6	4	1
Permitted Phases			6			4
Minimum Split (s)	45.0		25.0	60.0	20.0	25.0
Total Split (s)	65.0		35.0	100.0	35.0	35.0
Total Split (%)	48.1%		25.9%	74.1%	25.9%	25.9%
Maximum Green (s)	59.0		30.0	94.0	30.0	30.0
Yellow Time (s)	4.0		4.0	4.0	4.0	4.0
All-Red Time (s)	2.0		1.0	2.0	1.0	1.0
Lost Time Adjust (s)	0.0		0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0		5.0	6.0	5.0	5.0
Lead/Lag	Lead		Lag			Lag
Lead-Lag Optimize?	Yes		Yes			Yes
Walk Time (s)	7.0					
Flash Dont Walk (s)	16.0					
Pedestrian Calls (#/hr)	0					
Act Effct Green (s)	59.0		95.0	94.0	30.0	60.0
Actuated g/C Ratio	0.44		0.70	0.70	0.22	0.44
v/c Ratio	0.95		0.69	0.43	0.32	0.21
Control Delay	49.1		49.6	9.5	46.6	14.2
Queue Delay	0.0		0.0	0.0	0.0	0.0
Total Delay	49.1		49.6	9.5	46.6	14.2
LOS	D		D	A	D	B
Approach Delay	49.1			18.6	28.6	

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Approach LOS	D			B	C	
Queue Length 50th (ft)	592		196	193	92	50
Queue Length 95th (ft)	#757		265	233	152	76
Internal Link Dist (ft)	848			656	1401	
Turn Bay Length (ft)			260			40
Base Capacity (vph)	1477		448	2464	393	723
Starvation Cap Reductn	0		0	0	0	0
Spillback Cap Reductn	0		0	0	0	0
Storage Cap Reductn	0		0	0	0	0
Reduced v/c Ratio	0.95		0.69	0.43	0.32	0.21

Intersection Summary

Area Type: Other
Cycle Length: 135
Actuated Cycle Length: 135
Offset: 32 (24%), Referenced to phase 2:EBT and 6:WBTL, Start of Green
Natural Cycle: 90
Control Type: Pretimed
Maximum v/c Ratio: 0.95
Intersection Signal Delay: 33.5 Intersection LOS: C
Intersection Capacity Utilization 72.9% ICU Level of Service C
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3: Robert E Lee Rd & Barton Springs Rd



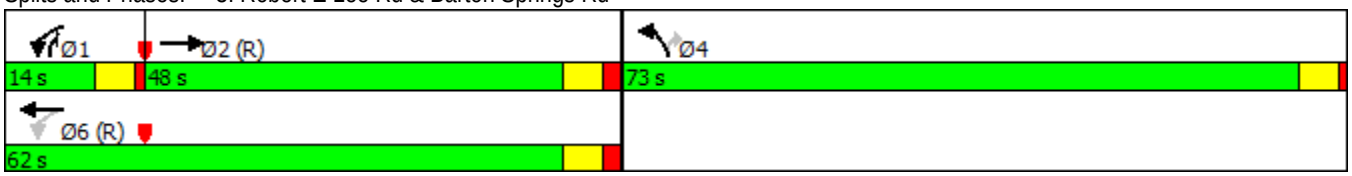
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	399	112	79	981	503	249
Future Volume (vph)	399	112	79	981	503	249
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)		0	260		0	40
Storage Lanes		0	1		1	1
Taper Length (ft)			25		25	
Lane Util. Factor	0.95	0.95	1.00	0.95	1.00	1.00
Ped Bike Factor	0.99		1.00		1.00	0.98
Frt	0.964					0.850
Flt Protected			0.950		0.950	
Satd. Flow (prot)	3391	0	1770	3539	1770	1583
Flt Permitted			0.230		0.950	
Satd. Flow (perm)	3391	0	428	3539	1763	1559
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)	33					68
Link Speed (mph)	35			35	30	
Link Distance (ft)	928			736	1481	
Travel Time (s)	18.1			14.3	33.7	
Confl. Peds. (#/hr)		2	1		6	6
Confl. Bikes (#/hr)						1
Peak Hour Factor	0.86	0.76	0.82	0.97	0.80	0.94
Growth Factor	105%	105%	105%	105%	105%	105%
Adj. Flow (vph)	487	155	101	1062	660	278
Shared Lane Traffic (%)						
Lane Group Flow (vph)	642	0	101	1062	660	278
Turn Type	NA		pm+pt	NA	Prot	pm+ov
Protected Phases	2		1	6	4	1
Permitted Phases			6			4
Minimum Split (s)	45.0		10.0	20.0	20.0	10.0
Total Split (s)	48.0		14.0	62.0	73.0	14.0
Total Split (%)	35.6%		10.4%	45.9%	54.1%	10.4%
Maximum Green (s)	42.0		9.0	56.0	68.0	9.0
Yellow Time (s)	4.0		4.0	4.0	4.0	4.0
All-Red Time (s)	2.0		1.0	2.0	1.0	1.0
Lost Time Adjust (s)	0.0		0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0		5.0	6.0	5.0	5.0
Lead/Lag	Lag		Lead			Lead
Lead-Lag Optimize?	Yes		Yes			Yes
Walk Time (s)	7.0					
Flash Dont Walk (s)	16.0					
Pedestrian Calls (#/hr)	0					
Act Effct Green (s)	42.0		57.0	56.0	68.0	77.0
Actuated g/C Ratio	0.31		0.42	0.41	0.50	0.57
v/c Ratio	0.60		0.37	0.72	0.74	0.30
Control Delay	39.9		28.1	36.5	32.8	10.3
Queue Delay	0.0		0.0	0.0	0.0	0.0
Total Delay	39.9		28.1	36.5	32.8	10.3
LOS	D		C	D	C	B

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Approach Delay	39.9			35.8	26.1	
Approach LOS	D			D	C	
Queue Length 50th (ft)	237		54	405	446	80
Queue Length 95th (ft)	285		84	487	493	129
Internal Link Dist (ft)	848			656	1401	
Turn Bay Length (ft)			260			40
Base Capacity (vph)	1077		270	1468	891	920
Starvation Cap Reductn	0		0	0	0	0
Spillback Cap Reductn	0		0	0	0	0
Storage Cap Reductn	0		0	0	0	0
Reduced v/c Ratio	0.60		0.37	0.72	0.74	0.30

Intersection Summary

Area Type: Other
Cycle Length: 135
Actuated Cycle Length: 135
Offset: 62 (46%), Referenced to phase 2:EBT and 6:WBTL, Start of Green
Natural Cycle: 90
Control Type: Pretimed
Maximum v/c Ratio: 0.74
Intersection Signal Delay: 33.5 Intersection LOS: C
Intersection Capacity Utilization 66.9% ICU Level of Service C
Analysis Period (min) 15

Splits and Phases: 3: Robert E Lee Rd & Barton Springs Rd



Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	882	381	255	996	113	121
Future Volume (vph)	882	381	255	996	113	121
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)		0	260		0	40
Storage Lanes		0	1		1	1
Taper Length (ft)			25		25	
Lane Util. Factor	0.95	0.95	1.00	0.95	1.00	1.00
Ped Bike Factor	0.98				0.97	0.97
Frt	0.954					0.850
Flt Protected			0.950		0.950	
Satd. Flow (prot)	3296	0	1770	3539	1770	1583
Flt Permitted			0.086		0.950	
Satd. Flow (perm)	3296	0	160	3539	1711	1541
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)	83					81
Link Speed (mph)	35			35	30	
Link Distance (ft)	928			736	1481	
Travel Time (s)	18.1			14.3	33.7	
Confl. Peds. (#/hr)		19	1		14	14
Confl. Bikes (#/hr)		4				4
Peak Hour Factor	0.91	0.88	0.82	0.94	0.91	0.78
Growth Factor	105%	105%	105%	105%	105%	105%
Adj. Flow (vph)	1018	455	327	1113	130	163
Shared Lane Traffic (%)						
Lane Group Flow (vph)	1473	0	327	1113	130	163
Turn Type	NA		pm+pt	NA	Prot	pm+ov
Protected Phases	2		1	6	4	1
Permitted Phases			6			4
Minimum Split (s)	45.0		25.0	60.0	20.0	25.0
Total Split (s)	79.0		34.0	113.0	22.0	34.0
Total Split (%)	58.5%		25.2%	83.7%	16.3%	25.2%
Maximum Green (s)	73.0		29.0	107.0	17.0	29.0
Yellow Time (s)	4.0		4.0	4.0	4.0	4.0
All-Red Time (s)	2.0		1.0	2.0	1.0	1.0
Lost Time Adjust (s)	0.0		0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0		5.0	6.0	5.0	5.0
Lead/Lag	Lead		Lag			Lag
Lead-Lag Optimize?	Yes		Yes			Yes
Walk Time (s)	7.0					
Flash Dont Walk (s)	16.0					
Pedestrian Calls (#/hr)	0					
Act Effct Green (s)	73.0		108.0	107.0	17.0	46.0
Actuated g/C Ratio	0.54		0.80	0.79	0.13	0.34
v/c Ratio	0.81		0.69	0.40	0.59	0.28
Control Delay	28.2		42.9	4.7	67.2	15.6
Queue Delay	0.0		0.0	0.0	0.0	0.0
Total Delay	28.2		42.9	4.7	67.2	15.6
LOS	C		D	A	E	B

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Approach Delay	28.2			13.4	38.5	
Approach LOS	C			B	D	
Queue Length 50th (ft)	511		171	131	109	47
Queue Length 95th (ft)	614		239	156	179	77
Internal Link Dist (ft)	848			656	1401	
Turn Bay Length (ft)			260			40
Base Capacity (vph)	1820		473	2804	222	587
Starvation Cap Reductn	0		0	0	0	0
Spillback Cap Reductn	0		0	0	0	0
Storage Cap Reductn	0		0	0	0	0
Reduced v/c Ratio	0.81		0.69	0.40	0.59	0.28

Intersection Summary	
Area Type:	Other
Cycle Length: 135	
Actuated Cycle Length: 135	
Offset: 32 (24%), Referenced to phase 2:EBT and 6:WBTL, Start of Green	
Natural Cycle: 90	
Control Type: Pretimed	
Maximum v/c Ratio: 0.81	
Intersection Signal Delay: 22.5	Intersection LOS: C
Intersection Capacity Utilization 75.5%	ICU Level of Service D
Analysis Period (min) 15	

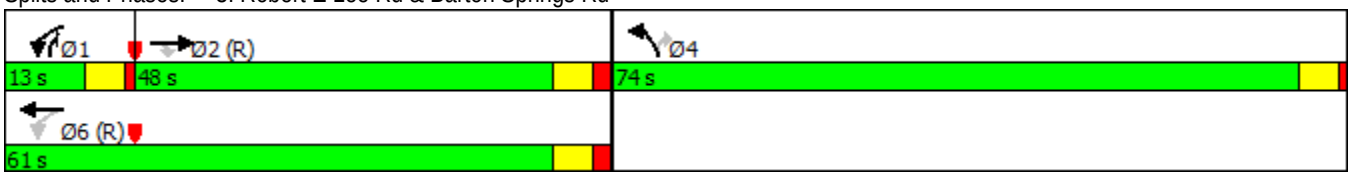
Splits and Phases: 3: Robert E Lee Rd & Barton Springs Rd

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	399	112	79	981	503	249
Future Volume (vph)	399	112	79	981	503	249
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)		250	260		0	130
Storage Lanes		1	1		1	1
Taper Length (ft)			25		25	
Lane Util. Factor	0.95	1.00	1.00	0.95	1.00	1.00
Ped Bike Factor		0.97	1.00		1.00	0.98
Frt		0.850				0.850
Flt Protected			0.950		0.950	
Satd. Flow (prot)	3539	1583	1770	3539	1770	1583
Flt Permitted			0.329		0.950	
Satd. Flow (perm)	3539	1543	612	3539	1763	1559
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)		155				136
Link Speed (mph)	35			35	30	
Link Distance (ft)	928			736	1481	
Travel Time (s)	18.1			14.3	33.7	
Confl. Peds. (#/hr)		2	1		6	6
Confl. Bikes (#/hr)						1
Peak Hour Factor	0.86	0.76	0.82	0.97	0.80	0.94
Growth Factor	105%	105%	105%	105%	105%	105%
Adj. Flow (vph)	487	155	101	1062	660	278
Shared Lane Traffic (%)						
Lane Group Flow (vph)	487	155	101	1062	660	278
Turn Type	NA	Perm	pm+pt	NA	Prot	pm+ov
Protected Phases	2		1	6	4	1
Permitted Phases		2	6			4
Minimum Split (s)	45.0	45.0	10.0	20.0	20.0	10.0
Total Split (s)	48.0	48.0	13.0	61.0	74.0	13.0
Total Split (%)	35.6%	35.6%	9.6%	45.2%	54.8%	9.6%
Maximum Green (s)	42.0	42.0	8.0	55.0	69.0	8.0
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	1.0	2.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0	6.0	5.0	6.0	5.0	5.0
Lead/Lag	Lag	Lag	Lead			Lead
Lead-Lag Optimize?	Yes	Yes	Yes			Yes
Walk Time (s)	7.0	7.0				
Flash Dont Walk (s)	16.0	16.0				
Pedestrian Calls (#/hr)	0	0				
Act Effct Green (s)	42.0	42.0	56.0	55.0	69.0	77.0
Actuated g/C Ratio	0.31	0.31	0.41	0.41	0.51	0.57
v/c Ratio	0.44	0.26	0.31	0.74	0.73	0.29
Control Delay	38.7	6.1	27.4	37.7	31.7	6.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	38.7	6.1	27.4	37.7	31.7	6.9
LOS	D	A	C	D	C	A

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Approach Delay	30.8			36.8	24.3	
Approach LOS	C			D	C	
Queue Length 50th (ft)	179	0	54	410	439	51
Queue Length 95th (ft)	220	27	85	494	485	96
Internal Link Dist (ft)	848			656	1401	
Turn Bay Length (ft)		250	260			130
Base Capacity (vph)	1101	586	322	1441	904	949
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.44	0.26	0.31	0.74	0.73	0.29

Intersection Summary	
Area Type: Other	
Cycle Length: 135	
Actuated Cycle Length: 135	
Offset: 62 (46%), Referenced to phase 2:EBT and 6:WBTL, Start of Green	
Natural Cycle: 90	
Control Type: Pretimed	
Maximum v/c Ratio: 0.74	
Intersection Signal Delay: 31.1	Intersection LOS: C
Intersection Capacity Utilization 66.9%	ICU Level of Service C
Analysis Period (min) 15	

Splits and Phases: 3: Robert E Lee Rd & Barton Springs Rd



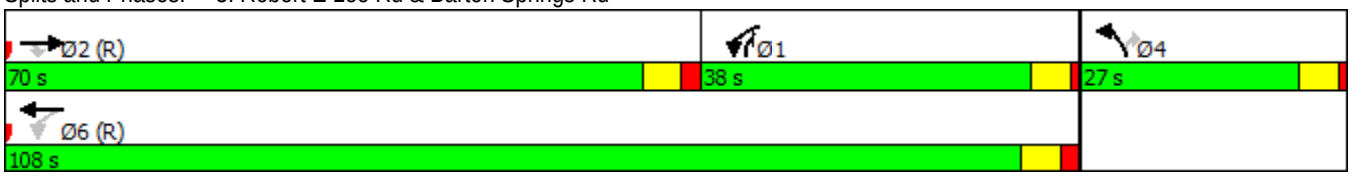
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	882	381	255	996	113	121
Future Volume (vph)	882	381	255	996	113	121
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)		250	260		0	130
Storage Lanes		1	1		1	1
Taper Length (ft)			25		25	
Lane Util. Factor	0.95	1.00	1.00	0.95	1.00	1.00
Ped Bike Factor		0.92			0.97	0.98
Frt		0.850				0.850
Flt Protected			0.950		0.950	
Satd. Flow (prot)	3539	1583	1770	3539	1770	1583
Flt Permitted			0.185		0.950	
Satd. Flow (perm)	3539	1460	345	3539	1724	1545
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)		455				55
Link Speed (mph)	35			35	30	
Link Distance (ft)	928			736	1481	
Travel Time (s)	18.1			14.3	33.7	
Confl. Peds. (#/hr)		19	1		14	14
Confl. Bikes (#/hr)		4				4
Peak Hour Factor	0.91	0.88	0.82	0.94	0.91	0.78
Growth Factor	105%	105%	105%	105%	105%	105%
Adj. Flow (vph)	1018	455	327	1113	130	163
Shared Lane Traffic (%)						
Lane Group Flow (vph)	1018	455	327	1113	130	163
Turn Type	NA	Perm	pm+pt	NA	Prot	pm+ov
Protected Phases	2		1	6	4	1
Permitted Phases		2	6			4
Minimum Split (s)	45.0	45.0	25.0	60.0	20.0	25.0
Total Split (s)	70.0	70.0	38.0	108.0	27.0	38.0
Total Split (%)	51.9%	51.9%	28.1%	80.0%	20.0%	28.1%
Maximum Green (s)	64.0	64.0	33.0	102.0	22.0	33.0
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	1.0	2.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0	6.0	5.0	6.0	5.0	5.0
Lead/Lag	Lead	Lead	Lag			Lag
Lead-Lag Optimize?	Yes	Yes	Yes			Yes
Walk Time (s)	7.0	7.0				
Flash Dont Walk (s)	16.0	16.0				
Pedestrian Calls (#/hr)	0	0				
Act Effct Green (s)	64.0	64.0	103.0	102.0	22.0	55.0
Actuated g/C Ratio	0.47	0.47	0.76	0.76	0.16	0.41
v/c Ratio	0.61	0.49	0.54	0.42	0.45	0.24
Control Delay	28.1	3.7	24.1	6.4	56.8	16.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	28.1	3.7	24.1	6.4	56.8	16.1
LOS	C	A	C	A	E	B

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Approach Delay	20.6			10.5	34.2	
Approach LOS	C			B	C	
Queue Length 50th (ft)	339	0	73	160	104	56
Queue Length 95th (ft)	410	51	122	192	171	84
Internal Link Dist (ft)	848			656	1401	
Turn Bay Length (ft)		250	260			130
Base Capacity (vph)	1677	931	611	2673	288	671
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.61	0.49	0.54	0.42	0.45	0.24

Intersection Summary

Area Type: Other
Cycle Length: 135
Actuated Cycle Length: 135
Offset: 32 (24%), Referenced to phase 2:EBT and 6:WBTL, Start of Green
Natural Cycle: 90
Control Type: Pretimed
Maximum v/c Ratio: 0.61
Intersection Signal Delay: 17.3 Intersection LOS: B
Intersection Capacity Utilization 62.1% ICU Level of Service B
Analysis Period (min) 15

Splits and Phases: 3: Robert E Lee Rd & Barton Springs Rd



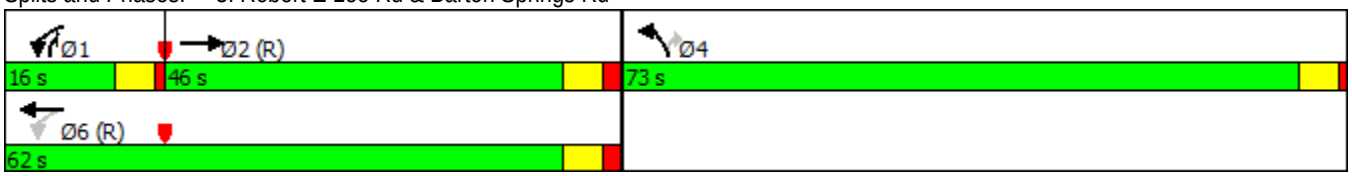
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	399	112	79	981	503	249
Future Volume (vph)	399	112	79	981	503	249
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)		0	260		0	40
Storage Lanes		0	1		1	1
Taper Length (ft)			25		25	
Lane Util. Factor	0.95	0.95	1.00	0.95	1.00	1.00
Ped Bike Factor	0.99				1.00	0.98
Frt	0.964					0.850
Flt Protected			0.950		0.950	
Satd. Flow (prot)	3391	0	1770	3539	1770	1583
Flt Permitted			0.089		0.950	
Satd. Flow (perm)	3391	0	166	3539	1763	1559
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)	32					44
Link Speed (mph)	35			35	30	
Link Distance (ft)	928			736	1481	
Travel Time (s)	18.1			14.3	33.7	
Confl. Peds. (#/hr)		2	1		6	6
Confl. Bikes (#/hr)						1
Peak Hour Factor	0.86	0.76	0.82	0.97	0.80	0.94
Growth Factor	151%	151%	151%	151%	151%	151%
Adj. Flow (vph)	701	223	145	1527	949	400
Shared Lane Traffic (%)						
Lane Group Flow (vph)	924	0	145	1527	949	400
Turn Type	NA		pm+pt	NA	Prot	pm+ov
Protected Phases	2		1	6	4	1
Permitted Phases			6			4
Minimum Split (s)	45.0		10.0	20.0	20.0	10.0
Total Split (s)	46.0		16.0	62.0	73.0	16.0
Total Split (%)	34.1%		11.9%	45.9%	54.1%	11.9%
Maximum Green (s)	40.0		11.0	56.0	68.0	11.0
Yellow Time (s)	4.0		4.0	4.0	4.0	4.0
All-Red Time (s)	2.0		1.0	2.0	1.0	1.0
Lost Time Adjust (s)	0.0		0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0		5.0	6.0	5.0	5.0
Lead/Lag	Lag		Lead			Lead
Lead-Lag Optimize?	Yes		Yes			Yes
Walk Time (s)	7.0					
Flash Dont Walk (s)	16.0					
Pedestrian Calls (#/hr)	0					
Act Effct Green (s)	40.0		57.0	56.0	68.0	79.0
Actuated g/C Ratio	0.30		0.42	0.41	0.50	0.59
v/c Ratio	0.90		0.72	1.04	1.07	0.43
Control Delay	56.6		48.7	73.3	82.0	13.0
Queue Delay	0.0		0.0	0.0	0.0	0.0
Total Delay	56.6		48.7	73.3	82.0	13.0
LOS	E		D	E	F	B

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Approach Delay	56.6			71.2	61.6	
Approach LOS	E			E	E	
Queue Length 50th (ft)	397		79	~759	~916	146
Queue Length 95th (ft)	456		#130	#899	#952	214
Internal Link Dist (ft)	848			656	1401	
Turn Bay Length (ft)			260			40
Base Capacity (vph)	1027		200	1468	891	932
Starvation Cap Reductn	0		0	0	0	0
Spillback Cap Reductn	0		0	0	0	0
Storage Cap Reductn	0		0	0	0	0
Reduced v/c Ratio	0.90		0.72	1.04	1.07	0.43

Intersection Summary

Area Type: Other
Cycle Length: 135
Actuated Cycle Length: 135
Offset: 62 (46%), Referenced to phase 2:EBT and 6:WBTL, Start of Green
Natural Cycle: 110
Control Type: Pretimed
Maximum v/c Ratio: 1.07
Intersection Signal Delay: 64.5 Intersection LOS: E
Intersection Capacity Utilization 92.2% ICU Level of Service F
Analysis Period (min) 15
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3: Robert E Lee Rd & Barton Springs Rd



Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	882	381	255	996	113	121
Future Volume (vph)	882	381	255	996	113	121
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)		0	260		0	40
Storage Lanes		0	1		1	1
Taper Length (ft)			25		25	
Lane Util. Factor	0.95	0.95	1.00	0.95	1.00	1.00
Ped Bike Factor	0.98				0.96	0.97
Frt	0.954					0.850
Flt Protected			0.950		0.950	
Satd. Flow (prot)	3296	0	1770	3539	1770	1583
Flt Permitted			0.049		0.950	
Satd. Flow (perm)	3296	0	91	3539	1703	1540
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)	87					29
Link Speed (mph)	35			35	30	
Link Distance (ft)	928			736	1481	
Travel Time (s)	18.1			14.3	33.7	
Confl. Peds. (#/hr)		19	1		14	14
Confl. Bikes (#/hr)		4				4
Peak Hour Factor	0.91	0.88	0.82	0.94	0.91	0.78
Growth Factor	151%	151%	151%	151%	151%	151%
Adj. Flow (vph)	1464	654	470	1600	188	234
Shared Lane Traffic (%)						
Lane Group Flow (vph)	2118	0	470	1600	188	234
Turn Type	NA		pm+pt	NA	Prot	pm+ov
Protected Phases	2		1	6	4	1
Permitted Phases			6			4
Minimum Split (s)	45.0		25.0	60.0	20.0	25.0
Total Split (s)	82.0		33.0	115.0	20.0	33.0
Total Split (%)	60.7%		24.4%	85.2%	14.8%	24.4%
Maximum Green (s)	76.0		28.0	109.0	15.0	28.0
Yellow Time (s)	4.0		4.0	4.0	4.0	4.0
All-Red Time (s)	2.0		1.0	2.0	1.0	1.0
Lost Time Adjust (s)	0.0		0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0		5.0	6.0	5.0	5.0
Lead/Lag	Lead		Lag			Lag
Lead-Lag Optimize?	Yes		Yes			Yes
Walk Time (s)	7.0					
Flash Dont Walk (s)	16.0					
Pedestrian Calls (#/hr)	0					
Act Effct Green (s)	76.0		110.0	109.0	15.0	43.0
Actuated g/C Ratio	0.56		0.81	0.81	0.11	0.32
v/c Ratio	1.12		1.11	0.56	0.96	0.45
Control Delay	89.4		121.1	5.5	113.7	31.8
Queue Delay	0.0		0.0	0.0	0.0	0.0
Total Delay	89.4		121.1	5.5	113.7	31.8
LOS	F		F	A	F	C

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Approach Delay	89.4			31.7	68.3	
Approach LOS	F			C	E	
Queue Length 50th (ft)	~1106		~421	213	167	134
Queue Length 95th (ft)	#1242		#543	252	#320	173
Internal Link Dist (ft)	848			656	1401	
Turn Bay Length (ft)			260			40
Base Capacity (vph)	1893		422	2857	196	519
Starvation Cap Reductn	0		0	0	0	0
Spillback Cap Reductn	0		0	0	0	0
Storage Cap Reductn	0		0	0	0	0
Reduced v/c Ratio	1.12		1.11	0.56	0.96	0.45

Intersection Summary

Area Type: Other
Cycle Length: 135
Actuated Cycle Length: 135
Offset: 32 (24%), Referenced to phase 2:EBT and 6:WBTL, Start of Green
Natural Cycle: 150
Control Type: Pretimed
Maximum v/c Ratio: 1.12
Intersection Signal Delay: 61.6 Intersection LOS: E
Intersection Capacity Utilization 99.9% ICU Level of Service F
Analysis Period (min) 15
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3: Robert E Lee Rd & Barton Springs Rd

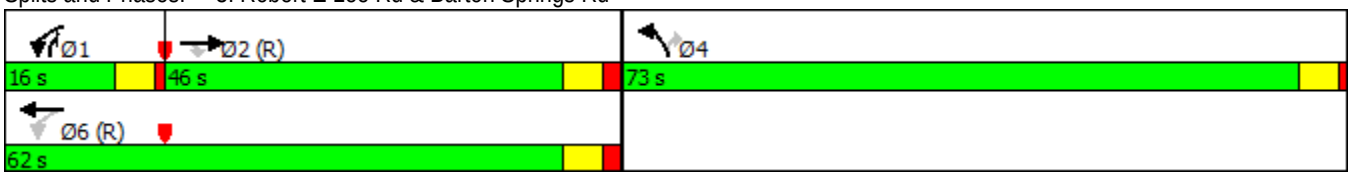
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	399	112	79	981	503	249
Future Volume (vph)	399	112	79	981	503	249
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)		250	260		0	130
Storage Lanes		1	1		1	1
Taper Length (ft)			25		25	
Lane Util. Factor	0.95	1.00	1.00	0.95	1.00	1.00
Ped Bike Factor		0.97			1.00	0.98
Frt		0.850				0.850
Flt Protected			0.950		0.950	
Satd. Flow (prot)	3539	1583	1770	3539	1770	1583
Flt Permitted			0.184		0.950	
Satd. Flow (perm)	3539	1543	343	3539	1763	1559
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)		223				44
Link Speed (mph)	35			35	30	
Link Distance (ft)	928			736	1481	
Travel Time (s)	18.1			14.3	33.7	
Confl. Peds. (#/hr)		2	1		6	6
Confl. Bikes (#/hr)						1
Peak Hour Factor	0.86	0.76	0.82	0.97	0.80	0.94
Growth Factor	151%	151%	151%	151%	151%	151%
Adj. Flow (vph)	701	223	145	1527	949	400
Shared Lane Traffic (%)						
Lane Group Flow (vph)	701	223	145	1527	949	400
Turn Type	NA	Perm	pm+pt	NA	Prot	pm+ov
Protected Phases	2		1	6	4	1
Permitted Phases		2	6			4
Minimum Split (s)	45.0	45.0	10.0	20.0	20.0	10.0
Total Split (s)	46.0	46.0	16.0	62.0	73.0	16.0
Total Split (%)	34.1%	34.1%	11.9%	45.9%	54.1%	11.9%
Maximum Green (s)	40.0	40.0	11.0	56.0	68.0	11.0
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	1.0	2.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0	6.0	5.0	6.0	5.0	5.0
Lead/Lag	Lag	Lag	Lead			Lead
Lead-Lag Optimize?	Yes	Yes	Yes			Yes
Walk Time (s)	7.0	7.0				
Flash Dont Walk (s)	16.0	16.0				
Pedestrian Calls (#/hr)	0	0				
Act Effct Green (s)	40.0	40.0	57.0	56.0	68.0	79.0
Actuated g/C Ratio	0.30	0.30	0.42	0.41	0.50	0.59
v/c Ratio	0.67	0.36	0.56	1.04	1.07	0.43
Control Delay	45.4	6.1	33.2	73.3	82.0	13.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	45.4	6.1	33.2	73.3	82.0	13.0
LOS	D	A	C	E	F	B

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Approach Delay	35.9			69.8	61.6	
Approach LOS	D			E	E	
Queue Length 50th (ft)	284	0	79	~759	~916	146
Queue Length 95th (ft)	334	27	115	#899	#952	214
Internal Link Dist (ft)	848			656	1401	
Turn Bay Length (ft)		250	260			130
Base Capacity (vph)	1048	614	261	1468	891	932
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.67	0.36	0.56	1.04	1.07	0.43

Intersection Summary

Area Type: Other
Cycle Length: 135
Actuated Cycle Length: 135
Offset: 62 (46%), Referenced to phase 2:EBT and 6:WBTL, Start of Green
Natural Cycle: 110
Control Type: Pretimed
Maximum v/c Ratio: 1.07
Intersection Signal Delay: 59.1 Intersection LOS: E
Intersection Capacity Utilization 92.2% ICU Level of Service F
Analysis Period (min) 15
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3: Robert E Lee Rd & Barton Springs Rd



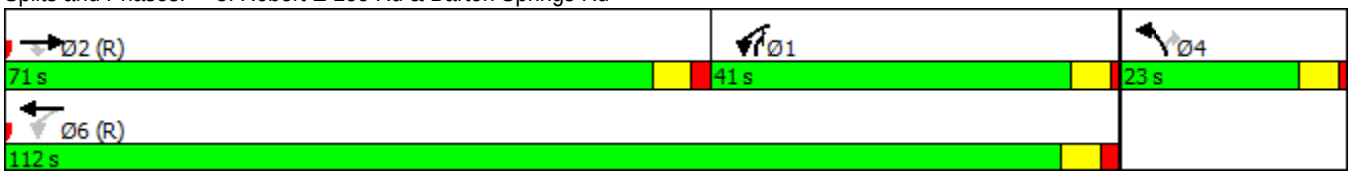
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	882	381	255	996	113	121
Future Volume (vph)	882	381	255	996	113	121
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)		250	260		0	130
Storage Lanes		1	1		1	1
Taper Length (ft)			25		25	
Lane Util. Factor	0.95	1.00	1.00	0.95	1.00	1.00
Ped Bike Factor		0.92			0.97	0.98
Frt		0.850				0.850
Flt Protected			0.950		0.950	
Satd. Flow (prot)	3539	1583	1770	3539	1770	1583
Flt Permitted			0.062		0.950	
Satd. Flow (perm)	3539	1461	115	3539	1714	1545
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)		462				15
Link Speed (mph)	35			35	30	
Link Distance (ft)	928			736	1481	
Travel Time (s)	18.1			14.3	33.7	
Confl. Peds. (#/hr)		19	1		14	14
Confl. Bikes (#/hr)		4				4
Peak Hour Factor	0.91	0.88	0.82	0.94	0.91	0.78
Growth Factor	151%	151%	151%	151%	151%	151%
Adj. Flow (vph)	1464	654	470	1600	188	234
Shared Lane Traffic (%)						
Lane Group Flow (vph)	1464	654	470	1600	188	234
Turn Type	NA	Perm	pm+pt	NA	Prot	pm+ov
Protected Phases	2		1	6	4	1
Permitted Phases		2	6			4
Minimum Split (s)	45.0	45.0	25.0	60.0	20.0	25.0
Total Split (s)	71.0	71.0	41.0	112.0	23.0	41.0
Total Split (%)	52.6%	52.6%	30.4%	83.0%	17.0%	30.4%
Maximum Green (s)	65.0	65.0	36.0	106.0	18.0	36.0
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	1.0	2.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0	6.0	5.0	6.0	5.0	5.0
Lead/Lag	Lead	Lead	Lag			Lag
Lead-Lag Optimize?	Yes	Yes	Yes			Yes
Walk Time (s)	7.0	7.0				
Flash Dont Walk (s)	16.0	16.0				
Pedestrian Calls (#/hr)	0	0				
Act Effct Green (s)	65.0	65.0	107.0	106.0	18.0	54.0
Actuated g/C Ratio	0.48	0.48	0.79	0.79	0.13	0.40
v/c Ratio	0.86	0.69	0.88	0.58	0.80	0.37
Control Delay	37.4	11.5	60.1	6.7	80.8	25.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	37.4	11.5	60.1	6.7	80.8	25.4
LOS	D	B	E	A	F	C

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Approach Delay	29.4			18.8	50.1	
Approach LOS	C			B	D	
Queue Length 50th (ft)	584	120	336	245	162	124
Queue Length 95th (ft)	691	244	#420	290	#284	159
Internal Link Dist (ft)	848			656	1401	
Turn Bay Length (ft)		250	260			130
Base Capacity (vph)	1703	943	532	2778	236	637
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.86	0.69	0.88	0.58	0.80	0.37

Intersection Summary

Area Type: Other
Cycle Length: 135
Actuated Cycle Length: 135
Offset: 32 (24%), Referenced to phase 2:EBT and 6:WBTL, Start of Green
Natural Cycle: 90
Control Type: Pretimed
Maximum v/c Ratio: 0.88
Intersection Signal Delay: 26.5 Intersection LOS: C
Intersection Capacity Utilization 80.9% ICU Level of Service D
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3: Robert E Lee Rd & Barton Springs Rd



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Appendix B - Bridge Initial Assessments

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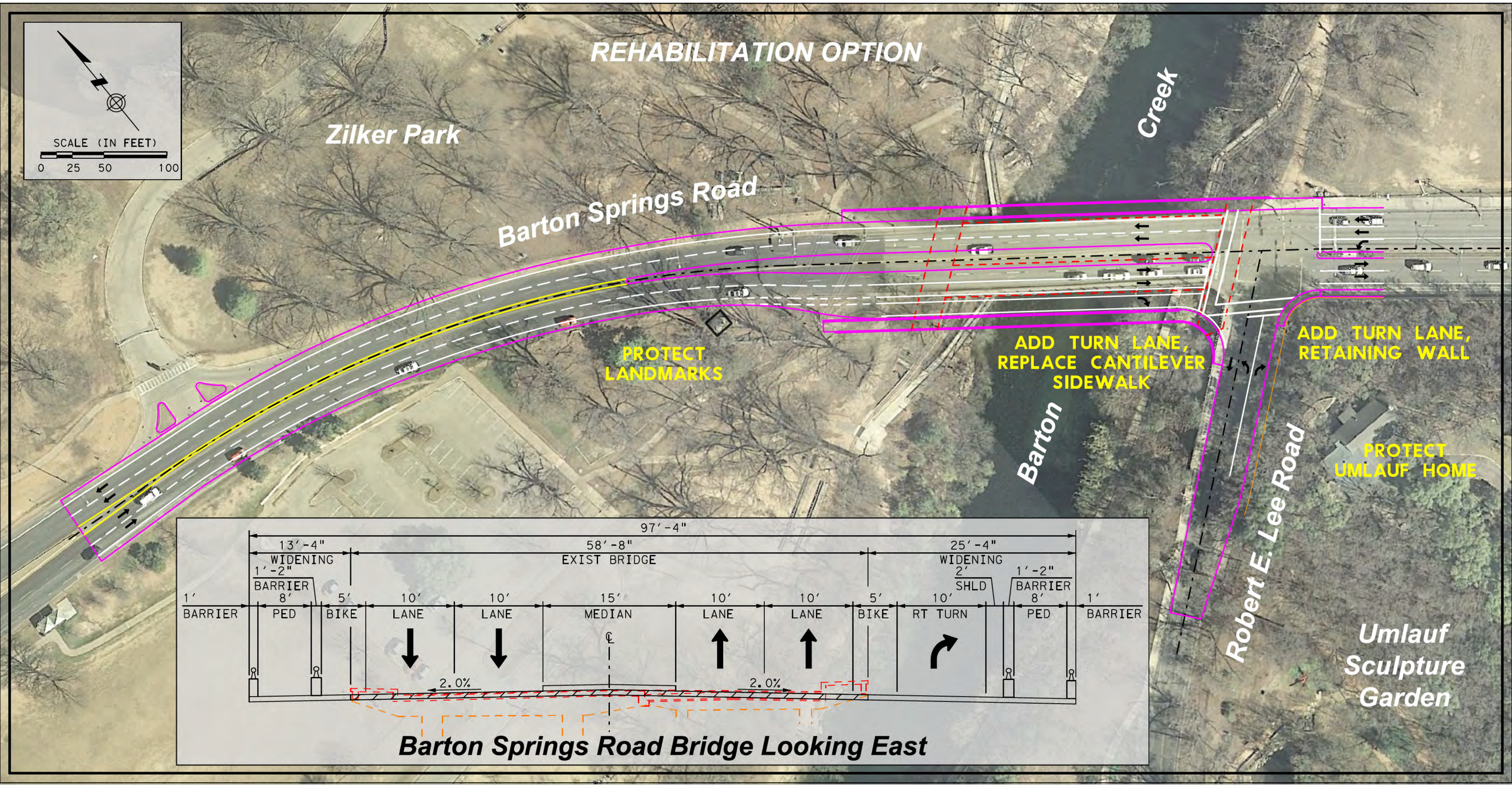
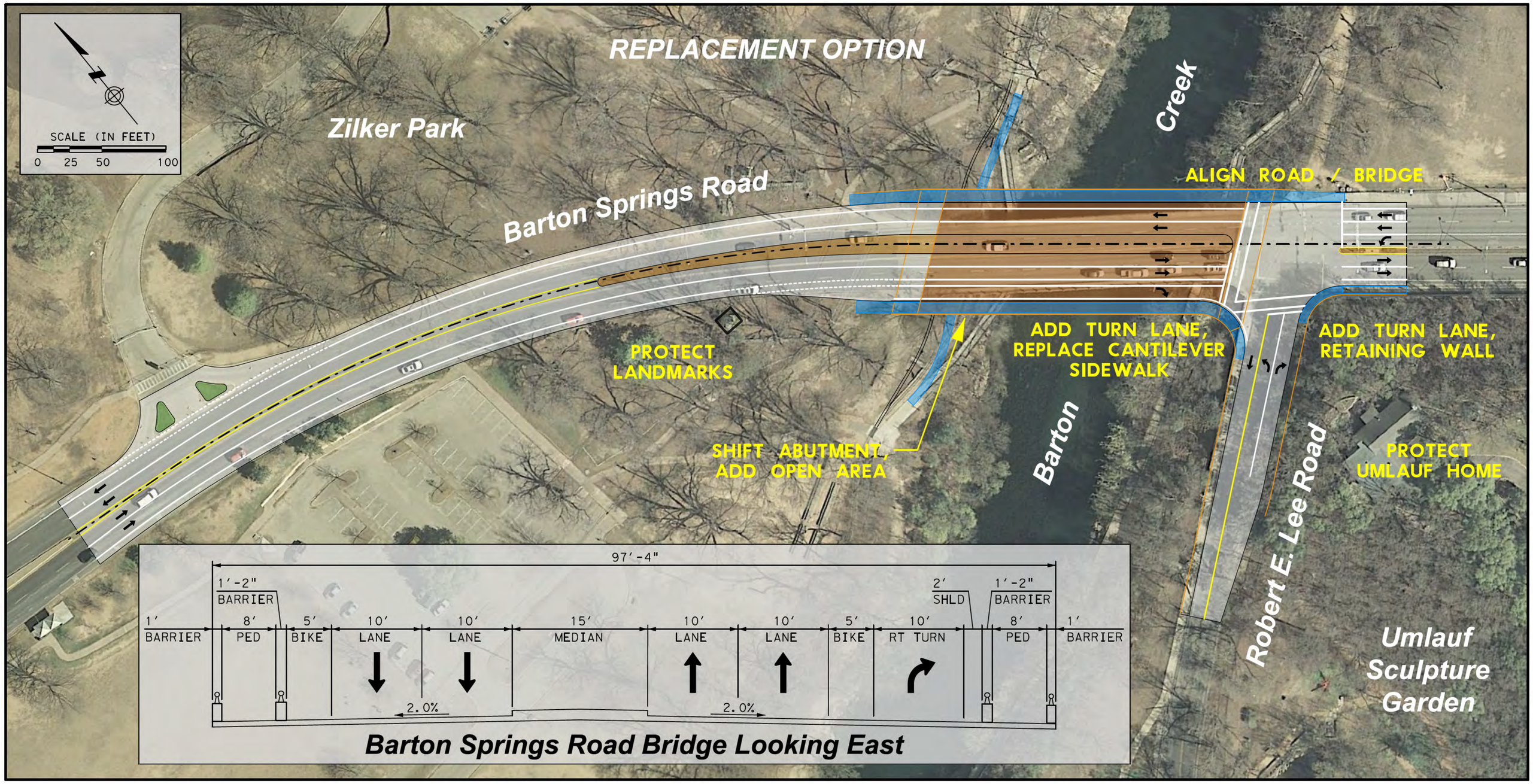
B-1 - Initial Geometry - Feb 2018


REHABILITATION OPTION
SCALE (IN FEET)
0 25 50 100
Zilker Park
Barton Springs Road
Barton Creek
PROTECT LANDMARKS
ADD TURN LANE, REPLACE CANTILEVER SIDEWALK
ADD TURN LANE, RETAINING WALL
PROTECT UMLAUF HOME
Robert E. Lee Road
Umlauf Sculpture Garden
97'-4"
13'-4" WIDENING
58'-8" EXIST BRIDGE
25'-4" WIDENING
1'-2" BARRIER
2' SHLD
1'-2" BARRIER
1' BARRIER
8' PED
5' BIKE
10' LANE
10' LANE
15' MEDIAN
10' LANE
10' LANE
5' BIKE
10' RT TURN
8' PED
1' BARRIER
2.0%
2.0%
Barton Springs Road Bridge Looking East


REPLACEMENT OPTION
SCALE (IN FEET)
0 25 50 100
Zilker Park
Barton Springs Road
Creek
ALIGN ROAD / BRIDGE
PROTECT LANDMARKS
ADD TURN LANE, REPLACE CANTILEVER SIDEWALK
ADD TURN LANE, RETAINING WALL
SHIFT ABUTMENT, ADD OPEN AREA
Barton
Robert E. Lee Road
PROTECT UMLAUF HOME
Umlauf Sculpture Garden
97'-4"
1'-2" BARRIER
2' SHLD
1'-2" BARRIER
1' BARRIER
8' PED
5' BIKE
10' LANE
10' LANE
15' MEDIAN
10' LANE
10' LANE
5' BIKE
10' RT TURN
8' PED
1' BARRIER
2.0%
2.0%
Barton Springs Road Bridge Looking East

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B-2 - Rehabilitation Feasibility - May 2018

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B-3 - Public Works Management Briefing - July 2018

Barton Springs Rd. Bridge Briefing

Barton Springs Rd. Bridge - Setting

- Three-span open concrete spandrel arch on concrete foundations;
- 212' long 58'-8" wide;
- 1925 original construction, prior to highland lakes system in 1930s;
- 1946 widened to current x-sect; 2 lanes each direction;
- Located at entrance to Zilker Park – in national register of historic places; bridge is a contributing factor:
  - Hike/bike trails underneath both abutments; children's train (Zephyr) under west abutment; canoe/kayak rentals and traffic;
  - Park is setting for large events (Austin City Limit Fest; Trail of Lights; Concerts); significant traffic for autos, pedestrian, shuttle bus, etc.;
  - Civilian Conservation Corps historic monuments nearby;
- Key commuter route and east-west arterial – 22,000 ADT;
- Intersection and key Barton Hills and Zilker neighborhood entrance immediately east of bridge on Azie Morton Rd (prev. Robert E Lee):
  - Intersection is integral to any future bridge work.

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Barton Springs Rd. Bridge - Setting

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Barton Springs Rd. Bridge - Overview

- Purpose and Need for this project is safety-related bridge improvements:
  - Insufficient bike / pedestrian paths (functionally obsolete);
  - Bridge roadway lanes not aligned with lanes east of Azie Morton;
  - Elevated / overhanging sidewalk is integral with intersection – past movement / cracking;
  - Hillside instability (rock fall) and obsolete retaining wall on Azie Morton east side at intersection; integrate replacement with bridge project;
  - Age of structure;
  - Overall congestion of bridge, intersection;
- Original Goal is to Evaluate:
  - 2 Rehabilitation Options;
  - 3 Replacement Options;
  - If it becomes apparent the Rehabilitation Options are not feasible, then document and continue with replacement options.

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Barton Springs Rd. Bridge – Work Performed

- **Traffic / Intersection Study**
  - Transportation Department Request
  - Traffic counts along Barton Springs Rd
  - Modeling Auto/Pedestrian movements – current and future
  - Identified current/future time savings/delay reductions by:
    - Adding right turn lane from Barton Springs Rd to Azie Morton Rd;
    - Extending right turn lane from Azie Morton Rd. to Barton Springs Rd.
  - Transportation Department concurred

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Barton Springs Rd. Bridge – Work Performed

- **Bridge Condition Inspection**
  - Detailed Inspection, Condition Assessment Report and Material Study
  - Structurally overall Fair Condition; but with some structural elements in poor condition
    - Longitudinal beam supporting 1925 deck with 1945 bridge
    - Various spandrel columns and floor beams
  - Rehabilitation recommendations include replacing the deck, floor beams, longitudinal support beam, and spandrel columns (leaving only the arches)
  - Effectively eliminates the 'minimal impact' rehabilitation option

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Barton Springs Rd. Bridge – Plan Layouts

- Roadway/Bridge Layouts – Rehabilitation and Replacement
  - Both options include expanded deck, bike lanes, sidewalks;
  - Addition of right turn lane;
  - MOT considerations for continuation of 2-lanes EW of traffic during construction:
    - Initial movement of west-bound lanes to the north;
    - This is likely also important to lessen impacts for major City events (ie. ACL Fest)
    - This in effect provides opportunity for placemaking and wider pedestrian space on the north side;

  - Potential impacts / under review:
    - Historic monuments on west bank (reviewing adjustment of MOT or potential to adjust monument location);
    - Heritage trees (potential to move);
  - Rehab Alignment:
    - Expands bridge but keeps existing centerline alignment - therefore does not improve Barton Springs roadway alignment with east side;
  - Replacement Alignment:
    - Improved Barton Springs roadway alignment.

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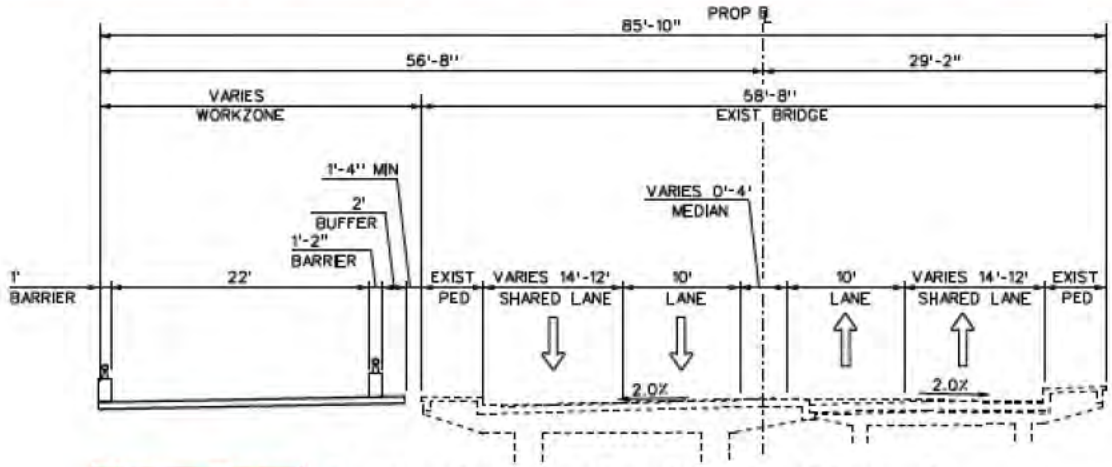
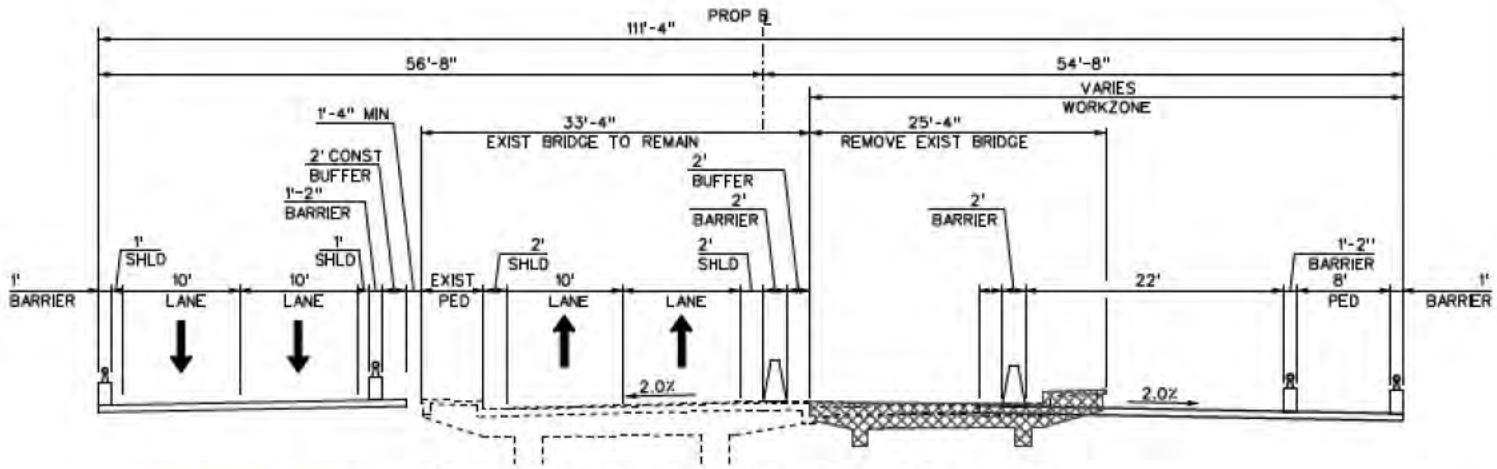
Barton Springs Rd. MOT – Looking East

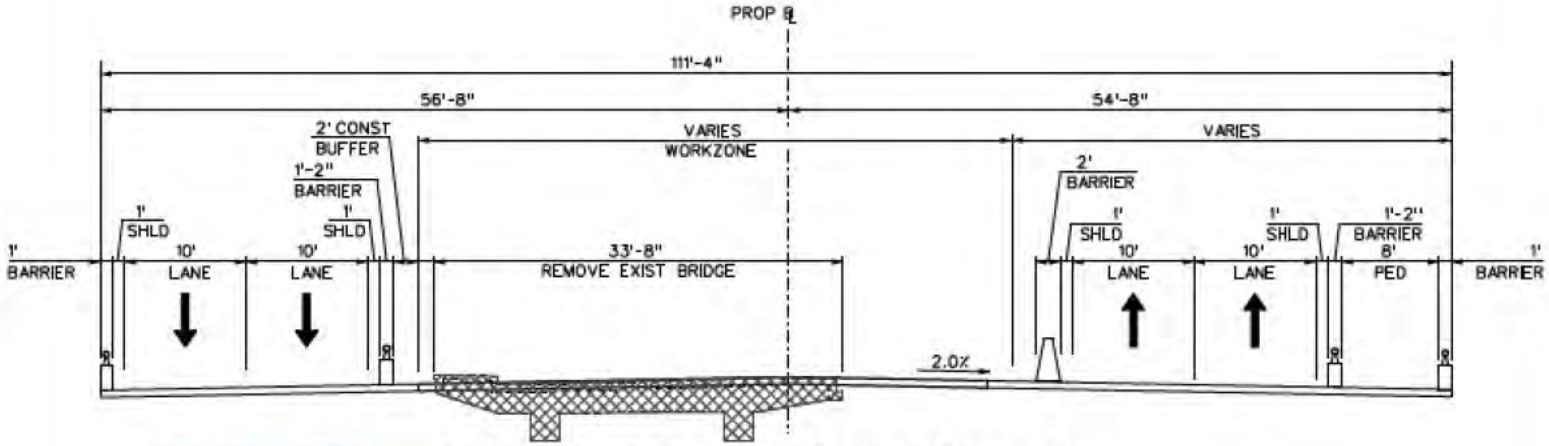


Working/Prelim **Barton Springs Road Bridge Phase 1**



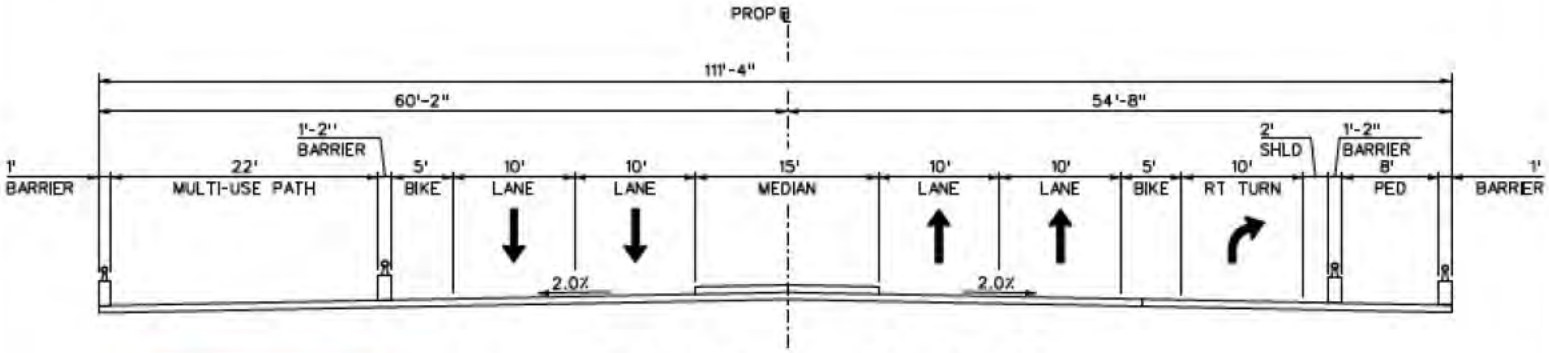
Working/Prelim **Barton Springs Road Bridge Phase 2**

Barton Springs Rd. MOT – Looking East



Working/Prelim

Barton Springs Road Bridge Phase 3



Working/Prelim

Proposed Barton Springs Road Bridge

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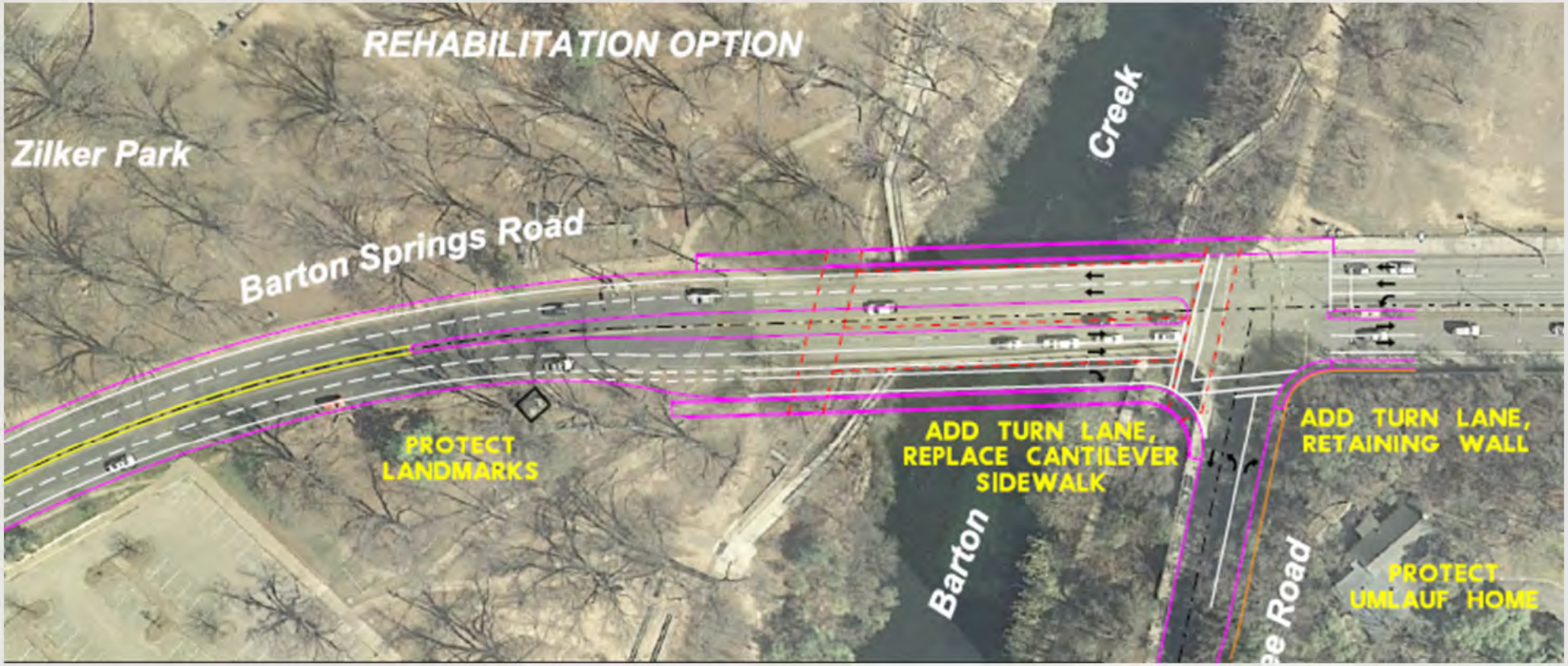
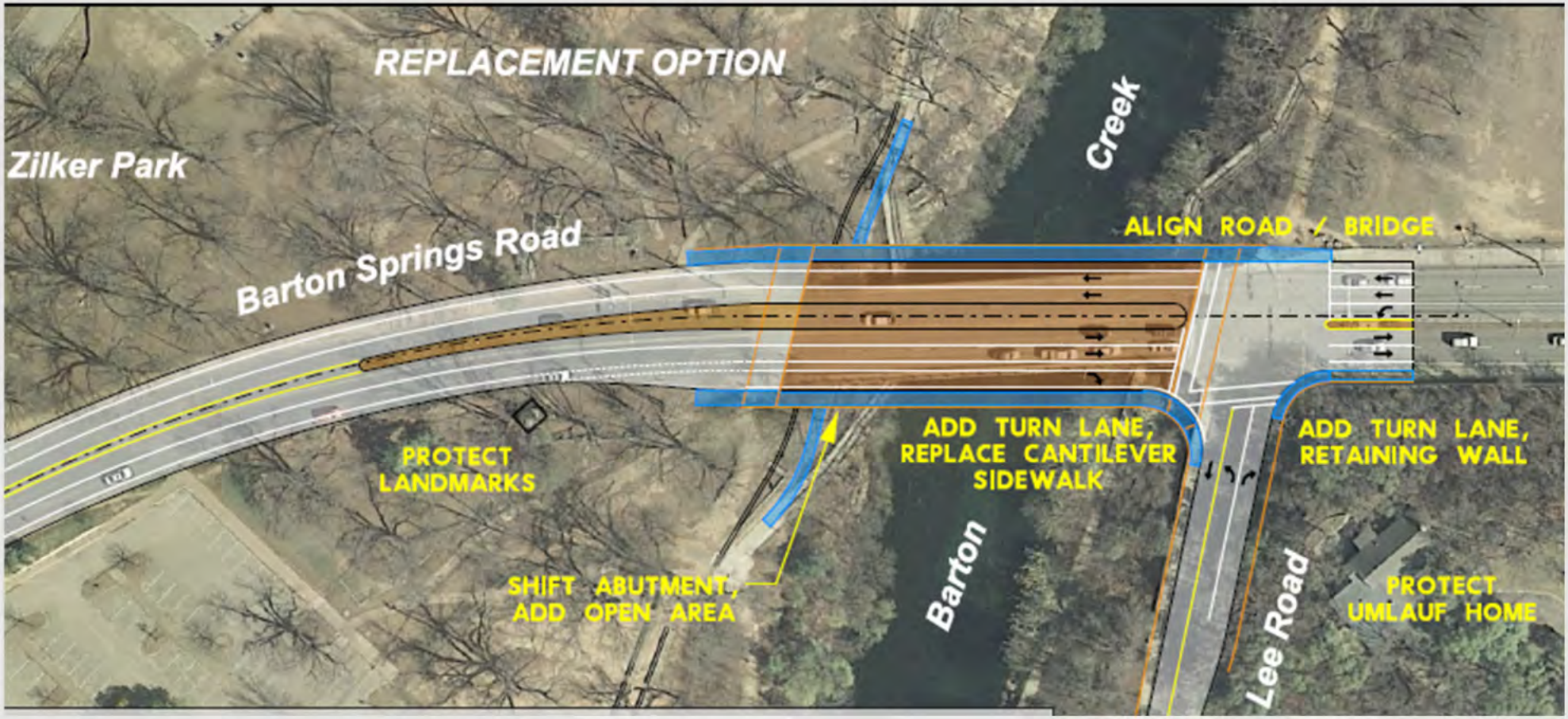
Barton Springs Rd. Bridge – Rehabilitation Plan



URS

Barton Springs Rd. Bridge – Replacement Plan



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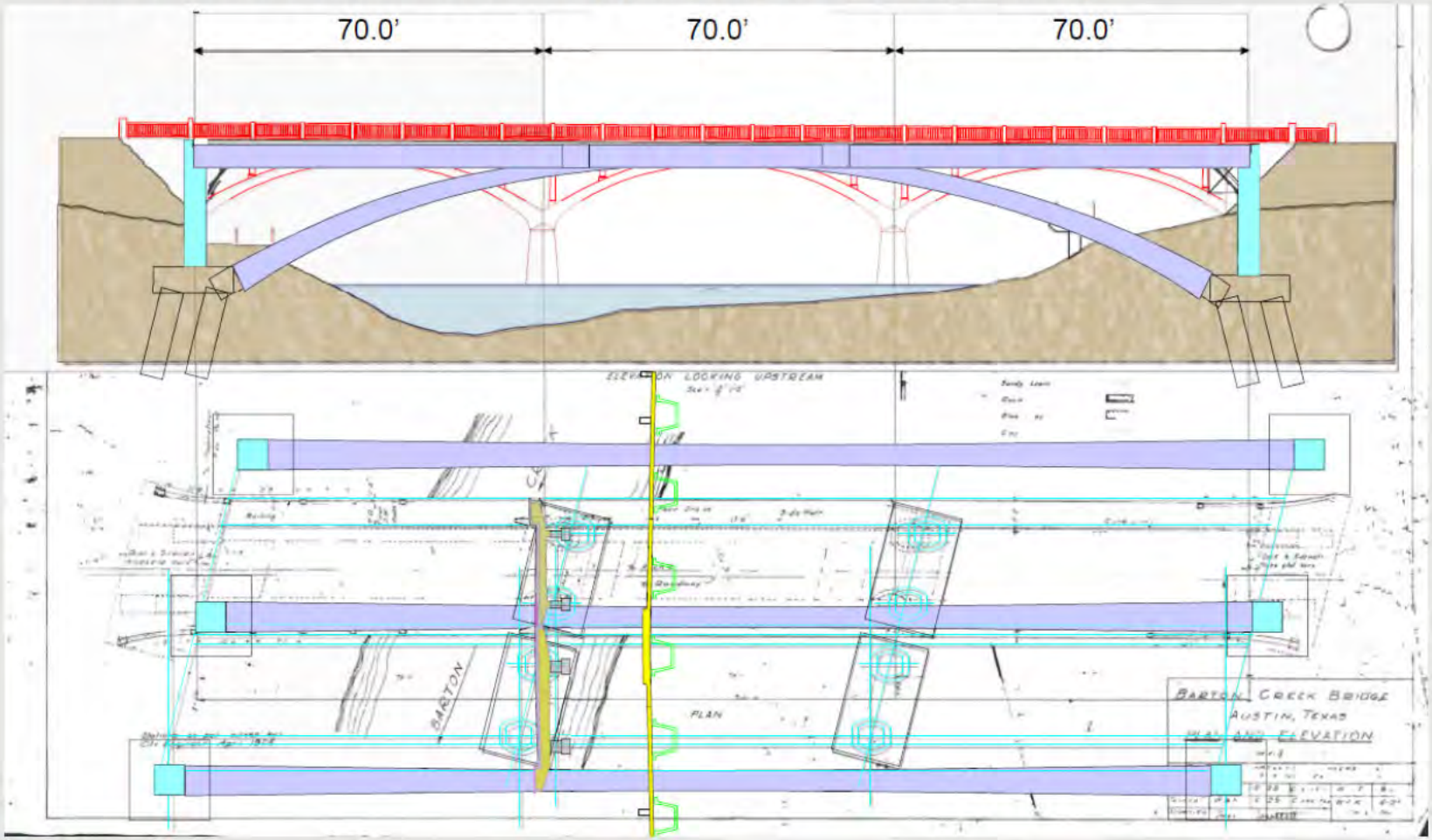
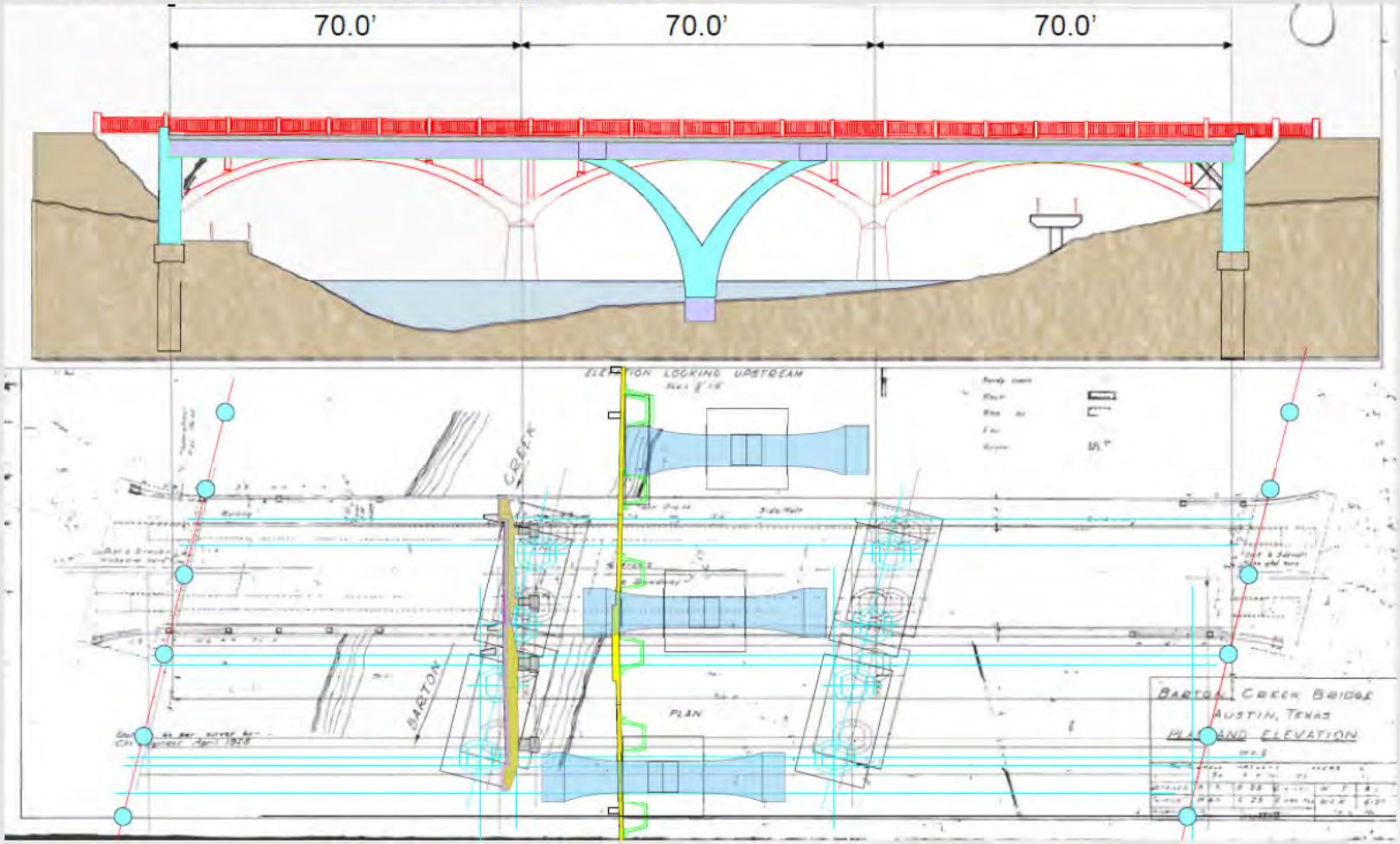
Bridge Replacement Concepts – Single Span

- U Beam span from end bent to crown;
- Each of three arch ribs support a pair of U Beams;



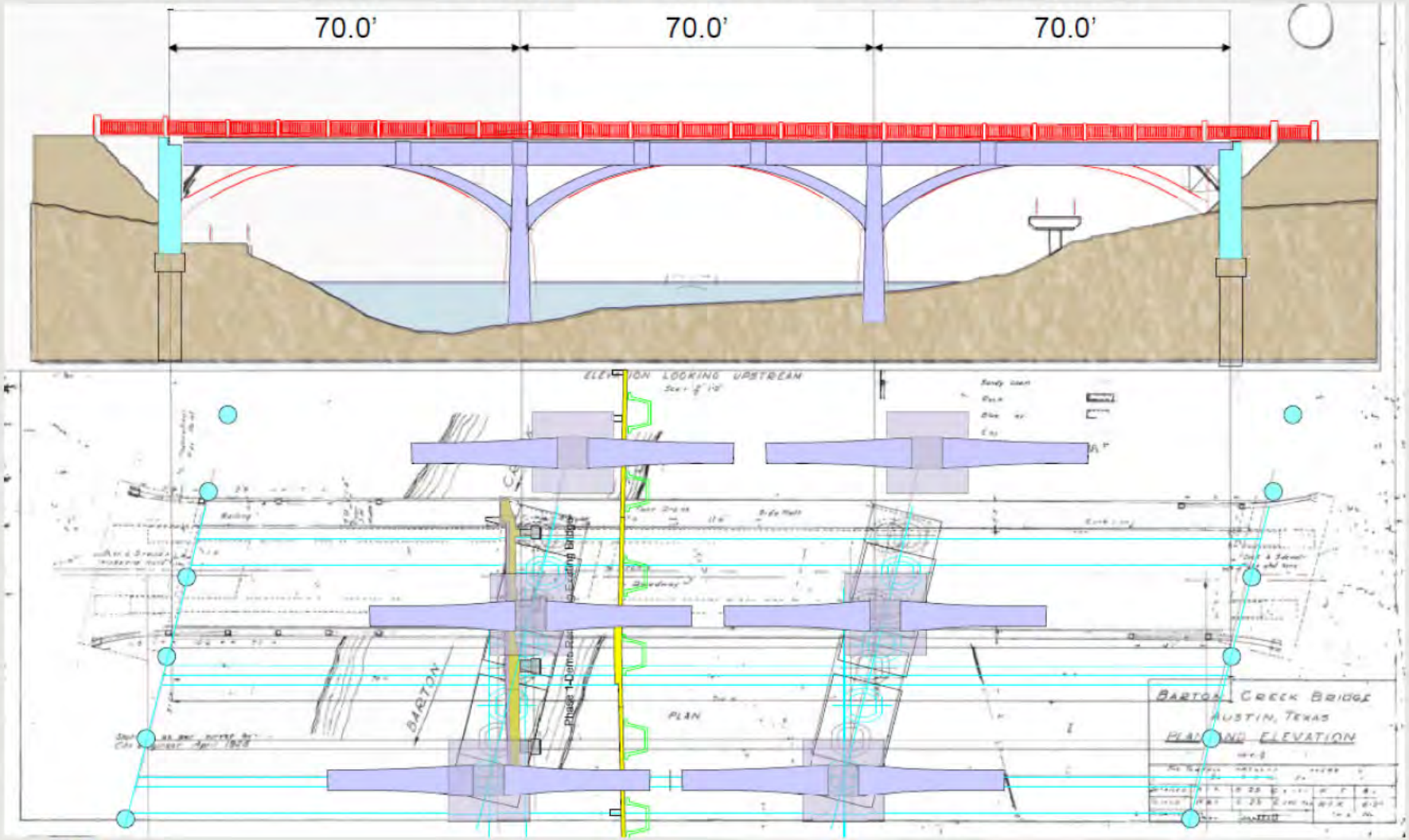
Bridge Replacement Concepts – Two Span

- Tulip type center pier with two girder spans
- U Beams similar to single span



Bridge Replacement Concepts – Three Span

– Under review – attempt with 3 arch ribs, but may require 6



Bridge Replacement Concepts - Summary

- Preliminary Outcomes
  - West and East roadways aligned
  - Moves western abutment to the west
    - Provides additional room/safety for hike/bike trail and Zephyr train
  - Requires less foundation footprint in Barton Creek
  - Longer Service Life

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Next Steps – Current Scope

- Bridge Architect Renderings – Rehab / Replacement
- Desktop ENV Review – combined LOC
- Compare Rehabilitation and Replacement Options
- High level evaluation matrix of decision categories
  - High Level Cost comparison ($/SF)
  - Comparison of Features/Benefits
- Technical Memorandum
- Target Fall 2018

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Next Steps – BCER Phase Completion

- City Decision on Path Forward (Rehab vs Replacement or carry both)
- Design Workshops/Meetings /Initial Aesthetics Workshop
- Initial Stakeholder Meetings
- Initial Public Open House
- Alternative Refinements
- Alternative Evaluations/Input
- Alternative Preference Recommendation
- City Management Team Review
- Council Member (Kitchens – District 5) input
- Stakeholder Meetings
- Public Open House
- Preferred Alternative Refinements
- Design Charrette/Workshop – Stakeholder Inputs, Structural/Architectural Refinements
- Preferred Alternative Recommendation
- City Management Team Review
- Present Preferred Corridor/Bridge Type to Council Member Kitchens
- CAMPO Funding
- Develop Bridge Conceptual Engineering Report

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B-4 - Preliminary Renderings - Sept 2018

Preliminary - NOT FOR DISTRIBUTION

TOUCHSTONE ARCHITECTURE™

title: Oblique Overhead View of Existing Structure

date: 6 September 2018

Barton Springs Bridge - Austin, Texas

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sheet: a1010

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TOUCHSTONE ARCHITECTURE™

title: Renovation of Existing Bridge

date: 6 September 2018

Barton Springs Bridge - Austin, Texas

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sheet: a101

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TOUCHSTONE ARCHITECTURE

title: Single Arch_01

date: 6 September 2018

Barton Springs Bridge - Austin, Texas

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sheet: a102

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TOUCHSTONE ARCHITECTURE

title: Single Arch_02

date: 6 September 2018

Barton Springs Bridge - Austin, Texas

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TOUCHSTONE ARCHITECTURE

title: "Y" Pier 01

date: 6 September 2018

Barton Springs Bridge - Austin, Texas

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TOUCHSTONE ARCHITECTURE™

title: Triple Arch_02

date: 6 September 2018

Barton Springs Bridge - Austin, Texas

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TOUCHSTONE ARCHITECTURE™

title: Triple Arch_01

date: 6 September 2018

Barton Springs Bridge - Austin, Texas

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TOUCHSTONE ARCHITECTURE™

title: Sidewalk View

date: 6 September 2018

Barton Springs Bridge - Austin, Texas

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TOUCHSTONE ARCHITECTURE™

title: Oblique Overhead View

date: 6 September 2018

Barton Springs Bridge - Austin, Texas

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sheet: a109

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Appendix C - Restart Assessments

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C-1 - Project Update – Nov 2021

Barton Springs Road Bridge – Project Update

November 15, 2021

Agenda

- Review
  - Previous Work
  - 2019 Bridge Concepts
  - 2019 Direction and Funding
- Recent Work
  - Bridge Rehab and Replacement
  - Bridge Architecture / Renderings
  - Cost
- Next Steps
  - Interim Report
  - Charrette

Barton Springs Rd. / Azie Morton Intersection Assessment

- Right-turn bays added for both Barton Springs Rd. and Azie Morton Rd.
  - Reduce delays during peak hour;
  - Support / improve construction phasing for both bridge and Azie Morton retaining wall;

Technical Memorandum
Barton Springs Road Bridge – Traffic Analysis

Intersection LOS Analysis

Existing conditions and No Build and Build conditions for both 2020 and 2040 were analyzed and the overall intersection LOS and delay results are presented in **Table 3** and approach LOS and delay in **Table 4**. Through the course of the analysis, it was determined that the primary sources of congestion are the northbound left turning traffic in the AM peak hour and the eastbound right turning traffic in the PM peak hour. Therefore, the clear alternative for roadway improvements are the addition of turn bays. The Build condition includes a lengthened northbound right turn bay with 130' of storage and an eastbound right turn bay with 250' of storage. The turn bay lengths are based on physical constraints along the approaches. Although storage length for turn bays is often derived from queue lengths in the LOS analysis, this intersection presents several physical constraints including existing trees, driveways, and parking lots. The lengths used are intended to minimize impacts to these constraints while still providing improved vehicle operations. The Synchro reports are provided in **Appendix B**. The Yearly Reduced Vehicle-Hours column in **Table 4** was calculated assuming 250 days per year with peak hour congestion.

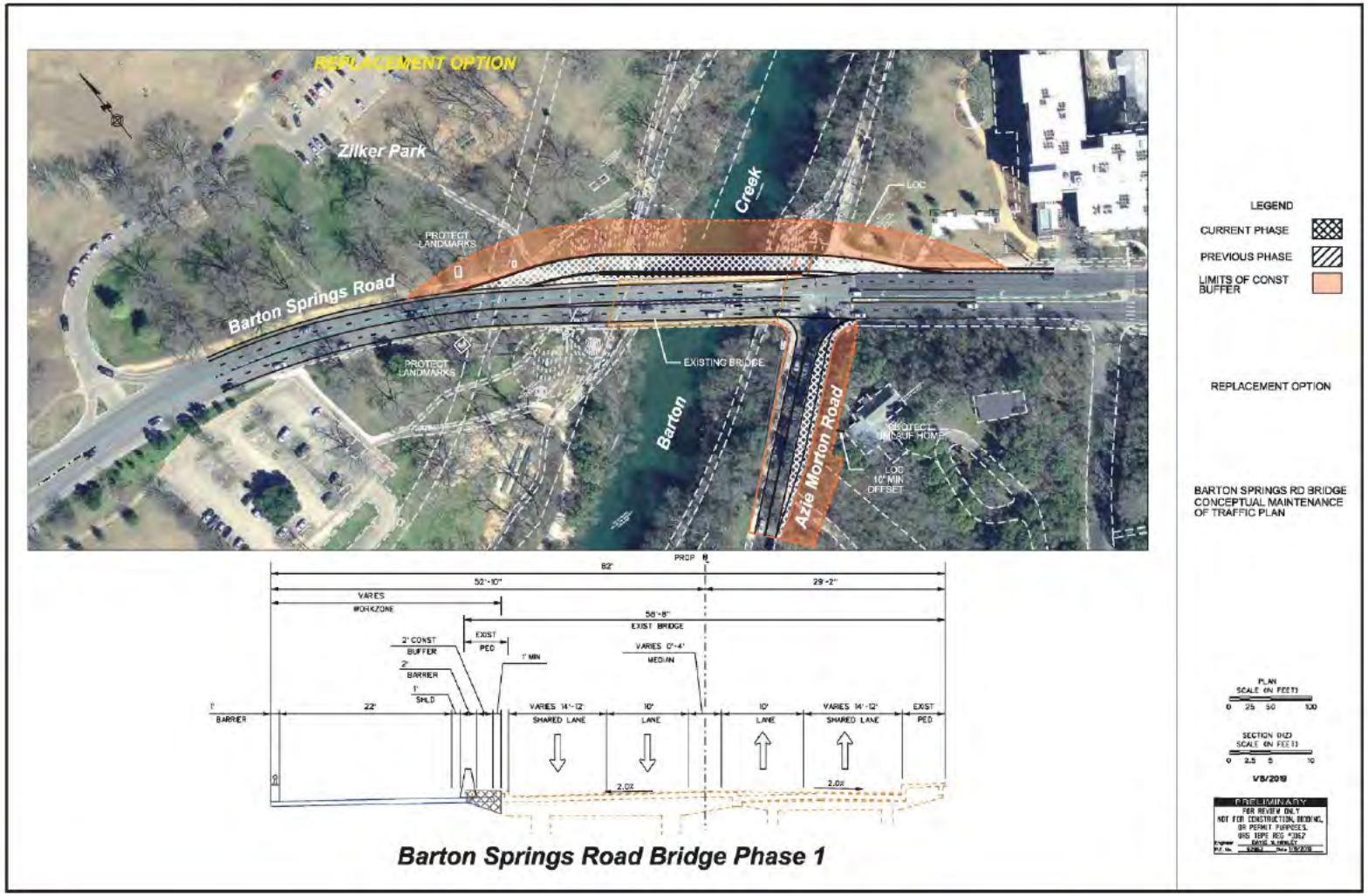
Table 3: Intersection LOS and Delay

Year	Peak	No Build		Build	
		LOS	Delay (sec)	LOS	Delay (sec)
2017	AM	C	31.1		
	PM	C	33.5		
2020	AM	C	33.5	C	31.1
	PM	C	22.5	B	17.3
2040	AM	E	64.5	E	59.1
	PM	E	61.6	C	26.5

Table 4: Approach LOS and Delay

Approach	Year	Volume	No Build		Build		Yearly Reduced Veh-Hrs
			LOS	Delay (sec)	LOS	Delay (sec)	
AM Northbound	2017	752	C	29.6			
PM Eastbound		1263	D	49.1			
AM Northbound	2020	790	C	26.1	C	24.3	99
PM Eastbound		1326	C	28.2	C	20.6	700
AM Northbound	2040	1136	E	61.6	E	61.6	0
PM Eastbound		1907	F	89.4	C	29.4	7,946

Maintenance of Traffic / Phasing Concepts (2018)



Barton Springs Road Bridge Phase 1

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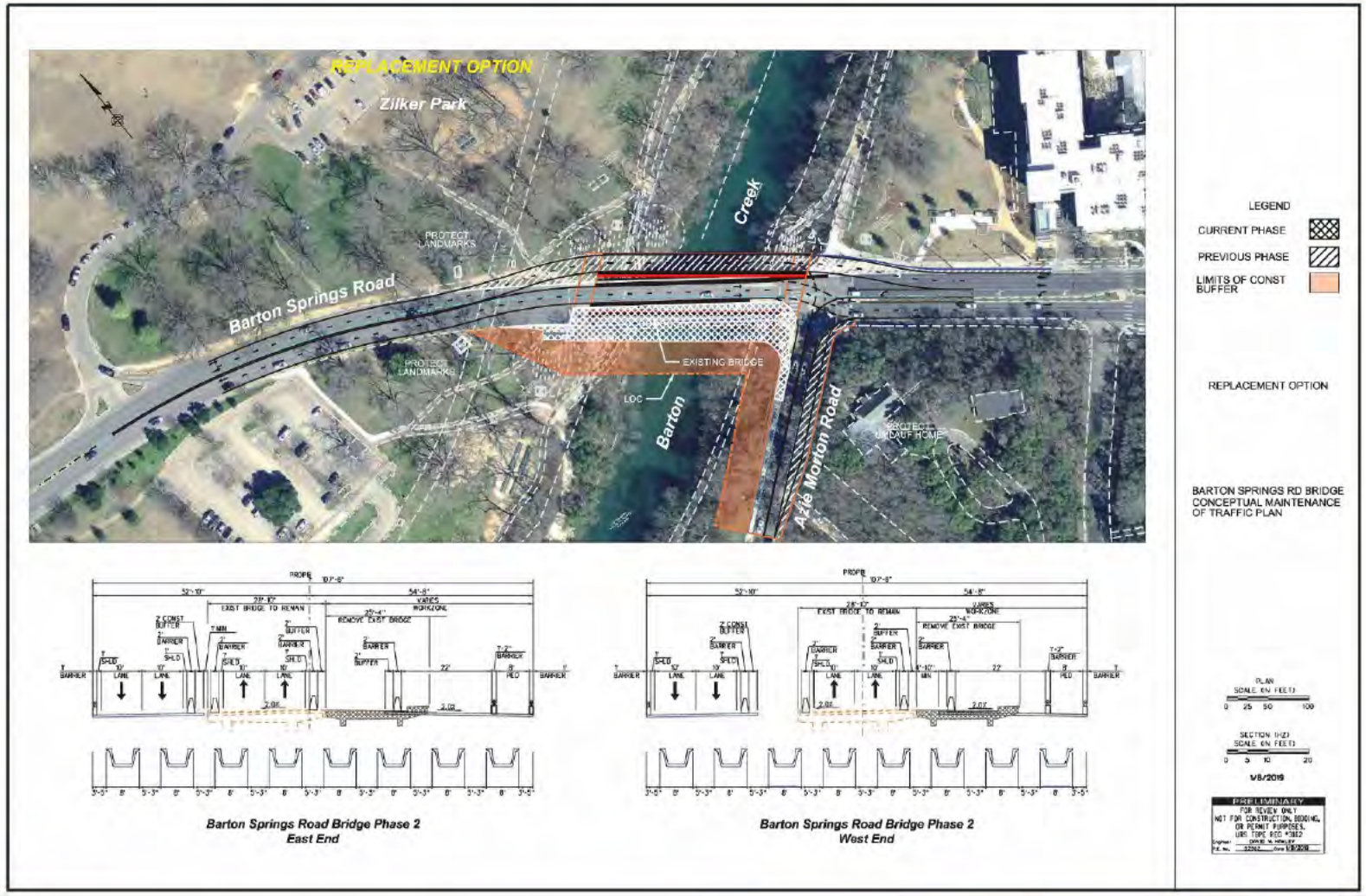
Maintenance of Traffic / Phasing Concepts (2018)



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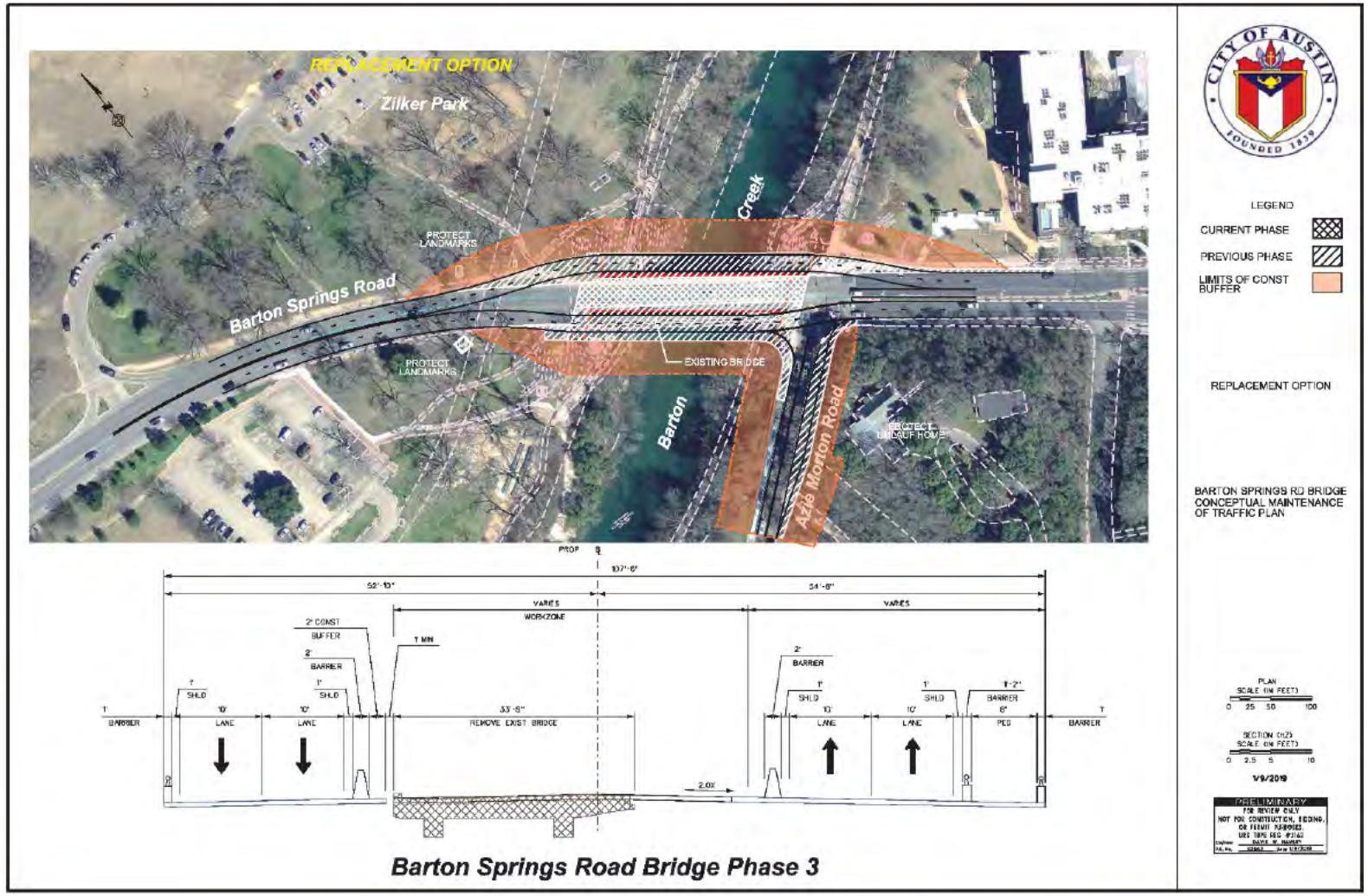
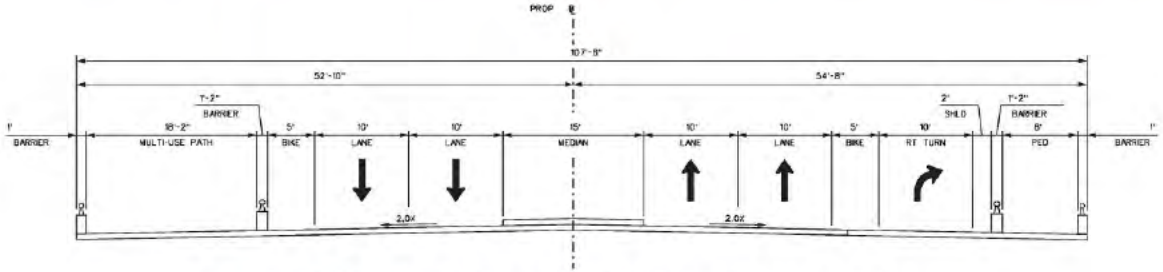
Maintenance of Traffic / Phasing Concepts (2018)



URS

Maintenance of Traffic / Phasing Concepts (2018)



Proposed Barton Springs Road Bridge Looking East

LEGEND

PROPOSED BRIDGE

SIDEWALK/PATH

ROADWAY PAVEMENT

REPLACEMENT OPTION

BARTON SPRINGS RD BRIDGE
CONCEPTUAL MAINTENANCE
OF TRAFFIC PLAN

PLAN
SCALE (IN FEET)
0 25 50 100

SECTION (INZ)
SCALE (IN FEET)
0 2.5 5 10

1/8/2019

PRELIMINARY
FOR REVIEW ONLY
NOT FOR CONSTRUCTION, BIDDING,
OR PERMIT PURPOSES.
URS TBPE REG #2162

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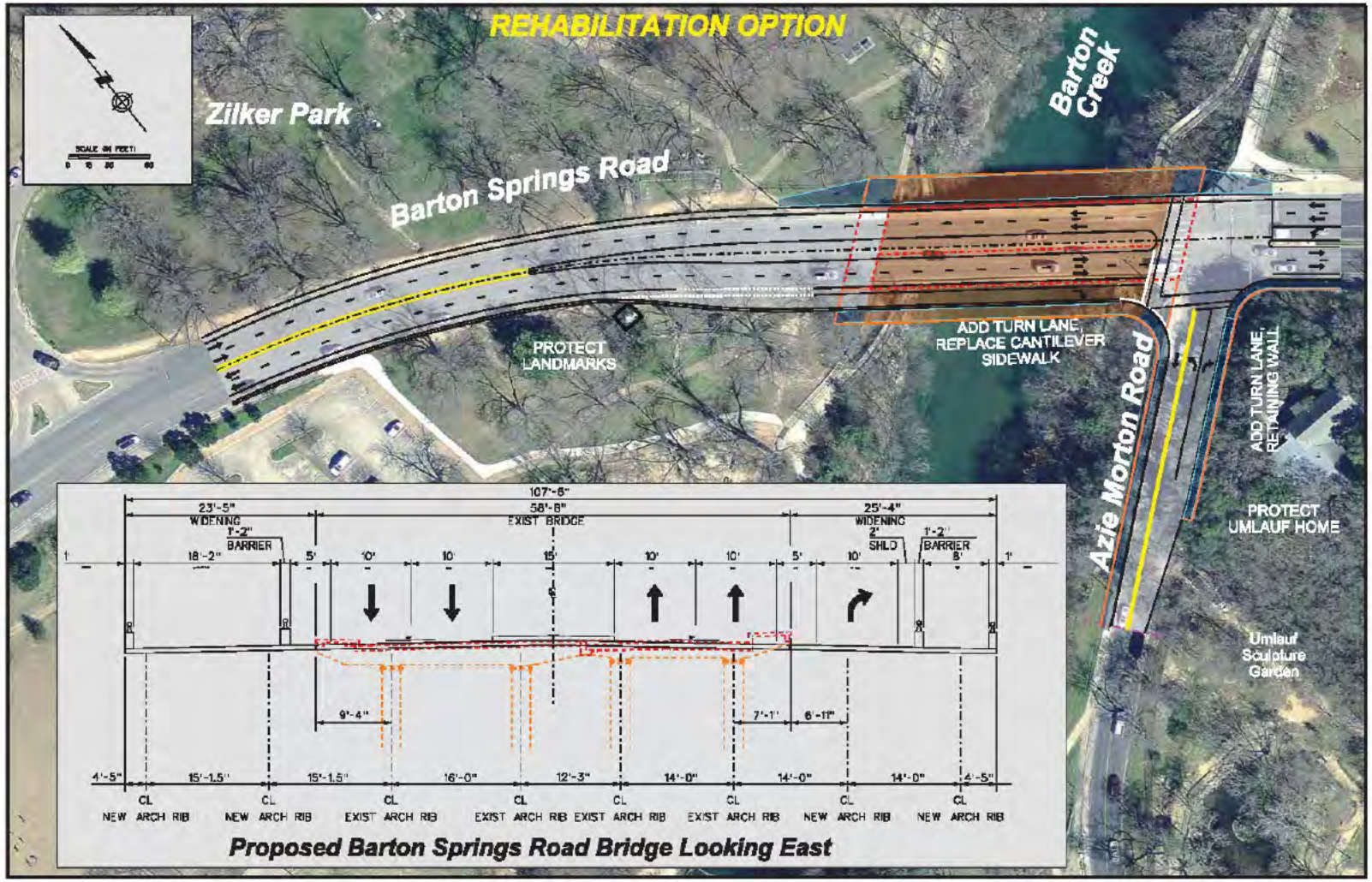
Phase II Bridge Concepts (2018-19)

Rehabilitation

Incorporates MOT; geometry; intersection needs

Feasible structural concept;

Intersection PI remains



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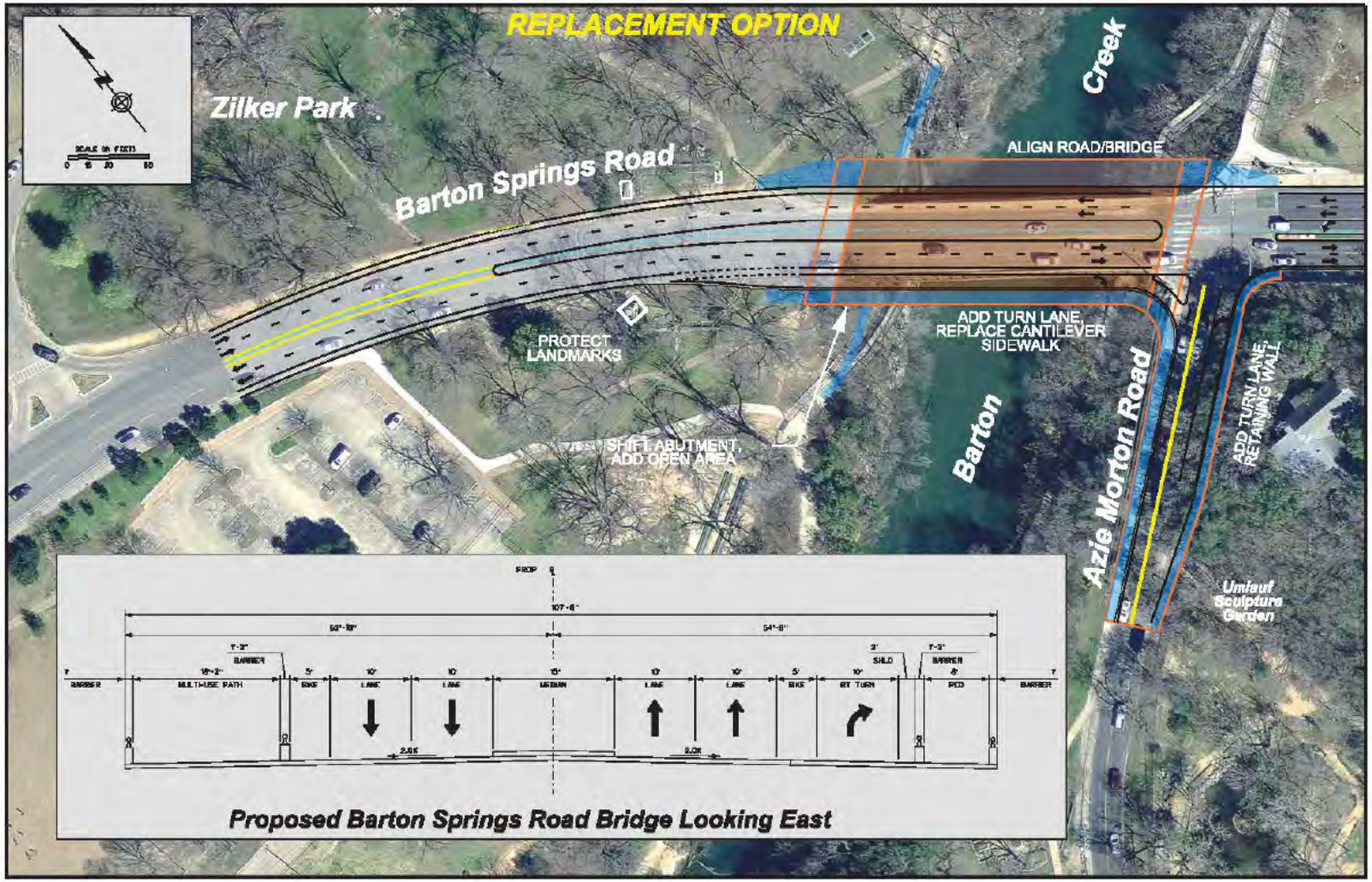
Phase II Bridge Concepts (2018-19)

Replacement

Incorporates MOT; geometry; intersection needs

Resolves intersection PI issue

West abutment shift – opened area for hike/bike trail



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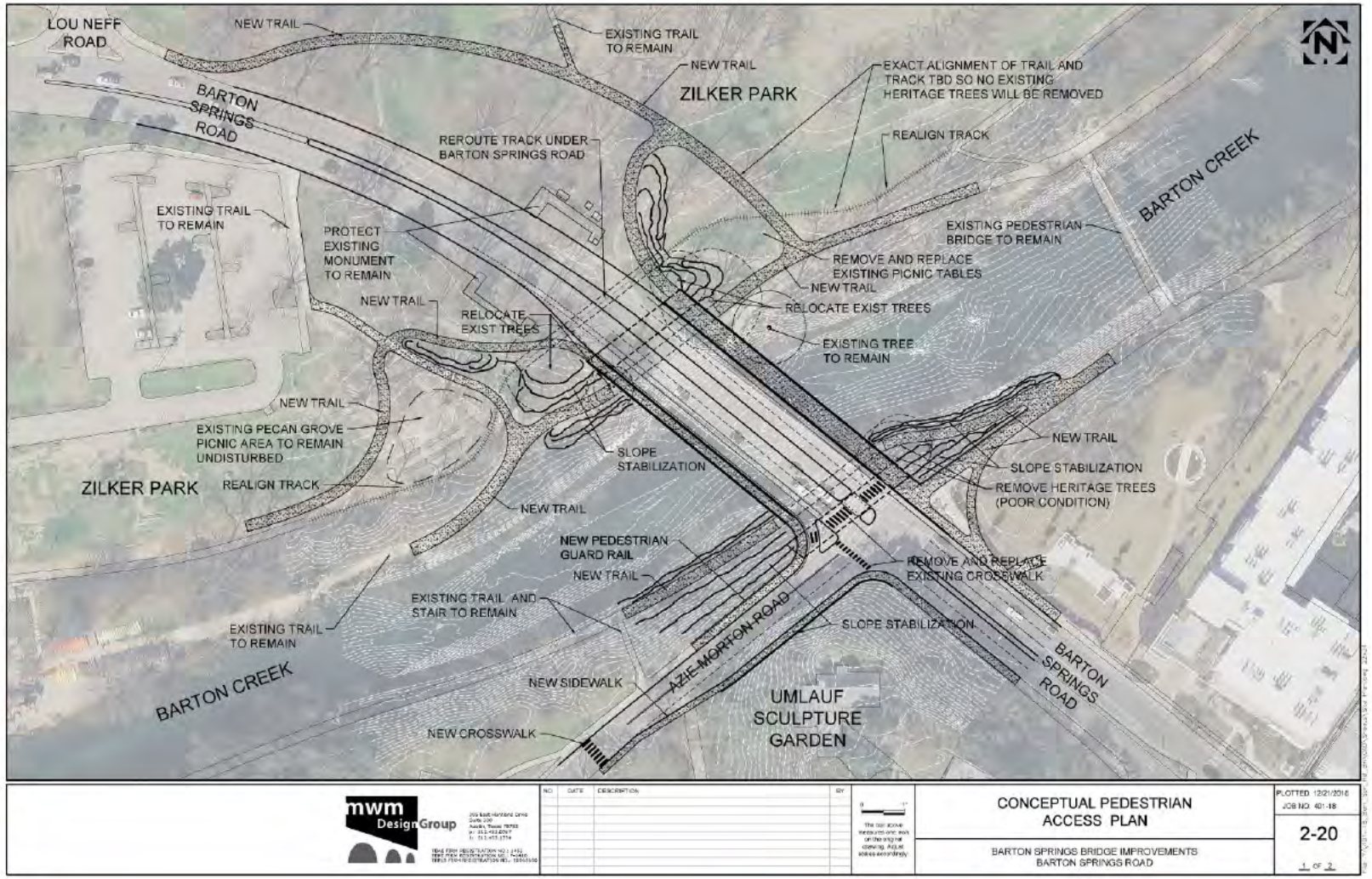
Phase II Bridge Concepts (2018-19)

URS

Phase II Bridge Concepts (2018-19)



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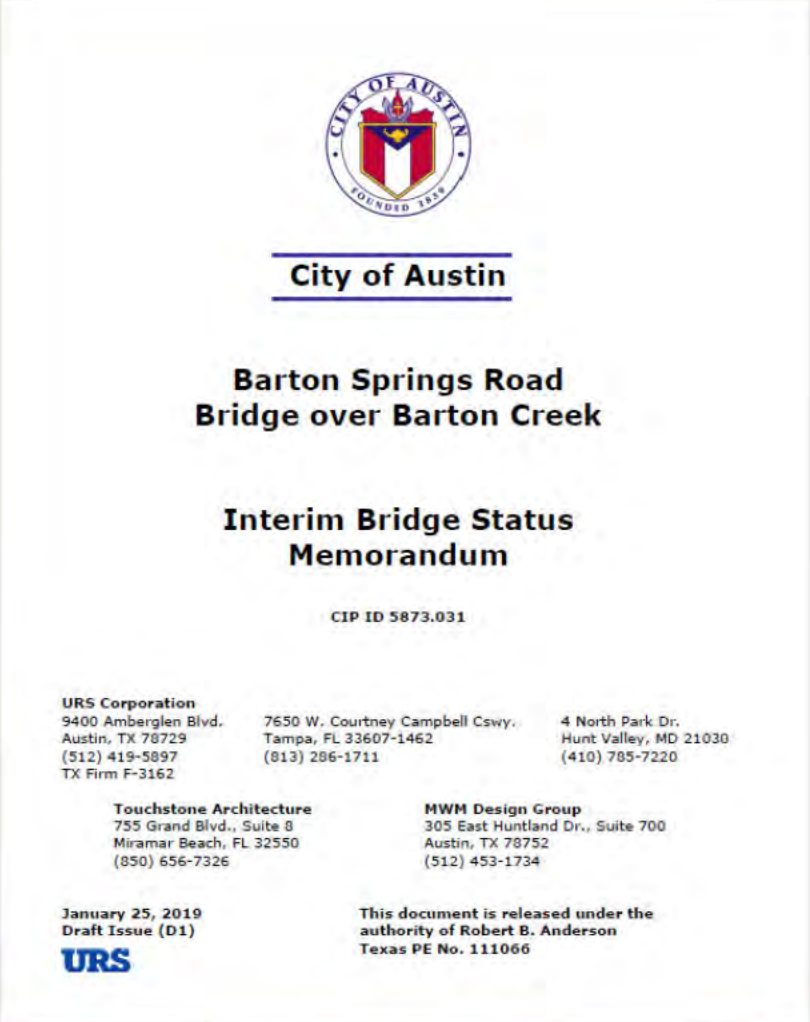
Direction and Funding (2019)

- Interim Memorandum Draft (Jan 2019)
- Desire to move forward with Replacement
- CAMPO/BUILD Grant efforts
  - Federal Funding – requisite shift in NEPA Clearance
  - Desire for Public Meeting/Outreach
- Funding and Pause – not enough funding, for both:
  - Public Outreach / Stakeholders / Public Meeting
  - Follow through with design efforts



City of Austin

Barton Springs Road
Bridge over Barton Creek

Interim Bridge Status
Memorandum

CIP ID 5873.031

URS Corporation
9400 Amberglen Blvd.
Austin, TX 78729
(512) 419-5897
TX Firm F-3162

7650 W. Courtney Campbell Cswy.
Tampa, FL 33607-1462
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(512) 453-1734

January 25, 2019
Draft Issue (D1)
URS

This document is released under the authority of Robert B. Anderson
Texas PE No. 111066

Recent Work (2021)

- Use of Existing Funds
- Structural Modeling for Replacement Options
- Refine Bridge Renderings
- Refine Bridge Cost Comparisons

Bridge Renderings – Rehabilitation Option

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Option 1 – Arch Support Longitudinally Framed

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Option 2 – Single Longitudinally Framed Y-Pier

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Option 3 – Conventional Pier Concept

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Bridge Cost – Unit Cost Development

Cost Studies

Barton Springs Road Bridge

Unit Cost Comparison 25-Aug-21 (Updated costs)
(file: Barton Creek Cost Estimates07.xlsx) 10-Nov-21

Item	Unit	Old Unit Price	Used (New) Unit Price	Florida Unit Price (From SDG)		Texas Unit Price
Superstructure						
Girder and Deck						
Deck Concrete	CY	$ 1,000	$ 1,200	$ 1,200	Deck Class IV	$ 1,250
Diaphragm Concrete	CY	$ 1,000	$ 1,000	$ 1,200	Deck Class IV	$ 1.00
Reinforcing Steel - Black	LB	NA	$ 1.00	$ 1.00	Carbon Stl	$ 1.00
Reinforcing Steel - Stainless	LB	$ 4.00	NA	$ 4.00	SS	$ 1.00
AASHTO Type IV - 72 inch Depth	FT	NA	$ 320	$ 320	72" FIB	$ 1.00
Prestressed Concrete U-Beam (U54)	FT	$ 200	NA	$ 800	FL U-BM 54"	$ 1.00
Post-Tensioning Strand	LB	$ 10.00	$ 10.00	$ 8.00	PT Str Grout	$ 1.00
Post-Tensioning Bar	LB	$ 10.00	$ 10.00	$ 10.00	PT Bar Grout	$ 1.00
Approach Slabs	CY	$ 20	$ 400	$ 1.00		$ 400
Temporary Works - Shoring Systems	EA	$ 75,000.00	$ 100,000.00	$ 1.00		$ 1.00
Misc. Appurtenances						
Overlay	SF	$ 5.00	$ 6.00	$ 1.00		$ 5.78
Expansion Joints	FT	$ 200	$ 250	$ 250	Strip Steel	$ 1.00
Texas Type C411 Barrier	FT	$ 500	$ 140	$ 140	Vert F	$ 1.00
Sidewalk Barriers	FT	$ 500	$ 150	$ 150	Vrt Fc+Bullet	$ 1.00
Traffic Median	FT	NA	$ 180	$ 1.00		$ 1.00
Sidewalk Pavers	SY	$ 80	NA	$ 1.00		$ 70.28
Bearings - Laminated Pads	EA	$ 500	$ 1,000	$ 1,000	per CF	$ -498.96
Concrete - Surface Treatments	SF	$ 10.00	$ 5.00	$ 1.00		$ 3.77
Period Light Fixtures and Conduits	LS	$ 50,000	$ 50,000	$ 1.00		$ 1.00
Miscellaneous Items	LS	NA	$ 200,000	$ 1.00		$ 1.00
Substructure						
Piers or Arch Ribs						
Concrete - Piers and Pier Caps	CY	$ 750	$ 950	$ 950	Sub Concrete	$ 1.00
Concrete - Arch Ribs	CY	$ 1,250	$ 1,250	$ 1.00		$ 1.00
Reinforcing - Black	LB	NA	$ 1.00	$ 1.00	Carbon Stl	$ 1.00
Reinforcing - Stainless	LB	$ 4.00	NA	$ 4.00	SS	$ 1.00
Post-Tensioning Strand	LB	$ 10.00	$ 10.00	$ 8.00	PT Str Grout	$ 1.00
Post-Tensioning Bar	LB	$ 10.00	$ 10.00	$ 10.00	PT Bar Grout	$ 1.00
Temporary Foundation Shoring (Reused)	EA	$ 200,000.00	NA	$ 1.00		$ 1.00
Concrete - Surface Treatments	SF	$ 8.00	$ 5.00	$ 1.00		$ 3.77
Pier Foundations						
Foundation Preparation - Cofferdam	LS	$ 30,000	$ 500,000	$ 1.00		$ 1.00
Footing Concrete - Tremie Seal	CY	$ 300	$ 650	$ 650	Seal	$ 400.00
Footing Concrete	CY	$ 750	$ 950	$ 626	Mass	$ 636.26
Footing Reinforcing - Black	LB	NA	$ 1.00	$ 1.00	Carbon Stl	$ 1.00
Footing Reinforcing - Stainless	LB	$ 4.00	NA	$ 4.00	SS	$ 1.00
3.5 ft. Drilled Shaft Furnished and Installed	FT	$ 350	$ 950	$ 950	w/ excavation	$ -429.27
8 ft. Drilled Shaft Furnished and Installed	FT	NA	$ 3,000	$ 2,980	w/ excavation	$ 944.92
9 ft. Drilled Shaft Furnished and Installed	FT	NA	$ 3,300	$ 3,300	w/ excavation	$ 1,060.15
Abutment						
Excavation	CY	$ 50	$ 100	$ 1.00		$ 100.00
Abutment Concrete	CY	$ 500	$ 950	$ 950	Sub Concrete	$ 921.03
Abutment Reinforcing - Black	LB	NA	$ 1.00	$ 1.00	Carbon Stl	$ 1.00
Abutment Reinforcing - Stainless	LB	$ 4.00	NA	$ 4.00	SS	$ 1.00
Concrete - Surface Treatments	SF	$ 8.00	$ 5.00	$ 1.00		$ 3.77
3.5 ft. Drilled Shaft Furnished and Installed	FT	$ 350	$ 950	$ 950	w/ excavation	$ -429.27
Temporary Walls	SF	$ 50.00	$ 50.00	$ 15	Temporary	$ 9.93
Permanent Walls	SF	$ 50.00	$ 50.00	$ 30	Permanent	$ 50.20

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Bridge Cost – Options 1 and 2

Cost Studies

Barton Springs Road Bridge

Option 1 - Concrete Arch (New)
(file: Barton Creek Cost Estimates07.xlsx)

date: 10-Nov-21
date: 10-Nov-21

	SPAN LENGTH (feet)	Width (feet)	AREA (ft²)
Abutment to Abutment:	235.0	107.5	25263

Item		Unit	Quantity	Unit Price	Subtotal	Total
Superstructure						
Girder and Deck						
Deck Concrete		CY	783	$ 1,200	$ 939,565	
Diaphragm Concrete		CY	368	$ 1,000	$ 368,013	
Reinforcing - Black		LB	287,746	$ 1.00	$ 287,746	
AASHTO Type IV - 72 Inch Depth		FT	1,880	$ 320	$ 601,600	
Post-Tensioning Strand		LB	82,949	$ 10.00	$ 829,490	
Post-Tensioning Bar		LB	42,900	$ 10.00	$ 429,000	
Approach Slabs		CY	158	$ 400	$ 63,704	
Temporary Works - Shoring Systems		EA	2	$ 100,000	$ 200,000	
Girder and Deck Subtotal:					$ 3,717,118	
Misc. Appurtenances						
Overlay		SF	24,793	$ 6.00	$ 148,755	
Expansion Joints		FT	215	$ 250	$ 53,750	
Barriers		FT	940	$ 155	$ 145,700	
Traffic Median		FT	235	$ 160	$ 37,600	
Bearings		EA	32	$ 1,000	$ 32,000	
Concrete - Surface Treatments		SF	3,760	$ 5.00	$ 18,800	
Period Light Fixtures and Conduits		LS	1	$ 50,000	$ 50,000	
Miscellaneous Items		LS	1	$ 200,000	$ 200,000	
Misc. Appurtenances Subtotal:					$ 686,605	
Superstructure Subtotal (1)						$ 4,403,723
Substructure						
Piers or Arch Ribs						
Concrete - Piers		CY	-	$ 950	$ -	
Concrete - Arch Ribs		CY	535	$ 1,250	$ 669,319	
Reinforcing - Black		LB	214,182	$ 1.00	$ 214,182	
Post-Tensioning Strand		LB	-	$ 10.00	$ -	
Post-Tensioning Bar		LB	10,000	$ 10.00	$ 100,000	
Concrete - Surface Treatments		SF	20,592	$ 5.00	$ 102,960	
Piers or Arch Ribs Subtotal:					$ 1,086,462	
Pier Foundations						
Foundation Preparation - Cofferdam		LS	2	$ 500,000	$ 1,000,000	
Footing Concrete - Tremie Seal		CY	196	$ 650	$ 127,111	
Footing Concrete		CY	587	$ 950	$ 557,333	
Footing Reinforcing - Black		LB	117,333	$ 1.00	$ 117,333	
Drilled Shaft Furnished and Installed		FT	-	$ 950	$ -	
Pier Foundations Subtotal:					$ 1,801,778	
Abutment						
Excavation		CY	7,400	$ 100	$ 740,000	
Abutment Concrete		CY	261	$ 950	$ 247,704	
Abutment Reinforcing - Black		LB	52,148	$ 1.00	$ 52,148	
Concrete - Surface Treatments		SF	8,400	$ 5.00	$ 42,000	
Drilled Shaft Furnished and Installed		FT	640	$ 950	$ 608,000	
Temporary Walls		SF	6,600	$ 50.00	$ 330,000	
Permanent Walls		SF	8,400	$ 50.00	$ 420,000	
Abutment Subtotal:					$ 1,599,852	
Substructure Subtotal (2)						$ 4,588,091
Main Bridge Quantities Subtotal (1) + (2)					$ 8,991,814	
Bridge Demolition	10%				$ 899,181	
Mobilization	5%				$ 449,591	
Architecture and Engineering Fees	15%				$ 1,348,772	
Maintenance of Traffic	10%				$ 899,181	
Estimated Cost of Work						$ 12,588,640
Contingencies						
Contingency	25%				$ 2,247,954	
Total Project Cost					$ -	$ 14,836,493
					Bridge Grand Total	$ 14,836,493
					Square Foot Total	$ 587.23
					Cost Factor	1.43

Cost Studies

Barton Springs Road Bridge

Option 2 - Concrete Single Pier (New)
(file: Barton Creek Cost Estimates07.xlsx)

date: 10-Nov-21
date: 10-Nov-21

	SPAN LENGTH (feet)	Width (feet)	AREA (ft²)
Abutment to Abutment:	235.0	107.5	25263

Item		Unit	Quantity	Unit Price	Subtotal	Total
Superstructure						
Girder and Deck						
Deck Concrete		CY	783	$ 1,200	$ 939,565	
Diaphragm Concrete		CY	368	$ 1,000	$ 368,013	
Reinforcing - Black		LB	287,746	$ 1.00	$ 287,746	
AASHTO Type IV - 72 Inch Depth		FT	1,880	$ 320	$ 601,600	
Post-Tensioning Strand		LB	82,949	$ 10.00	$ 829,490	
Post-Tensioning Bar		LB	42,900	$ 10.00	$ 429,000	
Approach Slabs		CY	158	$ 400	$ 63,704	
Temporary Works - Shoring Systems		EA	2	$ 100,000	$ 200,000	
Girder and Deck Subtotal:					$ 3,717,118	
Misc. Appurtenances						
Overlay		SF	24,793	$ 6.00	$ 148,755	
Expansion Joints		FT	215	$ 250	$ 53,750	
Barriers		FT	940	$ 155	$ 145,700	
Traffic Median		FT	235	$ 160	$ 37,600	
Bearings		EA	32	$ 1,000	$ 32,000	
Concrete - Surface Treatments		SF	3,760	$ 5.00	$ 18,800	
Period Light Fixtures and Conduits		LS	1	$ 50,000	$ 50,000	
Miscellaneous Items		LS	1	$ 200,000	$ 200,000	
Misc. Appurtenances Subtotal:					$ 686,605	
Superstructure Subtotal (1)						$ 4,403,723
Substructure						
Piers or Arch Ribs						
Concrete - Piers & Tie Beam		CY	352	$ 950	$ 334,400	
Concrete - Arch Ribs		CY	-	$ 1,250	$ -	
Reinforcing - Black		LB	140,800	$ 1.00	$ 140,800	
Post-Tensioning Strand		LB	-	$ 10.00	$ -	
Post-Tensioning Bar		LB	2,525	$ 10.00	$ 25,254	
Concrete - Surface Treatments		SF	3,600	$ 5.00	$ 18,000	
Piers or Arch Ribs Subtotal:					$ 518,454	
Pier Foundations						
Foundation Preparation - Cofferdam		LS	-	$ 500,000	$ -	
Footing Concrete - Tremie Seal		CY	-	$ 650	$ -	
Footing Concrete		CY	455	$ 950	$ 432,356	
Footing Reinforcing - Black		LB	91,022	$ 1.00	$ 91,022	
Drilled Shaft Furnished and Installed		FT	120	$ 3,300	$ 396,000	
Pier Foundations Subtotal:					$ 919,378	
Abutment						
Excavation		CY	7,400	$ 100	$ 740,000	
Abutment Concrete		CY	261	$ 950	$ 247,704	
Abutment Reinforcing - Black		LB	52,148	$ 1.00	$ 52,148	
Concrete - Surface Treatments		SF	8,400	$ 5.00	$ 42,000	
Drilled Shaft Furnished and Installed		FT	640	$ 950	$ 608,000	
Temporary Walls		SF	6,600	$ 50.00	$ 330,000	
Permanent Walls		SF	8,400	$ 50.00	$ 420,000	
Abutment Subtotal:					$ 1,599,852	
Substructure Subtotal (2)						$ 3,137,684
Main Bridge Quantities Subtotal (1) + (2)					$ 7,541,406	
Bridge Demolition	10%				$ 754,141	
Mobilization	5%				$ 377,070	
Architecture and Engineering Fees	15%				$ 1,131,211	
Maintenance of Traffic	10%				$ 754,141	
Estimated Cost of Work						$ 10,557,969
Contingencies						
Contingency	25%				$ 1,885,352	
Total Project Cost					$ -	$ 12,443,321
					Bridge Grand Total	$ 12,443,321
					Square Foot Total	492.54
					Cost Factor	1.22

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Bridge Cost – Options 3 and 4

Cost Studies

Barton Springs Road Bridge

Option 3 - Concrete Dual Pier (New)
(file: Barton Creek Cost Estimates07.xlsx)

			10-Nov-21
			10-Nov-21

	SPAN LENGTH (feet)	Width (feet)	AREA (ft²)
Abutment to Abutment:	236.0	107.5	25263

Item	Unit	Quantity	Unit Price	Subtotal	Total
Superstructure					
Girder and Deck					
Deck Concrete	CY	783	$ 1,200	$ 939,565	
Diaphragm Concrete	CY	368	$ 1,000	$ 368,013	
Reinforcing - Black	LB	287,746	$ 1.00	$ 287,746	
AASHTO Type IV - 72 Inch Depth	FT	1,860	$ 320	$ 601,600	
Post-Tensioning Strand	LB	20,360	$ 10.00	$ 203,602	
Post-Tensioning Bar	LB	-	$ 10.00	$ -	
Approach Slabs	CY	159	$ 400	$ 63,704	
Temporary Works - Shoring Systems	EA	2	$ 100,000	$ 200,000	
Girder and Deck Subtotal:				$ 2,664,230	
Misc. Appurtenances					
Overlay	SF	24,793	$ 6.00	$ 148,756	
Expansion Joints	FT	215	$ 250	$ 53,750	
Barriers	FT	940	$ 155	$ 145,700	
Traffic Median	FT	235	$ 160	$ 37,600	
Bearings	EA	48	$ 1,000	$ 48,000	
Concrete - Surface Treatments	SF	3,760	$ 5.00	$ 18,800	
Period Light Fixtures and Conduits	LS	1	$ 50,000	$ 50,000	
Miscellaneous Items	LS	1	$ 200,000	$ 200,000	
Misc. Appurtenances Subtotal:				$ 702,605	
Superstructure Subtotal (1)					$ 3,366,835
Substructure					
Piers or Arch Ribs					
Concrete - Piers & Tie Beam	CY	269	$ 930	$ 249,527	
Concrete - Arch Ribs	CY	-	$ 1,250	$ -	
Reinforcing - Black	LB	105,064	$ 1.00	$ 105,064	
Post-Tensioning Strand	LB	-	$ 10.00	$ -	
Post-Tensioning Bar	LB	1,021	$ 10.00	$ 10,206	
Concrete - Surface Treatments	SF	3,760	$ 5.00	$ 28,800	
Piers or Arch Ribs Subtotal:				$ 393,597	
Pier Foundations					
Foundation Preparation - Cofferdam	LS	-	$ 500,000	$ -	
Footing Concrete - Tremie Seal	CY	-	$ 850	$ -	
Footing Concrete	CY	-	$ 950	$ -	
Footing Reinforcing - Black	LB	-	$ 1.00	$ -	
Drilled Shaft Furnished and Installed	FT	240	$ 3,000	$ 720,000	
Pier Foundations Subtotal:				$ 720,000	
Abutment					
Excavation	CY	7,400	$ 100	$ 740,000	
Abutment Concrete	CY	261	$ 950	$ 247,704	
Abutment Reinforcing - Black	LB	52,148	$ 1.00	$ 52,148	
Concrete - Surface Treatments	SF	8,400	$ 5.00	$ 42,000	
Drilled Shaft Furnished and Installed	FT	640	$ 950	$ 608,000	
Temporary Walls	SF	6,600	$ 50.00	$ 330,000	
Permanent Walls	SF	8,400	$ 50.00	$ 420,000	
Abutment Subtotal:				$ 1,699,852	
Substructure Subtotal (2)					$ 2,813,449
Main Bridge Quantities Subtotal (1) + (2)				$ 6,180,284	
Bridge Demolition 10%				$ 618,028	
Mobilization 5%				$ 309,014	
Architecture and Engineering Fees 15%				$ 927,043	
Maintenance of Traffic 10%				$ 618,028	
Estimated Cost of Work					$ 8,652,397
Contingencies					
Contingency 25%				$ 1,545,071	
Total Project Cost				$ -	$ 10,197,468
				Bridge Grand Total	$ 10,197,468
				Square Foot Total	403.66
				Cost Factor	1.00

Cost Studies

Barton Springs Road Bridge

Option 4 - Rehabilitation
(file: 12Nov2021_Barton Creek Cost Estimates08.xlsx)

			10-Nov-21
			10-Nov-21

	SPAN LENGTH (feet)	Width (feet)	AREA (ft²)
Abutment to Abutment:	207.3	107.5	22288

Item	Unit	Quantity	Unit Price	Subtotal	Total
Superstructure					
Girder and Deck					
Demolish Existing Floor System / Columns	SF	13,482	$ 55	$ 742,049	
Refrofit Existing Arch Ribs (FiberWrap/Rebar)	EA	16	$ 27,500	$ 440,000	
Drill and Grout Rebar (Existing Arch Crowns)	LF	150	$ 110	$ 16,500	
Deck Concrete	CY	552	$ 1,200	$ 662,630	
Spandrel Columns Concrete	CY	61	$ 770	$ 46,727	
Stiffening Girders Concrete (Rehab)	CY	92	$ 1,100	$ 101,200	
Reinforcing - Black	LB	726,219	$ 1.00	$ 726,219	
Longitudinal Beams	CY	32	$ 1,100	$ 35,534	
Transverse Floor Beams	CY	120	$ 1,100	$ 131,738	
Approach Slabs	CY	159	$ 400	$ 63,704	
Temporary Works - Shoring Systems	EA	2	$ 100,000	$ 200,000	
Girder and Deck Subtotal:				$ 3,170,361	
Misc. Appurtenances					
Overlay	SF	24,558	$ 6.00	$ 147,348	
Expansion Joints	FT	215	$ 250	$ 53,750	
Barriers	FT	920	$ 155	$ 142,600	
Traffic Median	FT	207	$ 160	$ 33,158	
Teflon Disk Bearings	EA	168	$ 2,500	$ 420,000	
Concrete - Surface Treatments	SF	1,650	$ 5.00	$ 8,292	
Repair Existing Concrete Surface (Rehab)	SF	13,848	$ 55	$ 761,640	
Cathodic Protection System (Rehab)	SF	5,794	$ 55	$ 318,648	
Period Light Fixtures and Conduits	LS	1	$ 50,000	$ 50,000	
Miscellaneous Items	LS	1	$ 200,000	$ 200,000	
Misc. Appurtenances Subtotal:				$ 2,135,443	
Superstructure Subtotal (1)					$ 5,305,804
Substructure					
Piers or Arch Ribs					
Concrete - Piers	CY	290	$ 770	$ 223,565	
Concrete - Arch Ribs	CY	176	$ 1,320	$ 232,320	
Reinforcing - Black	LB	186,548	$ 1.00	$ 186,548	
Concrete - Surface Treatments	SF	7,200	$ 5.00	$ 36,000	
Piers or Arch Ribs Subtotal:				$ 678,453	
Pier Foundations					
Footing Concrete	CY	240	$ 770	$ 184,800	
Footing Reinforcing - Black	LB	60,000	$ 1.00	$ 60,000	
Pier Foundations Subtotal:				$ 244,800	
Abutment					
Excavation	CY	3,704	$ 100	$ 370,370	
Abutment Thrust Blocks Concrete	CY	400	$ 1,100	$ 439,874	
Abutment Front and Sidewalls	CY	433	$ 550	$ 238,333	
Abutment Reinforcing - Black	LB	208,259	$ 1.00	$ 208,259	
Concrete - Surface Treatments	SF	8,400	$ 5.00	$ 42,000	
Drilled Shaft Furnished and Installed	FT	1,320	$ 950	$ 1,254,000	
Abutment Subtotal:				$ 2,552,837	
Substructure Subtotal (2)					$ 3,475,890
Main Bridge Quantities Subtotal (1) + (2)				$ 8,781,695	
Bridge Demolition 0%				$ -	
Mobilization 5%				$ 439,085	
Architecture and Engineering Fees 15%				$ 1,317,254	
Maintenance of Traffic 10%				$ 878,169	
Estimated Cost of Work					$ 11,416,203
Contingencies					
Contingency 25%				$ 2,195,424	
Total Project Cost				$ -	$ 13,611,626
				Bridge Grand Total	$ 13,611,626
				Square Foot Total	610.71
				Cost Factor	$ 1.33

URS

Bridge Cost Comparison

Barton Springs Road Bridge

Conceptual Engineering Cost Estimate

Comparison of Alternatives by Bob Anderson 10-Nov-21

(file: 12Nov2021_Barton Creek Cost Estimates08.xlsx) chk Steve Metzer 10-Nov-21

Alternative	Bridge Total ($M)	Weighted Costing (Based on Total)	Costing Differences ($M)	Costing Rank (Based on Total)
Option 1 - Concrete Arch (New)	14.84	1.45	4.64	*4*
Option 2 - Concrete Single Pier (New)	12.44	1.22	2.25	*2*
Option 3 - Concrete Dual Pier (New)	10.20	1.00	0.00	*1*
Option 4 - Rehabilitation	13.61	1.33	3.41	*3*

URS

Next Steps

- Interim Report
  - Update with recent renderings, cost
- BCER Phase
  - Use Interim Report and renderings as basis for next Charrette

BCER

- Public Involvement Plan
- Charrette No. 1
  - Public Works Management Team and City Stakeholders
  - Outcome – confirm direction (Rehab vs. Replacement)
  - Potential identify 1 or 2 selected concepts to carry forward
- Council Briefing
  - Brief on above
  - Brief on upcoming public involvement approach (THC; external stakeholders; Open House)
  - Obtain Council confirmation of direction
  - Obtain new inputs; messaging from Council

C-2 - Draft Interim Bridge Status Memorandum – Feb 2022

City of Austin

Barton Springs Road Bridge over Barton Creek

Interim Bridge Status Memorandum

CIP ID 5873.031

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February 24, 2022

Draft Issue (D2)

URS

This document is released under the authority of Robert B. Anderson Texas PE No. 111066

REVISIONS

Project: City of Austin – Barton Springs Road Bridge over Barton Creek

Document: Interim Bridge Status Memorandum

Revision	Date of Issue	Description
D0	01/17/19	Draft Issue for Internal Comment
D1	01/25/19	Draft Issue for City Management Team Review/Comment
D2	02/24/22	Draft Issue for City Management Team Review/Comment

Statement of Limitations

This report is intended for the City of Austin and is not to be distributed to third parties outside the City's organization.

This interim memo provides an update regarding the status of the conceptual design work performed by URS for the proposed facility. This work is ongoing and not complete. Information included in this memo is subject to change prior to release of the Final Bridge Conceptual Engineering Report.

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1. INTRODUCTION

1.1 Background

URS is under contract to the City of Austin to conduct a variety of tasks to evaluate rehabilitation or replacement options for the Barton Springs Road Bridge over Barton Creek. The location of the bridge, at the entrance to Zilker Park, is a focal point of key community events such as the Austin City Limits Music Festival, South by Southwest Conference and Music Festival (SXSW), Barton Springs, Trail of Lights, and Blues on the Green. Barton Springs Rd. and the associated bridge is also a key connection for vehicular, bike, and pedestrian access linking Mopac to downtown and the South Lamar/Congress corridors, as well as providing the primary northern entrance to the Zilker and Barton Hills neighborhoods via Azie Morton Rd., located immediately east of the bridge.

The three-span open spandrel concrete arch bridge was originally built in 1925 and was expanded to the north in 1946. The current bridge is 212' long and 58'-8" wide. The age of the structure has warranted progressively more detailed inspection and condition assessments over time. In addition, the bridge geometry is functionally obsolete with respect to bikes and pedestrians, and the roadway west of Azie Morton is un-aligned with the roadway east of Azie Morton. The City's preliminary bridge deck concept approximately doubles the width of the bridge deck to accommodate wider sidewalks on either side of the bridge, two bicycle lanes, four travel lanes, and a median to match the cross section of Barton Springs Road established by a previous reconstruction of that roadway east of Azie Morton.

The bridge is currently a bottle-neck, with congestion for all modes of travel at the Barton Springs Road/Azie Morton intersection. The proximity of the bridge and Azie Morton intersection (including structural cantilevered sidewalk) specifies the two features are integral to one another. For that reason, in addition to the evaluation of the bridge structure, the City is interested in understanding the potential for reducing congestion at this intersection and entrance to Zilker Park via assessment of potential improvements to the combination of roadway, bridge, and intersection. Reducing congestion will provide future benefits to the local neighborhoods, commuters (all travel modes), local businesses, as well as Zilker Park users and event attendees.

1.2 Project Objectives

URS has been contracted (C.I.P. Project Number 5873.031) to provide design services for rehabilitation or replacement of the existing bridge. The original project scope included consideration of two potential bridge rehabilitation options and additional options for bridge replacement. A general description of these options is:

- *Rehabilitation Option 1*: One option to rehabilitate and preserve the existing structure… This option must include consideration of a retrofit… bridge railing system to upgrade the substandard existing railings. This option also includes consideration and feasibility of a complementary structure or other means to adequately address additional capacity desired for bike and pedestrian traffic on both sides of the bridge.
- *Rehabilitation Option 2*: One option to rehabilitate the existing structure and enhance the deck by widening it to incorporate wider sidewalks and a bike lane on both sides. This new bridge deck option may either be placed on the existing substructure or a widened, expanded substructure as necessary.

- *Replacement Options*: Three options for complete reconstruction of the bridge designed to modern structural codes to include a wider bridge deck to allow for realigning the Barton Springs Road intersection for improved safety, bike lanes on both sides, and wider ADA compliant sidewalks.

1.3 Bridge Engineering Process

The overall process envisioned for the bridge rehabilitation/replacement is as follows:

- Preliminary Selection and Concept Engineering. This phase will assess the feasibility of bridge rehabilitation or replacement. Based on the preferred option, this phase will also select the bridge type and style, and preliminary concept options; this will include preliminary design options and conceptual evaluations of each option. The evaluations will consist of assessments such as bridge structural engineering, architectural, roadway, utilities, and environmental feasibility. These options will be supported, and the evaluations vetted by City of Austin stakeholder departments and executive management. Public involvement will be conducted, with specific stakeholder and public meetings conducted at strategic milestones. The result of the Preliminary Selection phase will be a vetted/selected bridge design option; this phase will be documented in a Bridge Conceptual Engineering Report (BCER). The confirmed design option will then proceed to the design phase.
- Preliminary (30%) Design. This phase consists of the 30% Design and the Preliminary Engineering Report. The primary outcomes of this phase include obtaining detailed information from onsite topographic and bathymetric surveying, engineering field investigations, and environmental field investigations. This detailed information will allow for preliminary detailed engineering of bridge and roadway areas. It will also allow for early coordination with federal, state, and local permitting agencies to vet the design and determine the available strategies for obtaining permits/approvals of the design to support bidding/construction.
- Final Design and Permitting. Includes detailed design for all disciplines, and obtaining permits and approvals from all federal, state, and City agencies and departments.
- Bidding and Construction. This phase includes obtaining bids and City contracting for the Construction Contractor and managing the construction process.

1.3.1 Preliminary Selection and Concept Engineering – Process Phase 1

Due to funding limitations, the overall Preliminary Selection process was divided into smaller scopes of work. The first scope of work (Phase 1) was the Bridge Inspection and Condition Assessment. The objective of this phase was to understand the condition of the existing bridge based on a detailed visual inspection and selected sampling/testing of the bridge concrete. It was also understood that the results of this phase may provide insight into the viability of one or both rehabilitation options.

The Bridge Inspection and Condition Assessment Report for Barton Springs Road Bridge [R-1] was submitted in January 2017. The condition assessment report indicated that the overall bridge was in fair condition; however, the deck (with integral longitudinal joint), floor beams, and spandrel columns had exhibited the most degradation, although all structural components had exhibited some degradation. As a result, any rehabilitation desiring increased service life would need to remove the deck, floor beams, and spandrel columns, essentially stripping the

structure down to the arch ribs as a starting point. As indicated in the report, these results, by definition, remove Rehabilitation Option 1 as a feasible alternative, since the intent of that option was a "low-impact", "preserve-structure" rehabilitation option from visual, construction, and cost standpoints.

Based on the above, the URS Team is focusing on Rehabilitation Option 2 and on potential bridge replacement options moving forward.

1.3.2 Preliminary Selection and Concept Engineering – Process Phase 2

The second scope of work, and the subject of this memorandum, expands on the bridge condition inspection, and focuses on:

- Load capacity and rehabilitation analysis of the existing bridge;
- An assessment of roadway/intersection needs and intersection options to complement the options associated with bridge replacement and rehabilitation;
- Structural assessment of Rehabilitation Option 2;
- Development and assessment of three bridge replacement concepts/options; and
- Preliminary costing for the rehabilitation and replacement options.

The intent of Phase 2 is to provide the City an understanding of the roadway/ intersection/bridge needs and options to meet those needs, in order to guide the remaining phases of concept and design refinement and bridge selection.

1.3.3 Preliminary Selection and Concept Engineering – Process Phase 3

Phase 3 and beyond will provide the remainder of the Preliminary Selection phase, and will focus on the full vetting of the rehabilitation and/or replacement options.

2. SUMMARY OF RESULTS

This section of the report summarizes the work performed as part of this Phase 2 Scope of work, and associated technical findings.

2.1 Bridge Cultural/Historical Background

The original Barton Springs Road bridge was built in 1925 and widened to its current configuration in 1945. The bridge is located adjacent to Zilker Park, which is listed in the National Register of Historic Places (NRHP); the bridge is considered a contributing resource to the Park. The Barton Springs Archeological and Historical District (formed in 1985) is also located within the Zilker Historic District and the downstream boundary of this district is in close proximity to the bridge.

The work performed to date has focused primarily on the roadway and structural feasibility and concepts associated with future bridge rehabilitation or replacement options. It is understood that all future planning and design work will also include coordination and discussions with key cultural/historic preservation stakeholders such as the City's Parks and Recreation Department (PARD) and Historic Preservation Office, as well as the Texas Historic Commission (THC).

2.2 Barton Springs/Azie Morton Road Intersection Assessment

As discussed above, the location of the bridge, at the entrance to Zilker Park, is a focal point of key community events and gatherings such as the Austin City Limits Music Festival. Barton Springs Road (and bridge) is also a key commuter corridor with access to Mopac and Bee Caves Road, as well as being a key entry/exit to the Zilker and Barton Hills neighborhoods via Azie Morton Road. The Azie Morton Road intersection, due to this proximity, is integral to any future bridge work.

In addition to the evaluation of the bridge structure, a traffic analysis was conducted in the area to understand the potential for reducing congestion at the Barton Springs/Azie Morton intersection and entrance to Zilker Park. Existing traffic counts and intersection turning movements were reviewed and anticipated traffic growth patterns through the year 2040 were incorporated.

The results of the study indicated that inclusion of right turn bays for both Barton Springs Rd. and Azie Morton Road would improve vehicle operations and reduce delays during peak hour traffic. Accordingly, these improvements were incorporated into the concept development for both bridge rehabilitation and replacement.

2.3 Roadway Alignment Concepts (Rehabilitation vs Replacement)

The existing centerline alignment of Barton Springs Road contains a Point of Intersection (PI) within or near the Azie Morton Road intersection. The effects of this PI appear worse in the westbound (WB) direction due to the narrow existing bridge and forced lane shift across the intersection related to the existing WB left turn lane to Azie Morton. This adverse geometry can be alleviated somewhat with the Rehabilitation Option (see Figure 2-1), but is entirely resolved with the Replacement Option (see Figure 2-2).

2.3.1 Rehabilitation Option

The Rehabilitation Option will reuse portions of the existing bridge structure (with rehabilitation measures implemented) and widen each side to provide the ultimate width necessary for proposed multi-modal travel ways. Due to complexities involved

in variable-width bridge widening, it is not feasible to adjust the Barton Springs Road centerline alignment bearing along the bridge in the Rehabilitation Option. Proposed improvements in this option include: widened pedestrian paths, potential for additional pedestrian amenities along the north side, improved bicycle facilities, maintain two vehicle travel lanes in each direction, full-width median opposite the WB left turn lane to Azie Morton, eastbound (EB) right turn lane to Azie Morton, and northbound (NB) right turn lane from Azie Morton to Barton Springs Road. However, the PI condition will remain, and future drivers will experience a slight shift as they travel through the Azie Morton intersection.

2.3.2 Replacement Option

The Replacement Option will remove the existing bridge structure in its entirety and provide a new structure with the ultimate width necessary for proposed multi-modal travel ways. The proposed structure will be designed with the centerline alignment bearing matching the existing roadway east of Azie Morton. This will require a minor transition within the centerline radius just west of Barton Creek that will not contain a PI and will meet current City of Austin design requirements.

This revised centerline alignment can accommodate the preservation of the historic stone monuments marking the entrance to Zilker Park. Proposed improvements in this option include the same benefits listed under the Rehabilitation Option with the added benefit of having a consistent alignment that meets current design standards and eliminates the PI condition within or near the Azie Morton intersection. Additionally, this option allows for lengthening the bridge by moving the western abutment to the west, In so doing, the Replacement Option provides additional space to facilitate improvements to existing Zilker Park facilities, such as walking paths and the Zilker Zephyr miniature railroad, both of which pass under the Barton Springs Road Bridge on the west bank. This additional space for improvements is not feasible with the Rehabilitation Option.

2.4 Maintenance of Traffic / Construction Phasing

General Construction Phasing and Maintenance of Traffic (MOT) during construction are similar for both Rehabilitation and Replacement Options. Due to the nature of this key commuter corridor and special events center, and due to the anticipated duration of the bridge construction, it was thought to be essential to maintain all four lanes of traffic in operation during bridge construction. It is currently planned to include three phases of construction, maintaining two traffic lanes in each direction with traffic shifts between each phase to accommodate the subsequent phases of work. There are likely to be occasional lane closures for specific components of the work or to facilitate material and/or equipment loading and unloading, but these should be limited to off-peak hours. More specific descriptions of each phase are in the sections below and illustrated in Figures 2-3 to 2-5. An illustration of the completed plan view and typical section is shown in Figure 2-6.

2.4.1 Phase 1 (Figure 2-3)

Phase 1 of the MOT will be split into 2 Steps to maximize vehicle and pedestrian movement through the project.

Phase 1 Step 1

- Shift traffic along Azie Morton Road over to the west to setup a work zone on the east side of Azie Morton. Construct proposed retaining wall, right turn

lane, and new sidewalk on Azie Morton. Pedestrian traffic will be unaffected by this phase of MOT and can continue to travel on existing facilities.

Phase 1 Step 2

- Maintain traffic along Barton Springs Road generally in existing locations with appropriate protections (concrete barriers and advanced warning devices) installed to inform and protect traveling public and to protect construction workers, materials, and equipment.
- Detour pedestrian traffic wanting to cross Barton Springs from Azie Morton along east side of Azie Morton on newly constructed sidewalk. A temp crossing will be set up on the east side of the Azie Morton / Barton Springs intersection.
- Construct north and south portions of Barton Springs Road bridge / approach pavement with appropriate permanent and temporary barriers as well as retaining wall and pavement cantilevered sidewalk along east side of Azie Morton Road.
- Proposed improvements constructed during this phase will facilitate traffic operations during construction and then can be further developed to provide enhanced pedestrian amenities such as unique gathering places and/or overlooks to Barton Creek and Lady Bird Lake with direct pedestrian connections to trails passing under the bridge along Barton Creek.

2.4.2 Phase 2 (Figure 2-4)

- Update MOT signs, structures, and devices to facilitate Phase 2 work.
- Split WB traffic along Barton Springs Road. One lane will be routed onto the new bridge constructed during Phase 1, and the other lane will be routed down the existing outside lane of WB traffic.
- Split EB traffic along Barton Springs Road. One lane will be diverted to what was the inside lane of WB traffic, and the other will be routed onto the new bridge constructed in Phase 1.
- Shift NB and SB traffic along Azie Morton Road to the east onto pavement completed during Phase 1.
- Demolish (for replacement) or redeck (for rehabilitation) existing EB bridge.
- Shift EB pedestrian traffic from the existing bridge to the new bridge constructed in Phase 1.
- Construct southern interior portion of proposed Barton Springs Road bridge and approach pavement.

2.4.3 Phase 3 (Figure 2-5)

- Update MOT signs, structures, and devices to facilitate Phase 3 work.
- Split WB traffic along Barton Springs Road. One lane will continue on the bridge built in Phase 1. The other lane will be shifted south onto the new bridge built in Phase 2.
- Split EB traffic along Barton Springs Road. One lane will remain on the bridge built in Phase 1. The other lane will be routed onto the bridge built in Phase 2. To make the geometry of this shift work, the left turn off of Barton Springs Road onto Azie Morton Road will need to be closed. The left turn can still be made, it will just need to be combined with the straight lane.
- Maintain pedestrian traffic as it was in Phase 2.
- Demolish (for replacement) or redeck (for rehabilitation) existing WB bridge.
- Construct northern interior portion of proposed Barton Springs Road bridge and approach pavement.

2.4.4 Final Tasks – Complete Construction

- Update MOT signs, structures, and devices to facilitate final tasks for bridge completion. Remove temporary features no longer needed.
- Route all Barton Springs Road traffic onto permanent approach pavement and bridge completed in previous phases – shift lanes toward median to extent necessary to construct barriers between roadway and pedestrian areas.
- Shift vehicle and pedestrian traffic into final proposed locations after miscellaneous elements are completed. Remove all remaining temporary features and perform final site cleanup for project acceptance by the City.

2.5 Bridge Rehabilitation Summary

2.5.1 Introduction

As discussed above, the URS Team has performed an assessment of Rehabilitation Option 2, taking into consideration the roadway geometry and MOT needs. The rehabilitation of the existing structure within the proposed widened cross section is considered a feasible design alternative. This alternative provides for preservation – primarily through concrete remediation and cathodic protection methods – of the existing bridge main arch and substructure elements. However, replacement of the existing bridge deck, floor system, and arch spandrel columns is required based upon the amount of deterioration present in these reinforced concrete elements. Detailed information regarding the condition evaluation of the existing bridge elements was provided in the 2017 *Bridge Inspection and Condition Assessment Report* by URS and the associated 2017 *On-Site Sampling and Laboratory Investigation* by CTL Group.

2.5.2 Bridge Rehabilitation Feasibility

The feasibility of the proposed design alternative has been studied in the context of providing the following requirements:

- Required roadway section;
- Load-carrying capacity in accordance with the current AASHTO LRFD Design Code;
- Aesthetic compatibility with respect to the original structure(s);
- Future remaining service life that is comparable to that of a replacement structure; and
- Construction cost that is competitive with that of a replacement structure.

It is still too early in the planning process to develop detailed architectural styles or designs and coordinate same with the THC and stakeholders. Based on previous discussions with THC related to similar types of projects, the new bridge elements constructed as part of an overall rehabilitation should not be a replica of, but be complementary to, the existing bridge elements. Reconstruction/rehabilitation will be accomplished in individual stages with no reduction of the existing roadway lane capacity as in the above MOT descriptions; however, pedestrian traffic will be limited periodically and required to detour during the reconstruction. Also, extensive temporary falsework with associated foundations within Barton Creek will be required to support new portions of the bridge rehabilitation while it is being constructed.

2.5.3 Description of Existing Condition

The south structure is 97 years old, and the north structure is 76 years old. The bridge overall has a condition rating of "Fair," and most structural components

generally have a condition rating of "Good", based on the *FHWA Condition Rating Guidelines*. As indicated by the recommendations of the 2017 *Bridge Inspection and Condition Assessment Report*, the preferred method of mitigating corrosion of the existing bridge elements is to limit water intrusion through the deck. With respect to the arch ribs and piers, the main load-carrying members, the results of the concrete testing indicate that the concrete quality is generally good. However, additional steps to implement means of cathodic protection into the structure are also desired, since the depths of carbonation and chloride content at some locations in the arch ribs are at the level of the reinforcement and at a concentration consistent with the threshold for initiation of corrosion of the reinforcing bars.

Given the advanced age of the deck, and the fact that the most serious deterioration is found within the vicinity of the longitudinal deck joint, it is preferable to replace the deck entirely and eliminate the longitudinal joint and transverse joints where practical. In addition, the spandrel columns exhibit low concrete compressive strength and severe cracking, spalling, and/or delamination (2017 *On-Site Sampling and Laboratory Investigation*). The cracking of the shorter spandrel columns is further exacerbated by their structural configurations (moment connections at both the top and bottom), which attract an inordinately large amount of shear loading.

Therefore, any proposed bridge rehabilitation strategy that provides a substantial increase in service life requires "stripping" the structure down to the arch ribs and reconstructing the spandrel columns, floor system, and deck.

Unknown Information: Some key unknown information that requires further investigation includes the following items:

- The results of a future concrete corrosion Inspection and Testing Program to better identify the levels of corrosion of existing bridge elements to remain in place. The outcome of this sampling and testing work may indicate that rehabilitation is not practical or feasible with respect to the estimated remaining service life of the original bridge elements.
- The effects upon existing foundations from adjacent construction on existing or new foundations.
- The existing West Abutment foundation – the original drawings appear to indicate that the bridge foundation is in fine-grained soils and not on limestone. Additional investigations are warranted, and pending these results, additional foundation remediation may be required.

Each of these items can likely be contained within the contingent cost ranges developed for the bridge rehabilitation described below; however, the final condition of the existing bridge elements to remain could possibly discourage or disqualify this design alternative.

2.5.4 Service Life Estimates

It is currently estimated that the bridge structure will begin to require significant maintenance in 3 to 5 years if the current level of corrosive activity goes unchecked. The major items identified as being susceptible to corrosion are elements of the floor system and the spandrel columns. This rehabilitation alternative addresses those items, as well as future needs. While an exact corrosion remediation strategy has not been identified, it is anticipated that both remediation repairs and the installation of a cathodic protection system will be employed as part of the rehabilitation. The further remediation and protection means and methods are not yet fully developed. The extent and details of this system will require future bridge material sampling and

testing work for evaluation of the existing structural elements. Potentially, the outcome of this study may suggest that this proposed rehabilitation option is not practical or feasible with respect to the estimated remaining service life of the original bridge elements.

In accordance with current design practices, it is anticipated that the level of remediation and future corrosion mitigation methods will be employed to achieve an additional 50 to 75 years of bridge service life subsequent to the rehabilitation. It is not anticipated that this work will have significant effect upon the historic character of the bridge, since requirements for any repairs and the final concrete finish of both existing and new bridge elements would be vetted with the THC and would be intended to adhere to or complement the characteristics of the original bridge construction.

2.5.5 Existing Structure - Load Capacity Estimates

[redacted]

[redacted]

2.5.6 Rehabilitation Concept and Components

The proposed roadway and sidewalk section accommodated by the new structure is 109'-4" in width (see Exhibit 2-1). The existing bridge is only 58'-8" in width. In an effort to preserve the historic character of the existing bridge, the additional width will be accommodated by a nearly symmetrical widening with two additional arch sections on each side that are visually/dimensionally similar to their adjacent 1925 Original Structure and 1945 Widened Structure elements.

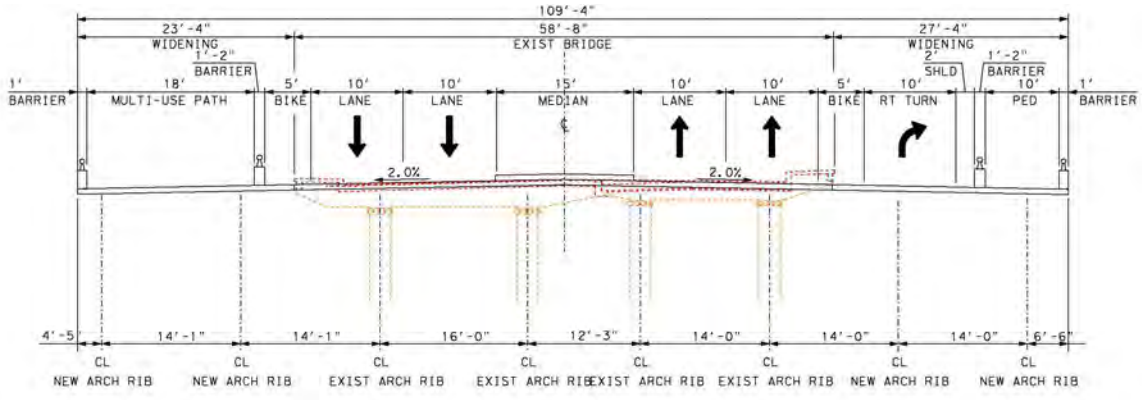


Exhibit 2-1. Roadway/Sidewalk Cross-Section Rehabilitation Option Concept

The rehabilitation concept is based upon the need to provide adequate load carrying capacity in accordance with AASHTO LRFD criteria and to repair/replace deteriorated structural elements as required, while preserving the primary aesthetic and historic features of the existing bridge to the maximum extent possible. Again, it is understood that rehabilitation strategies in the future will necessitate coordination with THC and similar stakeholders. Additional widening is accommodated by providing additional main structure elements that are aesthetically compatible with the existing bridge elements.

To provide the required additional load carrying capacity for the existing bridge arch ribs, spandrel columns, and piers, longitudinal stiffening elements/beams are proposed to be incorporated into the new deck system (see Exhibit 2-2). A single stiffening beam is placed over each arch rib, which redistributes a portion of the externally applied dead and live loads. An analysis of the structure incorporating an 18-inch-deep by 24-inch-wide stiffening element that is composite with the arch rib in the vicinity of the arch crown results in a reduction of applied loads to the arch rib and piers that makes this rehabilitation concept feasible with respect to meeting AASHTO LRFD load requirements. Also, it is anticipated that in addition to this element being "fixed" with the arch ribs over the crown section, the stiffening beams would be placed on bearings – or possibly with concrete hinge connections - over the remaining spandrel columns to mitigate the aforementioned large shear loads being transferred to the spandrel columns. Finally, localized shear and bending retrofits are required at the arch spring lines adjacent to the abutments.

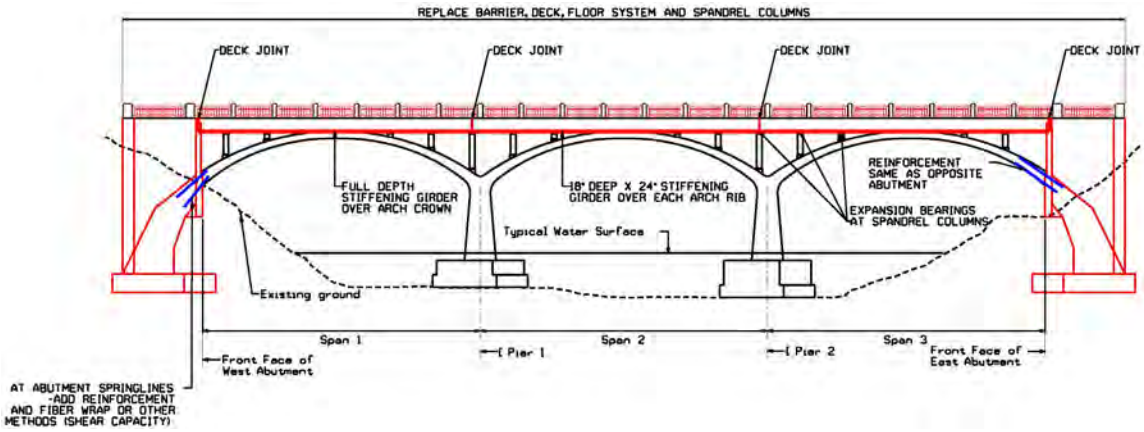


Exhibit 2-2. Features of Rehabilitated Bridge

The structure widening on the skewed section over Barton Creek is accomplished in a manner similar to the 1945 addition to the Original 1925 bridge. Transverse floor beams are provided that are normal to the arch ribs with longitudinal deck beams provided between each pair of arch ribs to allow for a framing plan of the deck supports, as well as the spandrel columns to be uniform throughout the entire width of the widened structure along the skew.

In an effort to 'complement' the visual character of the existing bridge, the new widened sections – two arch ribs per side - will not require the incorporation of the additional longitudinal stiffening elements. URS has used this method of rehabilitation for the recent design of the widening and jointless reconstruction of the Henley Street Bridge in Knoxville, Tennessee – another historically significant structure.

Other than localized repairs, no retrofit of the existing bridge substructure is currently anticipated. As differing from the original design, preliminary geotechnical recommendations include the use of drilled shaft foundations for the new substructure units. An advantage of drilled shaft construction is the mitigation of environmental impacts to Barton Creek associated with cofferdam construction and stream bed excavation.

2.5.7 Rehabilitation Renderings

As part of this study, renderings have been prepared for the rehabilitation concept; as described above, it is still too early in the planning process to develop detailed architectural styles, and so for purposes of this memorandum and renderings, new bridge elements will appear very similar, which is the result of being early in the planning and concept process. The renderings in Figures 2-7 to 2-12 provide a conceptual depiction of the sequence of construction, beginning with removal of deck and spandrel columns, construction of new arches, and ending with a depiction of the completed rehabilitation.

2.5.8 Estimated Costs

Some preliminary bridge costs have been developed for the construction of this alternative. The concept-level cost considers typical bridge structural items, but it does not include overall project costs such as those for approach roadways, trails, retaining walls, utilities and other ancillary features. An estimated raw construction

cost of the bridge rehabilitation option ranges from roughly $425 to $700 per square foot of deck area. The cost range includes contingencies for unknowns and is based on the current early stage in design and associated cost variances.

The raw cost estimate range presented does not include escalation contingencies which may exist in an inflationary period; however, it does assist in ranking options based on consistent application of unit costs. Also, the rehabilitation cost is a present cost and does not account for the time value of money related to maintenance costs and the building of a replacement bridge at some time in the future. For example, if the rehabilitated bridge would need to be replaced 50 years in the future and the new bridge would need to be replaced 100 years in the future, building a new bridge extends the replacement cycle by 50 years.

2.6 Bridge Replacement Summary

2.6.1 Introduction

The URS Team was requested to develop some high-level concepts for bridge replacement alternatives, to help provide high level alternative comparisons to the more detailed rehabilitation feasibility assessment. In parallel to the development of the rehabilitation option, the URS Team worked to satisfy project requirements and goals with replacement alternatives. When developing the concept replacement options, the following primary project objectives were considered:

- Maintenance of Traffic;
- Cost;
- Durability and Sustainability;
- Aesthetics; and
- Improved Interface with Barton Creek and Trail Features.

2.6.2 Bridge Replacement Feasibility

The main aspect related to the feasibility of new bridge alternatives relates to traffic control, phased demolition of the existing bridge, and corresponding phased construction of the new bridge (see Figure 2-2). Both the existing and new bridges will remain stable, and possess required load capacity, as the phased construction is advanced. The demolition of the existing bridge will also require temporary walls to hold the soil embankment while the new bridge abutments are constructed. For Options 1 and 2 described below, temporary falsework with associated foundations within Barton Creek will be required to support the bridge while it is being constructed. Drilled shaft foundations are anticipated for the new permanent bridge; thus, none of the existing structure will be reused structurally. Nonetheless, the existing bridge may be reused for fill, rip-rap, scrap, or other needs as feasible.

2.6.3 Replacement Concept and Components

The URS Team developed several conceptual replacement alternatives that used a consistent superstructure design and variation of themes for the substructure. For the sake of economy and their compatibility with the proposed phased construction, TxDOT I-Beams were chosen as the primary longitudinal load carrying elements. These are intended to be constructed in pairs with intermediate diaphragms framed to substructure supports. This framing concept will dramatically increase visual transparency for the underside of the bridge and reduce visual clutter by cutting the number of substructure elements in half. Thus, four substructures will be used for

the replacement bridge alternative, while eight substructures are used with the rehabilitation concept.

For the longitudinally framed arch (Option 1) and longitudinally framed single column substructure (Option 2):

- The intermediate diaphragms support the girders indirectly, i.e., the girder is offset from the substructures transversely.
- It is anticipated that longitudinal and transverse post-tensioning will be used to assist in carrying loads in the beams and diaphragms.
- The renderings show concrete with the shape of a truncated pyramid extending from the girder face at the intermediate diaphragm points. These blocks are used to protect anchorages for the transverse post-tensioning.

For the transverse framed substructure dual column substructure (Option 3):

- A Y-shaped column will provide a direct support for pairs of girders, i.e., each girder is supported by a leg of the "Y". Longitudinal post-tensioning of the girders and transverse post-tensioning of the diaphragms is eliminated.
- Blocks at the exterior fascia of the girders and the diaphragms are eliminated.
- Temporary falsework to support the girders during construction is eliminated.

For the substructures, the alternatives developed are single, double, and three portal forms. In terms of structural behavior, Option 1, which has arch supports extending to each bank, will behave like a thrust arch. For Options 2 and 3, the girders frame directly to intermediate substructures and exhibit beam action. Beam action framing has the advantage in that intermediate foundations do not need to resist large thrust loads from the arch, and more open space is created at the ends of the bridge for trail access.

Renderings of the replacement options are included in Figures 2-13 to 2-15. These renderings show views of the completed bridge. Figures 2-16 and 2-17 show views of the deck with conceptual landscaping and pedestrian amenities. As with the rehabilitation alternative, it is understood that any replacement strategies moving forward will include extensive coordination with THC and similar cultural/historical stakeholders.

2.6.4 Estimated Costs

Similar to rehabilitation, preliminary bridge costs have been developed for the construction of replacement alternatives. These costs consider typical bridge structural items, but do not include overall project costs such as those for approach roadways, trails, retaining walls, utilities, and other ancillary features. An estimated raw construction cost of the bridge replacement options ranges from roughly $400 to $750 per square foot of deck area. The cost range is based on the current early stage in concept design and associated cost variances, as well as the greater diversity of feasible bridge types and aesthetics from which to select.

Again, the raw cost estimates presented do not include escalation contingencies which may exist in an inflationary period; however, they do assist in ranking options based on consistent application of unit costs.

2.7 Conceptual Zilker Park/Pedestrian Opportunities

Closely associated with the proposed bridge, roadway, and sidewalk improvements will be new park/pedestrian improvements to provide improved connectivity from

existing facilities to the new construction. The bridge project anticipates improvements to existing park/pedestrian facilities as well as construction of new facilities. While still in the early planning stages, this memo provides some potential opportunities and improvements, as shown in Figure 2-18 and described below. This conceptual plan shows the completion of trails, streambank stabilization, and other improvements, described below.

2.7.1 Structure/Tree Protection and Mitigation

Key historic structures such as the existing park monuments and the pecan grove picnic area will be protected from disturbance during the work; these important facilities are part of the historical character of the park. Heritage trees that have the potential to be in conflict with the bridge construction have been assessed; these trees can be moved/re-located to mitigate potential damage or alternatively can be stabilized and protected depending upon the degree of conflict. These aspects of the work will be coordinated with City stakeholders throughout future planning and design efforts.

2.7.2 Zilker Park – Zilker Zephyr

Figure 2-18 shows a replacement of the Zilker Zypher track with either the rehabilitation or replacement scheme. New tracks would need to be placed in/around the bridge abutment and reconnected with the existing track at some determined distance from the bridge. The alignment of the Zilker Zypher track is directly adjacent to the existing western bridge abutment and underneath the bridge. Maintaining safe operation of the Zilker Zypher at this current alignment and underneath the bridge is not feasible during any future bridge construction.

With the existing bridge and the rehabilitation option, the track will be located in the same approximate location; this existing location has both vertical (headroom) and horizontal space constraints. The replacement option provides a shift of the abutment to the west and provides an opportunity for more space for the train and riders.

2.7.3 Zilker Park Hike/Bike Trail

The existing east-side trail underneath the bridge has experienced erosion/ undercutting from Barton Creek. Bridge construction would also likely include trail improvements such as:

- Trail stabilization to address erosion issues;
- Slope stabilization under and adjacent to bridge; and,
- Restored trail segments to connect to existing trail further north/south.

The existing west-side trail underneath the bridge includes a pedestrian bridge that is located to avoid the existing arches. For the bridge rehabilitation option, the pedestrian path and bridge will need to be removed and rebuilt to accommodate new arches, with associated headroom and bridge structure requirements. For a bridge replacement option, the pedestrian path and bridge can be similarly removed and rebuilt; alternatively, the path may be able to be re-located onto the bank adjacent to the re-located west abutment, with the additional space made available on this side.

The above improvements to the Butler Hike and Bike trail system are also anticipated to be conducted with streambank stabilization elements. Additional trails

have been proposed in concept to support the pedestrian amenities located on the bridge. These additional trails also provide enhanced pedestrian access from Butler Hike and Bike trail to other areas of the park, as shown in Figure 2-18.

2.7.4 Barton Springs Road

The existing sidewalk east of bridge on the north side will be re-aligned for connection to the new and wider bridge sidewalk, as well as a new transition and tie to the existing hike/bike trail.

Existing cross-walks at the intersection of Barton Springs Rd. and Azie Morton Rd. will continue to operate similarly to current operations. However, the final layout of the crosswalks will reflect the new lane and roadway geometry, so that there will be some minor adjustments in the cross-walk dimensions.

2.7.5 Azie Morton Road

The right turn bay on Azie Morton Road is envisioned to be constructed in the initial early phase of the project. It is anticipated that this work would accompany work to improve historic instability of the adjacent hillside and would also include replacement of the existing wood retaining wall along Azie Morton. This extended turn bay would include either a temporary or a permanent sidewalk and would connect to the existing sidewalk on the south side of Barton Springs Road.

This new sidewalk east of Azie Morton could be utilized during construction to maintain pedestrian access across the bridge. An additional (and possibly temporary) pedestrian crosswalk could be included south of the Azie Morton intersection; this would allow crossing of Azie Morton during and after construction.

2.7.6 Bridge Pedestrian Enhancements

The south side pedestrian sidewalk is anticipated to be widened from its current width of roughly 4' to approximately 10' wide to provide additional safety and capacity and the potential for a shared-use path. Figure 2-17 shows a concept rendering of the southern pedestrian path.

As described above, MOT strategies are proposed to accommodate and maintain the existing four lanes of traffic during construction. This approach will allow an opportunity to provide a pedestrian path on the north side that would be significantly wider to allow for the higher pedestrian volumes typically encountered on the north side. The additional width is especially useful during high pedestrian use and key events such as the Trail of Lights, and Austin City Limits Fest. Figure 2-16 is a concept rendering of the northern pedestrian bridge path, showing opportunities for enhanced placemaking.

2.8 Pedestrian Maintenance of Traffic Conceptual Plan

The construction of the Barton Springs Road Bridge (either rehabilitation or replacement) impacts several existing park activities. As indicated above, the Zilker Zypher and several trails will be affected by bridge construction, and so, anticipate upgrades as part of the project. The Pedestrian Maintenance of Traffic Plan (PMOT) has conceptually identified possible alternate and temporary routes to address the impacted park pathways during construction, as shown in Figure 2-19. The proposed pedestrian access plan for the existing Barton Springs Road bridge is predicated on maintaining the highest levels of pedestrian access and park functionality as viable.

There are several existing trails affected by the Barton Springs Road Bridge construction. The existing Butler Hike and Bike trails are located under the existing bridge along the east and west banks of Barton Creek. Maintaining safe pedestrian access to those trails that are underneath the bridge during bridge construction is not feasible. In addition to temporarily re-routing the east and west banks Butler Hike and Bike trails, access across the bridge is proposed to be temporarily suspended during some construction phases; however, temporary and functional alternate pathways have been proposed in concept.

Mitigation for the temporary trail closures can be accomplished by a variety of measures as indicated in Figure 2-19. This includes an existing crosswalk east of the bridge, a temporary crosswalk between Lou Neff Road and the west side of the bridge, and use of the existing pedestrian bridge across Barton Creek north of Barton Springs Road. The combination of the temporary facilities and paths will provide similar pedestrian access throughout the construction of the bridge.

The use of the crosswalk east of the bridge will be coordinated with the construction of the hillside slope stabilization near the Umlauf Sculpture Garden, as described previously. It is anticipated that the slope stabilization will be initiated prior to the need for this crosswalk use and would be one of the first components of the overall project. Access to the east bank Butler Hike and Bike trail will also require temporary trail improvements north of the bridge.

The new sidewalk shown on the east side of Azie Morton Road (whether temporary or permanent) is intended to carry pedestrians across Barton Springs Road east of the bridge, during bridge construction.

The Azie Morton Road temporary crosswalk is intended to provide access to the east bank Butler Hike and Bike trail system and Azie Morton from north or south sidewalks of Barton Springs Rd. The crosswalk is located to provide optimal pedestrian access to the Butler Hike and Bike Trail.

The temporary crosswalk west of the bridge is intended to be constructed with a short segment of temporary trail to connect to one of the new trails, and is located so pedestrians and bicyclists can cross Barton Springs Road west of the bridge during construction. The temporary crosswalk is proposed to be removed following bridge construction, and pedestrian operations will revert to the present scheme with one signaled crossing just east of the bridge. The exact location of the temporary crosswalk will be coordinated with vehicular sight lines and may require other temporary signage/markings to ensure pedestrian safety.

The existing pedestrian bridge north of the road can be used for pedestrians north of Barton Springs Road, and the temporary pedestrian bridge can be used for hike/bike trail users, as well as pedestrians along Barton Springs Road.

2.9 Preliminary Environmental Issues/Permits

URS developed a conceptual boundary of the limits of the project area, based on some of the preliminary work/construction identified and described in various sections of this memo; additional space for construction buffer zones was also applied. This study area was used for a preliminary review of proximate environmental resource considerations. At this conceptual stage, there was no distinction made between bridge rehabilitation and replacement, since their limits of construction operations are so similar.

URS collected environmental data for the study area from readily available desktop sources, including existing Geographic Information Systems (GIS) datasets and current, scientific literature. Data requests were submitted through the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Conservation (IPaC) and the Texas Parks and Wildlife Department's (TPWD) Texas Natural Diversity Database (TxNDD) for lists of federal and state listed species and other protected resources which may occur within or near the study area.

Additional files obtained from the Texas Archeological Research Laboratory (TARL) and the Texas Historical Commission (THC) were reviewed for recorded archeological sites or districts listed in the National Register, State Antiquities Landmarks, Registered Texas Historic Landmarks, local landmarks/districts, architectural surveys, cemeteries, or archeological surveys that might occur within or near the proposed study area.

Preliminary data collection findings have been summarized in Table 2-3. This table provides a preliminary list of environmental permits and approvals that have been identified as potentially applicable, and which will be further vetted in future phases of the project. Further investigations and data collection may show that some of these potential requirements are not applicable.

Figure 2-20 was also developed based on the preliminary findings; this figure shows some of the anticipated environmental constraints in and around the project area, and which are included in Table 2-3. This map or similar maps will be developed and updated as future, more detailed investigations are conducted.

Future construction and environmental permits and approvals will be based, in part on the decisions made for bridge rehabilitation or replacement. Many, if not most of the environmental constraints will be the same for either. As the project moves forward, an effort will be made to first identify environmental constraints, and then work to either avoid, minimize, or mitigate impacts to environmental resources. Table 2-3 identifies the various agencies with whom coordination efforts will be initiated as the project moves forward. Environmental mitigation will be part of those coordination efforts, as applicable.

Table 2-3. Preliminary Federal/State/City of Austin Permits and Approvals for the Barton Springs Road Bridge Project

Regulatory Agency	Regulation/Guidance	Permitting Trigger/ Permit Type	Field Surveys and/or Deliverables Requirements
U.S. Army Corps of Engineers (USACE), Fort Worth District	Section 404 of the Clean Water Act (CWA), Section 10 of the Rivers and Harbors Act	Barton Creek is considered a potentially jurisdictional "water of the U.S."; therefore, is regulated by the USACE. Per Nationwide Permit (NWP) 14 – Linear Transportation Projects, a Pre-Construction Notification (PCN) to the USACE Fort Worth District is required if: (1) the loss of waters of the U.S. exceeds 1/10-acre; or (2) there is a discharge in a special aquatic site, including wetlands. If permanent impacts to waters of the U.S. are less than 1/10-acre, no wetlands are impacted, and all NWP general conditions are met, than formal notification is not required. An Individual Permit (IP) is required if the loss of waters of the U.S. exceeds 0.50 acre. *This project is not anticipated to exceed this impact threshold; therefore, no IP submittal is anticipated.	**Field Survey** – Waters of the U.S. and Wetlands Delineation **Deliverable** – Determination of Potentially Jurisdictional Waters of the U.S. and Wetlands Report – Section 404 of the Clean Water Act Permitting Memo that quantities impacts to potentially jurisdictional waters of the U.S. from project activities. **As-Needed** – Pre-Application Meeting with the USACE Ft. Worth District to discuss project – Nationwide Permit 14 PCN Application submittal with applicable attachments
Texas Historical Commission (THC)	Section 106 of the National Historic Preservation Act of 1966, Antiquities Code of Texas	The Barton Springs Road Bridge is a contributing resource to the Zilker Park Historic District, which is listed on the National Register of Historic Places (NRHP); and in proximity to the Barton Springs Archeological and Historic District; therefore, coordination with the THC will be a part of the overall project design/construction process. In addition, compliance is required as part of the Section 404 process. As part of this THC coordination, an intensive cultural resources field survey will be performed in compliance with the Antiquities Code of Texas.	**Field Survey** – Intensive Cultural Resources Field Survey **Deliverable** – THC Consultation Letter – Antiquities Permit Application – Cultural Resources Survey and Report

Regulatory Agency	Regulation/Guidance	Permitting Trigger/ Permit Type	Field Surveys and/or Deliverables Requirements
U.S. Fish and Wildlife Service (USFWS)	Federal Endangered Species Act (ESA)	Potential habitat for federally listed threatened or endangered species is identified near the Barton Springs Road Bridge; therefore, coordination with the USFWS will be a part of the overall project design/construction process. In addition, compliance is required as part of the Section 404 process. The USFWS coordination process will be inclusive to all species listed as federal or threatened within Travis County; therefore, field surveys/studies will encompass listed terrestrial, aquatic, and karst invertebrate species.	**Field Survey** – Federal and State Listed Species Survey and Habitat Assessment – Karst Feature Survey (encompassing Karst Zone 3) – Salamander Habitat Assessment **Deliverable** – USFWS Informal Consultation letter – Federal and State Listed Threatened and Endangered Species Assessment Report **As-Needed** – Migratory Bird Nesting Surveys – Federally Listed Aquatic Species/Mussel Surveys – Salamander Presence/Absence Surveys
Texas Parks and Wildlife Department (TPWD)	Chapters 67 (Nongame Species) and 68 (Endangered Species) of the Texas Parks and Wildlife (TPW) Code and Sections 65.171 - 65.176 (Threatened and Endangered Nongame Species) of Title 31 of the Texas Administrative Code (T.A.C.)	TPWD prohibits the take, possession, transportation, or sale of any of the animal species designated by state law as endangered or threatened without the issuance of a permit. As such, due diligence will be performed to determine if state listed rare, threatened, or endangered species have the potential to occur within the limits of construction. Field investigations will also be conducted to determine potential presence or absence of preferred habitat types. If needed, coordination with TPWD will be performed during the overall project design/construction process.	**Field Survey** – Federal and State Listed Species Survey and Habitat Assessment **Deliverable** – Federal and State Listed Threatened and Endangered Species Assessment Report **As-Needed** – State Listed Mussel Surveys – Aquatic Resource Relocation Plan (ARRP) for Dewatering Events

Regulatory Agency	Regulation/Guidance	Permitting Trigger/ Permit Type	Field Surveys and/or Deliverables Requirements
TPWD	Marl, Sand, Gravel, Shell or Mudshell Permits-Chapter 86, subtitle F, of the Texas Parks and Wildlife Code	Barton Creek is perennial and greater than 30' in width; therefore, is potentially subject to this permit because construction activities may be required within the bed and bank of Barton Creek for bridge piers/piling. The State claims the bed and the sand and gravel within in it as State-owned if the stream is perennial and greater than 30' in width. A Permit from TPWD is required to "disturb or take" streambed materials from a streambed claimed by the State.	**As-Needed** – General Permit (31 TAC § 69.115) – disturbance or removal of less than 1,000 cubic yards of sedimentary material. – Individual Permit (31 TAC §69.105) - disturbance or removal of greater than 1,000 cubic yards of sedimentary material or executive director finds adverse impacts to natural resources.
Texas Commission of Environmental Quality (TCEQ)	Edwards Aquifer Protection Program- Edwards Aquifer Rules, Title 30 Texas Administrative Code (TAC) Chapter 213	The limits of construction are located above the Edwards Aquifer Transition Zone. An Edwards Aquifer protection plan (EAPP) is required for construction activities on the recharge, transition, or contributing zones of the Edwards Aquifer. The plan will outline the best management practices that will be implemented and maintained, both during and after construction activities, to prevent contaminants found in storm water from reaching the Edwards Aquifer.	**Field Survey** – Geologic Assessment **Deliverable** – Edwards Aquifer Protection Plan with BMPs and Stormwater Pollution Prevent Plan **As-Needed** – Recharge and Transition Zone Exception Request Form and associated attachments – Construction monitoring for sensitive geologic features – Water Pollution Abatement Plan (WPAP)
TCEQ	Clean Water Act, Section 401, State Certification of Water Quality	Construction activities within Barton Creek will impact less than 1,500 linear feet of waters of the U.S. TCEQ regulates the discharges of pollutants to surface waters through the Texas Pollutant Discharge Elimination System (TPDES), adhere to Construction General Permit (TXR150000). Section 401 Certification is necessary for projects requiring a Section 404 of the CWA Permit from USACE.	**Deliverable** – Tier I Checklist (submitted within the USACE NWP/PCN application)

Regulatory Agency	Regulation/Guidance	Permitting Trigger/ Permit Type	Field Surveys and/or Deliverables Requirements
TCEQ	Clean Water Act, Section 402, National Pollutant Discharge Elimination System,	The limits of construction are approximately 3 acres in areal extent. Authorization to TCEQ required for soil disturbing activities greater than 1 acre. Soil disturbing activities from 1 to 5 acres are considered small construction activities. Soil disturbing activities greater than 5 acres are considered large construction activities.	**Deliverable** Small Construction Activity deliverables include: – Stormwater Pollution Prevention Plan (SWPPP), submitted within engineering design plan set – Sign and post a construction site notice – At least 2 days before beginning construction, provide a copy of the site notice to the operator of any Municipal Separate Storm Sewer System (MS4) into which stormwater will be discharged
City of Austin (COA)	Austin City Code	Construction within the Austin City Limits requires a Site Development Permit.	**Field Survey** – Various environment surveys and geotechnical investigations. **Deliverable** – Various reports/submittals required for approved construction plans

Regulatory Agency	Regulation/Guidance	Permitting Trigger/ Permit Type	Field Surveys and/or Deliverables Requirements
COA	Land Development Code (LDC) 25-8, Subchapter B, Article 1	Known heritage trees are located near the Barton Springs Road Bridge that may be impacted. Within the COA a survey of all trees eight inches in diameter at breast height (dbh) or greater, is required. Proposed removal of any tree that is eight inches or greater in dbh must be indicated on a site plan and approved by the COA arborist. Based on COA regulations, a protected tree is defined as any tree species with a dbh of 19 inches or greater and a heritage tree is defined as a species listed in LDC Chapter 25-8, Subchapter B, Article 1 with a dbh of 24 inches or greater. The tree species on the heritage tree list include Texas Ash (*Fraxinus albicans*), Bald Cypress (*Taxodium distichum*), American Elm (*Ulmus americana*), Cedar Elm (*Ulmus crassifolia*), Texas Madrone (*Arbutus xalapensis*), Bigtooth Maple (*Acer grandidentatum*), all Oak species (*Quercus* spp.), Pecan (*Carya illinoinensis*), Arizona Walnut (*Juglans major*), and Eastern Black Walnut (*Juglans nigra*). A Tree Ordinance Review Application (TORA) is required for protected and heritage trees impacted by a development, including trees proposed for removal, impacts within the critical root zone (CRZ), and pruning that exceeds 25 percent of the tree canopy.	**Field Survey** – Tree Survey **Deliverable** – Tree Survey Memo **As-Needed** – TORA and required attachments – Coordination with COA

Regulatory Agency	Regulation/Guidance	Permitting Trigger/ Permit Type	Field Surveys and/or Deliverables Requirements
COA	LDC 25-8-121, City Code 30-5-121	The Barton Springs Road Bridge is located within the 100-year floodplain and the Critical Water Quality Zone (CWQZ). In addition, the banks of Barton Creek have slopes with a gradient of more than 15 percent. The Environmental Criteria Manual (ECM) requires an analysis of potential impacts to sensitive environmental resources, including Critical Environmental Features (CEFs), within a project area and within 150 feet of a project area. CEFs include springs/seeps, point recharge features (e.g., sinkholes), bluffs, canyon rimrocks, and wetlands. To protect CEFs, a protective buffer must be established. The standard buffer distance for all CEFs is 150 feet with a maximum of 300 feet for point recharge features; however, they may be reduced depending on the CEF. Generally, the buffer distances would be determined after an intensive CEF survey is completed and through coordination with the COA Watershed Protection Department.	**Field Survey** – CEF Survey **Deliverable** – Environmental Resource Inventory **As-Needed** – CEF Report – Coordination with COA Watershed Protection Department

*Required permits include, but are not limited to, the items described in the matrix above. The regulatory agencies have the final discretion of permitting requirements/needs. Due to the early nature of this project, this permits/approvals list is conceptual in nature, and commitments needed to obtain permits have not yet been established.

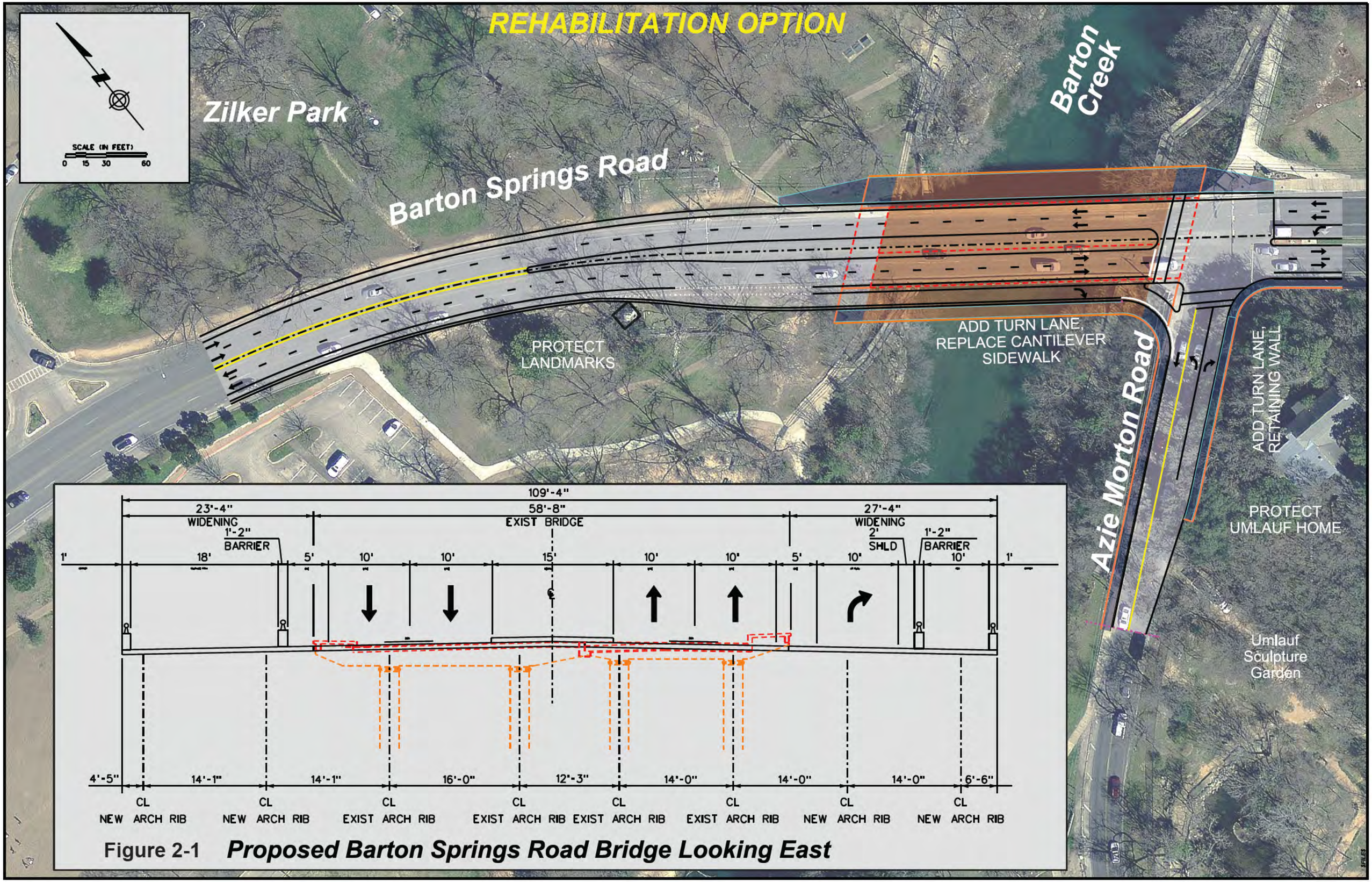


Figure 2-1 ***Proposed Barton Springs Road Bridge Looking East***

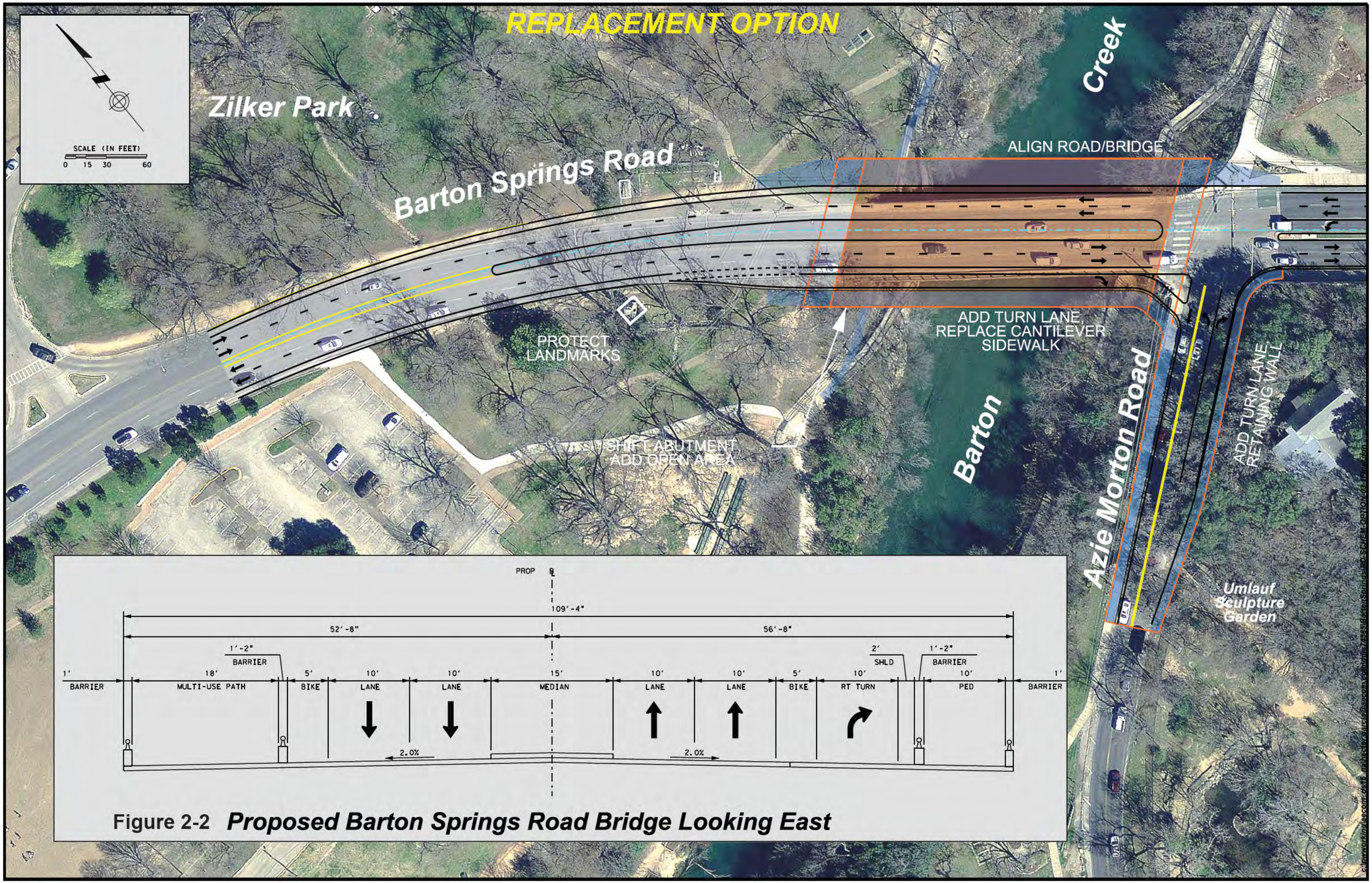
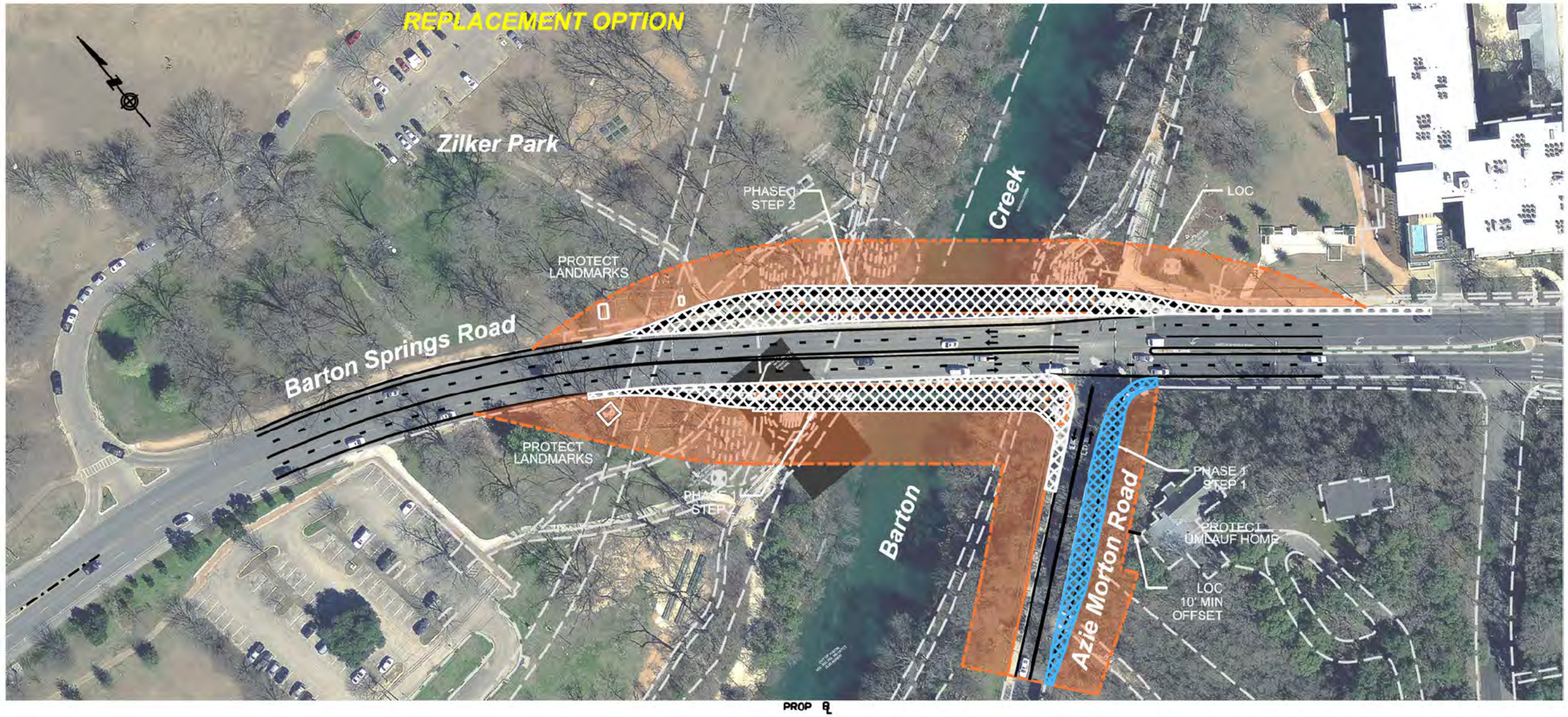
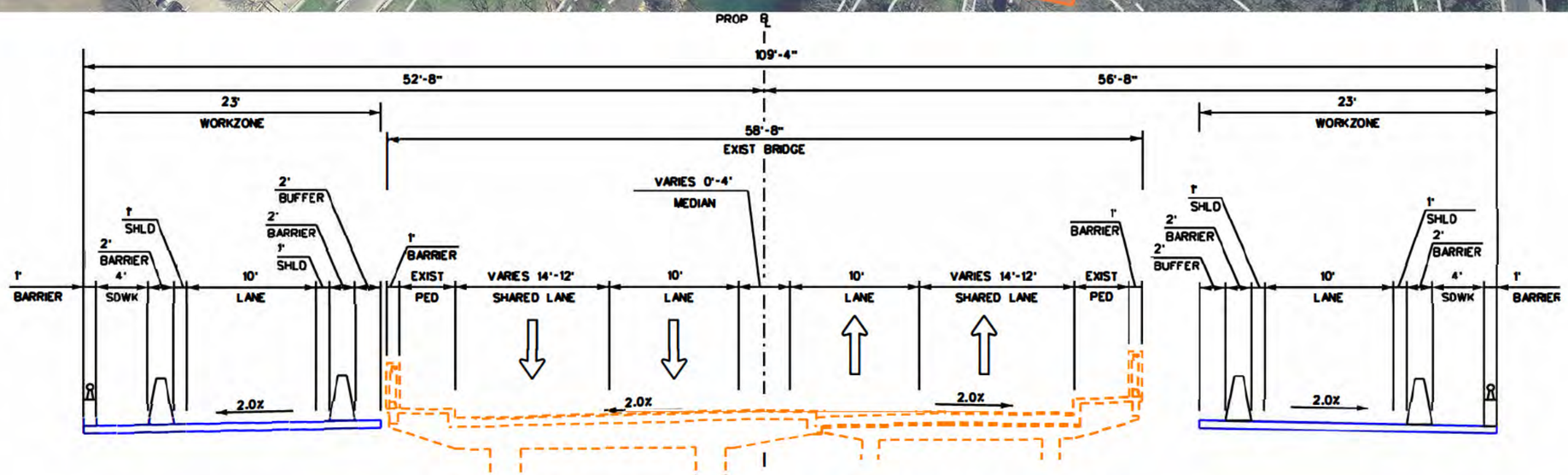


Figure 2-2 ***Proposed Barton Springs Road Bridge Looking East***





Barton Springs Road Bridge Phase 1

LEGEND

- PHASE 1 STEP 1
- PHASE 1 STEP 2
- PREVIOUS PHASE
- LIMITS OF CONST BUFFER

REPLACEMENT OPTION

Figure 2-3

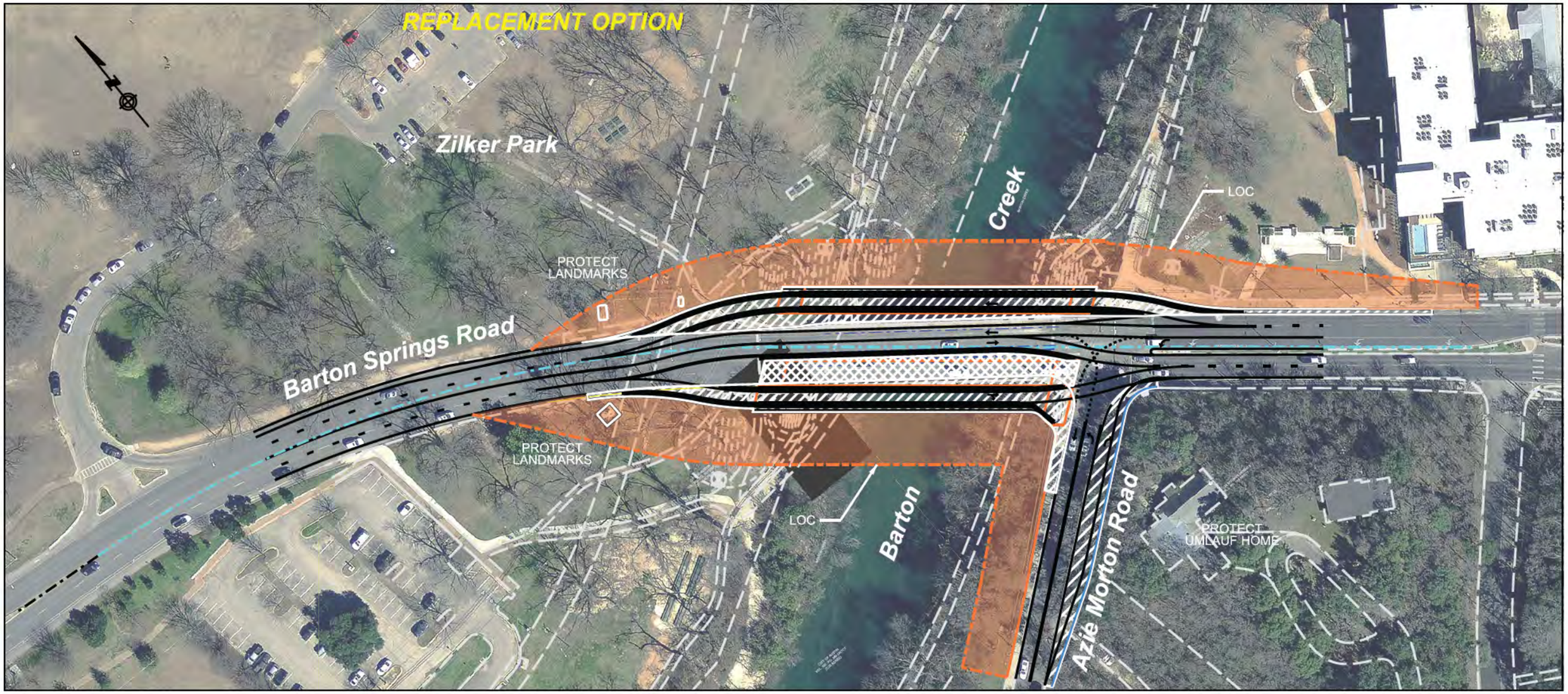
BARTON SPRINGS RD BRIDGE CONCEPTUAL MAINTENANCE OF TRAFFIC PLAN

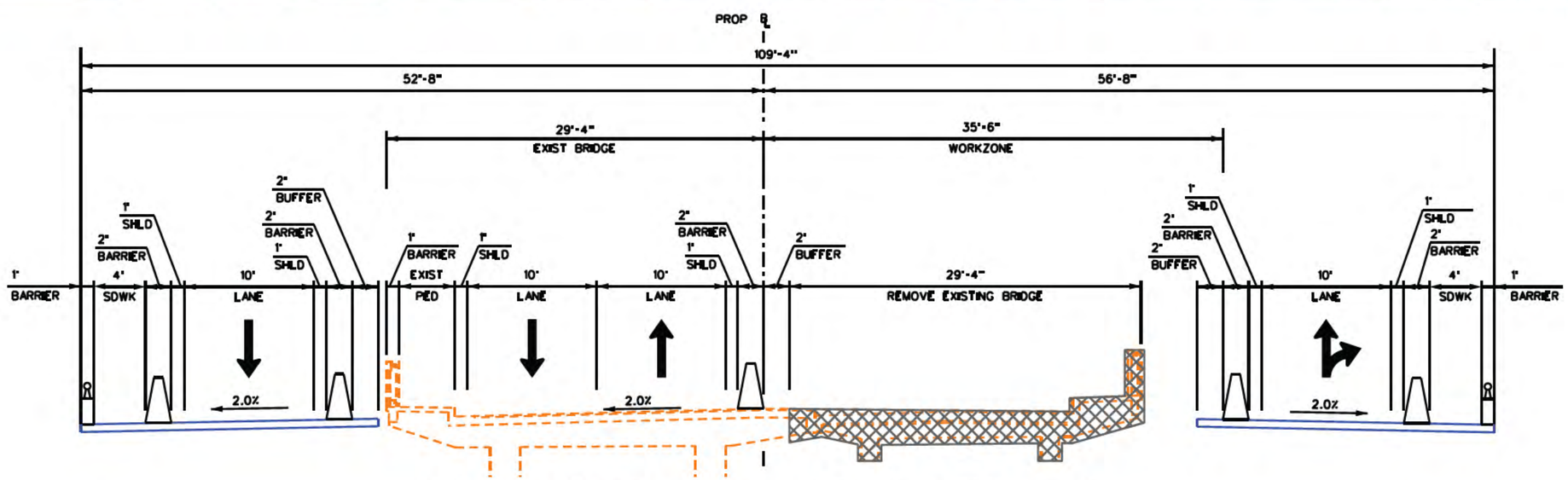
PLAN SCALE (IN FEET)
0 25 50 100

SECTION (HZ) SCALE (IN FEET)
0 2.5 5 10

SDATES

PRELIMINARY
FOR REVIEW ONLY
NOT FOR CONSTRUCTION, BIDDING, OR PERMIT PURPOSES.
URS TBPE REG #3162
Engineer DAVID W. MALLEY
P.E. No. 92952 Date SDATES





Barton Springs Road Bridge Phase 2

LEGEND

CURRENT PHASE

PREVIOUS PHASE

LIMITS OF CONST BUFFER

REPLACEMENT OPTION

Figure 2-4

BARTON SPRINGS RD BRIDGE CONCEPTUAL MAINTENANCE OF TRAFFIC PLAN

PLAN SCALE (IN FEET)
0 25 50 100

SECTION (HZ) SCALE (IN FEET)
0 5 10 20

SDATES

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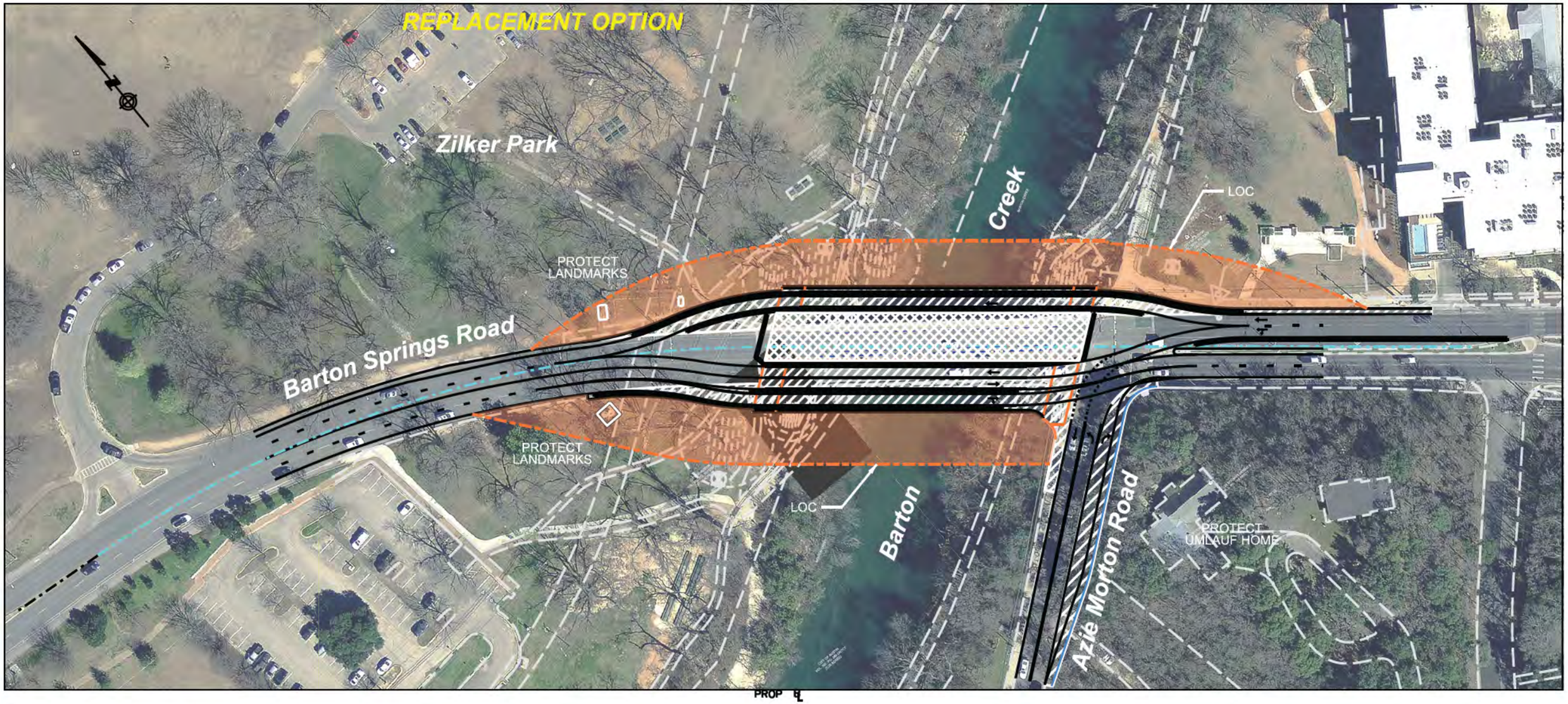
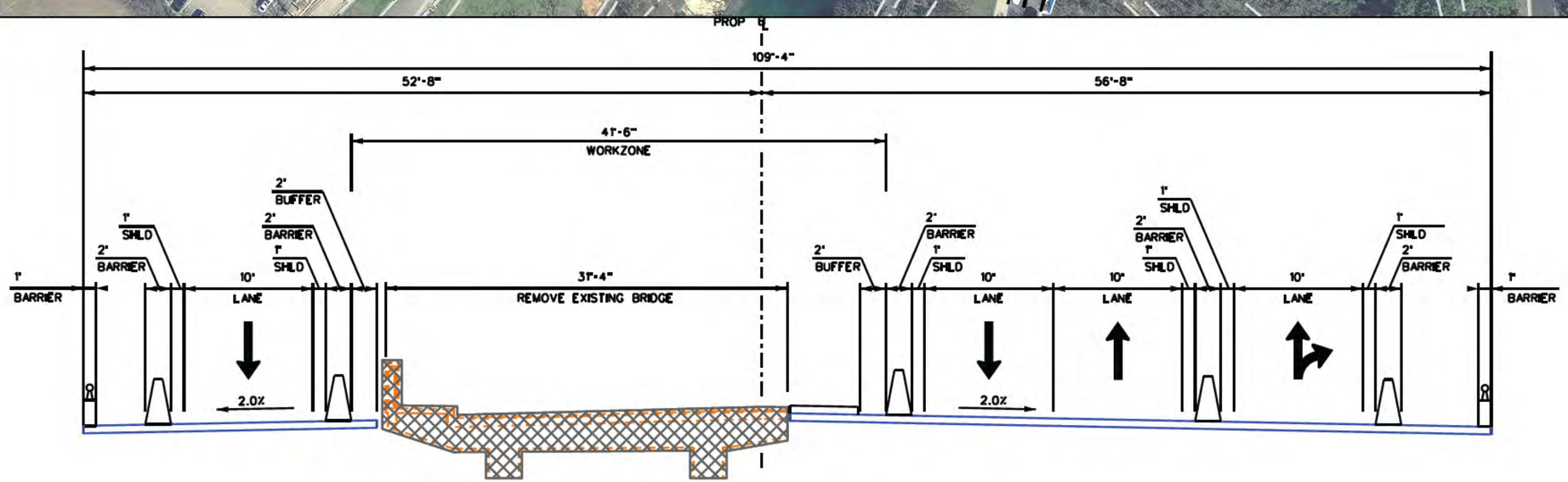
NOT FOR CONSTRUCTION, BIDDING, OR PERMIT PURPOSES.
URS TBPE REG #3162
Engineer DAVID McNAMARA
P.E. No. 92952 Date SDATES





Barton Springs Road Bridge Phase 3

LEGEND

CURRENT PHASE

PREVIOUS PHASE

LIMITS OF CONST BUFFER

REPLACEMENT OPTION

Figure 2-5

BARTON SPRINGS RD BRIDGE CONCEPTUAL MAINTENANCE OF TRAFFIC PLAN

PLAN SCALE (IN FEET)
0 25 50 100

SECTION (HZ) SCALE (IN FEET)
0 2.5 5 10

SDATES

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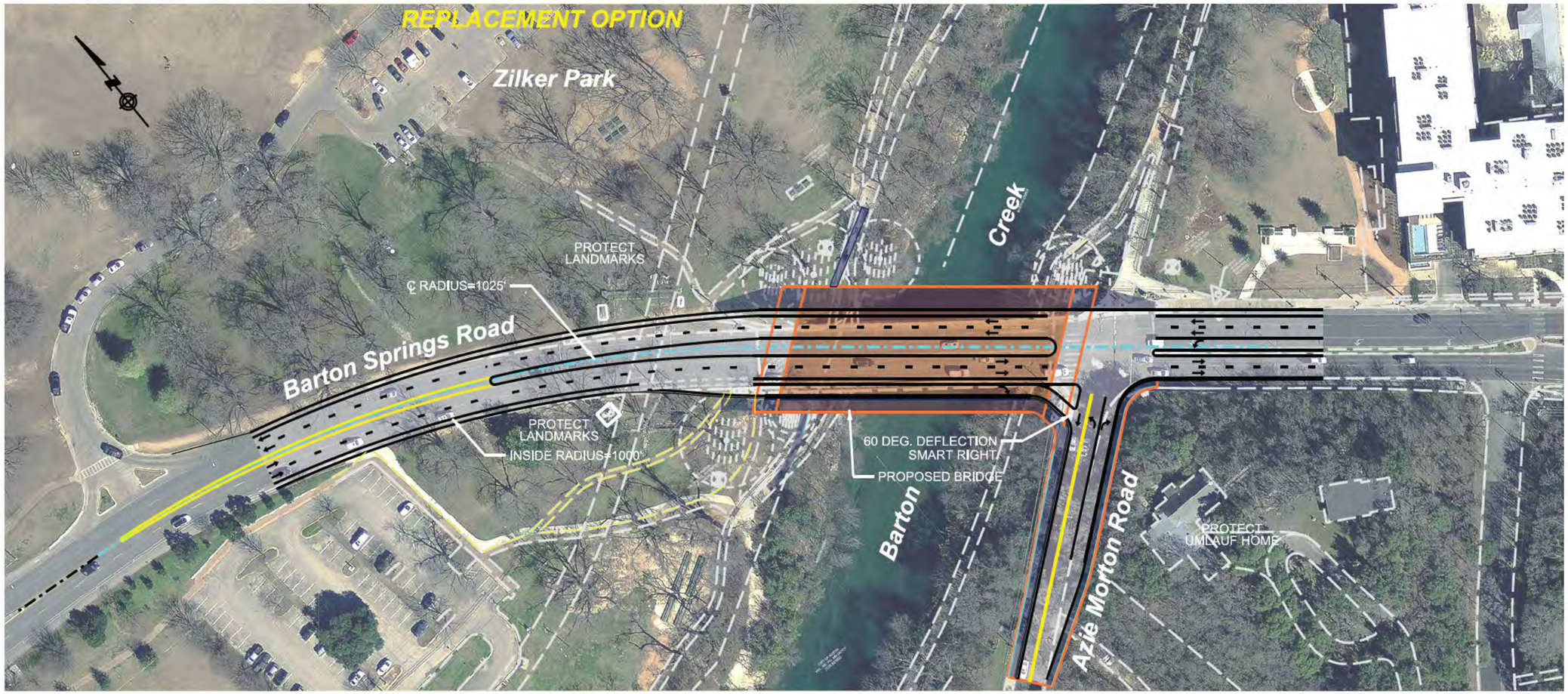
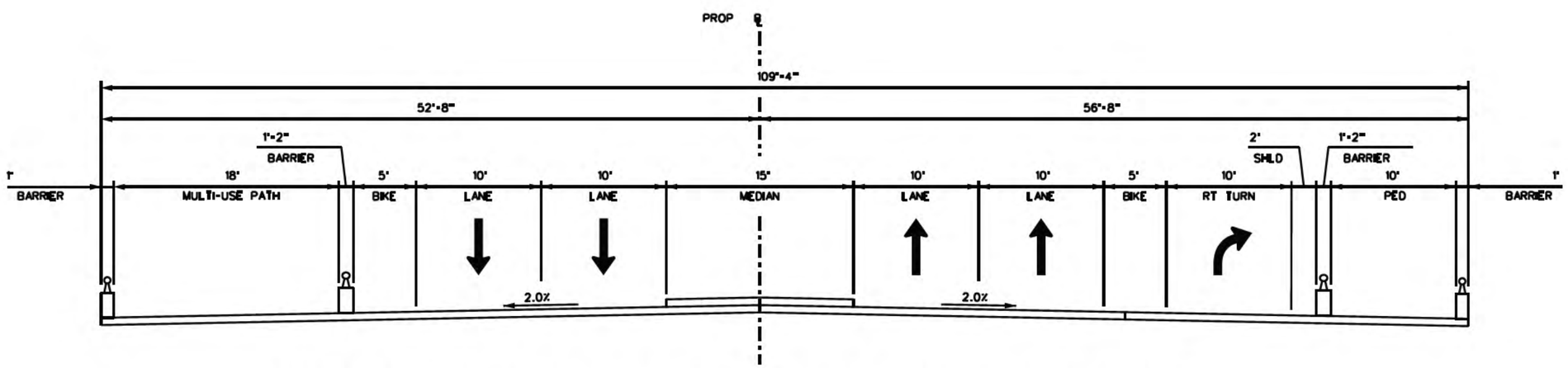
FOR REVIEW ONLY
NOT FOR CONSTRUCTION, BIDDING, OR PERMIT PURPOSES.
URS TBPE REG #3162
Engineer DAVID W. MINGUEY
P.E. No. 92962 Date SDATES





Proposed Barton Springs Road Bridge Looking East

LEGEND

PROPOSED BRIDGE

SIDEWALK/PATH

ROADWAY PAVEMENT

REPLACEMENT OPTION

Figure 2-6

BARTON SPRINGS RD BRIDGE
CONCEPTUAL MAINTENANCE
OF TRAFFIC PLAN

PLAN
SCALE (IN FEET)
0 25 50 100

SECTION (HZ)
SCALE (IN FEET)
0 2.5 5 10

SDATES

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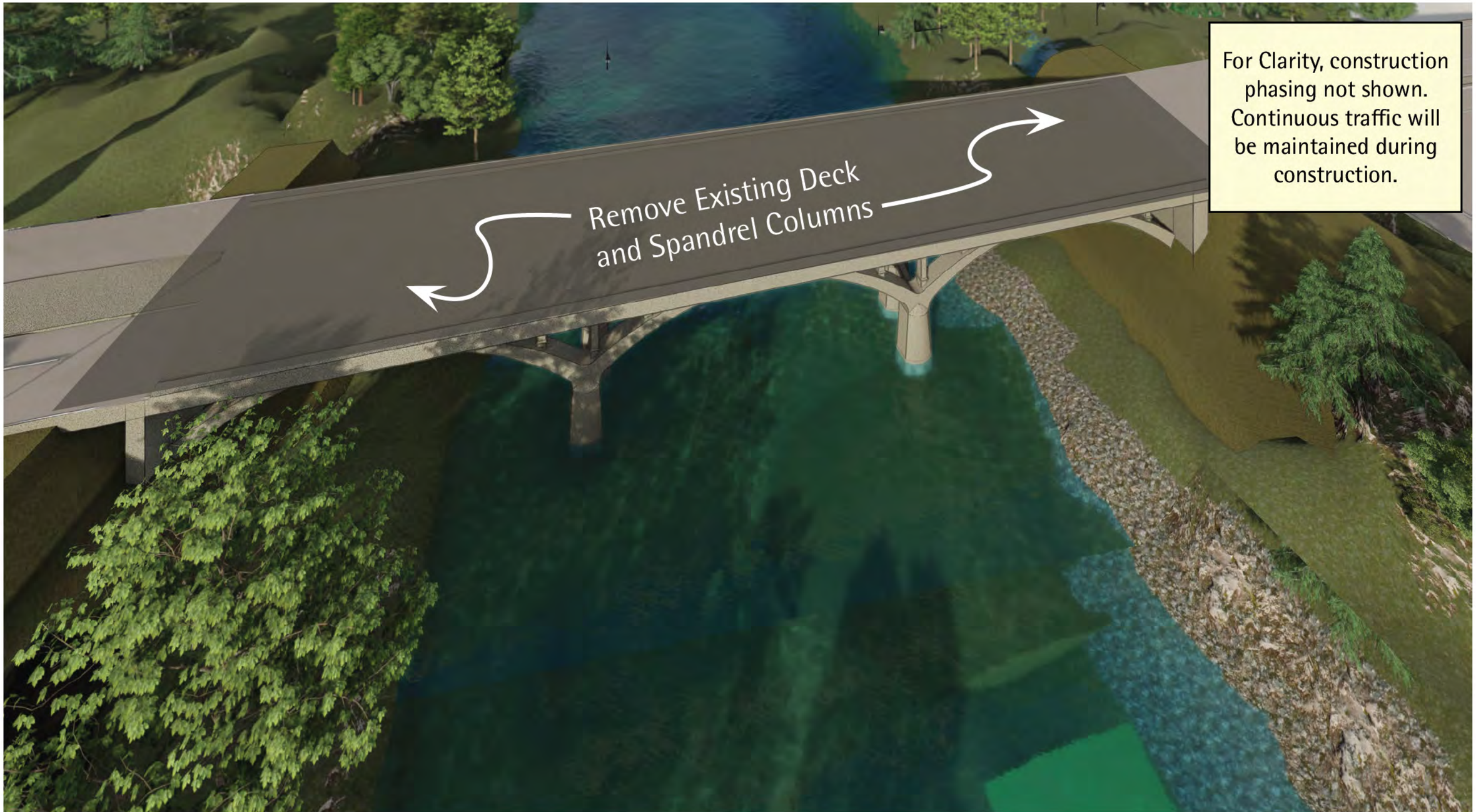
URS TBPE REG #3162
Engineer DAVID McMINN
P.E. No. 92952 Date SDATES



TOUCHSTONE ARCHITECTURE URS

Preliminary - NOT FOR DISTRIBUTION

title: Renovation Sequence_01

date: 12 December 2018 sheet: a110

Barton Springs Bridge - Austin, Texas

Figure 2-7

Th s a ch tectu a ende ng conveys des gn
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For Clarity, construction phasing not shown. Continuous traffic will be maintained during construction.

Install Cathodic Protection and Repair Concrete

Repair Existing Abutments

Retrofit / Strengthen Arch Ribs at all Abutment Springlines

Repair Western Arch Foundations

TOUCHSTONE ARCHITECTURE URS

Preliminary - NOT FOR DISTRIBUTION

title: Renovation Sequence_02

date: 12 December 2018 sheet: a111

Barton Springs Bridge - Austin, Texas

Figure 2-8

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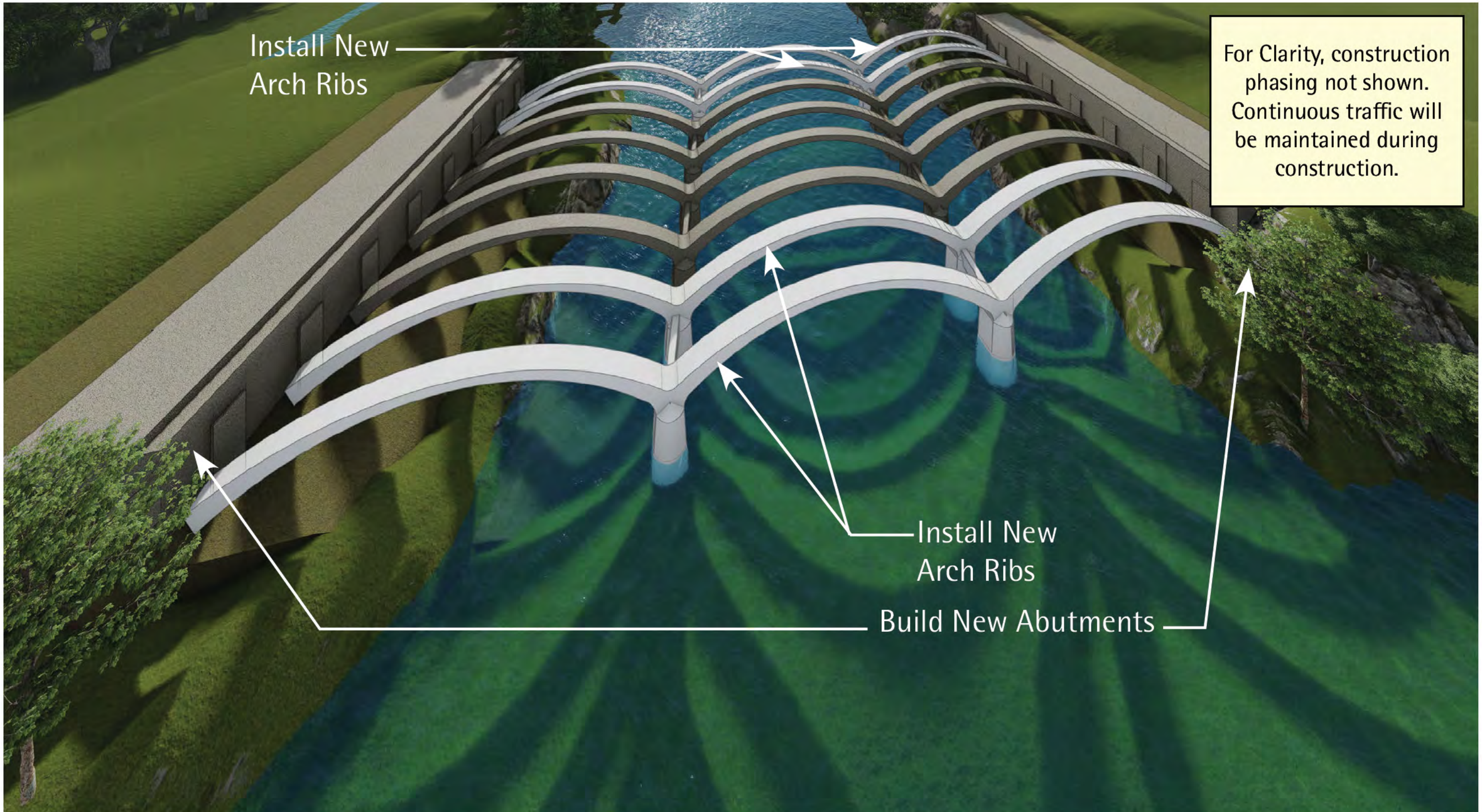

TOUCHSTONE ARCHITECTURE URS

Preliminary - NOT FOR DISTRIBUTION

title: Renovation Sequence_03

date: 12 December 2018 sheet: a112

Barton Springs Bridge - Austin, Texas

Figure 2-9

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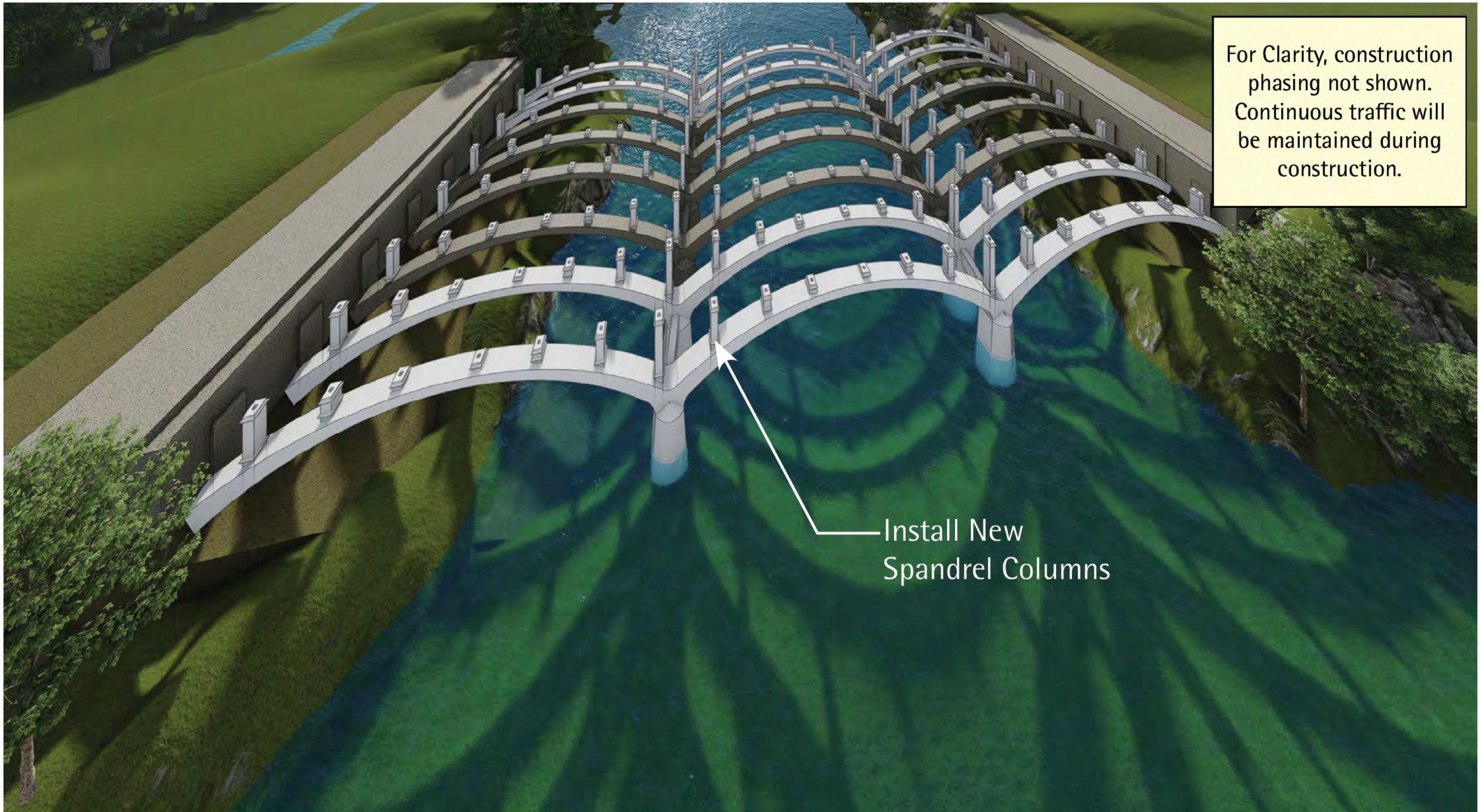

TOUCHSTONE ARCHITECTURE URS

Preliminary - NOT FOR DISTRIBUTION

title: Renovation Sequence_04

date: 12 December 2018 sheet: a113

Barton Springs Bridge - Austin, Texas

Figure 2-10

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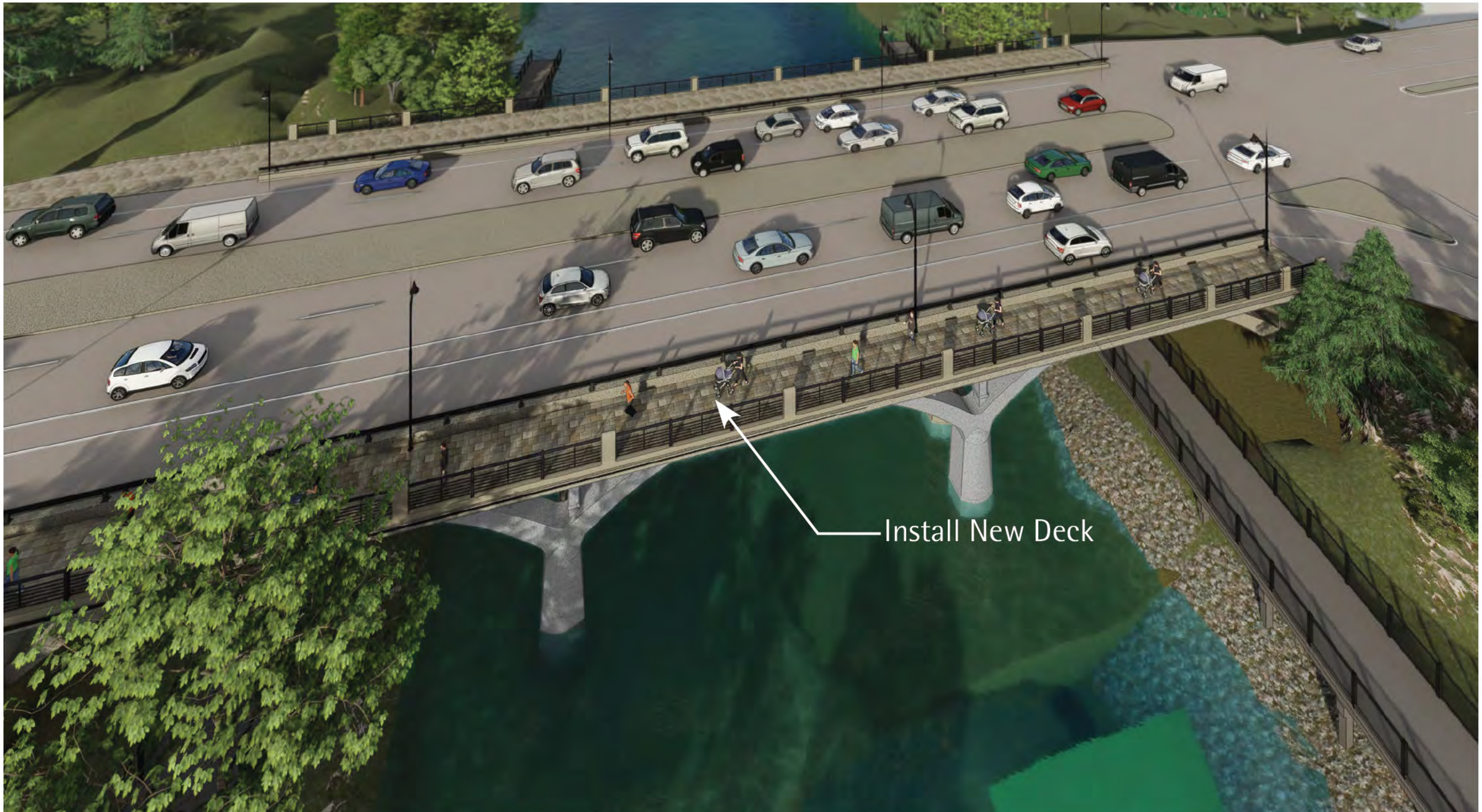

TOUCHSTONE ARCHITECTURE URS

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title: Renovation Sequence_05

date: 12 December 2018 sheet: a114

Barton Springs Bridge - Austin, Texas

Figure 2-11

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Preliminary - NOT FOR DISTRIBUTION

title: Widen Existing Spandrel Arches

date: 10 November 2021 sheet: a101

Barton Springs Bridge - Austin, Texas

Figure 2-12

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Preliminary - NOT FOR DISTRIBUTION

title: Single Arch Concept

date: 10 November 2021 sheet: a102

Barton Springs Bridge - Austin, Texas

Figure 2-13

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Preliminary - NOT FOR DISTRIBUTION

title: "Y" Pier Concept

date: 10 November 2021 sheet: a103

Barton Springs Bridge - Austin, Texas

Figure 2-14

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Preliminary - NOT FOR DISTRIBUTION

title: Conventional Pier Concept

date: 10 November 2021 sheet: a104

Barton Springs Bridge - Austin, Texas

Figure 2-15

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TOUCHSTONE ARCHITECTURE URS

Preliminary - NOT FOR DISTRIBUTION

title: Sidewalk View

date: 12 December 2018 sheet: a108

Barton Springs Bridge - Austin, Texas

Figure 2-16

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TOUCHSTONE ARCHITECTURE URS

Preliminary - NOT FOR DISTRIBUTION

title: Sidewalk View

date: 12 December 2018 sheet: a107

Barton Springs Bridge - Austin, Texas

Figure 2-17

Th s a ch tectu a ende ng conveys des gn
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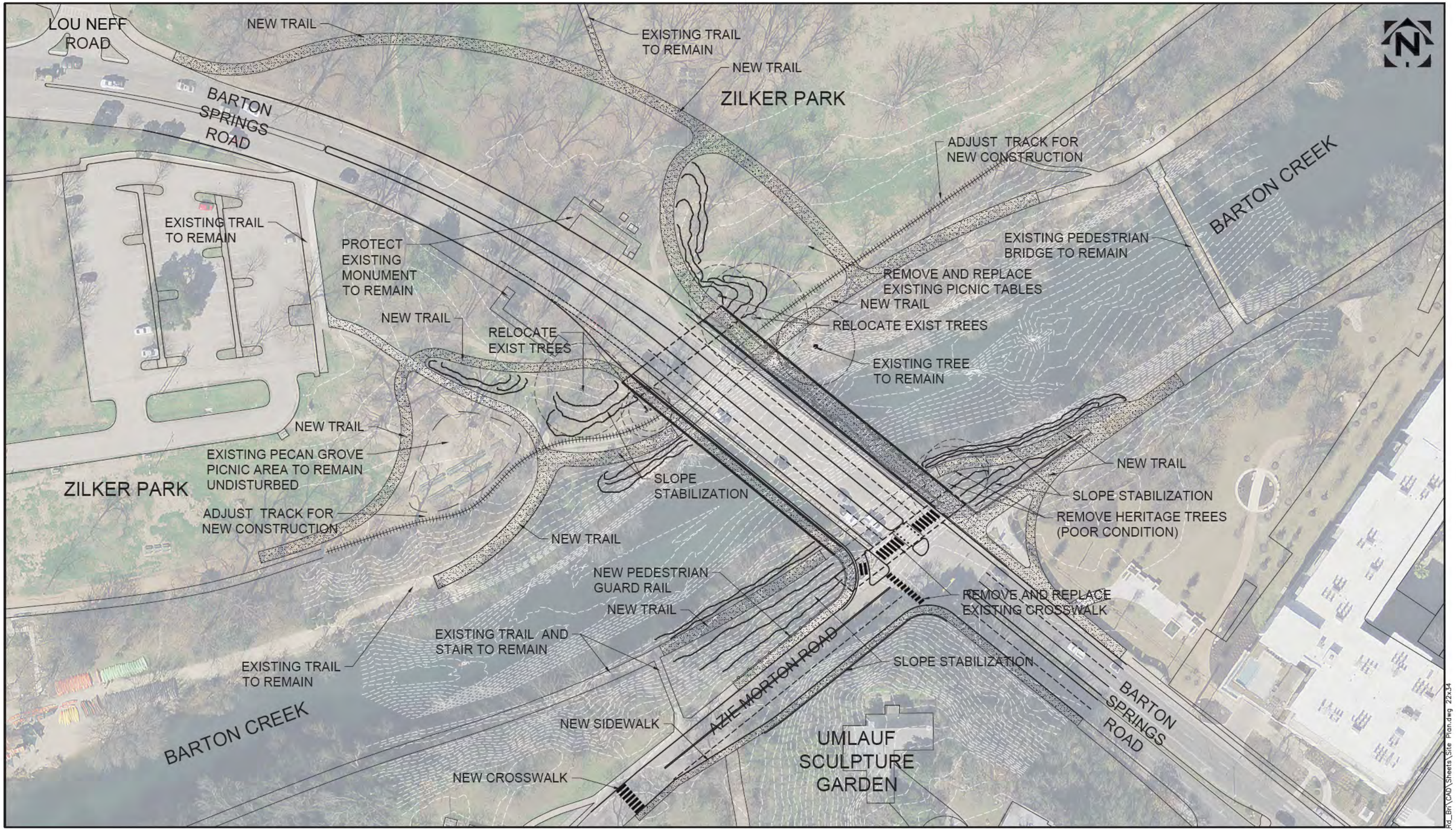

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TBPE FIRM REGISTRATION NO.: F-1416
TBPLS FIRM REGISTRATION NO.: 10065600

NO.	DATE	DESCRIPTION	BY

0 1"
The bar above measures one inch on the original drawing. Adjust scales accordingly.

CONCEPTUAL PEDESTRIAN ACCESS PLAN

BARTON SPRINGS BRIDGE IMPROVEMENTS
BARTON SPRINGS ROAD

PLOTTED: 2/8/2022
JOB NO: 401-18

Figure 2-18
1 OF 2

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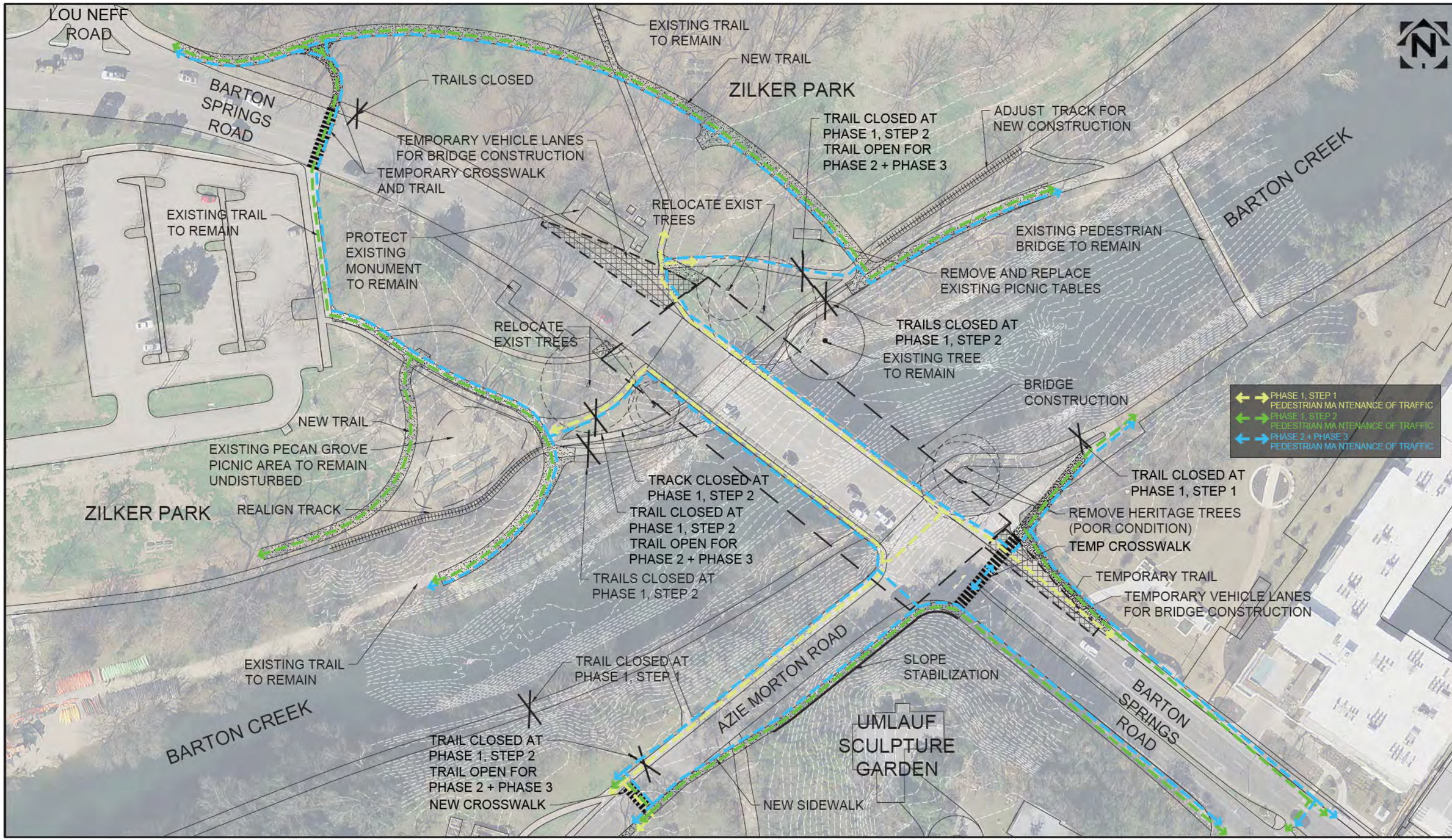

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0 1"
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PEDESTRIAN MAINTENANCE OF TRAFFIC CONCEPTUAL PLAN

BARTON SPRINGS BRIDGE IMPROVEMENTS
BARTON SPRINGS ROAD

PLOTTED: 2/8/2022
JOB NO: 401-18

Figure 2-19

2 OF 2

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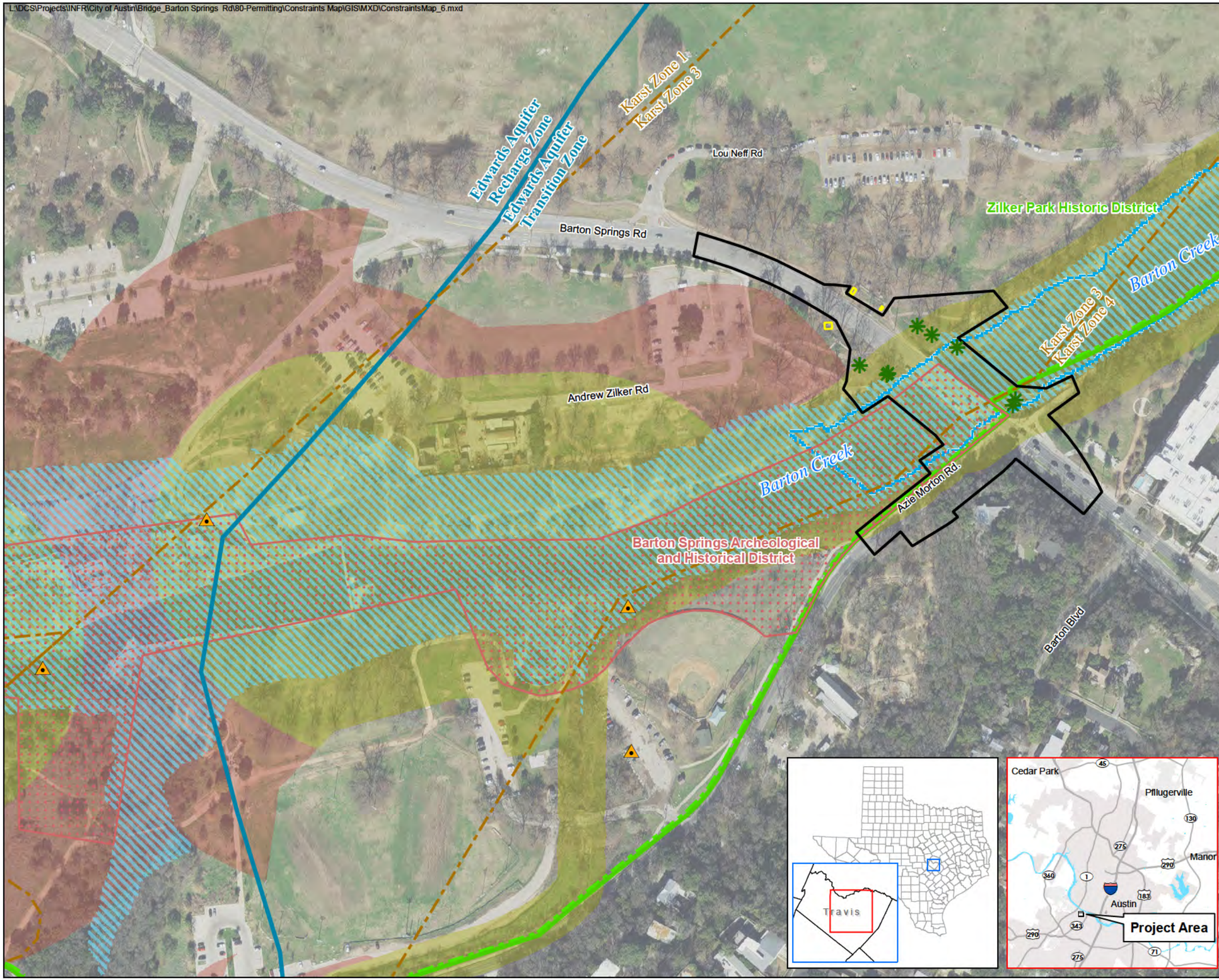

N

0 200 400

SCALE IN FEET

- Known Heritage Tree Location
- Spring
- Regulatory Floodplain (100-Year)
- City of Austin Fully Developed 100-Year Floodplain
- Karst Zone
- Edwards Aquifer Zone
- Preliminary Limits of Construction Operations
- Entrance Monuments
- Zilker Park Historic District
- Barton Springs Archeological and Historical District
- Critical Water Quality Zone
- Water Quality Transition Zone

KARST ZONE KEY	
Karst Zone	Description
1	Areas known to contain endangered cave fauna
3	Areas that probably do not contain endangered cave fauna.
4	Areas which do not contain endangered cave fauna

Data Sources: City of Austin, Texas Historical Commission, Federal Emergency Management Agency, US Fish and Wildlife Service, National Hydrography Dataset, Texas Parks and Wildlife Department

Imagery: TNRIS 2020.

Figure 2-20

Barton Springs Road Bridge
City of Austin

Preliminary Environmental Constraints Map

3. COMPARISON OF PRELIMINARY REPLACEMENT / REHABILITATION CONCEPTS

A summary and comparison of various features and components of both rehabilitation and replacement bridge concepts are provided in Table 3-1.

Table 3-1. Comparison of Bridge Rehabilitation / Replacement Concepts

Feature/Component	Bridge Rehabilitation Concept	Bridge Replacement Concept
Roadway Geometry		
Barton Springs Road Right Turn lane onto Azie Morton	Includes new right turn lane to reduce que time, delays and congestion	Includes new right turn lane to reduce que time, delays and congestion
Azie Morton Road extended Right Turn lane onto Barton Springs Road	Included	Included
Barton Springs Road Alignment	Barton Springs Rd. will be improved but still unaligned; the required "zig zag" by west bound traffic will be much less abrupt. Rehabilitation requires the new structure to be built on the existing centerline alignment.	Barton Springs Rd. will be aligned and straight along and through the intersection, with no conflict in east- or westbound traffic.
Park Amenities / Improvements		
Zilker Zephyr Train	The train will have to be replaced under the bridge, in a similar configuration to current layout.	Moving the western abutment further west provides additional horizontal space. The train can be replaced similar to the current layout, or relocated with additional space for rider room and safety.
West bank hike/bike trail pedestrian bridge under Barton Springs Rd	The pedestrian bridge will need to be removed and replaced in a similar manner to existing layout.	The pedestrian bridge will need to be removed. It can either be replaced similar to current layout, or it may be able to be relocated as a path on the additional space allowed by moving the western abutment.
Hike / Bike Trail passage below the bridge	Passage length under bridge will be roughly twice as wide as existing. Passage space and headroom will be similar to existing layout.	Passage length will be similar to rehab length. Passage space will see combination of new structures and abutments to allow opportunity for added vertical and horizontal open space underneath bridge.

Feature/Component	Bridge Rehabilitation Concept	Bridge Replacement Concept
Bridge Structure		
Bridge Architecture and Aesthetics	Existing arches and foundations will be preserved and remain. Remaining structures will undergo cathodic protection including concrete and condition mitigation and re-surface work. Rehab concept will add new arches upstream and downstream. New arches will be complementary to but not a replicate of the existing arches, depending upon aesthetic coordination with historic preservation agencies. Visibility of new arches will be predominant. Substructure to consist of 8 arch lines	Existing arches will be removed. Replacement concepts are variable and not yet set. New bridge aesthetic can be complementary and similar to the existing bridge (3 span) or can be a new bridge type/span arrangement. Replacement concept to consist of 4 arch lines in lieu of 8.
Bridge Length and Abutment Locations	For rehab, existing abutment locations will remain, and will expand or widen to the north and to the south to accommodate the additional arches for a wider bridge, in a similar geometric arrangement to existing.	Replacement concept will shift the west abutment to the west, to provide more space and safety for pedestrian trail and the Zilker Zephyr train on the West Bank.
Bridge foundation work in Barton Creek	Work on existing foundations in the creek will include cathodic protection and concrete mitigation and concrete re-surface work. Includes construction of 8 new foundations (for 4 new arch lines each with two piers), in Barton Creek. Extensive foundations for temporary works will be required.	The existing arches and foundations would likely be removed, down to the creek bed. Replacement concepts range from no foundations (Option 1 – Arch Concept) to 4 foundations (Option 2 – Longitudinally Framed Y-Pier Concept), to 8 (Transversely Framed Y-Pier Concept). Foundations for temporary works will be required.
Bicycle Elements on Bridge	Includes approx. 5 ft-wide bike lanes on each side, to match bike lanes to the east.	Includes approx. 5-ft-wide bike lanes on each side, to match bike lanes to the east.
Pedestrian Elements on Bridge	Includes approx. 10 ft-wide sidewalk on south side and nearly twice as wide on north side.	Includes approx. 10-ft-wide sidewalk on south side and nearly twice as wide on north side.
Service Life	Target Service Life extension of 50-75 years This is dependent upon results from additional sampling/testing of the existing bridge materials.	Target Service Life of 100 years
Bridge Construction Cost	Concept Cost Range of $425 - $700/SF	Concept Cost Range of $400 - $750/SF

Feature/Component	Bridge Rehabilitation Concept	Bridge Replacement Concept
Constructability / Risk	Constructability more difficult due to the requirement for precision-demolition, and the need to protect existing structures to remain, while constructing new work on or adjacent. Subject to greater project risk with unknown material conditions of existing structures and subsurface foundation conditions.	

Primary Bridge Rehabilitation Concept benefits and opportunities include:

- Increased structure safety and extended service life;
- Increased mobility and connectivity;
- Decrease in traffic congestion; and
- Preservation of portions of the existing bridge, from a cultural/historical perspective. Limitations with this are that for most users, what will be visible will be new and/or refurbished structures and not intact existing structures.

Primary Bridge Replacement Concept benefits and opportunities include:

- Increased structure safety and additional extended service life;
- Increased mobility and connectivity;
- Decrease in traffic congestion;
- Better roadway alignment;
- Opportunity for aesthetic choice in new bridge;
- Opportunity for more space and room for placement of Zilker Zephyr and pedestrian path on west bank of Barton Creek;
- Opportunity for more head room and space underneath bridge for hike/bike trail on east bank, depending upon bridge type selection;
- Less design/construction risk due to unknowns; and
- Financial benefits with longer service life for similar or less cost.

4. REFERENCES

R-1. URS Corporation (An AECOM Company). *Barton Springs Road over Barton Creek Bridge Inspection and Condition Assessment Report*, Bridge 14-227-0-B002-26-001, Austin, Texas, January 2017

austin MOBILITY BONDS

C-3 - Design Charrette - March 2022

Barton Springs Road Bridge – Design Charrette – March 10, 2022

URS

Welcome

- Introductions

- Goals for the Meeting
  - Project orientation
  - Review process of selecting an alternative for bridge
  - Answer questions about project and results thus far
  - Arrive at group agreement on project direction

URS

Agenda

- Project Overview
  - Bridge Background / Setting / Site Issues
  - Purpose and Need
  - Project Scope; Bridge Selection Process
- Ancillary Components
- Previous Work and Outcomes
  - Bridge Inspection; Intersection Modeling
  - Roadway Geometry / Alignment Concepts
  - Maintenance of Traffic / Construction Phasing Concepts
  - Bridge Rehabilitation Concepts
  - Bridge Replacement Concepts
  - Zilker Park / Environmental Concepts
- Bridge Alternatives Discussion
  - Side by Side Comparison – Rehabilitation vs. Replacement
  - Summary of Benefits / Opportunities
  - Group Discussion
  - Group Recommendation of Initial Project Direction

URS

Barton Springs Rd. Bridge - Setting

- Three-span open concrete spandrel arch on concrete foundations;
- 212’ long 58’-8” wide
- 1925 original construction
- 1946 widened to current x-sect; 2 lanes each direction
- Located at entrance to Zilker Park
- Key commuter route and east-west arterial
- Barton Springs Rd. / Azie Morton Intersection
  - Key Barton Hills and Zilker neighborhood entrance immediately east of bridge
  - Intersection integral to future bridge work

URS

Barton Springs Rd. Bridge – Site Challenges and Constraints

URS

Barton Springs Rd. Bridge – Purpose and Need

- Purpose and Need for this project is to make safety-related bridge improvements that address the following:
  - Age of structure / structural degradation
  - Insufficient bike / pedestrian paths (functionally obsolete);
  - Bridge roadway lanes not aligned with lanes east of Azie Morton;
  - Hillside instability (rock fall) and obsolete retaining wall on Azie Morton east side at intersection
  - Elevated / overhanging sidewalk integral to intersection – past movement / cracking
  - Bridge/intersection congestion

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Barton Springs Rd. Bridge – Original Objectives

- *Rehabilitation Option 1:*
  - Rehabilitate but preserve existing structure (light touch)
  - Retrofit/upgrade bridge crash railing
  - Consider feasibility of complementary structures for bike and pedestrian traffic on both sides of the bridge.
- *Rehabilitation Option 2:*
  - Rehabilitate and widen deck
  - Address bicycle and pedestrian paths on the bridge
- *3 Replacement Options:*
  - Completely reconstruct bridge
  - Widen bridge deck
  - Realign Barton Springs Road intersection for improved safety

URS

Barton Springs Rd. Bridge – Selection Process

City Department Design Charrette 1
- Project Definition
- Rehab / Replacement
- Other Components
- Benefits/Opportunities
- Receive Input
- Recommend Gen'l Direction

City Council Briefing
- General Direction
- No Decision Until Vetted
- Receive Input

Optional - City Department Stakeholders
- Incorporate Council Inputs
- Refine Messaging

Texas Historic Commission
- Present Project
- Confirm Project Direction
- ID Key Issues; Stakeholders
- Messaging Input

City Department Design Charrette 2
- Input from Previous Meetings
- Concept Refinement
- Receive Input
- Confirm Project Direction

Public Engagement

External/Public Stakeholder Meetings
- Present Project
- Present Project Direction
- Receive Input

Public Open House 1
- Present Project
- Present Project Direction
- Receive Input

City Department Design Charrette 3
- Input from Previous Meetings
- Concept Refinement
- Receive Input
- Select Alternative
- Recommendation for Council

City Council Confirmation
- Brief on Process
- Brief Inputs (Agency, Public)
- Confirm Recommendation
- Receive Input

Public Open House 2
- Present Project
- Confirm Project Direction
- Design/Construction Process
- Receive Input

URS

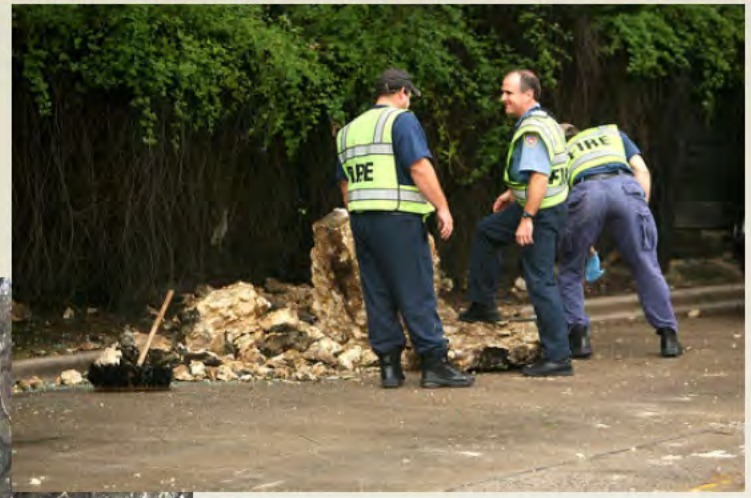
Barton Springs Rd. Bridge – Project Schedule

- Preliminary Phase - Completion Summer 2023
  - Council Briefing 1 — Spring 2022
  - Texas Historical Commission — Spring 2022
  - Public Engagement 1 — Fall 2022
  - Council Briefing 2 — Winter 2022
  - Public Engagement 2 — Spring 2023
  - Complete Preliminary Phase — Summer 2023
- Design Phase - Fall 2023 to Spring 2025
  - RCA to Council — Summer 2023
- Bid/Award/Execution Phase - Spring 2025 to Fall 2025
  - RCA to Council — Summer 2025
- Construction Phase - Fall 2025 to Spring 2027

URS

Ancillary Project Components – Umlauf Retaining Wall

- Hillside Instability
- Replacement of old retaining wall
- Early project work – allows for maintaining traffic; bridge workspace



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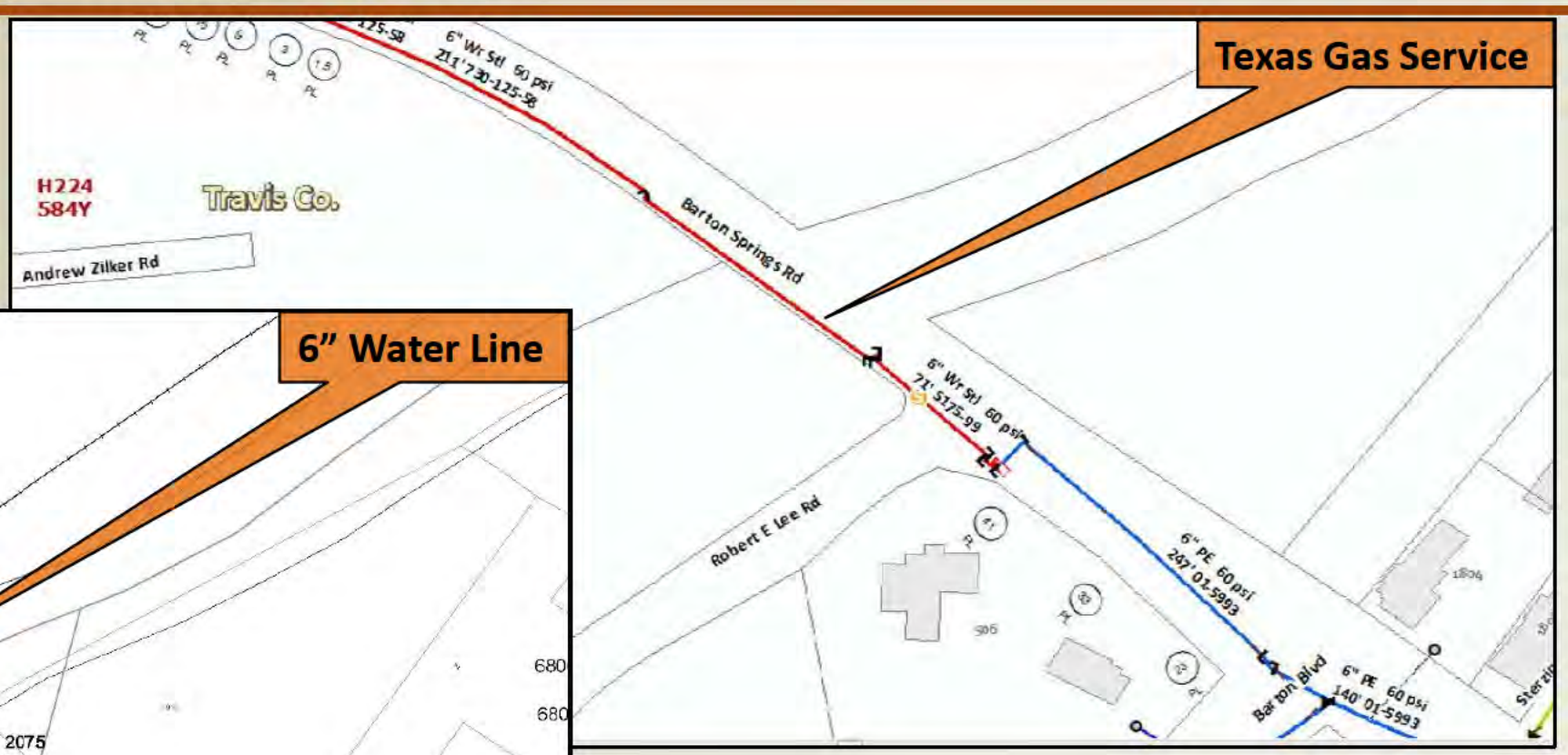
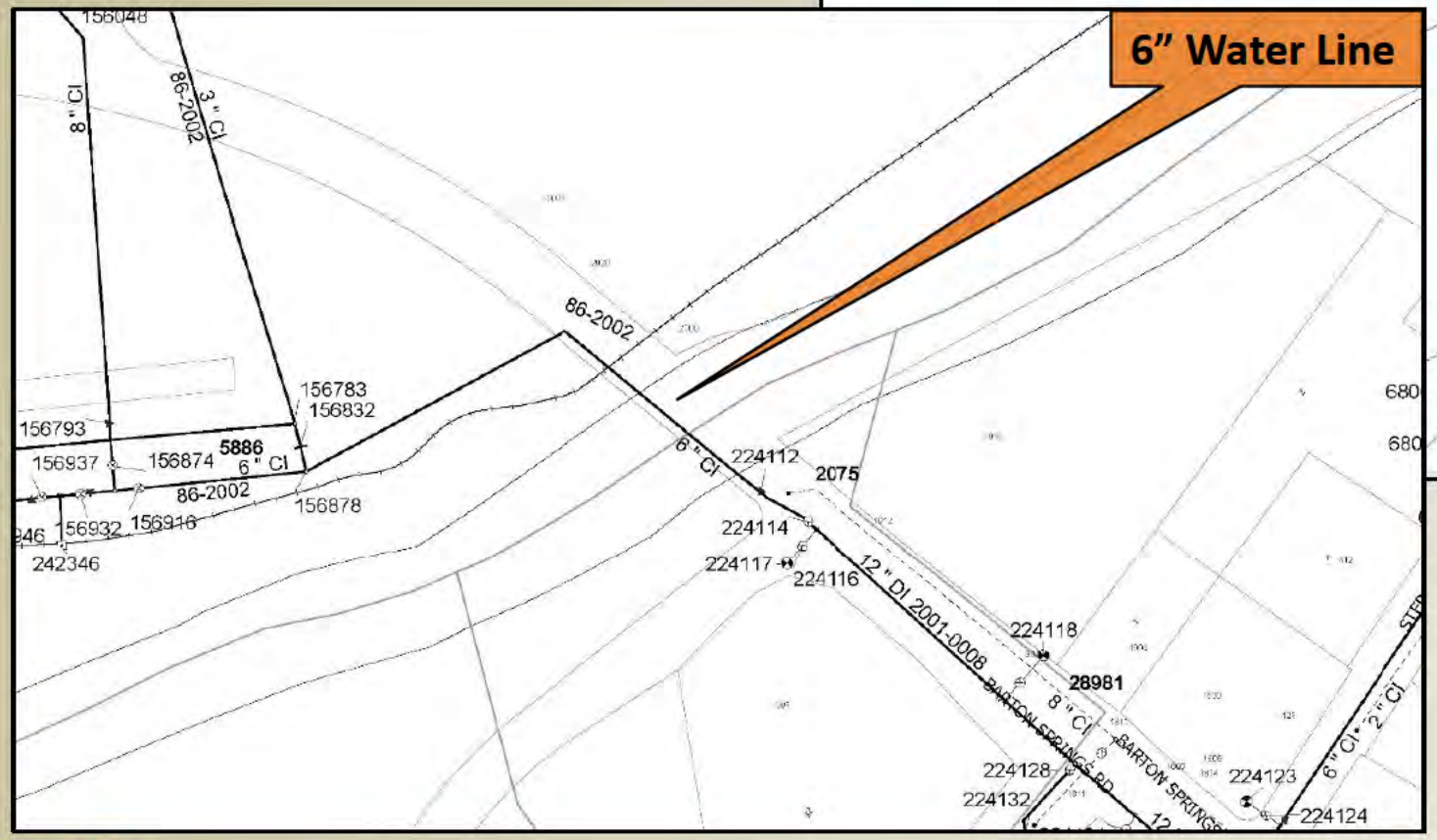
Ancillary Project Components - Utilities

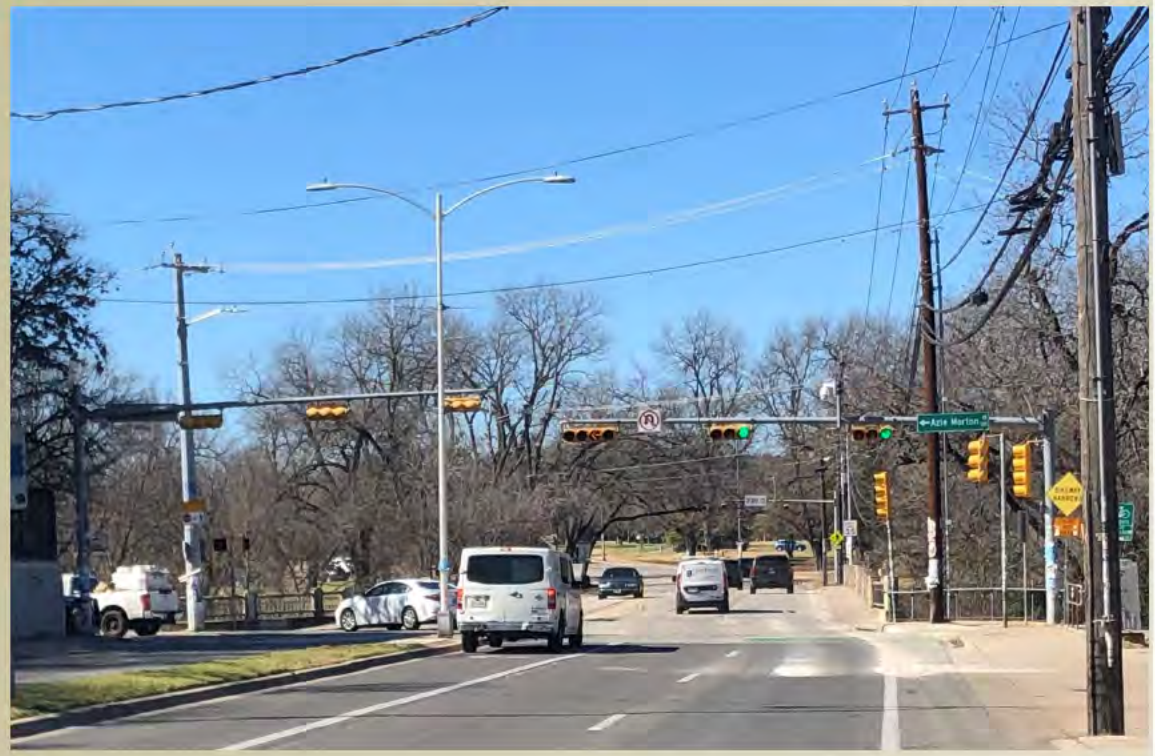
- Texas Gas Service
- 6” water line

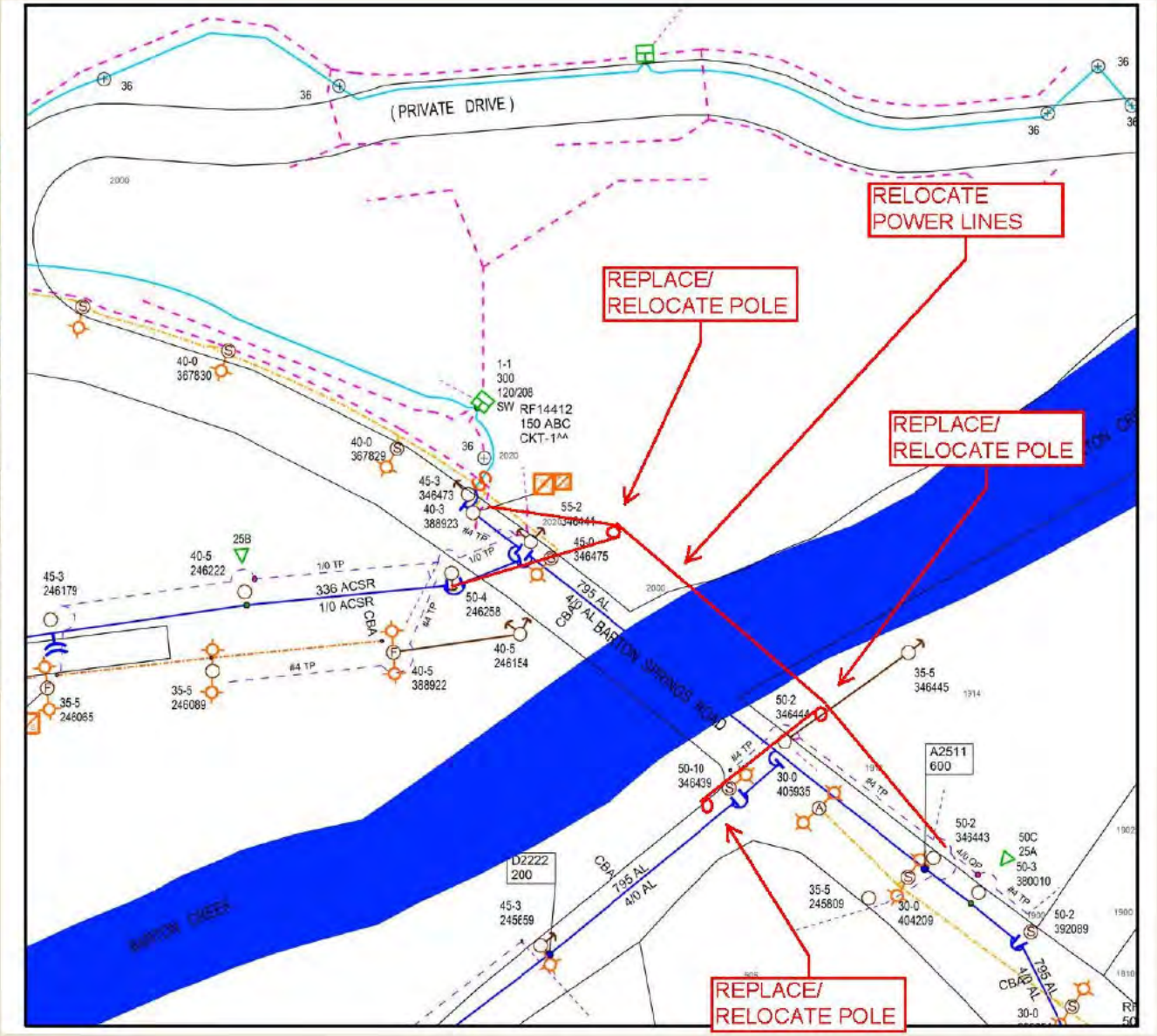




Ancillary Project Components - Utilities

- Austin Energy





Previous Work and Outcomes

- Bridge Inspection and Condition Assessment
- Barton Springs / Azie Morton Intersection Modeling
- Roadway Geometry / Alignment Concepts
- Maintenance of Traffic / Construction Phasing Concepts
- Bridge Rehabilitation Concepts
- Bridge Replacement Concepts
- Zilker Park Pedestrian / Connectivity Concepts
- Environmental Issues / Permitting Needs

URS

Bridge Inspection Outcomes

- Deck (with integral longitudinal joint), floor beams, and spandrel columns exhibited the most degradation.
- All structural components exhibited some degradation.
- Rehabilitation for increased service life would need to remove deck, floor beams, and spandrel columns, stripping structure to arch ribs as a starting point.
- These results remove Rehabilitation Option 1 as feasible alternative since that option was the "low-impact", “preserve-structure” option.
- Based on the above, we are now focused on Rehabilitation Option 2 and on potential bridge replacement options.

URS

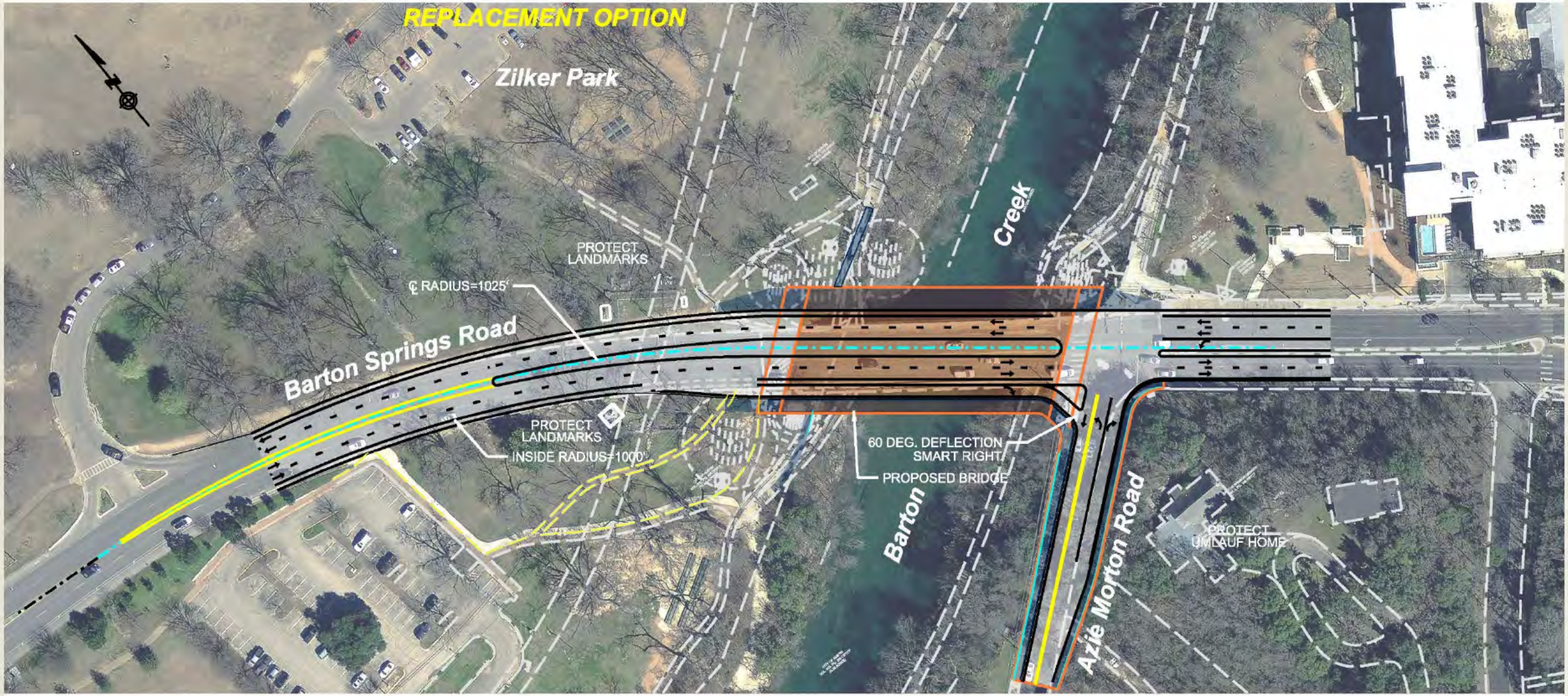
Barton Springs / Azie Morton Intersection Analysis (Jan. 2018)

- Intersection modeling
- Right-turn bays added for both Barton Springs Rd. and Azie Morton Rd.
  - Reduce delays during peak hours
  - Support / improve construction phasing for both bridge and Azie Morton retaining wall
  - Provide additional multimodal capacity (buses, pedestrians) for traffic control during special events

Year	Peak	No Build		Build	
		LOS	Delay (sec)	LOS	Delay (sec)
2017	AM	C	31.1		
	PM	C	33.5		
2040	AM	E	64.5	E	59.1
	PM	E	61.6	C	26.5

URS

Roadway Geometry / Alignment Concepts



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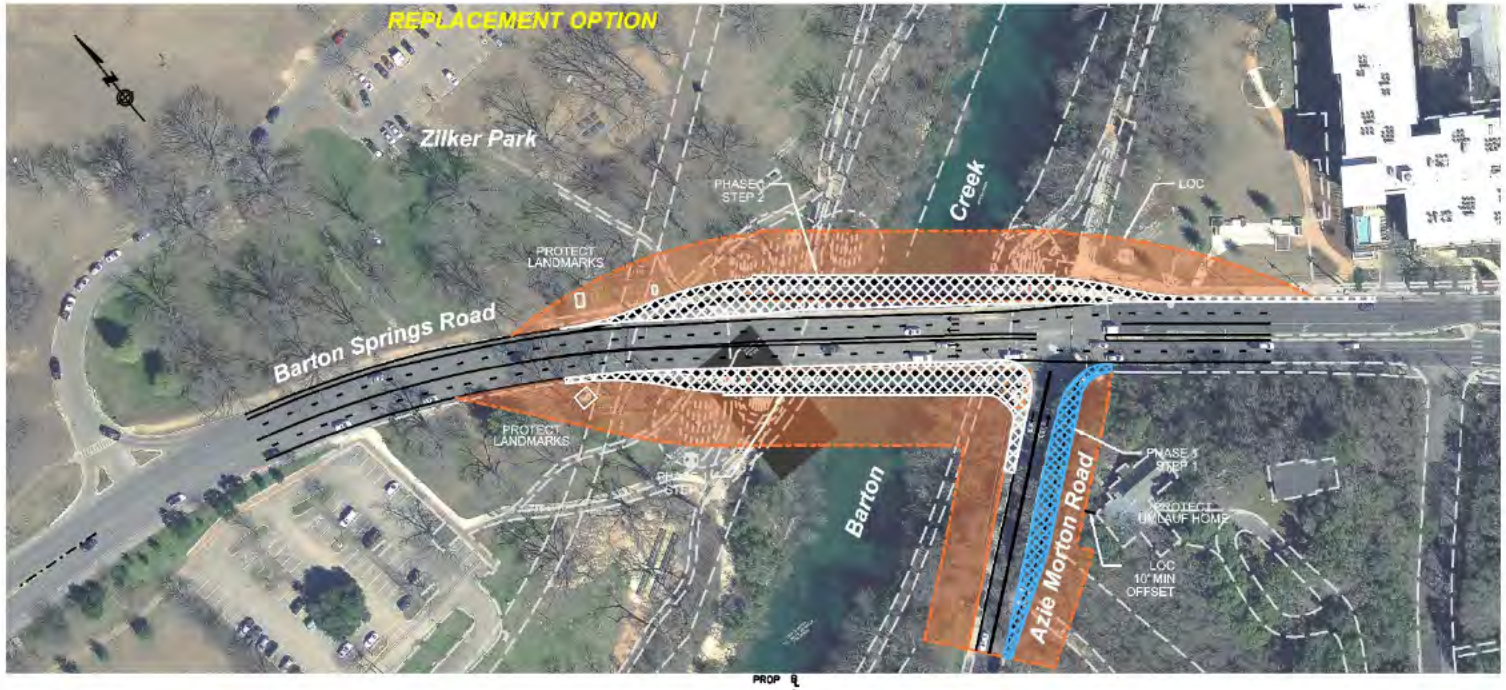
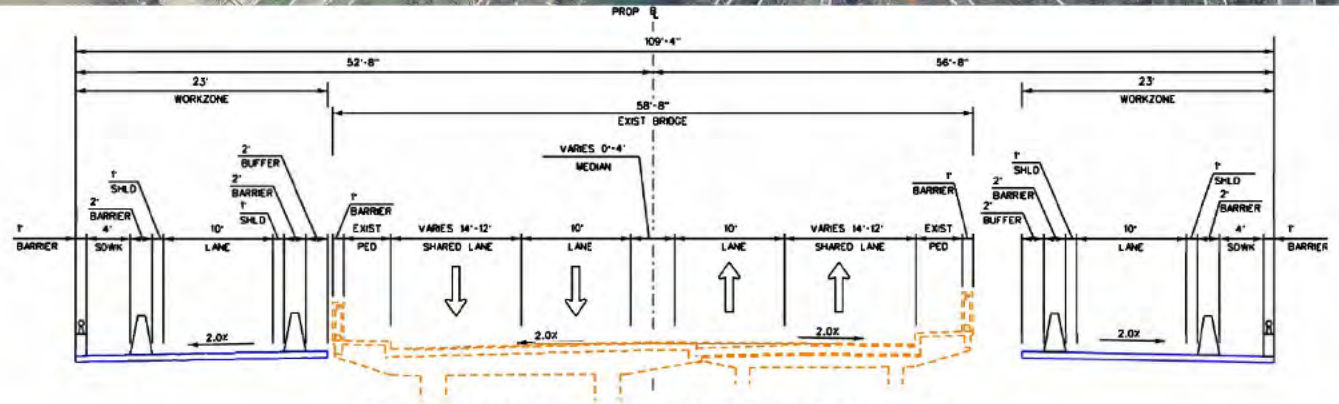
Maintenance of Traffic / Phasing Concepts





Barton Springs Road Bridge Phase 1

LEGEND

- PHASE 1 STEP 1
- PHASE 1 STEP 2
- PREVIOUS PHASE
- LIMITS OF CONST BUFFER

REPLACEMENT OPTION

Figure 2-3

BARTON SPRINGS RD BRIDGE CONCEPTUAL MAINTENANCE OF TRAFFIC PLAN

PLAN SCALE (IN FEET) 0 25 50 100

SECTION (HZ) SCALE (IN FEET) 0 2.5 5 10

SDATES

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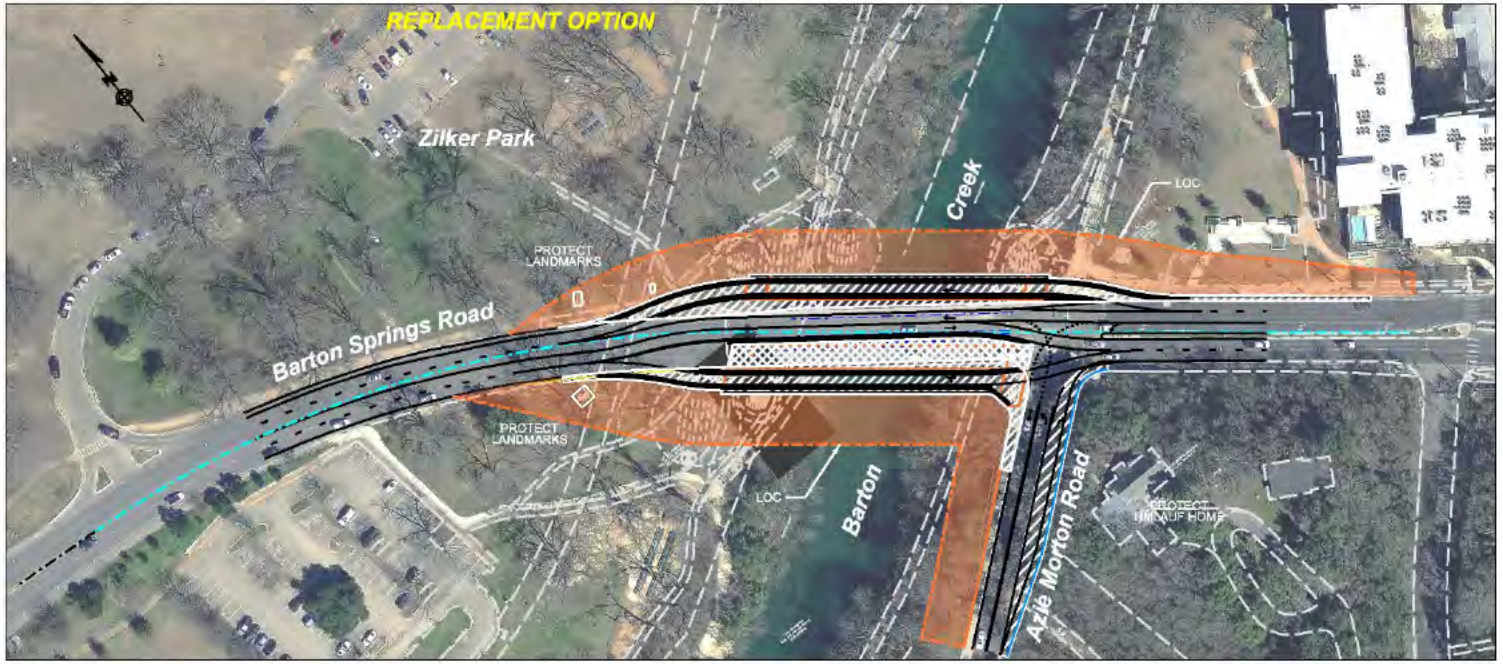
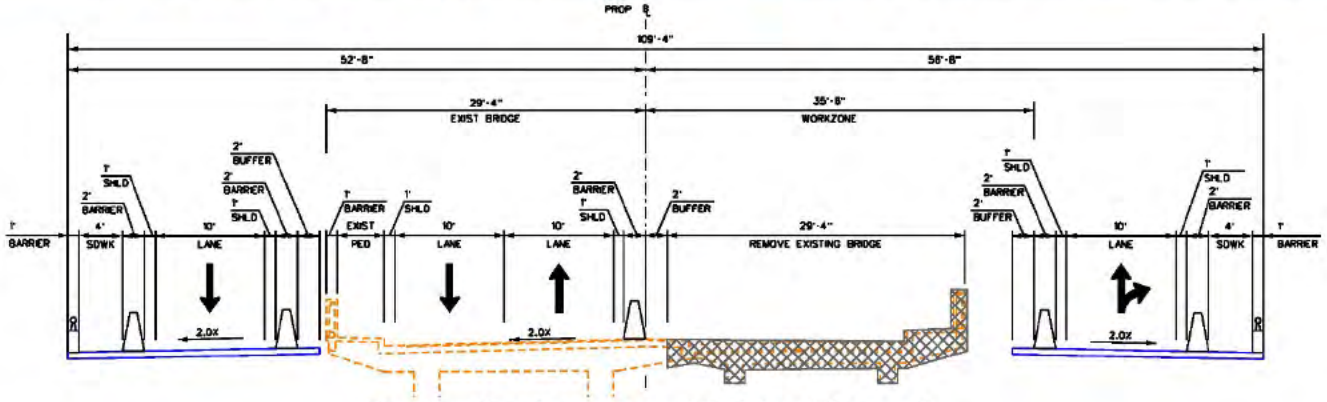
URS TBPE REG #3162

Maintenance of Traffic / Phasing Concepts





Barton Springs Road Bridge Phase 2

LEGEND

CURRENT PHASE

PREVIOUS PHASE

LIMITS OF CONST BUFFER

REPLACEMENT OPTION

Figure 2-4

BARTON SPRINGS RD BRIDGE CONCEPTUAL MAINTENANCE OF TRAFFIC PLAN

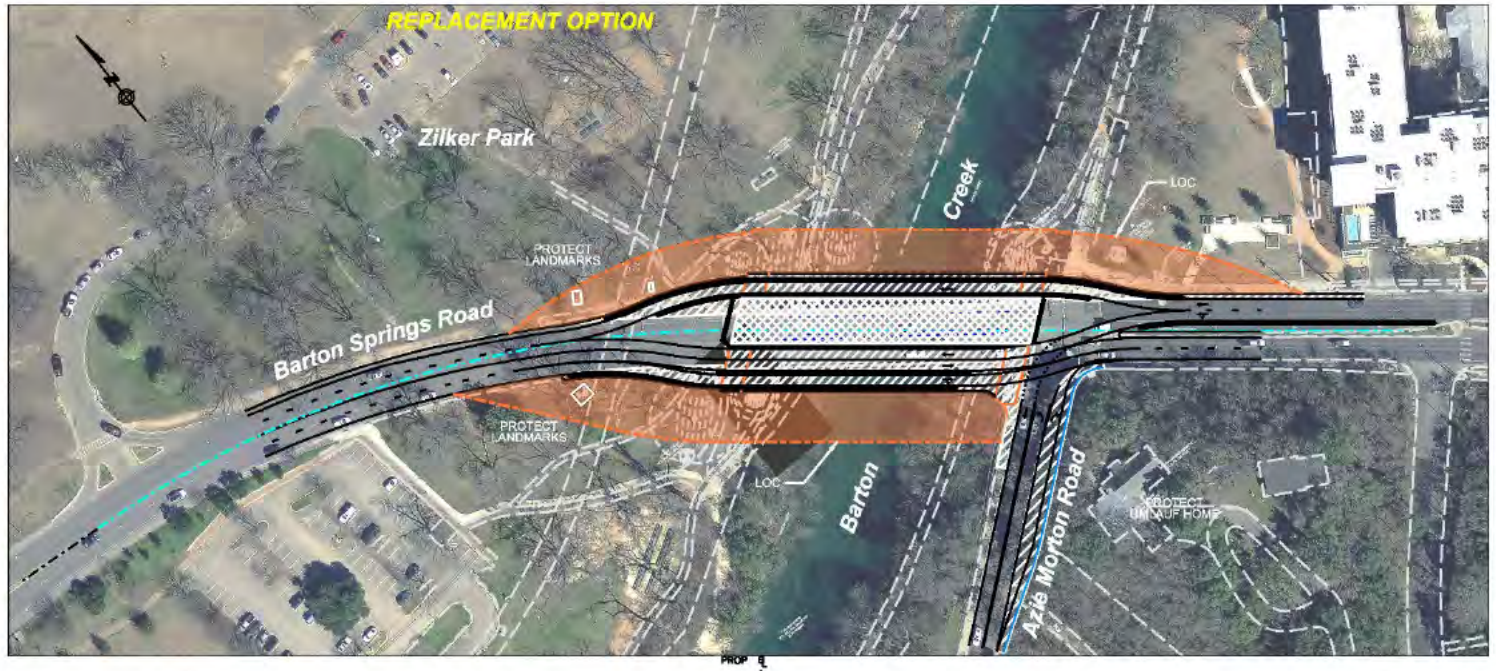
PLAN SCALE (IN FEET) 0 25 50 100

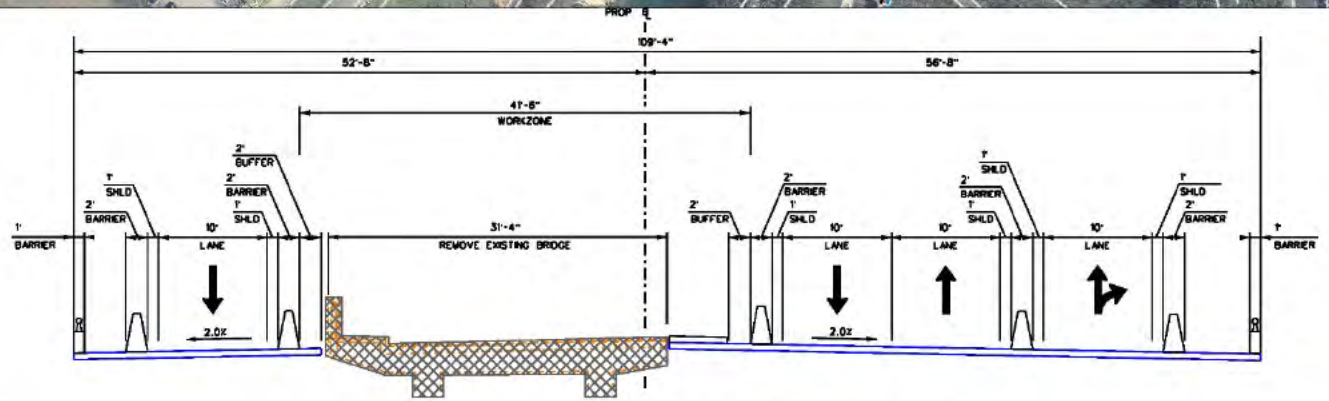
SECTION (HZ) SCALE (IN FEET) 0 5 10 20

SDATES

PRELIMINARY FOR REVIEW ONLY NOT FOR CONSTRUCTION, BIDDING, OR PERMIT PURPOSES. URS TBPE REG #2162

Maintenance of Traffic / Phasing Concepts





Barton Springs Road Bridge Phase 3

LEGEND

CURRENT PHASE

PREVIOUS PHASE

LIMITS OF CONST BUFFER

REPLACEMENT OPTION

Figure 2-5

BARTON SPRINGS RD BRIDGE CONCEPTUAL MAINTENANCE OF TRAFFIC PLAN

PLAN SCALE (IN FEET) 0 25 50 100

SECTION (HZ) SCALE (IN FEET) 0 2.5 5 10

SDATES

PRELIMINARY
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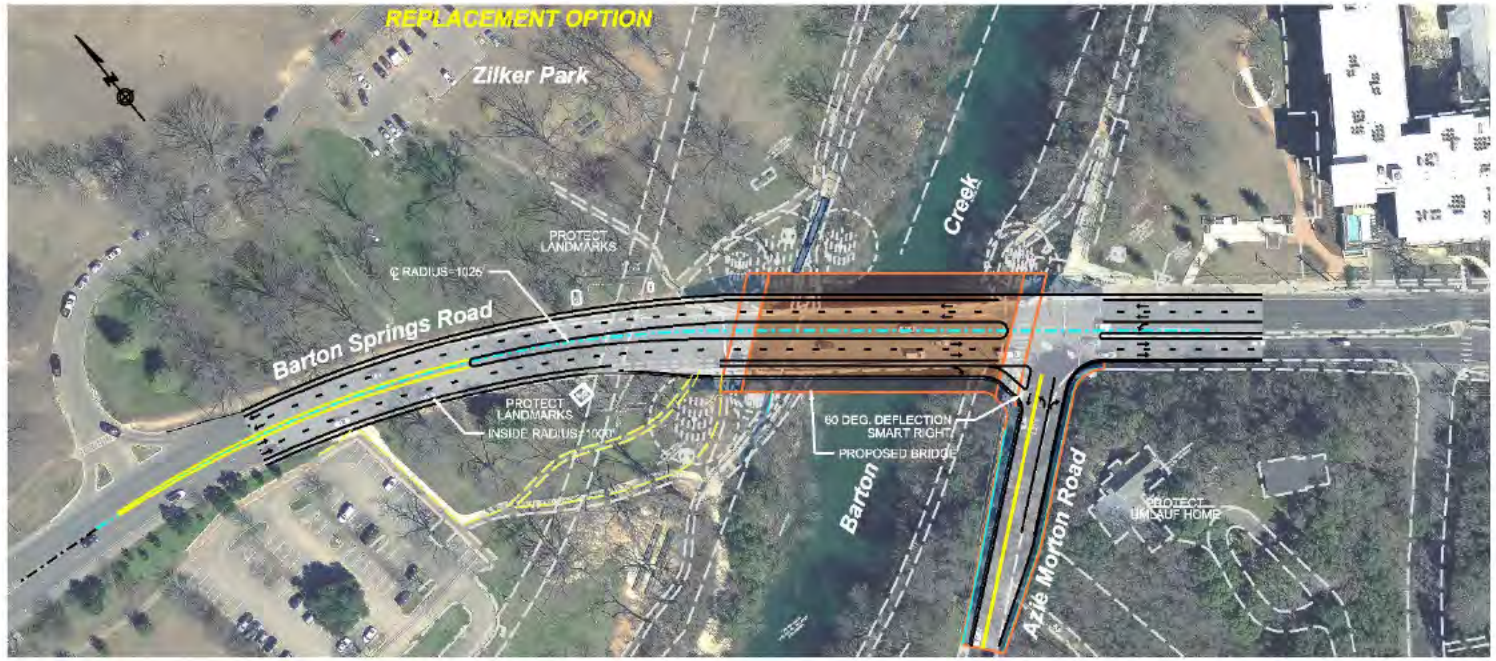
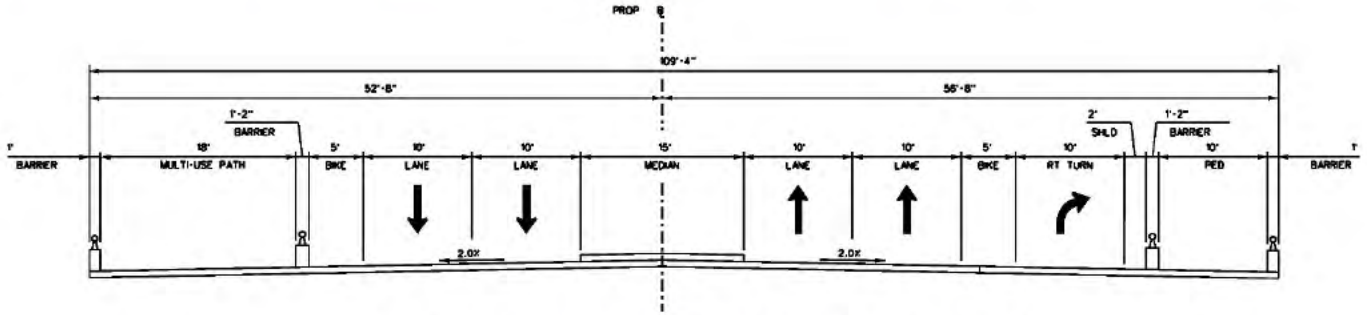
URS TBPE REG #3662

Maintenance of Traffic / Phasing Concepts





Proposed Barton Springs Road Bridge Looking East

LEGEND

PROPOSED BRIDGE

SIDEWALK/PATH

ROADWAY PAVEMENT

REPLACEMENT OPTION

Figure 2-6

BARTON SPRINGS RD BRIDGE CONCEPTUAL MAINTENANCE OF TRAFFIC PLAN

PLAN SCALE (IN FEET) 0 25 50 100

SECTION (HZ) SCALE (IN FEET) 0 2.5 5 10

DATES

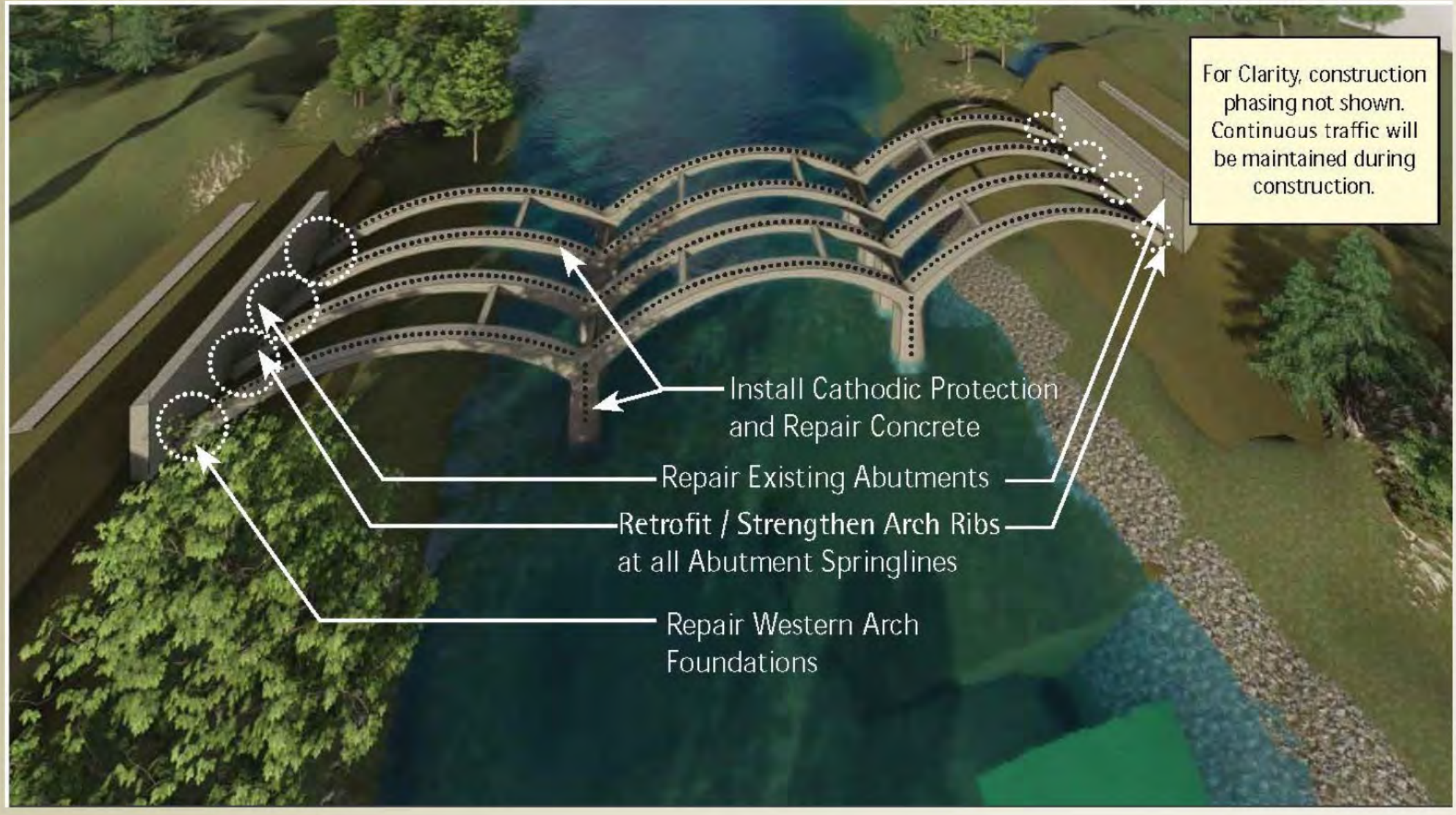
PRELIMINARY
FOR REVIEW ONLY
NOT FOR CONSTRUCTION, BIDDING, OR PERMIT PURPOSES.
URS TBPE REG #3862

Northern Pedestrian Pathway

Questions

Rehabilitation Concepts

Rehabilitation Concepts



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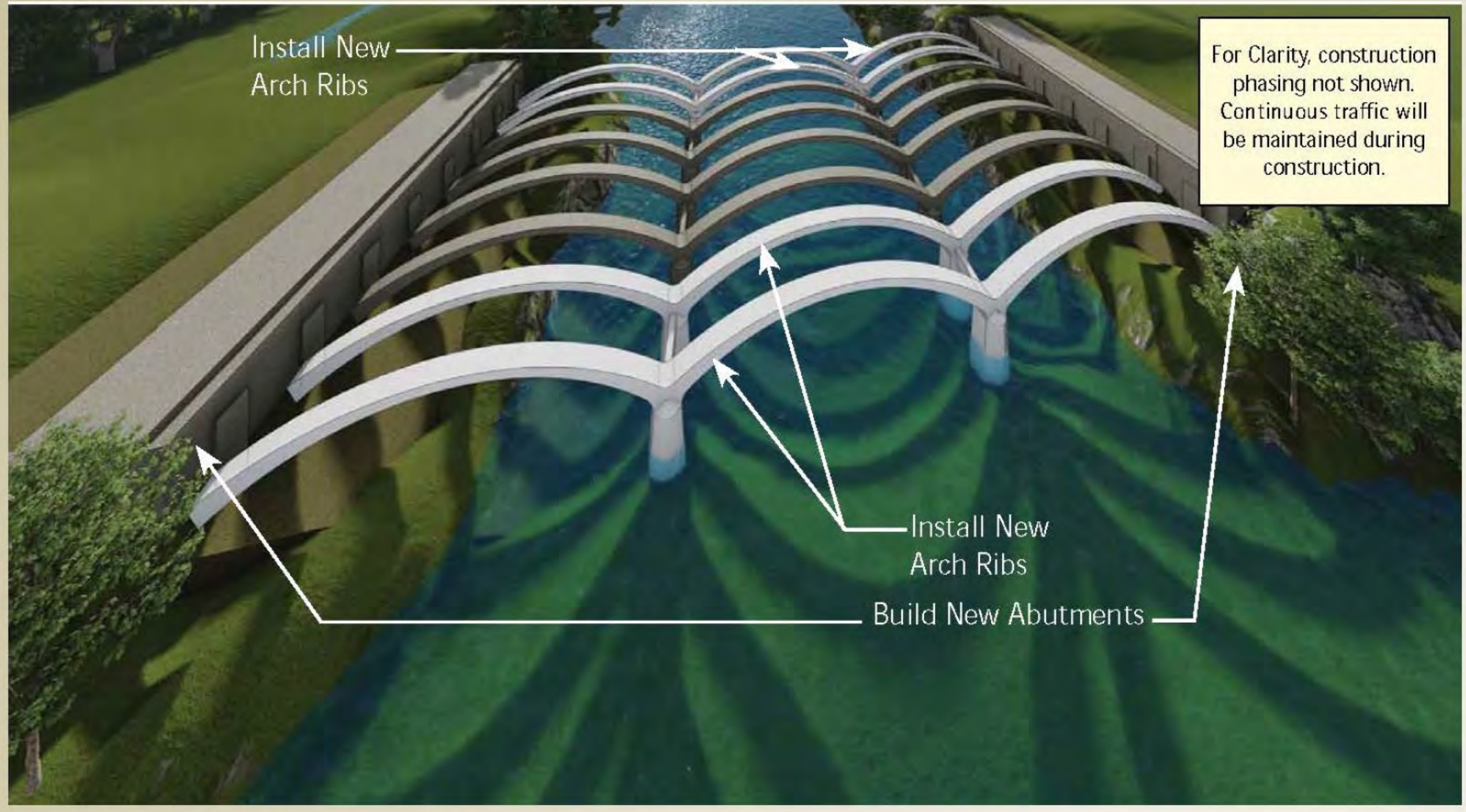
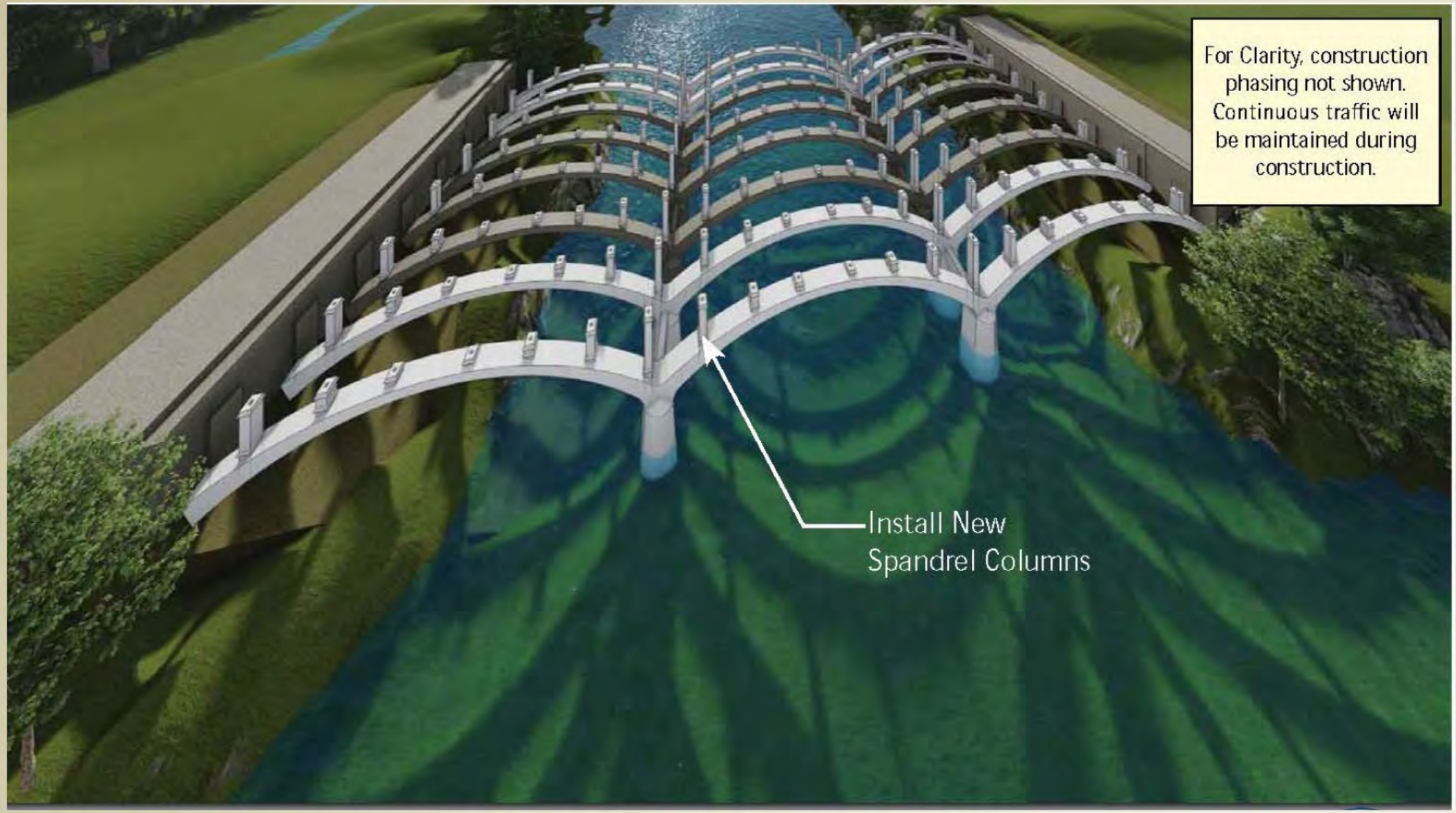
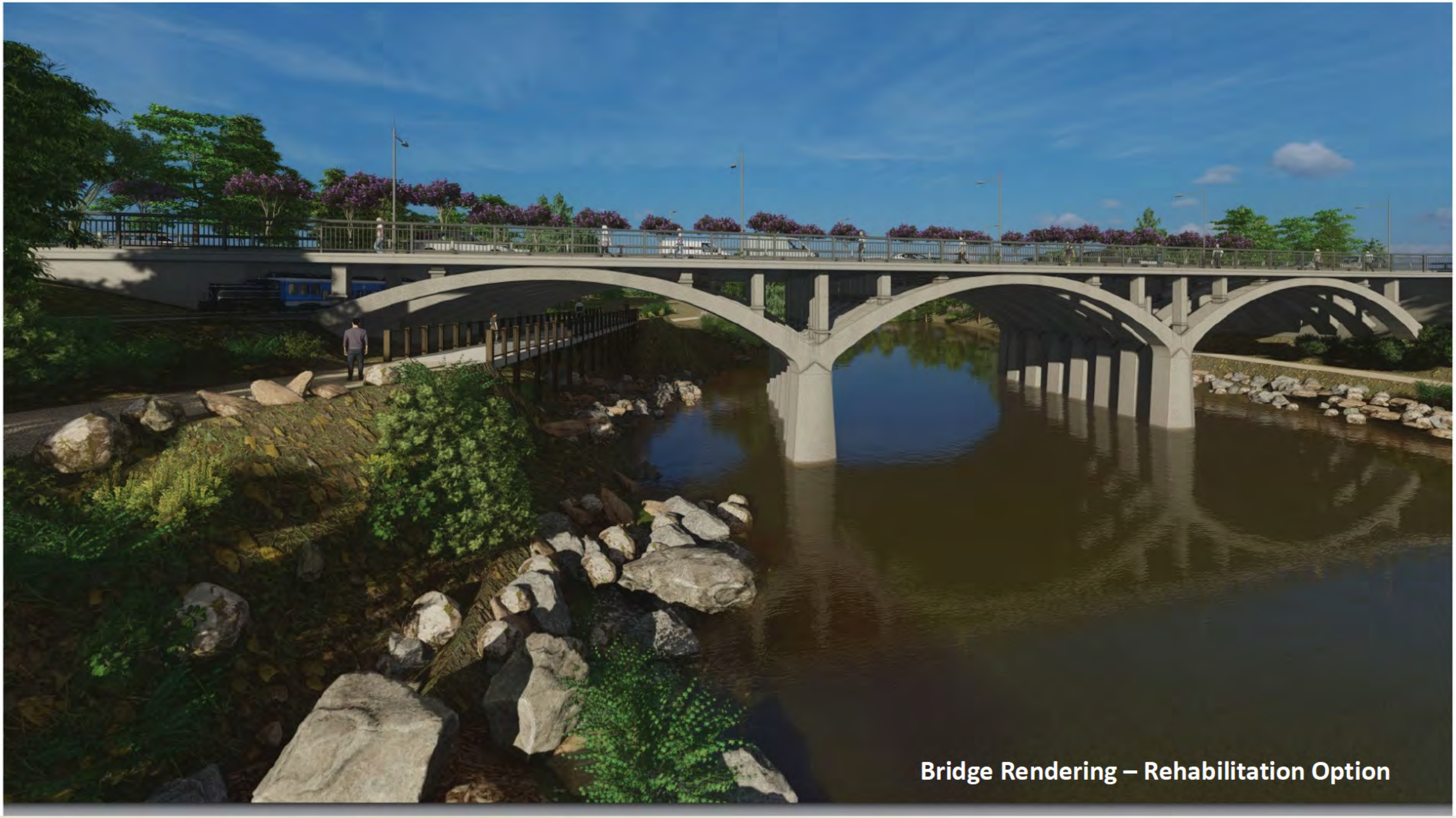
Rehabilitation Concepts



Rehabilitation Concepts





Bridge Rendering – Rehabilitation Option

Replacement Concepts

- Descriptions:
  1. Options 1 and 2 limit substructure elements to four, providing more open space beneath the bridge.
  2. Options 1 and 2 incorporate indirect supports and both transverse and longitudinal post-tensioning.
  3. Option 2 splits the channel in half.

Replacement Option 1 – Longitudinally Framed Arch

Replacement Option 2 –Longitudinally Framed Single Column

Replacement Option 3 –Transversely Framed Dual Column

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Structural Design Basis

1. Bulb-Tees - accommodate the staged widening and are significantly less costly.
2. Arch option was configured to lessen bending moments in the arch ribs. This created a more "pointy" arch and moved the ribs adjacent to the shore, which could affect hydraulics.
3. Structural modeling was performed to prove feasibility of concepts and give preliminary quantity estimates.
4. Stainless steel rebar was replaced with black (uncoated) rebar to save cost.
5. Unit Prices, available historical information from TxDOT and FDOT.
6. Options 2 and 3 use mono-shafts.

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Under Bridge – Rehabilitation Option

Option 1 – Longitudinally Framed Arch

Option 2 –Longitudinally Framed Single Y-Pier

Option 3 – Transverse Framed Dual Y-Pier

Option 1 – Longitudinally Framed Arch

Option 2 –Longitudinally Framed Single Y-Pier

Option 3 – Transverse Framed Dual Y-Pier

Under Bridge – Rehabilitation Option

Option 1 – Longitudinally Framed Arch

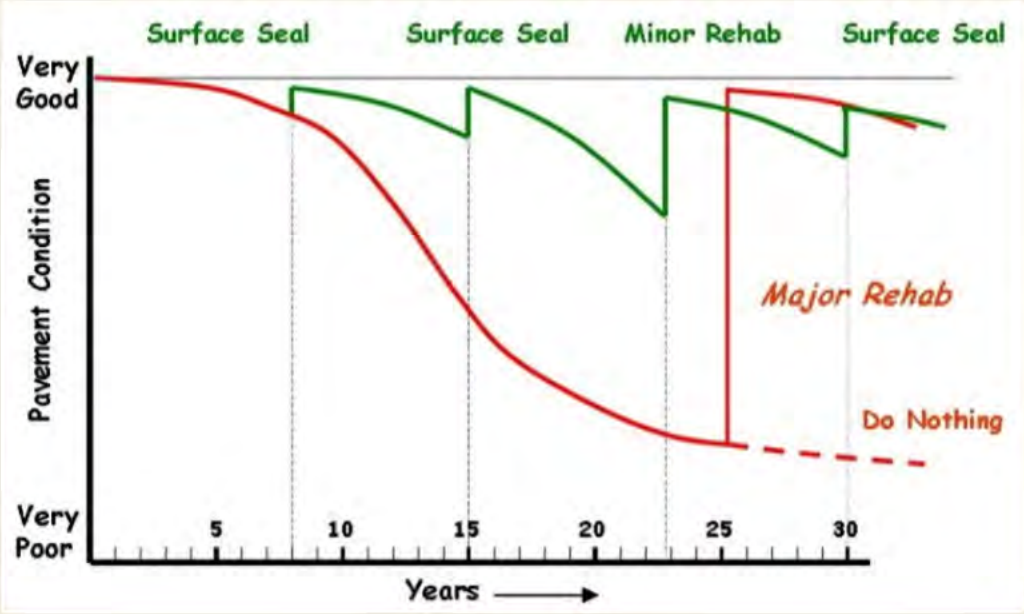
Option 2 –Longitudinally Framed Single Y-Pier

Option 3 – Transverse Framed Dual Y-Pier

Bridge Cost Estimates

2nd Tier Costing based upon Preliminary Design:

1. Includes Quantity Breakdown
2. Includes Unit Cost development
3. Includes Contingency of 25%
4. Deterioration Modeling and Life Cycle Evaluations not included



Cost Studies

Barton Springs Road Bridge

Option 1 - Concrete Arch (New)
(file: 24Feb2022_Barton Creek Cost Estimates12.xlsx)

by RBA date 24-Feb-21
chk SJM date 24-Feb-21

	SPAN LENGTH (feet)	Width (feet)	AREA (ft^2)
Abutment to Abutment:	235.0	109.3	25693

Item		Unit	Quantity	Unit Price	Subtotal	Total
Superstructure						
Girder and Deck						
Deck Concrete		CY	795	$ 1,200	$ 953,923	
Diaphragm Concrete		CY	368	$ 1,000	$ 368,013	
Reinforcing - Black		LB	290,737	$ 1.00	$ 290,737	
AASHTO Type IV - 72 Inch Depth		FT	1,880	$ 320	$ 601,600	
Post-Tensioning Strand		LB	82,849	$ 10.00	$ 828,490	
Post-Tensioning Bar		LB	42,800	$ 10.00	$ 428,000	
Approach Slabs		CY	159	$ 400	$ 63,704	
Temporary Works - Shoring Systems		EA	4	$ 100,000	$ 400,000	
Girder and Deck Subtotal:					$ 3,934,468	
Misc. Appurtenances						
Overlay		SF	24,988	$ 6.00	$ 149,930	
Expansion Joints		FT	219	$ 250	$ 54,667	
Barriers		FT	940	$ 155	$ 145,700	
Traffic Median		FT	235	$ 160	$ 37,600	
Bearings		EA	32	$ 1,000	$ 32,000	
Concrete - Surface Treatments		SF	3,760	$ 5.00	$ 18,800	
Period Light Fixtures and Conduits		LS	1	$ 50,000	$ 50,000	
Miscellaneous Items (Includes Const. Engr.)		LS	1	$ 700,000	$ 700,000	
Misc. Appurtenances Subtotal:					$ 1,188,696	
Superstructure Subtotal (1)						$ 5,123,164
Substructure						
Piers or Arch Ribs						
Concrete - Piers		CY	-	$ 950	$ -	
Concrete - Arch Ribs		CY	535	$ 1,250	$ 669,319	
Reinforcing - Black		LB	214,182	$ 1.00	$ 214,182	
Post-Tensioning Strand		LB	-	$ 10.00	$ -	
Post-Tensioning Bar		LB	10,000	$ 10.00	$ 100,000	
Concrete - Surface Treatments		SF	20,592	$ 5.00	$ 102,960	
Piers or Arch Ribs Subtotal:					$ 1,086,462	
Pier Foundations						
Foundation Preparation - Cofferdam		LS	2	$ 500,000	$ 1,000,000	
Footing Concrete - Tremie Seal		CY	196	$ 650	$ 127,111	
Footing Concrete		CY	880	$ 950	$ 836,000	
Footing Reinforcing - Black		LB	176,000	$ 1.00	$ 176,000	
Drilled Shaft Furnished and Installed		FT	960	$ 950	$ 912,000	
Pier Foundations Subtotal:					$ 3,051,111	
Abutment						
Excavation		CY	7,400	$ 100	$ 740,000	
Abutment Concrete		CY	261	$ 950	$ 247,704	
Abutment Reinforcing - Black		LB	52,148	$ 1.00	$ 52,148	
Concrete - Surface Treatments		SF	8,400	$ 5.00	$ 42,000	
Drilled Shaft Furnished and Installed		FT	640	$ 950	$ 608,000	
Temporary Walls		SF	6,600	$ 50.00	$ 330,000	
Permanent Walls		SF	8,400	$ 50.00	$ 420,000	
Abutment Subtotal:					$ 1,699,852	
Substructure Subtotal (2)						$ 5,837,425
Main Bridge Quantities Subtotal (1) + (2)					$ 10,960,588	
Bridge Demolition	10%				$ 1,096,059	
Mobilization	5%				$ 548,029	
Architecture and Engineering Fees	15%				$ 1,644,088	
Maintenance of Traffic	10%				$ 1,096,059	
Estimated Cost of Work						$ 15,344,824
Contingencies						
Contingency	25%				$ 2,740,147	
Total Project Cost					$ -	$ 18,084,971
					Bridge Grand Total	$ 18,084,971
					Square Foot Total	$ 703.88
					Cost Factor	1.77

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Bridge Cost Comparison

Barton Springs Road Bridge

Conceptual Engineering Cost Estimate
Comparison of Alternatives

(file: 23Feb2022_Barton Creek Cost Estimates12.xlsx)

by Bob Anderson 24-Feb-21
chk Steve Metzer 24-Feb-21

Alternative	Bridge Total ($M)	Bridge ($/sq. ft.)*	Weighted Costing (Based on Total)	Costing Differences ($M)	Costing Rank (Based on Total)
Option 1 - Concrete Arch (New)	18.08	703.88	1.77	7.86	*4*
Option 2 - Concrete Single Pier (New)	13.63	530.50	1.33	3.40	*2*
Option 3 - Concrete Dual Pier (New)	10.23	398.14	1.00	0.00	*1*
Option 4 - Rehabilitation	14.70	648.30	1.44	4.47	*3*

* Note: New bridges have 13.3% more square feet of deck area than rehabilited bridge.
(New = 25,693 sq. ft. versus Rehab = 22,668 sq. ft.)

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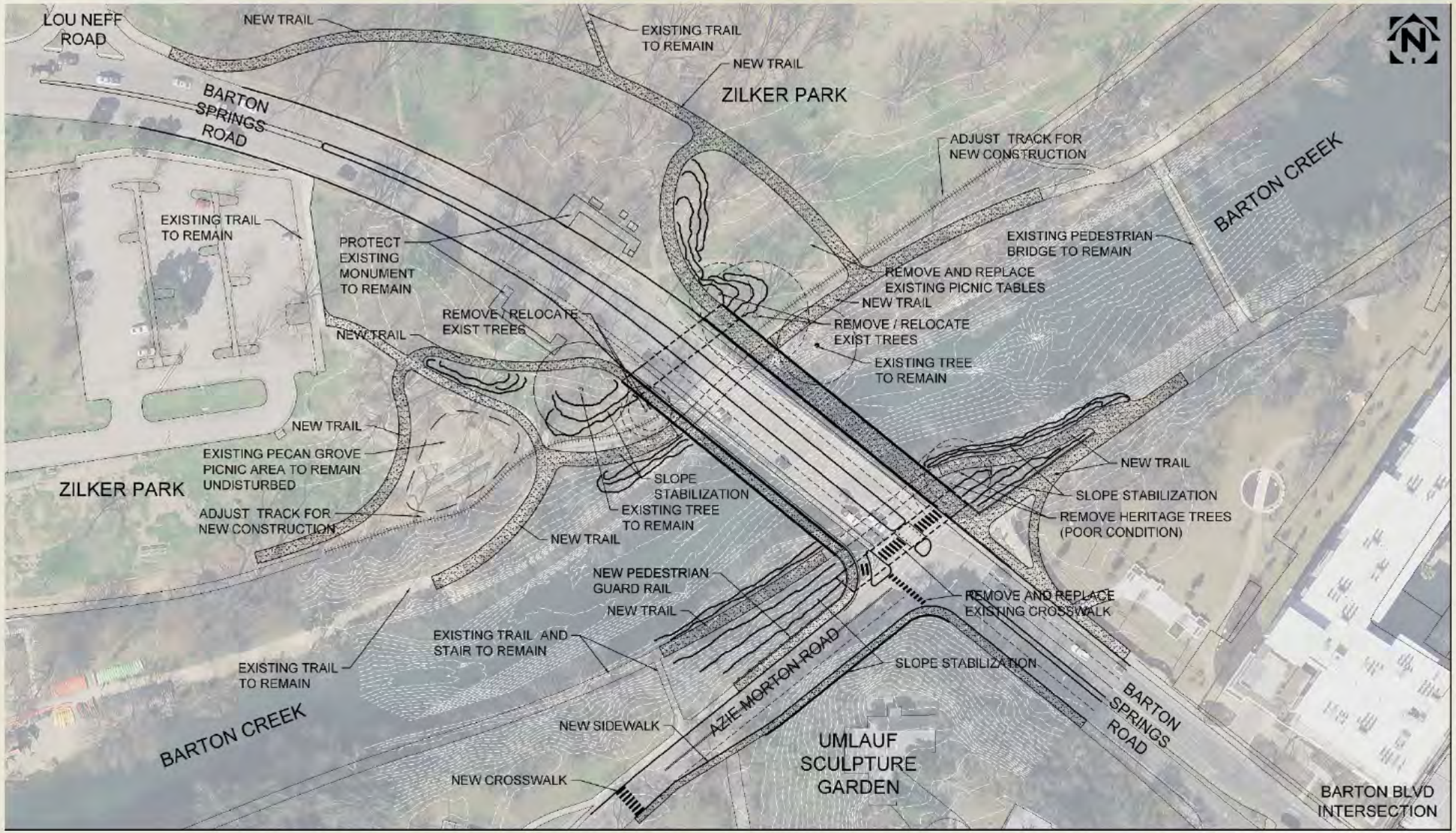
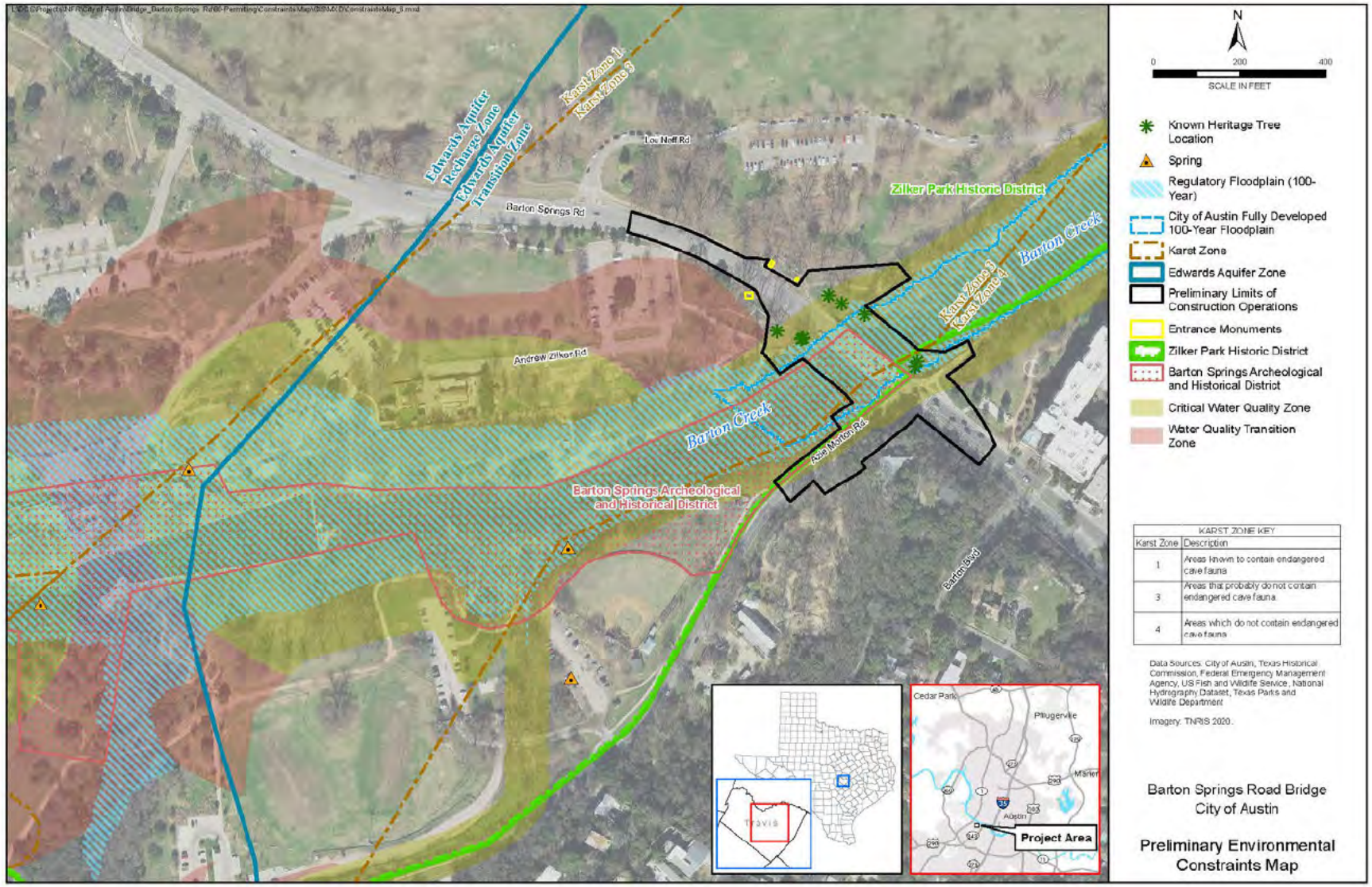
Questions

Zilker Park Concept Pedestrian Access Plan



- Protect Landmarks
- Protect / Move / Mitigate Heritage Trees
- **Flexibility and Connectivity with Zilker Park Vision Plan**

Environmental Issues / Constraints Map



Environmental Issues / Permit Matrix

- Federal Permits/Approvals Required
  - Clean Water Act
    - Project requires Section 404 Nationwide Permit and Section 401 Certification due to anticipated impacts to Barton Creek.
    - Project requires compliance with the National Pollutant Discharge Elimination System (NPDES).
  - Endangered Species Act – Project requires habitat assessment for federally listed species and informal coordination with the U.S. Fish and Wildlife Service (USFWS) to determine potential for species occurrence.
    - May also require presence/absence surveys for listed species and formal Section 7 consultation with the USFWS.

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Environmental Issues / cont'd

- Federal Permits/Approvals Required cont'd
  - Section 106 of National Historic Preservation Act – As part of the Section 404 process and because bridge is contributing resource to Zilker Park Historic District, compliance with Section 106 is required.
    - Under Section 106, a project can have 'No Adverse Effect' or 'Adverse Effect' on historic properties
    - 'Adverse Effect' requires coordination with Texas Historical Commission (THC) for mitigation
    - Rehabilitation and Replacement – all options anticipated to have an adverse effect
    - For either rehabilitation or replacement, a detailed plan and finding of effect must be submitted to the THC and a Memorandum of Agreement (MOA) compiled and signed by all involved parties/agencies.
      - Address Adverse Effect - Coordinate chosen mitigation with THC for either option, and could include:
        - » Large format photography to accompany written history of bridge and its importance to Austin and Zilker Park
        - » Interpretive signage, especially in a location easily accessible to pedestrians using the bridge

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Environmental Issues / cont'd

- State Permits/Approvals
  - Texas Parks and Wildlife Department
    - Project requires habitat assessment for state-listed species to determine potential for species occurrence
      - Presence/absence surveys for mussel species and an Aquatic Resource Relocation Plan (ARRP) may also be required.
    - Project requires coordination with TPWD to determine potential requirements for a Marl, Sand, Gravel, Shell, or Mudshell Permit due to Barton Creek being a perennial stream and 30 feet wide.
  - Texas Commission on Environmental Quality
    - Project located in Edwards Aquifer Transition Zone, therefore requiring an Edwards Aquifer Protection Plan (EAPP).
  - Texas Parks and Wildlife Code Chapter 26
    - Project will impact parklands.

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Environmental Issues / cont'd

- Local Permits/Approvals
  - Austin City Code
  - Land Development Code
  - Environmental Criteria Manual

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Comparison of Alternatives

Feature/Component	Bridge Rehabilitation Concept	Bridge Replacement Concept
Roadway Geometry		
General Similarities	Right turn lanes included to reduce que time, delays and congestion.	Right turn lanes included to reduce que time, delays and congestion.
Barton Springs Rd Alignment across intersection	Improved but not completely aligned, since Rehab requires use of existing structure centerline.	Optimum – road will be aligned and straight through the intersection.
Park Amenities / Improvements		
General Similarities	New / rebuilt pathways to meet with Zilker Park Vision Plan concepts	New / rebuilt pathways to meet with Zilker Park Vision Plan concepts
West Bank ▪ Zilker Zephyr Train ▪ Pedestrian Bridge	Requires removal during construction Likely replaced in a similar manner to existing layout.	Requires removal during construction Moving the western abutment further west provides additional horizontal space. Either replaced similar to current layout, or potential for combining train and pedestrian path on the additional space allowed.
East Bank - Hike / Bike Trail passage below the bridge	Passage space and headroom will be similar to existing layout.	New structures and abutments allow opportunity for added vertical and horizontal open space underneath bridge.

Comparison of Alternatives

Feature/Component	Bridge Rehabilitation Concept	Bridge Replacement Concept
Bridge Structure		
General Similarities	Cross section – widths for roadway, bicycle, and pedestrian pathways.	Cross section – widths for roadway, bicycle, and pedestrian pathways.
Bridge Architecture and Aesthetics	Existing arches and foundations will be preserved and remain. Remaining structures will undergo cathodic protection including concrete and condition mitigation and re-surface work. Rehab concept will add new arches upstream and downstream. New arches will be complementary to but not a replicate of the existing arches, depending upon aesthetic coordination with historic preservation agencies. Visibility of new arches will be predominant. Substructure to consist of 8 arch lines .	Existing arches will be removed. Replacement concepts are pending City review. Opportunity for choice in a new bridge aesthetic. Replacement concept to consist of 4 arch lines.
Bridge Length and Abutment Locations	Existing abutment locations will remain and expand to the north and to the south. Length remains the same.	West abutment shifts to the west, to lengthen bridge and provide more space for pedestrian trail and Zilker Zephyr train.

Comparison of Alternatives

Feature/Component	Bridge Rehabilitation Concept	Bridge Replacement Concept
Bridge Structure (continued)		
Bridge Foundation Work in Barton Creek	Work on existing foundations in the creek will include cathodic protection and concrete mitigation and concrete re-surface work. Includes construction of 8 new foundations (for 4 new arch lines each with two piers), in Barton Creek. Foundations for temporary works will be required.	The existing arches and foundations would likely be removed, down to the creek bed. Replacement concepts range from: ▪ no foundations (Option 1 – Arch Concept) ▪ 4 foundations (Option 2 – Longitudinally Framed Y-Pier Concept), ▪ 8 foundations (Transversely Framed Y-Pier Concept). Foundations for temporary works will be required.
Service Life	Target Service Life extension of 50-75 years This is dependent upon results from additional sampling/testing of the existing bridge materials.	Target Service Life of 100 years
Bridge Construction Cost	Concept Cost Range of $425 - $700/SF	Concept Cost Range of $400 - $750/SF
Constructability / Risk	Constructability more difficult due to the requirement for precision-demolition, and the need to protect existing structures to remain, while constructing new work on or adjacent. Subject to greater project risk with unknown material conditions of existing structures and subsurface foundation conditions.	

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Summary of Benefits / Opportunities

Rehabilitation	Replacement
Increased structure safety and extended service life	Increased structure safety and additional extended service life
Increased mobility and connectivity	Increased mobility and connectivity
Improved roadway alignment	Optimum roadway alignment
Decreased traffic congestion	Decreased traffic congestion
Preservation of portions of existing bridge	Opportunity for aesthetic choices in new bridge
	Opportunity for more space and room for placement of Zilker Zephyr and/or pedestrian path on west bank of Barton Creek
	Opportunity for more head room and space underneath bridge for hike/bike trail on east bank, depending upon bridge type selection
	Less design/construction/cost risk due to unknowns
	Longer service life for similar or less cost than rehab

Break

Discussion / Recommendations

- Group Discussion/Questions
- Group Recommendation – Initial Direction
  - Not final decision
  - Decision made by Council after agency, stakeholder, public input/vetting
  - Top alternative to carry forward
  - Refinements

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Under Bridge – Rehabilitation Option

Option 1 – Longitudinally Framed Arch

Option 2 –Longitudinally Framed Single Y-Pier

Option 3 – Transverse Framed Dual Y-Pier

Next Steps

City Department Design Charrette 1
- Project Definition
- Rehab / Replacement
- Other Components
- Benefits/Opportunities
- Receive Input
- Recommend Gen'l Direction

City Council Briefing
- General Direction
- No Decision Until Vetted
- Receive Input

Optional - City Department Stakeholders
- Incorporate Council Inputs
- Refine Messaging

Texas Historic Commission
- Present Project
- Confirm Project Direction
- ID Key Issues; Stakeholders
- Messaging Input

City Department Design Charrette 2
- Input from Previous Meetings
- Concept Refinement
- Receive Input
- Confirm Project Direction

Public Engagement

External/Public Stakeholder Meetings
- Present Project
- Present Project Direction
- Receive Input

Public Open House 1
- Present Project
- Present Project Direction
- Receive Input

City Department Design Charrette 3
- Input from Previous Meetings
- Concept Refinement
- Receive Input
- Select Alternative
- Recommendation for Council

City Council Confirmation
- Brief on Process
- Brief Inputs (Agency, Public)
- Confirm Recommendation
- Receive Input

Public Open House 2
- Present Project
- Confirm Project Direction
- Design/Construction Process
- Receive Input

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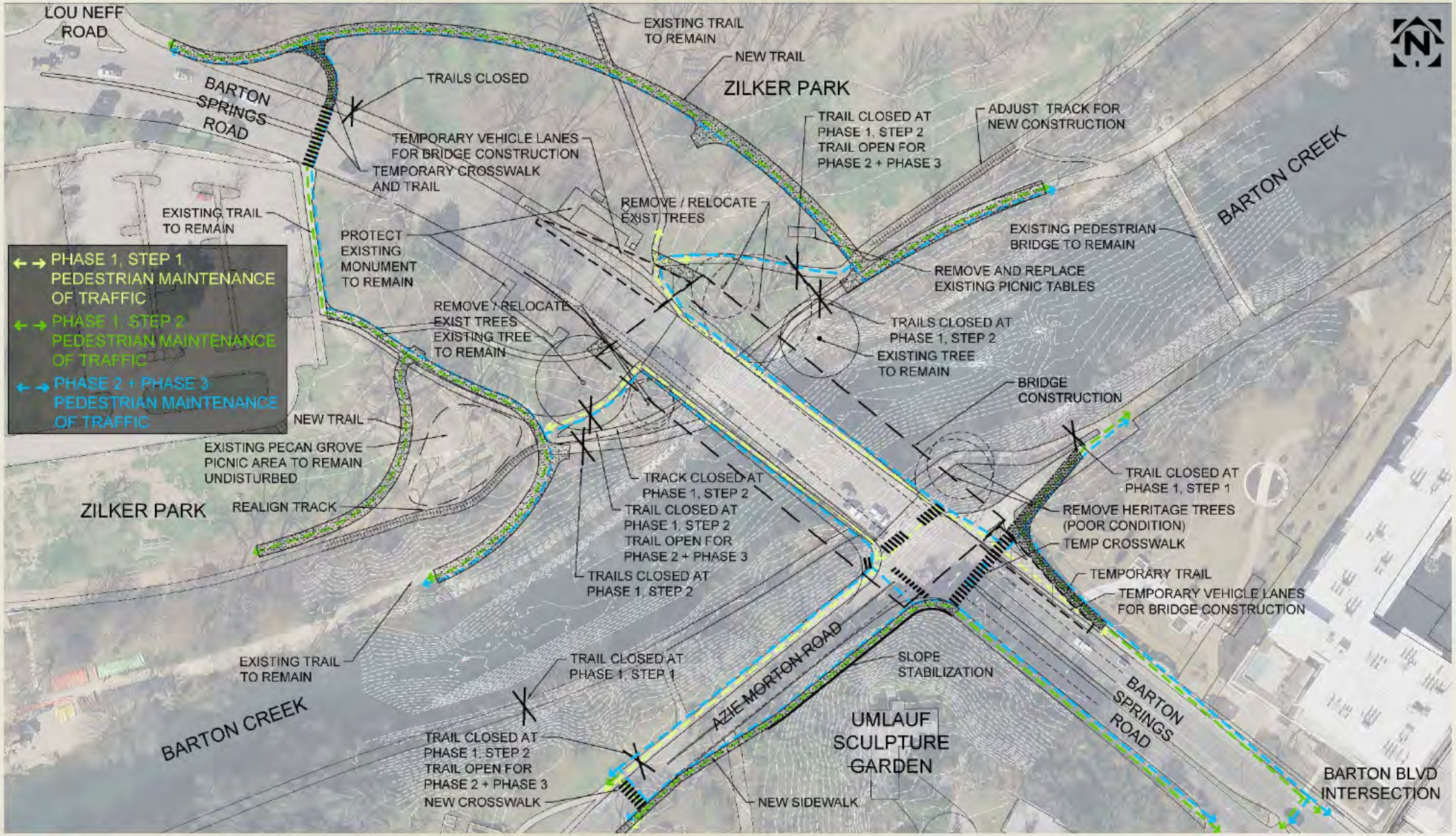
Thank you for your time !

Zilker Park Concept Pedestrian MOT Plan



- Connectivity during construction

austin MOBILITY BONDS

C-4 - Rehabilitation vs Replacement Memo – September 2022

City of Austin

Barton Springs Road Bridge over Barton Creek

Rehabilitation vs. Replacement Memorandum

CIP ID 5873.031

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September 28, 2022
Final (F1)

This document is released under the authority of Robert B. Anderson Texas PE No. 111066

REVISIONS

Project: City of Austin – Barton Springs Road Bridge over Barton Creek

Document: Rehab vs. Replacement Memo

Revision	Date of Issue	Description
D0	08/22/2022	Draft Issue for Internal Comment
D1	09/12/2022	Revised Draft Issue post PWD comments
D2	09/19/2022	Revised Draft Issue cost table and replacement comparison
F1	09/28/2022	Final Issue

Contents

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1.1 Purpose and Need 3
1.2 Bridge Cultural / Historical Background / Existing Condition 3
2. DESIGN CONCEPTS 5
2.1 Design Elements Common to Both Rehabilitation and Replacement 5
2.2 Rehabilitation Option 5
2.3 Replacement Option 7
3. COMPARISON OF PRELIMINARY REPLACEMENT / REHABILITATION CONCEPTS 10
4. SUMMARY AND RECOMMENDATIONS 12

Statement of Limitations

This report is intended for the City of Austin and is distributed to third parties outside the City's organization, with their consent.

This interim memo provides a direct comparison between the rehabilitation and replacement options for the Barton Springs Road Bridge over Barton Creek and provides a recommendation from the design team. This report is intended to outline the current design approach and highlight the pros and cons associated with the rehabilitation and replacement concepts. To limit the size and focus of this memo, the detailed work associated with existing bridge inspection and preliminary concept development and analysis are incorporated by reference.

1. INTRODUCTION

This section of the report summarizes the purpose and need for the project and provides some Cultural and Historical Background.

1.1 Purpose and Need

The purpose and need for this project is centered on safety-related bridge improvements that address the following items:

- Age of structure / structural degradation;
- Insufficient bike / pedestrian paths (functionally obsolete);
- Bridge roadway lanes not aligned with lanes east of Azie Morton;
- Hillside instability (rock fall) and obsolete retaining wall on Azie Morton east side at intersection;
- Elevated / overhanging sidewalk integral to intersection – past movement / cracking; and
- Bridge / intersection congestion.

1.2 Bridge Cultural / Historical Background / Existing Condition

The original Barton Springs Road bridge was built in 1925 and widened to its current configuration in 1945. The bridge is located adjacent to Zilker Park, which is listed in the National Register of Historic Places (NRHP); and is considered a contributing resource to the Park. The Barton Springs Archeological and Historical District (formed in 1985) is also located within the Zilker Historic District and the downstream boundary of this district is in close proximity to the bridge.

The age of the south and north structures is 97 and 76 years, respectively. The bridge overall has a condition rating of "Fair," and most structural components generally have a condition rating of "Good", based on the *FHWA Condition Rating Guidelines*.

Given the advanced age of the deck, and the fact that the most serious deterioration is found within the vicinity of the longitudinal deck joint, it is necessary to replace the deck entirely and eliminate the longitudinal joint and transverse joints where practical. This precludes efforts to keep and repair all of the existing bridge components. In addition, the spandrel columns exhibit low concrete compressive strength and severe cracking, spalling, and/or delamination (2017 *On-Site Sampling and Laboratory Investigation*). The cracking of the shorter spandrel columns is further exacerbated by their structural configurations (moment connections at both the top and bottom), which attract an inordinately large amount of shear loading.

Therefore, any proposed bridge rehabilitation strategy that provides a substantial increase in service life requires "stripping" the structure down to the arch ribs and reconstructing the spandrel columns, floor system, and deck. Sliding bearings at the tops of the new spandrel columns will decouple the deck from the supporting structure.

Figure 1. Deterioration of Longitudinal Beam

In addition to the condition of the existing bridge, the site presents a number of challenges and constraints. Many of these are illustrated in the issues map below:

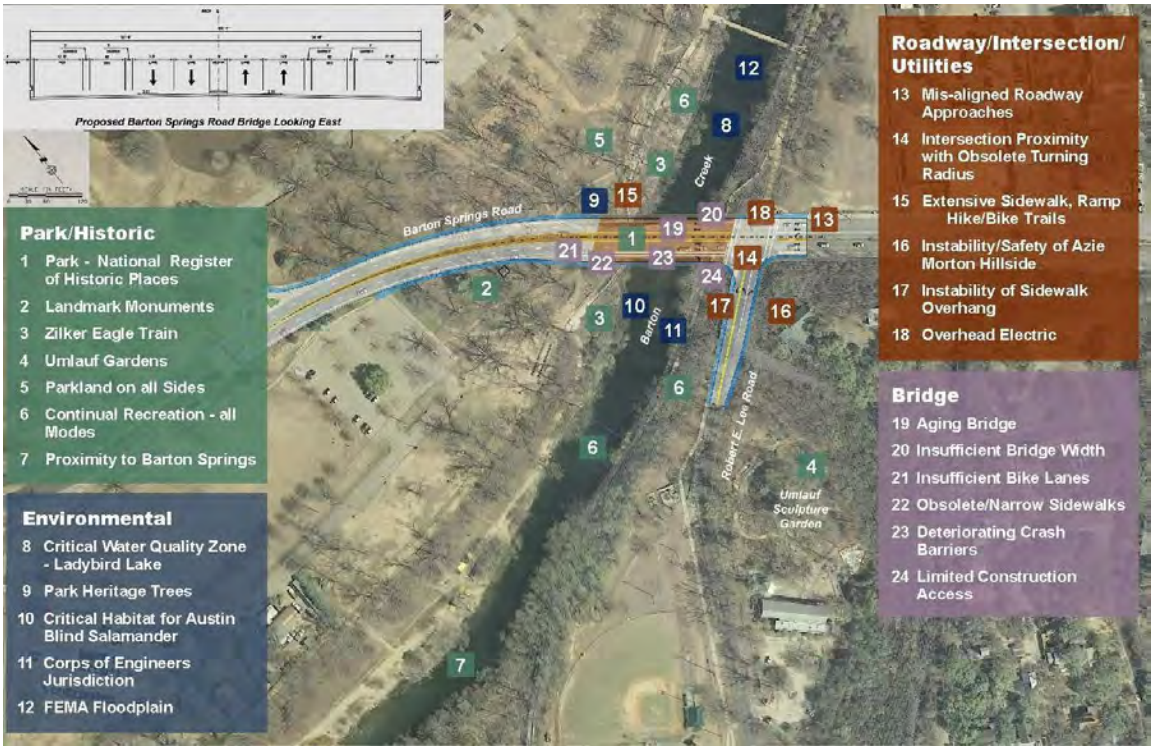

Figure 2. Barton Springs Rd. Bridge Challenges and Constraints

2. DESIGN CONCEPTS

2.1 Design Elements Common to Both Rehabilitation and Replacement

Barton Springs Road serves as a vital roadway connector. Improvements include the realignment of the travel lanes to improve or eliminate the current offset movement at the Azie Morton Road interchange.

The bridge provides a vital bicycle and pedestrian link to the Zilker Park and the existing bike/ pedestrian facilities are inadequate. The redesigned bridge provides dedicated bike lanes as well as a 14 ft. wide sidewalk on the south side of the bridge and an 18 ft. wide shared use path on the north side of the bridge. The design also links the sidewalks to the park trail system and accommodates the trails underneath the bridge.

Lastly, the design will maintain space for the "Zilker Eagle" train that will be refurbished in the near future.

Both the rehabilitation scheme and the replacement scheme share the same above-deck configuration, resulting in an overall bridge width increase from 59 ft. to 109 ft. Therefore, either approach will provide the same result with respect to traffic and bike/ pedestrian movements.

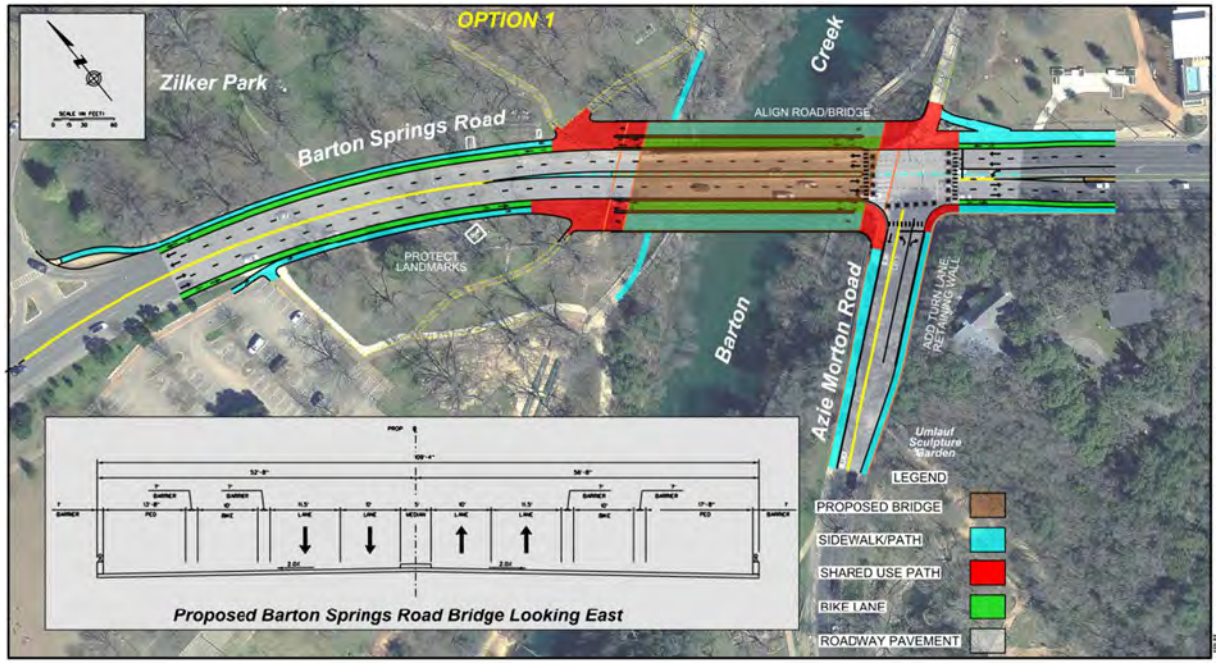

Figure 3. Bridge and Roadway Proposed Geometric Plan

2.2 Rehabilitation Option

The Rehabilitation Option will reuse portions of the existing bridge structure (with rehabilitation measures implemented) and widen each side to provide the ultimate width necessary for proposed multi-modal travel ways.

Due to the deterioration of the existing bridge, only the existing arch ribs will remain.

Figure 4. Bridge Rehabilitation – Remove Deck and Spandrel Columns; Remediate Remaining Structures

Once the arches are exposed, work will include reinforcement of the existing abutments, repairs to the arches and installation of a cathodic protection system to reduce further deterioration of the steel rebar in the arch ribs.

Four additional lines of arch ribs will be added to accommodate the wider deck above. Therefore, the existing arch ribs will only be visible when viewed from underneath the structure.

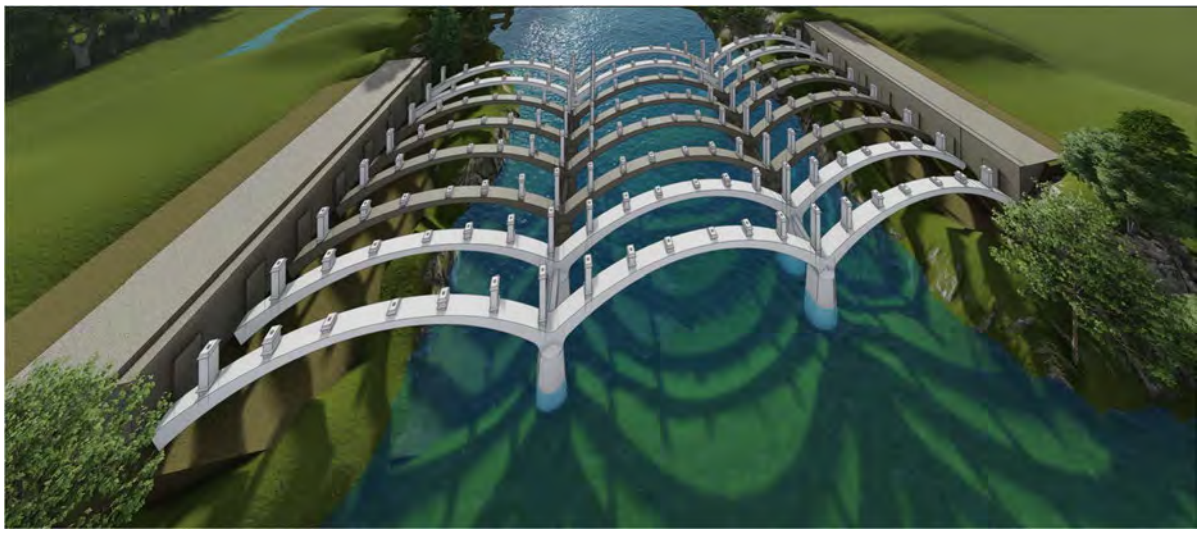

Figure 5. Install New Arch Ribs, Spandrel Columns and Extend Abutments

The fully rehabilitated bridge will maintain the overall appearance and configuration of the existing bridge, utilizing similar details for the arches, spandrel columns, longitudinal beams, etc. In accordance with current design practices, it is anticipated that the level of remediation and future corrosion mitigation methods will be employed to achieve an additional 50 to 75 years of bridge service life subsequent to the rehabilitation.

While the rehabilitation option will provide the appearance of keeping the existing bridge, less than half of the original structure will remain intact and very little surficial materials will remain. Furthermore, very little of the original structure will be plainly visible after the new rib extensions on both sides and the installation of new spandrel columns and deck. As such, what will be predominantly in view is new bridge structure and materials.

Figure 6. Rehabilitation Option Rendering

2.3 Replacement Option

The Replacement Option will remove the existing bridge structure in its entirety and provide a new structure with the ultimate width necessary for proposed multi-modal travel ways.

This option allows for lengthening the bridge by moving the western abutment to the west. In so doing, the Replacement Option provides additional space to facilitate improvements to existing Zilker Park facilities, such as walking paths and the Zilker Eagle miniature railroad, both of which pass under the Barton Springs Road Bridge on the west bank. This additional space for improvements is not feasible with the Rehabilitation Option.

A number of design options for the replacement bridge were developed and vetted with the City of Austin and various stakeholders. Table 2-1 provides a summary of the comparison of rehabilitation options.

Table 2-1 – Comparison of Bridge Replacement Options.

	Option 1 - Single Arch	**Option 2 - "Y" Pier Longitudinal**	**Option 3 - "Y" Pier Transverse**
Description	Option 1 is comprised of four arch ribs bearing on thrust block at either side of the creek. The form the arch makes creates a contemporary reference to the existing bridge form.	Option 2 consists of four "Y" piers located at the center of creek that create an arch-like appearance. There are two bearing points on the "Y" pier with a longitudinal tie to accommodate the tension in the top of the pier.	Option 3 utilizes eight "Y" piers arched in the transverse direction. The piers are located near the third-points of the structure and maintain an open center channel in the creek
PrStructural Complexity	This option utilizes a complex post-tensioning system in the main arches and large scale thrust block to transfer load from the bridge to the ground. The superstructure girders and intermediate diaphragms are post-tensioned.	The "Y" piers utilize post-tensioning tendons to pre-compress a tie at the top of the pier to resist the longitudinal forces created by the bearing points of the structure. The piers rest on conventional foundations located in the creek. The superstructure girders and intermediate diaphragms are post-tensioned.	**Advantage** Post-tensioning bars are used to pre-compress a transverse tie at the top of the pier. These piers rest on conventional foundations in the creek. The superstructure girders are post-tensioned.
Visual Openness	The bold forms of the arches create the highest level of visual obstruction. However, the structure does provide direct views along the centerline of the creek when seen from the water.	The "Y" piers create more openness than Option 1. However, the location of the piers in the center of the creek obstructs the views down the centerline of the creek.	**Advantage** Option 3 provides more visual openness than Options 1 and 2. The pier placement also creates unobstructed views along the center of the creek.
Constructability	Option 1 requires temporary piers and complex falsework to form the arches. It is the most complex to build.	Option 2 utilizes conventional construction techniques and has the fewest number of foundations in the water. However, the tension ties at the top of the piers will require specialty construction techniques including complex falsework.	**Advantage** Option 3 generally uses conventional construction techniques and should not pose any unusual problems for a bridge of this type and scale. The post-tensioning of the girders and post-tensioned tension ties at the top of the piers will require some specialty construction techniques.
Initial Const. Cost	$18.1M	$13.6M	**Advantage** **$10.2M**

The preferred alternative for replacement is depicted below and utilizes a concrete beam superstructure with two lines of "Y" piers oriented parallel to the channel and at a slight skew to the bridge's beam elements. This configuration maximizes the views through the bridge and maintains an open center channel in Barton Creek below. The unique pier design pays homage to the arches of the existing bridge, while utilizing the most current methods of design and construction.

Figure 7. Replacement Option Rendering

2.4 Bridge Option Cost Comparison

Table 2-2 provides a comparison of estimated life-cycle costs of the Rehabilitation Option and the three Replacement Options. The cost includes a preliminary construction cost estimate, as well as life cycle cost from estimated maintenance /rehabilitation costs throughout the 75-year design life, and then brought back to today's dollars. A range of discount rates (expected interest minus inflation) can be used; Table 2-2 uses 3%. The initial construction cost and life cycle costs did not alter the ranking of alternatives.

Table 2-2 Cost Comparison of Bridge Options.

Bridge Alternative	Initial Const. Bridge Est. Total ($M)	Life Cycle Est. Bridge Total ($M) *	Bridge ($/sq. ft.)**	Weighted Costing (Based on Total)	Costing Differences ($M)	Costing Rank (Based on Total)
Option 1 - Concrete Arch (New)	18.1	21.2	825	1.59	7.9	4
Option 2 - Concrete Single Pier (New)	13.6	16.7	648	1.25	3.4	2
Option 3 - Concrete Dual Pier (New)	10.2	13.3	519	1.00	N/A	1
Option 4 - Rehabilitation	14.5	17.8	787	1.34	4.5	3

* *Note 1: Comparison of Options Using 3% Discount Rate*

** *Note 2: Replacement bridges have 13.3% more square feet of deck area than rehabilitated bridge. (New = 25,693 sq. ft. versus Rehab = 22,668 sq. ft.)*

*** *Note 3: Cost only for Bridge Construction; not roadway, utilities, retaining walls, or other disciplines*

3. COMPARISON OF PRELIMINARY REPLACEMENT / REHABILITATION CONCEPTS

A summary and comparison of various features and components of both rehabilitation and replacement bridge concepts are provided in Table 3-1.

Table 3-1. Comparison of Bridge Rehabilitation / Replacement Concepts

Highlighted Boxes Represent Benefit Over Other Option

Feature/Component	Bridge Rehabilitation Concept	Preferred Bridge Replacement Concept (Option 3)
Roadway Geometry		
Azie Morton Road extended Right Turn lane onto Barton Springs Road	Included	Included
Barton Springs Road Alignment	Barton Springs Rd. will be improved but still unaligned; the required "zig zag" by west bound traffic will be much less abrupt. Rehabilitation requires the new structure to be built on the existing centerline alignment.	**Advantage** Barton Springs Rd. will have the point of inflection removed from the alignment. The result will be a straight intersection, with no conflict in east- or westbound traffic and no "zig zag".
Park Amenities / Improvements		
Zilker Eagle Train	The train will have to be replaced under the bridge, in a similar configuration to current layout.	**Advantage** Moving the western abutment further west provides additional horizontal space. The train can be replaced similar to the current layout, or relocated with additional space for rider room and safety.
West bank hike/bike trail pedestrian bridge under Barton Springs Rd	The pedestrian bridge will need to be removed and replaced in a similar manner to existing layout.	**Advantage** The pedestrian bridge will need to be removed. It can either be replaced similar to current layout, or it may be able to be relocated as a path on the additional space allowed by moving the western abutment.
Hike / Bike Trail passage below the bridge	Passage length under bridge will be roughly twice as wide as existing. Passage space and headroom will be similar to existing layout.	**Advantage** Passage length will be similar to rehab length. Passage space will see combination of new structures and abutments to allow opportunity for added vertical and horizontal open space underneath bridge.

Feature/Component	Bridge Rehabilitation Concept	Preferred Bridge Replacement Concept (Option 3)
Bridge Structure		
Bridge Architecture and Aesthetics	Existing arches and foundations will be preserved and remain. Remaining structures will undergo cathodic protection including concrete and condition mitigation and re-surface work. Rehab concept will add new arches upstream and downstream. New arches will be complementary to but not a replicate of the existing arches, depending upon aesthetic coordination with Texas Historical Commission. Visibility of new arches will be predominant. Substructure to consist of 8 arch lines	Existing arches will be removed. Replacement concepts will include 4 arch lines. New bridge aesthetic can be complementary to the existing bridge (3 span) type/span arrangement. Replacement concept to consist of 4 substructure elements at two locations in lieu of 8 continuous elements providing more open view sheds.
Impacts to Historic Structure	**Advantage** Rehabilitation of the existing bridge preserves some of the existing historic bridge elements.	Replacement removes the existing historic elements and relies on mitigation strategies to offset impacts.
Bridge Length and Abutment Locations	For rehab, existing abutment locations will remain, and will expand or widen to the north and to the south to accommodate the additional arches for a wider bridge, in a similar geometric arrangement to existing.	**Advantage** Replacement concept will shift the west abutment to the west, to provide more space and safety for pedestrian trail and the Zilker Eagle train on the West Bank.
Bridge foundation work in Barton Creek	Work on existing foundations in the creek will include cathodic protection and concrete mitigation and concrete re-surface work. Includes construction of 8 new foundations (for 4 new arch lines each with two piers), in Barton Creek.	The existing arches and foundations would likely be removed, down to the creek bed. Replacement concept includes 8 foundations – for 4 substructure elements at 2 locations.
Temporary Construction in Barton Creek	Extensive foundations for temporary works will be required	**Advantage** Assuming bridge can be constructed by barge mounted cranes, foundations for temporary works will not be required.
Bicycle Elements on Bridge	Includes 10 ft-wide bike lanes on each side, to accommodate 2-way bike operations on either side of the bridge.	Includes 10 ft-wide bike lanes on each side, to accommodate 2-way bike operations on either side of the bridge.

Feature/Component	Bridge Rehabilitation Concept	Preferred Bridge Replacement Concept (Option 3)
Pedestrian Elements on Bridge	Includes a 14 ft-wide sidewalk on the south side and 18 ft wide sidewalk on the north side.	Includes a 14 ft-wide sidewalk on the south side and 18 ft wide sidewalk on the north side.
Service Life	Target Service Life extension of 50-75 years This is dependent upon results from additional sampling/testing of the existing bridge materials.	**Advantage** Target Service Life of 75 years This can be extended to 100 years with durability enhancements to the design basis and prescribed materials. This would entail an increase in cost of roughly 10% or more.
Bridge Maintenance	Increased long term maintenance cost and requirements	**Advantage** Less maintenance cost and staffing labor required
Engineer's Estimate of Probable Bridge Construction Cost *(range indicating minimum and maximum cost including 50% inflation over course of design and bidding of the project)*	$14.5M - $22M	**Advantage** $10.2M – 15.5M
Constructability / Risk	Constructability more difficult due to the requirement for precision-demolition, and the need to protect existing structures to remain, while constructing new work on or adjacent. Subject to greater project risk with unknown material conditions of existing structures and subsurface foundation conditions.	**Advantage** Comparatively less construction and project risk.

4. SUMMARY AND RECOMMENDATIONS

The existing Barton Springs Bridge is an historic structure that contributes to the urban and historic fabric of Zilker Park and Austin, Texas. The bridge is also a part of the larger transportation infrastructure system that serves the community. This project is difficult because we must strike a proper balance between historic preservation, public safety and the use of public funds. The Section 106 process of "Avoid – Minimize – Mitigate" helps to identify the best path forward.

The deterioration of the existing bridge has reached a stage that cannot be ignored and the level of repair that is required eliminates the possibility of a "light-touch" restoration. Thus,

historic impact avoidance and historic impact minimization are simply not possible. Therefore, the focus of the investigation has centered on the development of feasible restoration and replacement schemes that meet the current transportation demands while providing a structure with a lifespan of at least 75 additional years of service.

Both rehabilitation and replacement can accommodate the transportation needs in a similar fashion. The replacement scheme offers numerous additional benefits (highlighted cells in the above table) including better accommodations of the Zilker Eagle mini-train and enhanced trails underneath the bridge.

The most significant differences between the rehabilitation scheme and the replacement scheme are cost and risk. The particular replacement bridge alternative selected is not the least expensive design possible, it includes enhanced features such as unique piers and upgraded abutments. Even with these enhancements, the cost of the replacement bridge is 40% less than the rehabilitation scheme. Furthermore, ongoing maintenance cost and labor requirements are less with the replacement scheme. There is also a great deal of risk associated with the rehabilitation scheme. While the bridge condition survey was thorough, there are many things that could increase the cost of rehabilitation once the initial demolition exposes all of the "hidden" elements of the bridge.

We understand the significance of the existing bridge and the importance of preserving historical assets. However, as stewards of the taxpayer's money there is an obligation to make the best value decision for the community. If the bridge is rehabilitated, very little of the existing structure will remain and those remaining elements will be almost entirely concealed by the new construction. This fact coupled with the significant increase in cost and risk leads the design team to recommend replacement as the path forward.

The project is continuing an on-going coordination with the Texas Historical Commission (THC); and it is intended that input from both the THC and U.S. Army Corps of Engineers will be forthcoming as coordination continues.

austin MOBILITY BONDS

C-5 - MMA Memo City Staff to Council – Nov. 2022

MEMORANDUM

TO: Mayor and Council Members

FROM: James Snow, Interim Director
Public Works Department

DATE: November 15, 2022

SUBJECT: **Update on Barton Springs Rd. Bridge Project**

This memo provides an update on staff's efforts to address the existing bridge over Barton Springs Rd. This includes determining the condition of the existing bridge, outlining alternatives for rehabilitation or replacement, and making a recommendation on the most appropriate path forward.

Attached to this memo is a detailed summary of key concepts and technical findings on the preferred bridge alternative for the Barton Springs Road Bridge over Barton Creek.

Background:
Built in 1925, the Barton Springs Road Bridge provides access over Barton Creek along Barton Springs Road at the entrance to Zilker Park. The bridge was widened to its current form in 1946, which includes two traffic lanes in each direction. The bridge also features narrow sidewalks along each side, guard rails and a sidewalk below the bridge.

While the existing bridge is in fair condition structurally, many of its features are functionally obsolete and require rehabilitation or replacement to ensure safety and longevity. Given that the existing bridge presents mobility challenges for vehicles, bikes and pedestrians, this project will provide needed mobility enhancements for all users. Intersection improvements to nearby Barton Springs Road and Azie Morton Drive are necessary as part of this project.

In November 2020, Austin voters approved $102 million for major infrastructure projects, with the option of allocating a portion of that funding to address the Barton Springs Rd. Bridge. The project is currently funded for completion of preliminary engineering, including finalizing a Bridge Conceptual Engineering Report (BCER), as well as developing a design for a preferred solution (rehabilitation of existing bridge or reconstruction of a new structure). Future funding would need to be identified to move forward with construction.

Rehabilitation vs. Replacement: Design Considerations

The project began with the study of two Rehabilitation Alternatives (one geared towards minor rehabilitation and one more extensive) and three complete Replacement Alternatives. Based on a

2016 inspection of the bridge, the minor rehabilitation option was removed from consideration, leaving one major rehabilitation option and three replacement options.

All four remaining alternatives were considered using design concepts that were developed to accommodate bridge roadway, pedestrian, and bike users. These design concepts were vetted with various City Departments including significant input from the Austin Transportation Department. Additional input for design concepts included accommodating traffic during construction, existing and future hike/bike trail elements, as well as hillside instability issues along the nearby Umlauf property. The result is that all four alternatives would include at least: A bridge widened on both sides to keep the current four traffic lanes; Two new 10 ft. bike lanes; Pedestrian paths of 14 ft. and 18 ft. on the north and south side, respectively.

Rehabilitation Alternative
The lone rehabilitation option includes removal of deck, substructure, and columns, and leaving only the arch ribs. The existing arch ribs and abutments will require repair/resurfacing and installation of a cathodic protection system to reduce further deterioration.

Four additional lines of arch ribs will be added to accommodate the wider deck above. While the rehabilitation option will provide the appearance of keeping the existing bridge, much less than half of the original structure will remain intact and very little surficial materials will remain; furthermore, the new arch ribs will essentially block the historic/existing arch ribs from exterior view.

Replacement Alternatives
Three alternatives were developed and compared in cost, aesthetics, constructability, and visual perspective from trails, sidewalks, parkland, and the creek. Please see **Table 2.1** below for details. The preferred alternative for replacement shown below maximizes views through the bridge and maintains an open center channel in Barton Creek. This is also the most cost-effective alternative.

Preferred Replacement Alternative

This preferred Replacement Alternative was specifically compared to the Rehabilitation Alternative, with respect to various features and components, such as roadway alignment, accommodation of hike/bike trails, Barton Creek impacts, cost, maintenance requirements, constructability, and risk. A table of these factors is presented in the attached document.

Table 2-1 – Comparison of Bridge Replacement Options.

	Option 1 - Single Arch	Option 2 - "Y" Pier Longitudinal	Option 3 - "Y" Pier Transverse
Description	Option 1 is comprised of four arch ribs bearing on thrust block at either side of the creek. The form the arch makes creates a contemporary reference to the existing bridge form.	Option 2 consists of four "Y" piers located at the center of creek that create an arch-like appearance. There are two bearing points on the "Y" pier with a longitudinal tie to accommodate the tension in the top of the pier.	Option 3 utilizes eight "Y" piers arched in the transverse direction. The piers are located near the third-points of the structure and maintain an open center channel in the creek
PreStructural Complexity	This option utilizes a complex post-tensioning system in the main arches and large scale thrust block to transfer load from the bridge to the ground. The superstructure girders and intermediate diaphragms are post-tensioned.	The "Y" piers utilize post-tensioning tendons to pre-compress a tie at the top of the pier to resist the longitudinal forces created by the bearing points of the structure. The piers rest on conventional foundations located in the creek. The superstructure girders and intermediate diaphragms are post-tensioned.	Advantage Post-tensioning bars are used to pre-compress a transverse tie at the top of the pier. These piers rest on conventional foundations in the creek. The superstructure girders are post-tensioned.
Visual Openness	The bold forms of the arches create the highest level of visual obstruction. However, the structure does provide direct views along the centerline of the creek when seen from the water.	The "Y" piers create more openness than Option 1. However, the location of the piers in the center of the creek obstructs the views down the centerline of the creek.	Advantage Option 3 provides more visual openness than Options 1 and 2. The pier placement also creates unobstructed views along the center of the creek.
Constructability	Option 1 requires temporary piers and complex falsework to form thearches. It is the most complex to build.	Option 2 utilizes conventional construction techniques and has the fewest number of foundations in the water. However, the tension ties at the top of the piers will require specialty construction techniques including complex falsework.	Advantage Option 3 generally uses conventional construction techniques and should not pose any unusual problems for a bridge of this type and scale. The post-tensioning of the girders and post-tensioned tension ties at the top of the piers will require some specialty construction techniques.
Initial Const. Cost	$18.1M	$13.6M	Advantage $10.2M

The Replacement option offers numerous benefits over the Rehabilitation option, including better accommodations of the Zilker Eagle mini-train, enhanced trails underneath the bridge, and others highlighted in the more detailed design summary. The most significant differences between the rehabilitation scheme and the replacement scheme are cost and risk. The cost of the replacement option is 40% less than the rehabilitation option, and more risk is inherent in the rehabilitation scheme, due to the reliance on existing structural members whose true capacity can only be revealed through the subsequent design and construction process.

Recommendation: Move Forward to Update Community on Replacement Alternative
Based on the information outlined above and within the attached, staff recommends replacement of the existing bridge as the preferred alternative moving forward. Replacement offers the best choice based on value, historical preservation, and being a long term transportation solution for the community.

cc: Spencer Cronk, City Manager
Gina Fiandaca, Assistant City Manager

Attachment: Memo from Consultant re: Rehabilitation and Replacement Options for Bridge of Barton Creek

City of Austin

Barton Springs Road Bridge over Barton Creek

Rehabilitation vs. Replacement Memorandum

CIP ID 5873.031

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September 28, 2022
Final (F1)

This document is released under the authority of Robert B. Anderson Texas PE No. 111066

REVISIONS

Project: City of Austin – Barton Springs Road Bridge over Barton Creek

Document: Rehab vs. Replacement Memo

Revision	Date of Issue	Description
D0	08/22/2022	Draft Issue for Internal Comment
D1	09/12/2022	Revised Draft Issue post PWD comments
D2	09/19/2022	Revised Draft Issue cost table and replacement comparison
F1	09/28/2022	Final Issue

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1.2 Bridge Cultural / Historical Background / Existing Condition 3
2. DESIGN CONCEPTS 5
2.1 Design Elements Common to Both Rehabilitation and Replacement 5
2.2 Rehabilitation Option 5
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3. COMPARISON OF PRELIMINARY REPLACEMENT / REHABILITATION CONCEPTS 10
4. SUMMARY AND RECOMMENDATIONS 12

Statement of Limitations

This report is intended for the City of Austin and is distributed to third parties outside the City's organization, with their consent.

This interim memo provides a direct comparison between the rehabilitation and replacement options for the Barton Springs Road Bridge over Barton Creek and provides a recommendation from the design team. This report is intended to outline the current design approach and highlight the pros and cons associated with the rehabilitation and replacement concepts. To limit the size and focus of this memo, the detailed work associated with existing bridge inspection and preliminary concept development and analysis are incorporated by reference.

1. INTRODUCTION

This section of the report summarizes the purpose and need for the project and provides some Cultural and Historical Background.

1.1 Purpose and Need

The purpose and need for this project is centered on safety-related bridge improvements that address the following items:

- Age of structure / structural degradation;
- Insufficient bike / pedestrian paths (functionally obsolete);
- Bridge roadway lanes not aligned with lanes east of Azie Morton;
- Hillside instability (rock fall) and obsolete retaining wall on Azie Morton east side at intersection;
- Elevated / overhanging sidewalk integral to intersection – past movement / cracking; and
- Bridge / intersection congestion.

1.2 Bridge Cultural / Historical Background / Existing Condition

The original Barton Springs Road bridge was built in 1925 and widened to its current configuration in 1945. The bridge is located adjacent to Zilker Park, which is listed in the National Register of Historic Places (NRHP); and is considered a contributing resource to the Park. The Barton Springs Archeological and Historical District (formed in 1985) is also located within the Zilker Historic District and the downstream boundary of this district is in close proximity to the bridge.

The age of the south and north structures is 97 and 76 years, respectively. The bridge overall has a condition rating of "Fair," and most structural components generally have a condition rating of "Good", based on the *FHWA Condition Rating Guidelines*.

Given the advanced age of the deck, and the fact that the most serious deterioration is found within the vicinity of the longitudinal deck joint, it is necessary to replace the deck entirely and eliminate the longitudinal joint and transverse joints where practical. This precludes efforts to keep and repair all of the existing bridge components. In addition, the spandrel columns exhibit low concrete compressive strength and severe cracking, spalling, and/or delamination (2017 *On-Site Sampling and Laboratory Investigation*). The cracking of the shorter spandrel columns is further exacerbated by their structural configurations (moment connections at both the top and bottom), which attract an inordinately large amount of shear loading.

Therefore, any proposed bridge rehabilitation strategy that provides a substantial increase in service life requires "stripping" the structure down to the arch ribs and reconstructing the spandrel columns, floor system, and deck. Sliding bearings at the tops of the new spandrel columns will decouple the deck from the supporting structure.

Figure 1. Deterioration of Longitudinal Beam

In addition to the condition of the existing bridge, the site presents a number of challenges and constraints. Many of these are illustrated in the issues map below:

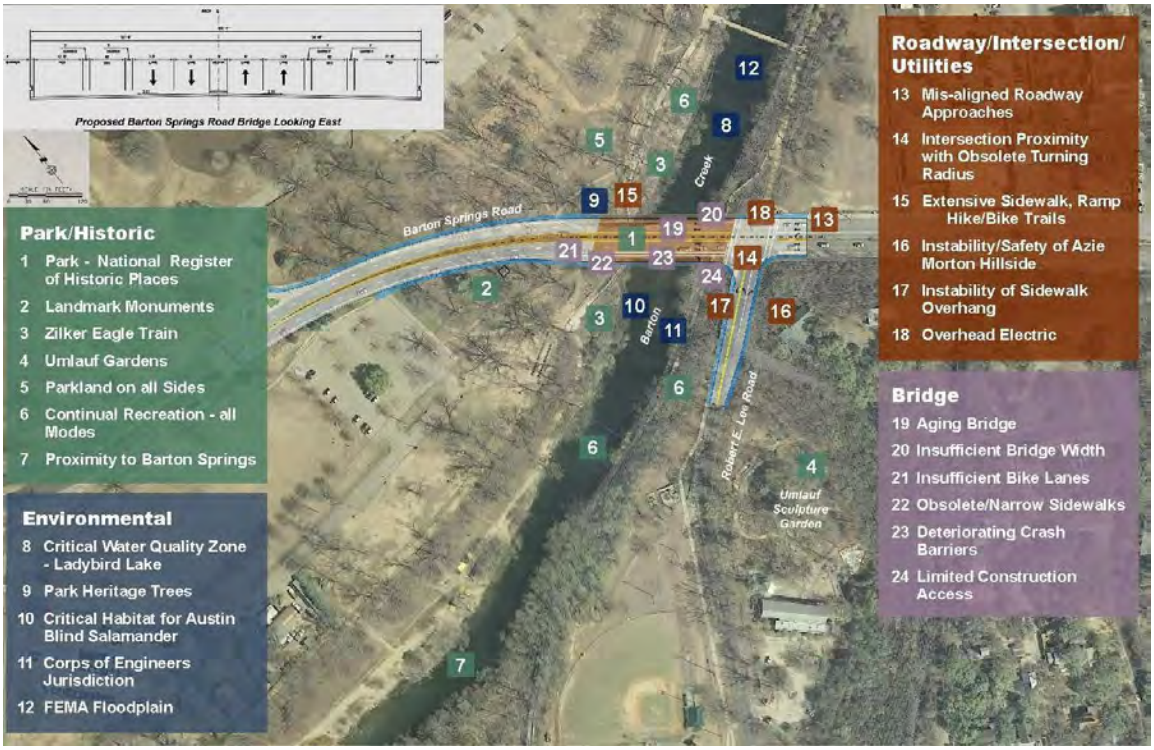

Figure 2. Barton Springs Rd. Bridge Challenges and Constraints

2. DESIGN CONCEPTS

2.1 Design Elements Common to Both Rehabilitation and Replacement

Barton Springs Road serves as a vital roadway connector. Improvements include the realignment of the travel lanes to improve or eliminate the current offset movement at the Azie Morton Road interchange.

The bridge provides a vital bicycle and pedestrian link to the Zilker Park and the existing bike/ pedestrian facilities are inadequate. The redesigned bridge provides dedicated bike lanes as well as a 14 ft. wide sidewalk on the south side of the bridge and an 18 ft. wide shared use path on the north side of the bridge. The design also links the sidewalks to the park trail system and accommodates the trails underneath the bridge.

Lastly, the design will maintain space for the "Zilker Eagle" train that will be refurbished in the near future.

Both the rehabilitation scheme and the replacement scheme share the same above-deck configuration, resulting in an overall bridge width increase from 59 ft. to 109 ft. Therefore, either approach will provide the same result with respect to traffic and bike/ pedestrian movements.

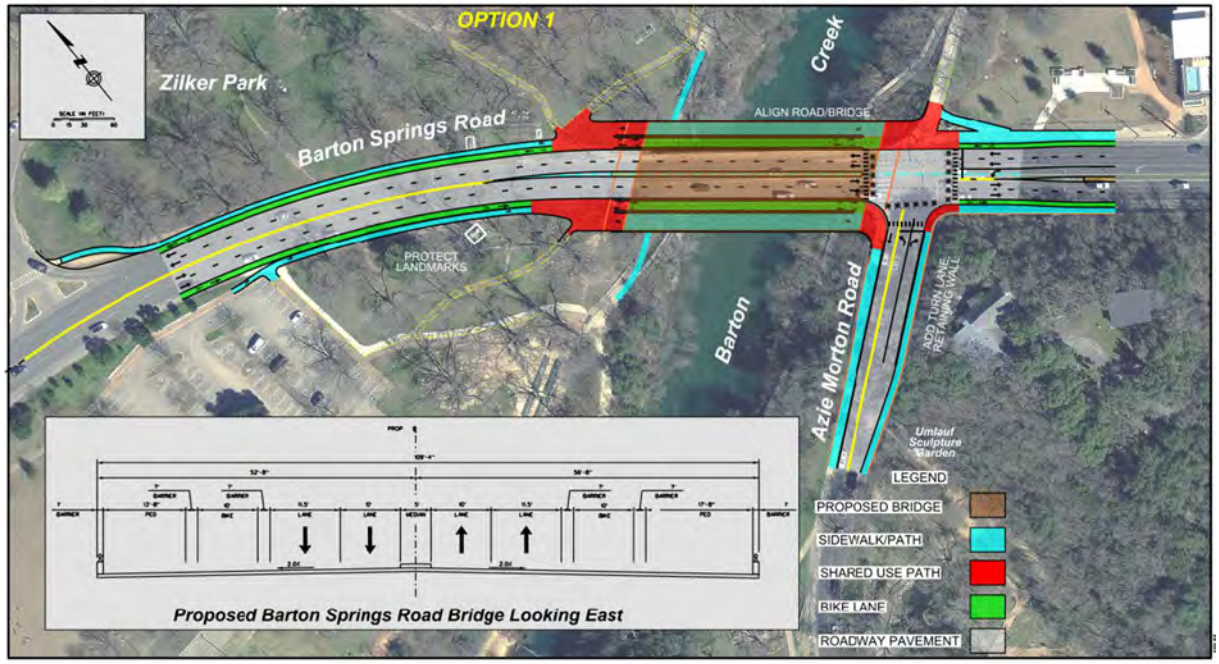

Figure 3. Bridge and Roadway Proposed Geometric Plan

2.2 Rehabilitation Option

The Rehabilitation Option will reuse portions of the existing bridge structure (with rehabilitation measures implemented) and widen each side to provide the ultimate width necessary for proposed multi-modal travel ways.

Due to the deterioration of the existing bridge, only the existing arch ribs will remain.

Figure 4. Bridge Rehabilitation – Remove Deck and Spandrel Columns; Remediate Remaining Structures

Once the arches are exposed, work will include reinforcement of the existing abutments, repairs to the arches and installation of a cathodic protection system to reduce further deterioration of the steel rebar in the arch ribs.

Four additional lines of arch ribs will be added to accommodate the wider deck above. Therefore, the existing arch ribs will only be visible when viewed from underneath the structure.

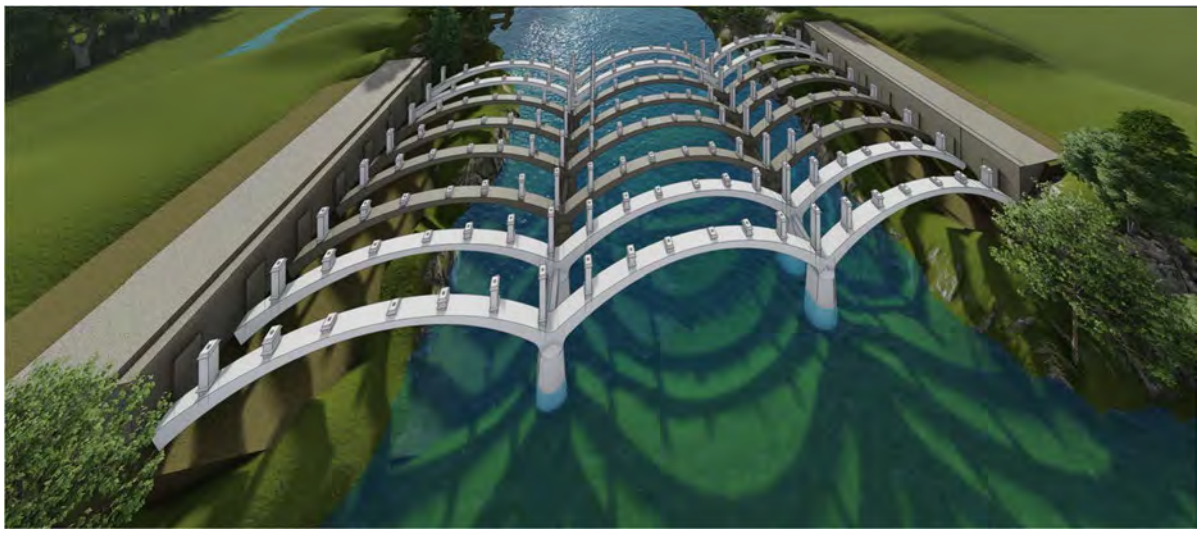

Figure 5. Install New Arch Ribs, Spandrel Columns and Extend Abutments

The fully rehabilitated bridge will maintain the overall appearance and configuration of the existing bridge, utilizing similar details for the arches, spandrel columns, longitudinal beams, etc. In accordance with current design practices, it is anticipated that the level of remediation and future corrosion mitigation methods will be employed to achieve an additional 50 to 75 years of bridge service life subsequent to the rehabilitation.

While the rehabilitation option will provide the appearance of keeping the existing bridge, less than half of the original structure will remain intact and very little surficial materials will remain. Furthermore, very little of the original structure will be plainly visible after the new rib extensions on both sides and the installation of new spandrel columns and deck. As such, what will be predominantly in view is new bridge structure and materials.

Figure 6. Rehabilitation Option Rendering

2.3 Replacement Option

The Replacement Option will remove the existing bridge structure in its entirety and provide a new structure with the ultimate width necessary for proposed multi-modal travel ways.

This option allows for lengthening the bridge by moving the western abutment to the west. In so doing, the Replacement Option provides additional space to facilitate improvements to existing Zilker Park facilities, such as walking paths and the Zilker Eagle miniature railroad, both of which pass under the Barton Springs Road Bridge on the west bank. This additional space for improvements is not feasible with the Rehabilitation Option.

A number of design options for the replacement bridge were developed and vetted with the City of Austin and various stakeholders. Table 2-1 provides a summary of the comparison of rehabilitation options.

Table 2-1 – Comparison of Bridge Replacement Options.

	Option 1 - Single Arch	**Option 2 - "Y" Pier Longitudinal**	**Option 3 - "Y" Pier Transverse**
Description	Option 1 is comprised of four arch ribs bearing on thrust block at either side of the creek. The form the arch makes creates a contemporary reference to the existing bridge form.	Option 2 consists of four "Y" piers located at the center of creek that create an arch-like appearance. There are two bearing points on the "Y" pier with a longitudinal tie to accommodate the tension in the top of the pier.	Option 3 utilizes eight "Y" piers arched in the transverse direction. The piers are located near the third-points of the structure and maintain an open center channel in the creek
PrStructural Complexity	This option utilizes a complex post-tensioning system in the main arches and large scale thrust block to transfer load from the bridge to the ground. The superstructure girders and intermediate diaphragms are post-tensioned.	The "Y" piers utilize post-tensioning tendons to pre-compress a tie at the top of the pier to resist the longitudinal forces created by the bearing points of the structure. The piers rest on conventional foundations located in the creek. The superstructure girders and intermediate diaphragms are post-tensioned.	**Advantage** Post-tensioning bars are used to pre-compress a transverse tie at the top of the pier. These piers rest on conventional foundations in the creek. The superstructure girders are post-tensioned.
Visual Openness	The bold forms of the arches create the highest level of visual obstruction. However, the structure does provide direct views along the centerline of the creek when seen from the water.	The "Y" piers create more openness than Option 1. However, the location of the piers in the center of the creek obstructs the views down the centerline of the creek.	**Advantage** Option 3 provides more visual openness than Options 1 and 2. The pier placement also creates unobstructed views along the center of the creek.
Constructability	Option 1 requires temporary piers and complex falsework to form the arches. It is the most complex to build.	Option 2 utilizes conventional construction techniques and has the fewest number of foundations in the water. However, the tension ties at the top of the piers will require specialty construction techniques including complex falsework.	**Advantage** Option 3 generally uses conventional construction techniques and should not pose any unusual problems for a bridge of this type and scale. The post-tensioning of the girders and post-tensioned tension ties at the top of the piers will require some specialty construction techniques.
Initial Const. Cost	$18.1M	$13.6M	**Advantage** **$10.2M**

The preferred alternative for replacement is depicted below and utilizes a concrete beam superstructure with two lines of "Y" piers oriented parallel to the channel and at a slight skew to the bridge's beam elements. This configuration maximizes the views through the bridge and maintains an open center channel in Barton Creek below. The unique pier design pays homage to the arches of the existing bridge, while utilizing the most current methods of design and construction.

Figure 7. Replacement Option Rendering

2.4 Bridge Option Cost Comparison

Table 2-2 provides a comparison of estimated life-cycle costs of the Rehabilitation Option and the three Replacement Options. The cost includes a preliminary construction cost estimate, as well as life cycle cost from estimated maintenance /rehabilitation costs throughout the 75-year design life, and then brought back to today's dollars. A range of discount rates (expected interest minus inflation) can be used; Table 2-2 uses 3%. The initial construction cost and life cycle costs did not alter the ranking of alternatives.

Table 2-2 Cost Comparison of Bridge Options.

Bridge Alternative	Initial Const. Bridge Est. Total ($M)	Life Cycle Est. Bridge Total ($M) *	Bridge ($/sq. ft.)**	Weighted Costing (Based on Total)	Costing Differences ($M)	Costing Rank (Based on Total)
Option 1 - Concrete Arch (New)	18.1	21.2	825	1.59	7.9	4
Option 2 - Concrete Single Pier (New)	13.6	16.7	648	1.25	3.4	2
Option 3 - Concrete Dual Pier (New)	10.2	13.3	519	1.00	N/A	1
Option 4 - Rehabilitation	14.5	17.8	787	1.34	4.5	3

* *Note 1: Comparison of Options Using 3% Discount Rate*

** *Note 2: Replacement bridges have 13.3% more square feet of deck area than rehabilitated bridge. (New = 25,693 sq. ft. versus Rehab = 22,668 sq. ft.)*

*** *Note 3: Cost only for Bridge Construction; not roadway, utilities, retaining walls, or other disciplines*

3. COMPARISON OF PRELIMINARY REPLACEMENT / REHABILITATION CONCEPTS

A summary and comparison of various features and components of both rehabilitation and replacement bridge concepts are provided in Table 3-1.

Table 3-1. Comparison of Bridge Rehabilitation / Replacement Concepts

Highlighted Boxes Represent Benefit Over Other Option

Feature/Component	Bridge Rehabilitation Concept	Preferred Bridge Replacement Concept (Option 3)
Roadway Geometry		
Azie Morton Road extended Right Turn lane onto Barton Springs Road	Included	Included
Barton Springs Road Alignment	Barton Springs Rd. will be improved but still unaligned; the required "zig zag" by west bound traffic will be much less abrupt. Rehabilitation requires the new structure to be built on the existing centerline alignment.	**Advantage** Barton Springs Rd. will have the point of inflection removed from the alignment. The result will be a straight intersection, with no conflict in east- or westbound traffic and no "zig zag".
Park Amenities / Improvements		
Zilker Eagle Train	The train will have to be replaced under the bridge, in a similar configuration to current layout.	**Advantage** Moving the western abutment further west provides additional horizontal space. The train can be replaced similar to the current layout, or relocated with additional space for rider room and safety.
West bank hike/bike trail pedestrian bridge under Barton Springs Rd	The pedestrian bridge will need to be removed and replaced in a similar manner to existing layout.	**Advantage** The pedestrian bridge will need to be removed. It can either be replaced similar to current layout, or it may be able to be relocated as a path on the additional space allowed by moving the western abutment.
Hike / Bike Trail passage below the bridge	Passage length under bridge will be roughly twice as wide as existing. Passage space and headroom will be similar to existing layout.	**Advantage** Passage length will be similar to rehab length. Passage space will see combination of new structures and abutments to allow opportunity for added vertical and horizontal open space underneath bridge.

Feature/Component	Bridge Rehabilitation Concept	Preferred Bridge Replacement Concept (Option 3)
Bridge Structure		
Bridge Architecture and Aesthetics	Existing arches and foundations will be preserved and remain. Remaining structures will undergo cathodic protection including concrete and condition mitigation and re-surface work. Rehab concept will add new arches upstream and downstream. New arches will be complementary to but not a replicate of the existing arches, depending upon aesthetic coordination with Texas Historical Commission. Visibility of new arches will be predominant. Substructure to consist of 8 arch lines	Existing arches will be removed. Replacement concepts will include 4 arch lines. New bridge aesthetic can be complementary to the existing bridge (3 span) type/span arrangement. Replacement concept to consist of 4 substructure elements at two locations in lieu of 8 continuous elements providing more open view sheds.
Impacts to Historic Structure	**Advantage** Rehabilitation of the existing bridge preserves some of the existing historic bridge elements.	Replacement removes the existing historic elements and relies on mitigation strategies to offset impacts.
Bridge Length and Abutment Locations	For rehab, existing abutment locations will remain, and will expand or widen to the north and to the south to accommodate the additional arches for a wider bridge, in a similar geometric arrangement to existing.	**Advantage** Replacement concept will shift the west abutment to the west, to provide more space and safety for pedestrian trail and the Zilker Eagle train on the West Bank.
Bridge foundation work in Barton Creek	Work on existing foundations in the creek will include cathodic protection and concrete mitigation and concrete re-surface work. Includes construction of 8 new foundations (for 4 new arch lines each with two piers), in Barton Creek.	The existing arches and foundations would likely be removed, down to the creek bed. Replacement concept includes 8 foundations – for 4 substructure elements at 2 locations.
Temporary Construction in Barton Creek	Extensive foundations for temporary works will be required	**Advantage** Assuming bridge can be constructed by barge mounted cranes, foundations for temporary works will not be required.
Bicycle Elements on Bridge	Includes 10 ft-wide bike lanes on each side, to accommodate 2-way bike operations on either side of the bridge.	Includes 10 ft-wide bike lanes on each side, to accommodate 2-way bike operations on either side of the bridge.

Feature/Component	Bridge Rehabilitation Concept	Preferred Bridge Replacement Concept (Option 3)
Pedestrian Elements on Bridge	Includes a 14 ft-wide sidewalk on the south side and 18 ft wide sidewalk on the north side.	Includes a 14 ft-wide sidewalk on the south side and 18 ft wide sidewalk on the north side.
Service Life	Target Service Life extension of 50-75 years This is dependent upon results from additional sampling/testing of the existing bridge materials.	**Advantage** Target Service Life of 75 years This can be extended to 100 years with durability enhancements to the design basis and prescribed materials. This would entail an increase in cost of roughly 10% or more.
Bridge Maintenance	Increased long term maintenance cost and requirements	**Advantage** Less maintenance cost and staffing labor required
Engineer's Estimate of Probable Bridge Construction Cost *(range indicating minimum and maximum cost including 50% inflation over course of design and bidding of the project)*	$14.5M - $22M	**Advantage** $10.2M – 15.5M
Constructability / Risk	Constructability more difficult due to the requirement for precision-demolition, and the need to protect existing structures to remain, while constructing new work on or adjacent. Subject to greater project risk with unknown material conditions of existing structures and subsurface foundation conditions.	**Advantage** Comparatively less construction and project risk.

4. SUMMARY AND RECOMMENDATIONS

The existing Barton Springs Bridge is an historic structure that contributes to the urban and historic fabric of Zilker Park and Austin, Texas. The bridge is also a part of the larger transportation infrastructure system that serves the community. This project is difficult because we must strike a proper balance between historic preservation, public safety and the use of public funds. The Section 106 process of "Avoid – Minimize – Mitigate" helps to identify the best path forward.

The deterioration of the existing bridge has reached a stage that cannot be ignored and the level of repair that is required eliminates the possibility of a "light-touch" restoration. Thus,

historic impact avoidance and historic impact minimization are simply not possible. Therefore, the focus of the investigation has centered on the development of feasible restoration and replacement schemes that meet the current transportation demands while providing a structure with a lifespan of at least 75 additional years of service.

Both rehabilitation and replacement can accommodate the transportation needs in a similar fashion. The replacement scheme offers numerous additional benefits (highlighted cells in the above table) including better accommodations of the Zilker Eagle mini-train and enhanced trails underneath the bridge.

The most significant differences between the rehabilitation scheme and the replacement scheme are cost and risk. The particular replacement bridge alternative selected is not the least expensive design possible, it includes enhanced features such as unique piers and upgraded abutments. Even with these enhancements, the cost of the replacement bridge is 40% less than the rehabilitation scheme. Furthermore, ongoing maintenance cost and labor requirements are less with the replacement scheme. There is also a great deal of risk associated with the rehabilitation scheme. While the bridge condition survey was thorough, there are many things that could increase the cost of rehabilitation once the initial demolition exposes all of the "hidden" elements of the bridge.

We understand the significance of the existing bridge and the importance of preserving historical assets. However, as stewards of the taxpayer's money there is an obligation to make the best value decision for the community. If the bridge is rehabilitated, very little of the existing structure will remain and those remaining elements will be almost entirely concealed by the new construction. This fact coupled with the significant increase in cost and risk leads the design team to recommend replacement as the path forward.

The project is continuing an on-going coordination with the Texas Historical Commission (THC); and it is intended that input from both the THC and U.S. Army Corps of Engineers will be forthcoming as coordination continues.

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C-6 – Bridge Alternative Cost Estimates

Opinion of Probable Cost Estimate
Barton Springs Bridge - CIP 5873.031
Lou Neff Rd. to Azie Morton Rd.
Rehabilitation Option - Bridge Only Const. Cost

URS 13640 Briarwick Drive Austin, Texas 78729 512.454.4797
TBPE Firm #3162 AN AECOM COMPANY

Base Bid:

Bid Item	Quantity	Unit	Item Description	Unit Price	Amount
			SUPERSTRUCTURE		
			GIRDER AND DECK		
	13,492	SF	Demolish Existing Floor System / Columns	$ 60	$ 809,508
	16	EA	Retrofit Existing Arch Ribs (FiberWrap/Rebar)	$ 27,500	$ 440,000
	150	LF	Drill and Grout Rebar (Exisitng Arch Crowns)	$ 110	$ 16,500
	562	CY	Deck Concrete	$ 1,200	$ 673,929
	61	CY	Spandrel Columns Concrete	$ 1,000	$ 60,685
	92	CY	Stiffening Girders Concrete (Rehab)	$ 1,100	$ 101,200
	728,573	LB	Reinforcing - Black	$ 1 05	$ 765,002
	36	CY	Longitudinal Beams	$ 1,100	$ 39,594
	120	CY	Transverse Floor Beams	$ 1,100	$ 131,738
	159	CY	Approach Slabs	$ 800	$ 127,407
	4	EA	Temporary Works - Shoring Systems	$ 100,000	$ 400,000
			GIRDER AND DECK SUBTOTAL		$ 3,565,562
			MISC. APPURTENANCES		
	22,046	SF	Overlay	$ 9	$ 198,417
	219	FT	Expansion Joints	$ 250	$ 54,667
	920	FT	Barriers	$ 155	$ 142,600
	207	FT	Traffic Median	$ 160	$ 33,168
	168	EA	Teflon Disk Bearings	$ 2,500	$ 420,000
	1,658	SF	Concrete - Surface Treatments	$ 12	$ 19,901
	13,848	SF	Repair Exisitng Concrete Surface (Rehab)	$ 60	$ 830,880
	1	EA	Cathodic Protection System (Rehab)	$ 200,000	$ 200,000
	1	LS	Period Light Fixtures and Conduits	$ 50,000	$ 50,000
	1	LS	Miscellaneous Items	$ 200,000	$ 200,000
			MISC. APPURTENANCES SUBTOTAL		$ 2,149,632
			SUPERSTRUCTURE TOTAL (1)		$ 5,715,195
			SUBSTRUCTURE		
			PIERS OR ARCH RIBS		
	290	CY	Concrete - Piers & Tie Beam	$ 770	$ 223,585
	176	CY	Concrete - Arch Ribs	$ 1,320	$ 232,320
	186,548	LB	Reinforcing - Black	$ 1 05	$ 195,876
	7,200	SF	Concrete - Surface Treatments	$ 12	$ 86,400
			PIERS OR ARCH RIBS SUBTOTAL		$ 738,181
			PIER FOUNDATIONS		
	240	CY	Footing Concrete	$ 950	$ 228,000
	60,000	LB	Footing Reinforcing - Black	$ 1 05	$ 63,000
			PIER FOUNDATIONS SUBTOTAL		$ 291,000
			ABUTMENT		
	3,704	CY	Excavation	$ 100	$ 370,370
	400	CY	Abutment Thrust Blocks Concrete	$ 1,100	$ 439,674
	433	CY	Abutment Front and Sidewalls	$ 1,000	$ 433,333
	208,259	CL	Abutment Reinforcing - Black	$ 1 05	$ 218,672
	8,400	SF	Concrete - Surface Treatments	$ 12	$ 100,800
	1,320	FT	Drilled Shaft Furnished and Installed	$ 950	$ 1,254,000
			ABUTMENT SUBTOTAL		$ 2,816,850
			SUBSTRUCTURE TOTAL (2)		$ 3,846,031
			MAIN BRIDGE QUANTITIES SUBTOTAL (1+2)		$ 9,561,226
			MISC.		
	0	LS	Bridge Demolition	$ 1,400,000	$ -
	1	LS	Mobilization (5%)	$ 478,061	$ 478,061
	1	LS	Architecture and Engineering Fees (15%)	$ 1,434,184	$ 1,434,184
	1	LS	Maintenance of Traffic (10%)	$ 956,123	$ 956,123
BASE BID. . . .					$ 12,429,593
Engineer's Estimate of Contingency (25%)					$ 2,390,306
Engineer's Estimate of Probable Cost					$ 14,819,900

Opinion of Probable Cost Estimate

Barton Springs Bridge - CIP 5873.031

Lou Neff Rd. to Azie Morton Rd.

Option 1 - Concrete Arch (New) - Bridge Only Const. Cost

URS
13640 Brunwick Drive
Austin, Texas 78729
512.454.8797
TBPE Firm #3192 AN AECOM COMPANY

Base Bid:

Bid Item	Quantity	Unit	Item Description	Unit Price	Amount
			SUPERSTRUCTURE		
			GIRDER AND DECK		
	795	CY	Deck Concrete	$ 1,200	$ 953,923
	368	CY	Diaphragm Concrete	$ 1,000	$ 368,013
	290,737	LB	Reinforcing - Black	$ 1.05	$ 305,274
	1,880	FT	AASHTO Type IV - 72 Inch Depth	$ 350	$ 658,000
	82,849	LB	Post-Tensioning Strand	$ 10	$ 828,490
	42,800	LB	Post-Tensioning Bar	$ 10	$ 428,000
	159	CY	Approach Slabs	$ 800	$ 127,407
	4	EA	Temporary Works - Shoring Systems	$ 100,000	$ 400,000
			GIRDER AND DECK SUBTOTAL		$ 4,069,108
			MISC. APPURTENANCES		
	24,988	SF	Overlay	$ 9	$ 224,894
	219	FT	Expansion Joints	$ 250	$ 54,667
	940	FT	Barriers	$ 155	$ 145,700
	235	FT	Traffic Median	$ 160	$ 37,600
	32	EA	Bearings	$ 1,000	$ 32,000
	3,760	SF	Concrete - Surface Treatments	$ 12	$ 45,120
	1	LS	Period Light Fixtures and Conduits	$ 50,000	$ 50,000
	1	LS	Miscellaneous Items	$ 200,000	$ 200,000
			MISC. APPURTENANCES SUBTOTAL		$ 789,981
			SUPERSTRUCTURE TOTAL (1)		$ 4,859,089
			SUBSTRUCTURE		
			PIERS OR ARCH RIBS		
	0	CY	Concrete - Piers & Tie Beam	$ 950	$ -
	535	CY	Concrete - Arch Ribs	$ 1,250	$ 669,319
	214,182	LB	Reinforcing - Black	$ 1.05	$ 224,891
	0	LB	Post-Tensioning Strand	$ 10	$ -
	10,000	LB	Post-Tensioning Bar	$ 10	$ 100,000
	20,592	SF	Concrete - Surface Treatments	$ 12	$ 247,104
			PIERS OR ARCH RIBS SUBTOTAL		$ 1,241,315
			PIER FOUNDATIONS		
	2	LS	Foundation Preparation - Cofferdam	$ 500,000	$ 1,000,000
	196	CY	Footing Concrete - Tremie Seal	$ 650	$ 127,111
	880	CY	Footing Concrete	$ 950	$ 836,000
	176,000	LB	Footing Reinforcing - Black	$ 1.05	$ 184,800
	960	FT	Drilled Shaft Furnished and Installed	$ 950	$ 912,000
			PIER FOUNDATIONS SUBTOTAL		$ 3,059,911
			ABUTMENT		
	7,400	CY	Excavation	$ 100	$ 740,000
	261	CY	Abutment Concrete	$ 950	$ 247,704
	52,148	LB	Abutment Reinforcing - Black	$ 1.05	$ 54,756
	8,400	SF	Concrete - Surface Treatments	$ 12	$ 100,800
	640	FT	Drilled Shaft Furnished and Installed	$ 950	$ 608,000
	6,600	SF	Temporary Walls	$ 50	$ 330,000
	8,400	SF	Permanent Walls (MSE)	$ 65	$ 546,000
			ABUTMENT SUBTOTAL		$ 2,627,259
			SUBSTRUCTURE TOTAL (2)		$ 6,928,485
			MAIN BRIDGE QUANTITIES SUBTOTAL (1+2)		$ 11,787,574
			MISC.		
	1	LS	Bridge Demolition	$ 1,400,000	$ 1,400,000
	1	LS	Mobilization (5%)	$ 589,379	$ 589,379
	1	LS	Architecture and Engineering Fees (15%)	$ 1,768,136	$ 1,768,136
	1	LS	Maintenance of Traffic (10%)	$ 1,178,757	$ 1,178,757
BASE BID. . . .					$ 16,723,846
Engineer's Estimate of Contingency (25%)					$ 2,946,894
Engineer's Estimate of Probable Cost					$ 19,670,740

Opinion of Probable Cost Estimate

Barton Springs Bridge - CIP 5873.031

Lou Neff Rd. to Azie Morton Rd.

Option 2 - Concrete Single Pier (New) - Bridge Only Const. Cost

URS 13640 Brunwick Drive Austin, Texas 78729 512.454.8797
TBPE Firm #3192 AN AECOM COMPANY

Base Bid:

Bid Item	Quantity	Unit	Item Description	Unit Price	Amount
			SUPERSTRUCTURE		
			GIRDER AND DECK		
	795	CY	Deck Concrete	$ 1,200	$ 953,923
	368	CY	Diaphragm Concrete	$ 1,000	$ 368,013
	290,737	LB	Reinforcing - Black	$ 1.05	$ 305,274
	1,880	FT	AASHTO Type IV - 72 Inch Depth	$ 350	$ 658,000
	82,849	LB	Post-Tensioning Strand	$ 10	$ 828,490
	42,800	LB	Post-Tensioning Bar	$ 10	$ 428,000
	159	CY	Approach Slabs	$ 800	$ 127,407
	4	EA	Temporary Works - Shoring Systems	$ 100,000	$ 400,000
			GIRDER AND DECK SUBTOTAL		$ 4,069,108
			MISC. APPURTENANCES		
	24,988	SF	Overlay	$ 9	$ 224,894
	219	FT	Expansion Joints	$ 250	$ 54,667
	940	FT	Barriers	$ 155	$ 145,700
	235	FT	Traffic Median	$ 160	$ 37,600
	32	EA	Bearings	$ 1,000	$ 32,000
	3,760	SF	Concrete - Surface Treatments	$ 12	$ 45,120
	1	LS	Period Light Fixtures and Conduits	$ 50,000	$ 50,000
	1	LS	Miscellaneous Items	$ 200,000	$ 200,000
			MISC. APPURTENANCES SUBTOTAL		$ 789,981
			SUPERSTRUCTURE TOTAL (1)		$ 4,859,089
			SUBSTRUCTURE		
			PIERS OR ARCH RIBS		
	352	CY	Concrete - Piers & Tie Beam	$ 950	$ 334,400
	0	CY	Concrete - Arch Ribs	$ 1,250	$ -
	140,800	LB	Reinforcing - Black	$ 1.05	$ 147,840
	0	LB	Post-Tensioning Strand	$ 10	$ -
	2,525	LB	Post-Tensioning Bar	$ 10	$ 25,254
	3,600	SF	Concrete - Surface Treatments	$ 12	$ 43,200
			PIERS OR ARCH RIBS SUBTOTAL		$ 550,694
			PIER FOUNDATIONS		
	0	LS	Foundation Preparation - Cofferdam	$ 500,000	$ -
	0	CY	Footing Concrete - Tremie Seal	$ 650	$ -
	455	CY	Footing Concrete	$ 950	$ 432,356
	91,022	LB	Footing Reinforcing - Black	$ 1.05	$ 95,573
	120	FT	Drilled Shaft Furnished and Installed	$ 3,300	$ 396,000
			PIER FOUNDATIONS SUBTOTAL		$ 923,929
			ABUTMENT		
	7,400	CY	Excavation	$ 100	$ 740,000
	261	CY	Abutment Concrete	$ 950	$ 247,704
	52,148	LB	Abutment Reinforcing - Black	$ 1.05	$ 54,756
	8,400	SF	Concrete - Surface Treatments	$ 12	$ 100,800
	640	FT	Drilled Shaft Furnished and Installed	$ 950	$ 608,000
	6,600	SF	Temporary Walls	$ 50	$ 330,000
	8,400	SF	Permanent Walls (MSE)	$ 65	$ 546,000
			ABUTMENT SUBTOTAL		$ 2,627,259
			SUBSTRUCTURE TOTAL (2)		$ 4,101,882
			MAIN BRIDGE QUANTITIES SUBTOTAL (1+2)		$ 8,960,971
			MISC.		
	1	LS	Bridge Demolition	$ 1,400,000	$ 1,400,000
	1	LS	Mobilization (5%)	$ 448,049	$ 448,049
	1	LS	Architecture and Engineering Fees (15%)	$ 1,344,146	$ 1,344,146
	1	LS	Maintenance of Traffic (10%)	$ 896,097	$ 896,097
BASE BID. . . .					$ 13,049,263
Engineer's Estimate of Contingency (25%)					$ 2,240,243
Engineer's Estimate of Probable Cost					$ 15,289,505

Opinion of Probable Cost Estimate

Barton Springs Bridge - CIP 5873.031

Lou Neff Rd. to Azie Morton Rd.

Option 3 - Concrete Dual Pier (New) - Bridge Only Const. Cost

URS
13640 Brunwick Drive
Austin, Texas 78729
512.454.8797
TBPE Firm #3192 AN AECOM COMPANY

Base Bid:

Bid Item	Quantity	Unit	Item Description	Unit Price	Amount
			SUPERSTRUCTURE		
			GIRDER AND DECK		
	795	CY	Deck Concrete	$ 1,200	$ 953,923
	368	CY	Diaphragm Concrete	$ 1,000	$ 368,013
	290,737	LB	Reinforcing - Black	$ 1.05	$ 305,274
	1,880	FT	AASHTO Type IV - 72 Inch Depth	$ 350	$ 658,000
	20,360	LB	Post-Tensioning Strand	$ 10	$ 203,602
	0	LB	Post-Tensioning Bar	$ 10	$ -
	159	CY	Approach Slabs	$ 800	$ 127,407
	2	EA	Temporary Works - Shoring Systems	$ 100,000	$ 200,000
			GIRDER AND DECK SUBTOTAL		$ 2,816,220
			MISC. APPURTENANCES		
	24,988	SF	Overlay	$ 9	$ 224,894
	219	FT	Expansion Joints	$ 250	$ 54,667
	940	FT	Barriers	$ 155	$ 145,700
	235	FT	Traffic Median	$ 160	$ 37,600
	48	EA	Bearings	$ 1,000	$ 48,000
	3,760	SF	Concrete - Surface Treatments	$ 12	$ 45,120
	1	LS	Period Light Fixtures and Conduits	$ 50,000	$ 50,000
	1	LS	Miscellaneous Items	$ 200,000	$ 200,000
			MISC. APPURTENANCES SUBTOTAL		$ 805,981
			SUPERSTRUCTURE TOTAL (1)		$ 3,622,201
			SUBSTRUCTURE		
			PIERS OR ARCH RIBS		
	263	CY	Concrete - Piers & Tie Beam	$ 950	$ 249,527
	0	CY	Concrete - Arch Ribs	$ 1,250	$ -
	105,064	LB	Reinforcing - Black	$ 1.05	$ 110,317
	0	LB	Post-Tensioning Strand	$ 10	$ -
	1,021	LB	Post-Tensioning Bar	$ 10	$ 10,206
	5,760	SF	Concrete - Surface Treatments	$ 12	$ 69,120
			PIERS OR ARCH RIBS SUBTOTAL		$ 439,170
			PIER FOUNDATIONS		
	0	LS	Foundation Preparation - Cofferdam	$ 500,000	$ -
	0	CY	Footing Concrete - Tremie Seal	$ 650	$ -
	0	CY	Footing Concrete	$ 950	$ -
	0	LB	Footing Reinforcing - Black	$ 1.05	$ -
	240	FT	Drilled Shaft Furnished and Installed	$ 3,000	$ 720,000
			PIER FOUNDATIONS SUBTOTAL		$ 720,000
			ABUTMENT		
	7,400	CY	Excavation	$ 100	$ 740,000
	261	CY	Abutment Concrete	$ 950	$ 247,704
	52,148	LB	Abutment Reinforcing - Black	$ 1.05	$ 54,756
	8,400	SF	Concrete - Surface Treatments	$ 12	$ 100,800
	640	FT	Drilled Shaft Furnished and Installed	$ 950	$ 608,000
	6,600	SF	Temporary Walls	$ 50	$ 330,000
	8,400	SF	Permanent Walls (MSE)	$ 65	$ 546,000
			ABUTMENT SUBTOTAL		$ 2,627,259
			SUBSTRUCTURE TOTAL (2)		$ 3,786,429
			MAIN BRIDGE QUANTITIES SUBTOTAL (1+2)		$ 7,408,631
			MISC.		
	1	LS	Bridge Demolition	$ 1,400,000	$ 1,400,000
	1	LS	Mobilization (5%)	$ 370,432	$ 370,432
	1	LS	Architecture and Engineering Fees (15%)	$ 1,111,295	$ 1,111,295
	1	LS	Maintenance of Traffic (10%)	$ 740,863	$ 740,863
BASE BID. . . .					$ 11,031,220
Engineer's Estimate of Contingency (25%)					$ 1,852,158
Engineer's Estimate of Probable Cost					$ 12,883,377

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C-7 – Geotechnical Data Report

GEOTECHNICAL DATA REPORT

BARTON SPRINGS ROAD
BRIDGE AND ROADWAY IMPROVEMENTS
CIP ID NO. 5873.031
AUSTIN, TEXAS

AECOM

Austin, Texas

Balcones Geotechnical

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Submitted herewith is the Geotechnical Data Report (GDR) for the above referenced project. In brief, this report presents the results of the field investigation, laboratory testing, and discussion of area geology, site and subsurface conditions based on geotechnical data collected for this project.

The findings and recommendations for this study are being submitted in a multi-report format consisting of a Geotechnical Data Report (GDR) presented herein, and Geotechnical Design Memoranda (GDM) to provide geotechnical recommendations for the bridge, retaining walls, and pavement design. The GDM will be submitted under separate cover, and as design progresses.

Balcones Geotechnical, LLC (Balcones) appreciates the opportunity to provide these geotechnical services to the project team and looks forward to our continued association throughout final design and construction phases.

Sincerely,

BALCONES GEOTECHNICAL, LLC
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INTRODUCTION

The project will include bridge and roadway improvements to the existing Barton Springs Road bridge over Barton Creek, in Austin, Texas. The project site is located at the intersection of Barton Springs Road and Azie Morton Road, as shown on the Vicinity Map, Plate 1. Proposed project components will include:

- Widening and/or replacement of the existing Barton Springs Rd Bridge over Barton Creek with pedestrian access improvements.
- Adding a turn lane at Azie Morton Road with construction of retaining walls and stabilizing the hillside slope.
- Stream bank improvements and stabilization along Barton Creek at the bridge abutments and nearby pedestrian trail.

Selected site photographs of the bridge and existing retaining wall are below.

Photo 1 (2/18/2022) – Barton Springs Rd Bridge over Barton Creek, facing east

Photo 2 (2/18/2022) – Azie Morton Rd Retaining Wall, facing north

A Preliminary Geotechnical Investigation and Report was issued by Arias Geoprofessionals, dated March 20, 2018. The previous scope of work included drilling 3 borings and providing preliminary foundation recommendations for use in evaluating design alternatives for bridge improvement being considered at the time. Boring and laboratory data performed for that previous study are included in this report.

The following sections of this report include a discussion of authorization and scope; field and laboratory investigation procedures; and area geology, site and subsurface conditions. Geotechnical recommendations for the proposed improvements are being submitted under separate cover in a Geotechnical Design Memorandum (GDM) format.

AUTHORIZATION AND SCOPE

The geotechnical investigation was authorized by AECOM with issuance of Purchase Order No. 140460 dated January 11, 2022. The contract includes Attachment 1 which outlines the authorized and agreed upon scope of services.

The scope of the investigation included: 1) drilling 10 borings to determine subsurface conditions along the project alignment and for obtaining representative samples for laboratory testing; 2) laboratory testing to determine classification and index properties of site soils and rock, and 3) preparation of this Geotechnical Data Report (GDR). Geotechnical Design Memoranda (GDM) will be submitted under separate cover to provide geotechnical recommendations for bridge foundations, retaining walls and slope stabilization, and for pavements.

Field sampling and laboratory testing were conducted in general accordance with methods, procedures, and practices set forth by the American Society for Testing and Materials, latest version of Annual Book of ASTM Standards, where applicable.

FIELD INVESTIGATION

The field investigation consisted of drilling ten (10) borings, designated T-1 through T-5 for borings drilled along the pedestrian trail, and W-1 through W-5 for borings drilled along the proposed roadway retaining wall along Azie Morton Road. Approximate boring locations are shown on the Plan of Borings, presented on Plate 2.

The T-borings were drilled to depths of 40 to 60 ft below existing grade, and the W-borings were drilled to depths of 50 to 110 ft below existing grade. As mentioned previously, borings have been drilled in the vicinity of this project by Arias[1], and by Fugro[2]. The applicable borings are included in this report.

A summary of boring drilling information is presented in the following Table 1. Ground surface elevations (GSE) shown in the table and on the boring logs were estimated from the 1-ft contour ground surface information provided by the project team, and should be considered approximate. Latitude and Longitude GPS coordinates were obtained at the boring locations using a hand-held GPS device and should also be considered approximate.

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1 Geotechnical Investigation, Barton Springs Road Bridge Improvement Project, for AECOM by Arias Geoprofessionals, Report No. 2015-762 (March 20, 2018).

2 Geotechnical Investigation, Barton Springs Road Improvements, for City of Austin by Fugro South, Inc., Report No. 1001-2559 (June 14, 1999).

Table 1 – Boring Summary					
Boring No.	**GSE (ft)**	**Date Drilled**	**Depth Drilled**	**Latitude**	**Longitude**
T-1	452	4/8/2022	60	30.265115	-97.765769
T-2	452	4/6/2022	60	30.265278	-97.765510
T-3	450	4/28/2022	60	30.265081	-97.764473
T-4	436	4/13/2022	40	30.264782	-97.765302
T-5	436	4/12/2022	40	30.264630	-97.765602
W-1	461	4/26/2022	60	30.264663	-97.765098
W-2	462	4/26/2022	60	30.264563	-97.765272
W-3	462	4/19/2022	50	30.264424	-97.765476
W-4	502	5/3/2022	105	30.264232	-97.765057
W-5	503	5/5/2022	110	30.264122	-97.765169
Previous, Nearby Boring Data					
B-1	451.9	11/28/2017	60	10,069,509.6	3,107,010.1
B-2	449.1	11/27/2017	60	10,069,607.4	3,107,210.5
B-4	457.6	11/28/2017	65	10,069,402.7	3,107,435.1
FB-1	508	4/27/1999	95	30.264142	-97.764864

GSE – Ground Surface Elevation
B-1, B-2, B-4 from Arias 2018 Report (surveyed in Northing and Easting)
FB-1 from Fugro 1999 Report (Lat/Long estimated from report Plan of Borings)

Approximate boring locations for nearby borings B-1, B-2, B-4 and FB-1 are also shown on the Plan of Borings, Plate 2. Requested boring locations for this study were modified for drill rig access, utility clearance, and/or right of entry constraints. Also shown on Plate 2 are the previously-drilled borings by Arias (2018) on one previous boring drilled by Fugro (April 1999).

The borings were drilled with a track-mounted drilling rig equipped with 1) continuous flight augers for advancing the holes dry and recovering disturbed samples (ASTM D 1452), 2) seamless push tubes for obtaining relatively undisturbed soil samples of cohesive strata (ASTM D1587), 3) split-barrel samplers and drive weight assembly for obtaining representative samples and measuring the penetration resistance (N values) of non-cohesive soil strata (ASTM D1586), and 4) double-tube wireline core barrels equipped with diamond or carbide bits for obtaining NQ diameter rock cores (ASTM D 2113). Selected site photographs of the Acker Rebel track drill rig used for this current investigation are shown on the following page.

Photo 3 (4/19/2022) – Drilling W-3

Photo 4 (5/3/2022) – Drilling W-5

Detailed descriptions of subsurface materials encountered at the boring locations are presented on the Logs of Borings included in Appendix A. Photographs of rock core samples for the borings are also included in Appendix A, following the respective boring log. Keys to Terms and Symbols used on the logs are also set forth in Appendix A following the boring logs. A Generalized Subsurface Profile for the project borings is provided on Plate 3.

Pocket penetrometer values in tons per square foot, and Standard Penetration Test N-values in blows per foot, and Core Recovery and Rock Quality Designation (RQD) values in percent (ASTM D6032), are shown on the logs of borings at the respective test depth. Groundwater and/or drilling fluid observations made during drilling are presented on the boring logs. Borings were backfilled with a mixture of auger cuttings and bentonite upon completion of drilling. Borings drilled in grassed areas were accessed using mats to protect vegetation and mature tree root zones, and included erosion control measure to control migration of sediment and fluids during drilling. Drilling spoils were drummed and disposed of off site.

Photo 5 (4/5/2022) – Mobilizing to T-2

Photo 6 (4/8/2022) – Demobilizing from T-1

LABORATORY INVESTIGATION

The laboratory testing program included classification and strength testing of soil and rock strata encountered in the borings. The testing included standard soil index and rock strength testing, advanced laboratory testing consisting of consolidated-undrained triaxial, direct shear, and pressure swell testing; and analytical testing. Results are presented in Appendix B and summarized in the following sections. Detailed descriptions of the test procedures are included in Appendix B, preceding the laboratory data.

Soil and Rock Testing

Soil classification tests, including Atterberg limit determinations (ASTM D4318), partial grain-size analyses (ASTM D422), and moisture content (ASTM D2216), were conducted on representative samples of the soil strata.

Unconfined compression (UC) (ASTM D7012) and unconsolidated-undrained triaxial compression (UU) (ASTM D2850) testing was conducted on representative samples of limestone and clayshale, respectively, to evaluate the compressive strength of the subsurface strata.

The results of these tests are tabulated on the boring logs at the sample recovery depths. Test results are presented in the Summary of Laboratory testing table included in Appendix B. Grain size curves are presented in Appendix B-1.

Advanced Lab Testing

Advanced testing was performed on representative samples of clay, clayshale and limestone to characterize undrained and drained shear strengths for global stability analyses of the proposed retaining wall system. The test samples were selected by Balcones and testing was performed by TRI Environmental. The advanced testing included:

- Pressure Swell (ASTM D4546)
- Direct Shear (ASTM D3080)
- Consolidated Undrained (CU) Triaxial Compression with pore-pressure measurements (ASTM D4767) (remolded samples)

Individual test results are in Appendices B-2 through B-4 and are summarized in the following subsections, which include a brief description of the test procedure.

Pressure Swell (ASTM D4546, Modified). One pressure swell test was conducted on a relatively undisturbed sample of clayshale obtained from the boring W-4. The sample tested was approximately 2 inches in diameter and about 1 inch in height. In this test method, a soil specimen is restrained laterally and axially drained while subjected to an applied vertical loading. Initially, the sample is inundated with water and load is applied to maintain zero change in height, referred to as the "swell pressure." Once the swell pressure is determined, the load is removed in increments, and the resulting change in height (swell) versus load is measured and plotted. Pressure Swell test results are presented in Appendix B-2 and summarized below.

Table 2 – Pressure Swell Test Results

Boring No.	Sample Depth	Sample Description	Swell Pressure (psf)	Void Ratio (e_0)	Free Swell (%)
W-4	56 – 57	Dark gray to brownish gray Clayshale (Del Rio)	340	0.418	1.3%

Direct Shear Test of Soil (ASTM D 3080). Strength characteristics were evaluated by consolidated-drained direct shear tests on relatively undisturbed samples. The test samples were one-inch in height, and a single specimen was tested for each consolidating normal stress. The resulting strain was limited for the first two normal stress increments, and residual strains were allowed in the last load increment. After a normal load is applied and primary consolidation is complete, the sample is sheared in a horizontal direction until failure. The shear strain, based on consolidation properties, is slow enough to inhibit excess pore water pressure during shear. Drainage is allowed through both the top and bottom of the sample. The interpreted effective friction angle and cohesion intercept (ϕ', c') are summarized in the table below. The results are presented in Appendix B-3.

Table 3 – Direct Shear Test Results

Boring No.	Sample Depth	Sample Description	Effective Cohesion, c' (psf)	Effective Friction Angle, ϕ'
W-4	38	Brownish gray Clayshale (Del Rio)	3,670	13.1°
W-4	58	Dark gray Clayshale (Del Rio)	450	14.9°
W-4	74	Dark gray Clayshale (Del Rio)	650	24.2°
W-5	37	Brownish gray Clayshale (Del Rio)	560(1)	17.8°(1)
W-5	53	Brownish gray to dark gray Clayshale (Del Rio)	446(1)	20.3°(1)
W-5	69	Dark gray Clayshale (Del Rio)	40	30.8°

(1) Use 0.25" deflection criteria

Consolidated Undrained Triaxial Compression Test of Soil (ASTM D 4767). Two multi-specimen consolidated-undrained (CU) triaxial test with pore pressure measurements (ASTM D4767) were conducted on representative samples of Del Rio Clay. Samples were remolded from the split-spoon samples at a specified density and moisture content. The samples were tested at three different confining pressures to determine the Mohr-Coulomb strength envelope.

In the consolidated-undrained (CU) triaxial compression tests performed using remolded split-spoon samples for this project, 2-inch diameter by 4¼-inch long specimens were loaded into a triaxial test chamber, seated, and backpressure saturated. Pore water pressure measurements are made until the sample is saturated (zero air voids). Following backpressure saturation, the sample is subjected to a selected confining pressure and allowed to consolidate. Once the sample sufficiently consolidates, the sample is sheared and generated pore water pressures are measured. The load applied (stress) and the sample deformation (strain) is measured.

From the resulting stress vs. strain and pore water measurements at three different confining pressures, the following strength parameters can be deduced: total stress friction angle (ϕ), effective stress friction angle (ϕ'), total stress cohesion intercept ©, and effective stress cohesion intercept (c'). The CU triaxial test results are included in Appendix B-4. The reported c and ϕ values were obtained from the Mohr-Coulomb slope intercept data reduction technique and checked using stress paths.

Table 4 – CU Triaxial w/ Pore-Pressure Test Results (Remolded)

Boring No. Depth	Sample Description	Total Stress Parameters		Effective Stress Parameters	
		Cohesion, c (psf)	Friction Angle, ϕ	Cohesion, c' (psf)	Friction Angle, ϕ'
W-1 Composite (23.5 – 25 ft) (28.5 – 30 ft) (33.5 – 35 ft)	Gray Fat Clay (Del Rio)	860	11.7	400	18.9
W-2 Composite (7 – 8.5 ft) (9 – 10.5 ft) (13.5 – 15 ft) (18.5 – 20 ft)	Light brown to gray Fat Clay (Del Rio)	460	17.8	385	18.6

Shear Strength Data Reduction. Shear strengths can be characterized via direct shear testing on undisturbed samples from W-4 and W-5, and via CU testing on remolded samples from W-1 and W-2. Tests on undisturbed samples can provide information on the peak and residual (large-displacement) drained shear strength envelopes, whereas tests on remolded samples can provide information on the fully-softened shear strength envelope. The fully-softened shear strength (FSSS) is typically associated with repeated wetting and drying cycles in expansive clay, which can lead to gradual remolding of the soil structure and strength loss relative to peak values, but without the large shearing strains associated with residual or large-displacement strengths. Further background on the fully-softened shear strength can be found in Wright (2005) and Wright et al. (2007).

Analytical Testing

Analytical testing was conducted on one representative retained clayshale sample. The testing included: soluble sulfate content tests (ASTM D516), soluble chloride (ASTM D512), pH (ASTM G51), and box resistivity (ASTM G57). The results are presented in Appendix B-5 and summarized in the following table. Analytical test procedures are presented at the end of Appendix B.

Table 5 – Analytical Test Results

Boring No.	Sample Depth	Sample Description	Resistivity (ohm-cm)	pH	Sulfate Content (ppm)	Chloride Content (ppm)
W-4	25	Brownish gray Clayshale (Del Rio)	3.80E+02	6.59	7,600	150

SITE AND SUBSURFACE CONDITIONS

Physiography

The project bridge site is located over Barton Creek and along a 200-ft section Azie Morton Road, at its intersection with Barton Springs Road. Currently, the site is an active urban roadway with numerous pedestrian amenities. The USGS Topographic Map of the site is presented on Plate 4.

The existing bridge is about 200 ft in length and spans over Barton Creek. The confluence with the Colorado River is about 1,500 ft northeast of the project site. Due to the impoundment of the Colorado River forming Lady Bird Lake, backwater conditions are created at the Barton Springs Road site, where a normal pool of about El. 430 ft is maintained year-round.

Azie Morton Road. The improvements along Azie Morton Road will consist of a retaining wall to replace an existing timber tie wall along the east side of the roadway intersection near Barton Springs Road. The slope is approximately 40 ft tall, and includes structures at the top of the slope associated with the Umlauf Sculpture Garden and Museum. The retaining wall will also serve to keep boulders present at the top of the slope from falling onto Azie Morton Road.

Slope improvements may also be required along the west side of Azie Morton Road along the boundary with the Pedestrian Trail and Barton Creek. Ground surface elevations along this portion of the project generally range from about El. 462 ft along the roadway to about El. 435 ft along the pedestrian trail along the bank of Barton Creek.

West Bridge Approach. The west bridge approach is relatively flat with approximate ground surface elevations of El. 455 to 460 ft, with lower elevations near the creekbank. Pedestrian amenities, including a small pedestrian train known as Zilker Eagle, and associated track are located along the west bridge approach, extending beneath the existing bridge roadway. Photographs of the small train and track near boring T-2 are below.

Photos 7,8 (4/5/2022) – Zilker Eagle Train (small pedestrian train) and track beneath west bridge approach, near the boring T-2 location

Pedestrian Trail. The site conditions along the existing Barton Creek banks include an active pedestrian trail. Some portions of the trail along the east bank (west side of Azie Morton Road) are eroded, and include some structurally suspended components. The same is true along the west side of the creek. Selected site photographs of the trail along the east and west banks are shown on the following page.

Photo 9 (2/18/2022) – Pedestrian Trail beneath east bridge abutment, facing north

Photo 10 (2/18/2022) – Pedestrian Trail beneath west bridge abutment, facing north

Geology

According to published geologic mapping[3] and area boring data, the project alignment is mapped as being underlain by alluvium and Lower Colorado River and Tributary terrace deposits, further underlain by Del Rio Clay and Clayshale and Georgetown Limestone. Buda Limestone is also mapped at the upper elevations of the project site. A Geologic Map is presented on Plate 5. A Stratigraphic Column of the Austin Area[4] is presented on Plate 6. A brief description of the geologic formations encountered in this investigation, in order of youngest to oldest, is provided in the following subsections.

Alluvium, Terrace Deposits. Alluvium (Qal) and Terrace Deposits (Qlcr, Lower Colorado River; Qucr, Upper Colorado River; Qtt Terrace deposits) are sediments deposited by flowing water, likely the Colorado River and Barton Creek. The alluvium (Qal) is relatively more recent Holocene-era, while the Terrace deposits (Qlcr, Qucr, Qtt) are relatively older Pleistocene-era, both of the Quaternary epoch.

The deposits consist of various proportions of clay, silt, sand, and gravel, which typically coarsen in grainsize with depth. Some cobbles or boulders may be present in the lower portions of the Terrace deposits, associated with larger water bodies and more energy to carry large sediments. Sand and gravel lenses and layers, and cobbles, may be present at erratic locations

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3 Garner, L.E. and Young, K.P. (1976), "Environmental Geology of the Austin Area: An Aid to Urban Planning," Report of Investigation No. 86, Bureau of Economic Geology, The University of Texas at Austin, Plate VII (reprinted 1992).

4 Garner, L.E., "Environmental Geology of the Austin Area," M.A. Thesis, The University of Texas at Austin (1973).

within the fine-grained strata due to the depositional nature of alluvium. The contact with the underlying bedrock is erosional in nature and can vary by several feet in short distances.

It should be noted that, in general, it is difficult to discern the younger alluvial soils from older terrace deposits due to the similarity in composition and origin. Accordingly, no distinction was made on the boring logs regarding alluvium or terrace deposits and the stratum is referred to as alluvium.

Buda Formation. The Buda formation (Kbu) consists of an upper hard, resistant, fine grained, burrowed, glauconitic, shell-fragment limestone and a lower marly, nodular, and less resistant limestone. The Buda limestone is colored with shades of tan to orange-brown that resemble discoloration caused by heating. The Buda limestone is typically 35 to 40 ft thick in the downtown Austin area.

Del Rio Formation. The Del Rio formation (Kdr), when unweathered, is composed mostly of dark olive gray, greenish gray, to bluish gray, pyritic, selenitic, gypsiferous clayshale often with a few thin siltstone or sandstone beds near the top. The ram's horn oyster Exogyra Arietina, characteristic of the Del Rio formation and particularly abundant in the lower part, is the index fossil. The formation is commonly very stiff to hard, calcareous and occasionally thinly laminated. The Del Rio/Georgetown contact is abrupt at some locations and transitional in others with a transition zone of shaly limestones. With weathering, the Del Rio becomes tan and fissured. During the weathering process, large quantities of the illite clay mineral alter to montmorillonite, thereby significantly increasing the swelling potential.

The Del Rio clay and clayshale is a much weaker formation than the overlying Buda, and is highly plastic with a very high shrink/swell potential if subjected to moisture changes. The Del Rio Clay and Clayshale formation is on the order of 70 ft thick in the Austin area.

Georgetown Formation. The Georgetown formation (Kgt) consists of thin interbeds of gray to tan, richly fossiliferous, nodular, fine-grained, limestone and shaly limestone. The thickness of the unit in the Austin area is generally about 55 ft but varies from 40 to 60 ft. Small quantities of naturally occurring liquid and tarry hydrocarbons are found throughout the formation. The Edwards limestone formation (Ked) underlies the Georgetown limestone; however, the borings did not encounter Edwards limestone. Surface outcropping of Edwards limestone is mapped in the vicinity of the project site.

Stratigraphy and Engineering Properties

Subsurface conditions can best be understood by a thorough review of the boring logs included in Appendix A, and the Generalized Subsurface Profile presented on Plate 3. In general, the borings encountered alluvium, Del Rio clay and clayshale, Georgetown limestone, and Buda limestone.

A discussion of subsurface conditions and engineering properties for the Bridge/Structure borings and the Retaining Wall borings are presented in the following subsections. Measured pavement thicknesses at the boring locations are also summarized in the following subsections.

Bridge/Structure Borings. Borings T-1 through T-5, and previous Arias Borings B-1, B-2, and B-4 were drilled to depths 40 to 65 ft below existing grade. In general, the borings encountered alluvium over Georgetown limestone. Borings T-4, T-5, and B-2 encountered some thickness of Del Rio clay beneath the alluvium and above Georgetown limestone. A summary of engineering properties of the soil and rock encountered in the borings is given in the following Table 6.

Table 6 – Engineering Properties – Bridge / Structure Borings

Stratum	Contact Elevation	Description	Index / REC, RQD		Compressive Strength
Alluvium	Thickness: 6 to 42 ft (Avg 27 ft)	Dark brown to brown, gray, and reddish brown clay (CL, CH), clayey sand (SC), sand (SP-SC, SP), clayey gravel (GC), well-graded gravel (GW)	PI: 6 to 33 (Avg 17)	-200: 3 to 83 (Avg 47)	---
Del Rio Clay (Borings T-4, T-5, B-2)	Contact El: 430 to 434 ft	Dark gray to reddish brown to gray CLAY, (CL, CH), w/silt seams and sand partings	PI: 21 to 42 (Avg 32)	-200: 87 to 97 (Avg 90)	---
Georgetown Limestone	Contact El: 410 to 423 ft	Light gray to gray LIMESTONE, nodular, w/dark gray weathered clay seams and layers, and fossils	REC: 80 to 100 (Avg 98)	RQD: 41 to 100 (Avg 79)	UC: 86 to 539 tsf (Avg 193 tsf)

Retaining Wall Borings. Borings W-1 through W-5 and previous Fugro Boring FB-1 were drilled to depths 50 to 110 ft below existing grade. In general, the borings encountered Del Rio clay and clayshale over Georgetown limestone. Some alluvial and/or fill material was encountered in boring W-3 above the Del Rio clay. Borings W-4, W-5, and FB-1 were drilled at the top of the hill (Umlauf Sculpture Garden and Museum property) and encountered Buda limestone over Del Rio clay and clayshale, further underlain by Georgetown limestone. A summary of engineering properties of the soil and rock encountered in the retaining wall borings is given in the following table.

Table 7 – Engineering Properties – Retaining Wall Borings

Stratum	Contact Elevation	Description	Index		Compressive Strength
Alluvium (Boring W-3)	Thickness: 6 ft	Brown to reddish brown, clayey gravel (GC)	---	---	---
Buda Limestone (Borings W-4, W-5, B-1)	Thickness: 18 to 30 ft (Avg 24 ft)	Tan LIMESTONE, w/soft, highly weathered seams and layers	REC: 40 to 100 (Avg 89)	RQD: 0 to 87 (Avg 29)	UC: 42 to 347 tsf (Avg 216 tsf)
Del Rio Clay (Borings W-1, W-2, W-3, B-1)	Thickness: 11 to 33 ft (Avg 26 ft)	Light brown to gray to dark greenish gray fat clay (CH), w/sand and selenite seams	PI: 29 to 47 (Avg 39) REC: 45 and 80	Minus 200: 77 to 95 (Avg 88) RQD: 0 and 80	UU: 7 and 8 tsf
Del Rio Clayshale	Contact El: 426 to 485 ft	Dark gray to light gray to brownish gray to greenish gray CLAYSHALE, slightly fissile, w/selenite seams	PI: 23 to 39 (Avg 34) REC: 13 to 100 (Avg 95)	Minus 200: 90 to 99 (Avg 95) RQD: 0 to 100 (Avg 77)	UC: 6 to 27 tsf (Avg 14 tsf) UU: 3 to 16 tsf (Avg 6 tsf)
Georgetown Limestone	Contact El: 417 to 423 ft	Light gray to gray LIMESTONE, nodular, w/dark gray weathered clay seams and layers, and fossils	REC: 95 to 100 (Avg 99)	RQD: 57 to 100 (Avg 92)	UC: 30 to 359 tsf (Avg 182 tsf)

Pavements. Borings W-1, W-2 and W-3 encountered concrete and asphalt pavements. Trail borings T-4 and T-5 encountered sidewalk pavement. Pavement thicknesses measured at the boring locations are shown on the boring logs and summarized in the table below.

Table 8 – Existing Pavement Thickness

Boring No.	Pavement Thickness	Base Thickness
T-4	18" Concrete	6"
T-5	14" Concrete	6"
W-1	11.5" Concrete 5" Asphalt	8"
W-2	12.5" Concrete 4" Asphalt	8"
W-3	7" Asphalt	8"

Groundwater

Groundwater was encountered in 6 of the 10 project borings at the time of drilling, at depths of 10 to 30 ft (average 19 ft) below existing grade with corresponding elevations of El. 425 to El. 431 (average El. 428.4) feet. A summary of groundwater measurements is presented in the following Table 9.

Table 9 – Groundwater Summary

Boring No.	GSE (ft)	Drill Date	GW Depth, ft	GW Elevation, ft
T-1	452	4/8/2022	22.0	430
T-2	452	4/6/2022	23.0	429
T-3	450	4/28/2022	20.5	429.5
T-4	436	4/13/2022	11.0	425
T-5	436	4/12/2022	10.0	426
W-1	461	4/26/2022	30.0	431
W-2	462	4/26/2022	---	---
W-3	462	4/19/2022	---	---
W-4	502	5/3/2022	---	---
W-5	503	5/5/2022	---	---

GSE – Ground Surface Elevation GW – Groundwater
"---" None Encountered

For the borings drilled in the Barton Creek floodplain, groundwater will likely be present in the upper Alluvium or Del Rio clay soil strata, perched atop the underlying less pervious Del Rio clayshale and Georgetown limestone. For borings W-2 through W-5, groundwater was not encountered before wet rotary coring was initiated in the borings. Groundwater may have been present but not detected during drilling.

Groundwater conditions are based on antecedent rainfall conditions and proximity to surface waters (Barton Creek) and may be different at the time of construction. Excavations through alluvial soils can expect to encounter groundwater at approximate elevation El. 430± ft or higher due to the normal pool maintained at Barton Creek.

CONDITIONS

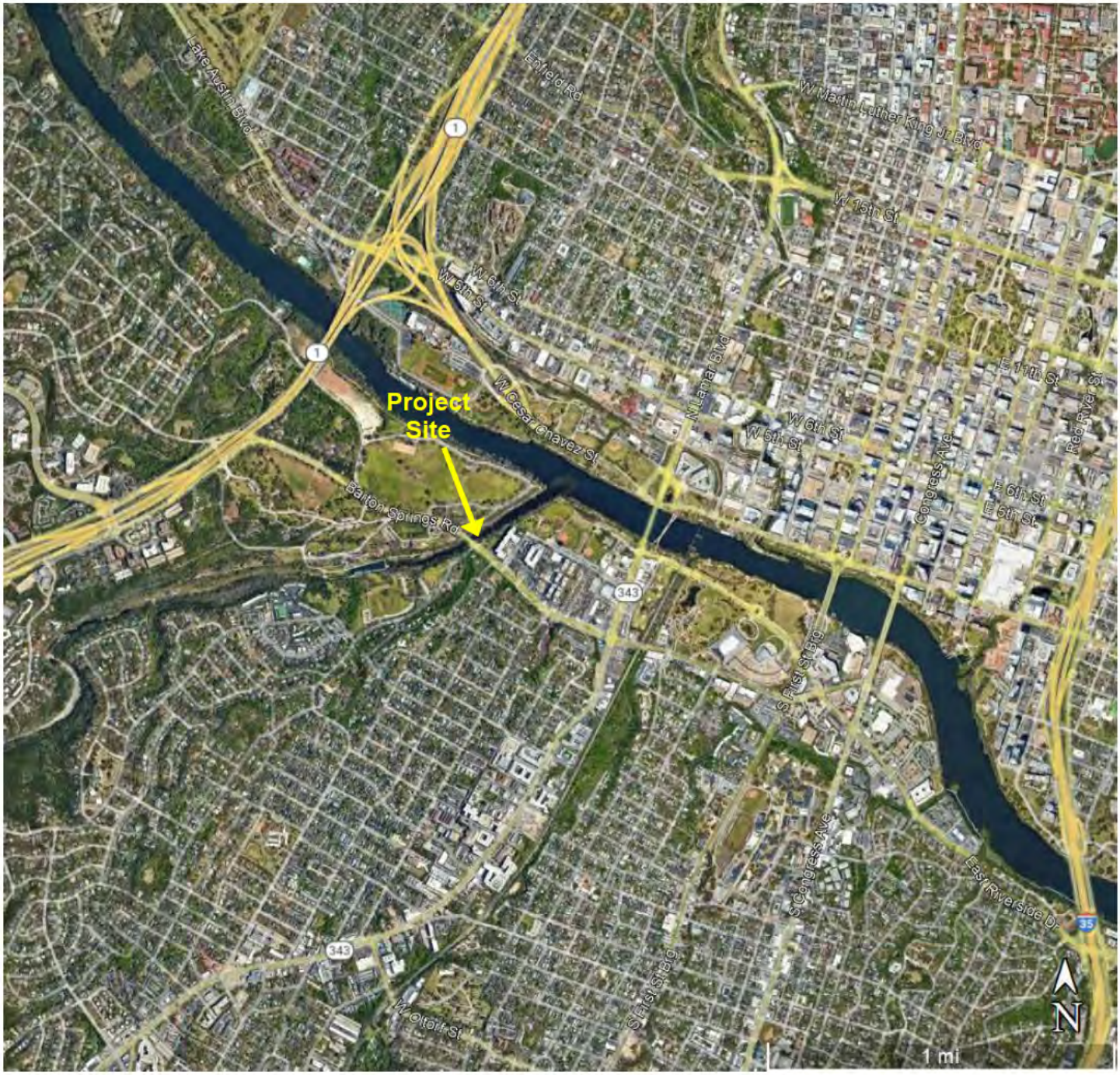
Since some variation was found in subsurface conditions at boring locations, all parties involved should take notice that even more variation may be encountered between boring locations. Statements in the report as to subsurface variation over given areas are intended only as estimations from the data obtained at specific boring locations.

The professional services that form the basis for this report have been performed using that degree of care and skill ordinarily exercised, under similar circumstances, by reputable geotechnical engineers practicing in the same locality. No other warranty, expressed or implied, is made as the professional advice set forth. The results contained in this report are directed at, and intended to be utilized within, the scope of work contained in the agreement executed by Balcones Geotechnical, LLC and client. This report is not intended to be used for any other purposes.

* * *

PLATES

Project No. 0121-014



Source: Google Earth Professional, aerial imagery dated 3/22/2022

VICINITY MAP

Barton Springs Road Bridge Improvements
Austin, Texas

Balcones Geotechnical

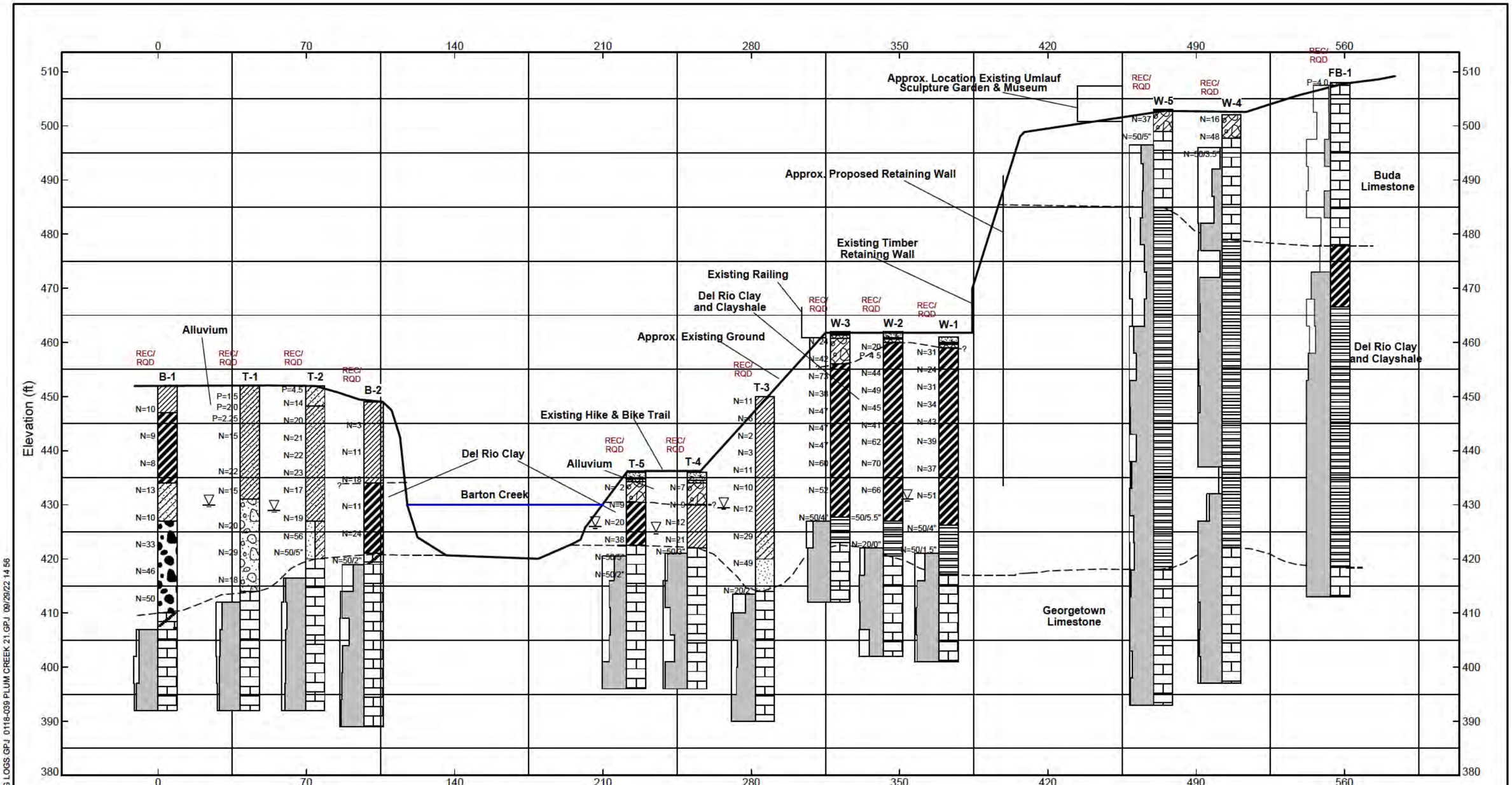
Plate 1

Source: Google Earth Professional, aerial imagery dated 3/25/2022

BORING LOCATION PLAN

Barton Springs Road Bridge Improvements
Austin, Texas

Balcones Geotechnical



Borings have been offset for clarity, scale is approximate

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LITHOLOGY GRAPHICS

Lean Clay	Fat Clay	Clayey Sand	Well-graded Gravel	Weathered Limestone
Limestone	Fill (made ground)	Shale	Sandy Lean Clay	Poorly-graded Sandy Gravel
Poorly-graded Sand with Clay	Poorly-graded Sand	Concrete	Clayey Gravel	Asphalt

GENERALIZED SUBSURFACE PROFILE

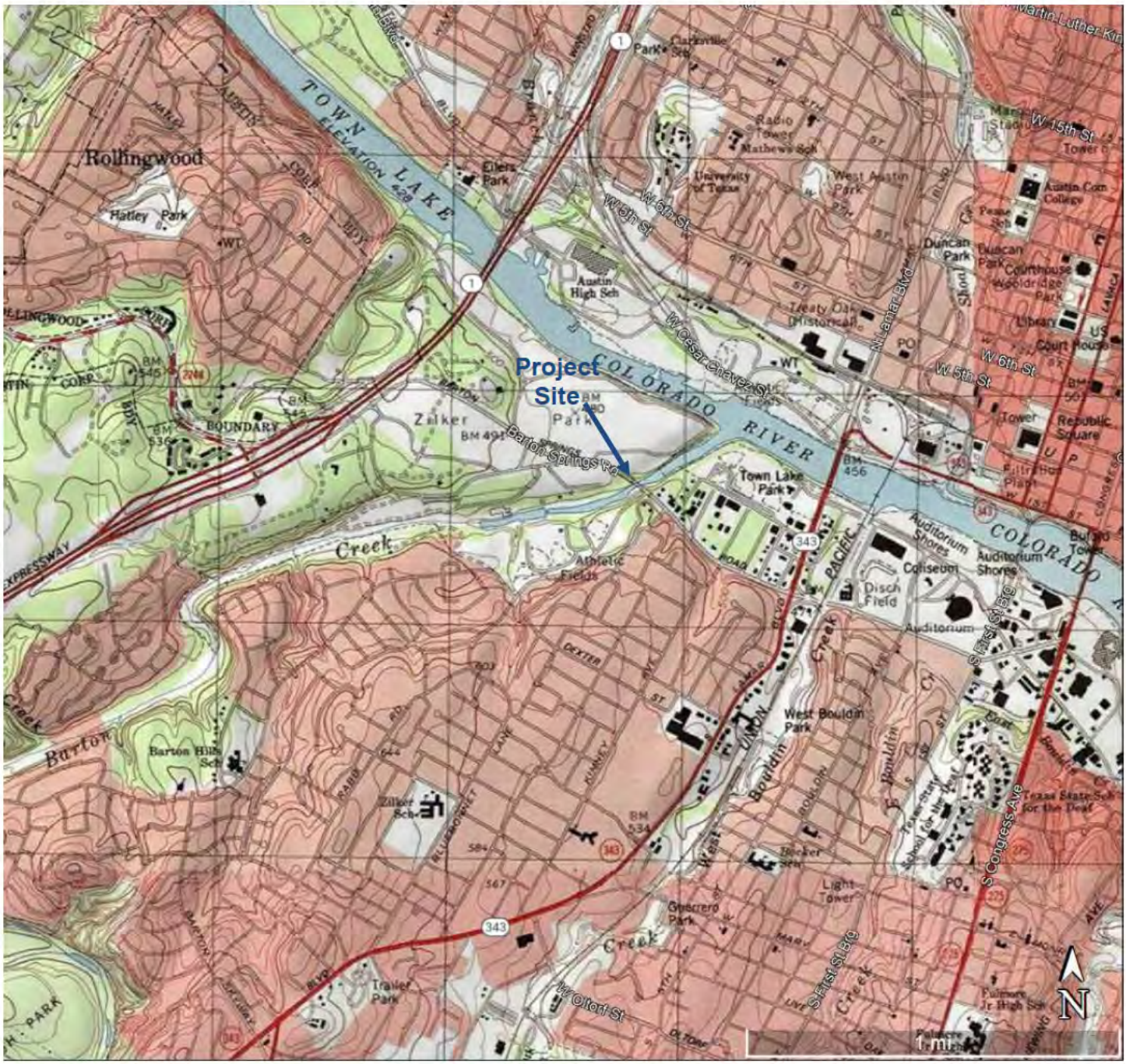
Project: Barton Springs Road Bridge Improvements

Location: Austin, Texas

Number: 0121-014

Plate 3

S MPLE FENCE - 11X17 PLUM 0121-014 BOR NG LOGS.GPJ 0118-039 PLUM CREEK 21.GPJ 09/29/22 14 56



Source: Earth Point Topo USGS Topographic Quadrangles, superimposed into Google Earth Professional

USGS TOPOGRAPHIC MAP

Barton Springs Road Bridge Improvements
Austin, Texas

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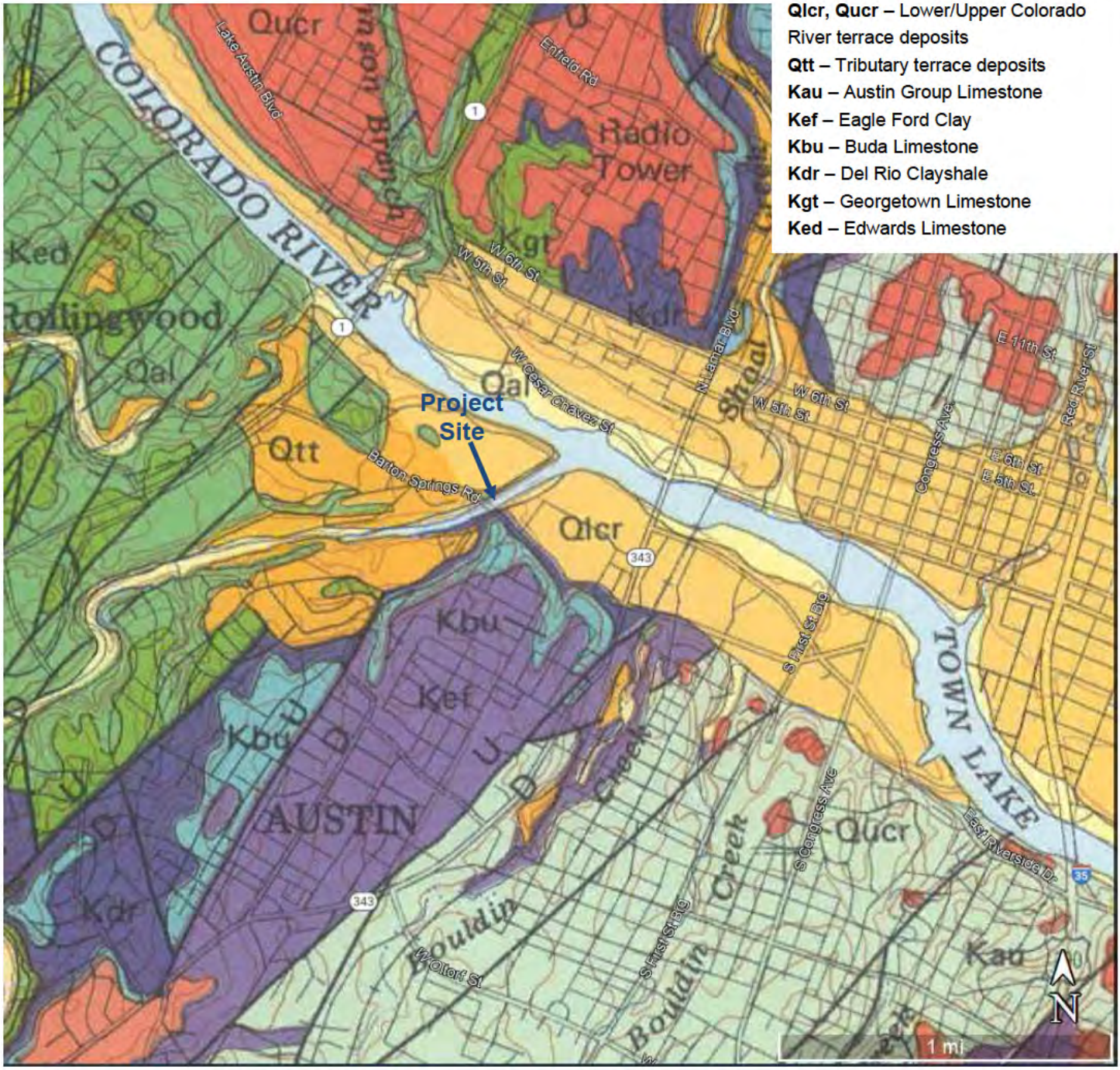
Project No. 0121-014

LEGEND (Youngest to Oldest)

Qal – Alluvium
Qlcr, Qucr – Lower/Upper Colorado River terrace deposits
Qtt – Tributary terrace deposits
Kau – Austin Group Limestone
Kef – Eagle Ford Clay
Kbu – Buda Limestone
Kdr – Del Rio Clayshale
Kgt – Georgetown Limestone
Ked – Edwards Limestone



Source: Garner and Young (1992). "Geologic Map of the Austin Area, Texas", superimposed into Google Earth Professional

GEOLOGIC MAP

Barton Springs Road Bridge Improvements
Austin, Texas

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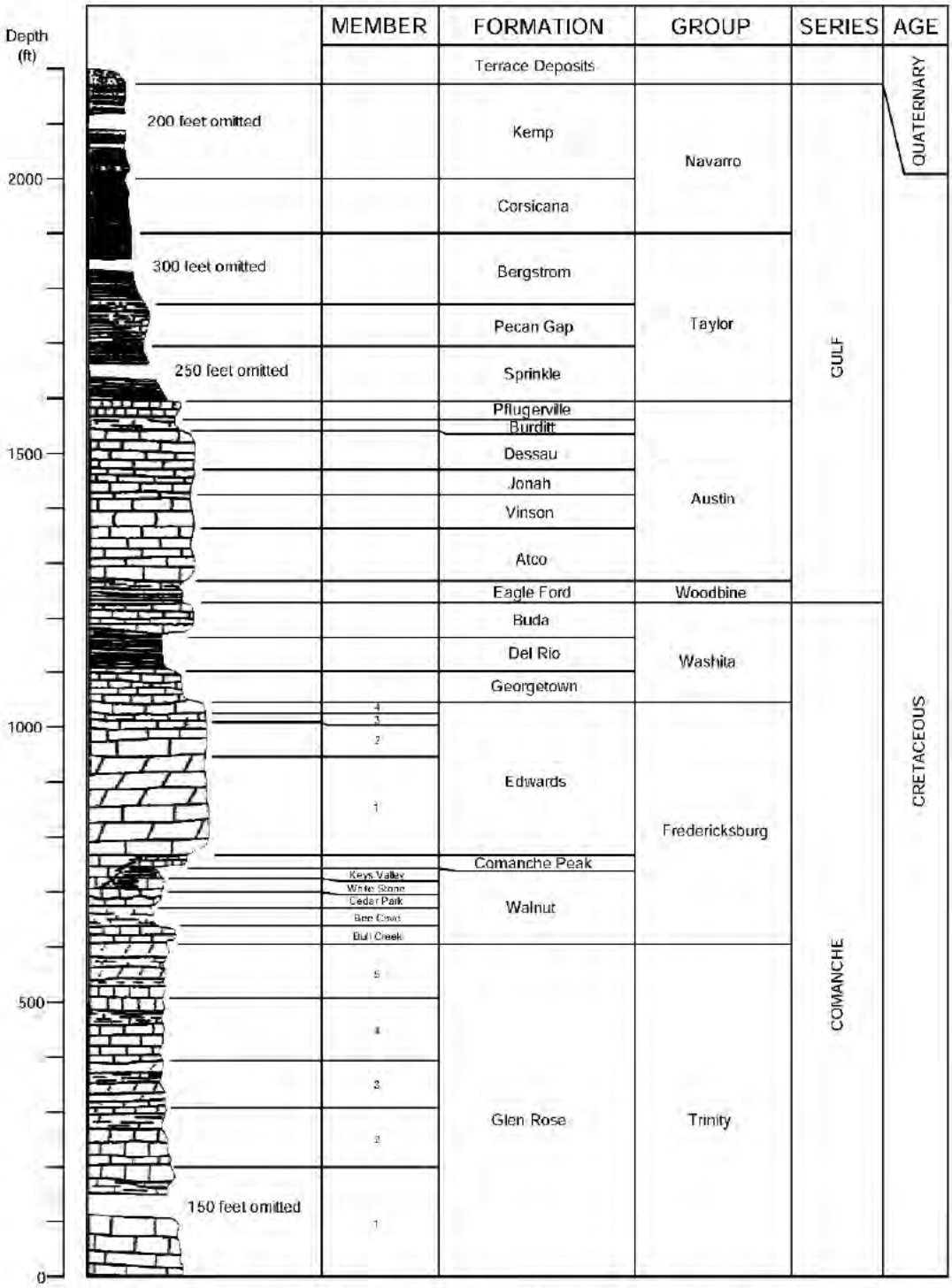
Plate 5



Source: L.E. Garner (1973) Master's thesis: Environmental Geology of the Austin Area

STRATIGRAPHIC COLUMN OF THE AUSTIN AREA

Barton Springs Road Bridge Improvements
Austin, Texas

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APPENDIX A – BORING LOGS

APPENDIX A-1 (Current Study)

Boring Logs and Core Photographs

Keys to Terms and Symbols

LOG OF BORING NO. T-1

LATITUDE: 30.265115
LONGITUDE: -97.765769

Barton Springs Road Bridge Improvements
Austin, Texas
PROJECT NO. 0121-014

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	COMPRESSIVE STRENGTH TSF
				SURF. ELEVATION: 452±								
			P=1.5	Dark brown to brown Sandy LEAN CLAY, stiff to very stiff, moist to wet, w/sand seams and scattered gravel. CL (Alluvium)								
				- clayey sand seams at 0 to 2 ft								
			P=2.0			18	33	16	100	60		
5			P=2.25									
10			N=6-6-9									
15			N=8-10-12									
20				*- less sand below 20 ft*	431.0	28	48	30	100	78		
			N=4-4-11	Brown GRAVEL with sand, medium dense, wet, w/trace clay. GP (Alluvium)	21.0							
25			N=5-7-13									
30			N=9-15-14			9			34	4		
35			N=21-9-9									
					414.0							
					38.0							

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COMPLETION DEPTH: 60.0
DATE DRILLED: 4-8-22
WATER LEVEL / SEEPAGE: 22.0
UPON COMPLETION:

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)
Q = Unconsolidated Undrained (tsf)

Plate 1a

BALCONES_STD4 0121-014 BORING LOGS.GPJ 06/30/22 19:13

LOG OF BORING NO. T-1

LATITUDE: 30.265115
LONGITUDE: -97.765769

Barton Springs Road Bridge Improvements
Austin, Texas
PROJECT NO. 0121-014

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	COMPRESSIVE STRENGTH TSF
				SURF. ELEVATION: 452±								
			REC=100 RQD=75	Light gray to gray LIMESTONE, moderately hard to hard, slightly to moderately weathered, slightly fractured, nodular, w/dark gray weathered clay seams and layers, fossils, and discontinuities. (Georgetown) *(continued)*		3					155	260(U)
45				*- multiple dark gray weathered clay seams and layers from 40.5 to 45 ft*								
			REC=100 RQD=85									
50												
			REC=98 RQD=87			4					150	116(U)
55				*- shallow inclined discontinuity at 55.2 ft*								
			REC=95 RQD=88									
60				*- moderately inclined discontinuity at 59.1 ft*	392.0 60.0							
65												
70												
75												

NOTES:
1. Boring advanced dry to 40 ft depth and groundwater encountered at depth of 22 ft below existing ground surface, and at 21.8 ft after 10 minutes.
2. On completion of drilling operation, hole noted open to 24 ft depth and water suface (drilling fluid) noted at 22 ft depth.

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COMPLETION DEPTH: 60.0
DATE DRILLED: 4-8-22
WATER LEVEL / SEEPAGE: 22.0
UPON COMPLETION:

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)
Q = Unconsolidated Undrained (tsf)

Plate 1b

SAMPLE PHOTOGRAPHS – T-1

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Austin, Texas

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SAMPLE PHOTOGRAPHS – T-1

Barton Springs Road Bridge Improvements
Austin, Texas

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LOG OF BORING NO. T-2

Barton Springs Road Bridge Improvements
Austin, Texas
PROJECT NO. 0121-014

LATITUDE: 30.265278
LONGITUDE: -97.765510

SURF. ELEVATION: 452±

DEPTH, FT	SAMPLES	POCKET PEN, tsf / Blows/ft. / REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	COMPRESSIVE STRENGTH TSF
		P=4.5	Dark brown to brown CLAYEY SAND with gravel, medium dense to dense, moist. SC (Alluvium)								
		N=7-7-7	*- push tube refusal at 1 ft*		6	27	11	76	42		
				448.2							
		N=15-10-10	Dark brown to brown Sandy LEAN CLAY, very stiff, moist, w/trace gravel. CL (Alluvium)	3.8							
5		N=7-9-12			13	38	22	96	69		
		N=8-11-11									
10		N=7-9-14									
15		N=5-8-9	*- less sand below 15 ft*		15	29	13	100	82		
20		N=8-10-9									
				427.0							
25		N=11-16-40	Brown to gray SAND with clay and gravel, very dense, wet, w/limestone and shell fragments. SP-SC (Alluvium)	25.0	10			59	7		
30		N=12-50/5									
				420.0							
35			Light gray to gray LIMESTONE, moderately hard to hard, slightly to moderately weathered, slightly fractured, nodular, w/dark gray weathered clay seams and layers, fossils, and discontinuities. (Georgetown)	32.0							
		REC=91 RQD=83	*- shaley seam at 38.5 ft*		4					151	109(U)

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COMPLETION DEPTH: 60.0
DATE DRILLED: 4-6-22
WATER LEVEL / SEEPAGE: 23.0
UPON COMPLETION:

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)
Q = Unconsolidated Undrained (tsf)

Plate 2a

BALCONES_STD4 0121-014 BORING LOGS.GPJ 06/30/22 19:13

LOG OF BORING NO. T-2

LATITUDE: 30.265278
LONGITUDE: -97.765510

Barton Springs Road Bridge Improvements
Austin, Texas
PROJECT NO. 0121-014

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	COMPRESSIVE STRENGTH TSF
				SURF. ELEVATION: 452±								
			REC=100 RQD=78	Light gray to gray LIMESTONE, moderately hard to hard, slightly to moderately weathered, slightly fractured, nodular, w/dark gray weathered clay seams and layers, fossils, and discontinuities. (Georgetown) *(continued)*								
45				*- 1 to 2 inch clay seams at 45.5, 46, and 46.5 ft*								
			REC=100 RQD=82			4					152	199(U)
50												
			REC=100 RQD=83									
55												
			REC=100 RQD=85	*- 5 inch shaley clay layer at 57 ft*								
				- healed moderately inclined discontinuity at 59.3 ft	392.0							
60					60.0							
65												
70												
75												

NOTES:
1. Boring advanced dry to 35.5 ft depth and groundwater encountered at depth of 23 ft below existing ground surface, and at 22.5 ft after 10 minutes.
2. On completion of drilling operation, hole noted open to 26 ft depth and water suface (drilling fluid) noted at 20.5 ft depth.

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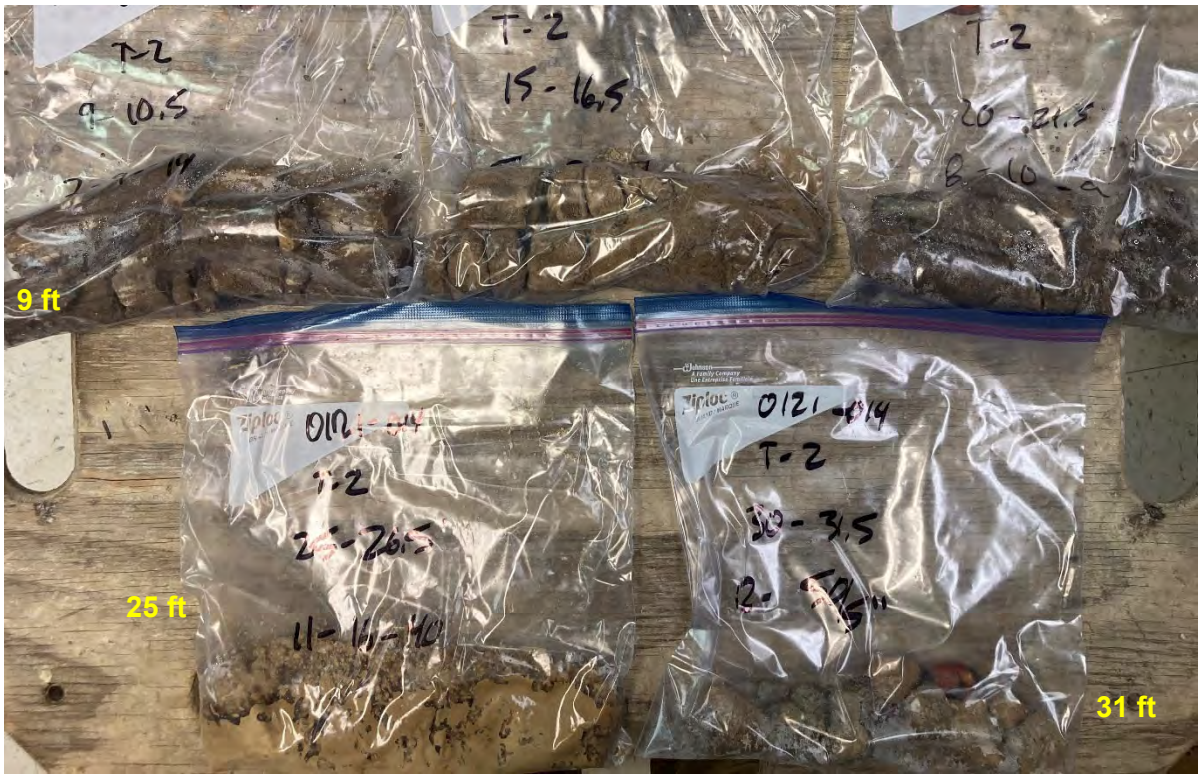
COMPLETION DEPTH: 60.0
DATE DRILLED: 4-6-22
WATER LEVEL / SEEPAGE: 23.0
UPON COMPLETION:

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)
Q = Unconsolidated Undrained (tsf)

Plate 2b



SAMPLE PHOTOGRAPHS – T-2

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SAMPLE PHOTOGRAPHS – T-2

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SAMPLE PHOTOGRAPHS – T-2

Barton Springs Road Bridge Improvements
Austin, Texas

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LOG OF BORING NO. T-3

LATITUDE: 30.265081
LONGITUDE: -97.764473

Barton Springs Road Bridge Improvements
Austin, Texas
PROJECT NO. 0121-014

SURF. ELEVATION: 450±

DEPTH, FT	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	COMPRESSIVE STRENGTH TSF
		N=2-4-7	Dark brown to tan to reddish brown LEAN CLAY with sand, very soft to stiff, moist to wet w/trace gravel. CL (Alluvium)								
		N=3-3-3									
		N=1-1-1			13	36	18	98	83		
5		N=WOH-1-2									
		N=4-5-6	- *sand seams below 8 ft*		13	35	18	100	64		
10											
15		N=2-4-6			20	30	11	100	72		
20		N=3-6-6									
				425.0							
25		N=6-8-21	Brown CLAYEY SAND with gravel, medium dense, wet. SC (Alluvium)	25.0	11			74	25		
				420.0							
30		N=9-9-40	Brown SAND with gravel, dense, wet. SP (Alluvium)	30.0	15			76	3		
35				414.0							
		N=4-8-20/2		36.0							
			- *dark gray clay seam at 37.5 ft*		5					148	281(U)
		REC=93 RQD=41									

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COMPLETION DEPTH: 60.0
DATE DRILLED: 4-28-22
WATER LEVEL / SEEPAGE: 20.5
UPON COMPLETION:

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)
Q = Unconsolidated Undrained (tsf)

Plate 3a

LOG OF BORING NO. T-3

LATITUDE: 30.265081
LONGITUDE: -97.764473

Barton Springs Road Bridge Improvements
Austin, Texas
PROJECT NO. 0121-014

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	COMPRESSIVE STRENGTH TSF
				SURF. ELEVATION: 450±								
			REC=100 RQD=90	Light gray to gray LIMESTONE, moderately hard to hard, slightly to moderately weathered, slightly to moderately fractured, nodular, w/dark gray weathered clay seams and layers, fossils, and discontinuities. (Georgetown) *(continued)*								
45				*- clay layer at 40 ft*								
			REC=100 RQD=73	*- shallow inclined discontinuity w/slickensides at 46.3 ft*		3					156	212(U)
				- multiple dark gray clay seams from 38 to 39 ft								
50				*- shallow inclined discontinuity w/slickensides at 50 ft*								
			REC=100 RQD=78									
55												
			REC=100 RQD=100			4					153	188(U)
					390.0							
60					60.0							
				NOTES: 1. Boring advanced dry to 37.5 ft depth and groundwater encountered at depth of 20.5 ft below existing ground surface, and at 21 ft after 10 minutes. 2. On completion of drilling operation, water suface (drilling fluid) noted at 21.5 ft depth and then hole caved-in at 17 ft depth.								
65												
70												
75												

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COMPLETION DEPTH: 60.0
DATE DRILLED: 4-28-22
WATER LEVEL / SEEPAGE: 20.5
UPON COMPLETION:

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)
Q = Unconsolidated Undrained (tsf)

Plate 3b

BALCONES_STD4 0121-014 BORING LOGS.GPJ 06/30/22 19:13

SAMPLE PHOTOGRAPHS – T-3

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Austin, Texas

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SAMPLE PHOTOGRAPHS – T-3

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SAMPLE PHOTOGRAPHS – T-3

Barton Springs Road Bridge Improvements
Austin, Texas

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LOG OF BORING NO. T-4

LATITUDE: 30.264782
LONGITUDE: -97.765302

Barton Springs Road Bridge Improvements
Austin, Texas
PROJECT NO. 0121-014

SURF. ELEVATION: 436±

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	COMPRESSIVE STRENGTH TSF
				18" Concrete, 6" Base Material	434.5							
					1.5							
			N=3-3-4	Brown CLAYEY GRAVEL with sand, loose, moist. GC (Alluvium)	434.0							
					2.0	7	32	17	52	20		
5			N=4-5-4		430.0							
			N=3-4-8	Gray to reddish brown LEAN CLAY, stiff to hard, moist to wet, w/sand. CL (Del Rio)	6.0							
			N=4-8-13									
10												
					422.0	14	36	21	100	87		
			N=30-50/3	Light gray to gray LIMESTONE, moderately hard to hard, slightly to moderately weathered, slightly to moderately fractured, nodular, w/dark gray weathered clay seams and layers, fossils, and discontinuities. (Georgetown)	14.0							
15			REC=93 RQD=83			4					159	165(U)
20			REC=100 RQD=93									
25			REC=100 RQD=72	- *clay-infilled burrow at 27.5 ft*		3					156	320(U)
30			REC=100 RQD=53	- *multiple dark gray clay seams and layers from 29.5 to 30.5 ft* - *multiple clay-infilled shallow inclined discontinuities from 31 to 33.5 ft*		3					154	217(U)
35			REC=100 RQD=93		396.0	4					153	86(U)

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COMPLETION DEPTH: 40.0
DATE DRILLED: 4-13-22
WATER LEVEL / SEEPAGE: 11.0
UPON COMPLETION:

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)
Q = Unconsolidated Undrained (tsf)

Plate 4a

LOG OF BORING NO. T-4

LATITUDE: 30.264782
LONGITUDE: -97.765302

Barton Springs Road Bridge Improvements
Austin, Texas
PROJECT NO. 0121-014

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	COMPRESSIVE STRENGTH TSF
				SURF. ELEVATION: 436±								
					40.0							
				NOTES: 1. Boring advanced dry to 15 ft depth and groundwater encountered at depth of 11 ft below existing ground surface, and at 10 ft after 10 minutes. 2. On completion of drilling operation, hole noted open to 4.5 ft depth.								
45												
50												
55												
60												
65												
70												
75												

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COMPLETION DEPTH: 40.0
DATE DRILLED: 4-13-22
WATER LEVEL / SEEPAGE: 11.0
UPON COMPLETION:

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)
Q = Unconsolidated Undrained (tsf)

Plate 4b

BALCONES_STD4 0121-014 BORING LOGS.GPJ 06/30/22 19:13

SAMPLE PHOTOGRAPHS – T-4

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Austin, Texas

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SAMPLE PHOTOGRAPHS – T-4

Barton Springs Road Bridge Improvements
Austin, Texas

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LOG OF BORING NO. T-5

LATITUDE: 30.264630
LONGITUDE: -97.765602

Barton Springs Road Bridge Improvements
Austin, Texas
PROJECT NO. 0121-014

SURF. ELEVATION: 436±

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	COMPRESSIVE STRENGTH TSF
				14" Concrete, 6" Base Material	434.8							
					1.2							
			N=1-4-8	Dark brown CLAYEY GRAVEL with sand, loose to medium dense, moist. GC (Alluvium)	434.3							
					1.7							
						10	34	19	65	35		
5			N=4-4-5		430.5							
			N=5-8-12	Brownish gray to gray FAT CLAY, very stiff to hard, moist to wet, w/sand. CH (Del Rio)	5.5							
			N=12-14-24			19	52	32	97	87		
10			N=35-50/5									
					422.5							
			N=50/2	Light gray to gray LIMESTONE, moderately hard to hard, slightly to moderately weathered, slightly to highly fractured, nodular, w/dark gray weathered clay seams and layers, fossils, and discontinuities. (Georgetown)	13.5							
15						5					146	347(U)
			REC=100 RQD=52	*- trace pyrite at 13.5 ft* *- dark gray clay layer at 17.5 ft*								
20				*- three shallow inclined discontinuities, partially healed from 20.5 to 21.3 ft*								
			REC=100 RQD=72	*- highly fractured from 23.5 to 24 ft*								
25						3					156	539(U)
			REC=100 RQD=67	*- highly fractured with dark gray clay seams and hydrocarbon odor from 28.5 to 29 ft*								
30												
			REC=100 RQD=72									
						4					150	106(U)
35												
			REC=100 RQD=100									
					396.0							

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COMPLETION DEPTH: 40.0
DATE DRILLED: 4-12-22
WATER LEVEL / SEEPAGE: 10.0
UPON COMPLETION:

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)
Q = Unconsolidated Undrained (tsf)

Plate 5a

BALCONES_STD4 0121-014 BORING LOGS.GPJ 06/30/22 19:13

LOG OF BORING NO. T-5

LATITUDE: 30.264630
LONGITUDE: -97.765602

Barton Springs Road Bridge Improvements
Austin, Texas
PROJECT NO. 0121-014

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	COMPRESSIVE STRENGTH TSF
				SURF. ELEVATION: 436±								
					40.0							
				NOTES: 1. Boring advanced dry to 15.5 ft depth and groundwater encountered at depth of 10 ft below existing ground surface, and at 9.5 ft after 10 minutes. 2. On completion of drilling operation, hole noted open to 5 ft depth.								
45												
50												
55												
60												
65												
70												
75												

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COMPLETION DEPTH: 40.0
DATE DRILLED: 4-12-22
WATER LEVEL / SEEPAGE: 10.0
UPON COMPLETION:

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)
Q = Unconsolidated Undrained (tsf)

Plate 5b

BALCONES_STD4 0121-014 BORING LOGS.GPJ 06/30/22 19:13

SAMPLE PHOTOGRAPHS – T-5

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Austin, Texas

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SAMPLE PHOTOGRAPHS – T-5

Barton Springs Road Bridge Improvements
Austin, Texas

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LOG OF BORING NO. W-1

LATITUDE: 30.264663
LONGITUDE: -97.765098

Barton Springs Road Bridge Improvements
Austin, Texas
PROJECT NO. 0121-014

SURF. ELEVATION: 461±

DEPTH, FT	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	COMPRESSIVE STRENGTH TSF
			11.5" Concrete, 5" Asphalt, 8" Base Material	460.0							
				1.0							
			Light brown to gray FAT CLAY, very stiff to hard, moist to wet, w/sand and selenite seams. (Del Rio)	459.6							
		N=6-13-18		1.4							
				459.0	15	66	45	97	89		
5		N=9-11-13		2.0							
		N=10-14-17									
		N=12-15-19									
10											
		N=11-19-24			20	63	38	100	95		
15											
		N=17-17-22									
20											
		N=12-15-22									
25											
		N=17-22-29				55	29				
30											
				426.2							
35		N=18-38-50/4	Gray to light gray CLAYSHALE, low hardness. (Del Rio)	34.8							
		N=48-50/1.5			16	41	23	100	92		

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COMPLETION DEPTH: 60.0
DATE DRILLED: 4-26-22
WATER LEVEL / SEEPAGE: 30.0
UPON COMPLETION:

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)
Q = Unconsolidated Undrained (tsf)

Plate 6a

BALCONES_STD4 0121-014 BORING LOGS.GPJ 06/30/22 19:13

LOG OF BORING NO. W-1

LATITUDE: 30.264663
LONGITUDE: -97.765098

Barton Springs Road Bridge Improvements
Austin, Texas
PROJECT NO. 0121-014

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	COMPRESSIVE STRENGTH TSF
				SURF. ELEVATION: 461±								
			REC=100 RQD=57	Gray to light gray CLAYSHALE, low hardness. (Del Rio) *(continued)* - *limestone seams below 41.5 ft [Transition to Georgetown Limestone]*	417.0							
45			REC=100 RQD=90	Light gray to gray LIMESTONE, moderately hard to hard, slightly to moderately weathered, slightly fractured, nodular, w/dark gray weathered clay seams and layers, fossils, and discontinuities. (Georgetown) - *dark gray clay layer at 46.5 to 47 ft*	44.0	4					151	139(U)
50			REC=100 RQD=93			5					149	141(U)
55			REC=100 RQD=90	- *multiple dark gray clay seams and layers from 56.6 to 58 ft*	401.0							
60					60.0							
65												
70												
75												

NOTES:
1. Boring advanced dry to 40 ft depth and groundwater encountered at depth of 30 ft below existing ground surface, and at 28.5 ft after 10 minutes.
2. On completion of drilling operation, hole noted open to 60 ft depth and water suface (drilling fluid) noted at 17 ft depth.

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COMPLETION DEPTH: 60.0
DATE DRILLED: 4-26-22
WATER LEVEL / SEEPAGE: 30.0
UPON COMPLETION:

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)
Q = Unconsolidated Undrained (tsf)

Plate 6b

BALCONES_STD4 0121-014 BORING LOGS.GPJ 06/30/22 19:13

SAMPLE PHOTOGRAPHS – W-1

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SAMPLE PHOTOGRAPHS – W-1

Barton Springs Road Bridge Improvements
Austin, Texas

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LOG OF BORING NO. W-2

Barton Springs Road Bridge Improvements
Austin, Texas
PROJECT NO. 0121-014

LATITUDE: 30.264563
LONGITUDE: -97.765272

SURF. ELEVATION: 462±

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	COMPRESSIVE STRENGTH TSF
				12.5" Concrete, 4" Asphalt, 8" Base Material	460.9							
					1.1							
				Light brown to gray FAT CLAY, stiff to hard, moist, w/sand and selenite seams. (Del Rio)	460.6							
			N=4-8-12		1.4							
			P=4 5		460.0	15	59	41	97	90		
5					2.0							
			N=14-17-27									
			N=15-22-27									
							65	37				
10			N=14-20-25									
			N=10-18-23									
15												
			N=13-27-35	- *dark gray below 19 ft*								
20												
			N=18-28-42			16	67	47	99	93		
25												
			N=24-28-38									
30												
			N=18-32-50/5 5		427.0	14	55	38	99	94		
35				Dark gray to light gray CLAYSHALE, low hardness, slightly fissile. (Del Rio)	35.0							
			N=32-10/1-10/0									

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COMPLETION DEPTH: 60.0
DATE DRILLED: 4-26-22
WATER LEVEL / SEEPAGE:
UPON COMPLETION:

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)
Q = Unconsolidated Undrained (tsf)

Plate 7a

BALCONES_STD4 0121-014 BORING LOGS.GPJ 06/30/22 19:13

LOG OF BORING NO. W-2

Barton Springs Road Bridge Improvements
Austin, Texas
PROJECT NO. 0121-014

LATITUDE: 30.264563
LONGITUDE: -97.765272

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	COMPRESSIVE STRENGTH TSF
				SURF. ELEVATION: 462±								
				- limestone seams below 40 ft [Transition to Georgetown Limestone]	420.5							
			REC=98 RQD=78	Light gray to gray LIMESTONE, moderately hard to hard, slightly to moderately weathered, slightly to moderately fractured, nodular, w/dark gray weathered clay seams and layers, fossils, and discontinuities. (Georgetown)	41.5	6					147	67(U)
45			REC=100 RQD=100	*- trace pyrite at 41.5 ft* *- fossiliferous from 44 to 45 ft* *- 2 inch chert seam at 45 ft* *- moderately inclined healed discontinuity at 45.8 ft*								
50			REC=98 RQD=97	*- dark gray clay seams from 47.2 to 47.8 ft*		4					151	155(U)
55				*- dark gray clay seam at 54.5 ft*								
			REC=100 RQD=57	*- multiple dark gray clay seams and layers from 55.5 to 58.5 ft*		3					154	120(U)
60					402.0 60.0							
65												
70												
75												

NOTES:
1. Boring advanced dry to 40 ft depth and groundwater not encountered above that depth.
2. On completion of drilling operation, hole noted open to 60 ft depth and water suface (drilling fluid) noted at 19 ft depth.

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COMPLETION DEPTH: 60.0
DATE DRILLED: 4-26-22
WATER LEVEL / SEEPAGE:
UPON COMPLETION:

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)
Q = Unconsolidated Undrained (tsf)

Plate 7b

SAMPLE PHOTOGRAPHS – W-2

Barton Springs Road Bridge Improvements
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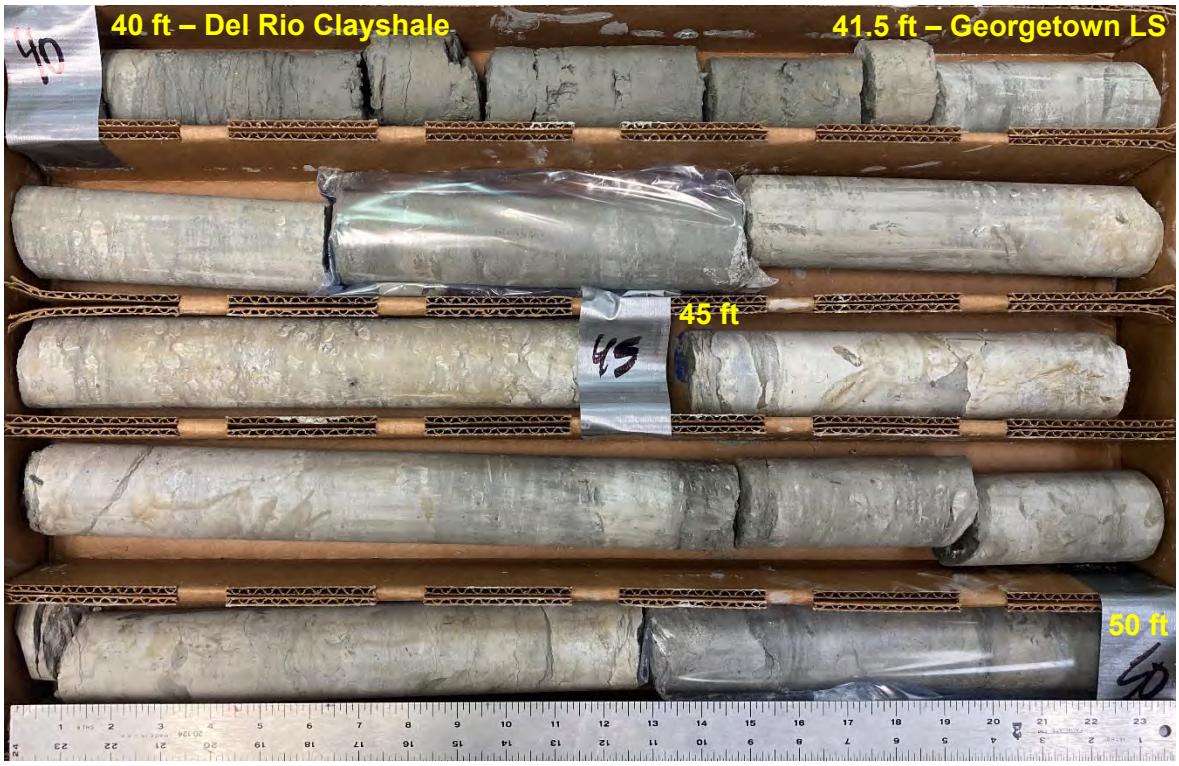

SAMPLE PHOTOGRAPHS – W-2

Barton Springs Road Bridge Improvements
Austin, Texas

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LOG OF BORING NO. W-3

LATITUDE: 30.264424
LONGITUDE: -97.765476

Barton Springs Road Bridge Improvements
Austin, Texas
PROJECT NO. 0121-014

SURF. ELEVATION: 462±

DEPTH, FT	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	COMPRESSIVE STRENGTH TSF
			7" Asphalt, 8" Base Material	461.4							
				0.6							
		N=17-11-13	Brown to reddish brown CLAYEY GRAVEL, medium dense to dense, moist. GC (Alluvium)	460.8							
				1.3							
		N=17-21-21									
5											
		N=28-46-27	Gray to light brown FAT CLAY with Sand, very stiff to hard, moist, w/sand and selenite seams. CH (Del Rio)	456.0							
				6.0	10	54	36	97	77		
		N=8-15-23									
10		N=11-20-27									
15		N=15-22-27									
20		N=13-20-27			17	65	45	100	91		
25		N=15-24-37									
30		N=14-20-32			17	54	35	96	83		
				427.7							
35		N=31-50/4	Gray to light gray CLAYSHALE, low hardness, w/trace shells and pyrite. (Del Rio)	34.3							
					16					118	6(Q)
		REC=100 RQD=73	*- limestone seams below 37.5 ft [Transition to Georgetown Limestone]*	423.0							
				39.0							

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COMPLETION DEPTH: 50.0
DATE DRILLED: 4-19-22
WATER LEVEL / SEEPAGE:
UPON COMPLETION:

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)
Q = Unconsolidated Undrained (tsf)

Plate 8a

BALCONES_STD4 0121-014 BORING LOGS.GPJ 06/30/22 19:13

LOG OF BORING NO. W-3

LATITUDE: 30.264424
LONGITUDE: -97.765476

Barton Springs Road Bridge Improvements
Austin, Texas
PROJECT NO. 0121-014

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	COMPRESSIVE STRENGTH TSF
				SURF. ELEVATION: 462±								
				Light gray to gray LIMESTONE, moderately hard to hard, slightly to moderately weathered, slightly fractured, nodular, w/dark gray weathered clay seams and layers, fossils, and discontinuities. (Georgetown) *(continued)*								
			REC=95 RQD=95			5					147	116(U)
45				*- several dark gray clay seams from 44 to 44.7 ft*								
			REC=95 RQD=95			4					152	283(U)
50					412.0 / 50.0							
				NOTES: 1. Boring advanced dry to 35 ft depth and groundwater not encountered above that depth. 2. On completion of drilling operation, hole noted open to 51 ft depth and water suface (drilling fluid) noted at 5 ft depth.								
55												
60												
65												
70												
75												

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COMPLETION DEPTH: 50.0
DATE DRILLED: 4-19-22
WATER LEVEL / SEEPAGE:
UPON COMPLETION:

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)
Q = Unconsolidated Undrained (tsf)

Plate 8b

SAMPLE PHOTOGRAPHS – W-3

Barton Springs Road Bridge Improvements
Austin, Texas

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SAMPLE PHOTOGRAPHS – W-3

Barton Springs Road Bridge Improvements
Austin, Texas

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LOG OF BORING NO. W-4

LATITUDE: 30.264232
LONGITUDE: -97.765057

Barton Springs Road Bridge Improvements
Austin, Texas
PROJECT NO. 0121-014

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	COMPRESSIVE STRENGTH TSF
				SURF. ELEVATION: 502±								
			N=3-4-12	Reddish brown to tan CLAYEY GRAVEL with Sand, dense to very dense, moist, w/limestone fragments. (Completely Weathered Limestone)								
			N=10-16-32	*- clayey sand seams from surface to 0.7 ft*	497.7							
5			N=50/3.5	Tan LIMESTONE, moderately hard to hard, slightly to highly weathered, highly fractured, fine-grained, w/coarse-grained highly weathered zones, and discontinuities. (Buda)	4.3							
			REC=100 RQD=8									
10						5					146	42(U)
			REC=100 RQD=42									
15												
			REC=100 RQD=33									
20												
			REC=95 RQD=87	*- shaley seams below 22.2 ft [Transition to Del Rio Clayshale]*	479.0							
				Brownish gray to dark gray CLAYSHALE, low hardness, fissile, w/selenite seams. (Del Rio)	23.0	11					131	6(U)
25												
			REC=100 RQD=7									
30												
			REC=98 RQD=92	*- moderately inclined discontinuity at 33 ft* *- selenite seam at 33.5 ft*		20					109	3(Q)
35												
			REC=100 RQD=90	*- dark gray seams below 39 ft*		11						

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COMPLETION DEPTH: 105.0
DATE DRILLED: 5-3-22
WATER LEVEL / SEEPAGE:
UPON COMPLETION:

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)
Q = Unconsolidated Undrained (tsf)

Plate 9a

LOG OF BORING NO. W-4

LATITUDE: 30.264232
LONGITUDE: -97.765057

Barton Springs Road Bridge Improvements
Austin, Texas
PROJECT NO. 0121-014

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	COMPRESSIVE STRENGTH TSF
				SURF. ELEVATION: 502±								
				Brownish gray to dark gray CLAYSHALE, low hardness, fissile, w/selenite seams. (Del Rio) *(continued)*								
			REC=100 RQD=98									
				- dark gray below 44.5 ft		19					109	3(Q)
45												
			REC=100 RQD=97									
						14					122	16(Q)
50				*- fossiliferous from 50 to 55.4 ft*								
			REC=100 RQD=90									
55												
						11	56	34	100	99		
			REC=100 RQD=100									
60				*- fossils at 60 ft*								
			REC=100 RQD=100									
						12					122	3(Q)
65												
			REC=13 RQD=0	[Core loss due to core barrel jam from 65 to 72 ft]								
70												
			REC=62 RQD=52									
75												
			REC=100 RQD=100	*- limestone seams below 77.5 ft [Transition to Georgetown Limestone]*								
						13					123	9(Q)
					422.0							

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COMPLETION DEPTH: 105.0
DATE DRILLED: 5-3-22
WATER LEVEL / SEEPAGE:
UPON COMPLETION:

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)
Q = Unconsolidated Undrained (tsf)

Plate 9b

BALCONES_STD4 0121-014 BORING LOGS.GPJ 06/30/22 19:13

LOG OF BORING NO. W-4

Barton Springs Road Bridge Improvements
Austin, Texas
PROJECT NO. 0121-014

LATITUDE: 30.264232
LONGITUDE: -97.765057

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	COMPRESSIVE STRENGTH TSF
				SURF. ELEVATION: 502±								
				Light gray to gray LIMESTONE, moderately hard to hard, slightly to moderately weathered, slightly fractured, nodular, w/dark gray weathered clay seams and layers, fossils, and discontinuities. (Georgetown)	80.0							
			REC=100 RQD=100			13					125	30(U)
				- clay seam at 84.5 ft								
85				*- fossiliferous from 85 to 86 ft*								
			REC=100 RQD=100			7					143	68(U)
90												
			REC=100 RQD=90	*- multiple inclined clay-coated discontinuities from 92.5 to 93.5 ft*								
95												
			REC=100 RQD=93			4					151	343(U)
100				*- clay seams at 100.5 ft*								
			REC=100 RQD=87			4					151	126(U)
105					397.0 / 105.0							
110												
115												

NOTES:
1. Boring advanced dry to 6 ft depth and groundwater not encountered above that depth.
2. On completion of drilling operation, hole noted open to 33 ft depth and water suface (drilling fluid) noted at 29 ft depth.

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COMPLETION DEPTH: 105.0
DATE DRILLED: 5-3-22
WATER LEVEL / SEEPAGE:
UPON COMPLETION:

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
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Q = Unconsolidated Undrained (tsf)

Plate 9c

SAMPLE PHOTOGRAPHS – W-4

Barton Springs Road Bridge Improvements
Austin, Texas

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SAMPLE PHOTOGRAPHS – W-4

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SAMPLE PHOTOGRAPHS – W-4

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SAMPLE PHOTOGRAPHS – W-4

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SAMPLE PHOTOGRAPHS – W-4

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SAMPLE PHOTOGRAPHS – W-4

Barton Springs Road Bridge Improvements
Austin, Texas

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512.380.9969

LOG OF BORING NO. W-5

LATITUDE: 30.264122
LONGITUDE: -97.765169

Barton Springs Road Bridge Improvements
Austin, Texas
PROJECT NO. 0121-014

SURF. ELEVATION: 503±

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	COMPRESSIVE STRENGTH TSF
				3" Asphalt	502.8							
			N=9-19-18	Tan CLAYEY GRAVEL, dense to very dense, moist, w/limestone fragments. (Completely Weathered Limestone)	0.3							
			N=38-50/5	Tan LIMESTONE, moderately hard to hard, slightly to highly weathered, slightly to moderately fractured, fine-grained, w/coarse-grained highly weathered zones, and discontinuities. (Buda)	499.0 4.0							
5				*- ferrous stained vug at 7.5 ft*								
			REC=100 RQD=52			5					147	347(U)
10				*- shallow to moderately inclined discontinuities at 10.3 ft*								
			REC=100 RQD=43									
15												
			REC=100 RQD=45		484.8							
				Brownish gray to dark gray CLAYSHALE, low hardness, fissile, w/selenite seams. (Del Rio)	18.2	11					129	9(U)
20				*- limestone seams from 19 to 21 ft [Transition to Del Rio Clayshale]*								
			REC=97 RQD=55									
25				*- 100% water loss at 25 ft*								
							63	39	100	99		
			REC=97 RQD=38									
30												
			REC=100 RQD=30			17					116	7(Q)
35												
			REC=88 RQD=38									

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COMPLETION DEPTH: 110.0
DATE DRILLED: 5-5-22
WATER LEVEL / SEEPAGE:
UPON COMPLETION:

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)
Q = Unconsolidated Undrained (tsf)

Plate 10a

BALCONES_STD4 0121-014 BORING LOGS.GPJ 06/30/22 19:13

LOG OF BORING NO. W-5

LATITUDE: 30.264122
LONGITUDE: -97.765169

Barton Springs Road Bridge Improvements
Austin, Texas
PROJECT NO. 0121-014

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	COMPRESSIVE STRENGTH TSF
				SURF. ELEVATION: 503±								
				Brownish gray to dark gray CLAYSHALE, low hardness, fissile, w/selenite seams. (Del Rio) *(continued)*								
			REC=100	*- dark gray seams below 40.7 ft*								
			RQD=82			19					109	4(Q)
45				*- dark gray seams and layers below 45 ft*								
			REC=100			17					111	3(Q)
			RQD=72									
50												
			REC=100									
			RQD=100	*- selenite seam at 53.5 ft*								
55												
			REC=100									
			RQD=95									
						18					114	5(Q)
60												
			REC=100									
			RQD=72	*- fossiliferous seam at 63.3*								
				- shell fossils at 63.5, 64.3, and 65 ft		16					117	5(Q)
65												
			REC=97									
			RQD=90									
70												
			REC=100									
			RQD=100									
75												
						15					117	4(Q)
			REC=100									
			RQD=82									

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COMPLETION DEPTH: 110.0
DATE DRILLED: 5-5-22
WATER LEVEL / SEEPAGE:
UPON COMPLETION:

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)
Q = Unconsolidated Undrained (tsf)

Plate 10b

LOG OF BORING NO. W-5

LATITUDE: 30.264122
LONGITUDE: -97.765169

Barton Springs Road Bridge Improvements
Austin, Texas
PROJECT NO. 0121-014

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION SURF. ELEVATION: 503±	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX, %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	COMPRESSIVE STRENGTH TSF
			REC=98 RQD=78	Brownish gray to dark gray CLAYSHALE, low hardness, fissile, w/selenite seams. (Del Rio) *(continued)* *- limestone seams and layers below 80 ft [Transition to Georgetown Limestone]*	418.0	12					131	9(Q)
85			REC=100 RQD=92	Light gray to gray LIMESTONE, moderately hard to hard, slightly to moderately weathered, slightly fractured, nodular, w/dark gray weathered clay seams and layers, fossils, and discontinuities. (Georgetown)	85.0	4					152	199(U)
90			REC=100 RQD=100	*- three shallow to moderately inclinded discontinuities from 92.2 to 93.2 ft* *- clay-filled high angle discontinuity from 94.5 to 95 ft*		3					156	354(U)
95			REC=100 RQD=100	*- clay-infilled burrows from 96.2 to 97 ft*								
100			REC=100 RQD=88			3					156	187(U)
105			REC=100 RQD=97									
110					393.0 110.0							
115												

NOTES:
1. Boring advanced dry to 6.5 ft depth and groundwater not encountered above that depth.
2. On completion of drilling operation, hole noted open to 53 ft depth and water suface (drilling fluid) noted at 51 ft depth.

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COMPLETION DEPTH: 110.0
DATE DRILLED: 5-5-22
WATER LEVEL / SEEPAGE:
UPON COMPLETION:

KEY:
P = Pocket Penetrometer
N = Standard Penetration Test (bpf)
U = Unconfined Compression (tsf)
Q = Unconsolidated Undrained (tsf)

Plate 10c

BALCONES_STD4 0121-014 BORING LOGS.GPJ 06/30/22 19:13

SAMPLE PHOTOGRAPHS – W-5

Barton Springs Road Bridge Improvements
Austin, Texas

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SAMPLE PHOTOGRAPHS – W-5

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Austin, Texas

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SAMPLE PHOTOGRAPHS – W-5

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SAMPLE PHOTOGRAPHS – W-5

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SAMPLE PHOTOGRAPHS – W-5

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SAMPLE PHOTOGRAPHS – W-5

Barton Springs Road Bridge Improvements
Austin, Texas

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TERMS AND SYMBOLS USED ON BORING LOGS FOR SOIL

SOIL TYPES

CLAY (CH)	**SHALY CLAY (CH)**	**CLAY (CL)**	**SANDY CLAY (CL)**
We Graded **SAND (SW)**	Poor y Graded **SAND (SP)**	**SILTY SAND (SM)**	**CLAYEY SAND (SC)**
We Graded **GRAVEL (GW)**	Poor y Graded **GRAVEL (GP)**	**SILTY GRAVEL (GM)**	**FILL** Mater a

SOIL GRAIN SIZE

U S STANDARD S EVE

12"	3"	3/4"	4	10	40	200

BOULDERS	COBBLES	GRAVEL		SAND			SILT	CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE		

304	76.2	19.1	4.76	2.00	0.420	0.074	0.002

SO L GRA N S ZE N M L METERS

STRENGTH OF COHESIVE SOILS (2)

CONSISTENCY	UNDRAINED COMPRESSIVE STRENGTH Tons Per Sq. Ft.
Very Soft	Less Than 0.25
Soft	0.25 to 0.50
F rm	0.5 to 1.00
St ff	1.00 to 2.00
Very St ff	2.00 to 4.00
Hard	greater than 4.00

DENSITY OF GRANULAR SOILS (2)

NUMBER OF BLOWS PER FT., N	RELATIVE DENSITY
0 4	Very Loose
4 10	Loose
10 30	Med um
30 50	Dense
Over 50	Very Dense

DESCRIPTIVE TERMS FOR SOIL (1)

DESCRIPTION	CRITERIA
Strat f ed	A ternat ng ayers of vary ng mater a or co or w th ayers at east 6 mm th ck.
Lam nated	A ternat ng ayers of vary ng mater a or co or w th the ayers ess than 6 mm th ck.
F ssured	Breaks a ong def n te p anes of fracture w th tt e res stance to fractur ng.
S ckens ded	Fracture p anes appear po shed or g ossy, somet mes str ated.
B ocky	Cohes ve so that can be broken down nto sma angu ar umps wh ch res st further breakdown.
Lensed	Inc us ons of sma pockets of d fferent so s.

MOISTURE

Dry	No water ev dent n samp e; f nes ess than p ast c m t.
Mo st	Samp e fee s damp; f nes near the p ast c m t
Very Mo st	Water v s b e on samp e; f nes greater p ast c m t and ess than qu d m t
Wet	Samp e bears free water; f nes greater than qu d m t.

INCLUSIONS (1)

Part ng	Inc us on <1/8" th ck extend ng through samp e
Seam	Inc us on 1/8" to 3" th ck extend ng through samp e.
Layer	Inc us on >3" th ck extend ng through samp e.
Trace	<5% of samp e.
Few	5% to 10% of samp e.
L tt e	15 to 25% of samp e.
W th	15% to 29% of samp e.

NOTE: Informat on on each bor ng og s a comp at on of subsurface cond t ons and so and rock c ass f cat ons obta ned from the f e d as we as from aboratory test ng of samp es. Strata have been nterpreted from common y accepted procedures. The stratum nes on the ogs may be trans t ona and approx mate n nature. Water eve measurements refer on y to those observed at the t mes and p aces nd cated, and may vary w th t me, geo og c cond t on or construct on act v ty.

REFERENCES: 1) ASTM D 2488 2) Peck, Hanson and Thornburn, (1974), Foundation Engineering.

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TERMS AND SYMBOLS USED ON BORING LOGS FOR ROCK

ROCK TYPES

- LIMESTONE
- SHALE
- SANDSTONE
- WEATHERED LIMESTONE
- WEATHERED SHALE
- WEATHERED SANDSTONE
- HIGHLY WEATHERED LIMESTONE
- ARGILLACEOUS LIMESTONE
- MARL

SAMPLER TYPES

- Thin-walled Tube
- Rock Core
- Standard Penetration Test
- Auger Sample
- THD Cone Penetration Test
- Bag Sample

SOLUTION & VOID CONDITIONS

Void	Interstice; a general term for pore space or other openings in rock.
Cavities	Small solutional concavities.
Vuggy	Containing small cavities, usually lined with a mineral of different composition from that of the surrounding rock.
Vesicular	Containing numerous small, unlined cavities, formed by expansion of gas bubbles or steam during solidification of the rock.
Porous	Containing pore, interstices, or other openings which may or may not interconnect.
Cavernous	Containing cavities or caverns, sometimes quite large. Most frequent in limestones and dolomites.

WEATHERING GRADES OF ROCKMASS(1)

Slightly	Discoloration indicates weathering of rock material and discontinuity surfaces.
Moderately	Less than half of the rock material is decomposed or disintegrated to a soil.
Highly	More than half of the rock material is decomposed or disintegrated to a soil.
Completely	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.
Residual Soil	All rock material is converted to soil. The mass structure and material fabric are destroyed.

HARDNESS

Friable	Crumbles under hand pressure
Low Hardness	Can be carved with a knife
Moderately Hard	Can be scratched easily with a knife
Very Hard	Cannot be scratched with a knife

BEDDING THICKNESS(2)

Very Thick	>4'
Thick	2'-4'
Thin	2"-2'
Very Thin	1/2"-2"
Laminated	0.08"-1/2"
Thinly-Laminated	<0.08"

JOINT DESCRIPTION

SPACING		INCLINATION		SURFACES	
Very Close	<2"	Horizontal	0-5	Slickensided	Polished, grooved
Close	2"-12"	Shallow	5-35	Smooth	Planar
Medium Close	12"-3'	Moderate	35-65	Irregular	Undulating or granular
Wide	>3'	Steep	65-85	Rough	Jagged or pitted
		Vertical	85-90		

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NOTE: Information on each boring log is a compilation of subsurface conditions and soil and rock classificaitons obtained from the field as well as from laboratory testing of samples. Strata have been interpreted by commonly accepted procedures. The stratum lines on the logs may be transitional and approximate in nature. Water level measurements refer only to those observed at the times and places indicated, and may vary with time, geologic condition or construction activity.

REFERENCES: 1) Br t sh Standard(1981) Code of Pract ce for S te Invest gat on BS 5930.
2) The Br dge D v s on, Texas H ghway Dept. Foundat on Exp orat on & Des gn Manua , 2nd Ed t on,rev sed June,1974.

APPENDIX A-2 (Previous Studies)

Arias Boring Logs B-1, B-2, and B-4, and Core Photographs (2018)

Keys to Terms and Symbols

Fugro Plan of Borings (1999)

Fugro Boring Log B-1

Keys to Terms and Symbols

Boring Log No. B-1

Project: **Barton Springs Bridge Improvement Project**
Barton Springs Rd at Barton Creek
Austin, TX

Location: See Boring Location Plan

Sampling Date: 11/27/2017 - 11/28/17
Elevation: 451.94 ft (By survey)
Coordinates: N: 10069509.6 E: 3107010.1
Backfill: Cuttings

Soil Description	Depth (ft)	Sample Type	N	REC RQD	WC	LL	PI	-200	DD	Uc
LEAN CLAY with Sand (CL), stiff, brown, w/silt, calcareous nodules, and scattered gravel	5	SS	N=10		16	38	22	79		
SANDY FAT CLAY (CH), stiff, dark brown, w/silt, calcareous nodules, and gravel	10	SS	N=9							
	15	SS	N=8		16	50	33	61		
CLAYEY SAND (SC), medium dense, tan and gray, w/silt and clay pockets, poorly-graded sand and gravel layers	20	SS	N=13							
- gravel layer from 23 to 24 ft	25	SS	N=10							
Well-graded GRAVEL with Sand (GW), dense, w/silt and clay pockets	30	SS	N=33		23	23	8	4		
	35	SS	N=46							
(continued)	40	SS	N=50							

Groundwater Data:
First encountered during drilling: 23.5-ft depth caved at 29 ft

Field Drilling Data:
Coordinates: Survey
Logged By: R. Wall
Driller: Austin Geo-Logic
Equipment: Truck-mounted drill rig

Hollow stem auger: 0 - 45 ft
Rock core: 45 - 60 ft

Nomenclature Used on Boring Log

Split Spoon (SS)
Rock Core (RC)
Water encountered during drilling

N = SPT Blow Count
REC = % Recovery
RQD = Rock Quality Designation
LL = Liquid Limit
PI = Plasticity Index

WC = Water Content (%)
-200 = % Passing #200 Sieve
DD = Dry Density (pcf)
Uc = Compressive Strength (psi)

2015-762.GPJ 3/8/18 (BORING LOG KSLAU11-17.ARIASSA12-01.GDT.LIBRARY2013-01 - KSL.GLB)

Boring Log No. B-1 (continued)

Project: **Barton Springs Bridge Improvement Project**
Barton Springs Rd at Barton Creek
Austin, TX

Location: See Boring Location Plan

Sampling Date: 11/27/2017 - 11/28/17
Elevation: 451.94 ft (By survey)
Coordinates: N: 10069509.6 E: 3107010.1
Backfill: Cuttings

Soil Description	Depth (ft)	Sample Type	N	REC RQD	WC	LL	PI	-200	DD	Uc
Well-graded GRAVEL with Sand (GW), dense, w/silt and clay pockets *(continued)*										
Weathered LIMESTONE, gray	45									
[Georgetown] LIMESTONE, gray, nodular, w/weathered clay seams and layers, fossils and discontinuities *- 1" weathered seam at 47 ft*	50	RC		REC=87 RQD=78	3				147	88
	55	RC		REC=100 RQD=78						
- 2" dark gray clay seam at 56.5'	60	RC		REC=97 RQD=87	3 1				151 148	140 151

Borehole terminated at 60 feet

Groundwater Data:
First encountered during drilling: 23.5-ft depth caved at 29 ft

Field Drilling Data:
Coordinates: Survey
Logged By: R. Wall
Driller: Austin Geo-Logic
Equipment: Truck-mounted drill rig

Hollow stem auger: 0 - 45 ft
Rock core: 45 - 60 ft

Nomenclature Used on Boring Log

Split Spoon (SS) | Rock Core (RC) | Water encountered during drilling

N = SPT Blow Count
REC = % Recovery
RQD = Rock Quality Designation
LL = Liquid Limit
PI = Plasticity Index

WC = Water Content (%)
-200 = % Passing #200 Sieve
DD = Dry Density (pcf)
Uc = Compressive Strength (psi)

B-1

B-1
45-50
45'
45 ft
MB
50 ft
MB
MB

50
50 ft
55
55 ft
59 ft
MB

59 ft
59
60 ft

Boring Log No. B-2

Project: **Barton Springs Bridge Improvement Project**
Barton Springs Rd at Barton Creek
Austin, TX

Location: See Boring Location Plan

Sampling Date: 11/27/2017 - 11/27/17
Elevation: 449.10 ft (By survey)
Coordinates: N: 10069607.4 E: 3107210.5
Backfill: Cuttings

Soil Description	Depth (ft)	Sample Type	N	REC RQD	WC	LL	PI	-200	DD	Uc
LEAN CLAY with Sand (CL), firm to very stiff, brown and gray, w/calcareous nodules, limestone gravel, and silt	5	SS	N=3							
	10	SS	N=11		13	29	14	76		
	15	SS	N=18							
FAT CLAY (CH), stiff to very stiff, dark gray to brown, w/silt seams and partings, sand layers, and scattered gravel	20	SS	N=11		36	63	42	97		
- wet below 23.5 ft	25	SS	N=24							
Weathered LIMESTONE, gray	30	SS	N=50/2"							
[Georgetown] LIMESTONE, gray, nodular, w/weathered clay seams and layers, fossils and discontinuities	35	RC		REC=90 RQD=45	1				152	175
- 4" dark gray clay layer at 35 ft	40	RC		REC=98 RQD=90	2				148	159

(continued)

Groundwater Data:
First encountered during drilling: 23.5-ft depth

Field Drilling Data:
Coordinates: Survey
Logged By: K. Lewis
Driller: Austin Geo-Logic
Equipment: Truck-mounted drill rig

Hollow stem auger: 0 - 30 ft
Rock core: 30 - 60 ft

Nomenclature Used on Boring Log

Split Spoon (SS) | Rock Core (RC) | Water encountered during drilling

N = SPT Blow Count
REC = % Recovery
RQD = Rock Quality Designation
LL = Liquid Limit
PI = Plasticity Index

WC = Water Content (%)
-200 = % Passing #200 Sieve
DD = Dry Density (pcf)
Uc = Compressive Strength (psi)

2015-762.GPJ 3/8/18 (BORING LOG KSLAU11-17.ARIASSA12-01.GDT.LIBRARY2013-01 - KSL.GLB)

Boring Log No. B-2 (continued)

Project: **Barton Springs Bridge Improvement Project**
Barton Springs Rd at Barton Creek
Austin, TX

Location: See Boring Location Plan

Sampling Date: 11/27/2017 - 11/27/17
Elevation: 449.10 ft (By survey)
Coordinates: N: 10069607.4 E: 3107210.5
Backfill: Cuttings

Soil Description	Depth (ft)	Sample Type	N	REC RQD	WC	LL	PI	-200	DD	Uc
[Georgetown] LIMESTONE, gray, nodular, w/weathered clay seams and layers, fossils and discontinuities *(continued)*										
- weathered dark gray clay layers from 43 to 45 ft		RC		REC=100 RQD=62						
	45									
		RC		REC=100 RQD=88						
	50									
		RC		REC=100 RQD=92	1				152	185
	55									
- 3" dark gray clay layer at 55.5 ft		RC		REC=100 RQD=95	1				150	255
	60									

Borehole terminated at 60 feet

Groundwater Data:
First encountered during drilling: 23.5-ft depth

Field Drilling Data:
Coordinates: Survey
Logged By: K. Lewis
Driller: Austin Geo-Logic
Equipment: Truck-mounted drill rig

Hollow stem auger: 0 - 30 ft
Rock core: 30 - 60 ft

Nomenclature Used on Boring Log

Split Spoon (SS) | Rock Core (RC) | Water encountered during drilling

N = SPT Blow Count
REC = % Recovery
RQD = Rock Quality Designation
LL = Liquid Limit
PI = Plasticity Index

WC = Water Content (%)
-200 = % Passing #200 Sieve
DD = Dry Density (pcf)
Uc = Compressive Strength (psi)

B-2

B-2

Boring Log No. B-4

Project: **Barton Springs Bridge Improvement Project**
Barton Springs Rd at Barton Creek
Austin, TX

Location: See Boring Location Plan

Sampling Date: 11/28/2017 - 11/28/17
Elevation: 457.56 ft (By survey)
Coordinates: N: 10069402.7 E: 3107435.1
Backfill: Cuttings/bentonite

Soil Description	Depth (ft)	Sample Type	N	REC RQD	WC	LL	PI	-200	DD	Uc
LEAN CLAY (CL), firm to stiff, brown to dark brown, w/silt, calcareous nodules, and scattered gravel										
	5	SS	N=5							
	10	SS	N=5							
	15	SS	N=5		18	26	11	63		
	20	SS	N=8							
CLAYEY SAND (SC), loose to medium dense, brown to light brown, w/silt and clay pockets, poorly-graded sand and gravel layers										
	25	SS	N=5							
	30	SS	N=15		22	19	6	15		
- blowcount amplified due to gravel content	35	SS	N=50/6"							
(continued)	40	SS	N=21							

Groundwater Data:
First encountered during drilling: 27-ft depth caved at 29 ft

Field Drilling Data:
Coordinates: Survey
Logged By: R. Wall
Driller: Austin Geo-Logic
Equipment: Truck-mounted drill rig

Hollow stem auger: 0 - 45 ft
Air rotary: 45 - 65 ft

Nomenclature Used on Boring Log

Split Spoon (SS) | Rock Core (RC) | Water encountered during drilling

N = SPT Blow Count
REC = % Recovery
RQD = Rock Quality Designation
LL = Liquid Limit
PI = Plasticity Index

WC = Water Content (%)
-200 = % Passing #200 Sieve
DD = Dry Density (pcf)
Uc = Compressive Strength (psi)

2015-762.GPJ 3/8/18 (BORING LOG KSLAU11-17.ARIASSA12-01.GDT.LIBRARY2013-01 - KSL.GLB)

Boring Log No. B-4 (continued)

Project: **Barton Springs Bridge Improvement Project**
Barton Springs Rd at Barton Creek
Austin, TX

Location: See Boring Location Plan

Sampling Date: 11/28/2017 - 11/28/17
Elevation: 457.56 ft (By survey)
Coordinates: N: 10069402.7 E: 3107435.1
Backfill: Cuttings/bentonite

Soil Description	Depth (ft)	Sample Type	N	REC RQD	WC	LL	PI	-200	DD	Uc
Weathered LIMESTONE, light gray, shaley seams and layers	45	SS	N=50/4"		11	30	16	50		
[Georgetown] LIMESTONE, gray, nodular, w/weathered clay seams and layers, fossils and discontinuities	50	RC		REC=80 RQD=73	4				150	116
	55	RC		REC=98 RQD=78						
- 2" dark gray clay layer at 56.5 and 57 ft	60	RC		REC=100 RQD=95	2				150	112
	65	RC		REC=100 RQD=94	3				150	103

Borehole terminated at 65 feet

Groundwater Data:
First encountered during drilling: 27-ft depth caved at 29 ft

Field Drilling Data:
Coordinates: Survey
Logged By: R. Wall
Driller: Austin Geo-Logic
Equipment: Truck-mounted drill rig

Hollow stem auger: 0 - 45 ft
Air rotary: 45 - 65 ft

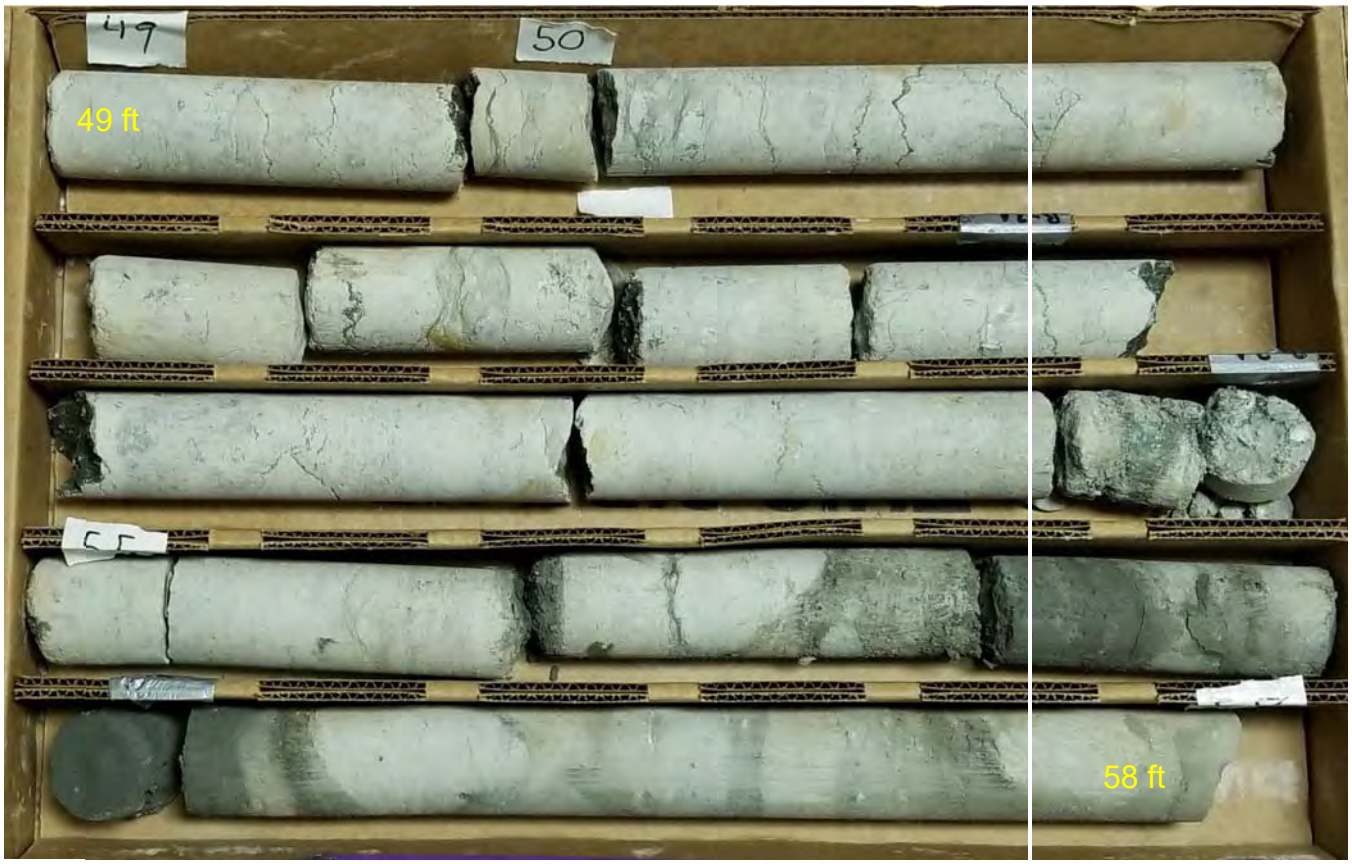
Nomenclature Used on Boring Log

Split Spoon (SS) | Rock Core (RC) | Water encountered during drilling

N = SPT Blow Count
REC = % Recovery
RQD = Rock Quality Designation
LL = Liquid Limit
PI = Plasticity Index

WC = Water Content (%)
-200 = % Passing #200 Sieve
DD = Dry Density (pcf)
Uc = Compressive Strength (psi)

B-4



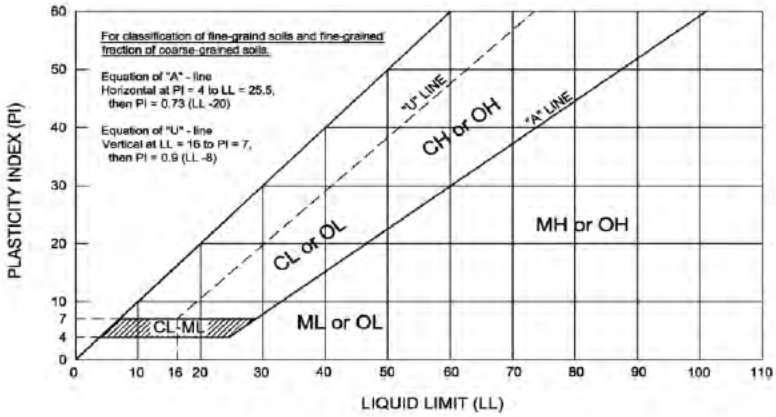
KEY TO TERMS AND SYMBOLS USED ON BORING LOGS

MAJOR DIVISIONS					GROUP SYMBOLS	DESCRIPTIONS
COARSE-GRAINED SOILS	More than half of material LARGER than No. 200 Sieve size	GRAVELS	More than Half of Coarse fraction is LARGER than No. 4 Sieve size	Clean Gravels (little or no Fines)	GW	Well-Graded Gravels, Gravel-Sand Mixtures, Little or no Fines
					GP	Poorly-Graded Gravels, Gravel-Sand Mixtures, Little or no Fines
				Gravels with Fines (Appreciable amount of Fines)	GM	Silty Gravels, Gravel-Sand-Silt Mixtures
					GC	Clayey Gravels, Gravel-Sand-Clay Mixtures
		SANDS	More than half of Coarse fraction is SMALLER than No. 4 Sieve size	Clean Sands (little or no Fines)	SW	Well-Graded Sands, Gravelly Sands, Little or no Fines
					SP	Poorly-Graded Sands, Gravelly Sands, Little or no Fines
				Sands with Fines (Appreciable amount of Fines)	SM	Silty Sands, Sand-Silt Mixtures
					SC	Clayey Sands, Sand-Clay Mixtures
FINE-GRAINED SOILS	More than half of material SMALLER than No. 200 Sieve size	SILTS & CLAYS		Liquid Limit less than 50	ML	Inorganic Silts & Very Fine Sands, Rock Flour, Silty or Clayey Fine Sands or Clayey Silts with Slight Plasticity
					CL	Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays
		SILTS & CLAYS		Liquid Limit greater than 50	MH	Inorganic Silts, Micaceous or Diatomaceous Fine Sand or Silty Soils, Elastic Silts
					CH	Inorganic Clays of High Plasticity, Fat Clays
FORMATIONAL MATERIALS		SANDSTONE				Massive Sandstones, Sandstones with Gravel Clasts
		MARLSTONE				Indurated Argillaceous Limestones
		LIMESTONE				Massive or Weakly Bedded Limestones
		CLAYSTONE				Mudstone or Massive Claystones
		CHALK				Massive or Poorly Bedded Chalk Deposits
		MARINE CLAYS				Cretaceous Clay Deposits
		GROUNDWATER				Indicates Final Observed Groundwater Level Indicates Initial Observed Groundwater Location

Density of Granular Soils	
Number of Blows per ft., N	Relative Density
0 - 4	Very Loose
4 - 10	Loose
10 - 30	Medium
30 - 50	Dense
Over 50	Very Dense

Consistency and Strength of Cohesive Soils		
Number of Blows per ft., N	Consistency	Unconfined Compressive Strength, q_u (tsf)
Below 2	Very Soft	Less than 0 25
2 - 4	Soft	0.25 - 0.5
4 - 8	Medium (Firm)	0.5 - 1.0
8 - 15	Stiff	1.0 - 2.0
15 - 30	Very Stiff	2.0 - 4.0
Over 30	Hard	Over 4 0

PLASTICITY CHART (ASTM D 2487-11)



KEY TO TERMS AND SYMBOLS USED ON BORING LOGS

TABLE 1 Soil Classification Chart (ASTM D 2487-11)

Criteria of Assigning Group Symbols and Group Names Using Laboratory Tests[A]				Soil Classification	
				Group Symbol	Group Name[B]
COARSE-GRAINED SOILS	Gravels (More than 50% of coarse fraction retained on No. 4 sieve)	Clean Gravels (Less than 5% fines[C])	Cu ≥ 4 and 1 ≤ Cc ≤ 3[D]	GW	Well-Graded Gravel[E]
			Cu < 4 and/or [Cc < 1 or Cc > 3][D]	GP	Poorly-Graded Gravel[E]
		Gravels with Fines (More than 12% fines[C])	Fines classify as ML or MH	GM	Silty Gravel[E F G]
More than 50% retained on No. 200 sieve			Fines classify as CL or CH	GC	Clayey Gravel[E F G]
	Sands (50% or more of coarse fraction passes No. 4 sieve)	Clean Sands (Less than 5% fines[H])	Cu ≥ 6 and 1 ≤ Cc ≤ 3[D]	SW	Well-Graded Sand[I]
			Cu < 6 and/or [Cc < 1 or Cc > 3][D]	SP	Poorly-Graded Sand[I]
		Sands with Fines (More than 12% fines[H])	Fines classify as ML or MH	SM	Silty Sand[F G I]
			Fines classify as CL or CH	SC	Clayey Sand[F G I]
FINE-GRAINED SOILS	Silts and Clays	inorganic	PI > 7 and plots on or above "A" line[J]	CL	Lean Clay[K L M]
	Liquid limit less than 50		PI < 4 or plots below "A" line[J]	ML	Silt[K L M]
		organic	Liquid limit - oven dried / Liquid limit - not dried <0.75	OL	Organic Clay[K L M N] / Organi Silt[K L M O]
50% or more passes the No. 200 sieve	Silts and Clays	inorganic	PI plots on or above "A" line	CH	Fat Clay[K L M]
	Liquid limit 50 or more		PI plots on or below "A" line	MH	Elastic Silt[K L M]
		organic	Liquid limit - oven dried / Liquid limit - not dried <0.75	OH	Organic Clay[K L M P] / Organic Silt[K L M Q]
HIGHLY ORGANIC SOILS	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-inch (75mm) sieve
[B] If field sample contained cobbles or boulders, or bo h, add "with cobbles or boulders, or both" to group name
[C] Gravels wi h 5% to 12% fines require dual symbols:
- GW-GM well-graded gravel with silt
- GW-GC well-graded gravel with clay
- GP-GM poorly-graded gravel with silt
- GP-GC poorly-graded gravel wi h clay

[D] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[E] If soil contains ≥ 15% sand, add "with sand" to group name
[F] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM
[G] If fines are organic, add "with organic fines" to group name
[H] Sand with 5% to 12% fines require dual symbols:
- SW-SM well-graded sand with silt
- SW-SC well-graded sand with clay
- SP-SM poorly-graded sand with silt
- SP-SC poorly-graded sand with clay

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name
[J] If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay
[K] If soil contains 15% to < 30% plus No. 200, add "with sand" or "with gravel," whichever is predominant
[L] If soil contains ≥ 30% plus No. 200, predominantly sand, add "sandy" to group name
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name
[N] PI ≥ 4 and plots on or above "A" line
[O] PI < 4 or plots below "A" line
[P] PI plots on or above "A" line
[Q] PI plots below "A" line

TERMINOLOGY

Boulders	Over 12-inches (300mm)	**Parting**	Inclusion < 1/8-inch thick extending through samples
Cobbles	12-inches to 3-inches (300mm to 75mm)	**Seam**	Inclusion 1/8-inch to 3-inches thick extending through sample
Gravel	3-inches to No. 4 sieve (75mm to 4.75mm)	**Layer**	Inclusion > 3-inches thick extending through sample
Sand	No. 4 sieve to No. 200 sieve (4.75mm to 0.075mm)		
Silt or Clay	Passing No. 200 sieve (0.075mm)		
Calcareous	Containing appreciable quantities of calcium carbonate, generally nodular		

Stratified	Alternating layers of varying material or color with layers at least 6mm thick
Laminated	Alternating layers of varying material or color with the layers less than 6mm thick
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay
Homogeneous	Same color and appearance throughout

KEY TO TERMS AND SYMBOLS USED ON BORING LOGS

Hardness Classification of Intact Rock

Class	Hardness	Field Test		Approximate Range of Uniaxial Compression Strength kg/cm² (tons/ft²)
I	Extremely hard	Many blows with geologic hammer required to break intact specimen.		> 2,000
II	Very hard	Hand held specimen breaks with hammer end of pick under more than one blow.		2,000 – 1,000
III	Hard	Cannot be scraped or pealed with knife, hand held specimen can be broken wi h single moderate blow with pick.		1,000 – 500
IV	Soft	Can just be scraped or peeled with knife. Indentations 1mm to 3mm show in specimen with moderate blow with pick.		500 – 250
V	Very soft	Material crumbles under moderate blow with sharp end of pick and can be peeled with a knife, but is too hard to hand-trim for triaxial test specimen.		250 – 10

Rock Weathering Classifications

Grade	Symbol	Diagnostic Features
Fresh	F	No visible sign of Decomposition or discoloration. Rings under hammer impact.
Slightly Weathered	WS	Slight discoloration inwards from open fractures, otherwise similar to F.
Moderately Weathered	WM	Discoloration throughout. Weaker minerals such as feldspar decomposed. Strength somewhat less than fresh rock, but cores cannot be broken by hand or scraped by knife. Texture preserved.
Highly Wea hered	WH	Most minerals somewhat decomposed. Specimens can be broken by hand with effort or shaved with knife. Core stones present in rock mass. Texture becoming indistinct, but fabric preserved.
Completely Weathered	WC	Minerals decomposed to soil, but fabric and structure preserved (Saprolite). Specimens easily crumbled or penetrated.
Residual Soil	RS	Advanced state of decomposition resulting in plas ic soils. Rock fabric and structure completely destroyed. Large volume change.

Rock Discontinuity Spacing

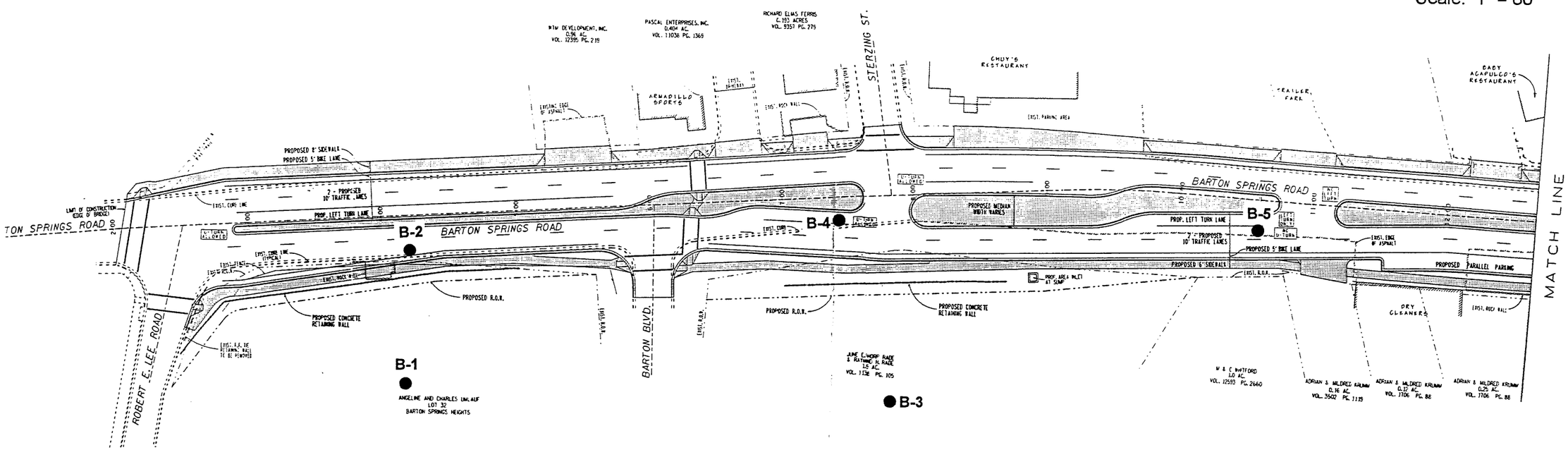
Description for Structural Features: Bedding, Foliation, or Flow Banding	Spacing	Description for Joints, Faults or Other Fractures
Very thickly (bedded, foliated, or banded)	More than 6 feet	Very widely (fractured or jointed)
Thickly	2 – 6 feet	Widely
Medium	8 – 24 inches	Medium
Thinly	2½ – 8 inches	Closely
Very thinly	¾ – 2½ inches	Very closely
Description for Micro-Structural Features: Lamination, Foliation, or Cleavage	**Spacing**	**Descriptions for Joints, Faults, or Other Fractures**
Intensely (laminated, foliated, or cleaved)	¼ – ¾ inch	Extremely close
Very intensely	Less than ¼ inch	

Engineering Classification for in Situ Rock Quality

RQD %	Velocity Index	Rock Mass Quality
90 – 100	0.80 – 1.00	Excellent
75 – 90	0.60 – 0.80	Good
50 – 75	0.40 – 0.60	Fair
25 – 50	0.20 – 0.40	Poor
0 – 25	0 – 0.20	Very Poor

FUGRO

Scale: 1" = 80'



PLAN OF BORINGS
Barton Springs Road Improvements
Austin, Texas

PLATE 2a

LOG OF BORING B-1

Barton Springs Road Improvements
Austin, Texas

TYPE: Wet Rotary — LOCATION: Umlauf Residence

SURF. EL. 508 ft± — Job No. 1001-2559

DEPTH, FT	SYMBOL	SAMPLES	BLOWS PER FOOT OR REC/(RQD),%	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX(PI),%	PASSING NO. 200 SIEVE,%	UNIT DRY WEIGHT, PCF	COMPRESSIVE STRENGTH, TSF
			72 (8)	Dark brown sandy lean CLAY, hard, w/roots. (Fill)	507.5 / 0.5						4.0(P)
				Tan LIMESTONE, highly weathered, hard, medium- to fine-grained, w/soft seams. (Buda)							
5			57 (7)	-100% water loss at 3.5 ft							
10			100 (25)	-100% water loss at 10.5 ft							
15			93 (0)								
20			100 (27)	-continuous water loss below 20 ft		1				162	259(U)
25			40 (0)								
30			45 (0)	Dark greenish gray fat CLAY, hard, fissured, w/selenite seams and fossils. CH (Del Rio)	478.0 / 30.0						
35			80 (80)			19	55	33	79	112	6.9(Q)
						18	67	44	92	123	7.6(Q)
40			100 (67)	Dark gray CLAYSHALE, low hardness. (Del Rio)	466.6 / 41.4						
						16				115	13(U)
45			88 (63)	-alternating greenish gray w/selenite crystals above 47 ft		14	59	39	90		

COMPLETION DEPTH: 95.0 ft — DEPTH TO WATER: See Note

DATE: 4/27/99

U = Unconfined
Q = Unconsolidated Undrained Triaxial
P = Pocket Penetrometer
T = Torvane

LOG OF BORING B-1

Barton Springs Road Improvements
Austin, Texas

TYPE: Wet Rotary LOCATION: Umlauf Residence

SURF. EL. 508 ft± Job No. 1001-2559

DEPTH, FT	SYMBOL	SAMPLES	BLOWS PER FOOT OR REC/(RQD),%	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX(PI),%	PASSING NO. 200 SIEVE,%	UNIT DRY WEIGHT, PCF	COMPRESSIVE STRENGTH, TSF
			93 (93)	Dark gray CLAYSHALE, low hardness. (Del Rio)		12				126	15(U)
55			100 (100)			16				117	14(U)
60			100 (100)	NOTE: Boring was advanced dry to the 0.5-ft depth and no groundwater was encountered above that depth.							
65			100 (100)			14				118	15(U)
70			100 (100)	-soft seams 71 to 73 ft		13				125	12(U)
75			100 (100)			12				126	18(U)
80			100 (100)	-transition zone below 80 ft							
85			100 (100)			11				130	27(U)
90			100 (100)	Gray LIMESTONE, hard, fine-grained, nodular. (Georgetown)	418.5 89.5	4				153	359(U)
95					413.0 95.0	5				150	223(U)

COMPLETION DEPTH: 95.0 ft DEPTH TO WATER: See Note

DATE: 4/27/99

U = Unconfined
Q = Unconsolidated Undrained Triaxial
P = Pocket Penetrometer
T = Torvane

TERMS & SYMBOLS USED ON BORING LOGS FOR SOIL

SOIL TYPES

- CH, Fat Clay
- CL, Lean Clay
- ML, Silt
- Fill, Unclassified
- SP, Poorly-Graded Sand
- SC, Clayey Sand
- SM, Silty Sand
- SW, Well-Graded Sand
- GP, Poorly-Graded Gravel
- GC, Clayey Gravel
- GM, Silty Gravel
- GW, Well-Graded Gravel

SAMPLER TYPES

- Seamless Push Tube
- Core
- Standard Penetration Test
- Auger
- THD Cone Penetrometer Test
- Auger Sample

SOIL GRAIN SIZE

U.S.STANDARD SIEVE

6"	3"	3/4"	4	10	40	200

BOULDERS	COBBLES	GRAVEL		SAND			SILT	CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE		

152	76.2	19.1	4.76	2.00	0.420	0.074	0.002

SOIL GRAIN SIZE IN MILLIMETERS

STRENGTH OF COHESIVE SOILS(1)

CONSISTENCY	UNDRAINED SHEAR STRENGTH Kips Per Sq. Ft.
Very Soft	Less Than 0.25
Soft	0.25 to 0.50
Firm	0.50 to 1.00
Stiff	1.00 to 2.00
Very Stiff	2.00 to 4.00
Hard	Greater Than 4.00

DENSITY OF GRANULAR SOILS(1)

NUMBER OF BLOWS PER FT., N	RELATIVE DENSITY
0-4	Very Loose
4-10	Loose
10-30	Medium
30-50	Dense
Over 50	Very Dense

1) Peck, Hanson, and Thornburn, (1974), Foundation Engineering.

ASTM D 2488 TABLE 7 Criteria for Describing Structure

Description	Criteria
Stratified	Alternating layers of varying material or color with layers at least 6 mm thick; note thickness
Laminated	Alternating layers of varying material or color with the layers less than 6mm thick; note thickness
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness
Homogeneous	Same color and appearance throughout

ASTM D 2488 TABLE 3 Criteria for Describing Moisture Condition

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

ASTM D 2488 Note 15 Criteria for Describing Percentages of Gravel, Sand and Fines

Description	Criteria
Trace	Particles are present but estimated to be less than 5 %
Few	5 to 10 %
Little	15 to 25 %
Some	30 to 45 %
Mostly	50 to 100 %

Criteria for Describing Inclusions

Description	Criteria
Parting	Inclusion <1/8' thick extending through sample
Seam	Inclusion 1/8" to 3" thick extending through sample
Layer	Inclusion >3" thick extending through sample

TERMS & SYMBOLS USED ON BORING LOGS FOR ROCK

ROCK TYPES

- LIMESTONE
- DOLOMITE
- SANDSTONE
- HIGHLY WEATHERED LIMESTONE
- HIGHLY WEATHERED DOLOMITE
- SHALE
- DOLOMITIC LIMESTONE
- GRANITE
- CLAYSHALE

SAMPLER TYPES

- Seamless Push Tube
- Core
- Standard Penetration Test
- Auger
- TxDOT Cone Penetration Test
- Auger Sample

HARDNESS

Friable	- Crumbles under hand pressure
Low Hardness	- Can be carved with a knife
Moderately Hard	- Can be scratched easily with a knife
Hard	- Can be scratched with a knife with difficulty

SOLUTION & VOID CONDITIONS

Void	Interstice; a general term for pore space or other opening in rock.
Cavities	Small solutional concavities.
Vuggy	Containing small cavities, usually lined with a mineral of different composition from that of the surrounding rock.
Vesicular	Containing numerous small, unlined cavities, formed by expansion of gas bubbles or steam during solidification of the rock.
Porous	Containing pore, interstices, or other openings which may or may not interconnect.
Cavernous	Containing cavities or caverns, sometimes quite large. Most frequent in limestones and dolomites.

WEATHERING GRADES OF ROCKMASS (1)

TERM	DESCRIPTION
Slightly	Discoloration indicates weathering of rock material and discontinuity surfaces.
Moderately	Less than half of the rock material is decomposed or disintegrated to a soil
Highly	More than half of the rock material is decomposed or disintegrated to a soil.
Completely	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.
Residual Soil	All rock material is converted to soil. The mass structure and material fabric are destroyed.

BEDDING THICKNESS (2)

Very Thick	>4'
Thick	2' - 4'
Thin	2" - 2'
Very Thin	1/2" - 2"
Laminated	0.08" - 1/2"
Thinly-Laminated	<0.08"

JOINT DESCRIPTION

SPACING	INCLINATION	SURFACES
Very Close <2"	Horizontal 0 - 5	Slickensided - Polished, grooved
Close 2" - 12"	Shallow 5 - 35	Smooth - Planar
Medium Close 12" - 3'	Moderate 35 - 65	Irregular - Undulating or granular
Wide >3'	Steeply 65 - 85	Rough - Jagged or pitted
	Vertical 85 - 90	

REFERENCES:

1) British Standard (1981) Code of Practice for Site Investigation, BS 5930

2) The Bridge Div., Tx. Highway Dept. Foundation Exploration & Design Manual 2nd Edition, revised June, 1974.

APPENDIX B – LABORATORY TEST RESULTS

Summary of Laboratory Test Results

Balcones Geotechnical
Austin, TX 78731
512.380.9969

BARTON SPRINGS ROAD BRIDGE — BRIDGE AND ROADWAY IMPROVEMENTS — SUMMARY OF LABORATORY TEST RESULTS

								Atterberg Limits			Sieve Analysis							(UC) Unconfined Compressive Strength		(UU) Triaxial Unconsolidated-Undrained Compressive Strength			Pressure Swell			Triaxial CU (3 points)		Direct Shear		Analytical			
Boring No.	Top Depth (ft)	Bottom Depth (ft)	Test Assign-ment	Boring Type	Geologic Formation	USCS Soil Class-ification	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plast-icity Index	Gravel (%) (<3" and >#4)	Sand (%) (<#4 and >#200)	Fines (%) (<#200)	% Passing No. 4 Sieve	% Passing No. 40 Sieve	% Passing No. 200 Sieve	(UDW) Unit Dry Weight (pcf)	Compress-ive Strength q_u (tsf)	Shear Strength s_u (tsf)	Compress-ive Strength, q_u (tsf)	Shear Strength s_u (tsf)	Confining Pressure (psi)	Max Swell Pressure (psf)	Void Ratio e_o	Max Swell (%)	Effective Cohesion Intercept, c' (psi)	Effective Friction Angle ϕ' (deg)	Effective Cohesion Intercept, c' (psi)	Effective Friction Angle ϕ' (deg)	Chloride (ppm)	Sulfate (ppm)	pH	Resist-ivity (Ω/cm)
T-1	3	5	AL, Sieve	Bridge /Trail Slope Stabili-zation	Alluvium	CL	18	33	17	16	0	40	60	100	97	60																	
	20	21.5				CL	28	48	18	30	0	22	78	100	99	78																	
	30	31.5	Sieve			GP	9				66	30	4	34	13	4																	
	42	43	UC rock		Georgetown Limestone		3										155	260	130														
	53	54					4										150	116	58														
T-2	1	2.5	AL, Sieve	Bridge /Trail Slope Stabili-zation	Alluvium	SC	6	27	16	11	24	34	42	76	62	42																	
	5	6.5				CL	13	38	16	22	4	27	69	96	89	69																	
	15	16.5				CL	15	29	16	13	0	18	82	100	99	82																	
	25	26.5	Sieve			SP-SC	10				41	52	7	59	13	7																	
	37	38	UC rock		Georgetown Limestone		4										151	109	55														
	47	48					4										152	199	100														
T-3	4	5.5	AL, Sieve	Bridge /Trail Slope Stabili-zation	Alluvium	CL	13	36	18	18	2	15	83	98	97	83																	
	8	9.5				CL	13	35	17	18	0	36	64	100	96	64																	
	15	16.5				CL	20	30	19	11	0	28	72	100	98	72																	
	25	26.5	Sieve			SC	11				26	49	25	74	36	25																	
	30	31.5				SP	15				24	73	3	76	11	3																	
	37	38	UC rock		Georgetown Limestone		5										148	281	141														
	47	48					3										156	212	106														
	57	58					4										153	188	94														
T-4	4	5.5	AL, Sieve	Bridge /Trail Slope Stabili-zation	Alluvium	GC	7	32	15	17	48	32	20	52	30	20																	
	13.5	14.5			Del Rio Clay	CL	14	36	15	21	0	13	87	100	97	87																	
	17	18	UC rock		Georgetown Limestone		4										159	165	83														
	27	28					3										156	320	160														
	34	35					3										154	217	109														
	39	40					4										153	86	43														
T-5	3 5	5	AL, Sieve	Bridge /Trail Slope Stabili-zation	Alluvium	GC	10	34	15	19	35	30	35	65	44	35																	
	7 5	9			Del Rio Clay	CH	19	52	20	32	3	10	87	97	91	87																	
	16	17	UC rock		Georgetown Limestone		5										146	347	174														
	25	26					3										156	539	270														
	34	35					4										150	106	53														

Balcones Geotechnical
Austin, TX 78731
512.380.9969

BARTON SPRINGS ROAD BRIDGE — BRIDGE AND ROADWAY IMPROVEMENTS — SUMMARY OF LABORATORY TEST RESULTS

								Atterberg Limits			Sieve Analysis							(UC) Unconfined Compressive Strength		(UU) Triaxial Unconsolidated-Undrained Compressive Strength			Pressure Swell			Triaxial CU (3 points)		Direct Shear		Analytical			
Boring No.	Top Depth (ft)	Bottom Depth (ft)	Test Assign-ment	Boring Type	Geologic Formation	USCS Soil Class-ification	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plast-icity Index	Gravel (%) (<3" and >#4)	Sand (%) (<#4 and >#200)	Fines (%) (<#200)	% Passing No. 4 Sieve	% Passing No. 40 Sieve	% Passing No. 200 Sieve	(UDW) Unit Dry Weight (pcf)	Compress-ive Strength q_u (tsf)	Shear Strength s_u (tsf)	Compress-ive Strength, q_u (tsf)	Shear Strength s_u (tsf)	Confining Pressure (psi)	Max Swell Pressure (psf)	Void Ratio e_o	Max Swell (%)	Effective Cohesion Intercept, c' (psi)	Effective Friction Angle ϕ' (deg)	Effective Cohesion Intercept, c' (psi)	Effective Friction Angle ϕ' (deg)	Chloride (ppm)	Sulfate (ppm)	pH	Resist-ivity (Ω/cm)
W-1	4	5.5	AL, Sieve	Retaining Wall	Del Rio Clay	CH	15	66	21	45	3	8	89	97	92	89																	
	13.5	15				CH	20	63	25	38	0	5	95	100	97	95																	
	24	35	AL, CU Triaxial			CH		55	26	29																2.8	18.9						
	38.5	40	AL, Sieve		Del Rio Clayshale	CL	16	41	18	23	0	8	92	100	97	92																	
	44	45	UC rock		Georgetown Limestone		4										151	139	70														
	51	52					5										149	141	71														
W-2	4	5	AL, Sieve	Retaining Wall	Del Rio Clay	CH	15	59	18	41	3	7	90	97	93	90																	
	7	20	AL, CU Triaxial			CH		65	28	37																2.7	18.6						
	23.5	25	AL, Sieve			CH	16	67	20	47	1	6	93	99	95	93																	
	33.5	35				CH	14	55	17	38	1	5	94	99	97	94																	
	43	44	UC rock		Georgetown Limestone		6										147	67	34														
	50	51					4										151	155	78														
	57	58					3										154	120	60														
W-3	7	8.5	AL, Sieve	Retaining Wall	Del Rio Clay	CH	10	54	18	36	3	20	77	97	83	77																	
	18.5	20				CH	17	65	20	45	0	9	91	100	95	91																	
	28.5	30				CH	17	54	19	35	4	13	83	96	89	83																	
	36		UU rock		Del Rio Clayshale		16										118			6	3	18											
	42	43	UC rock		Georgetown Limestone		5										147	116	58														
	47	48					4										152	283	142														
W-4	10	11	UC rock	Retaining Wall	Buda Limestone		5										146	42	21														
	18	19			Del Rio Clayshale		11										131	6	3														
	25		Analytical																											150	7600	6.59	3.80E+02
	32		UU rock				20										109			3	2	15											
	38		Direct Shear				16																					25.5	13.1				
	44		UU rock				19										109			3	2	15											
	49						14										122			16	8	25											
	56	57	AL, Sieve, Pressure Swell			CH	11	56	22	34	0	1	99	100	100	99	121						340	0.418	1.3%								
	58		Direct Shear				16																					3.1	14 9				
	64		UU rock				12										122			3	1	30											
	74		Direct Shear				19																					4.5	24 2				
	78		UU rock				13										123			9	5	35											
	82	83	UC rock		Georgetown Limestone		13										125	30	15														
	88	89					7										143	68	34														
	97	98					4										151	343	172														
	103	104					4										151	126	63														

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BARTON SPRINGS ROAD BRIDGE — BRIDGE AND ROADWAY IMPROVEMENTS — SUMMARY OF LABORATORY TEST RESULTS

								Atterberg Limits			Sieve Analysis							(UC) Unconfined Compressive Strength		(UU) Triaxial Unconsolidated-Undrained Compressive Strength			Pressure Swell			Triaxial CU (3 points)		Direct Shear		Analytical			
Boring No.	Top Depth (ft)	Bottom Depth (ft)	Test Assign-ment	Boring Type	Geologic Formation	USCS Soil Class-ification	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plast-icity Index	Gravel (%) (<3" and >#4)	Sand (%) (<#4 and >#200)	Fines (%) (<#200)	% Passing No. 4 Sieve	% Passing No. 40 Sieve	% Passing No. 200 Sieve	(UDW) Unit Dry Weight (pcf)	Compress-ive Strength q_u (tsf)	Shear Strength s_u (tsf)	Compress-ive Strength, q_u (tsf)	Shear Strength s_u (tsf)	Confining Pressure (psi)	Max Swell Pressure (psf)	Void Ratio e_o	Max Swell (%)	Effective Cohesion Intercept, c' (psi)	Effective Friction Angle ϕ' (deg)	Effective Cohesion Intercept, c' (psi)	Effective Friction Angle ϕ' (deg)	Chloride (ppm)	Sulfate (ppm)	pH	Resist-ivity (Ω/cm)
W-5	9	10	UC rock	Retaining Wall	Buda Limestone		5										147	347	174														
	18	19			Del Rio Clayshale		11										129	9	5														
	26	27	AL, Sieve			CH		63	24	39	0	1	99	100	99	99																	
	33		UU rock				17										116			7	4	15											
	37		Direct Shear				26																					94.5	28.1				
	43		UU rock				19										109			4	2	20											
	47						17										111			3	2	25											
	53		Direct Shear				14																					11.2	21.4				
	59		UU rock				18										114			5	3	25											
	64						16										117			5	2	30											
	69		Direct Shear				14																					0.3	30 8				
	76		UU rock				15										117			4	2	35											
	84						12										131			9	5	40											
	87	88	UC rock		Georgetown Limestone		4										152	199	100														
	92	93					3										156	354	177														
	102	103					3										156	187	94														
B-1	3 5	5	AL, Sieve	Bridge	Alluvium	CL	16	38	16	22	1	20	79	99	97	79																	
	13.5	15				CH	16	50	17	33	3	36	61	97	86	61																	
	28.5	30				SP	23	23	15	8	44	52	4	56	15	4																	
	48	49	UC rock		Georgetown Limestone		3										147	88	44														
	57	58					3										151	140	70														
	59	60					1										148	151	76														
B-2	8 5	10	AL, Sieve	Bridge	Alluvium	CL	13	29	15	14	0	24	76	100	98	76																	
	18.5	20			Del Rio Clay	CH	36	63	21	42	0	3	97	100	99	97																	
	33	34	UC rock		Georgetown Limestone		1										152	175	88														
	39	40					2										148	159	80														
	52	53					1										152	185	93														
	59	60					1										150	255	128														
B-4	13.5	15	AL, Sieve	Bridge	Alluvium	CL	18	26	15	11	0	37	63	100	98	63																	
	28.5	30				SC-SM	22	19	13	6	0	85	15	100	94	15																	
	43.5	44.3				CL	11	30	14	16	16	34	50	84	62	50																	
	47	48	UC rock		Georgetown Limestone		4										150	116	58														
	57	58					2										150	112	56														
	63	64					3										150	103	52														

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BARTON SPRINGS ROAD BRIDGE — BRIDGE AND ROADWAY IMPROVEMENTS — SUMMARY OF LABORATORY TEST RESULTS

								Atterberg Limits			Sieve Analysis							(UC) Unconfined Compressive Strength		(UU) Triaxial Unconsolidated-Undrained Compressive Strength			Pressure Swell			Triaxial CU (3 points)		Direct Shear		Analytical			
Boring No.	Top Depth (ft)	Bottom Depth (ft)	Test Assign-ment	Boring Type	Geologic Formation	USCS Soil Class-ification	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plast-icity Index	Gravel (%) (<3" and >#4)	Sand (%) (<#4 and >#200)	Fines (%) (<#200)	% Passing No. 4 Sieve	% Passing No. 40 Sieve	% Passing No. 200 Sieve	(UDW) Unit Dry Weight (pcf)	Compress-ive Strength q_u (tsf)	Shear Strength s_u (tsf)	Compress-ive Strength, q_u (tsf)	Shear Strength s_u (tsf)	Confining Pressure (psi)	Max Swell Pressure (psf)	Void Ratio e_o	Max Swell (%)	Effective Cohesion Intercept, c' (psi)	Effective Friction Angle ϕ' (deg)	Effective Cohesion Intercept, c' (psi)	Effective Friction Angle ϕ' (deg)	Chloride (ppm)	Sulfate (ppm)	pH	Resist-ivity (Ω/cm)
FB-1	22	23	UC rock	Retaining Wall	Buda Limestone		1										162	259	130														
	35	36	AL, Sieve, UU rock		Del Rio Clay		19	55	22	33						79	112			7	3	15											
	38	39					18	67	23	44						92	123			8	4	18											
	43	44	UC rock		Del Rio Clayshale		16										115	13	7														
	49	50	AL				14	59	20	39						90																	
	51	52	UC rock				12										126	15	8														
	57	58					16										117	14	7														
	64	65					14										118	15	8														
	73	74					13										125	12	6														
	78	79					12										126	18	9														
	84	85					11										130	27	14														
	91	92			Georgetown Limestone		4										153	359	180														
	94	95					5										150	223	112														

Natural Water Content (ASTM D 2216)

Natural water content tests were performed on samples in which classification and/or strength tests were performed. Each sample was visually classified in the laboratory. Natural water contents are tabulated at sample depth on the boring logs.

Atterberg Limits (ASTM D 4318)

Atterberg limit tests are classification tests that determine the liquid limit and plastic limit of the soil fraction finer than the No. 40 sieve. The Atterberg limits are approximate water contents at which the soil tested behaves in a specified manner. The liquid limit is determined by measuring, in a standard device, the water content and number of blows required to close a specific width groove cut in a remolded soil sample a specified length. The plastic limit is determined by measuring the water content when threads of soil 1/8-inch in diameter begin to crumble. The plasticity index, defined as the difference between the liquid and plastic limits, indicates the degree of plasticity or the magnitude of the water content over which the soil remains plastic. Liquid limit and plasticity index values are tabulated at the sample depths on the boring logs. Atterberg Limits results are shown on the boring logs under the appropriate column at the sample test depth (Appendix A) and in the Summary of Laboratory Test Results (Appendix B).

Sieve Analysis (ASTM D422)

Grain-size characteristics of the natural soils were investigated by the determination of the percent of soil passing the Nos. 4, 10, 40 and 200 sieves. These tests were performed by washing or sieving material through the respective sieves. The results are presented graphically in Appendix B-1, and partial mechanical analyses consisting of percent passing the No. 4 and the No. 200 are presented on the boring logs at the respective sample depths.

For two samples, a sedimentation process using a hydrometer was used to determine the distribution of particle sizes finer than the No. 200 sieve. Prior to starting the hydrometer test, sodium hexametaphosphate was added to the clay and silt sample as a dispersing agent. The diameter of a particle corresponding to the percentage indicated by a given hydrometer reading is calculated according to Stokes' law.

(UC) Unconfined Compressive Strength (ASTM D7012)

Unconfined compression tests were conducted on selected intact rock samples. The compression test consists of applying an axial compression load to a laterally unsupported sample and compressing to failure. The unconfined compressive strength is the measured applied load at failure. Compressive strength results are shown on the boring logs under the appropriate column at the sample test depth (Appendix A) and in the Summary of Laboratory Test Results (Appendix B).

(UU) Unconsolidated-Undrained Triaxial Compressive Strength on Shale Samples (ASTM D2850)

In the unconsolidated-undrained triaxial compression test performed on rock specimens, a laterally supported cylindrical rock specimen was loaded axially in compression to failure. The test specimens were about 2 inches in diameter by 4 inches in length. A selected confining pressure is initially applied to the specimen, and then an axial load is applied to produce failure. Applied stress and axial deformation (strain) information is recorded during testing and used to determine failure. UU compressive strength results are shown on the boring logs under the appropriate column at the sample test depth (Appendix A) and in the Summary of Laboratory Test Results (Appendix B).

Analytical Testing of Soil (Chloride Content ASTM D512)

Summary of the test method — Dilute mercuric nitrate solution is added to an acidified sample in the presence of mixed dipheny1carbazonebromophenol blue indicator. The end point of the titration is the formation of the blue-violet mercury diphenylcarbazone complex.

Use a volume of sample such that it will contain not more than 20 mg of chloride ion, diluting the sample with water to approximately 50 mL volume, if necessary. Determine an indicator blank on 50 mL of chloride-free water, applying the same procedure followed for the sample.

Add 5 to 10 drops of mixed indicator solution and shake or swirl the flask. If a blue-violet or red color develops, add HNO_3 (3 volumes concentrated nitric acid and 997 volumes water) dropwise until the color changes to yellow. Add 1 mL of excess acid. If a yellow or orange color forms immediately on addition of the mixed indicator, add NaOH solution (10 g/L) dropwise until the color changes to blue-violet; then add HNO_3 (3 + 997) dropwise until the color changes to yellow and further add 1 mL excess of acid.

Titrate the solution and a blank with 0.025 $NHg(NO_3H)_2$ solution until a blue-violet color, as viewed by transmitted light, persists throughout the solution. Record the milliliters of $Hg(NO_3H)_2$ solution added in each case. Calculate the chloride ion concentration, in milligrams per liter.

Analytical Testing of Soil (Sulfate Content ASTM D516)

Summary of the test method — sulfate ion is converted to a barium sulfate suspension under controlled conditions. A solution containing glycerin and sodium chloride is added to stabilize the suspension and minimize interferences. The resulting turbidity is determined by a nephelometer, spectrophotometer, or photoelectric colorimeter and compared to a curve prepared from standard sulfate solutions.

Prepare a calibration curve showing sulfate ion content in milligrams per liter plotted against the corresponding photometer readings. Prepare standards by diluting with water 0.0, 2.0, 5.0, 10.0, 15.0, 20.0, 30.0, and 40.0 mL of standard sulfate solution to 100-mL volumes in volumetric flasks. These solutions will have sulfate ion concentrations of 0.0, 2.0, 5.0, 10.0, 15.0, 20.0, 30.0, and 40.0 mg/L (ppm), respectively.

Filter the sample if it is turbid. Pipet into a 250-mL beaker 100 mL or less of the clear sample containing between 0.5 and 4 mg of sulfate ion (Dissolve 0.1479 g of anhydrous sodium sulfate (Na_2SO_4) in water and dilute with water to 1 L in a volumetric flask). Dilute to 100 mL with water if required and add 5.0 mL of conditioning reagent (30 mL of concentrated hydrochloric acid 300 mL reagent water, 100 mL 95 % ethanol or isopropanol, 75 g sodium chloride, and 50 mL glycerol and mix). Mix in the stirring apparatus. While the solution is being stirred, add a measured spoonful of $BaCl_2$ crystals (0.3 g) and begin timing immediately. Stir exactly 1.0 min at constant speed. Immediately after the stirring period has ended, pour solution into the cell and measure the turbidity at 30-s intervals for 4 min. Record the maximum reading obtained in the 4-min period. If the sample contains color or turbidity, run a sample blank without the addition of the barium chloride. Convert the photometer readings obtained with the sample to milligrams per liter sulfate ion (SO_4) by use of the calibration curve.

Analytical Testing of Soil (pH ASTM G51)

During the calibration procedure for the pH meter, standard buffered solutions of known pH are necessary. At least two standard buffered pH solutions that span the soil pH to be measured are required. From practical experience, standard solutions of pH 4, 7, and 8 are recommended. By the nature of the measurement, pH is determined for a small volume of soil at each reading, and it is important that at least three measurements at different locations be made and a simple average calculated.

The reference electrode should be placed in contact with the soil near the glass electrode. Allow 1 or 2 min for equilibrium to be established, then take the meter reading. After approximately 1 min, repeat the meter reading. In general, the values will agree within 0.2 pH units. If the range of values is as large as 0.4, then repeat the test.

Analytical Testing of Soil (Resistivity ASTM G57)

Summary of the test method — The Wenner four-electrode method requires that four metal electrodes be placed with equal separation in a straight line in the surface of the soil. The resulting resistivity measurement represents the average resistivity of a hemisphere of soil of a radius equal to the electrode separation. A voltage is impressed between the outer electrodes, causing current to flow, and the voltage drop between the inner electrodes is measured using a sensitive voltmeter.

The equipment required for the measurement of the resistivity of soil samples, either in the field or in the laboratory, is identical to that needed for at-grade measurements except that the electrodes are replaced with an inert container containing four permanently mounted electrodes. If the current-carrying (outside) electrodes are not spaced at the same interval as the potential-measuring (inside) electrodes, the resistivity, ρ, is:

$$\rho, \Omega\cdot cm = \pi * b * R / (1 - (b/(b+a)))$$

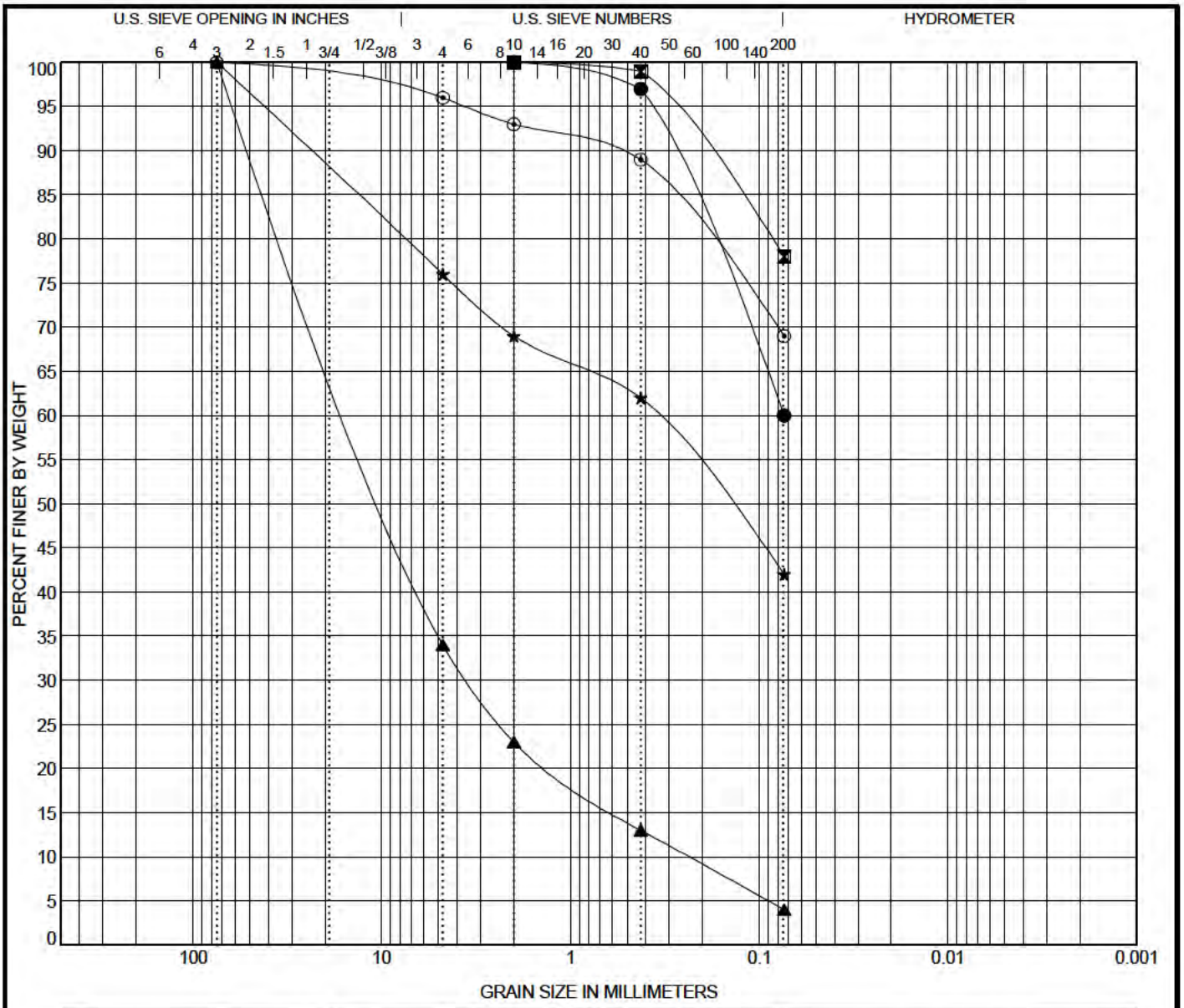
where:
b = outer electrode spacing, cm
a = inner electrode spacing, cm, and
R = resistance, Ω.

Soil samples should be representative of the area of interest where the stratum of interest contains a variety of soil types. It is desirable to sample each type separately. It will also be necessary to prepare a mixed sample. The sample should be reasonably large and thoroughly mixed so that it will be representative. The soil should be well-compacted in layers in the soil box, with air spaces eliminated as far as practicable.

Analytical test results are included in Appendix B-5.

APPENDIX B-1

Soil Testing – Grain Size Curves



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	T-1	4.0	SANDY LEAN CLAY(CL)	33	17	16		
⊠	T-1	20.0	LEAN CLAY with SAND(CL)	48	18	30		
▲	T-1	30.0	POORLY GRADED GRAVEL with SAND(GP)				3.60	59.35
★	T-2	1.0	CLAYEY SAND with GRAVEL(SC)	27	16	11		
⊙	T-2	5.0	SANDY LEAN CLAY(CL)	38	16	22		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	T-1	4.0	2	0.074			0.0	39.7	60.3	
⊠	T-1	20.0	2				0.0	21.8	78.2	
▲	T-1	30.0	75	14.086	3.468	0.237	66.0	29.9	4.1	
★	T-2	1.0	75	0.357			24.0	33.8	42.2	
⊙	T-2	5.0	75				4.0	26.8	69.2	

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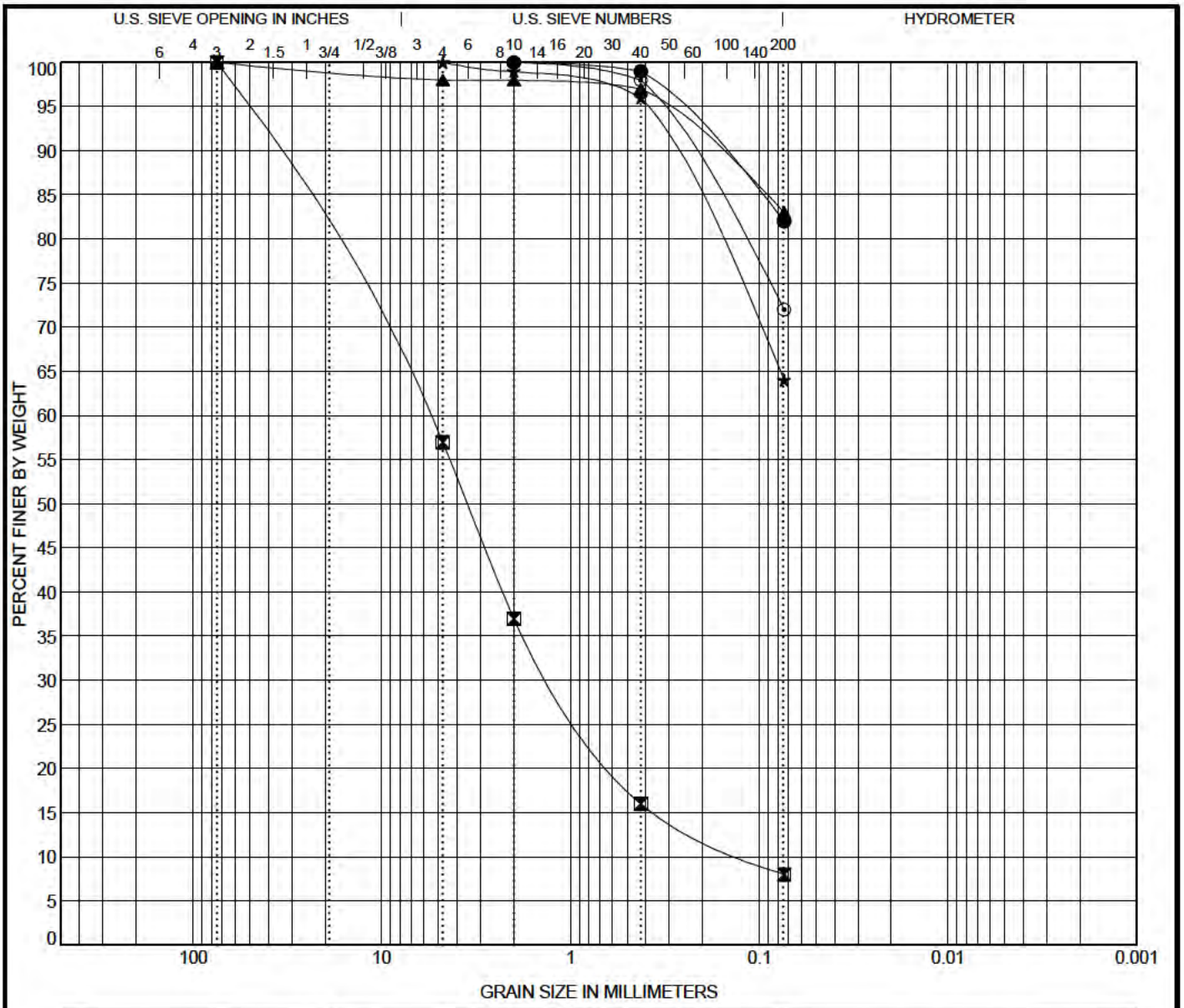
GRAIN SIZE DISTRIBUTION

Tested By	Date Tested	Checked By	Date Checked	Project No.	
				0121-014	PLATE 1

BG GRAIN SIZE GRAINSIZE.GPJ FUGRO DALLAS DATA TEMPLATE.GDT 09/15/22 13:21



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	T-2	15.0	LEAN CLAY with SAND(CL)	29	16	13		
⊠	T-2	25.0					2.16	50.27
▲	T-3	4.0	LEAN CLAY with SAND(CL)	36	18	18		
★	T-3	8.0	SANDY LEAN CLAY(CL)	35	17	18		
⊙	T-3	15.0	LEAN CLAY with SAND(CL)	30	19	11		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	T-2	15.0	2				0.0	17.9	82.1	
⊠	T-2	25.0	75	5.758	1.193	0.115	43.0	48.9	8.1	
▲	T-3	4.0	75				2.0	14.9	83.1	
★	T-3	8.0	4.75				0.0	35.8	64.2	
⊙	T-3	15.0	2				0.0	27.8	72.2	

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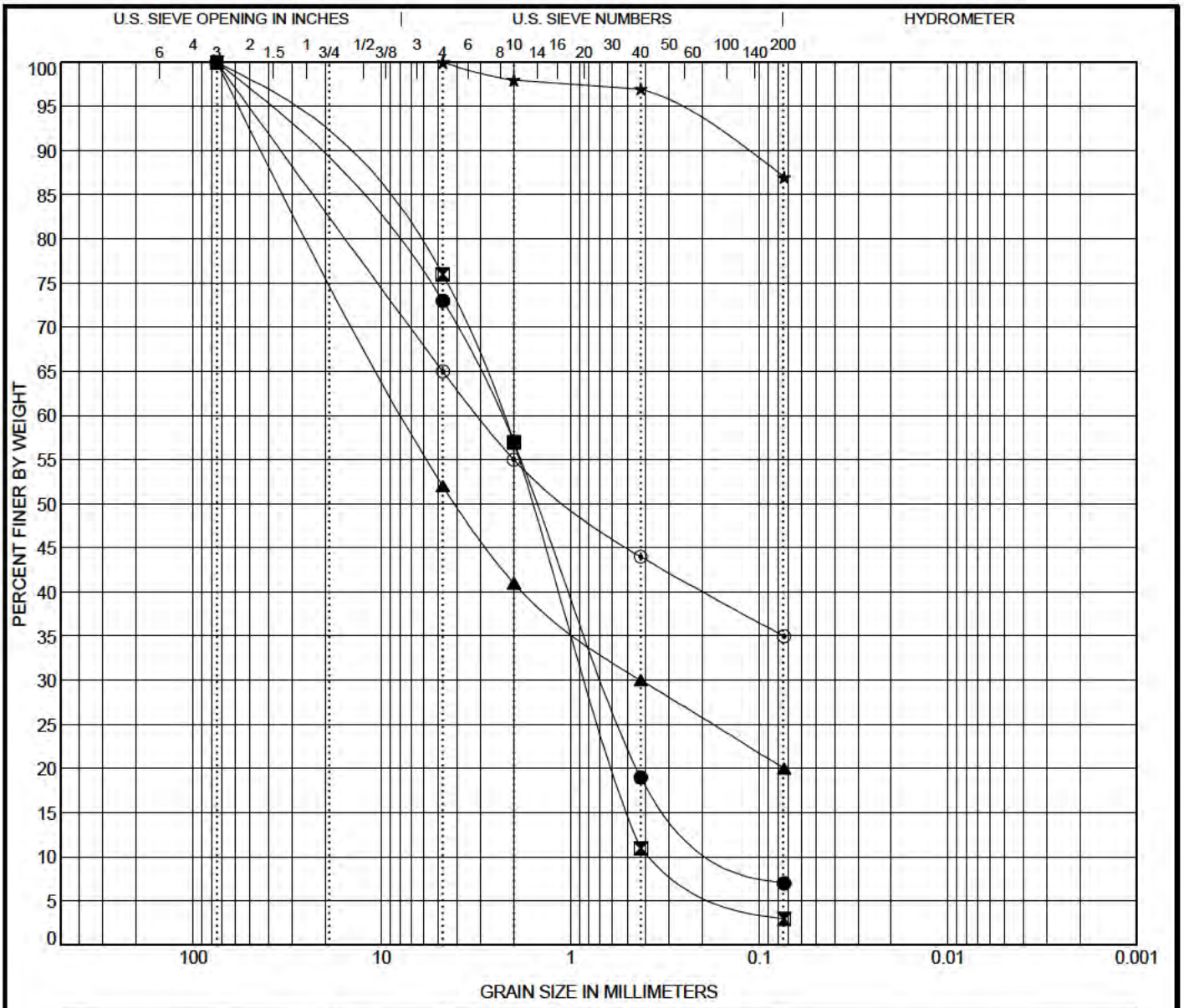
				0121-014	PLATE 2



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	T-3	25.0					1.64	20.53
⊠	T-3	30.0	POORLY GRADED SAND with GRAVEL(SP)				0.83	6.71
▲	T-4	4.0	CLAYEY GRAVEL with SAND(GC)	32	15	17		
★	T-4	14.0	LEAN CLAY(CL)	36	15	21		
⊙	T-5	4.0	CLAYEY GRAVEL with SAND(GC)	34	15	19		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	T-3	25.0	75	2.352	0.665	0.115	27.0	65.9	7.1	
⊠	T-3	30.0	75	2.293	0.806	0.342	24.0	72.9	3.1	
▲	T-4	4.0	75	7.524	0.425		48.0	31.9	20.1	
★	T-4	14.0	4.75				0.0	12.9	87.1	
⊙	T-5	4.0	75	3.082			35.0	29.9	35.1	

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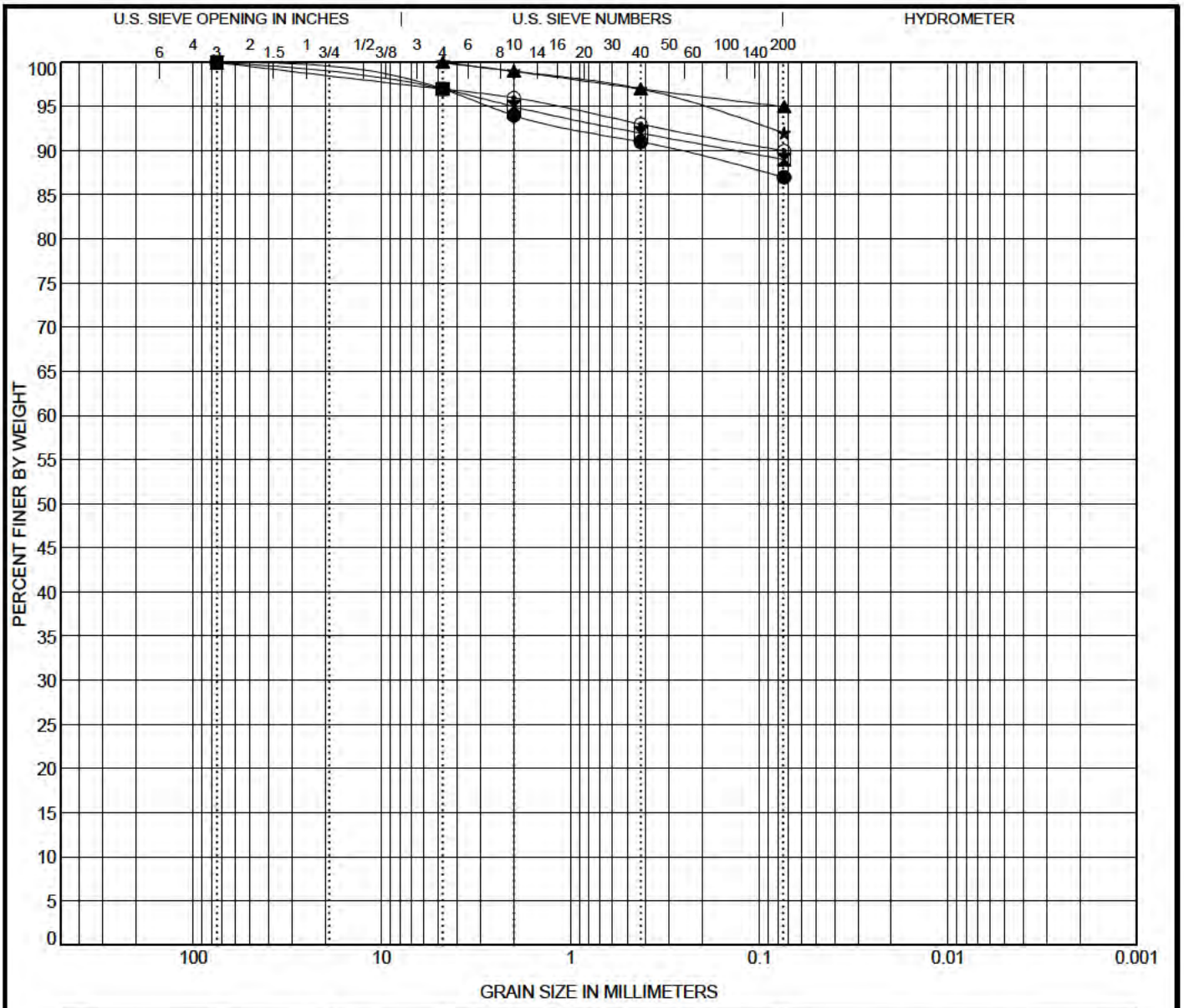
				0121-014	PLATE 3

BG GRAIN SIZE GRAINSIZE.GPJ FUGRO DALLAS DATA TEMPLATE.GDT 09/15/22 13:21



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	T-5	8.0	FAT CLAY(CH)	52	20	32		
⊠	W-1	4.0	FAT CLAY(CH)	66	21	45		
▲	W-1	14.0	FAT CLAY(CH)	63	25	38		
★	W-1	39.0	LEAN CLAY(CL)	41	18	23		
⊙	W-2	4.0	FAT CLAY(CH)	59	18	41		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	T-5	8.0	75				3.0	10.0	87.0	
⊠	W-1	4.0	75				3.0	8.0	89.0	
▲	W-1	14.0	4.75				0.0	5.0	95.0	
★	W-1	39.0	4.75				0.0	8.0	92.0	
⊙	W-2	4.0	75				3.0	7.0	90.0	

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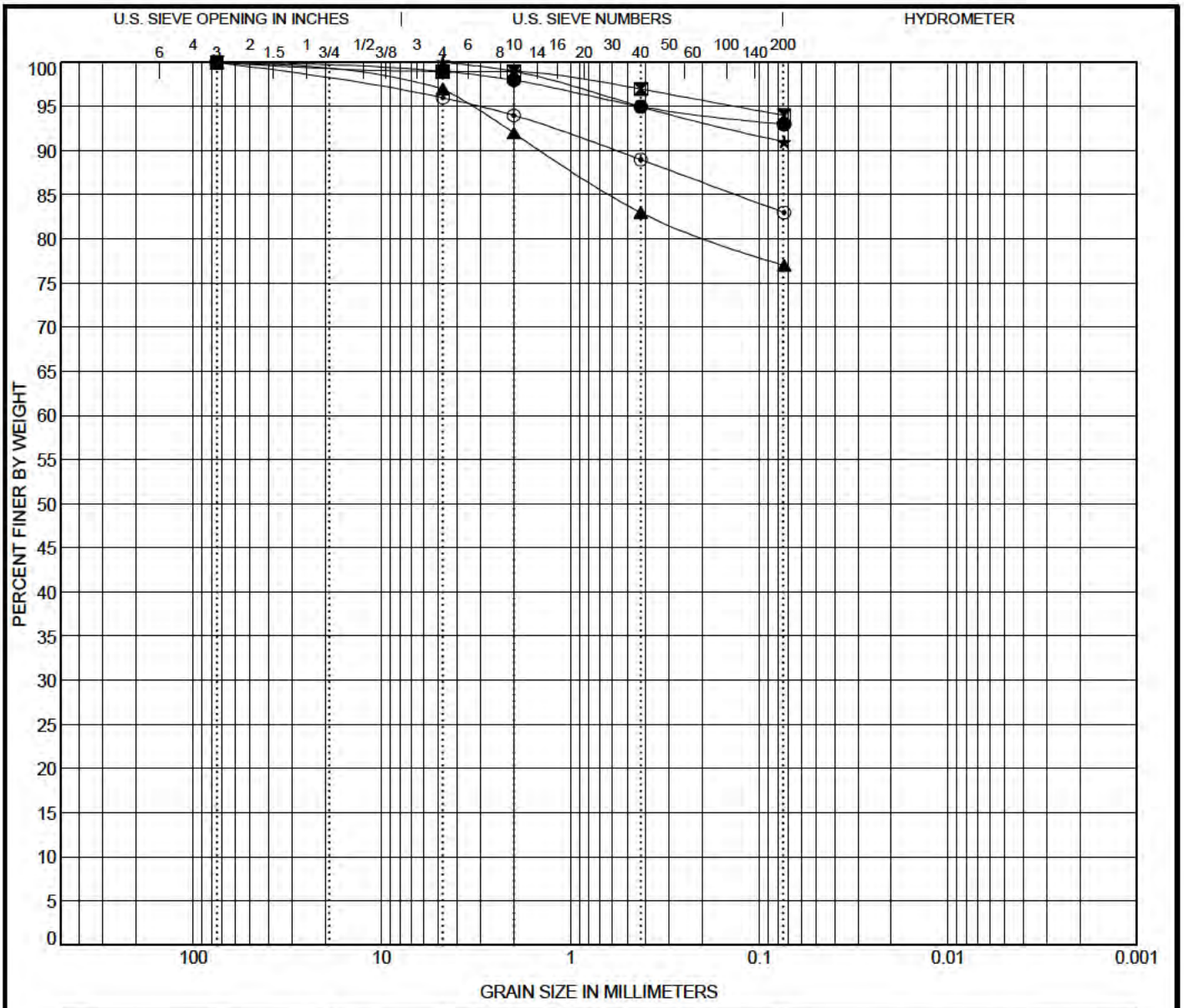
				0121-014	PLATE 4

BG GRAIN SIZE GRAINSIZE.GPJ FUGRO DALLAS DATA TEMPLATE.GDT 09/15/22 13:21



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	W-2	24.0	FAT CLAY(CH)	67	20	47		
⊠	W-2	34.0	FAT CLAY(CH)	55	17	38		
▲	W-3	7.0	FAT CLAY with SAND(CH)	54	18	36		
★	W-3	19.0	FAT CLAY(CH)	65	20	45		
⊙	W-3	29.0	FAT CLAY with SAND(CH)	54	19	35		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	W-2	24.0	75				1.0	6.0	93.0	
⊠	W-2	34.0	75				1.0	5.0	94.0	
▲	W-3	7.0	75				3.0	20.0	77.0	
★	W-3	19.0	4.75				0.0	9.0	91.0	
⊙	W-3	29.0	75				4.0	13.0	83.0	

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GRAIN SIZE DISTRIBUTION

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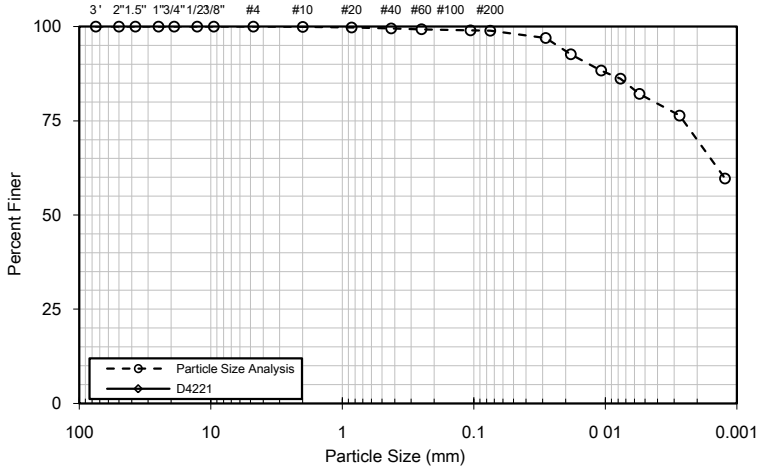
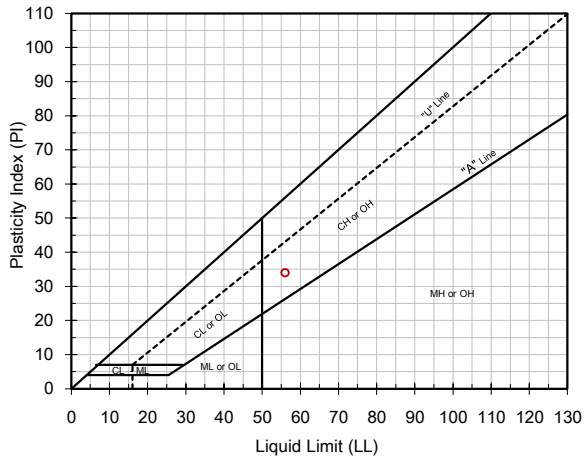
				0121-014	PLATE 5

Particle Size, Atterberg Limit, and USCS Analyses for Soils

Client: Balcones Geotechnical
Project: 0121-014 - Barton Springs Rd
Sample ID: W-4 (56)

TRI Log #: 72382.5





Mechanical Sieve				Dispersed		Vacuum with Agitation	
ASTM D422-63				ASTM D422-63		ASTM D4221	
Sieve Designation		Percent Passing	Gravel / Sand / Fines	Particle Size	Percent Passing	Particle Size	Percent Passing
-	mm			mm		mm	
3 in.	76.2	100.0	0.0	0.028	97.0	- -	- -
2 in.	50.8	100.0		0.018	92.7	- -	- -
1.5 in.	38.1	100.0		0.011	88.3	- -	- -
1 in.	25.4	100.0		0.008	86.2	- -	- -
3/4 in.	19.0	100.0		0.005	82.1	- -	- -
1/2 in.	12.7	100.0		0.003	76.4	- -	- -
3/8 in.	9.51	100.0		0.001	59.7	- -	- -
No. 4	4.76	100.0	1.1	Log-Linear Interpolation			
No. 10	2.00	99.9		Particle Size	Percent Passing	Particle Size	Percent Passing
No. 20	0.841	99.8		mm		mm	
No. 40	0.420	99.5					
No. 60	0.250	99.3		0.005	81.4	0.005	- -
No. 140	0.106	99.0		0.002	69.9	0.002	- -
No. 200	0.074	98.9	98.9	N m,2µm,d	70	N m,2µm,nd	-

D_X (mm), Log-Linear Interpolation						Percent Dispersion
10	30	50	60	Cu	Cc	(ASTM D4221)
- -	- -	- -	1.2E-03	- -	- -	-

USDA	Sand (%)		Silt (%)		Clay (%)	
Clay	(2.0-0.05 mm)	2.5	(0.05-0.002	27.5	(< 0.002 mm)	70.0

Atterberg Limits	
ASTM D4318, Method A : Multipoint, Air Dried	
Liquid Limit	56
Plastic Limit	22
Plastic Index	34
(NL = No Liquid Limit, NP = No Plastic Limit)	

USCS Classification (ASTM D2487)
Fat clay (CH)

Moisture Content (%)	ASTM D2216	- -
Organic Content (%)	ASTM D2974-C	- -
Carbonate Content (%)	ASTM D4373	- -

Relative / Index Density		
Minimum (pcf)	ASTM D4254	- -
Maximum, Oven-Dry (pcf)	ASTM D4253-1A	- -
Maximum, Wet (pcf)	ASTM D4253-1B	- -

Jeffrey A. Kuhn, Ph.D, P.E. 6/10/2022
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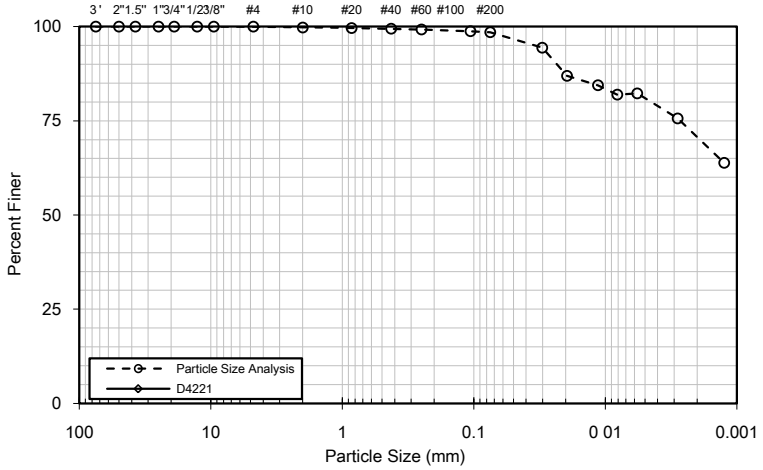
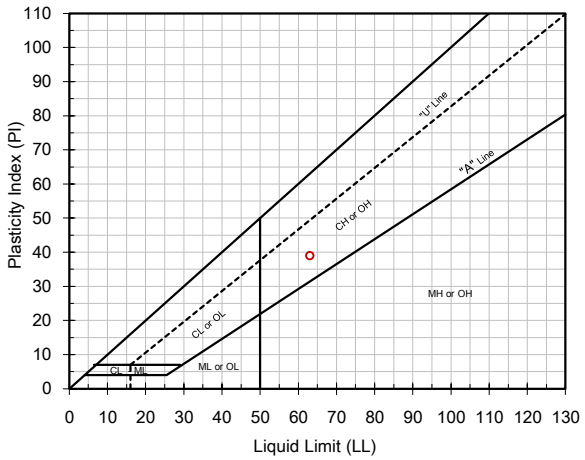
Particle Size, Atterberg Limit, and USCS Analyses for Soils

Client: Balcones Geotechnical
Project: 0121-014 - Barton Springs Rd
Sample ID: W-5 (26)

TRI Log #: 72382.4





Mechanical Sieve				Dispersed		Vacuum with Agitation	
ASTM D422-63				ASTM D422-63		ASTM D4221	
Sieve Designation		Percent Passing	Gravel / Sand / Fines	Particle Size	Percent Passing	Particle Size	Percent Passing
-	mm			mm		mm	
3 in.	76.2	100.0	0.0	0.030	94.4	- -	- -
2 in.	50.8	100.0		0.020	86.9	- -	- -
1.5 in.	38.1	100.0		0.011	84.4	- -	- -
1 in.	25.4	100.0		0.008	81.9	- -	- -
3/4 in.	19.0	100.0		0.006	82.3	- -	- -
1/2 in.	12.7	100.0		0.003	75.6	- -	- -
3/8 in.	9.51	100.0		0.001	63.8	- -	- -
No. 4	4.76	100.0	1.5	Log-Linear Interpolation			
No. 10	2.00	99.8		Particle Size	Percent Passing	Particle Size	Percent Passing
No. 20	0.841	99.6		mm		mm	
No. 40	0.420	99.4					
No. 60	0.250	99.2		0.005	81.0	0.005	- -
No. 140	0.106	98.8		0.002	70.7	0.002	- -
No. 200	0.074	98.5	98.5	N m,2µm,d	71	N m,2µm,nd	-

D_X (mm), Log-Linear Interpolation						Percent Dispersion
10	30	50	60	Cu	Cc	(ASTM D4221)
- -	- -	- -	- -	- -	- -	-

USDA	Sand (%)		Silt (%)		Clay (%)	
Clay	(2.0-0.05 mm)	4.8	(0.05-0.002	24.4	(< 0.002 mm)	70.8

Atterberg Limits	
ASTM D4318, Method A : Multipoint, Air Dried	
Liquid Limit	63
Plastic Limit	24
Plastic Index	39
(NL = No Liquid Limit, NP = No Plastic Limit)	

USCS Classification (ASTM D2487)
Fat clay (CH)

Moisture Content (%)	ASTM D2216	- -
Organic Content (%)	ASTM D2974-C	- -
Carbonate Content (%)	ASTM D4373	- -

Relative / Index Density		
Minimum (pcf)	ASTM D4254	- -
Maximum, Oven-Dry (pcf)	ASTM D4253-1A	- -
Maximum, Wet (pcf)	ASTM D4253-1B	- -

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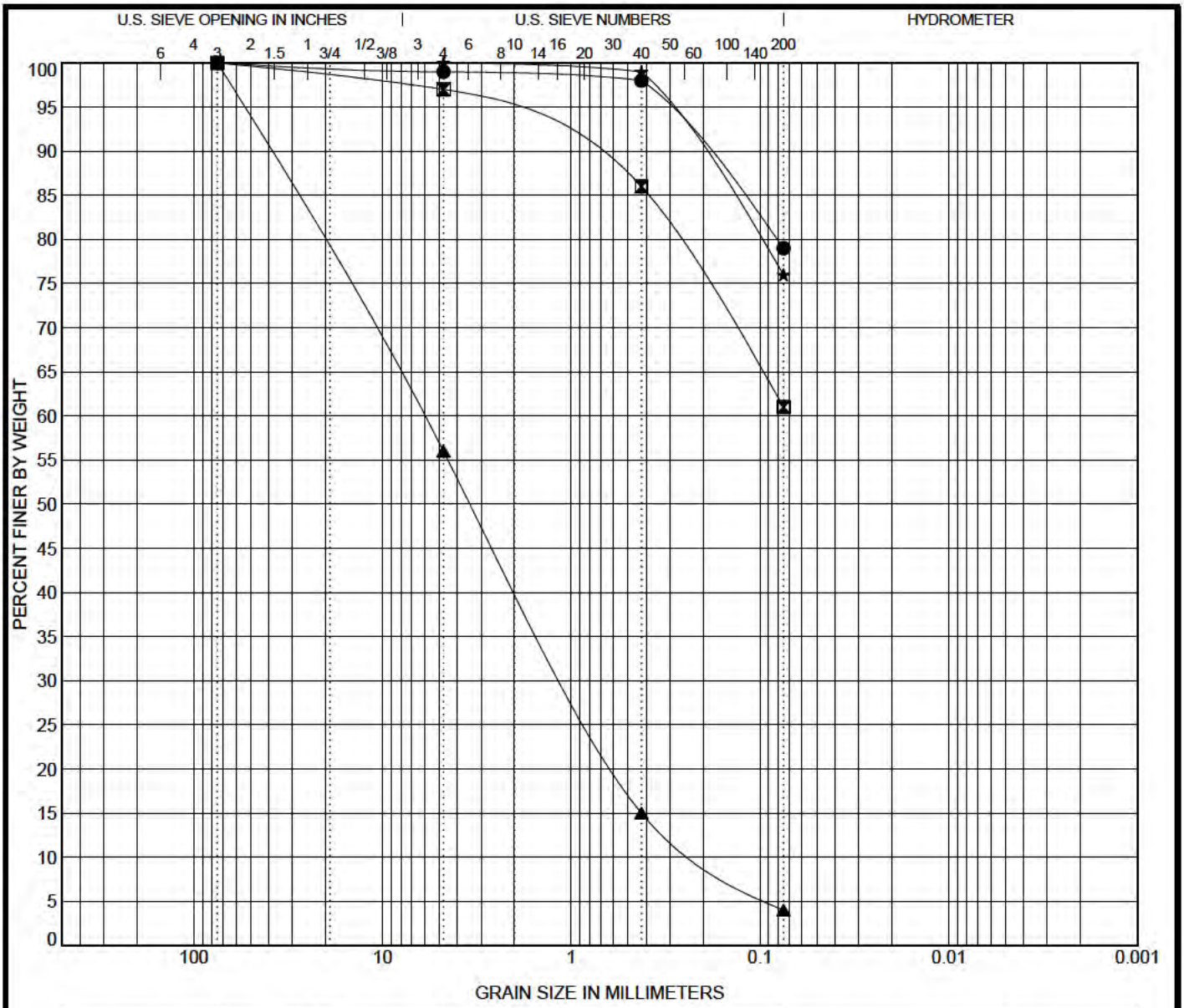


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring	Elev	Depth	Classification	LL	PL	PI	Cc	Cu
●	B-1	444.9	4.5	LEAN CLAY with SAND (CL)	38	16	22		
⊠	B-1	434.9	14.5	SANDY FAT CLAY (CH)	50	17	33		
▲	B-1	420.9	28.5	POORLY GRADED SAND with GRAVEL (SP)	23	15	8	0.90	31.60
★	B-2	440.9	8.5	LEAN CLAY with SAND (CL)	29	15	14		

	Boring	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-1	4.5	75				1.0	20.0	79.0	
⊠	B-1	14.5	75				3.0	36.0	61.0	
▲	B-1	28.5	75	6.104	1.028	0.193	44.0	52.0	4.0	
★	B-2	8.5	4.75				0.0	24.0	76.0	

Silt and clay fractions were determined using 0.002 mm as the maximum particle size for clay.

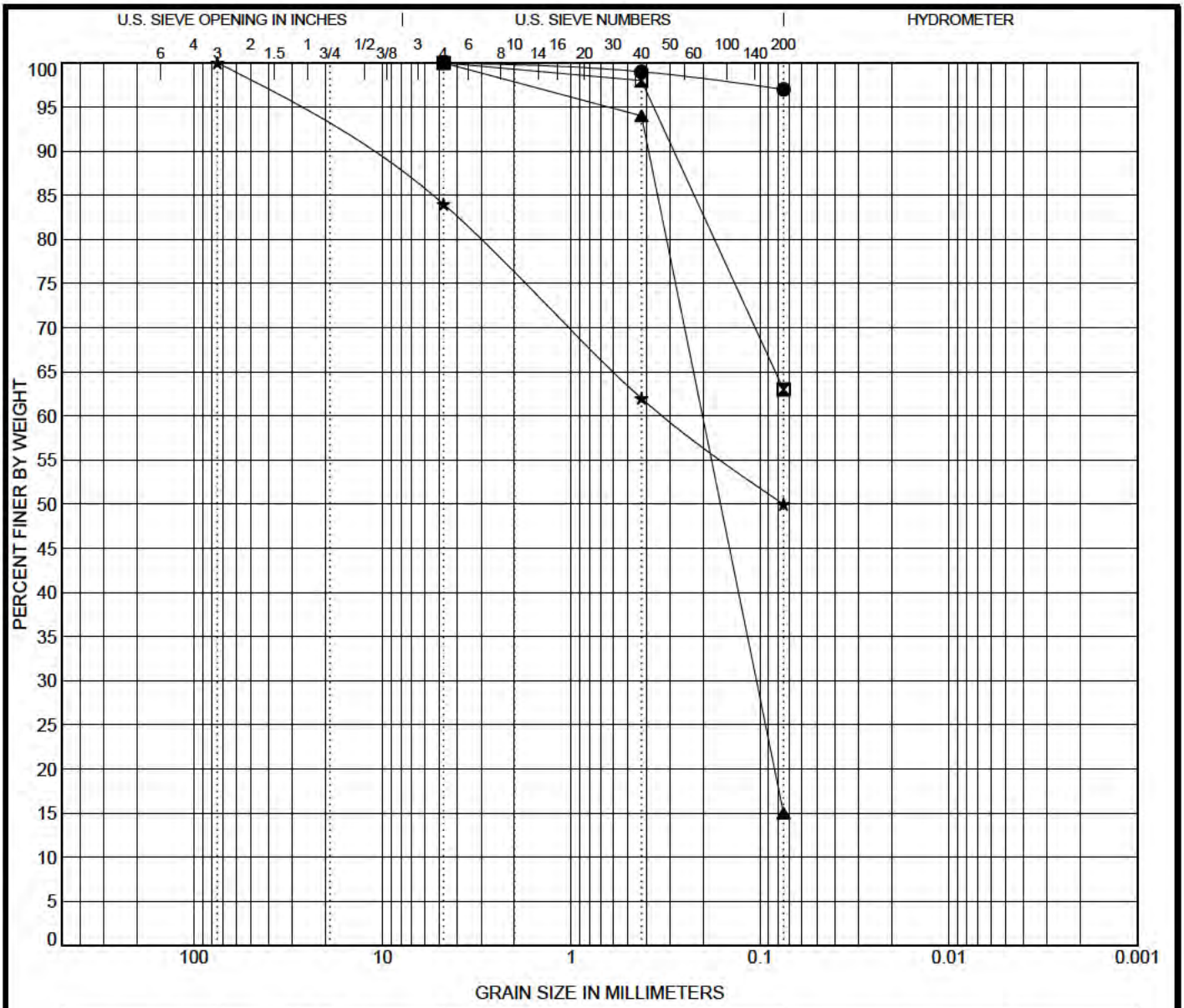
Arias & Associates, Inc.
13581 Pond Springs Rd, S210
Austin, TX 78729
Phone: 512.428.5550
Fax: 512.428.5525

GRAIN SIZE DISTRIBUTION

Project: Barton Springs Bridge Improvement Project

Location: See Boring Location Plan

Job No.: 2015-762



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring	Elev	Depth	Classification	LL	PL	PI	Cc	Cu
●	B-2	439.4	18.5	FAT CLAY (CH)	63	21	42		
⊠	B-4	444.4	13.5	SANDY LEAN CLAY (CL)	26	15	11		
▲	B-4	429.4	28.5	SILTY, CLAYEY SAND (SC-SM)	19	13	6		
★	B-4	414.4	43.5	SANDY LEAN CLAY with GRAVEL (CL)	30	14	16		

	Boring	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-2	18.5	4.75				0.0	3.0	97.0	
⊠	B-4	13.5	4.75				0.0	37.0	63.0	
▲	B-4	28.5	4.75	0.201	0.104		0.0	85.0	15.0	
★	B-4	43.5	75	0.318			16.0	34.0	50.0	

Silt and clay fractions were determined using 0.002 mm as the maximum particle size for clay.

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13581 Pond Springs Rd, S210
Austin, TX 78729
Phone: 512.428.5550
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GRAIN SIZE DISTRIBUTION

Project: Barton Springs Bridge Improvement Project

Location: See Boring Location Plan

Job No.: 2015-762

APPENDIX B-2

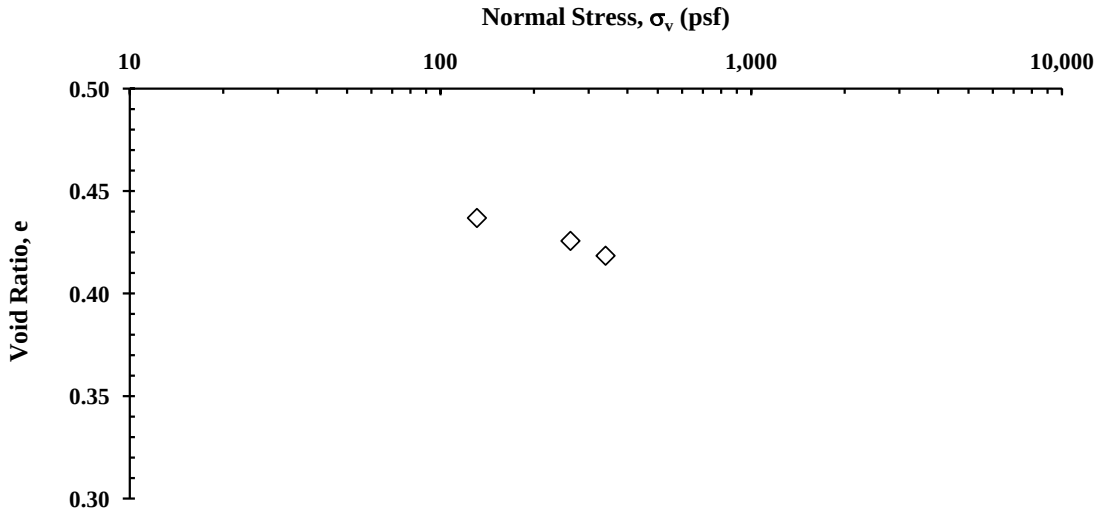
Pressure Swell Testing

Swell Pressure Measurement with Multistage Unloading

Client:	Balcones Geotechnical	TRI Log #:	72390.20
Project:	0121-014 - Barton Springs Rd	Test Method:	ASTM D4546-B MOD
Specimen:	W-4 (57)		

Stage	Initial[1,2]	Normal Stress (psf)[3,4]				
Normal Stress (psf)	120	340	262	131	-	-
Water Content, ω (%)	11.0	-	-	17.2	-	-
Diameter, d (in)	1.996	-	-	-	-	-
Height, h (in)	1.004	1.004	1.009	1.017	-	-
Total Unit Weight (pcf)	134.2	-	-	134.2	-	-
Dry Unit Weight (pcf)	120.9	-	-	120.9	-	-
Void Ratio, e	0.418	0.418	0.426	0.437	-	-
Δe / Δlog(σ)	-	-	-0.064	-0.037	-	-
Degree of Saturation, S (%)	72.3	-	-	≈100	-	-
Strain (%)[3,4]	0.000	0.000	-0.510	-1.299	-	-

1. The intact sample was provided by the client. A specimen was trimmed from the sample using a trimming turntable and mounted. Gs was assumed to be 2.75. Calculations include measured machine deflections.
2. In the specimen ring.
3. Sign convention: (+) Compression/Collapse, (-) Expansion/Swell
4. Modification: The initial stage of ASTM D2435 testing was performed in which the normal load required to prevent swelling is recorded. This value is being reported as the "Swell Pressure". Please note that alternate methods to determine "Swell Pressure" in an oedometer are presented in ASTM D4546 and thus this modified method could be considered a modification of both methods alike. Following the measurement of the swell pressure the sample was subsequently unloaded in a series of stages.



Jeffrey A. Kuhn, Ph.D., P.E. 6/18/2022
Analysis & Quality Review/Date

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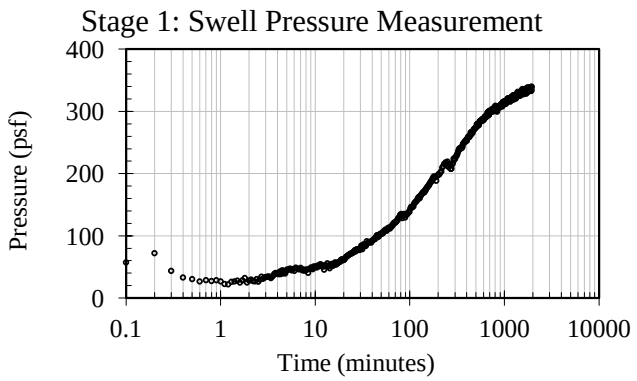
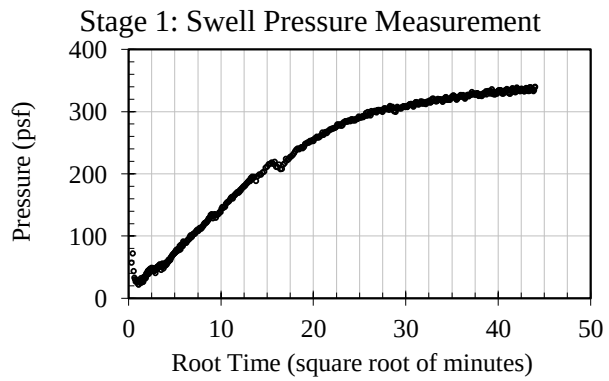
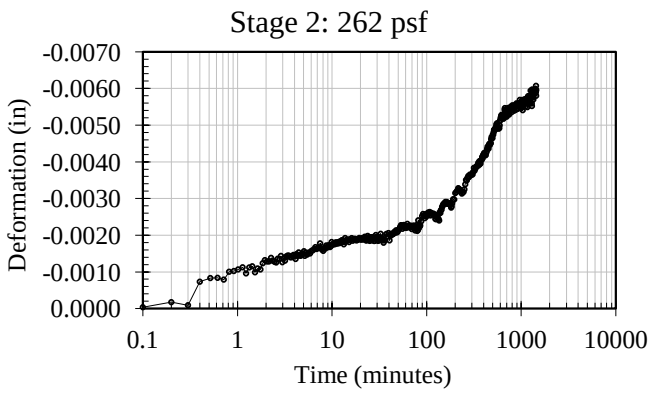
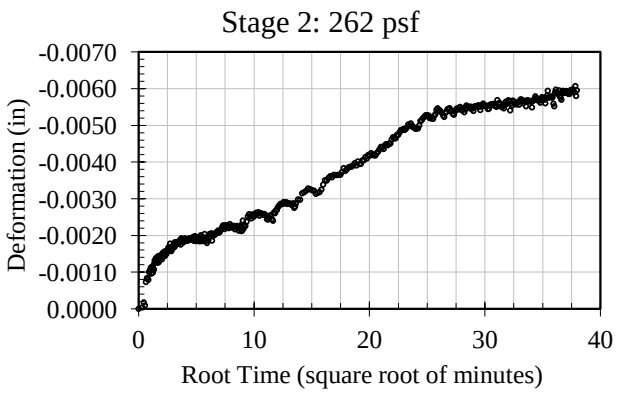
Swell Pressure Measurement with Multistage Unloading

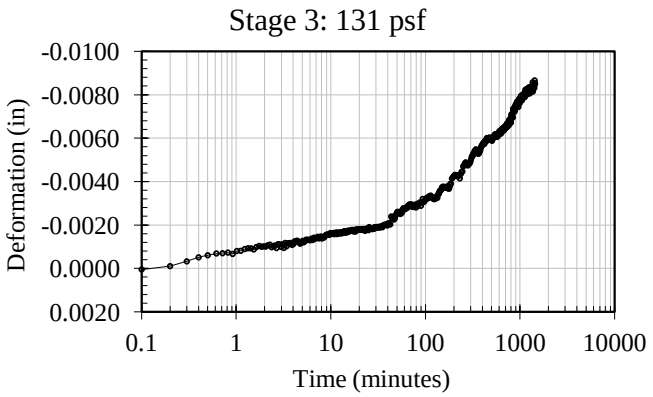
Client:	Balcones Geotechnical	TRI Log #:	72390.20
Project:	0121-014 - Barton Springs Rd	Test Method:	ASTM D4546-B MOD
Specimen:	W-4 (57)		

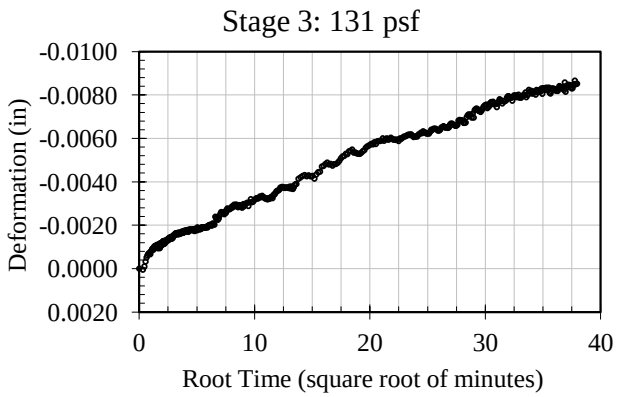












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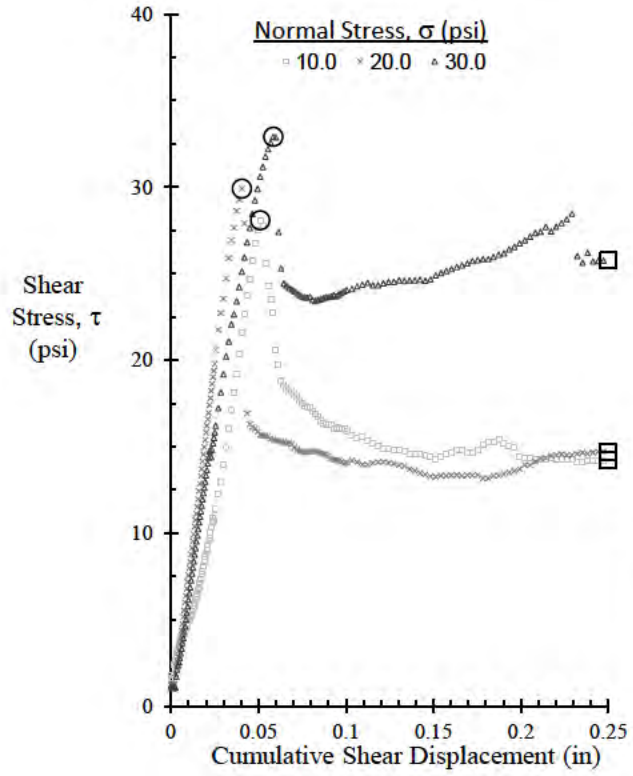
APPENDIX B-3

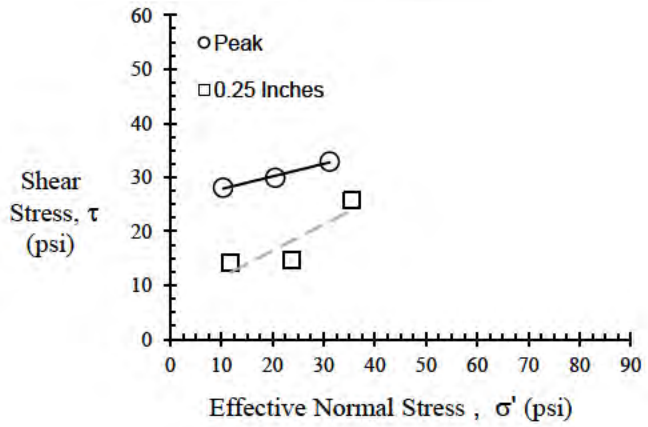
Direct Shear Testing

Direct Shear of Soil Under Consolidated-Drained Conditions

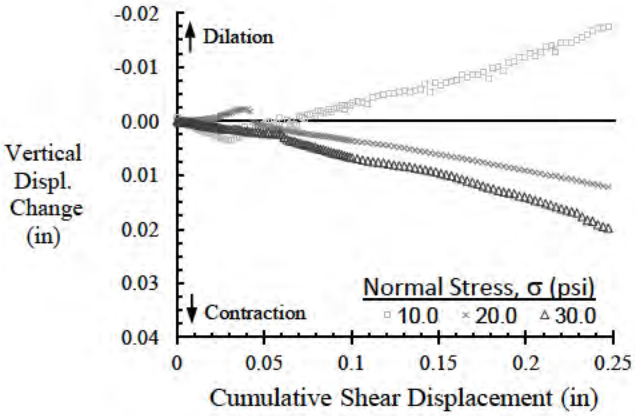
Client: Balcones Geotechnical
Project: 0121-014 - Barton Springs Rd
Sample: W-4 (38)

TRI Log#: 72390.6
Test Method: ASTM D3080





Note: Area Correction Has Been Applied



Specimen Number		1	2	3
Initial Condition	Diameter, in	2.00	2.00	2.00
	Height, in	1.00	1.00	1.00
	Water Content, %	10.8	15.9	20.1
	Saturation, %	65.3	74.0	84.3
	Dry Density, pcf	117.9	108.0	103.6
	Void Ratio	0.46	0.59	0.66
Consolidation Stress, σ' (psi)		10	20	30
Post-Consol	Height, in	0.97	0.98	0.98
	Dry Density, pcf	122.1	110.2	106.1
	Void Ratio	0.40	0.55	0.61
Displacement rate (in/min)		1E-04		
Final Water Content, %		19.8	23.6	24.4
Peak	Normal Stress, σ' (psi)	10.34	20.53	31.16
	Shear Stress, τ (psi)	28.09	29.92	32.91
	Secant Friction Angle, Degrees	69.8	55.5	46.6
	Displacement (in)	0.05	0.04	0.06
	ϕ'_d, degrees	13.1		
	c'_d, psi	25.5		
0.25 Inches	Normal Stress, σ' (psi)	11.86	23.72	35.58
	Shear Stress, τ (psi)	14.22	14.72	25.76
	Secant Friction Angle, Degrees	50.2	31.8	35.9
	ϕ'_d, degrees	25.9		
	c'_d, psi	6.7		

Note: The intact soil sample was extruded and specimens were prepared using a trimming turntable. A specific gravity of 2.75 was assumed for weight-volume calculations.

Jeffrey A. Kuhn, Ph.D., P.E., 6/23/22
Analysis & Quality Review/Date

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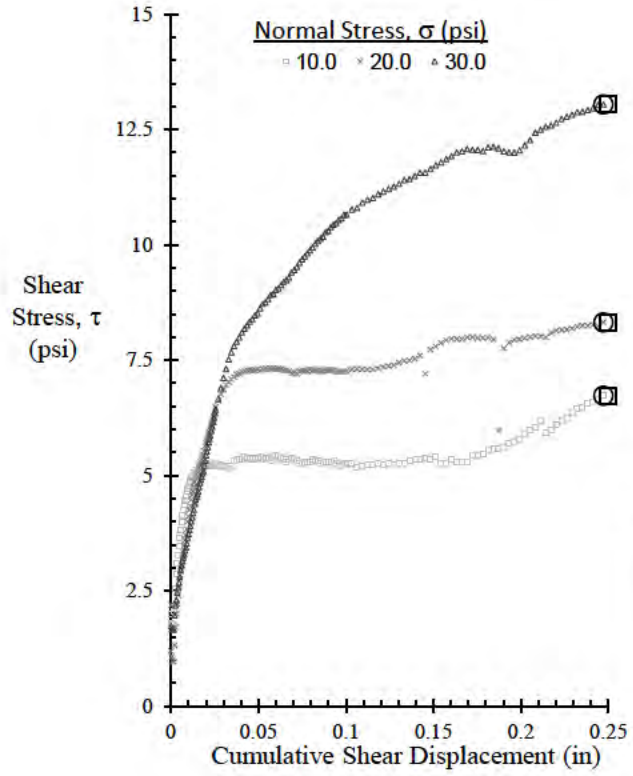
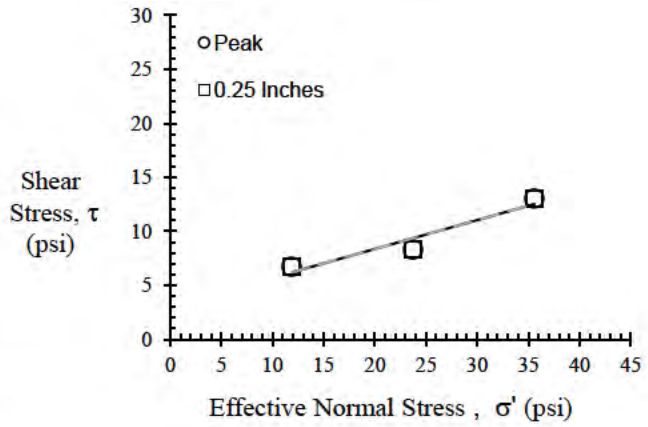
Direct Shear of Soil Under Consolidated-Drained Conditions

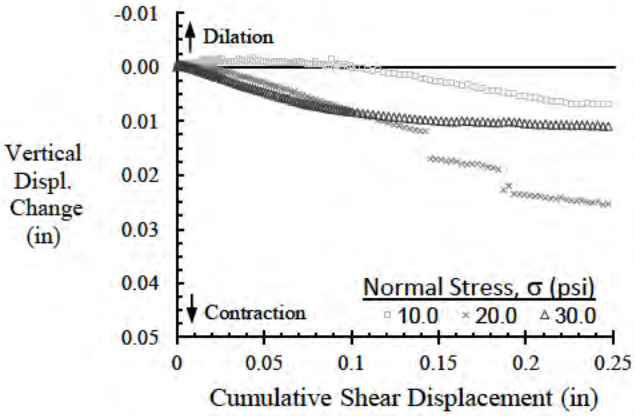
Client: Balcones Geotechnical
Project: 0121-014 - Barton Springs Rd
Sample: W-4 (58)

TRI Log#: 72390.7
Test Method: ASTM D3080





Note: Area Correction Has Been Applied



Specimen Number		1	2	3
Initial Condition	Diameter, in	2.00	2.00	2.00
	Height, in	1.00	1.00	1.00
	Water Content, %	17.5	14.5	17.2
	Saturation, %	99.8	86.7	119.3
	Dry Density, pcf	115.7	117.6	122.8
	Void Ratio	0.48	0.46	0.40
Consolidation Stress, σ' (psi)		10	20	30
Post-Consol	Height, in	1.00	0.99	0.99
	Dry Density, pcf	116.0	119.3	124.3
	Void Ratio	0.47	0.43	0.37
Displacement rate (in/min)		1E-04		
Final Water Content, %		19.3	21.1	19.9
Peak	Normal Stress, σ' (psi)	11.86	23.72	35.58
	Shear Stress, τ (psi)	6.73	8.32	13.04
	Secant Friction Angle, Degrees	29.6	19.3	20.1
	Displacement (in)	0.25	0.25	0.25
	ϕ'_d, degrees	14.9		
	c'_d, psi	3.1		
0.25 Inches	Normal Stress, σ' (psi)	11.86	23.72	35.58
	Shear Stress, τ (psi)	6.73	8.32	13.04
	Secant Friction Angle, Degrees	29.6	19.3	20.1
	ϕ'_d, degrees	14.9		
	c'_d, psi	3.1		

Note: The intact soil sample was extruded and specimens were prepared using a trimming turntable. A specific gravity of 2.75 was assumed for weight-volume calculations.

Jeffrey A. Kuhn, Ph.D., P.E., 6/23/22
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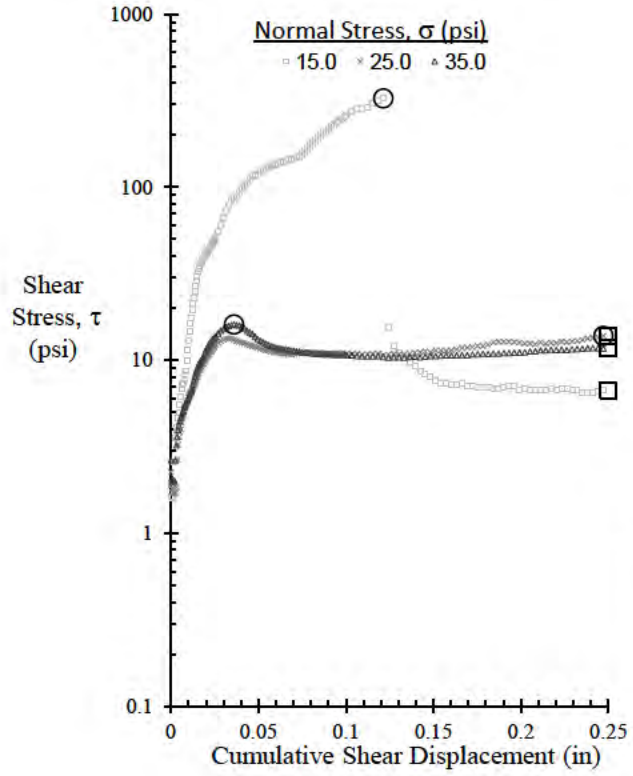
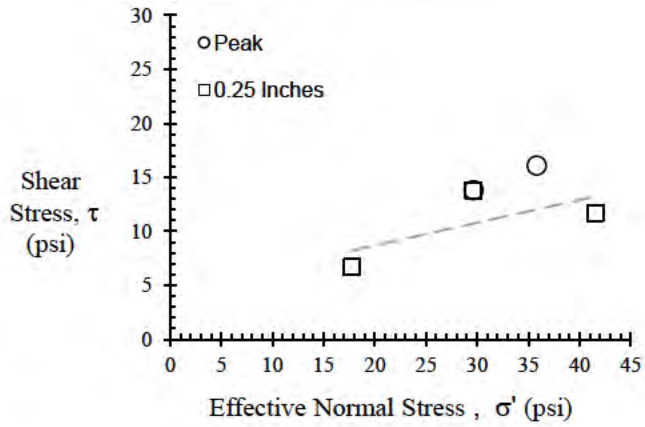
Direct Shear of Soil Under Consolidated-Drained Conditions

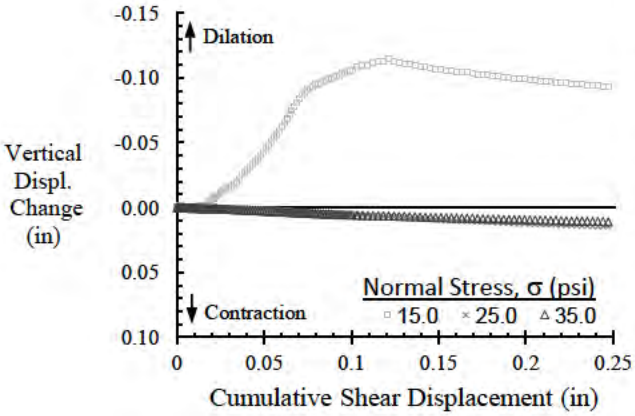
Client: Balcones Geotechnical
Project: 0121-014 - Barton Springs Rd
Sample: W-4 (74)

TRI Log#: 72390.8
Test Method: ASTM D3080





Note: Area Correction Has Been Applied



Specimen Number		1	2	3
Initial Condition	Diameter, in	2.00	2.00	2.00
	Height, in	1.00	1.00	1.00
	Water Content, %	19.6	18.8	19.6
	Saturation, %	99.7	92.7	93.0
	Dry Density, pcf	111.3	110.1	108.7
	Void Ratio	0.54	0.56	0.58
Consolidation Stress, σ' (psi)		15	25	35
Post-Consol	Height, in	0.98	0.95	0.97
	Dry Density, pcf	113.8	115.4	112.5
	Void Ratio	0.50	0.48	0.51
Displacement rate (in/min)		1E-04		
Final Water Content, %		19.2	21.2	23.9
Peak	Normal Stress, σ' (psi)	16.25	29.65	35.82
	Shear Stress, τ (psi)	325.99	13.81	16.09
	Secant Friction Angle, Degrees	87.1	25.0	24.2
	Displacement (in)	0.12	0.25	0.04
	ϕ'_d, degrees	Negative Intercept, Refer to Secant Friction Angles		
	c'_d, psi			
0.25 Inches	Normal Stress, σ' (psi)	17.79	29.65	41.51
	Shear Stress, τ (psi)	6.70	13.81	11.68
	Secant Friction Angle, Degrees	20.6	25.0	15.7
	ϕ'_d, degrees	11.8		
	c'_d, psi	4.5		

Note: The intact soil sample was extruded and specimens were prepared using a trimming turntable. A specific gravity of 2.75 was assumed for weight-volume calculations.

Jeffrey A. Kuhn, Ph.D., P.E., 6/23/22
Analysis & Quality Review/Date

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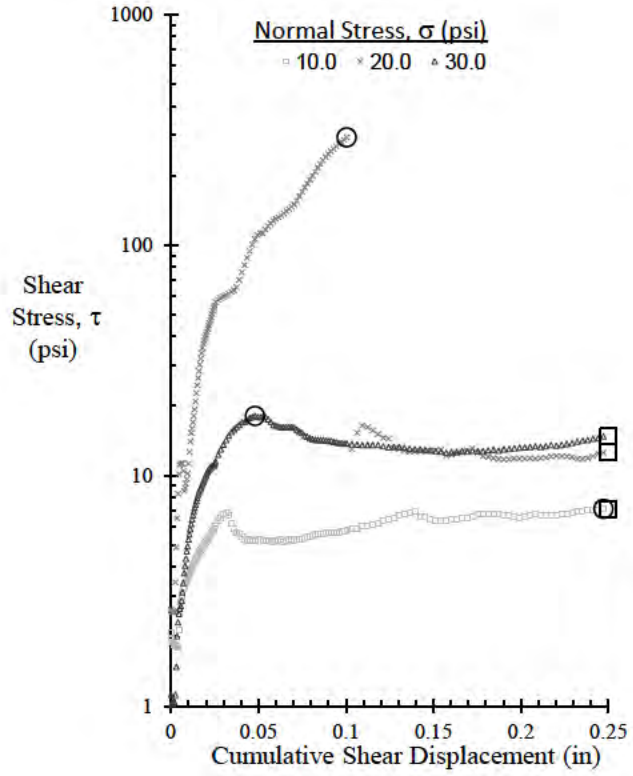
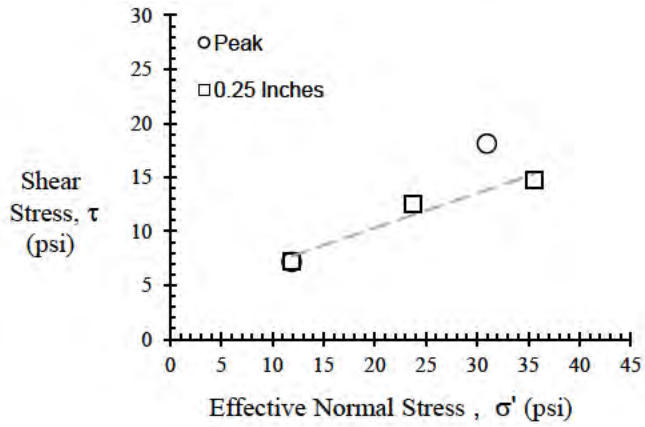
Direct Shear of Soil Under Consolidated-Drained Conditions

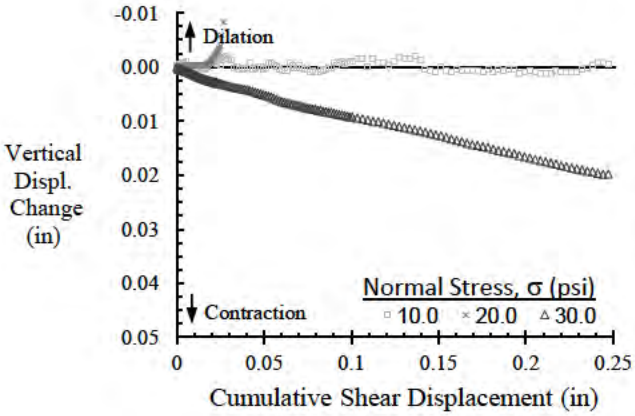
Client: Balcones Geotechnical
Project: 0121-014 - Barton Springs Rd
Sample: W-5 (37)

TRI Log#: 72390.16
Test Method: ASTM D3080





Note: Area Correction Has Been Applied



Specimen Number		1	2	3
Initial Condition	Diameter, in	2.00	2.00	2.00
	Height, in	1.00	1.00	1.00
	Water Content, %	27.2	26.3	26.1
	Saturation, %	88.9	89.9	89.4
	Dry Density, pcf	93.1	95.0	95.2
	Void Ratio	0.84	0.81	0.80
Consolidation Stress, σ' (psi)		10	20	30
Post-Consol	Height, in	1.00	0.95	0.95
	Dry Density, pcf	92.8	100.5	100.4
	Void Ratio	0.84	0.69	0.70
Displacement rate (in/min)		1E-04		
Final Water Content, %		30.2	30.0	30.6
Peak	Normal Stress, σ' (psi)	11.86	21.36	30.94
	Shear Stress, τ (psi)	7.17	292.43	18.12
	Secant Friction Angle, Degrees	31.1	85.8	30.4
	Displacement (in)	0.25	0.10	0.05
	ϕ'_d, degrees	28.1		
	c'_d, psi	94.5		
0.25 Inches	Normal Stress, σ' (psi)	11.86	23.72	35.58
	Shear Stress, τ (psi)	7.17	12.58	14.77
	Secant Friction Angle, Degrees	31.1	27.9	22.5
	ϕ'_d, degrees	17.8		
	c'_d, psi	3.9		

Note: The intact soil sample was extruded and specimens were prepared using a trimming turntable. A specific gravity of 2.75 was assumed for weight-volume calculations.

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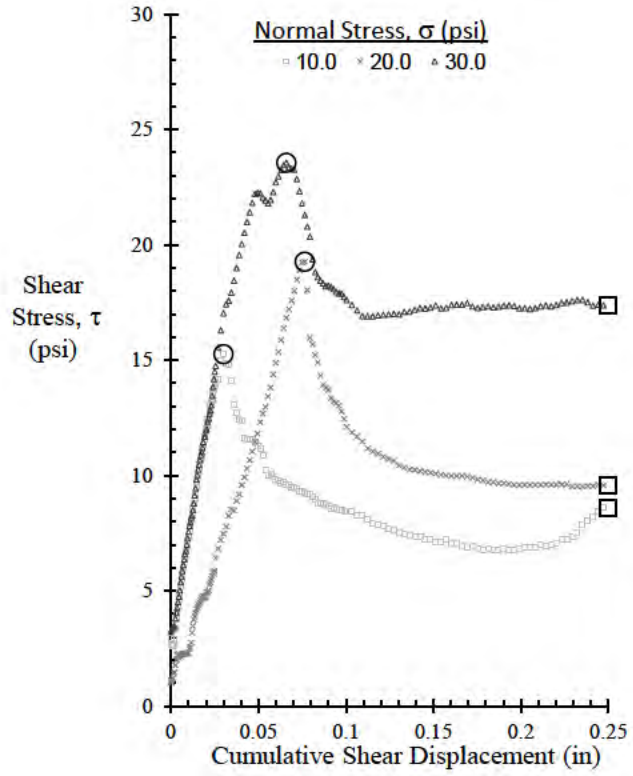
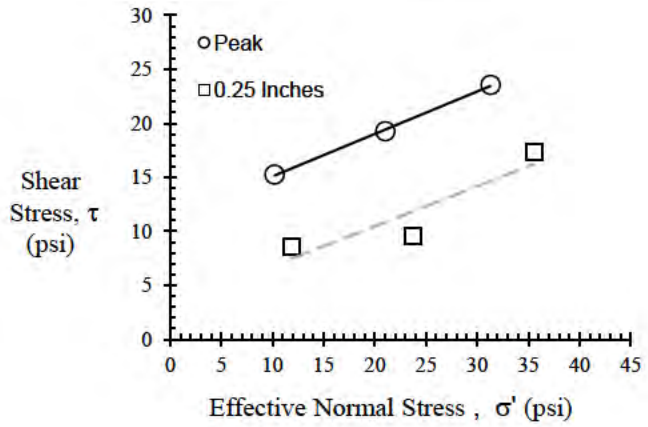
Direct Shear of Soil Under Consolidated-Drained Conditions

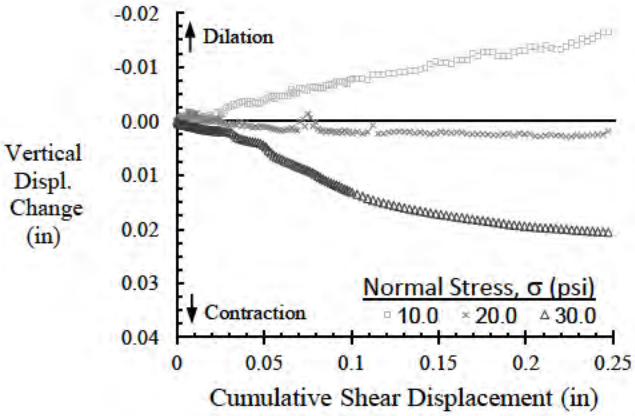
Client: Balcones Geotechnical
Project: 0121-014 - Barton Springs Rd
Sample: W-5 (53)

TRI Log#: 72390.17
Test Method: ASTM D3080





Note: Area Correction Has Been Applied



Specimen Number		1	2	3
Initial Condition	Diameter, in	2.00	2.00	2.00
	Height, in	1.00	1.00	1.00
	Water Content, %	14.6	13.6	13.3
	Saturation, %	78.8	69.3	68.7
	Dry Density, pcf	113.5	111.4	112.1
	Void Ratio	0.51	0.54	0.53
Consolidation Stress, σ' (psi)		10	20	30
Post-Consol	Height, in	0.98	0.99	0.95
	Dry Density, pcf	115.7	112.8	118.0
	Void Ratio	0.47	0.51	0.44
Displacement rate (in/min)		1E-04		
Final Water Content, %		18.2	22.5	20.1
Peak	Normal Stress, σ' (psi)	10.19	21.02	31.31
	Shear Stress, τ (psi)	15.26	19.27	23.56
	Secant Friction Angle, Degrees	56.3	42.5	37.0
	Displacement (in)	0.03	0.08	0.07
	ϕ'_d, degrees	21.4		
	c'_d, psi	11.2		
0.25 Inches	Normal Stress, σ' (psi)	11.86	23.72	35.58
	Shear Stress, τ (psi)	8.59	9.57	17.38
	Secant Friction Angle, Degrees	35.9	22.0	26.0
	ϕ'_d, degrees	20.3		
	c'_d, psi	3.1		

Note: The intact soil sample was extruded and specimens were prepared using a trimming turntable. A specific gravity of 2.75 was assumed for weight-volume calculations.

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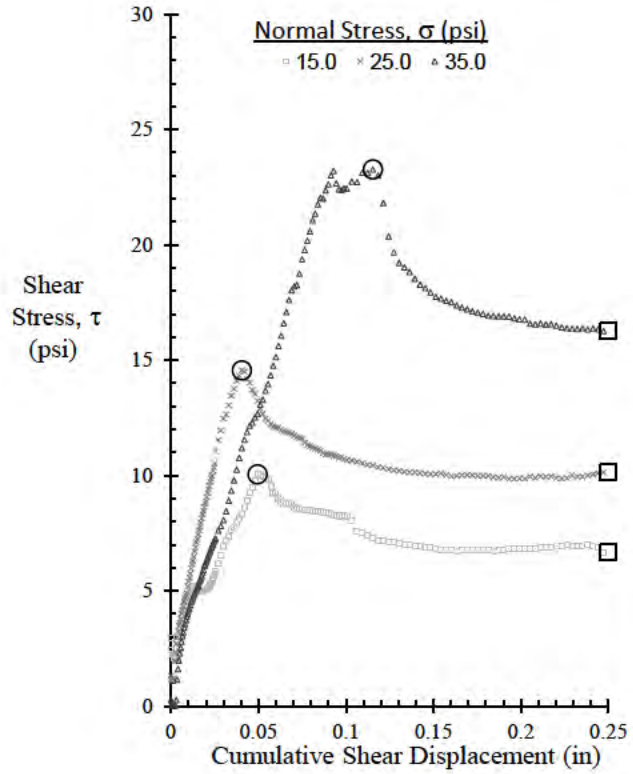
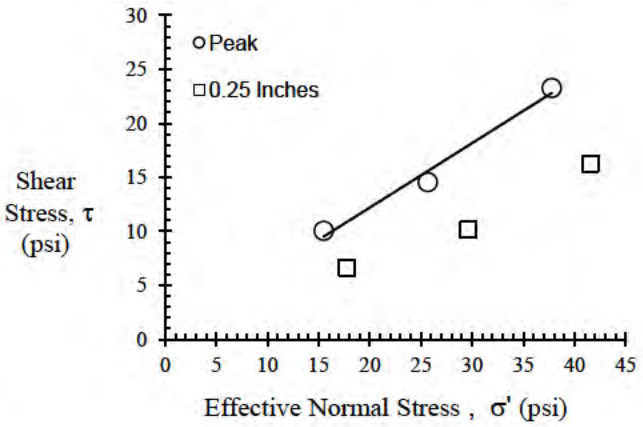
Direct Shear of Soil Under Consolidated-Drained Conditions

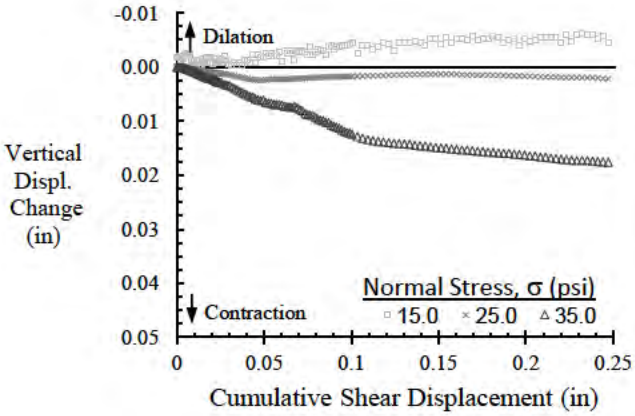
Client: Balcones Geotechnical
Project: 0121-014 - Barton Springs Rd
Sample: W-5 (69)

TRI Log#: 72390.18
Test Method: ASTM D3080





Note: Area Correction Has Been Applied



Specimen Number		1	2	3
Initial Condition	Diameter, in	2.00	2.00	2.00
	Height, in	1.00	1.00	1.00
	Water Content, %	14.8	11.3	16.1
	Saturation, %	73.3	66.0	80.1
	Dry Density, pcf	110.5	116.6	110.6
	Void Ratio	0.55	0.47	0.55
Consolidation Stress, σ' (psi)		15	25	35
Post-Consol	Height, in	1.00	0.99	0.99
	Dry Density, pcf	110.1	118.3	111.9
	Void Ratio	0.55	0.44	0.52
Displacement rate (in/min)		1E-04		
Final Water Content, %		24.1	22.1	21.8
Peak	Normal Stress, σ' (psi)	15.49	25.66	37.77
	Shear Stress, τ (psi)	10.05	14.56	23.27
	Secant Friction Angle, Degrees	33.0	29.6	31.6
	Displacement (in)	0.05	0.04	0.12
	ϕ'_d, degrees	30.8		
	c'_d, psi	0.3		
0.25 Inches	Normal Stress, σ' (psi)	17.79	29.65	41.52
	Shear Stress, τ (psi)	6.66	10.13	16.26
	Secant Friction Angle, Degrees	20.5	18.9	21.4
	ϕ'_d, degrees	Negative Intercept, Refer to Secant Friction Angles		
	c'_d, psi			

Note: The intact soil sample was extruded and specimens were prepared using a trimming turntable. A specific gravity of 2.75 was assumed for weight-volume calculations.

Jeffrey A. Kuhn, Ph.D., P.E., 7/15/22
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APPENDIX B-4

Consolidated Undrained Triaxial Compression Testing

Consolidated-Undrained Triaxial Compression

Client: Balcones Geotechnical
Project: 0121-014- Barton Springs Rd.
Sample: W-1 (23.5-25) (28.5-30) (33.5-35)

TRI Log #: 72382.1
Test Method: ASTM D4767

Specimens				
Identification	1	2	3	4
Depth/Elev. (ft)	-	-	-	-
Eff. Consol. Stress (psi)	10.0	20.0	30.0	-
Initial Specimen Properties				
Avg. Diameter (in)	2.01	2.00	2.00	-
Avg. Height (in)	4.32	4.41	4.46	-
Avg. Water Content (%)	18.8	18.9	19.5	-
Bulk Density (pcf)	130.0	128.3	127.2	-
Dry Density (pcf)	109.4	107.9	106.4	-
Specific Gravity (Assumed)	2.75			
Saturation (%)	90.9	88.1	87.6	-
Void Ratio, n	0.57	0.59	0.61	-
B-Value, End of Saturation	1.00	0.97	0.97	-

Test Setup	
Specimen Condition	Remolded
Specimen Preparation	Kneading and Impact Compaction, Six Lifts
Mounting Method	Wet
Consolidation	Isotropic

Post-Consolidation / Pre-Shear				
Void Ratio	0.48	0.50	0.50	-

Shear / Post-Shear				
Rate of Strain (%/hr)	0.25	0.25	0.25	-
Avg. Water Content (%)	25.7	24.0	24.9	-

At Failure								
Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$				Ratio, $(\sigma_1'/\sigma_3')_{max}$			
Axial Strain at Failure (%), $\varepsilon_{a,f}$	8.5	13.3	9.9	-	3.3	5.5	6.3	-
Minor Effective Stress (psi), $\sigma_3'_f$	10.7	21.2	21.6	-	7.9	16.5	20.4	-
Principal Stress Difference (psi), $(\sigma_1-\sigma_3)_f$	18.1	28.4	28.3	-	15.6	24.4	27.7	-
Pore Water Pressure, Δu_f (psi)	-0.7	-1.2	8.4	-	2.1	3.5	9.5	-
Major Effective Stress (psi), $\sigma_1'_f$	28.9	49.6	49.9	-	23.5	40.9	48.1	-
Secant Friction Angle (degrees)	27.3	23.6	23.3	-	29.7	25.2	23.9	-
Effective Friction Angle (degrees)	18.9				19.3			
Effective Cohesion (psi)	2.8				2.8			

Note: The presented M-C parameters are based on a linear regression in modified stress space, across all assigned effective consolidation stresses. This fit does not purported to capture typical curvature of envelopes that may, in particular, be observed across broader range in effective stresses. Please note that the stresses associated with peak principal stress ratio and peak principal stress difference are presented in tabular form on the first page of the report. There are alternate interpretations to theses two failure criterion including but not limited to strain compatibility and post-peak.

Jeffrey A. Kuhn , Ph.D., P.E., 9/7/2022
Analysis & Quality Review/Date

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Consolidated-Undrained Triaxial Compression

Client: Balcones Geotechnical
Project: 0121-014- Barton Springs Rd.
Sample: W-1 (23.5-25) (28.5-30) (33.5-35)

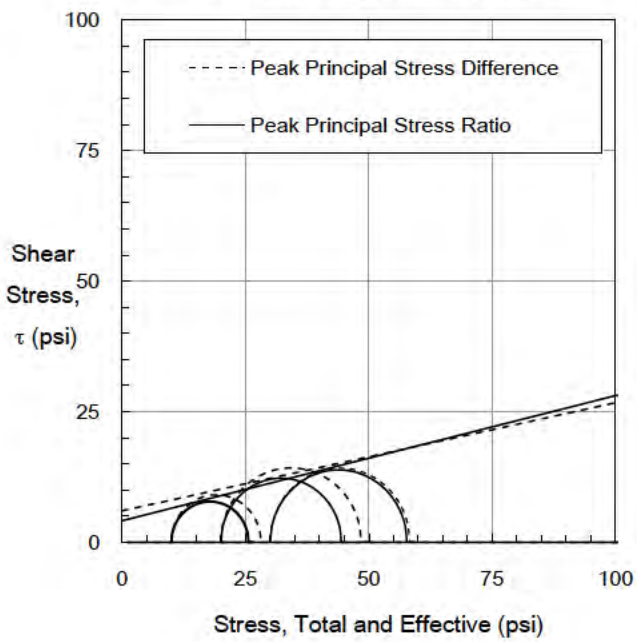
TRI Log #: 72382.1
Test Method: ASTM D4767

R / "Total Stress" Envelope			
Failure Criterion: Peak Principal Stress		Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Friction Angle (deg)	ϕ_R	11.7	13.5
Cohesion (psi)	c_R	6.0	4.1

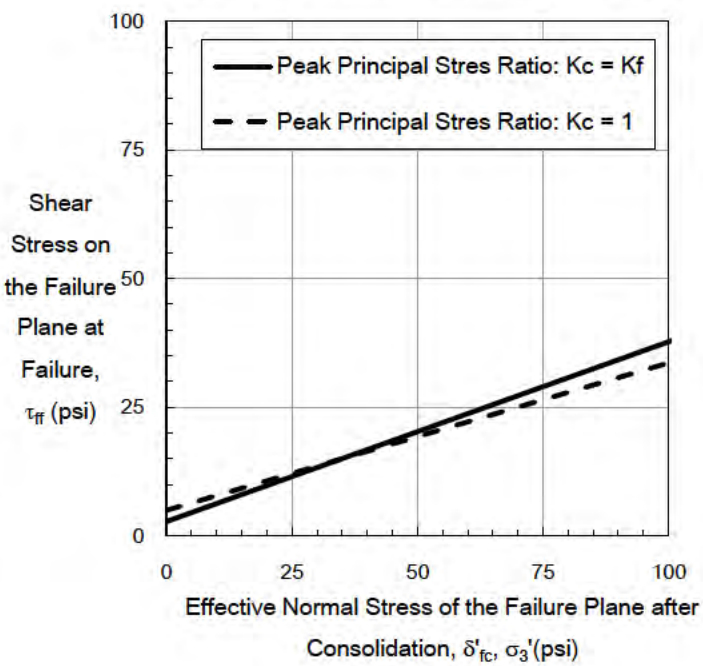
Kc = Kf Envelope, Effective Stress Envelope (Duncan et al. 1990)			
Failure Criterion: Peak Principal Stress		Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	ϕ'	18.9	19.3
Effective Cohesion (psi)	c'	2.8	2.8

Kc = 1 (τ_{ff} vs σ'_{fc}) Envelope, Total Stress Envelope (Duncan et al. 1990)			
Failure Criterion: Peak Principal Stress		Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Friction Angle (deg)	$d_{Kc=1}$	13.5	16.0
Cohesion (psi)	$\psi_{Kc=1}$	7.0	4.9

R / "Total Stress" Envelope



Three-Stage Rapid Drawdown Envelopes



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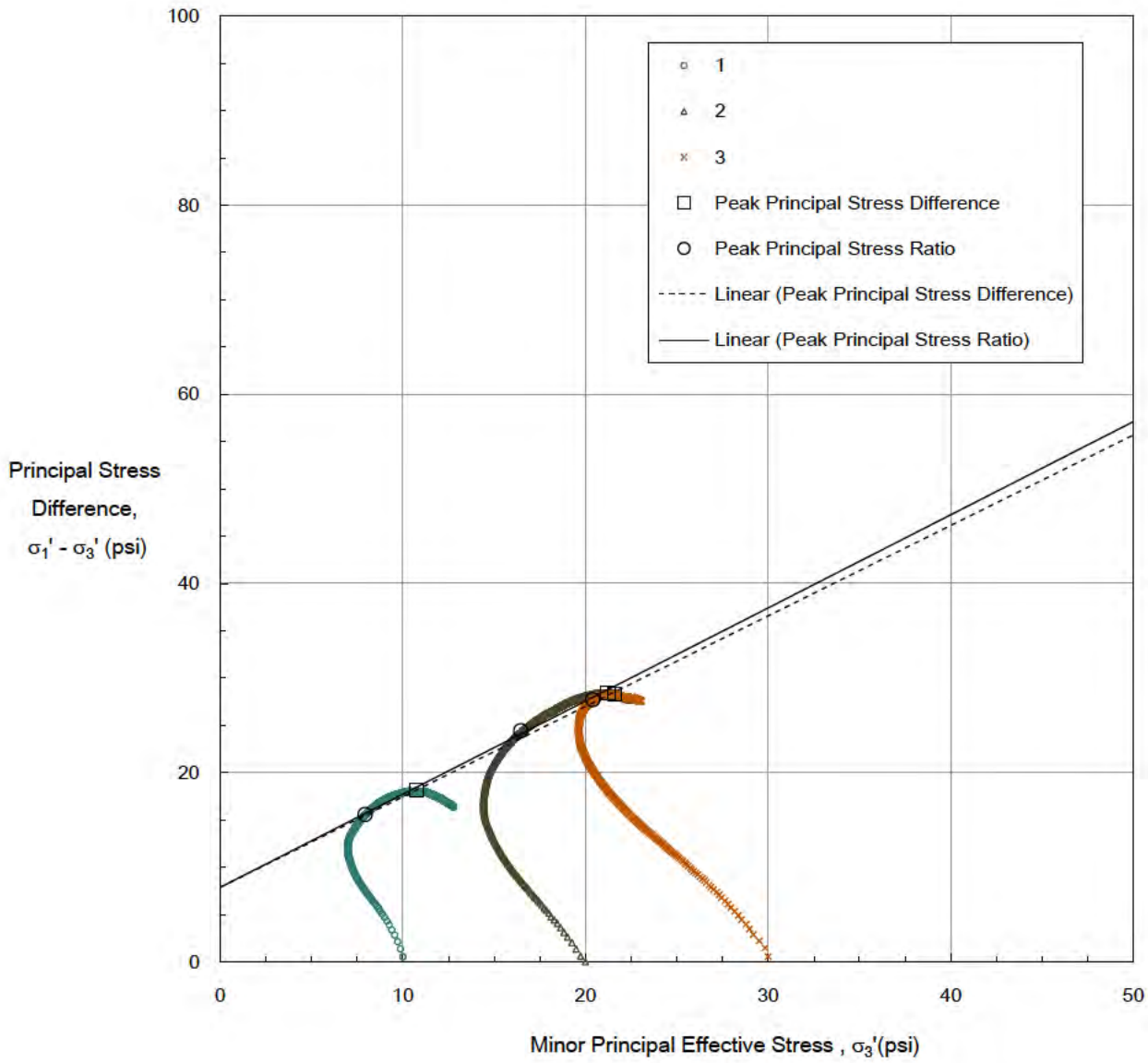
Consolidated-Undrained Triaxial Compression

Client: Balcones Geotechnical
Project: 0121-014- Barton Springs Rd.
Sample: W-1 (23.5-25) (28.5-30) (33.5-35)

TRI Log #: 72382.1
Test Method: ASTM D4767

Modified Mohr-Coulomb



Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	18.9	19.3
Effective Cohesion (psi)	2.8	2.8

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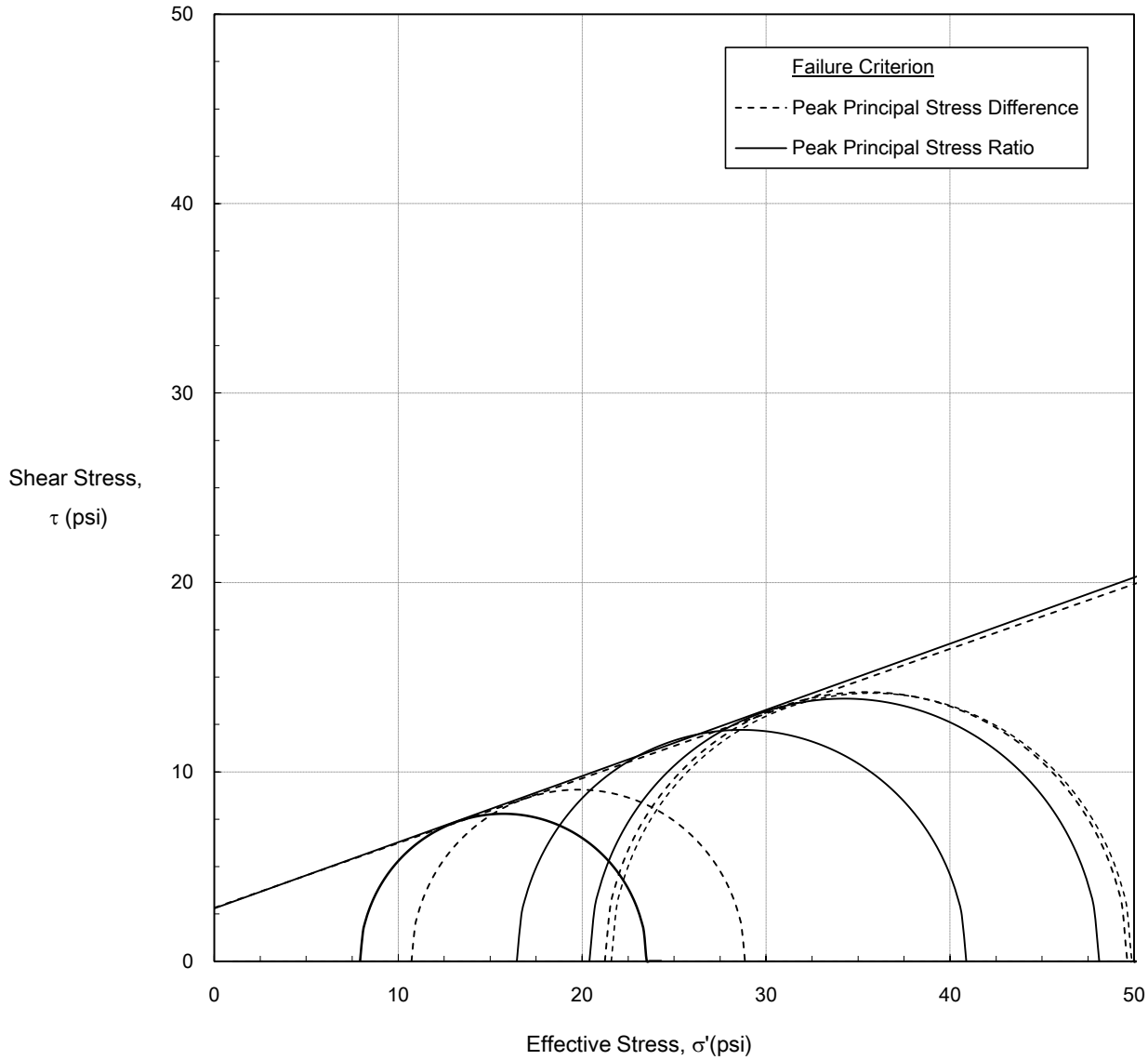
Consolidated-Undrained Triaxial Compression

Client: Balcones Geotechnical
Project: 0121-014- Barton Springs Rd.
Sample: W-1 (23.5-25) (28.5-30) (33.5-35)

TRI Log #: 72382.1
Test Method: ASTM D4767

Mohr-Coulomb



Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	18.9	19.3
Effective Cohesion (psi)	2.8	2.8

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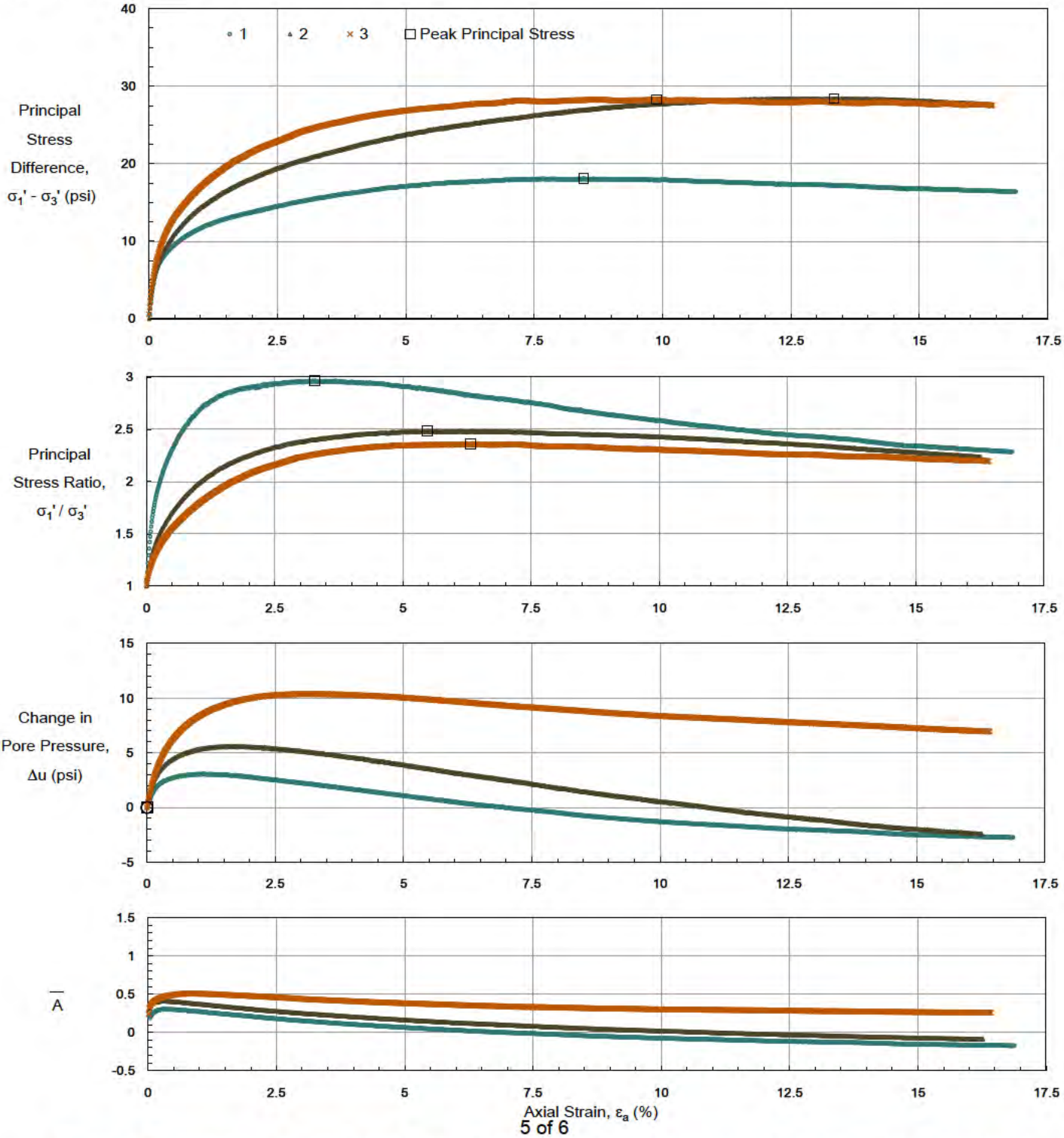
Consolidated-Undrained Triaxial Compression

Client: Balcones Geotechnical
Project: 0121-014- Barton Springs Rd.
Sample: W-1 (23.5-25) (28.5-30) (33.5-35)

TRI Log #: 72382.1
Test Method: ASTM D4767



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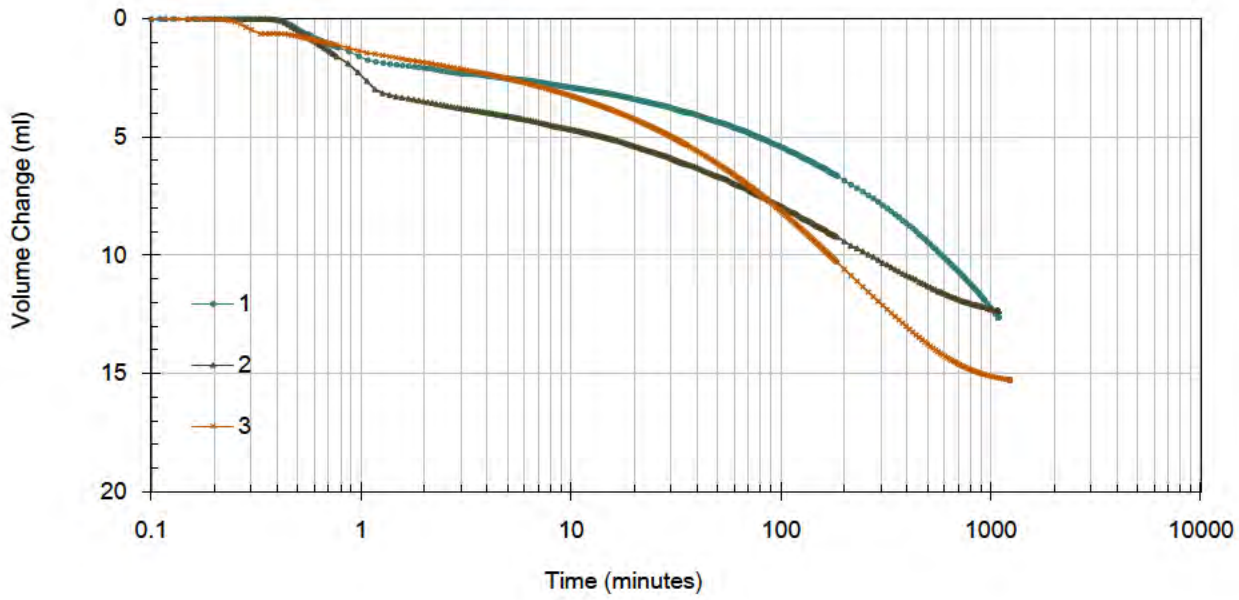
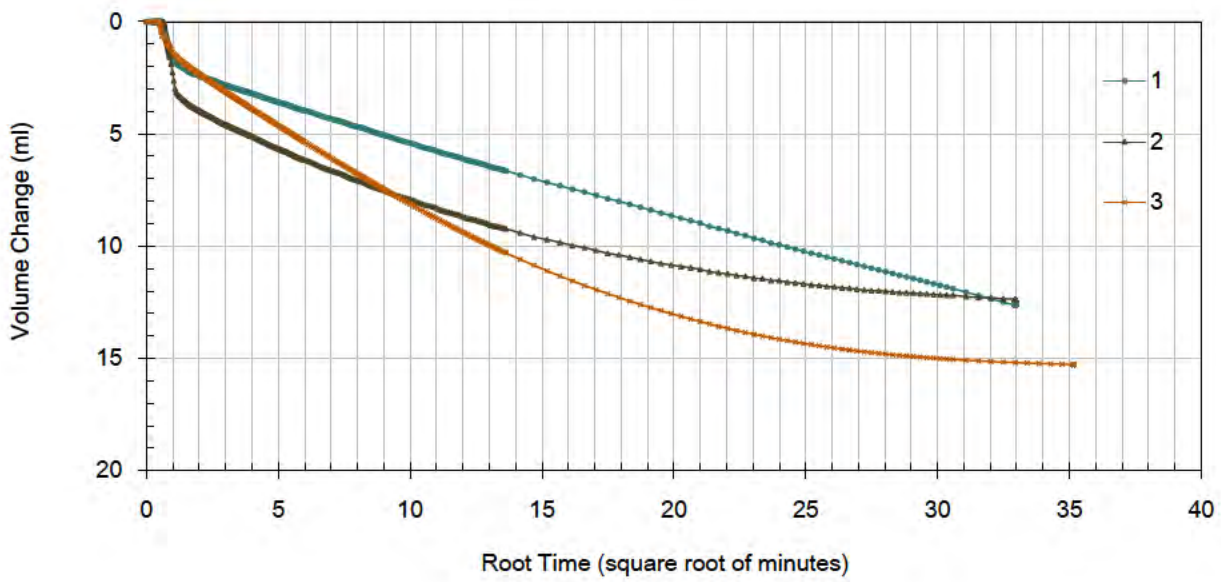
Consolidated-Undrained Triaxial Compression

Client: Balcones Geotechnical
Project: 0121-014- Barton Springs Rd.
Sample: W-1 (23.5-25) (28.5-30) (33.5-35)

TRI Log #: 72382.1
Test Method: ASTM D4767

Consolidation





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Consolidated-Undrained Triaxial Compression

Client: Balcones Geotechnical
Project: 0121-014- Barton Springs Rd.
Sample: W-2 (7-8.5) (9-10.5) (13.5-15) (18.5-20)

TRI Log #: 72382.2
Test Method: ASTM D4767

Specimens				
Identification	1	2	3	4
Depth/Elev. (ft)	-	-	-	-
Eff. Consol. Stress (psi)	5.0	15.0	25.0	-
Initial Specimen Properties				
Avg. Diameter (in)	2.01	2.00	2.00	-
Avg. Height (in)	4.38	4.37	4.41	-
Avg. Water Content (%)	18.7	19.8	19.6	-
Bulk Density (pcf)	128.3	130.1	129.2	-
Dry Density (pcf)	108.1	108.5	108.0	-
Specific Gravity (Assumed)	2.75			
Saturation (%)	87.5	93.9	91.5	-
Void Ratio, n	0.59	0.58	0.59	-
B-Value, End of Saturation	0.99	1.00	0.79	-

Test Setup	
Specimen Condition	Remolded
Specimen Preparation	Kneading and Impact Compaction, Six Lifts
Mounting Method	Wet
Consolidation	Isotropic

Post-Consolidation / Pre-Shear				
Void Ratio	0.57	0.52	0.54	-

Shear / Post-Shear				
Rate of Strain (%/hr)	0.25	0.25	0.25	-
Avg. Water Content (%)	27.8	25.2	24.4	-

At Failure								
Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$				Ratio, $(\sigma_1'/\sigma_3')_{max}$			
Axial Strain at Failure (%), $\varepsilon_{a,f}$	8.6	11.6	15.0	-	1.4	6.0	5.4	-
Minor Effective Stress (psi), $\sigma_3'_f$	6.1	15.3	24.8	-	3.4	11.5	19.4	-
Principal Stress Difference (psi), $(\sigma_1-\sigma_3)_f$	13.4	21.7	31.0	-	10.4	19.7	27.4	-
Pore Water Pressure, Δu_f (psi)	-1.0	-0.3	0.3	-	1.7	3.5	5.7	-
Major Effective Stress (psi), $\sigma_1'_f$	19.5	37.0	55.7	-	13.8	31.2	46.8	-
Secant Friction Angle (degrees)	31.6	24.6	22.6	-	37.5	27.5	24.4	-
Effective Friction Angle (degrees)	18.6				20.2			
Effective Cohesion (psi)	2.7				2.5			

Note: The presented M-C parameters are based on a linear regression in modified stress space, across all assigned effective consolidation stresses. This fit does not purported to capture typical curvature of envelopes that may, in particular, be observed across broader range in effective stresses. Please note that the stresses associated with peak principal stress ratio and peak principal stress difference are presented in tabular form on the first page of the report. There are alternate interpretations to theses two failure criterion including but not limited to strain compatibility and post-peak.

Jeffrey A. Kuhn , Ph.D., P.E., 9/7/2022
Analysis & Quality Review/Date

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TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

Consolidated-Undrained Triaxial Compression

Client: Balcones Geotechnical
Project: 0121-014- Barton Springs Rd.
Sample: W-2 (7-8.5) (9-10.5) (13.5-15) (18.5-20)

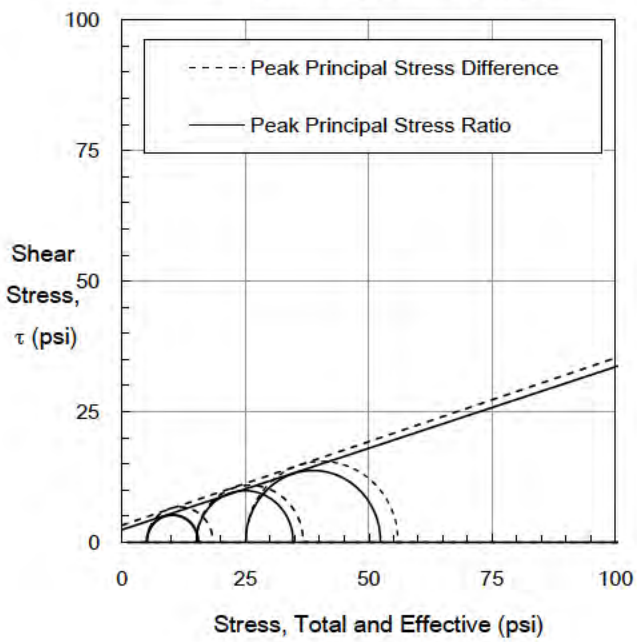
TRI Log #: 72382.2
Test Method: ASTM D4767

R / "Total Stress" Envelope			
Failure Criterion: Peak Principal Stress		Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Friction Angle (deg)	ϕ_R	17.8	17.3
Cohesion (psi)	c_R	3.2	2.4

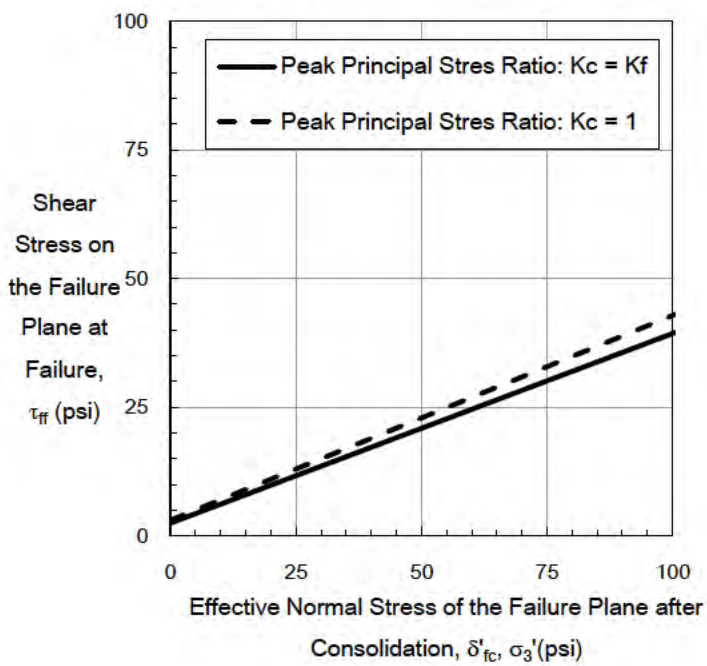
Kc = Kf Envelope, Effective Stress Envelope (Duncan et al. 1990)			
Failure Criterion: Peak Principal Stress		Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	ϕ'	18.6	20.2
Effective Cohesion (psi)	c'	2.7	2.5

Kc = 1 (τ_{ff} vs σ'_{fc}) Envelope, Total Stress Envelope (Duncan et al. 1990)			
Failure Criterion: Peak Principal Stress		Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Friction Angle (deg)	$d_{Kc=1}$	22.6	21.7
Cohesion (psi)	$\psi_{Kc=1}$	4.2	3.0

R / "Total Stress" Envelope



Three-Stage Rapid Drawdown Envelopes



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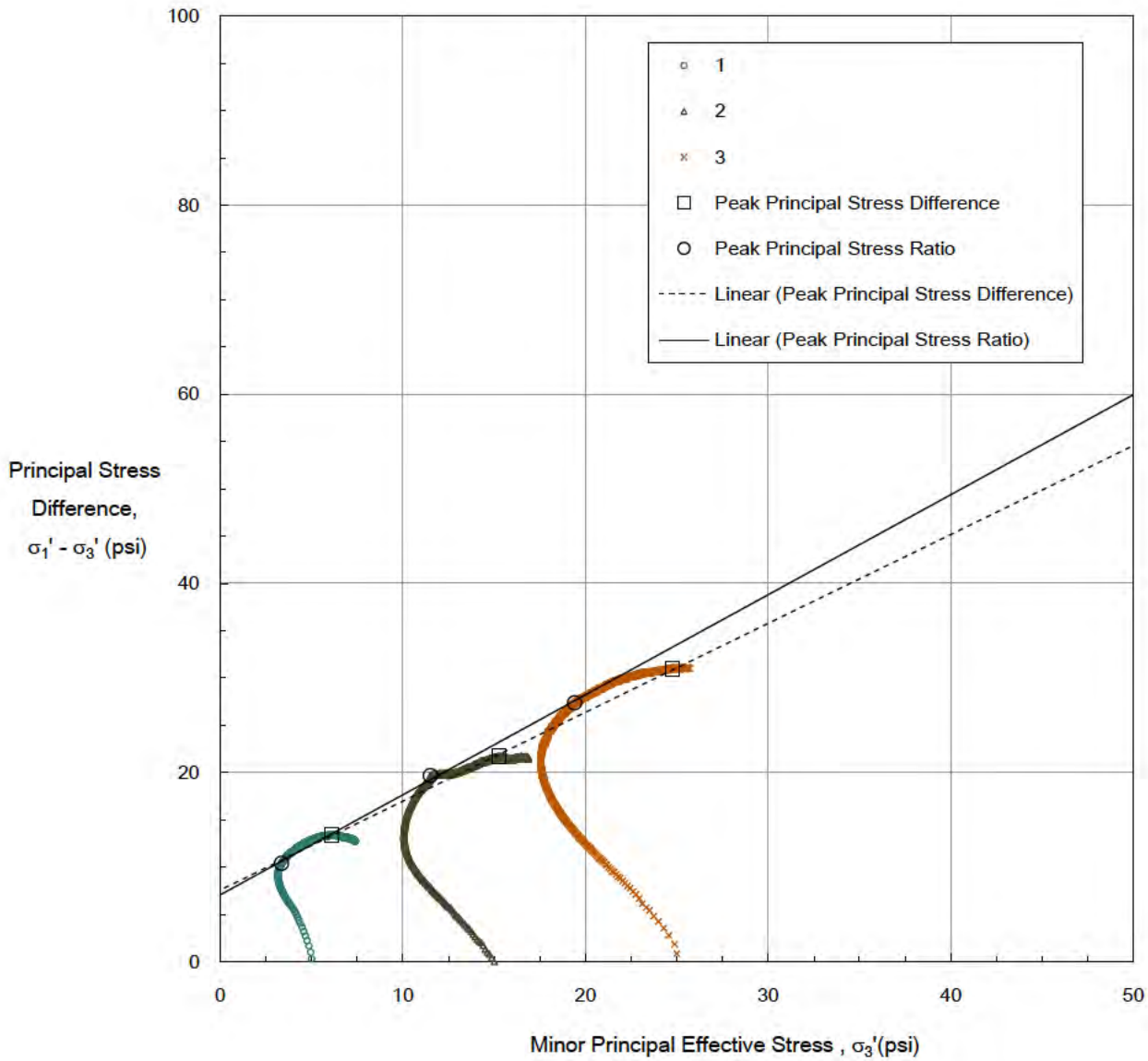
Consolidated-Undrained Triaxial Compression

Client: Balcones Geotechnical
Project: 0121-014- Barton Springs Rd.
Sample: W-2 (7-8.5) (9-10.5) (13.5-15) (18.5-20)

TRI Log #: 72382.2
Test Method: ASTM D4767

Modified Mohr-Coulomb



Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	18.6	20.2
Effective Cohesion (psi)	2.7	2.5

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TRI ENVIRONMENTAL, INC.
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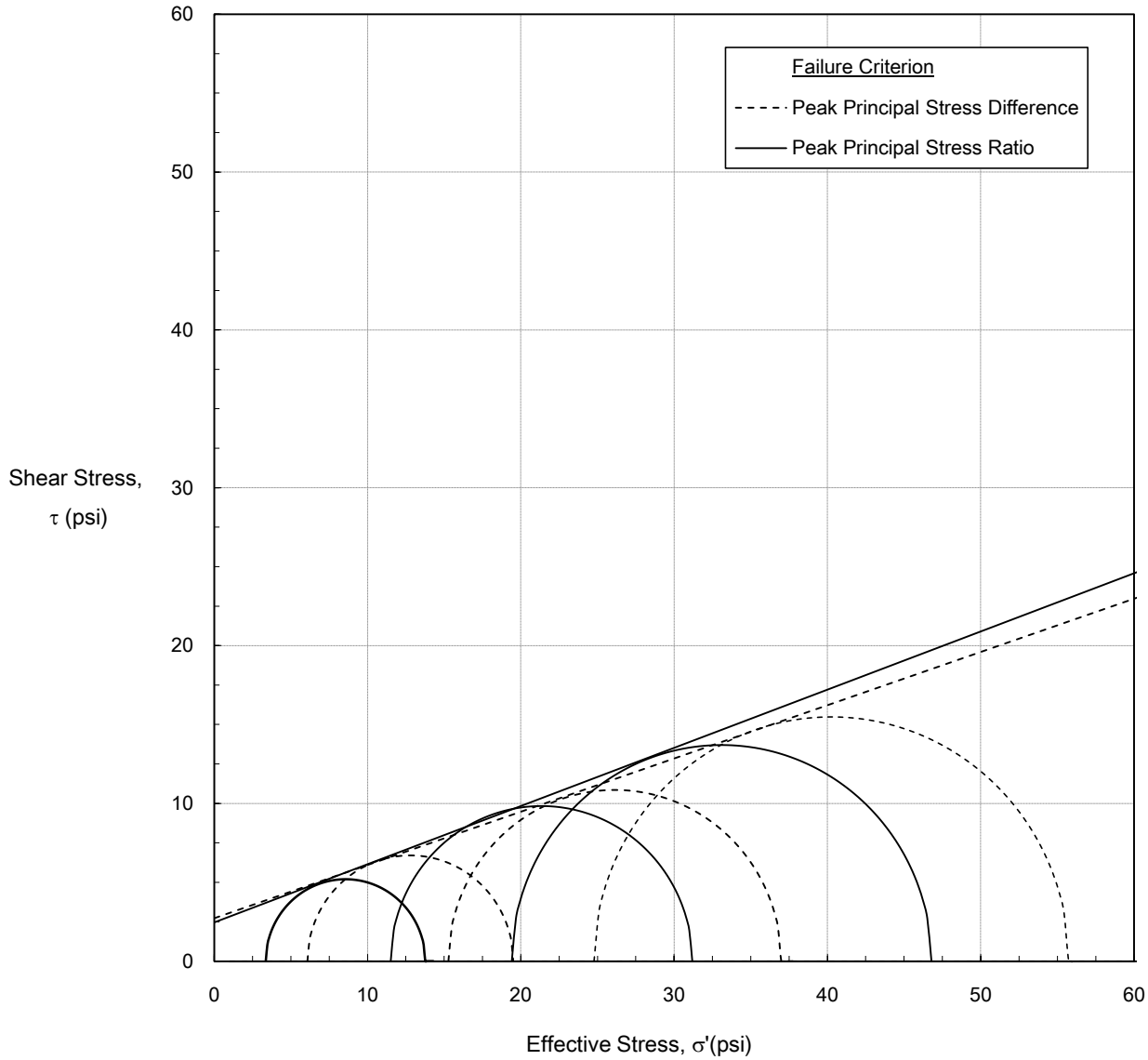
Consolidated-Undrained Triaxial Compression

Client: Balcones Geotechnical
Project: 0121-014- Barton Springs Rd.
Sample: W-2 (7-8.5) (9-10.5) (13.5-15) (18.5-20)

TRI Log #: 72382.2
Test Method: ASTM D4767

Mohr-Coulomb



Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	18.6	20.2
Effective Cohesion (psi)	2.7	2.5

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Consolidated-Undrained Triaxial Compression

Client: Balcones Geotechnical
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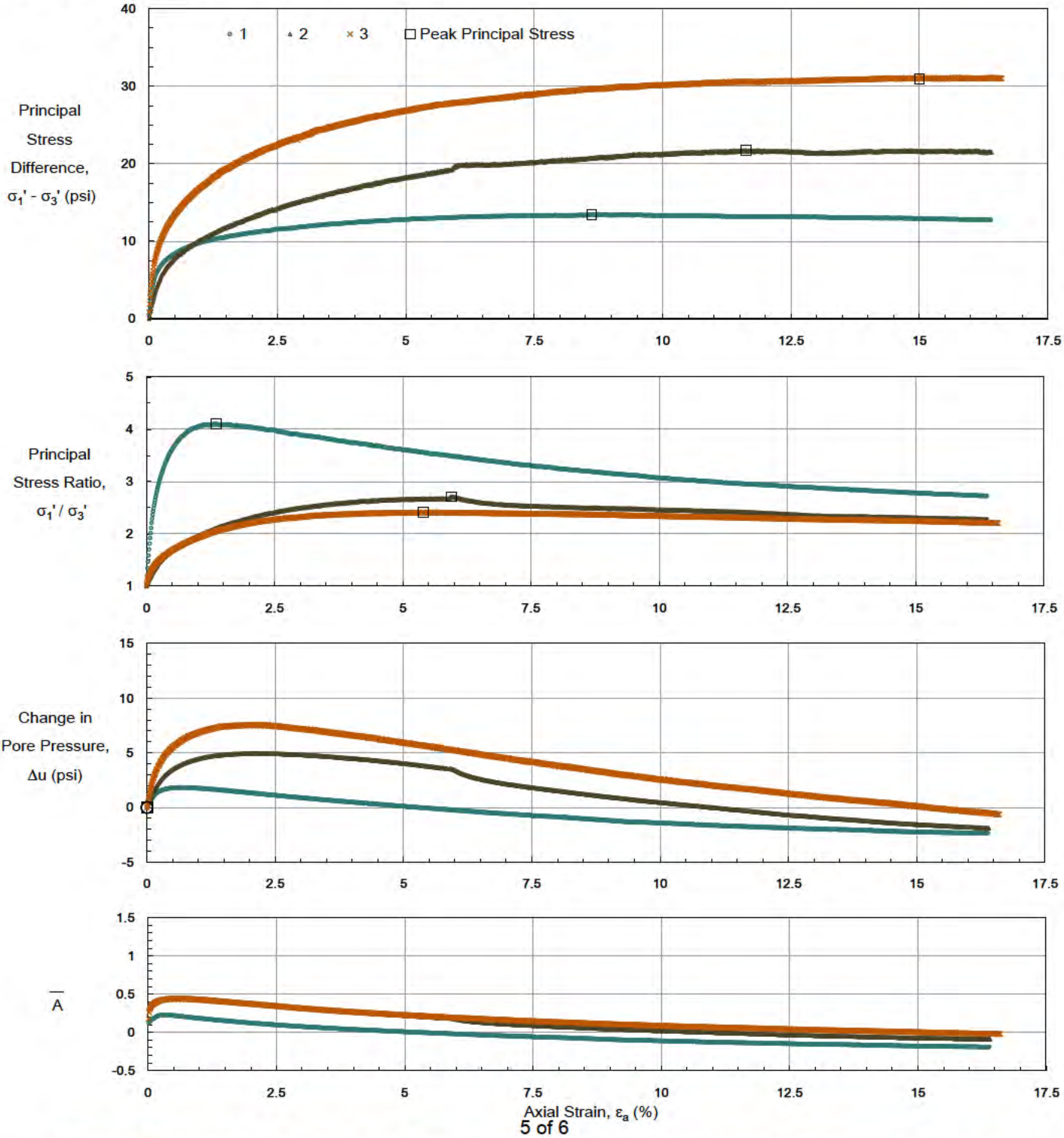
Test Method: ASTM D4767



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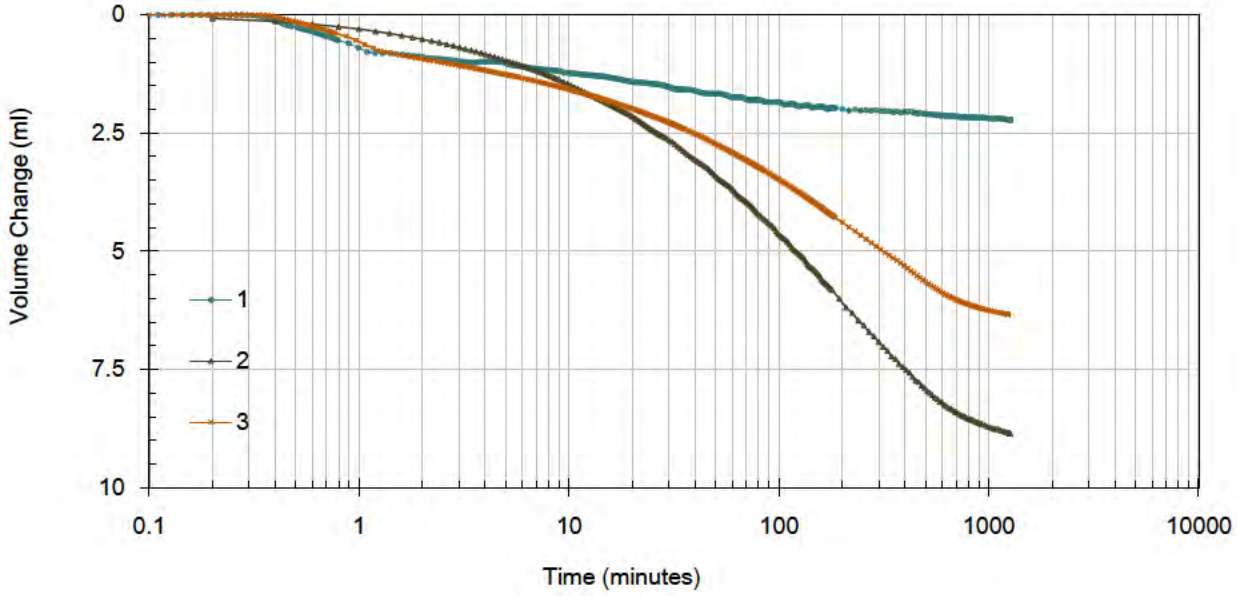
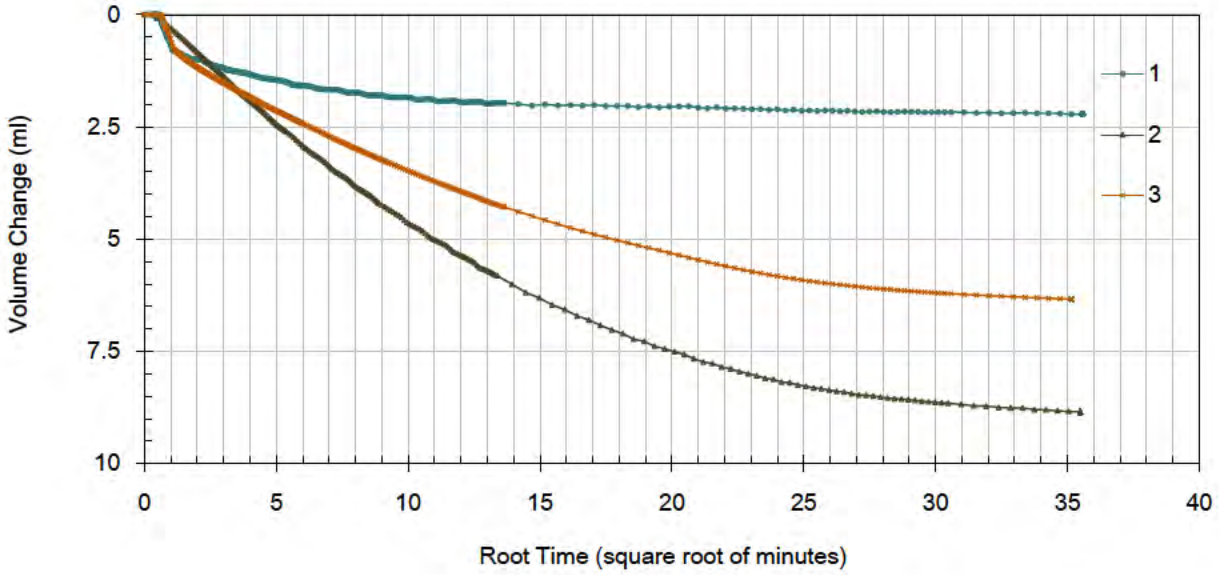
Consolidated-Undrained Triaxial Compression

Client: Balcones Geotechnical
Project: 0121-014- Barton Springs Rd.
Sample: W-2 (7-8.5) (9-10.5) (13.5-15) (18.5-20)

TRI Log #: 72382.2
Test Method: ASTM D4767

Consolidation





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TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

APPENDIX B-5

Analytical Testing

Client: Balcones Geotechnical

TRI Log #: 72383

Project: 0121-014- Barton Springs Rd.

Jeffrey A. Kuhn, Ph.D., P.E., 6/2/2022

Quality Review/Date

Analytical

COC Line #	Sample Identification	Chloride Content (mg/kg)	Sulfate Content (mg SO_4/kg)	pH	Resistivity (ohm-cm)
-	Test Method	ASTM D512	ASTM D516	ASTM G51	ASTM G57
-	Method Detection Limit (MDL)	[5 mg/l](2)	[5 mg/l](2)	-	-
1	W-4 (25)	150	7,600	6.59	3.8E+02

(1) ND No Detection - Below Method Detection Limit (MDL)

(2) MDL is volumetric. Results are mass per mass of dry soil.

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TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

austin MOBILITY BONDS

C-8 – Proposed Project Construction Cost

Opinion of Probable Cost Estimate
Barton Springs Bridge - CIP 5873.031
Lou Neff Rd. to Azie Morton Rd.
Option 3 - Concrete Dual Pier (New) - Total Const. Cost

URS 13640 Briarwick Drive Austin, Texas 78729 512.454.4797
TBPE Firm #3162 AN AECOM COMPANY

Base Bid:

Bid Item	Quantity	Unit	Item Description	Unit Price	Amount
			SIGNING & PAVEMENT MARKINGS		
SP824S PM	5	EA	TRAFFIC SIGNS (POST MOUNT)	$ 800.00	$ 4,000
SP824S RE	5	EA	TRAFFIC SIGNS (RELOCATED SIGN ON NEW POST)	$ 800.00	$ 4,000
829S-B	14	EA	TYPE I BICYCLE LANE PREFERENTIAL (DIRECTIONAL ARROW) SYMBOLS, WHITE IN COLOR	$ 200.00	$ 2,800
829S-C	14	EA	TYPE I BICYCLE LANE PREFERENTIAL (BIKE RIDER) SYMBOLS, WHITE IN COLOR	$ 275.00	$ 3,850
829S-D	17	EA	TYPE I BICYCLE LANE (BIKE CHEVRON-GREEN BACKED) SYMBOL, WHITE IN COLOR	$ 300.00	$ 5,100
829S-AB	176	LF	Type I Bicycle Lane Markings, 4 inches in width, white in color, broken	$ 4.52	$ 795.52
871S-A-24W	55	LF	REFLECTORIZED TYPE I THERMOPLASTIC PAVEMENT MARKINGS 24 INCHES IN WIDTH, 90 MILS IN THICKNESS WHITE IN COLOR	$ 10.00	$ 550
871S-A-4Y	1686	LF	REFLECTORIZED TYPE I THERMOPLASTIC PAVEMENT MARKINGS 4 INCHES IN WIDTH, 90 MILS IN THICKNESS YELLOW IN COLOR	$ 1.50	$ 2,529
871S-G A	16	EA	REFLECTORIZED TYPE II PAINT PAVEMENT MARKINGS ARROWS, 90 MILS IN THICKNESS WHITE IN COLOR	$ 70.00	$ 1,120
871S-D IP	8	EA	REFLECTORIZED TYPE II PAINT PAVEMENT SYMBOL (SUP INVERTED PEDESTRIAN), WHITE IN COLOR, APPROX. 5' X 3'	$ 15.00	$ 120
875S-A 4A	2406	LF	PAVEMENT SURFACE PREPARATION FOR EXISTING PAVEMENT SURFACE 4 INCHES IN WIDTH, FOR ASPHALT SURFACE	$ 0.10	$ 241
875S-A 24A	55	LF	PAVEMENT SURFACE PREPARATION FOR EXISTING PAVEMENT SURFACE 24 INCHES IN WIDTH, FOR ASPHALT SURFACE	$ 1.30	$ 72
875S-C AA	16	EA	PAVEMENT SURFACE PREPARATION FOR EXISTING SHAPE (ARROW), FOR ASPHALT SURFACE	$ 15.00	$ 240
			SIGNING & PAVEMENT MARKINGS TOTAL		$ 25,417
			TRAFFIC SIGNAL		
824S	4	EA	Traffic Signs	$ 400.00	$ 1,600
830S-SCF	1	EA	Traffic Signal Controller Foundation	$ 4,200.00	$ 4,200
831S-5	4	LF	4" Diameter Pedestrian Signal Foundation	$ 1,500.00	$ 6,000
831S-PSMP	3	EA	Pedestrian Signal Installation: Metal Pole	$ 1,500.00	$ 4,500
832S-VSM-4	4	EA	Vehicular Signal Installation, 4 Section, Complete In Place	$ 1,500.00	$ 6,000
834S-B	4	EA	Traffic Signal Pull Box, Type B	$ 2,100.00	$ 8,400
835S-LT3	400	LF	Installing Traffic Signal Conduit With Conduit 3 Inch In Diameter	$ 10.00	$ 4,000
838-PSM	4	EA	Furnish And Install Pedestrian Signal Installation: Countdown Type	$ 850.00	$ 3,400
839S-MA40	3	EA	40-Foot Mast Arm	$ 11,500.00	$ 34,500
840S-TSI	1	EA	Traffic Signal Installation	$ 30,000.00	$ 30,000
841S-TSR	1	EA	Traffic Signal Removal	$ 8,000.00	$ 8,000
SP 839S-LUM	3	EA	Luminaire Assembly For Type W Poles	$ 800.00	$ 2,400
SP 844S-3	400	LF	Class 3 Trench For Traffic Signal Conduit	$ 150.00	$ 60,000
SS Item 416-6006	45	LF	Drill Shaft Foundation (48") - TxDOT	$ 510.00	$ 22,950
SS Item 1008-PB	4	EA	Accessible Pedestrian Push Button	$ 1,600.00	$ 6,400
SS1008-PBE	4	EA	Accessible Pedestrian Signal Button Extension	$ 200.00	$ 800
SS1008-PSC	1	EA	Accessible Pedestrian - Signal Control Unit	$ 4,000.00	$ 4,000
SS1020-20C	400	LF	Traffic Signal Cable, Furnish And Install, 20C	$ 7.50	$ 3,000
SS1020-6G	100	LF	Ground Wire, Furnish And Install, #6 Bare	$ 3.50	$ 350
SS1020-C5E	100	LF	Traffic Signal Cable, Furnish And Install, Cat 5E	$ 4.00	$ 400

Opinion of Probable Cost Estimate
Barton Springs Bridge - CIP 5873.031
Lou Neff Rd. to Azie Morton Rd.
Option 3 - Concrete Dual Pier (New) - Total Const. Cost

URS 13640 Briarwick Drive Austin, Texas 78729 512.454.4797
TBPE Firm #3162 AN AECOM COMPANY

Base Bid:

Bid Item	Quantity	Unit	Item Description	Unit Price	Amount
SS1020-S6B	100	LF	Power Service Cable, Furnish And Install, #6 Insulated, Black	$ 3.00	$ 300
SS1040-T	1	EA	Radar Vehicle Detection System, 3 Approach Intersection, Complete In Place	$ 50,000.00	$ 50,000
SS1044-CCTV	1	EA	CCTV Camera, Complete In Place	$ 10,000.00	$ 10,000
SS1058-BBS	1	EA	Battery Back-Up System (BBS) For Traffic Signals	$ 3,300.00	$ 3,300
TRAFFIC SIGNAL TOTAL					$ 274,500
STRUCTURES					
BRIDGE - SUPERSTRUCTURE					
SS Item SUPSTRUCT-01	795	CY	Deck Concrete	$ 1,200.00	$ 954,000
SS Item SUPSTRUCT-02	368	CY	Diaphragm Concrete	$ 1,000.00	$ 368,100
SS Item SUPSTRUCT-03	290737	LB	Reinforcing - Black	$ 1.05	$ 305,300
SS Item SUPSTRUCT-04	1880	FT	AASHTO Type IV - 72 Inch Depth	$ 350.00	$ 658,000
SS Item SUPSTRUCT-05	20360	LB	Post-Tensioning Strand	$ 10.00	$ 203,700
SS Item SUPSTRUCT-06	159	CY	Approach Slabs	$ 800.00	$ 127,500
SS Item SUPSTRUCT-07	2	EA	Temporary Works - Shoring Systems	$ 100,000.00	$ 200,000
SS Item SUPSTRUCT-08	24988	SF	Overlay	$ 9.00	$ 224,900
SS Item SUPSTRUCT-09	219	FT	Expansion Joints	$ 250.00	$ 54,700
SS Item SUPSTRUCT-10	940	FT	Barriers	$ 155.00	$ 145,700
SS Item SUPSTRUCT-11	235	FT	Traffic Median	$ 160.00	$ 37,600
SS Item SUPSTRUCT-12	48	EA	Bearings	$ 1,000.00	$ 48,000
SS Item SUPSTRUCT-13	3760	SF	Concrete - Surface Treatments	$ 12.00	$ 45,200
SS Item SUPSTRUCT-14	1	LS	Period Light Fixtures and Conduits	$ 50,000.00	$ 50,000
SS Item SUPSTRUCT-15	1	LS	Miscellaneous Items (Includes Const. Engr.)	$ 200,000.00	$ 200,000
BRIDGE - SUBSTRUCTURE					
SS Item SUBSTRUCT-1	263	CY	Concrete - Piers & Tie Beam	$ 950.00	$ 249,600
SS Item SUBSTRUCT-2	105064	LB	Reinforcing - Black	$ 1.05	$ 110,400
SS Item SUBSTRUCT-3	1021	LB	Post-Tensioning Bar	$ 10.00	$ 10,300
SS Item SUBSTRUCT-4	5760	SF	Concrete - Surface Treatments	$ 12.00	$ 69,200
SS Item SUBSTRUCT-5	240	FT	Drilled Shaft Furnished and Installed	$ 3,000.00	$ 720,000
SS Item SUBSTRUCT-6	7400	CY	Excavation	$ 100.00	$ 740,000
SS Item SUBSTRUCT-7	261	CY	Abutment Concrete	$ 950.00	$ 247,800
SS Item SUBSTRUCT-8	52148	LB	Abutment Reinforcing - Black	$ 1.05	$ 54,800
SS Item SUBSTRUCT-9	8400	SF	Concrete - Surface Treatments	$ 12.00	$ 100,800
SS Item SUBSTRUCT-10	640	FT	Drilled Shaft Furnished and Installed	$ 950.00	$ 608,000
SS Item SUBSTRUCT-11	6600	SF	Temporary Walls	$ 50.00	$ 330,000
SS Item SUBSTRUCT-12	8400	SF	Permanent Walls (MSE)	$ 65.00	$ 546,000
BRIDGE - DEMOLITION					
SS Item STRUCTREM-01	1	LS	Bridge Demolition	$ 1,400,000.00	$ 1,400,000
BRIDGE SUBTOTAL					$ 8,809,600
RETAINING WALLS					
414S-C	15000	SF	CAST-IN-PLACE PORTLAND CEMENT CONCRETE RETAINING WALL, INCLUDING REINFORCEMENT	$ 110.00	$ 1,650,000
423-6007	5000	SF	RETAINING WALL (DRILL SHAFT) (FACIA)	$ 120.00	$ 600,000
SS Item	1	LS	CANTILEVER SIDEWALK	$ 250,000.00	$ 250,000
SS Item 416-6002	655	LF	Drill Shaft Foundation (24") - Txdot	$ 255.00	$ 167,100
SS Item 416-6004	1650	LF	Drill Shaft Foundation (36") - TxDOT	$ 300.00	$ 495,000
RETAINING WALLS SUBTOTAL					$ 3,162,100
STRUCTURES TOTAL					$ 11,971,700
LANDSCAPING & WATER QUALITY					
602S-D	600	SY	Grass Sodding	$ 11.25	$ 6,750
604S-E	5,000	SY	Native Seeding for Erosion Control Method, Hydraulic Planting Per Square Yard	$ 2.00	$ 10,000
608s	1	LS	Landscape	$ 30,000.00	$ 30,000
608s	1	LS	Temporary Irrigation	$ 6,000.00	$ 6,000
610S-A	1,500	LF	Protective Fencing Type A Chain Link fence (Typical Application-high damage potential)	$ 8.75	$ 13,125
610S-E	1	EA	Tree Trunk Protection (Wood Planking)	$ 310.00	$ 310
610S-R	20	EA	Removal of Existing Trees	$ 1,011.00	$ 20,220
628S-B	80	LF	Sediment Containment Dikes with filter fabric	$ 28.75	$ 2,300

Opinion of Probable Cost Estimate
Barton Springs Bridge - CIP 5873.031
Lou Neff Rd. to Azie Morton Rd.
Option 3 - Concrete Dual Pier (New) - Total Const. Cost

URS 13640 Briarwick Drive Austin, Texas 78729 512.454.4797
TBPE Firm #3162 AN AECOM COMPANY

Base Bid:

Bid Item	Quantity	Unit	Item Description	Unit Price	Amount
639S	150	LF	Rock Berm	$ 40.00	$ 6,000
641S	2	EA	Stabilized Construction Entrance	$ 2,625.00	$ 5,250
641S	200	SY	CRZ Stabilized Construction Entrance	$ 33.75	$ 6,750
642S	1,000	LF	Silt Fence for Erosion Control	$ 7.25	$ 7,250
710S-B	4	EA	Class III Bicycle Rack, hot dipped galvanized	$ 500.00	$ 2,000
SS320193-1	24	MO	Three-Year Landscape and Irrigation Maintenance, Trees	$ 750.00	$ 18,000
SS329300-06	200	EA	Mitigation Planting (1G + 5G)	$ 35.00	$ 7,000
SS329350-01	1	LS	Existing Tree Care	$ 100,000.00	$ 100,000
LANDSCAPING & WATER QUALITY TOTAL					$ 240,955
UTILITIES					
WATER PIPE					
402S-A	20	CY	CONCRETE ENCASEMENT AT BRIDGE TRANSITIONS	$ 150.00	$ 3,000
501S	75	LF	JACKING AND BORING 12-INCH PIPE, CLASS 250 DUCTILE IRON	$ 750.00	$ 56,300
505S-B-12"DIA	18	LF	ENCASEMENT PIPE 12" DIA., TYPE 3/8" STEEL	$ 320.00	$ 5,800
509S-1	500	LF	TRENCH EXCAVATION SAFETY PROTECTIVE SYSTEMS, (ALL DEPTHS)	$ 5.00	$ 2,500
511S-A12	1	EA	VALVES, GATE TYPE, 12" DIA.	$ 4,000.00	$ 4,000
511S-B	2	EA	FIRE HYDRANT ASSEMBLY (SEE STANDARD NO. 511S-9A)	$ 4,000.00	$ 8,000
511S-F	1	EA	AUTO COMBINATION AIR/VACUUM RELEASE VALVE ASSEMBLY, 8" DIA.	$ 15,000.00	$ 15,000
511S-G	19	VLF	ADDITIONAL BURY DEPTH	$ 75.00	$ 1,500
510-AWRJ12"Dia-DI	12	LF	FACTORY RESTRAINED JOINT PIPE, 12" DIA. DI CL350 WATER, (ALL DEPTHS), INCLUDING EXCAVATION AND BACKFILL	$ 220.00	$ 2,700
510-JW12"x12"Dia.	1	EA	WET CONNECTIONS, 12" DIA. X 12" DIA.	$ 5,000.00	$ 5,000
510-KW	10.6	Ton	DUCTILE IRON FITTINGS	$ 18,000.00	$ 190,800
WATER PIPE SUBTOTAL					$ 294,600
WASTEWATER PIPE					
402S-A	200	CY	CONCRETE ENCASEMENT AT BRIDGE TRANSITIONS	$ 200.00	$ 40,000
509S-1	600	LF	TRENCH EXCAVATION SAFETY PROTECTIVE SYSTEMS, (ALL DEPTHS)	$ 7.50	$ 4,500
722S-A	1	LS	PROTECTIVE COATING NEW STRUCTURES	$ 20,000.00	$ 20,000
506-ABWW	2	EA	ABANDONMENT OF EXISTING MANHOLE	$ 2,500.00	$ 5,000
506-M1WW6	2	EA	STANDARD PRE-CAST MANHOLE W/CIP BASE, 6' DIA.	$ 10,000.00	$ 20,000
510-AWW24"Dia-PVC	600	LF	PIPE, 24" DIA. PVC ASTM F679 PS115 WASTEWATER, (ALL DEPTHS), INCLUDING EXCAVATION AND BACKFILL	$ 350.00	$ 210,000
SS0201	2	EA	REMOVING EXISTING MANHOLE	$ 4,000.00	$ 8,000
SS02151-A8	200	CY	ABANDONING PIPE (FILL WITH FLOWABLE FILL), 8" DIA.	$ 150.00	$ 30,000
SS02151-B08	600	LF	REMOVING PIPE, 8" DIA	$ 30.00	$ 18,000
SS13004	1	LS	DRAIN PIT, CONCRETE, 6' X 6' X 4' BOX	$ 40,000.00	$ 40,000
WASTEWATER PIPE SUBTOTAL					$ 395,500
UTILITIES TOTAL					$ 690,100
ROADWAY					
101S-B	12	STA	PREPARE RIGHT OF WAY	$ 2,200.00	$ 26,400
111S-A	1000	CY	EXCAVATION	$ 12.00	$ 12,000
132S-A	4000	CY	EMBANKMENT	$ 15.00	$ 60,000
210S-A	1490	CY	FLEXIBLE BASE	$ 157.15	$ 234,154
306S	1047	GAL	PRIME COAT	$ 3.50	$ 3,665
340S-A-B	1871	TON	HOT MIX ASPHALTIC CONRETE PAVEMENT, TYPE B	$ 133.00	$ 248,843
340S-A-C	481	TON	HOT MIX ASPHALTIC CONRETE PAVEMENT, TYPE C	$ 235.00	$ 113,035
430S-B	2375	LF	P.C. CONCRETE CURB AND GUTTER (FINE GRADING)	$ 35.64	$ 84,645
432S-6	16075	SF	NEW P.C. CONCRETE SIDEWALKS, 6 INCH THICKNESS	$ 10.00	$ 160,750
432S-PRC-2	1255	LF	Pedestrian Railing (Standard 707S-2)	$ 180.00	$ 225,900
434S	1278	SF	6 INCH CONCRETE MEDIANS AND ISLANDS	$ 25.00	$ 31,950

Opinion of Probable Cost Estimate
Barton Springs Bridge - CIP 5873.031
Lou Neff Rd. to Azie Morton Rd.
Option 3 - Concrete Dual Pier (New) - Total Const. Cost

URS 13640 Briarwick Drive Austin, Texas 78729 512.454.4797
TBPE Firm #3162 AN AECOM COMPANY

Base Bid:

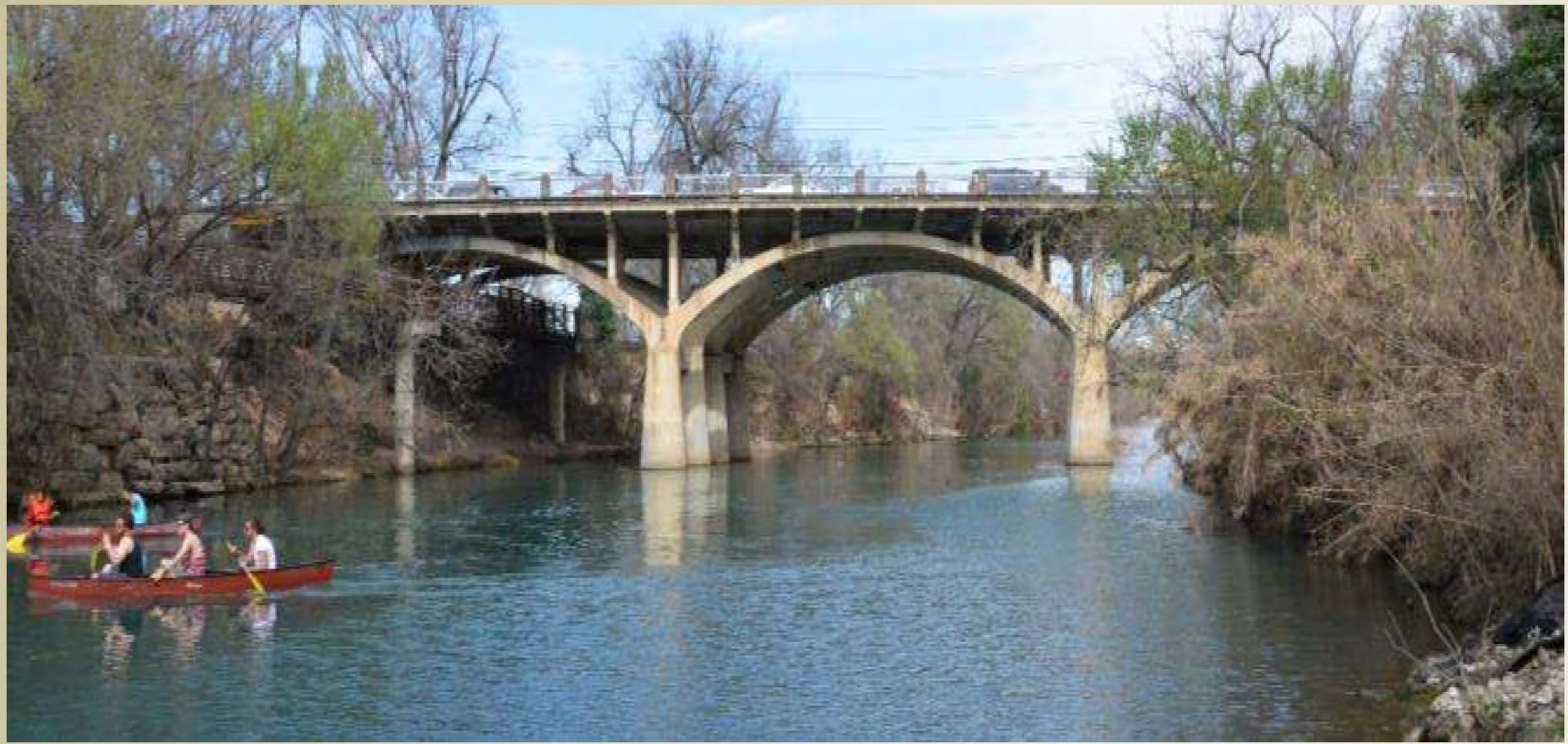
Bid Item	Quantity	Unit	Item Description	Unit Price	Amount
504S-3W	15	EA	ADJUSTING WATER VALVE BOXES TO GRADE	$ 600.00	$ 9,000
SP432S-BR	6300	SF	Bike Ramp (Includes Ramp Transitions, Paint for Curb, and Detectable Warning	$ 16.66	$ 104,958
SP430S-6E-2	980	LF	Cast in Place Bicycle Barrier Curb - 2.0' Wide	$ 85.00	$ 83,300
SP432S-SUPA	8196	SF	Shared Use Path per Detail 1302S-1, on Cmnt. Stab. Subgrade (cement treatment of material in place)	$ 16.76	$ 137,365
SS Item 465-6002	5	EA	MANH (COMPL)(PRM)(48IN)	$ 400.00	$ 2,000
SS Item 531-6004	6	EA	TXDOT TY 1 CURB RAMP	$ 1,800.00	$ 10,800
			ROADWAY SUBTOTAL		$ 1,548,764
			DRAINAGE		
506 M-60	5	EA	STANDARD PRE-CAST MANHOLE W/PRE-CAST BASE, 60-INCH DIA.	$ 8,000.00	$ 40,000
508S-I15S	5	EA	INLET, STANDARD -15	$ 9,000.00	$ 45,000
509S-1	200	LF	Trench Excavation Safety Protective Systems (all depths)	$ 10.00	$ 2,000
510-ASD-24	200	LF	Pipe, 24" Dia. (all depths), including Excavation and Backfill	$ 130.00	$ 26,000
510-VIDEO	200	LF	Video Inspection of Newly Installed Box Culverts and Storm Drain	$ 12.00	$ 2,400
403 6006	5600	SF	Temporary Shoring (Cofferdam)	$ 25.00	$ 140,000
111S-A	1245	CY	EXCAVATION	$ 12.00	$ 14,940
591S-G	1245	CY	CONCRETE RIPRAP	$ 660.00	$ 821,700
SP 508S-BCI10	1	EA	10 'Backless Curb Inlet	$ 5,000.00	$ 5,000
			DRAINAGE TOTAL		$ 1,097,040
			TRAFFIC CONTROL		
SS Item 681-6001	1	EA	Temporary Traffic Signals - TxDOT	$ 60,000.00	$ 60,000
803S-MO	24	MON	BARRICADES, SIGNS, AND TRAFFIC HANDLING	$ 15,800.00	$ 379,200
SS Item 403-2001	5000	SF	TEMPORARY SPL SHORING	$ 14.00	$ 70,000
			TRAFFIC CONTROL TOTAL		$ 509,200
			OVERALL CONSTRUCTION SUBTOTAL		$ 16,357,676
			MISC.		
	1	LS	Relocate Heritage Trees (5 to 6)	$ 1,000,000.00	$ 1,000,000
	1	LS	Chap 26 PARD Mitigation	$ 1,000,000.00	$ 1,000,000
	1	LS	Tree Mitigation	$ 200,000.00	$ 200,000
	1	LS	Art in Public Places (Est. 2%)	$ 327,153.51	$ 327,200
	1	LS	Maintenance of Traffic (10%)	$ 1,635,767.56	$ 1,635,800
	1	LS	MOBILIZATION (700S-TM, 5%)	$ 817,883.78	$ 817,900
			MISCELLANEOUS		$ 4,980,900
BASE BID. . . .					$ 21,338,600
Engineer's Estimate of Escalation (2 Years at 4% per year)					$ 887,700
Engineer's Estimate of Contingency (25%)					$ 5,334,700
Engineer's Estimate of Probable Cost					$ 27,561,000

Appendix D – Agency Discussions

austin MOBILITY BONDS

D-1 - Initial TX Historic Commission Meeting – June 2022

Barton Springs Road Bridge – Texas Historical Commission – June 30, 2022



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Welcome

- Introductions

- Goals for the Meeting
  - Project orientation
  - Review Process of Design Alternatives Analysis
  - Solicit Initial Input and Discuss Key Issues that Drive Project Direction

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Agenda

- Project Overview
  - Bridge Background / Setting / Site Issues
  - Purpose and Need
  - Bridge Options; Selection Process
- Previous Work and Outcomes
  - Bridge Inspection; Intersection Modeling
  - Roadway Geometry / Alignment Concepts
  - Zilker Park / Environmental Concepts
  - Bridge Rehabilitation Concepts
  - Bridge Replacement Concepts
- Bridge Alternatives Discussion
  - Rehabilitation vs. Replacement - Summary of Benefits / Opportunities
  - Group Discussion

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Barton Springs Rd. Bridge - Setting

- Three-span open concrete spandrel arch on concrete foundations;
- 212’ long 58’-8” wide
- 1925 original construction
- 1946 widened to current x-sect; 2 lanes each direction
- Located at entrance to Zilker Park
- Key commuter route and east-west arterial
- Barton Springs Rd. / Azie Morton Intersection
  - Key Barton Hills and Zilker neighborhood entrance immediately east of bridge
  - Intersection integral to future bridge work

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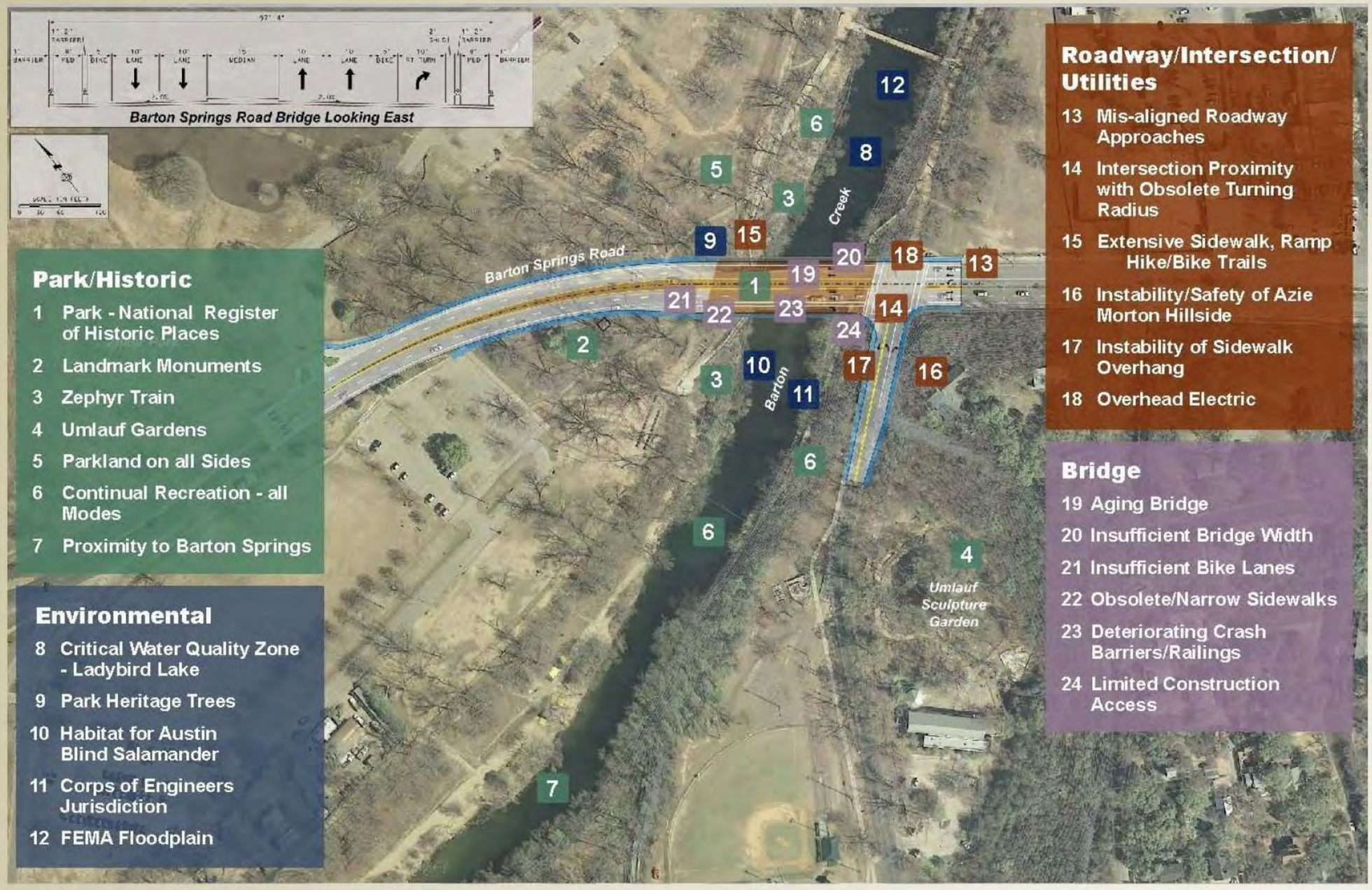
Barton Springs Rd. Bridge – Site Challenges and Constraints



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Barton Springs Rd. Bridge – Project Purpose and Need

- Purpose and Need for this project is to make safety-related bridge improvements that address the following:
  - Age of structure / structural degradation
  - Insufficient bike / pedestrian paths (functionally obsolete);
  - Bridge roadway lanes not aligned with lanes east of Azie Morton;
  - Hillside instability (rock fall) and obsolete retaining wall on Azie Morton east side at intersection
  - Elevated / overhanging sidewalk on Azie Morton west side and integral to intersection – past movement / cracking
  - Bridge/intersection congestion

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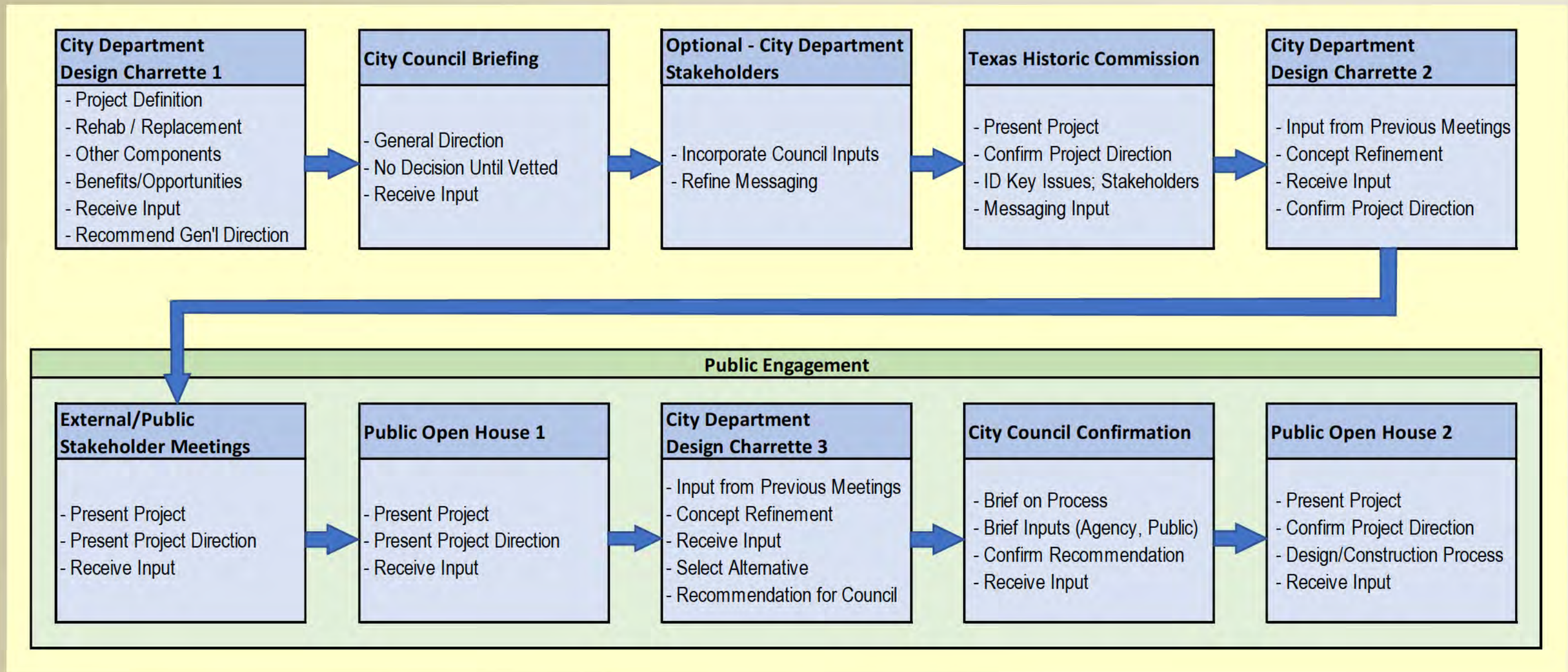
Barton Springs Rd. Bridge – Project Options – Avoid, Minimize, Mitigate

- *Based on Purpose and Need, Avoidance (Do Nothing) is not an Option*
- *Rehabilitation Option 1:*
  - Rehabilitate but preserve existing structure (light touch)
  - Retrofit/upgrade bridge crash railing
  - Consider feasibility of complementary structures for bike and pedestrian traffic on both sides of the bridge.
- *Rehabilitation Option 2:*
  - Rehabilitate and widen deck
  - Address bicycle and pedestrian paths on the bridge
- *3 Replacement Options:*
  - Completely reconstruct bridge
  - Widen bridge deck
  - Alignment and Azie Morton Rd intersection work for improved safety

URS

Barton Springs Rd. Bridge – Selection Process



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Barton Springs Rd. Bridge – Project Schedule

- Preliminary Phase - Completion Summer 2023
  - Council Briefing 1 — Spring 2022
  - Texas Historical Commission — Summer 2022
  - Public Engagement 1 — Fall 2022
  - Council Briefing 2 — Winter 2022
  - Public Engagement 2 — Spring 2023
  - Complete Preliminary Phase — Summer 2023
- Design Phase - Fall 2023 to Spring 2025
  - RCA to Council — Summer 2023
- Bid/Award/Execution Phase - Spring 2025 to Fall 2025
  - RCA to Council — Summer 2025
- Construction Phase - Fall 2025 to Spring 2027

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Previous Work and Outcomes

- Bridge Inspection and Condition Assessment
- Barton Springs / Azie Morton Intersection Modeling
- Roadway Geometry / Alignment Concepts
- Zilker Park Pedestrian / Connectivity Concepts
- Environmental Issues / Permitting Needs
- Analyze Bridge Rehabilitation Concepts
- Analyze Bridge Replacement Concepts

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Bridge Inspection Outcomes

- Deck (with integral longitudinal joint), floor beams, and spandrel columns exhibited the most degradation.
- All structural components exhibited some degradation.
- Rehabilitation for increased service life would need to remove deck, floor beams, and spandrel columns, stripping structure to arch ribs as a starting point.
- These results remove Rehabilitation Option 1 as feasible alternative since that option was the "low-impact", “preserve-structure” option.
- Based on the above, we are now focused on Rehabilitation Option 2 and on potential bridge replacement options.

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Barton Springs / Azie Morton Intersection Analysis (Jan. 2018)

- Intersection modeling
- Improve LOS for both Barton Springs Rd. and Azie Morton Rd.
  - Reduce delays during peak hours
  - Support / improve construction phasing for both bridge and Azie Morton retaining wall
  - Provide additional multimodal capacity (buses, pedestrians) for traffic control during special events

Year	Peak	No Build		Build	
		LOS	Delay (sec)	LOS	Delay (sec)
2017	AM	C	31.1		
	PM	C	33.5		
2040	AM	E	64.5	E	59.1
	PM	E	61.6	C	26.5

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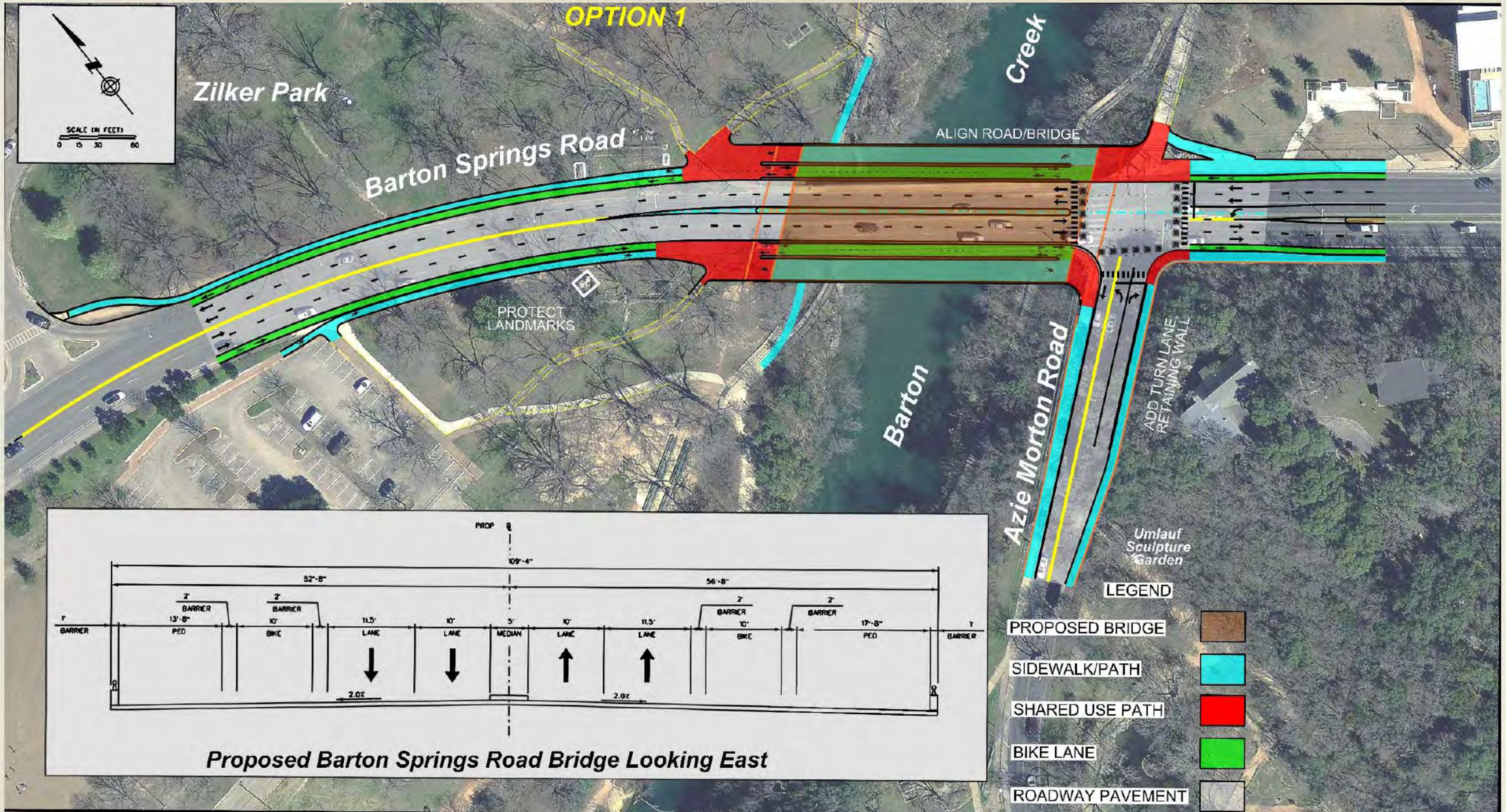
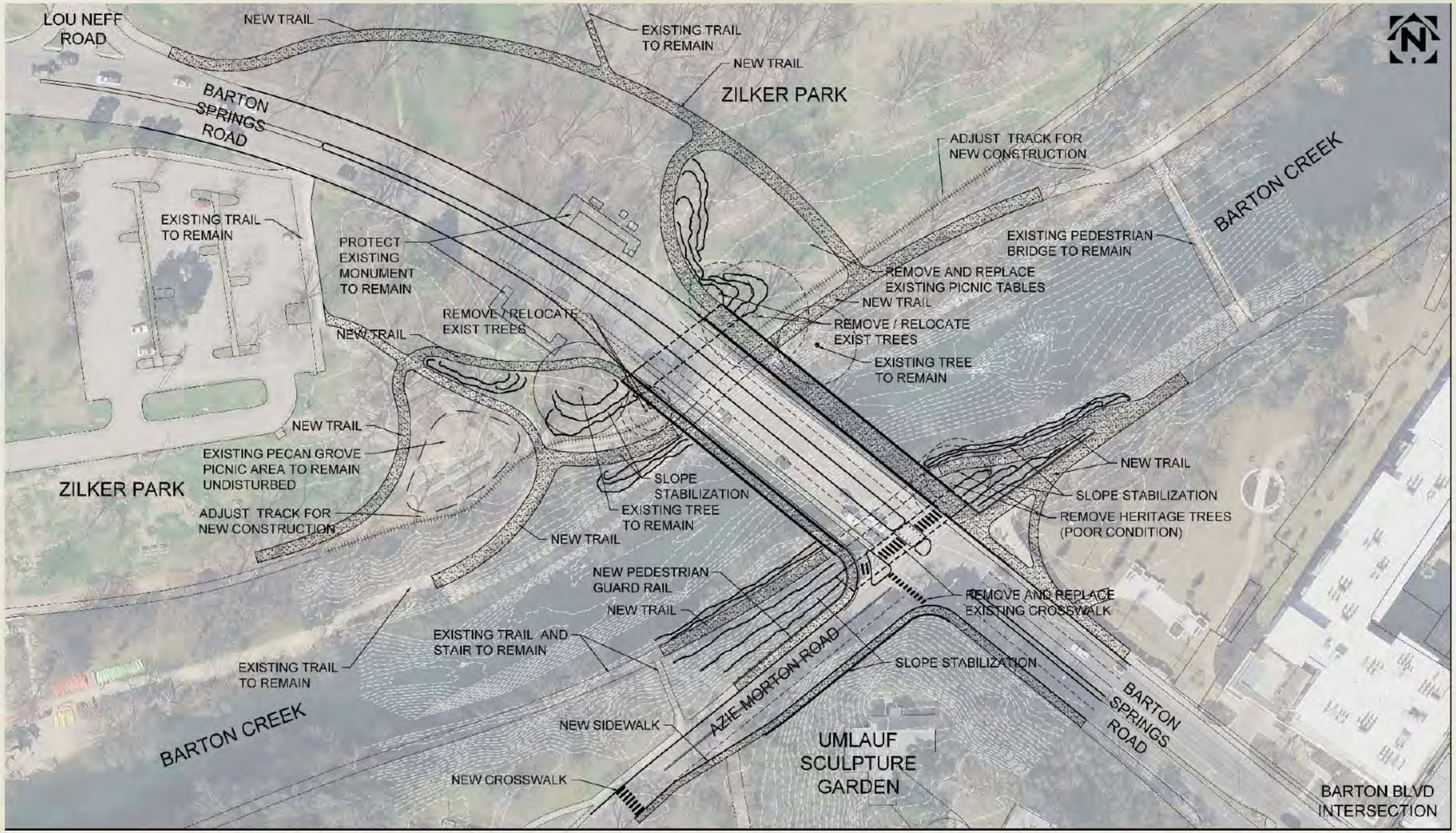
Roadway Geometry / Alignment Concepts



Zilker Park Pedestrian / Connectivity Concepts



- Protect Landmarks
- Protect / Move / Mitigate Heritage Trees
- **Flexibility and Connectivity with Zilker Park Vision Plan**

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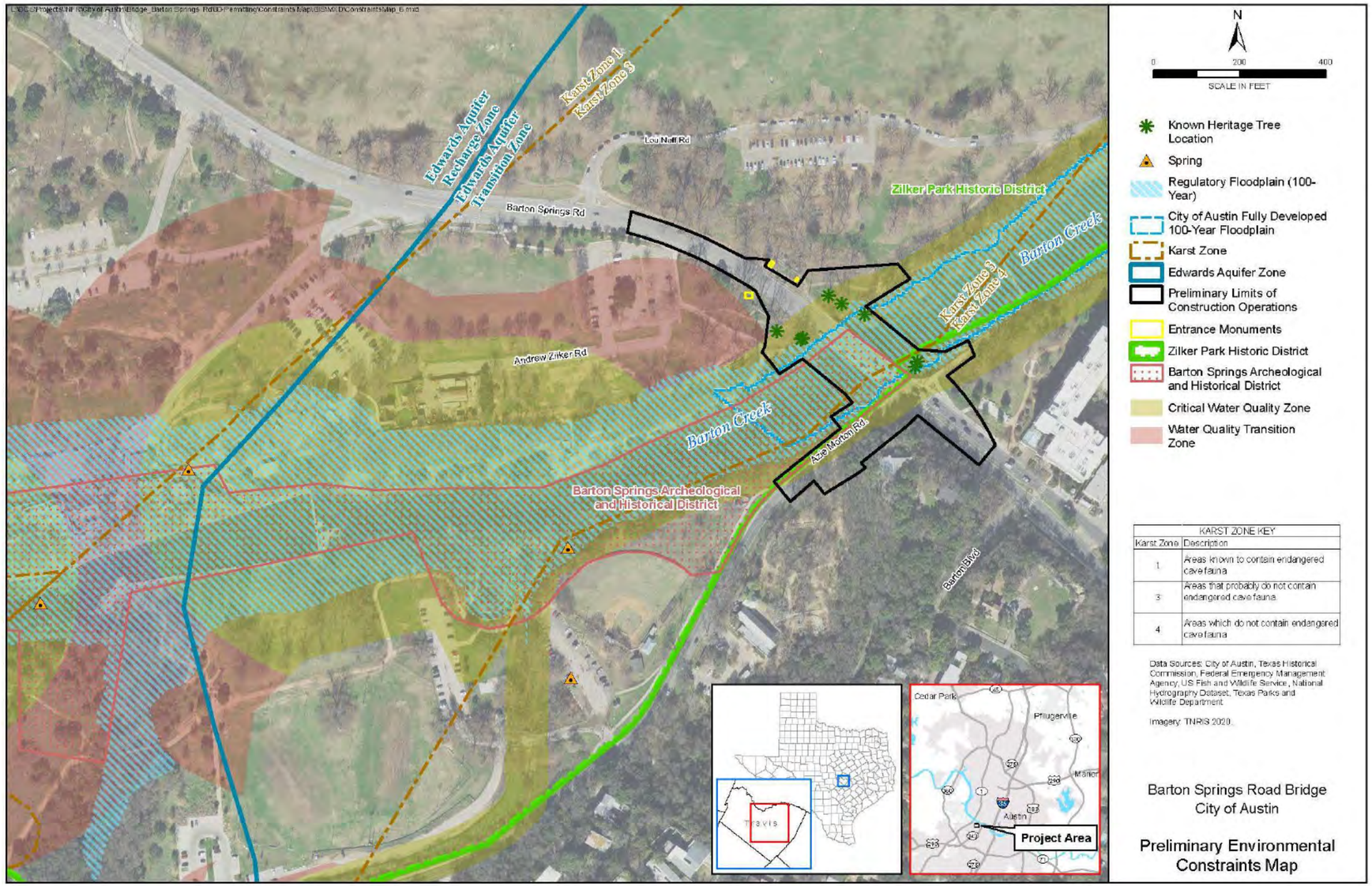
Northern Pedestrian Pathway

Environmental Issues / Constraints Map



Environmental / Permitting Concepts

Federal Permits/Approvals

Section 106 of National Historic Preservation Act

- Texas Historical Commission (THC) coordination for mitigation
- Avoidance and Minimization are not possible - remaining options have significant impact

U.S. Army Corps of Engineers

- Section 404 Nationwide Permit

U.S. Fish & Wildlife Service

- Habitat assessment and informal coordination to determine potential for species occurrence.
- Potential presence/absence surveys; and formal Section 7 consultation.

State Permits/Approvals

Texas Parks and Wildlife Department

- Habitat assessment for state-listed species
- Chapter 26 – Parkland impacts

Texas Commission on Environmental Quality

- Edwards Aquifer Protection
- Water Pollution and Abatement Plan (WPAP).

City of Austin Permits / Approvals

- Austin City Code
- Land Development Code
- Technical Design / Environmental Manuals

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Barton Springs Rd. Bridge – Rehabilitation / Replacement Alternatives

- *Based on Purpose and Need, Avoidance (Do Nothing) is not an Option*
- *Rehabilitation Option 1 - Removed:*
  - Rehabilitate but preserve existing structure (light touch)
  - Retrofit/upgrade bridge crash railing
  - Complementary structures for bike and pedestrian traffic
- *Rehabilitation Option 2 - Remains:*
  - Rehabilitate substructure and replace/widen bridge deck
  - Incorporate bicycle, pedestrian, and traffic improvements
- *3 Replacement Options:*
  - Completely reconstruct bridge
  - Widen bridge deck
  - Incorporate bicycle, pedestrian, and traffic improvements

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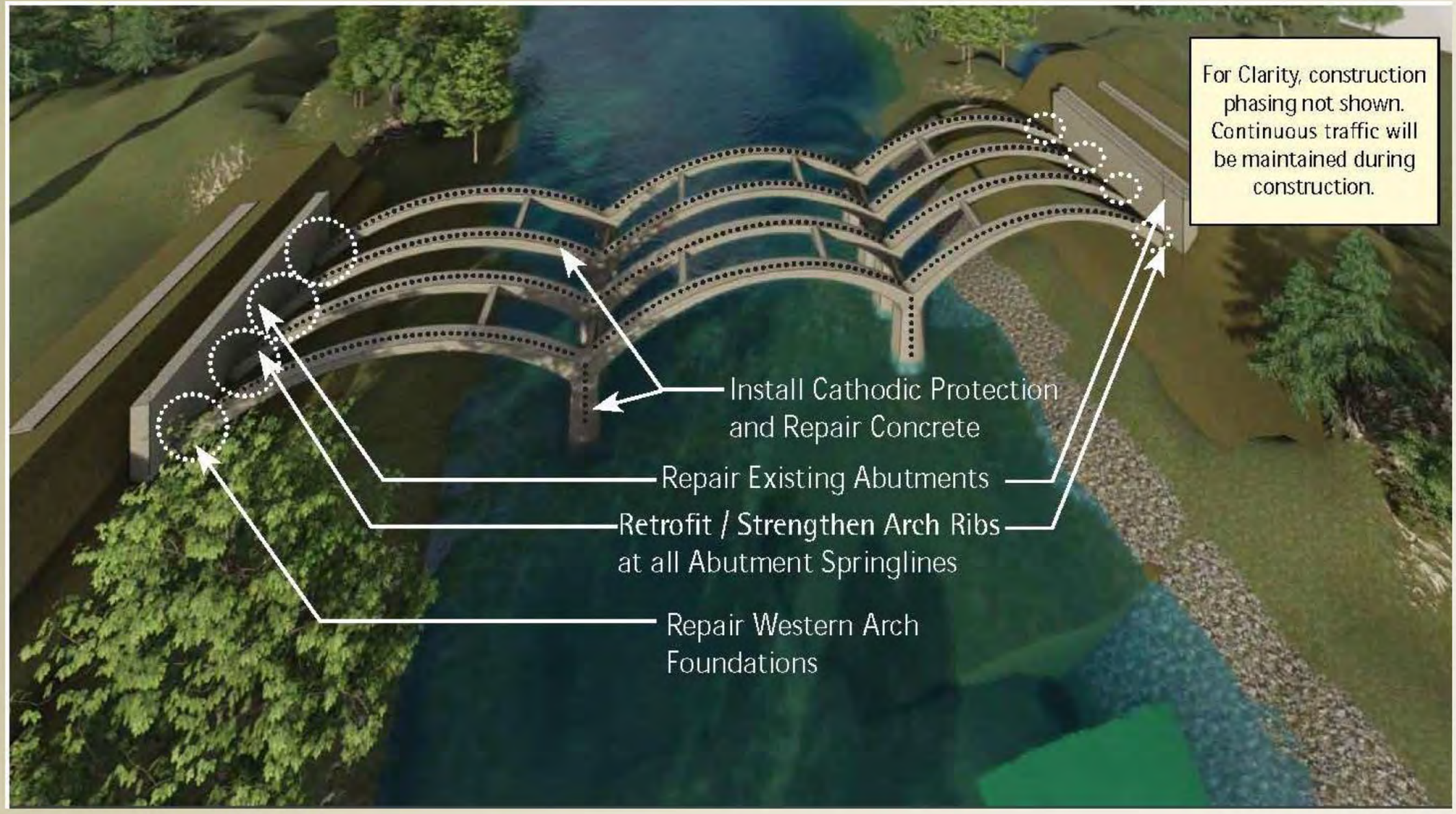
Rehabilitation Concepts

Rehabilitation Concepts



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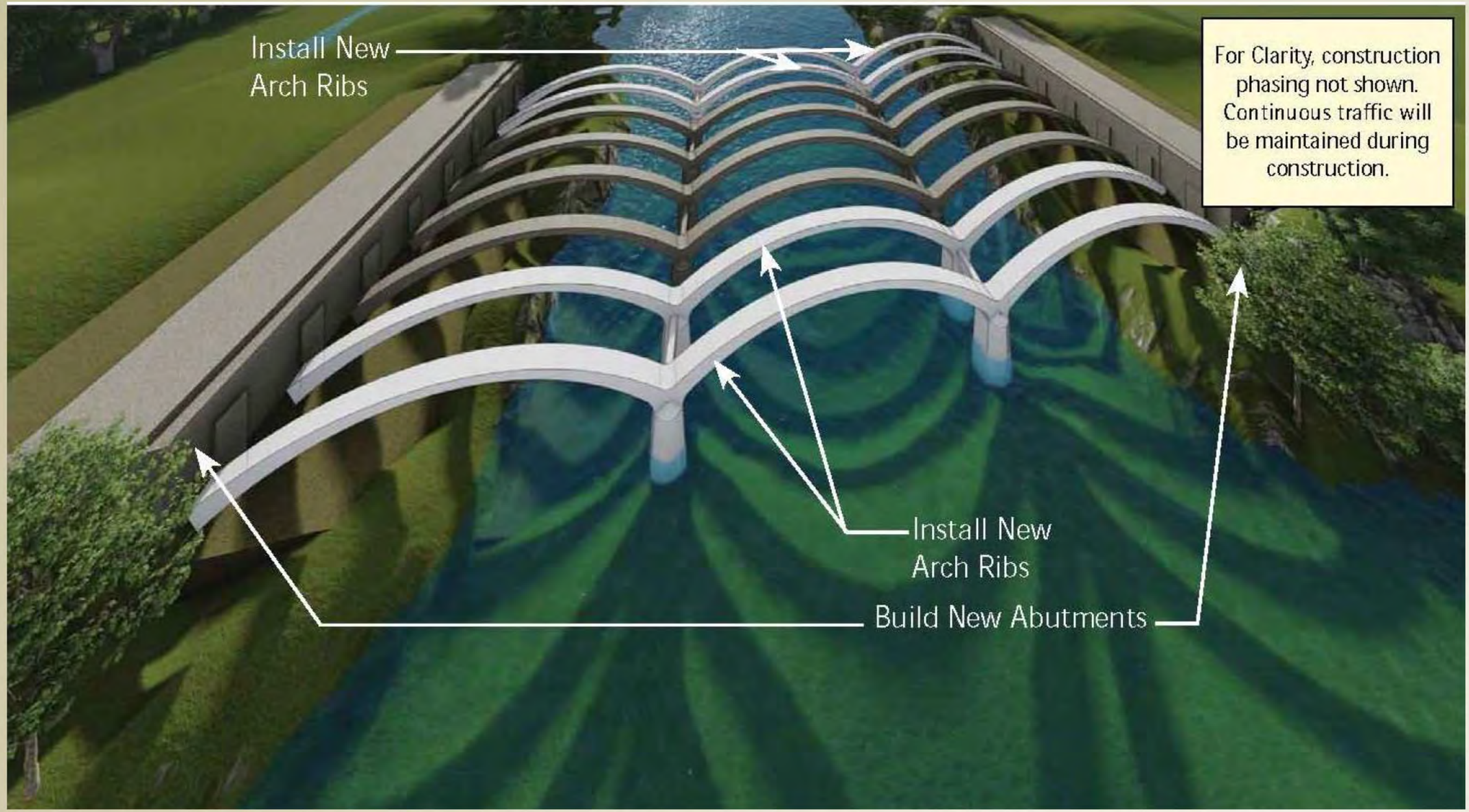
Rehabilitation Concepts



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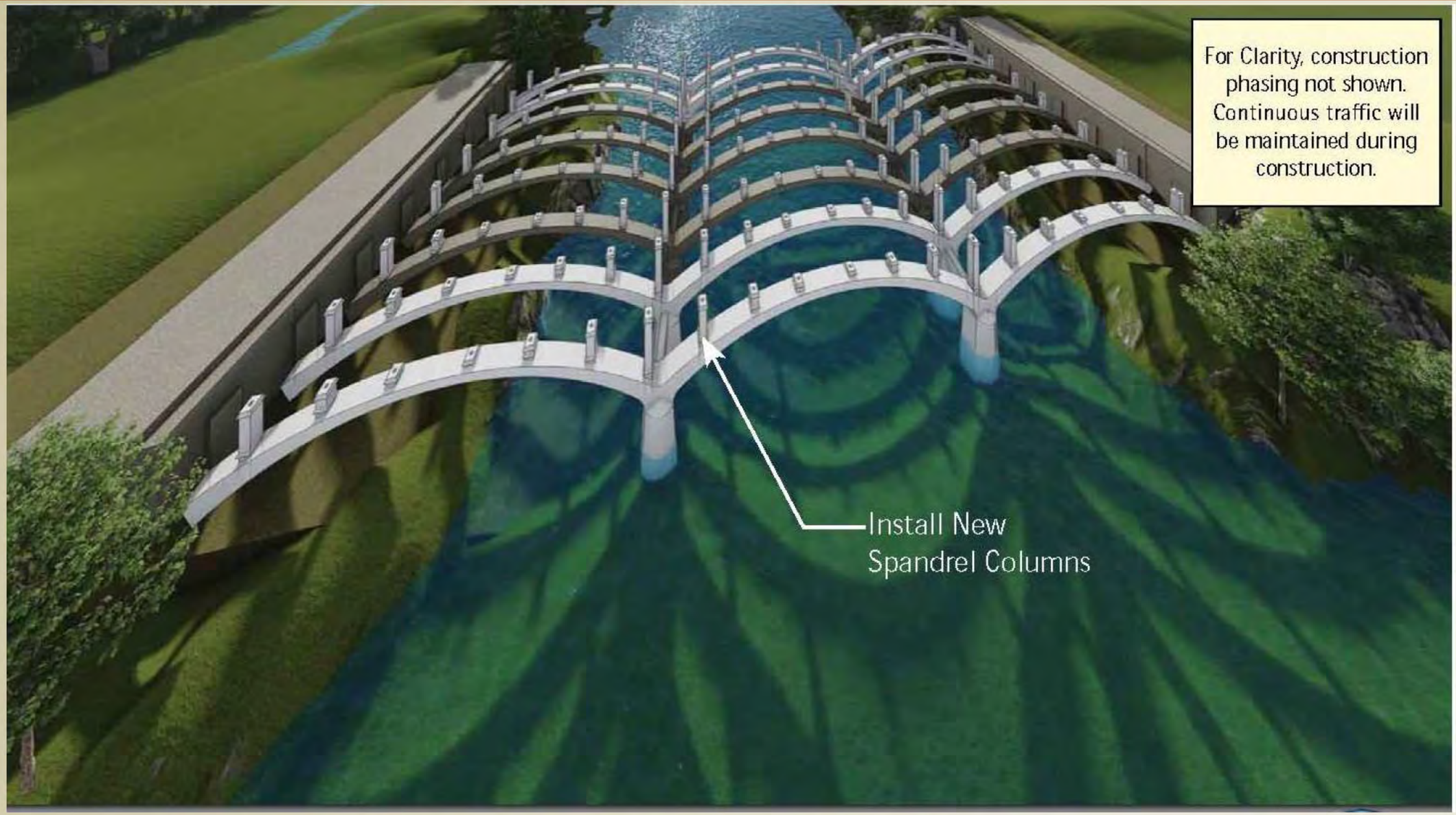
Rehabilitation Concepts



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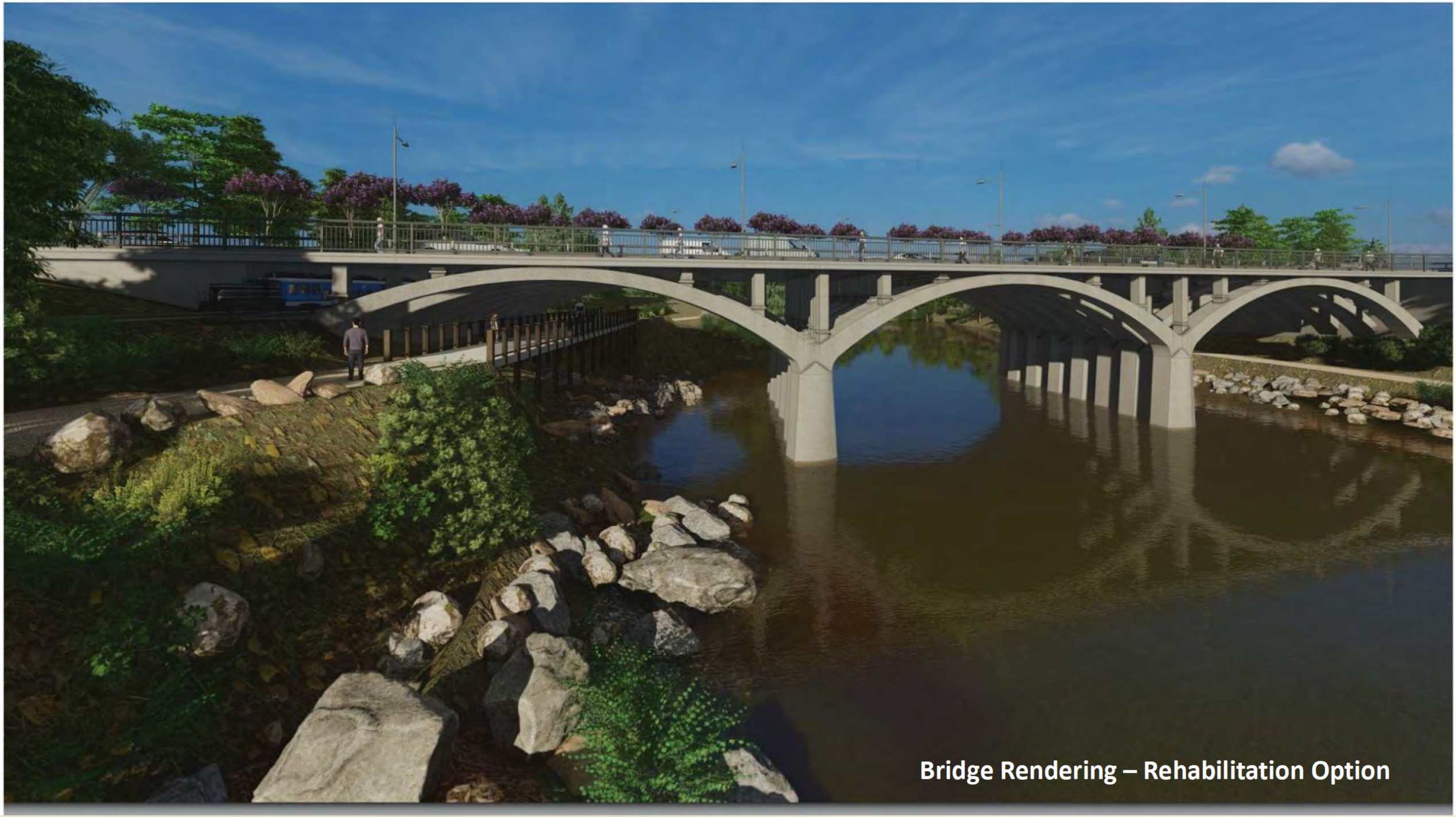

Bridge Rendering – Rehabilitation Option

Under Bridge – Rehabilitation Option

Replacement Concepts

- Descriptions:
  1. All concepts are “Above Basic” and influenced by the forms and details of the existing bridge.
  2. Options 1 and 2 limit substructure elements to four, providing more open space beneath the bridge.
  3. Options 1 and 2 incorporate indirect supports and both transverse and longitudinal post-tensioning.
  4. Option 2 splits the channel in half.

Replacement Option 1 – Longitudinally Framed Arch

Replacement Option 2 –Longitudinally Framed Single Column

Replacement Option 3 –Transversely Framed Dual Column

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Option 1 – Longitudinally Framed Arch

Option 1 – Longitudinally Framed Arch

Option 2 –Longitudinally Framed Single Y-Pier

Option 2 –Longitudinally Framed Single Y-Pier

Option 3 – Transverse Framed Dual Y-Pier

Option 3 – Transverse Framed Dual Y-Pier

Bridge Cost Estimates

Comparison of Alternatives Using 3% Discount Rate

Alternative	Bridge Total ($M)	Bridge ($/sq. ft.)*	Weighted Costing (Based on Total)	Costing Differences ($M)	Costing Rank (Based on Total)
Option 1 - Concrete Arch (New)	21.31	829.41	1.58	7.82	*4*
Option 2 - Concrete Single Pier (New)	16.77	652.63	1.24	3.28	*2*
Option 3 - Concrete Dual Pier (New)	13.49	524.88	1.00	0.00	*1*
Option 4 - Rehabilitation	18.40	811.78	1.36	4.92	*3*

* Note: New bridges have 13.3% more square feet of deck area than rehabilited bridge.
(New = 25,693 sq. ft. versus Rehab = 22,668 sq. ft.)

Includes Quantity Breakdown, Includes Unit Cost development

Includes Contingency of 25%, Includes Life Cycle Cost

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Summary of Benefits / Opportunities

Rehabilitation	Replacement
Increased structure safety and extended service life	Increased structure safety and extended service life
Increased mobility and connectivity	Increased mobility and connectivity
Improved roadway alignment	Improved roadway alignment
Decreased traffic congestion	Decreased traffic congestion
Preservation of portions of existing bridge • Caveats – concrete covered; structures obscured	Opportunity for aesthetic choices in new bridge
	Opportunity for more space and room for placement of Zilker Eagle and/or pedestrian paths on west bank of Barton Creek
	Opportunity for more head room and space underneath bridge for hike/bike trail on east bank, depending upon bridge type selection
	Less design/construction/cost risk due to existing material condition unknowns
	Cost savings from leading replacement options over rehab option

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Discussion

- Goals for the Meeting
  - *Project orientation*
  - *Review Process of Design Alternatives Analysis*

  - Solicit Initial Input and Discuss Key Issues that Drive Project Direction

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Discussion

Under Bridge – Rehabilitation Option

Option 1 – Longitudinally Framed Arch

Option 2 –Longitudinally Framed Single Y-Pier

Option 3 – Transverse Framed Dual Y-Pier

D-2 - Initial US Army Corps of Engineers Meeting – Nov. 2022

Barton Springs Pre-Application Meeting (DRAFT)

November 3, 2022, 2:00 pm to 3:00 pm

ATTENDEES

- [redacted]
- [redacted])
- [redacted]
- [redacted]

ACTION ITEMS

- AECOM to initiate USFWS informal coordination.
- AECOM to initiate coordination with the USACE District archeologist.

GENERAL DISCUSSION

This document serves as a general summary of the USACE Pre-Application Meeting Teleconference Call at 2:00 pm on November 3, 2022 for the Barton Springs Project.

- A brief summary of the proposed project and potential impacts to waters were presented.
    - Two alternatives are being considered for the proposed project, replacement of the bridge and rehabilitation of the bridge.
        - Replacement of the bridge is the recommended alternative.
    - Overall anticipated permanent impacts are anticipated to be minimal.
        - Replacement of the bridge would result in impacts to waters as a result of removal of the current bridge supports and construction of new bridge supports.
        - Rehabilitation of the bridge would result in impacts to waters as a result of reinforcement and improvement of the existing bridge supports as well as construction of four new bridge supports on either side of the existing structures (totaling eight new structures).
    - Anticipating that the project is likely to require some bank stabilization; however, unknown to the amount at this time.
- The applicant and cultural resources team met with the THC a few months ago. They requested additional information which was provided via the memo provided to the USACE on 9/29.
- The USACE would be the lead federal agency. The proposed project has no other federal involvement or federal funding.
- The current USACE District archeologist is leaving and there is currently not a replacement. The USACE suggested coordination with the current USACE District archeologist if we need answers on requirements/methodology as soon as possible. It is still possible he wouldn't be able to provide any guidance given his last day is 11/30. Otherwise, coordination would need to take place with the replacement archeologist once one is identified.
- USACE suggested initiating informal coordination with the USFWS to understand the threatened and endangered species implications with how close Barton Springs is to the proposed project. The concerns would be salamander species rather than karst species. It is likely the proposed project would require a Biological Assessment.
- The proposed project would be authorized under a Nationwide Permit 14 with a Pre-construction Notification.
    - At the time of this meeting, the USACE would not consider impacts to waters to be a loss of waters of the U.S. Therefore, the project is unlikely to require compensatory

mitigation. This determination may change as the project progresses and coordination continues.

- The USACE would be open to having a site visit; however, at this time does not think one would be required.

Prepare[redacted]November 9, 2022.

D-3 - Section 106 Evaluation – January 2023

SECTION 106 EFFECTS ASSESSMENT
OF THE
BARTON SPRINGS ROAD BRIDGE

CITY OF AUSTIN
TRAVIS COUNTY, TEXAS

January 2023

AmaTerra ENVIRONMENTAL, INC.

Section 106 Effects Assessment

of the

Barton Springs Road Bridge, Austin, Travis County, Texas

Prepared by:

Kurt Korfmacher
Architectural Historian and Principal Investigator

And

Erica Koteras
Historian

Consulting Firm:
AmaTerra Environmental, Inc.

Contact Information:
11842 Rim Rock Trail
Austin, TX 78737
Telephone: (512) 329-0031

January 2023

ABSTRACT

At the request of URS Corporation and on behalf of the City of Austin (City), AmaTerra Environmental, Inc. (AmaTerra) conducted an assessment of effect to the Barton Springs Road Bridge in Austin, Travis County, Texas. Barton Springs Road Bridge is a contributing resource to the Zilker Park Historic District, a property listed in the National Register of Historic Places (NRHP). The City proposes improvements to Barton Springs Road that would necessitate changes to the bridge, potentially including replacement of the existing bridge with a new structure. As the proposed undertaking would require permitting from the United States Army Corps of Engineers (USACE), it is subject to the requirements of Section 106 (36 CFR Part 800) of the National Historic Preservation Act (NHPA). As the City is a political entity of the State of Texas, the Antiquities Code of Texas (Texas Natural Resources Code, Title 9, Chapter 191) and its associated regulations (13 TAC 26) also apply.

In October 2022, professional historians meeting the Secretary of Interior Standards conducted an evaluation of the proposed project and its potential for effect on the NRHP-listed bridge and related contributing resources to the Zilker Park Historic District per Section 106 guidelines. Zilker Park Historic District is listed in the NRHP under Criteria A and C at the local level in the areas of Architecture, Conservation, Entertainment/Recreation, and Landscape Architecture, with a period of significance of 1917-1947. Both Barton Springs Road Bridge and the Main Entrance Piers (contributing) are within the project area.

The proposed bridge improvements are associated with a larger overall plan for Zilker Park known as the Zilker Park Vision Plan. This ambitious multi-year proposal would make major changes to large sections of Zilker Park to improve pedestrian flow and access, improve safety, restore and protect the natural environment, and make general improvements to how the park is accessed and operated for the long-term health of the park. Although improvements to the bridge are a component of the plan, the specific proposed improvements presented here have been developed in parallel but separately from the overall Zilker Park Vision Plan. As the improvements have utility beyond the Zilker Park Vision Plan, they are treated as a separate project from the Zilker Park Vision Plan for the purposes of this Section 106 evaluation.

Due to current conditions of the bridge, previous studies have determined that restoration of the existing structure is not feasible. The proposed project would involve either rehabilitation and expansion of the existing structure, or demolition and replacement of the bridge with a new structure. Both options would result in an adverse effect to the contributing Barton Springs Road Bridge by impacting its integrity of design, materials, workmanship, and feeling. The proposed project would not physically impact the Main Entrance Piers but would result in a change of setting due to the alterations to the nearby bridge. As such, the proposed action would result in a change to the setting, design, materials, workmanship, and feeling of Zilker Park Historic District and is thus recommended as having an **adverse effect** to historic properties under Section 106.

INTRODUCTION

PROJECT SUMMARY

The City proposes road improvements to the Barton Springs Road Bridge and the intersection of Barton Springs Road and Azie Morton Road in Austin, Travis County, Texas (**Figure 1**). The Barton Springs Road Bridge geometry is functionally obsolete with respect to bike and pedestrian traffic. In addition, the bridge is un-aligned with the roadway east of the intersection of Barton Springs Road and Azie Morton Road, located immediately east of the bridge. To improve safety along the roadway for vehicles, bicycles, and pedestrians, reduce congestion and improve traffic flow along Barton Springs Road and at the Azie Morton Road intersection, and address important safety concerns regarding the functional operation and condition of the bridge, the City proposes to rehabilitate or replace the existing bridge. Due to the deteriorated condition of the existing bridge superstructure, preservation of the bridge is not feasible (see **Attachment C** for details on the deteriorated condition of the bridge).

Barton Springs Road Bridge is considered a contributing resource to the NRHP-listed Zilker Park Historic District, and thus the project falls within the boundary of the NRHP historic district. At the request of URS Corporation and on behalf of the City, AmaTerra conducted an assessment of effect for the proposed undertaking following the requirements of Section 106 (36 CFR Part 800) of the NHPA.

OBJECTIVE AND METHODS

The primary objective of this project is to assess the potential effects to the NRHP contributing bridge and NRHP-listed historic district under Section 106. The technical approach for this recommendation on effect included research into the history of the Barton Springs Road Bridge and Zilker Park, examination of the proposed project activities, and an analysis of the impact of the proposed project activities on the aspects of integrity of the historic properties. Historians conducted fieldwork through survey forms and photographs, and relied on previous reports and documentation provided by URS on the condition of the Barton Springs Road Bridge and the various alternatives proposed. This data was then analyzed to produce a recommendation on potential adverse effect to historic properties under Section 106 following National Park Service guidelines for assessing effect to historic properties.

AREA HISTORIC PROPERTIES

The bridge and entrance piers are contributing resources to the Zilker Park Historic District. The Barton Springs Archeological and Historical District is also located within the Zilker Park Historic District, and the downstream boundary is within close proximity to the bridge. In addition to these historic properties, a review of the Texas Historical Commission (THC) Texas Historic Sites Atlas (Atlas) revealed one Registered Texas Historic Landmark (RTHL) within the study area of one-quarter mile, the IV Davis Homestead at 1610 Virginia Avenue. A supplemental review of the Texas Department of Transportation (TxDOT) Historic Resources of Texas Aggregator database (Aggregator) revealed additional contributing resources to the Zilker Park Historic District within the study area including stone walls and culverts, a picnic area, a sunken garden, the caretaker's cottage, and a maintenance shop (**Figure 2**). Three City of Austin Historic Landmarks are also within the study area: Barton Springs, the Zilker Park Caretaker's Cottage, and the IV Davis Homestead. In addition, the Umlauf Sculpture Garden and Museum is located directly to the south of the bridge along Azie Morton Road (**Figure 2**).

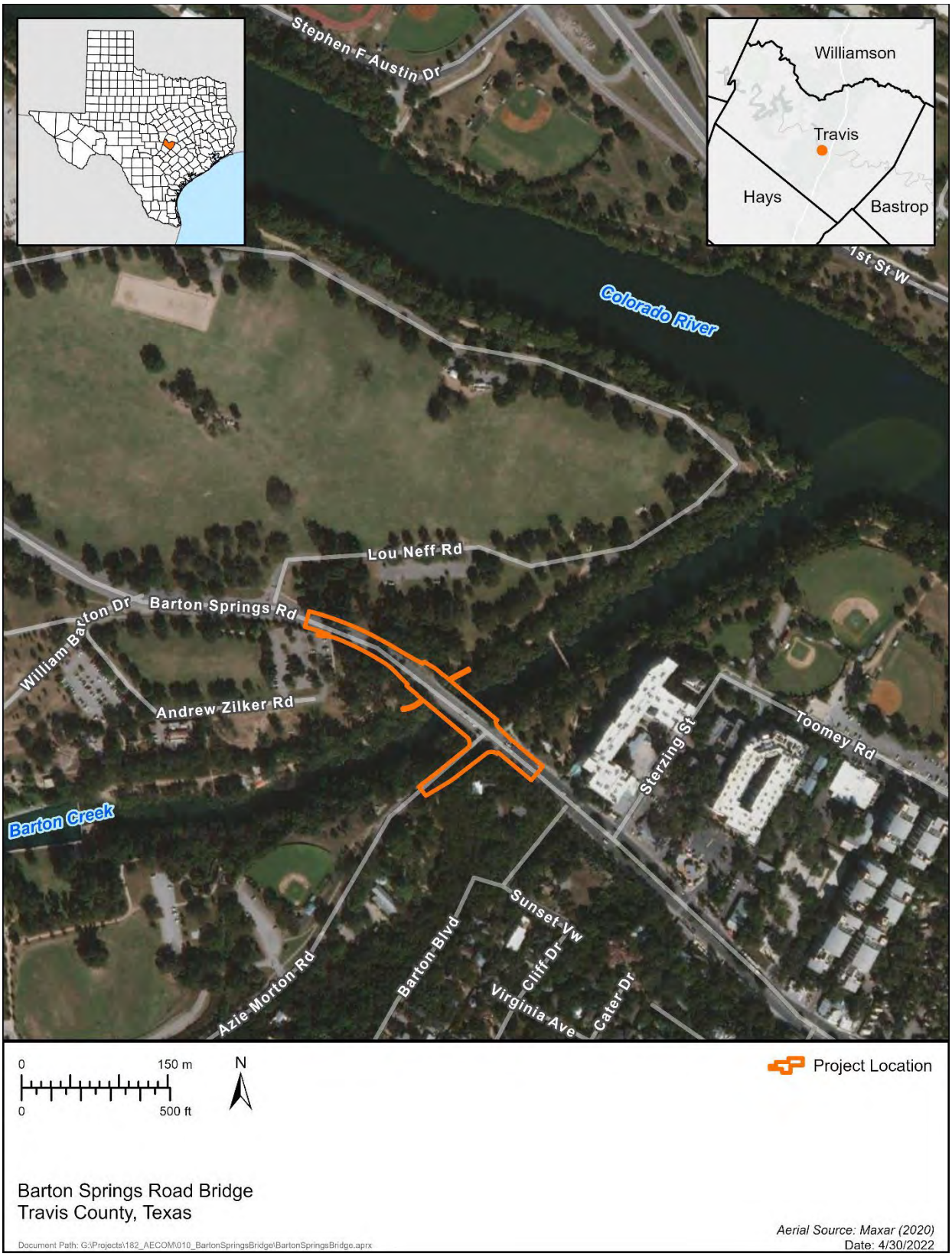


Figure 1. Project Location Map

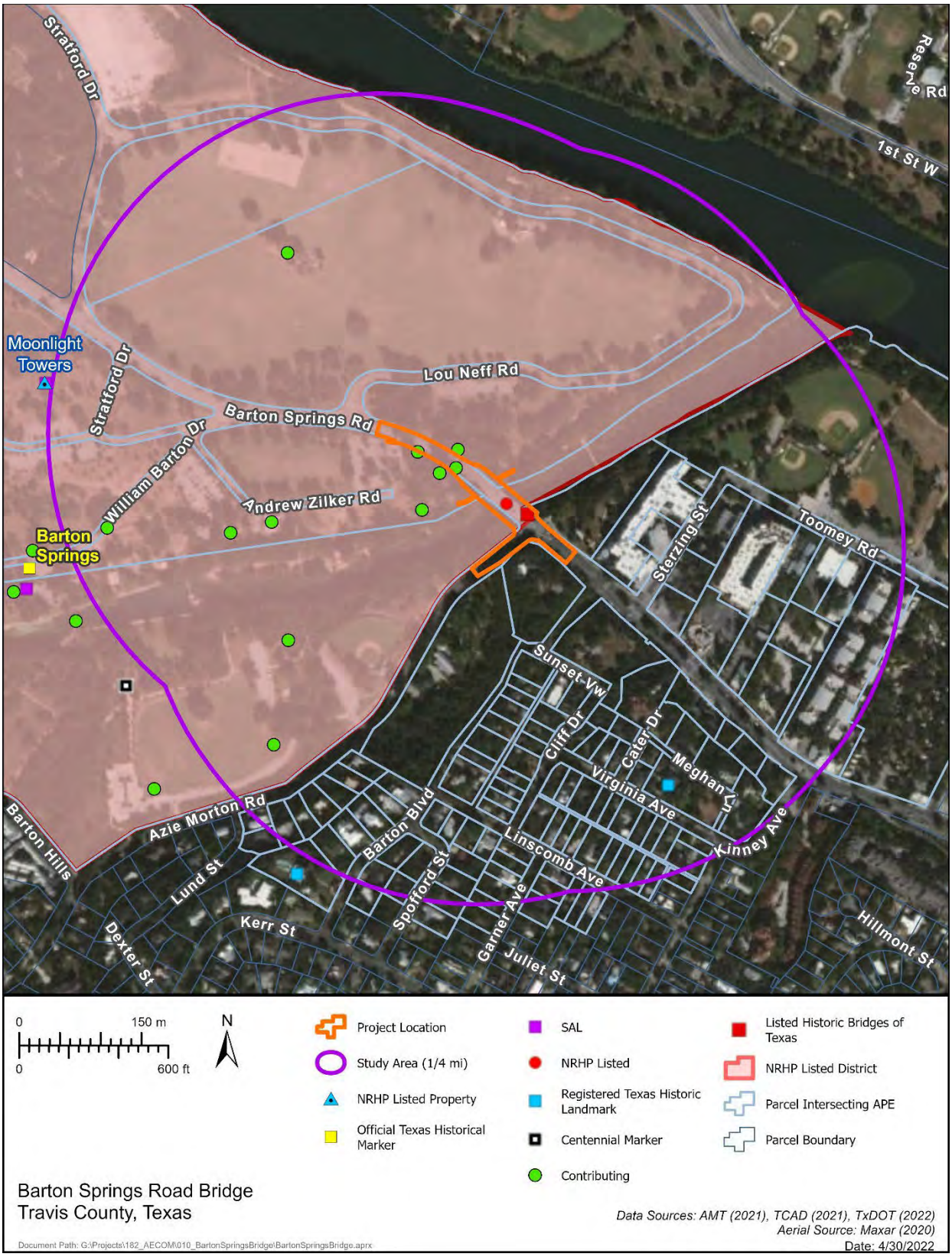


Figure 2. Historic Properties in the Study Area

FIELD SURVEY METHODOLOGY

The field work was conducted and supervised by an architectural historian meeting the Secretary of the Interior's professional qualifications (as defined in 36 CFR Part 61). Physical inspection of the resources consisted of a site inspection, photographic documentation, and recording relevant construction materials and character-defining features. All information was recorded on field notes and maps. For the purposes of the survey, the APE was determined to be the project footprint.

Photographic documentation included at least two photographic frames of the property from oblique angles to capture all visible sides, and any pertinent architectural detailing observed on the resource. Field data gathered included the current name, use, and function, if discernable; construction date (estimated, if unknown); architect or builder, if known; property type and subtype; architectural details and features.

EVALUATION OF PROJECT EFFECT

Under Section 106 of the NHPA [36 CFR Part 800.16(i)], an effect is any alteration to the characteristics of a historic property qualifying it for inclusion in or eligibility for the National Register. In practical terms, if a historic property is located within a project APE, then it is considered affected, and must be analyzed for adverse effect. An adverse effect, per Part 800.5(a)(1), is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the National Register in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association.

Examples of adverse effects include, but are not limited to, any of the following:

1. Physical destruction of or damage to all or part of the property;
2. Alteration of a property, including restoration, rehabilitation, repair, maintenance, stabilization, hazardous material remediation and provision of handicapped access, that is not consistent with the Secretary of the Interior's Standards for the Treatment of Historic Properties (36 CFR Part 68) and applicable guidelines;
3. Removal of the property from its historic location;
4. Change of the character of the property's use or of physical features within the property's setting that contribute to its historic significance;
5. Introduction of visual, atmospheric, or audible elements that diminish the integrity of the property's significant historic features.

If analysis concludes project action would have an adverse effect on one or more historic properties, then per Part 800.6, the federal agency involved (in this case, the USACE) must explore options to avoid, minimize, or mitigate harm to the affected historic properties. Consulting parties, including SHPO, affected Native American tribes (and the Tribal SHPO), other affected federal or state agencies, and any other duly recognized public or private entities must have the opportunity to review and comment on the findings of adverse effect and any proposed measures to avoid, minimize, or otherwise mitigate harm. Upon review and resolution of any disagreement among the parties, the lead agency and consulting parties may sign a MOA covering the adverse effects and their resolution (if any).

HISTORIC OVERVIEW OF ZILKER PARK

(The following information is a summary of the historic context presented in the 1997 NRHP nomination form for Zilker Park Historic District, included via reference.)

Originally settled by William Barton in the late 1830s, Barton Springs was an area that would slowly prosper as a cattle area, to a place of industrialization, and, finally, recreational. Post-Civil War, this area was utilized for waterpower and the land was leased out to local entrepreneurs. The springs were also popular bathing areas before the 1910s when they became swimming areas. Andrew Zilker would buy 37 acres of land that surrounded the natural spring. This transaction would go on to inspire a zealous wave in the Reform Park Movement (1900-1930). The park's development in the 1920s mirrored the concept of the movement by being 10-40 acres, having a bathing facility, sports fields, and a children's play area (NRHP Registration Form, 18-20).

Andrew Zilker's main motivation with transforming Barton Springs and the park was to preserve its integrity as a natural resource. Before his infamous 1917 three-party transaction, there were few parks in Austin and no recreation facilities matching what the Reform Park Movement aimed to achieve. The 1920s development of the park would usher in a new wave of park departments and park policies for future park installations in Austin. In 1926, the city authorized a bond to fund the park's expansion to 250-300 acres, and construction of the Barton Springs Park began. In 1928, the city established its first Recreation Department, and a five-year plan was curated to outline the future developments of the city's park facilities (NRHP Registration Form, 20).

This five-year plan would develop into a master plan set to preserve the natural topography and scenery of the remaining unconstructed park, which was 50-200 acres. Inspired by the park's development and public appeal, other neighborhood parks and playgrounds were created between 1929 and 1939. During the early 1930s, pedestrian trails and roadways were added to make the park more accessible outside the local population. With programs created due to the Great Depression, enhancements such as these and funding for park employment was possible (NRHP Registration Form, 21).

During the Great Depression, Four New Deal agencies and programs, as well as the National Park Service, are known to have contributed to Zilker's development. By 1939, the park was fully developed due to the amounts of federal funding it received during the Depression era. These developments include bridle paths, separate roadways, and enhancement to other pre-existing topographical features. While both parks, Barton Springs and Zilker Park, compliment the eras they were developed in, the construction of the current Barton Springs Bath House (1947) displays Moderne characteristics, fully signifying the end of the Depression-era Park development (NRHP Registration Form, 22-24).

Barton Springs Road Bridge

As part of the plans to develop Zilker Park, the city solicited designs for a new bridge over Barton Creek to provide access to the park from the south bank of the Colorado River. Terrell Bartlett Engineers of San Antonio designed the new bridge in 1925, featuring three spans supported by concrete arches on concrete piers with two traffic lanes, a pedestrian sidewalk, and decorative railing with integrated light posts (**Figure 3**). The bridge, constructed the following year, stretched 210 feet over Barton Creek, with a 20-foot-wide roadway, 5-foot sidewalk, and curbing.

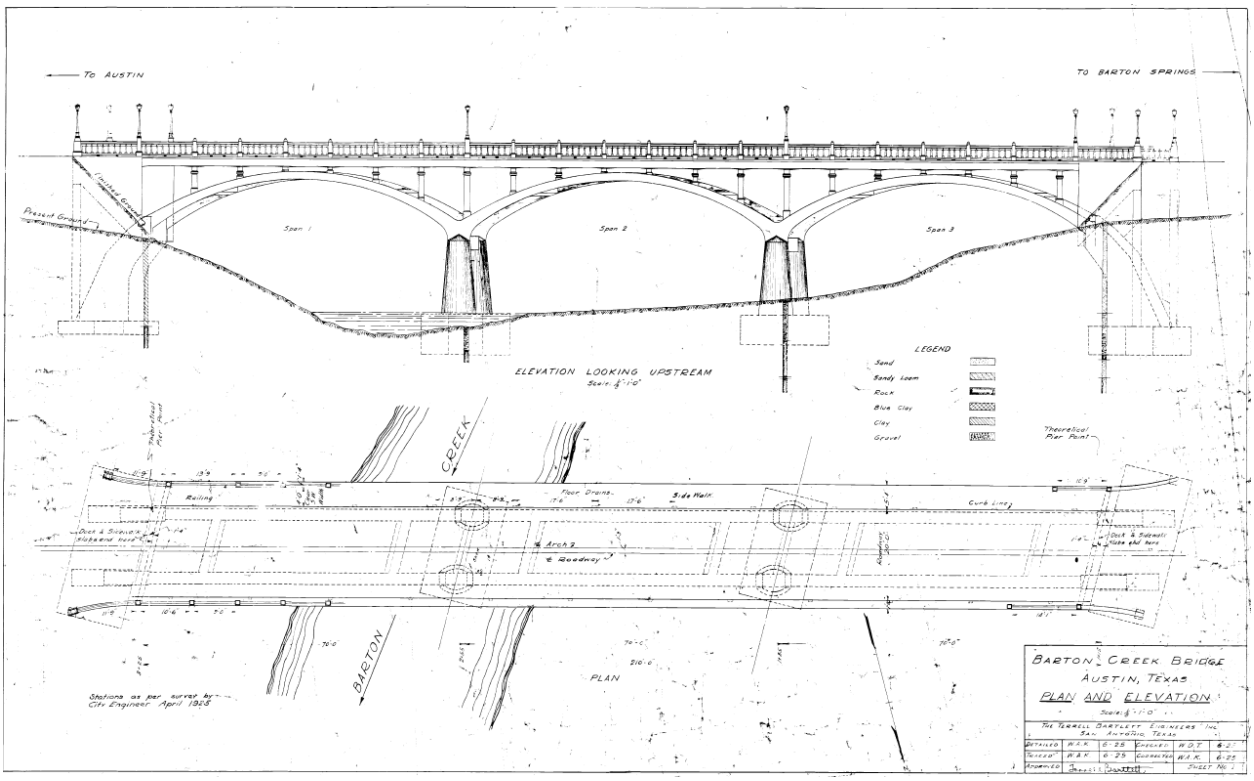


Figure 3: Original 1925 plans for the Barton Springs Road Bridge.

The growth of Austin and the success of Zilker Park meant the amount of traffic passing over the bridge soon exceeded its capacity. In 1945, city engineers revealed plans for expanding the existing bridge by more than doubling its width to accommodate two more lanes of traffic plus an additional sidewalk on the side opposite the existing one (**Figure 4**). Matching the design of the existing bridge, the new bridge measured nearly 60 feet across, adding a second set of arched spans matching the original set.

Today, Barton Springs Road is a four-lane road that serves as the primary thoroughfare through Zilker Park, located on the south bank of the Colorado River along Lady Bird Lake. The bridge over Barton Creek is at the east entrance to the park which serves as a focal point for important community events such as the annual Austin City Limits Music Festival, South by Southwest Conference and Music Festival (SXSW), Barton Springs, the holiday Trail of Lights, and Blues on the Green to name a few. Barton Springs Road and the bridge also serve vehicular, bicycle, and pedestrian traffic, and the road serves as a primary connector from Loop 1/Mopac Freeway to south Austin, downtown, and key corridors such as South Lamar Boulevard and Congress Avenue.

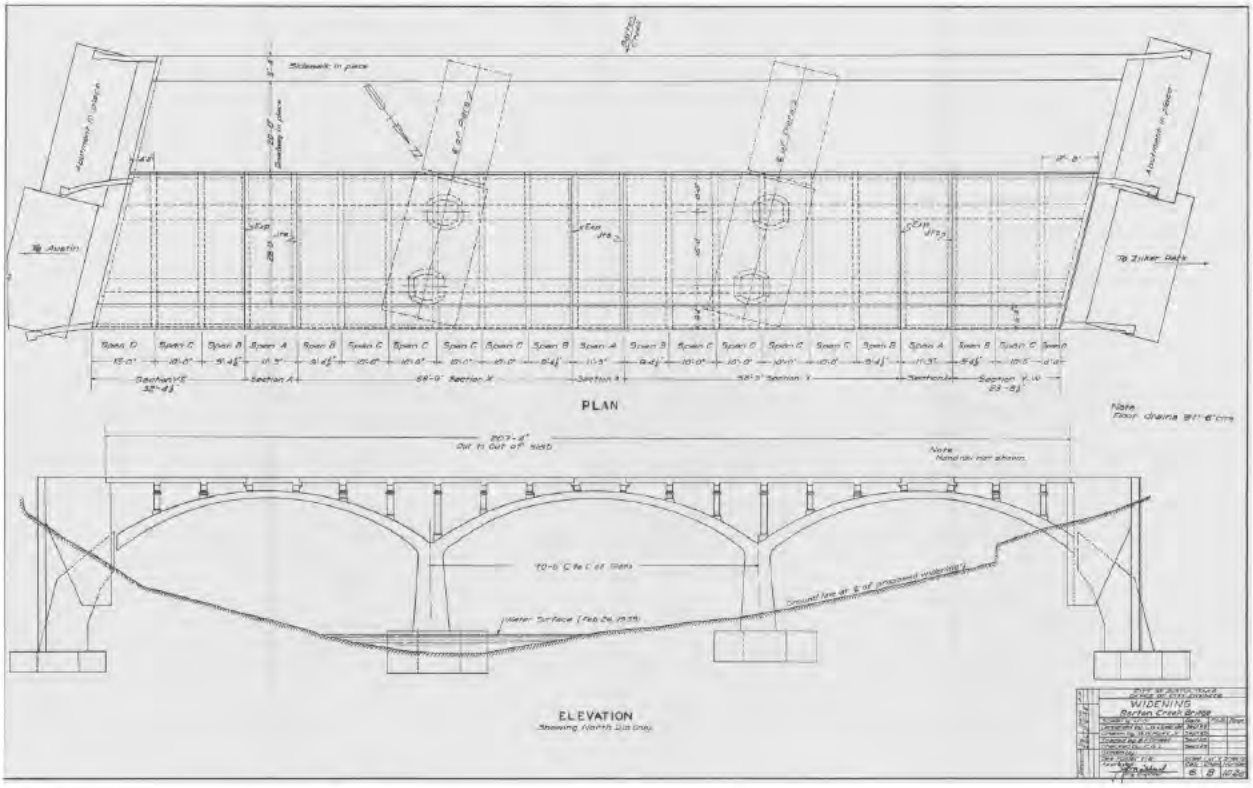


Figure 4: 1945 plans to expand the bridge to its present configuration.

HISTORIC RESOURCES SURVEY RESULTS

ARCHITECTURAL STYLES AND PROPERTY TYPES

In October 2022, project historians conducted a historic-age resources survey of the resources contributing to the Zilker Park Historic District within the project APE (**Figure 5**). A summary of eligibility is shown in **Table 1**. Photos of the properties may be found in **Attachment A**.

Table 1. Surveyed Resources

Resource	Year Built	Historic Use or Function	Style	NRHP Eligibility/ Criteria
01	1926/ 1945	Transportation/Bridge	Three-span open spandrel concrete arch	Listed (Contributing), Criteria A and C
02	1934	Landscape/Monument	Art Deco	Listed (Contributing), Criteria A and C
03	1934	Transportation/Culvert	Rustic	Eligible (Contributing), Criteria A and C

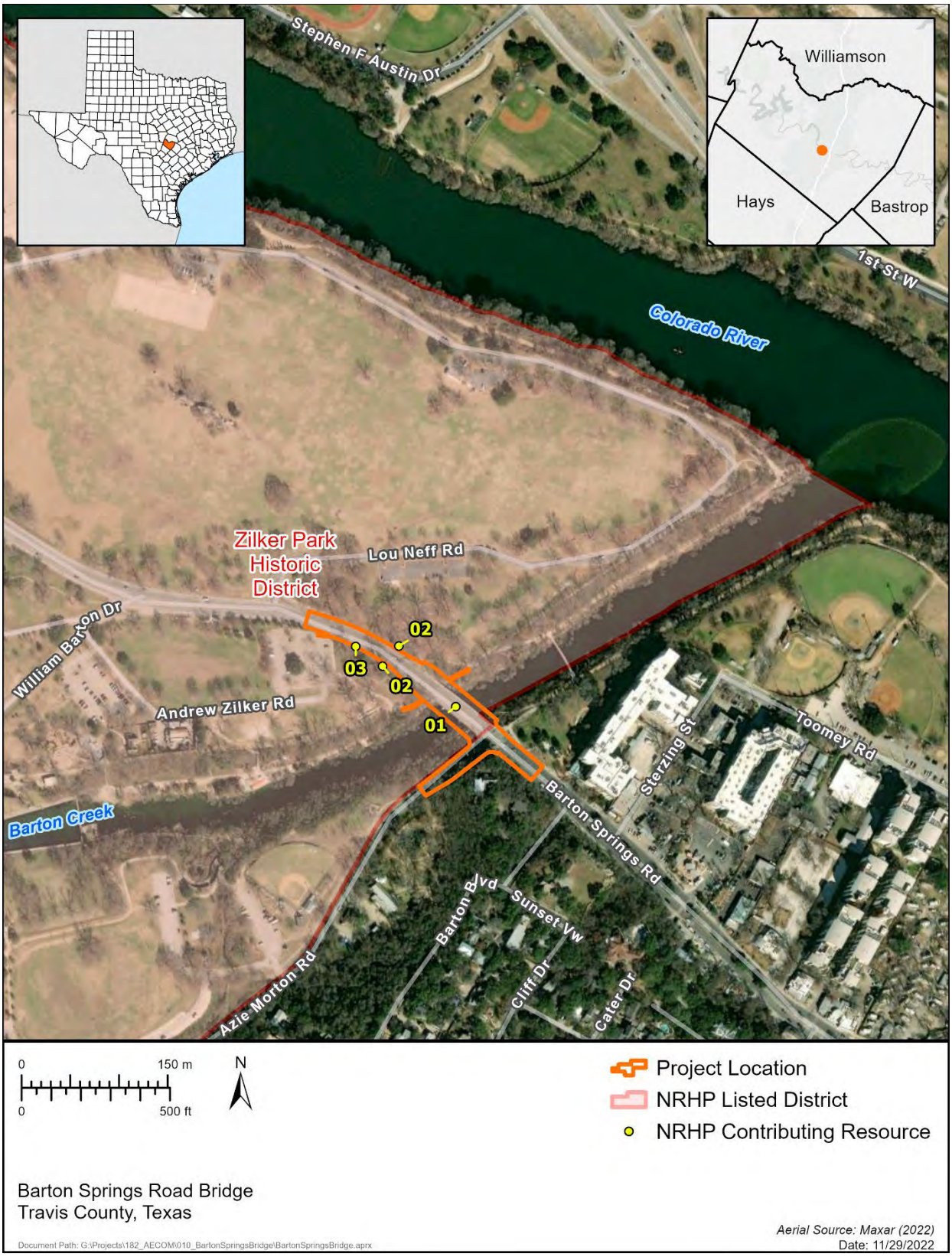


Figure 5. Surveyed Contributing Resource Locations.

RESOURCE DESCRIPTIONS

Resource No. 01: Barton Springs Road Bridge

The Barton Springs Road Bridge is a three-span, open spandrel concrete arch bridge originally constructed in 1925 and expanded on the north side in 1946. It is approximately 212' long and 58'-8" wide and carries four lanes of traffic and two sidewalks across Barton Creek. The railing consists of steel frame and tube set between cast concrete chamfered posts, with integrated conduits for light posts. Metal construction plaques are embedded in end posts at both the west and east ends of the bridge.

Alterations include the 1945 expansion on the northern section of the bridge and added pathways for pedestrians underneath the bridge on both banks of Barton Creek, and tracks for a miniature train on the west bank (although none of the paths connect directly to the bridge superstructure itself. Other alterations include removal of the light posts on the bridge at an indeterminate date. These changes were all present at the time the bridge was determined a contributing resource to the Zilker Park Historic District and do not detract from the bridge's integrity of location, design, setting, materials, workmanship, feeling, and association.

Resource No. 02: Zilker Park Main Entrance Piers

The Zilker Park Main Entrance Piers are two monuments and associated stone walls and planters that flank the east end of Barton Springs Road just west of the bridge. The primary south pier is a large monument with Art Deco styling. The monument is constructed of yellowed Cordova limestone quarried locally set in semi-regular courses, with decorative bands and overhangs. The words "ZILKER PARK" are lettered in iron on either side of the monument. A large limestone planter extends out from the base and to the east toward the bridge. The north side entrance pier is much smaller than the south pier (approximately one-third the height) and features more modest Art Deco styling, topped by a flat concrete cap. A limestone planter extends out to the east from the north pier, similar to the south pier. The piers have no obvious alterations and retain integrity of location, design, setting, materials, workmanship, feeling, and association.

The TxDOT Aggregator separates the planters and walls from the entrance piers as contributing resources to the historic district. However, as the NRHP nomination treats them as part of the entrance piers, the piers and planters were evaluated as a single resource for this study.

Resource No. 03: Stone Culvert

Resource No. 03 is a small stone culvert laid out on a north-south axis underneath Barton Springs Road west of the entrance piers. The culvert is made of rough-cut sandstone and concrete, with a stone head wall set back from the road, angled stone wing walls, and a simple cast concrete pipe. A modern stone skirt is set in the ground between the head wall and the roadway. The culvert is listed as a contributing resource on the TxDOT Aggregator but is not recorded as a contributing resource in the Zilker Park Historic District NRHP nomination form. It is treated as an eligible contributing resource for the purposes of this study, with integrity of location, design, setting, materials, workmanship, feeling, and association.

SECTION 106 EFFECTS ANALYSIS

PROPOSED PROJECT ACTIVITIES

The age and deteriorated condition of the bridge have warranted increased inspections over time, and the bridge geometry is functionally obsolete with respect to bike and pedestrian traffic. A bridge inspection was last performed in 2017. In addition, the bridge is un-aligned with the roadway east of the intersection of Barton Springs Road and Azie Morton Road, located immediately east of the bridge. To improve safety along the roadway for vehicles, bicycles, and pedestrians, reduce congestion and improve traffic flow along Barton Springs Road and at the Azie Morton Road intersection, and address important safety concerns regarding the functional operation and condition of the bridge, the City proposes to rehabilitate or replace the existing bridge and construct improvements to the associated bike paths, sidewalks, and the intersection of Barton Springs Road and Azie Morton Road (**Attachment B**). Due to the deteriorated condition of the existing bridge superstructure, preservation of the bridge is not feasible (**Attachment C**).

Option One: Bridge Rehabilitation

Rehabilitation would require removal of the existing bridge deck and spandrel columns, and then attempt to repair and reuse the existing concrete arches with the new columns and deck. Additional arches would also be needed to expand the bridge to approximately 109 feet in width in order to accommodate additional bike and pedestrian capacity and turn lanes to improve traffic flow at the Azie Morton Road intersection. The arches of the expanded bridge would match the existing bridge, although less than half of the original bridge would remain.

Option Two: Bridge Replacement

Replacement of the bridge would remove the existing bridge entirely and construct a new structure with sufficient width (approximately 109 feet) to accommodate the proposed multi-modal travel ways. The design of the replacement bridge is still under consideration and multiple alternatives are under development.

ANALYSIS OF ADVERSE EFFECT

Project historians used the results of the field survey, the information contained within the Zilker Park Historic District NRHP nomination form, the proposed project activities, and guidelines provided by the National Park Service to determine the level of effect on the NRHP listed properties within the project APE. **Table 2** summarizes the recommendations on effect.

Option One: Bridge Rehabilitation

Under the rehabilitation option, the existing bridge deck and spandrel columns would be replaced, and the existing concrete arches would be used to support the new deck. In addition, the bridge would be expanded to accommodate added traffic lanes and pedestrian pathways. While the addition would mimic the appearance of the existing bridge, the change in size would impact the bridge's integrity of design and feeling. Removal and replacement of the spandrel columns would impact the integrity of materials and workmanship. With impacts to integrity of design, materials, workmanship, and feeling, it is recommended that the proposed rehabilitation option would have an **adverse effect** on the NRHP contributing bridge under Section 106.

Additionally, preliminary proposed changes to the bike lane along Barton Springs Road would impact the stone culvert (Resource No. 03) located west of the entrance piers (Resource No. 02). This would impact the culvert's integrity of location, design, materials, workmanship, and feeling, resulting in a recommended finding of **adverse effect** to the NRHP contributing resource. The entrance piers and the landscaping walls (Resource No. 02) would not be impacted by the proposed improvements under either option, resulting in no loss of integrity and a recommended finding of **no adverse effect** to the contributing resources.

Although the retention of the existing bridge design would mimic the original bridge design, the increase in size would impact the general appearance of the approach to Zilker Park from the east. The increased width of the bridge would not be complementary to the historic district's existing physical aesthetics and would impact the historic district's integrity of setting, design, materials, workmanship, and feeling. As such, it is recommended that the bridge rehabilitation option would have an **adverse effect** on the NRHP-listed Zilker Park Historic District.

Option Two: Bridge Replacement

Under the replacement option, the existing bridge would be removed and replaced by a bridge meeting the design criteria of the proposed project. Although the design of the bridge is still under development, project engineers hope to include design elements that call back to the original design of the bridge, if not its appearance. However, removal of the bridge would impact the bridge's integrity of location, setting, design, materials, workmanship, feeling, and association, resulting in a recommendation of an **adverse effect** on the NRHP contributing bridge under Section 106.

Removal and replacement of the existing bridge would have as significant an impact on the Zilker Park Historic District as the rehabilitation option. The larger mass and scale of the bridge and new design elements would not be complementary to the historic district's existing physical aesthetics and would impact the historic district's integrity of design, setting, materials, workmanship, feeling, and association. As such, it is recommended that the bridge replacement option would have an **adverse effect** on the NRHP-listed Zilker Park Historic District.

Table 2. Summary of Effect

Resource	Option One Impact	Option Two Impact	Notes
01	Adverse Effect	Adverse Effect	Due to the nature of the work required under either option, both would have an adverse effect on the bridge.
02	No Adverse Effect	No Adverse Effect	Neither option would impact the integrity of the entrance piers or associated planters.
03	Adverse Effect	Adverse Effect	Proposed bike lane improvements would impact the integrity of the culvert.
Zilker Park Historic District	Adverse Effect	Adverse Effect	Changes to the bridge under either option are recommended to have an adverse effect on the historic district as a whole.

References Cited

National Register of Historic Places
1997 "Zilker Park Historic District." National Register of Historic Places Nomination Form, prepared by Julie Strong, et. al., Heritage Marketing, Austin.

APPENDIX A: HISTORIC RESOURCES SURVEY FORMS

Barton Springs Road Bridge
Historic Resources Survey
December 2022
Surveyed by Kurt Korfmacher and Erica Koteras

Resource No.	01	Address:	Barton Springs Rd at Barton Creek
Resource Type:	Structure	Function/Use:	Transportation/road-related (vehicular)
Estimated Year built:	1926/1946	References:	NRHP Nomination Form; bridge plaque
NRHP Eligibility:	Contributing resource of Zilker Park Historic District which is listed under Criteria A and C at the local level in the areas of Architecture, Conservation, Entertainment/Recreation, and Landscape Architecture, with a period of significance of 1917-1947.		

Description: The existing bridge is a three-span, open spandrel concrete arch bridge originally constructed in 1926 and expanded on the north side in 1946. It is approximately 212' long and 58'-8" wide and carries four lanes of traffic and two sidewalks across Barton Creek. Alterations include an added structure in the northern section of the bridge.

The bridge is considered a contributing resource to the NRHP-listed Zilker Park Historic District under Criteria A and C. It contributes to the urban and historic fabric of Zilker Park and is an integral public transportation system in Austin, Texas.

Camera direction: south

Resource No.	01	Address:	Barton Springs Rd at Barton Creek

Camera direction: east

Camera direction: west

Resource No.	01	Address:	Barton Springs Rd at Barton Creek

Camera direction: southeast

Camera direction: north

Resource No.	01	Address:	Barton Springs Rd at Barton Creek

Camera direction: northeast

Camera direction: east

Resource No.	01	Address:	Barton Springs Rd at Barton Creek

Camera direction: southeast

Camera direction: southwest

Resource No.	01	Address:	Barton Springs Rd at Barton Creek

Camera direction: southwest

Camera direction: southeast

Barton Springs Road Bridge
Historic Resources Survey
November 2022
Surveyed by Kurt Korfmacher and Erica Koteras

Resource No.	02	Address:	2207 Lou Neff Rd
Resource Type:	Object	Function/Use:	Landscape/Monument
Estimated Year built:	1934	References:	NRHP Nomination Form
NRHP Eligibility:	Contributing resource of Zilker Park Historic District which is listed under Criteria A and C at the local level in the areas of Architecture, Conservation, Entertainment/Recreation, and Landscape Architecture, with a period of significance of 1917-1947.		

Description: The Zilker Park Main Entrance Piers are found at the entrance to the park, west of the Barton Springs Road Bridge. The monument is constructed of yellowed Cordova limestone quarried locally, set in semi-regular courses, with decorative bands and overhangs. The words "ZILKER PARK" are lettered in iron on either side of the monument. The north side entrance pier is much smaller than the south pier (approximately one-third the height) and features more modest Art Deco styling, topped by a flat concrete cap.

The entrance piers are considered contributing resources to the NRHP-listed Zilker Park Historic District under Criteria A and C. They contribute to the urban and historic fabric of Zilker Park.

Camera direction: southwest looking at north entrance pier

Resource No.	02	Address:	2207 Lou Neff Rd

Camera direction: west

Camera direction: southwest

Resource No.	02	Address:	2207 Lou Neff Rd

Camera direction: northeast

Camera direction: northwest

Resource No.	02	Address:	2207 Lou Neff Rd

Camera direction: southeast

Camera direction: northwest looking at north entrance pier

Resource No.	02	Address:	2207 Lou Neff Rd

Camera direction: north

Barton Springs Road Bridge
Historic Resources Survey
November 2022
Surveyed by Kurt Korfmacher and Erica Koteras

Resource No.	03	Address:	2207 Lou Neff Rd
Resource Type:	Structure	Function/Use:	Transportation/Culvert
Estimated Year built:	C. 1934	References:	NRHP Nomination Form; TxDOT Aggregator
NRHP Eligibility:	Considered contributing to the Zilker Park Historic District under Criteria A and C at the local level in the areas of Architecture, Conservation, Entertainment/Recreation, and Landscape Architecture.		

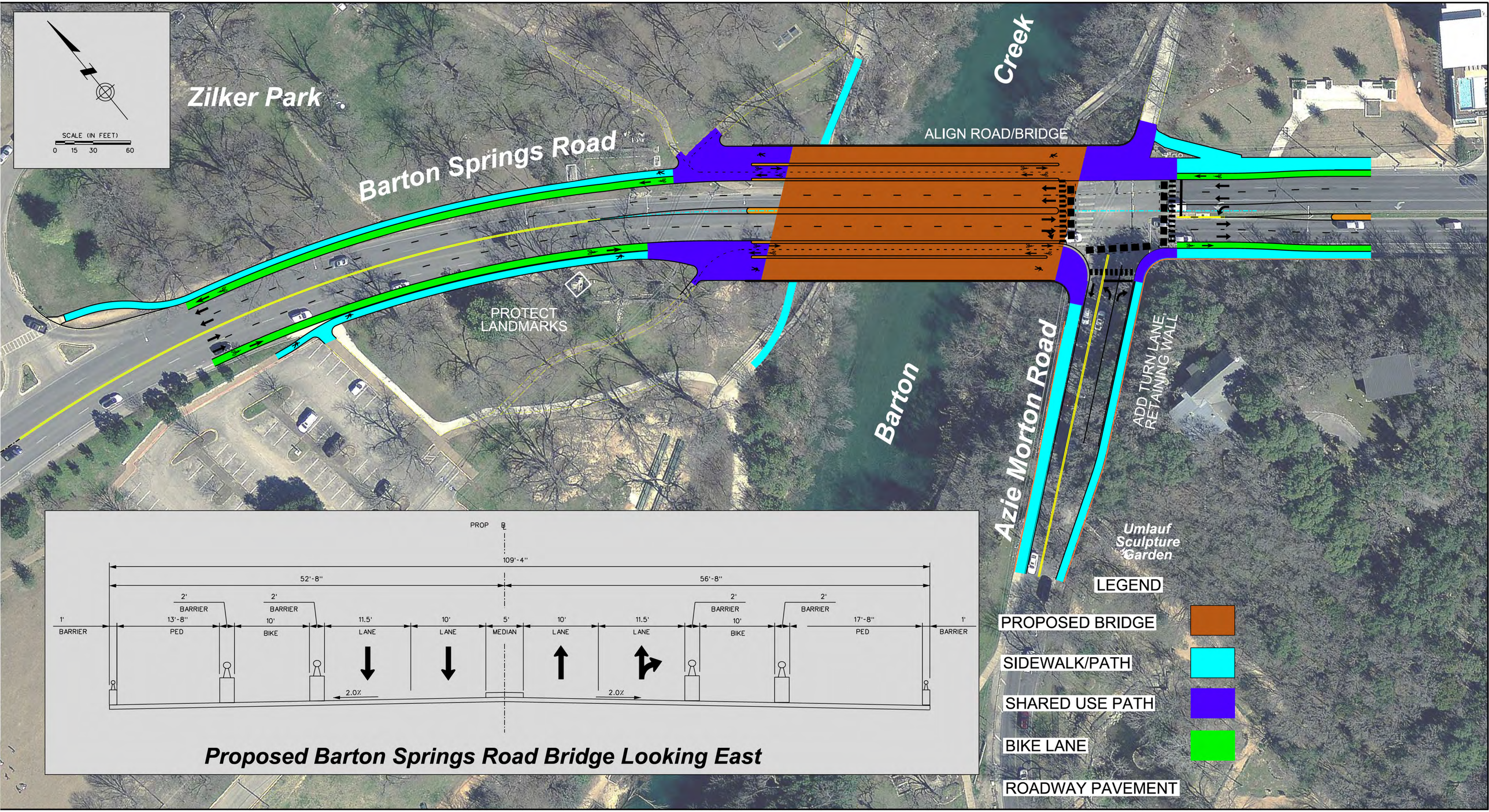
Description: The culvert bridge runs under the road just west of the Zilker Park Entrance Piers. It is made of rough-cut sandstone and concrete, with a stone head wall set back from the road, angled stone wing walls, and a simple cast concrete pipe. A modern stone skirt is set in the ground between the head wall and the roadway. It is listed as a contributing resource on the TxDOT Aggregator but is not recorded as a contributing resource in the Zilker Park Historic District NRHP nomination form. It is treated as a contributing resource for the purposes of this study.

Camera direction: northwest

Resource No.	03	Address:	2207 Lou Neff Rd

Camera direction: west

APPENDIX B: PRELIMINARY PLANS


Zilker Park
SCALE (IN FEET)
0 15 30 60
Barton Springs Road
ALIGN ROAD/BRIDGE
Barton Creek
PROTECT LANDMARKS
Azie Morton Road
ADD TURN LANE RETAINING WALL
Umlauf Sculpture Garden
PROP ℄
109'-4"
52'-8"
56'-8"
1' BARRIER
13'-8" PED
2' BARRIER
10' BIKE
2' BARRIER
11.5' LANE
10' LANE
5' MEDIAN
10' LANE
11.5' LANE
2' BARRIER
10' BIKE
2' BARRIER
17'-8" PED
1' BARRIER
2.0%
2.0%
Proposed Barton Springs Road Bridge Looking East
LEGEND
PROPOSED BRIDGE
SIDEWALK/PATH
SHARED USE PATH
BIKE LANE
ROADWAY PAVEMENT

APPENDIX C: CITY OF AUSTIN REHABILITATION VS. REPLACEMENT MEMORANDUM

City of Austin

Barton Springs Road Bridge over Barton Creek

Rehabilitation vs. Replacement Memorandum

CIP ID 5873.031

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September 28, 2022
Final (F1)

This document is released under the authority of Robert B. Anderson Texas PE No. 111066

REVISIONS

Project: City of Austin – Barton Springs Road Bridge over Barton Creek

Document: Rehab vs. Replacement Memo

Revision	Date of Issue	Description
D0	08/22/2022	Draft Issue for Internal Comment
D1	09/12/2022	Revised Draft Issue post PWD comments
D2	09/19/2022	Revised Draft Issue cost table and replacement comparison
F1	09/28/2022	Final Issue

Contents

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1.1 Purpose and Need 3
1.2 Bridge Cultural / Historical Background / Existing Condition 3
2. DESIGN CONCEPTS 5
2.1 Design Elements Common to Both Rehabilitation and Replacement 5
2.2 Rehabilitation Option 5
2.3 Replacement Option 7
3. COMPARISON OF PRELIMINARY REPLACEMENT / REHABILITATION CONCEPTS 10
4. SUMMARY AND RECOMMENDATIONS 12

Statement of Limitations

This report is intended for the City of Austin and is distributed to third parties outside the City's organization, with their consent.

This interim memo provides a direct comparison between the rehabilitation and replacement options for the Barton Springs Road Bridge over Barton Creek and provides a recommendation from the design team. This report is intended to outline the current design approach and highlight the pros and cons associated with the rehabilitation and replacement concepts. To limit the size and focus of this memo, the detailed work associated with existing bridge inspection and preliminary concept development and analysis are incorporated by reference.

1. INTRODUCTION

This section of the report summarizes the purpose and need for the project and provides some Cultural and Historical Background.

1.1 Purpose and Need

The purpose and need for this project is centered on safety-related bridge improvements that address the following items:

- Age of structure / structural degradation;
- Insufficient bike / pedestrian paths (functionally obsolete);
- Bridge roadway lanes not aligned with lanes east of Azie Morton;
- Hillside instability (rock fall) and obsolete retaining wall on Azie Morton east side at intersection;
- Elevated / overhanging sidewalk integral to intersection – past movement / cracking; and
- Bridge / intersection congestion.

1.2 Bridge Cultural / Historical Background / Existing Condition

The original Barton Springs Road bridge was built in 1925 and widened to its current configuration in 1945. The bridge is located adjacent to Zilker Park, which is listed in the National Register of Historic Places (NRHP); and is considered a contributing resource to the Park. The Barton Springs Archeological and Historical District (formed in 1985) is also located within the Zilker Historic District and the downstream boundary of this district is in close proximity to the bridge.

The age of the south and north structures is 97 and 76 years, respectively. The bridge overall has a condition rating of "Fair," and most structural components generally have a condition rating of "Good", based on the *FHWA Condition Rating Guidelines*.

Given the advanced age of the deck, and the fact that the most serious deterioration is found within the vicinity of the longitudinal deck joint, it is necessary to replace the deck entirely and eliminate the longitudinal joint and transverse joints where practical. This precludes efforts to keep and repair all of the existing bridge components. In addition, the spandrel columns exhibit low concrete compressive strength and severe cracking, spalling, and/or delamination (2017 *On-Site Sampling and Laboratory Investigation*). The cracking of the shorter spandrel columns is further exacerbated by their structural configurations (moment connections at both the top and bottom), which attract an inordinately large amount of shear loading.

Therefore, any proposed bridge rehabilitation strategy that provides a substantial increase in service life requires "stripping" the structure down to the arch ribs and reconstructing the spandrel columns, floor system, and deck. Sliding bearings at the tops of the new spandrel columns will decouple the deck from the supporting structure.

Figure 1. Deterioration of Longitudinal Beam

In addition to the condition of the existing bridge, the site presents a number of challenges and constraints. Many of these are illustrated in the issues map below:

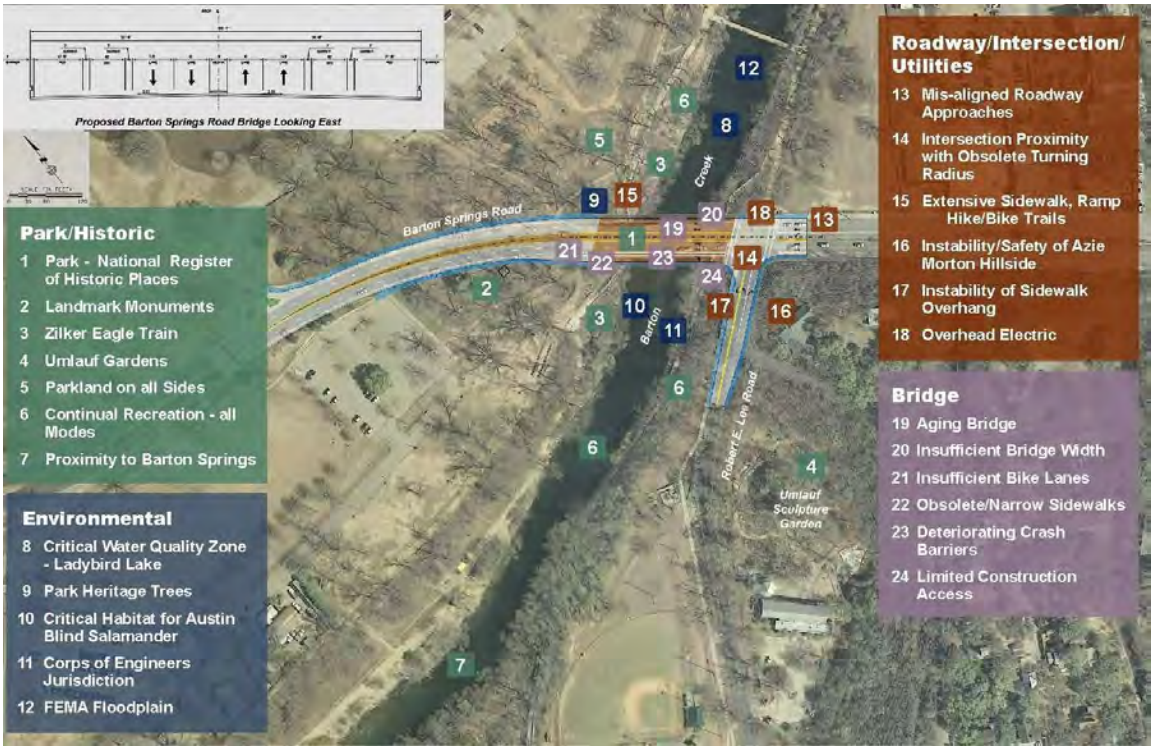


Figure 2. Barton Springs Rd. Bridge Challenges and Constraints

2. DESIGN CONCEPTS

2.1 Design Elements Common to Both Rehabilitation and Replacement

Barton Springs Road serves as a vital roadway connector. Improvements include the realignment of the travel lanes to improve or eliminate the current offset movement at the Azie Morton Road interchange.

The bridge provides a vital bicycle and pedestrian link to the Zilker Park and the existing bike/ pedestrian facilities are inadequate. The redesigned bridge provides dedicated bike lanes as well as a 14 ft. wide sidewalk on the south side of the bridge and an 18 ft. wide shared use path on the north side of the bridge. The design also links the sidewalks to the park trail system and accommodates the trails underneath the bridge.

Lastly, the design will maintain space for the "Zilker Eagle" train that will be refurbished in the near future.

Both the rehabilitation scheme and the replacement scheme share the same above-deck configuration, resulting in an overall bridge width increase from 59 ft. to 109 ft. Therefore, either approach will provide the same result with respect to traffic and bike/ pedestrian movements.

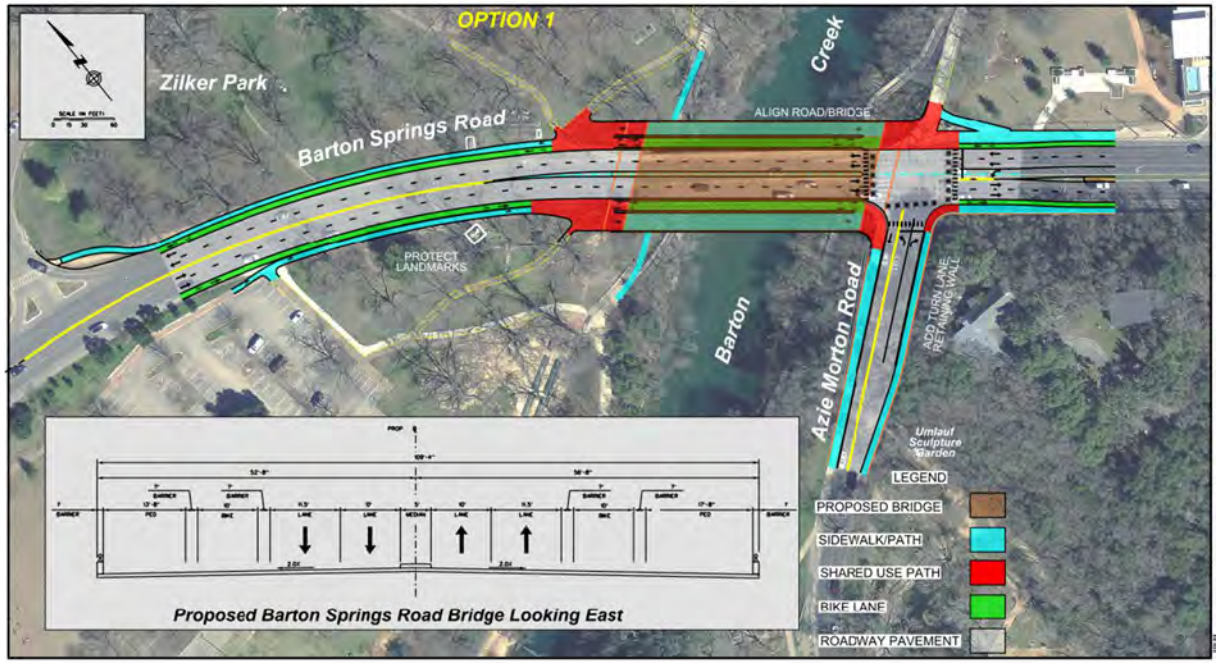


Figure 3. Bridge and Roadway Proposed Geometric Plan

2.2 Rehabilitation Option

The Rehabilitation Option will reuse portions of the existing bridge structure (with rehabilitation measures implemented) and widen each side to provide the ultimate width necessary for proposed multi-modal travel ways.

Due to the deterioration of the existing bridge, only the existing arch ribs will remain.

Figure 4. Bridge Rehabilitation – Remove Deck and Spandrel Columns; Remediate Remaining Structures

Once the arches are exposed, work will include reinforcement of the existing abutments, repairs to the arches and installation of a cathodic protection system to reduce further deterioration of the steel rebar in the arch ribs.

Four additional lines of arch ribs will be added to accommodate the wider deck above. Therefore, the existing arch ribs will only be visible when viewed from underneath the structure.

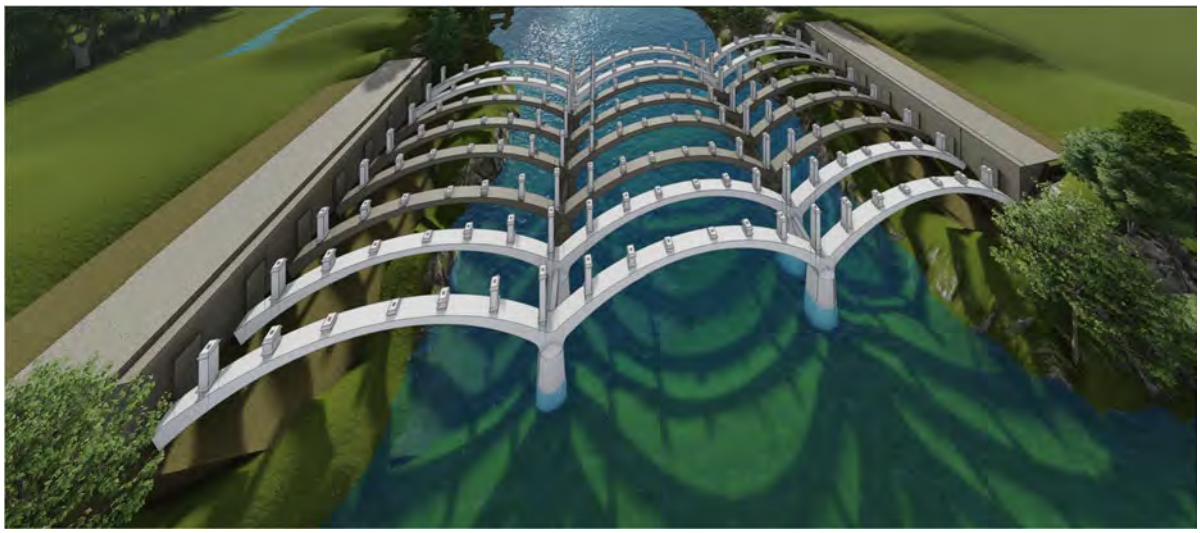


Figure 5. Install New Arch Ribs, Spandrel Columns and Extend Abutments

The fully rehabilitated bridge will maintain the overall appearance and configuration of the existing bridge, utilizing similar details for the arches, spandrel columns, longitudinal beams, etc. In accordance with current design practices, it is anticipated that the level of remediation and future corrosion mitigation methods will be employed to achieve an additional 50 to 75 years of bridge service life subsequent to the rehabilitation.

While the rehabilitation option will provide the appearance of keeping the existing bridge, less than half of the original structure will remain intact and very little surficial materials will remain. Furthermore, very little of the original structure will be plainly visible after the new rib extensions on both sides and the installation of new spandrel columns and deck. As such, what will be predominantly in view is new bridge structure and materials.

Figure 6. Rehabilitation Option Rendering

2.3 Replacement Option

The Replacement Option will remove the existing bridge structure in its entirety and provide a new structure with the ultimate width necessary for proposed multi-modal travel ways.

This option allows for lengthening the bridge by moving the western abutment to the west. In so doing, the Replacement Option provides additional space to facilitate improvements to existing Zilker Park facilities, such as walking paths and the Zilker Eagle miniature railroad, both of which pass under the Barton Springs Road Bridge on the west bank. This additional space for improvements is not feasible with the Rehabilitation Option.

A number of design options for the replacement bridge were developed and vetted with the City of Austin and various stakeholders. Table 2-1 provides a summary of the comparison of rehabilitation options.

Table 2-1 – Comparison of Bridge Replacement Options.

	Option 1 - Single Arch	**Option 2 - "Y" Pier Longitudinal**	**Option 3 - "Y" Pier Transverse**
Description	Option 1 is comprised of four arch ribs bearing on thrust block at either side of the creek. The form the arch makes creates a contemporary reference to the existing bridge form.	Option 2 consists of four "Y" piers located at the center of creek that create an arch-like appearance. There are two bearing points on the "Y" pier with a longitudinal tie to accommodate the tension in the top of the pier.	Option 3 utilizes eight "Y" piers arched in the transverse direction. The piers are located near the third-points of the structure and maintain an open center channel in the creek
PrStructural Complexity	This option utilizes a complex post-tensioning system in the main arches and large scale thrust block to transfer load from the bridge to the ground. The superstructure girders and intermediate diaphragms are post-tensioned.	The "Y" piers utilize post-tensioning tendons to pre-compress a tie at the top of the pier to resist the longitudinal forces created by the bearing points of the structure. The piers rest on conventional foundations located in the creek. The superstructure girders and intermediate diaphragms are post-tensioned.	**Advantage** Post-tensioning bars are used to pre-compress a transverse tie at the top of the pier. These piers rest on conventional foundations in the creek. The superstructure girders are post-tensioned.
Visual Openness	The bold forms of the arches create the highest level of visual obstruction. However, the structure does provide direct views along the centerline of the creek when seen from the water.	The "Y" piers create more openness than Option 1. However, the location of the piers in the center of the creek obstructs the views down the centerline of the creek.	**Advantage** Option 3 provides more visual openness than Options 1 and 2. The pier placement also creates unobstructed views along the center of the creek.
Constructability	Option 1 requires temporary piers and complex falsework to form the arches. It is the most complex to build.	Option 2 utilizes conventional construction techniques and has the fewest number of foundations in the water. However, the tension ties at the top of the piers will require specialty construction techniques including complex falsework.	**Advantage** Option 3 generally uses conventional construction techniques and should not pose any unusual problems for a bridge of this type and scale. The post-tensioning of the girders and post-tensioned tension ties at the top of the piers will require some specialty construction techniques.
Initial Const. Cost	$18.1M	$13.6M	**Advantage** **$10.2M**

The preferred alternative for replacement is depicted below and utilizes a concrete beam superstructure with two lines of "Y" piers oriented parallel to the channel and at a slight skew to the bridge's beam elements. This configuration maximizes the views through the bridge and maintains an open center channel in Barton Creek below. The unique pier design pays homage to the arches of the existing bridge, while utilizing the most current methods of design and construction.

Figure 7. Replacement Option Rendering

2.4 Bridge Option Cost Comparison

Table 2-2 provides a comparison of estimated life-cycle costs of the Rehabilitation Option and the three Replacement Options. The cost includes a preliminary construction cost estimate, as well as life cycle cost from estimated maintenance /rehabilitation costs throughout the 75-year design life, and then brought back to today's dollars. A range of discount rates (expected interest minus inflation) can be used; Table 2-2 uses 3%. The initial construction cost and life cycle costs did not alter the ranking of alternatives.

Table 2-2 Cost Comparison of Bridge Options.

Bridge Alternative	Initial Const. Bridge Est. Total ($M)	Life Cycle Est. Bridge Total ($M) *	Bridge ($/sq. ft.)**	Weighted Costing (Based on Total)	Costing Differences ($M)	Costing Rank (Based on Total)
Option 1 - Concrete Arch (New)	18.1	21.2	825	1.59	7.9	4
Option 2 - Concrete Single Pier (New)	13.6	16.7	648	1.25	3.4	2
Option 3 - Concrete Dual Pier (New)	10.2	13.3	519	1.00	N/A	1
Option 4 - Rehabilitation	14.5	17.8	787	1.34	4.5	3

* *Note 1: Comparison of Options Using 3% Discount Rate*

** *Note 2: Replacement bridges have 13.3% more square feet of deck area than rehabilitated bridge. (New = 25,693 sq. ft. versus Rehab = 22,668 sq. ft.)*

*** *Note 3: Cost only for Bridge Construction; not roadway, utilities, retaining walls, or other disciplines*

3. COMPARISON OF PRELIMINARY REPLACEMENT / REHABILITATION CONCEPTS

A summary and comparison of various features and components of both rehabilitation and replacement bridge concepts are provided in Table 3-1.

Table 3-1. Comparison of Bridge Rehabilitation / Replacement Concepts

Highlighted Boxes Represent Benefit Over Other Option

Feature/Component	Bridge Rehabilitation Concept	Preferred Bridge Replacement Concept (Option 3)
Roadway Geometry		
Azie Morton Road extended Right Turn lane onto Barton Springs Road	Included	Included
Barton Springs Road Alignment	Barton Springs Rd. will be improved but still unaligned; the required "zig zag" by west bound traffic will be much less abrupt. Rehabilitation requires the new structure to be built on the existing centerline alignment.	**Advantage** Barton Springs Rd. will have the point of inflection removed from the alignment. The result will be a straight intersection, with no conflict in east- or westbound traffic and no "zig zag".
Park Amenities / Improvements		
Zilker Eagle Train	The train will have to be replaced under the bridge, in a similar configuration to current layout.	**Advantage** Moving the western abutment further west provides additional horizontal space. The train can be replaced similar to the current layout, or relocated with additional space for rider room and safety.
West bank hike/bike trail pedestrian bridge under Barton Springs Rd	The pedestrian bridge will need to be removed and replaced in a similar manner to existing layout.	**Advantage** The pedestrian bridge will need to be removed. It can either be replaced similar to current layout, or it may be able to be relocated as a path on the additional space allowed by moving the western abutment.
Hike / Bike Trail passage below the bridge	Passage length under bridge will be roughly twice as wide as existing. Passage space and headroom will be similar to existing layout.	**Advantage** Passage length will be similar to rehab length. Passage space will see combination of new structures and abutments to allow opportunity for added vertical and horizontal open space underneath bridge.

Feature/Component	Bridge Rehabilitation Concept	Preferred Bridge Replacement Concept (Option 3)
Bridge Structure		
Bridge Architecture and Aesthetics	Existing arches and foundations will be preserved and remain. Remaining structures will undergo cathodic protection including concrete and condition mitigation and re-surface work. Rehab concept will add new arches upstream and downstream. New arches will be complementary to but not a replicate of the existing arches, depending upon aesthetic coordination with Texas Historical Commission. Visibility of new arches will be predominant. Substructure to consist of 8 arch lines	Existing arches will be removed. Replacement concepts will include 4 arch lines. New bridge aesthetic can be complementary to the existing bridge (3 span) type/span arrangement. Replacement concept to consist of 4 substructure elements at two locations in lieu of 8 continuous elements providing more open view sheds.
Impacts to Historic Structure	**Advantage** Rehabilitation of the existing bridge preserves some of the existing historic bridge elements.	Replacement removes the existing historic elements and relies on mitigation strategies to offset impacts.
Bridge Length and Abutment Locations	For rehab, existing abutment locations will remain, and will expand or widen to the north and to the south to accommodate the additional arches for a wider bridge, in a similar geometric arrangement to existing.	**Advantage** Replacement concept will shift the west abutment to the west, to provide more space and safety for pedestrian trail and the Zilker Eagle train on the West Bank.
Bridge foundation work in Barton Creek	Work on existing foundations in the creek will include cathodic protection and concrete mitigation and concrete re-surface work. Includes construction of 8 new foundations (for 4 new arch lines each with two piers), in Barton Creek.	The existing arches and foundations would likely be removed, down to the creek bed. Replacement concept includes 8 foundations – for 4 substructure elements at 2 locations.
Temporary Construction in Barton Creek	Extensive foundations for temporary works will be required	**Advantage** Assuming bridge can be constructed by barge mounted cranes, foundations for temporary works will not be required.
Bicycle Elements on Bridge	Includes 10 ft-wide bike lanes on each side, to accommodate 2-way bike operations on either side of the bridge.	Includes 10 ft-wide bike lanes on each side, to accommodate 2-way bike operations on either side of the bridge.

Feature/Component	Bridge Rehabilitation Concept	Preferred Bridge Replacement Concept (Option 3)
Pedestrian Elements on Bridge	Includes a 14 ft-wide sidewalk on the south side and 18 ft wide sidewalk on the north side.	Includes a 14 ft-wide sidewalk on the south side and 18 ft wide sidewalk on the north side.
Service Life	Target Service Life extension of 50-75 years This is dependent upon results from additional sampling/testing of the existing bridge materials.	**Advantage** Target Service Life of 75 years This can be extended to 100 years with durability enhancements to the design basis and prescribed materials. This would entail an increase in cost of roughly 10% or more.
Bridge Maintenance	Increased long term maintenance cost and requirements	**Advantage** Less maintenance cost and staffing labor required
Engineer's Estimate of Probable Bridge Construction Cost *(range indicating minimum and maximum cost including 50% inflation over course of design and bidding of the project)*	$14.5M - $22M	**Advantage** $10.2M – 15.5M
Constructability / Risk	Constructability more difficult due to the requirement for precision-demolition, and the need to protect existing structures to remain, while constructing new work on or adjacent. Subject to greater project risk with unknown material conditions of existing structures and subsurface foundation conditions.	**Advantage** Comparatively less construction and project risk.

4. SUMMARY AND RECOMMENDATIONS

The existing Barton Springs Bridge is an historic structure that contributes to the urban and historic fabric of Zilker Park and Austin, Texas. The bridge is also a part of the larger transportation infrastructure system that serves the community. This project is difficult because we must strike a proper balance between historic preservation, public safety and the use of public funds. The Section 106 process of "Avoid – Minimize – Mitigate" helps to identify the best path forward.

The deterioration of the existing bridge has reached a stage that cannot be ignored and the level of repair that is required eliminates the possibility of a "light-touch" restoration. Thus,

historic impact avoidance and historic impact minimization are simply not possible. Therefore, the focus of the investigation has centered on the development of feasible restoration and replacement schemes that meet the current transportation demands while providing a structure with a lifespan of at least 75 additional years of service.

Both rehabilitation and replacement can accommodate the transportation needs in a similar fashion. The replacement scheme offers numerous additional benefits (highlighted cells in the above table) including better accommodations of the Zilker Eagle mini-train and enhanced trails underneath the bridge.

The most significant differences between the rehabilitation scheme and the replacement scheme are cost and risk. The particular replacement bridge alternative selected is not the least expensive design possible, it includes enhanced features such as unique piers and upgraded abutments. Even with these enhancements, the cost of the replacement bridge is 40% less than the rehabilitation scheme. Furthermore, ongoing maintenance cost and labor requirements are less with the replacement scheme. There is also a great deal of risk associated with the rehabilitation scheme. While the bridge condition survey was thorough, there are many things that could increase the cost of rehabilitation once the initial demolition exposes all of the "hidden" elements of the bridge.

We understand the significance of the existing bridge and the importance of preserving historical assets. However, as stewards of the taxpayer's money there is an obligation to make the best value decision for the community. If the bridge is rehabilitated, very little of the existing structure will remain and those remaining elements will be almost entirely concealed by the new construction. This fact coupled with the significant increase in cost and risk leads the design team to recommend replacement as the path forward.

The project is continuing an on-going coordination with the Texas Historical Commission (THC); and it is intended that input from both the THC and U.S. Army Corps of Engineers will be forthcoming as coordination continues.

D-4 - THC Review of Section 106 Evaluation – March 2023

From: noreply@thc.state.tx.us
Sent: Wednesday, March 29, 2023 4:05 PM
To:

Subject: Barton Springs Road Bridge

Re: Project Review under Section 106 of the National Historic Preservation Act and/or the Antiquities Code of Texas
THC Tracking #202305976
Date: 03/29/2023
Barton Springs Road Bridge
Barton Springs Road

Description: Section 106 Effects Assessment report for proposed improvements to the Barton Springs Road Bridge. Currently under review at USACE-FWD under SWF-2022-00392 (Barton Springs Road Bridge over Barton Creek).

Dear Kurt Korfmacher:
Thank you for your submittal regarding the above-referenced project. This response represents the comments of the State Historic Preservation Officer, the Executive Director of the Texas Historical Commission (THC), pursuant to review under Section 106 of the National Historic Preservation Act and the Antiquities Code of Texas.

The review staff, led by Tiffany Osburn, Amy Borgens, Alex Toprac and Caitlin Brashear, has completed its review and has made the following determinations based on the information submitted for review:

Above-Ground Resources

- Property/properties are eligible for listing or already listed in the National Register of Historic Places.
- Adverse effects on historic properties.
- THC/SHPO concurs with information provided.

We have the following comments: The Texas Historical Commission Division of Architecture staff, led by Alex Toprac, has completed the review of the submitted project documentation and concurs the proposed bridge rehabilitation and replacement scope of work options, along with the proposed bike lane improvements, will have an adverse effect on the contributing Barton Springs Road Bridge and historic stone culvert, and therefore on the entire National Register of Historic Places (NRHP)-listed Zilker Park Historic District. If the City of Austin chooses to continue pursuing either proposed option for the United States Army Corps of Engineers (USACE) permitted undertaking, please proceed to follow the procedures under 36CFR§800.6. This will require further consultation between the City of Austin, the Texas Historical Commission, as the State Historic Preservation Office (SHPO), the USACE Fort Worth District, and any identified stakeholder consulting parties as part of the Section 106 process to minimize and mitigate the adverse effect on the historic resources through the development of a Memorandum of Agreement (MOA). The USACE Fort Worth District and City are also required to provide opportunity for public involvement. The City is required to provide our office documentation showing the consideration of avoidance alternatives and how such avoidance was found to be infeasible. The USACE must notify the Advisory Council on Historic Preservation of this adverse effect determination to allow their agency the opportunity to participate in the resolution of adverse effects consultation process, as provided by the aforementioned statutory regulations.

We look forward to further consultation with your office and hope to maintain a partnership that will foster effective historic preservation. Thank you for your cooperation in this review process, and for your efforts to preserve the irreplaceable heritage of Texas. If the project changes, or if new historic properties are found, please contact the review staff. If you have any questions concerning our review or if we can be of further assistance, please email the following reviewers: tiffany.osburn@thc.texas.gov, amy.borgens@thc.texas.gov, alex.toprac@thc.texas.gov, caitlin.brashear@thc.texas.gov.

This response has been sent through the electronic THC review and compliance system (eTRAC). Submitting your project via eTRAC eliminates mailing delays and allows you to check the status of the review, receive an electronic response, and generate reports on your submissions. For more information, visit http://thc.texas.gov/etrac-system.

Sincerely,

for Mark Wolfe, State Historic Preservation Officer
Executive Director, Texas Historical Commission

Please do not respond to this email.

cc:
SETH.SAMPSON@usace.army.mil,Jennifer.R.Walker2@usace.army.mil,alexander.shane@thc.texas.gov,Elizabeth.Brummett@thc.texas.gov</p

Appendix E – Public Engagement

austin MOBILITY BONDS

E-1 - Open House – April 2023

austin MOBILITY BONDS

E-1 - Open House Virtual Power Point

WELCOME

CITY OF AUSTIN BARTON SPRINGS ROAD BRIDGE

Purpose of the meeting

- ✓ **Learn** about the project
- ✓ **Ask** questions about potential improvements
- ✓ **Share** your thoughts on the recommended option

City of Austin Barton Springs Road Bridge

About the Bridge

Nearly
100
years old
built in 1926

20,000
Vehicles per day

1946
Bridge Expansion

Key Entrance
to Zilker Park and for Major City Events

$36 million
Preliminary Funding Estimate
(Construction + Soft Costs)

FUNDING SOURCE:
- Preliminary Design: 2012, 2018 and 2020 Bonds
- Design: 2020 Bonds
- Construction: TBD

City of Austin Barton Springs Road Bridge

Bridge Site Challenge and Constraint Categories:

- Park and Historic
- Environmental
- Roadway Intersection
- Bridge

Roadway Alignment Issues

City of Austin Barton Springs Road Bridge

Project Needs	Project Goals / Outcomes
Age of Structure ▪ 100 yrs old, Associated structural degradation	✓ Provide 75 Year Bridge Service Life
Safety ▪ Barton Springs roadway not aligned ▪ Hillside instability at Umlauf Gardens	✓ Improve Safety ✓ Stabilize Umlauf Gardens
Insufficient Paths ▪ Not enough bike or pedestrian paths on bridge	✓ Add Multi-modal and Connect with Park Trails
Intersection Congestion ▪ At Barton Springs / Azie Morton intersection	✓ Reduce Congestion with addition of right turn

City of Austin Barton Springs Road Bridge

Goal During Construction

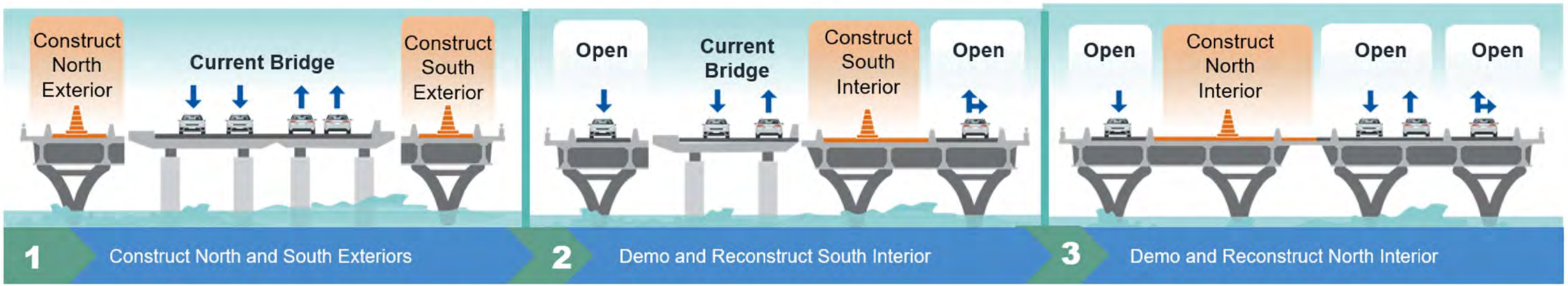
- ✓ Maintain all 4 lanes of traffic during construction
- ✓ Maintain the Azie Morton / Barton Springs intersection during construction

20,000
Vehicles per day on Barton Springs Road

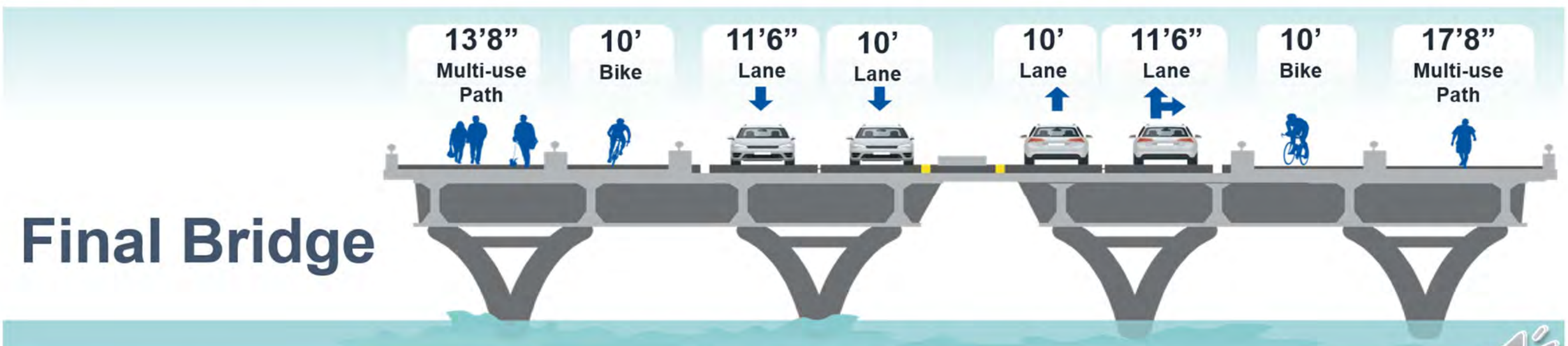
- Important commuter route
- Key access to Zilker Park
- Access to many special events (Trail of Lights, Austin City Limits, Blues on the Green, Zilker Park)
- Access to Zilker and Barton Hills neighborhoods

City of Austin Barton Springs Road Bridge

Bridge Construction Phasing: 4 lanes open through construction



Final Bridge



City of Austin Barton Springs Road Bridge

PROJECT OPTIONS

Public Meeting | March 2023

City of Austin Barton Springs Road Bridge

Rehabilitation Options

1. **PRESERVE** existing structure, consider separate bike/ped structure (minimal rework - light touch)
2. **REHABILITATE** and widen deck to include bike/ped

Replacement Options

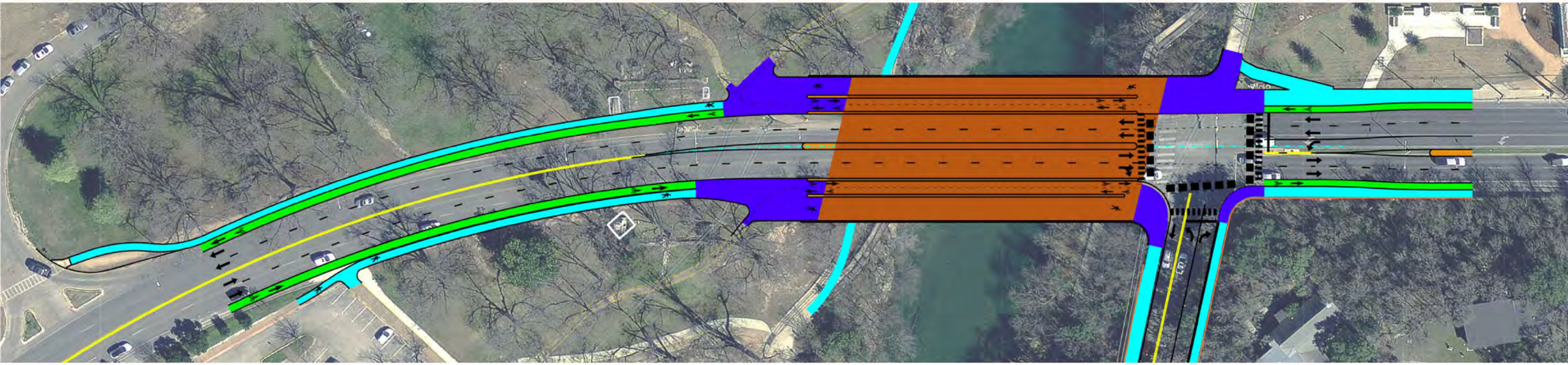
RECONSTRUCT BRIDGE completely and widen deck to include bike/ped

1. **One-Span** option

2. **Two-Span** option

3. **Three-Span** option

City of Austin Barton Springs Road Bridge



Elements Required for Rehabilitation or Replacement

Bike Lanes

- ✓ Widened Bike Lane
- ✓ Accommodate off-road biker trail users

Sidewalk / Path

- ✓ Accommodate hiking Trails
- ✓ Wider Ped. Paths
- ✓ Accommodate Pedestrians for Special Events

Shared Use Path

- ✓ Multimodal areas to accommodate off-road hike and bike trail users

Proposed Bridge

- ✓ Longer service life length
- ✓ Wider bridge
- ✓ Better alignment for safety
- ✓ Dedicated bike lanes

City of Austin Barton Springs Road Bridge

Bridge Inspection Findings

Rehabilitation for increased service life requires removal of deck, floor beams, and spandrel columns

- ✓ Demolish the structure to the arch ribs.
- ✓ Significant work is needed: major rehabilitation or bridge replacement.

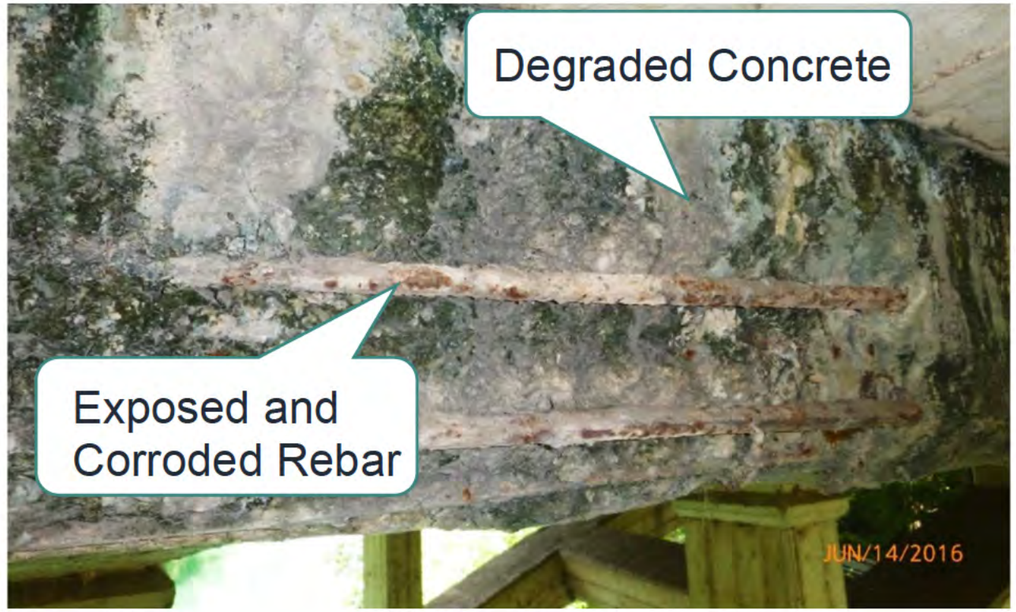
Do Nothing is not an option

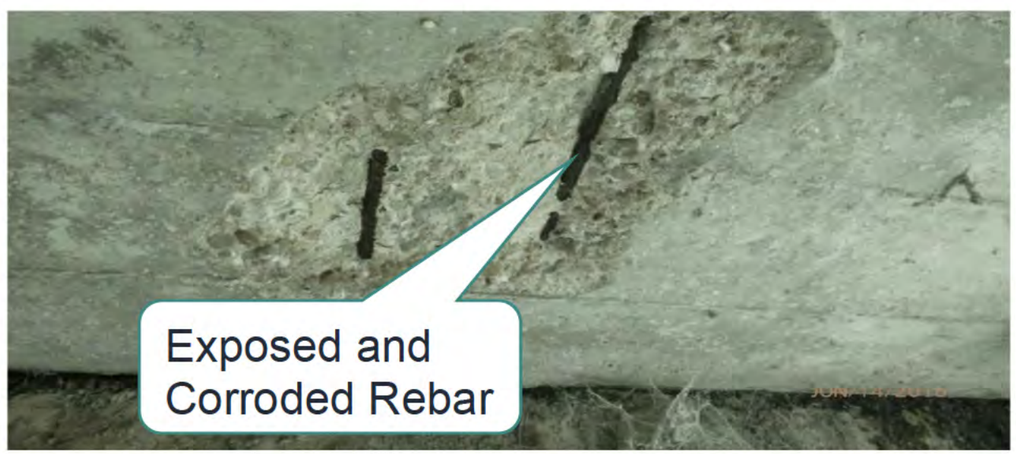
1 **Preserve** Rehabilitation Option 1 is not feasible

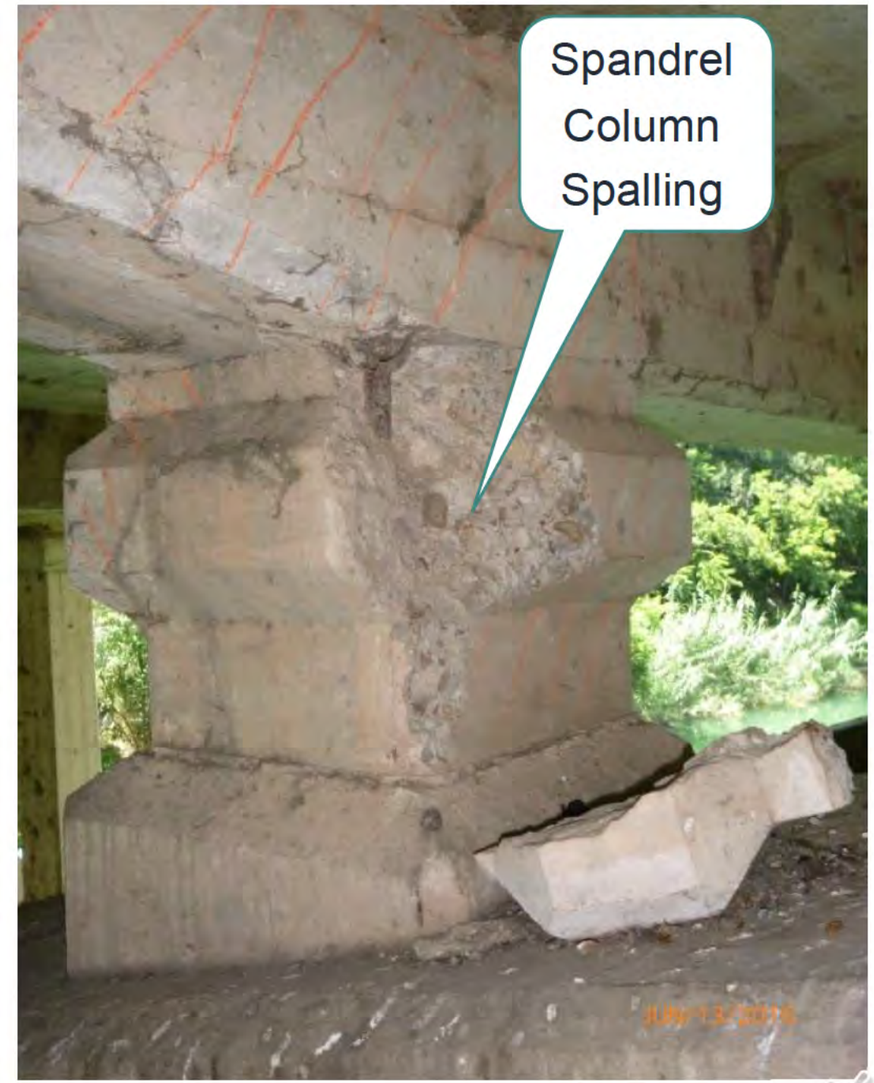
City of Austin Barton Springs Road Bridge

Bridge Inspection Findings

- ✓ Deck (with integral longitudinal joint), floor beams, and spandrel columns exhibited the most degradation.
- ✓ All structural components exhibited some degradation.





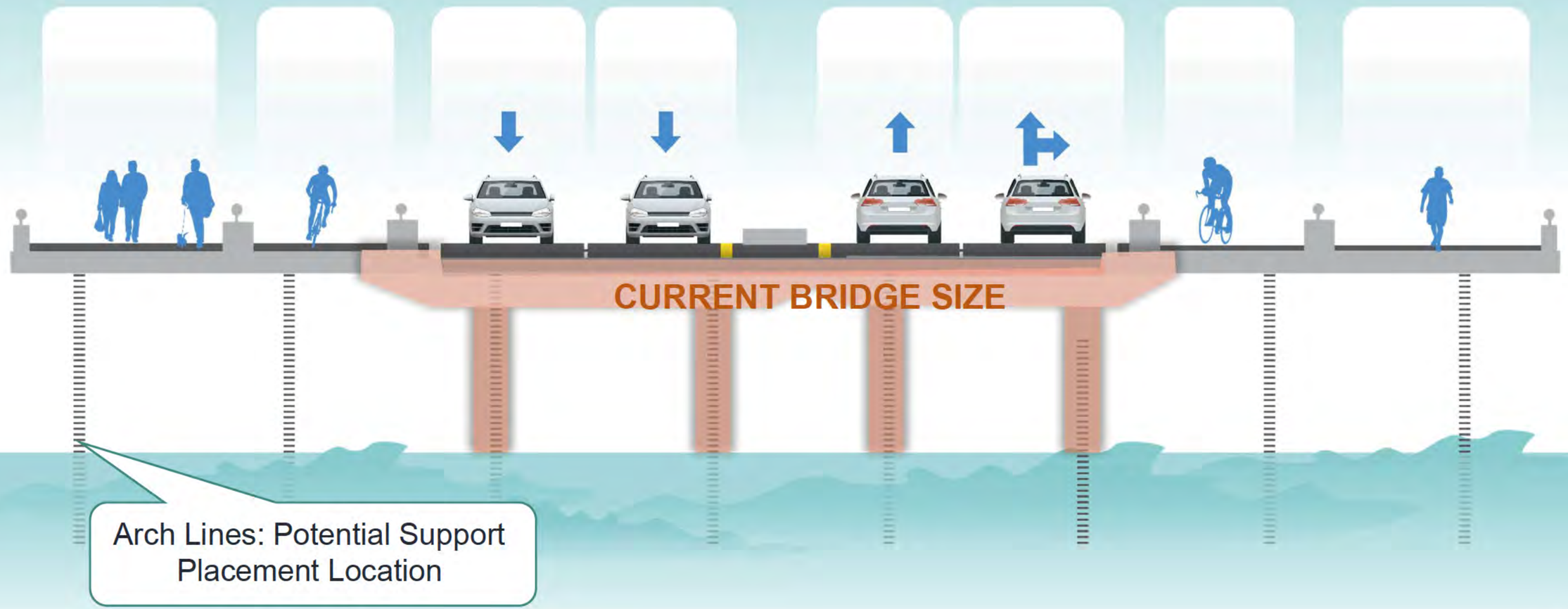


City of Austin Barton Springs Road Bridge

Bridge Rehabilitation Considerations

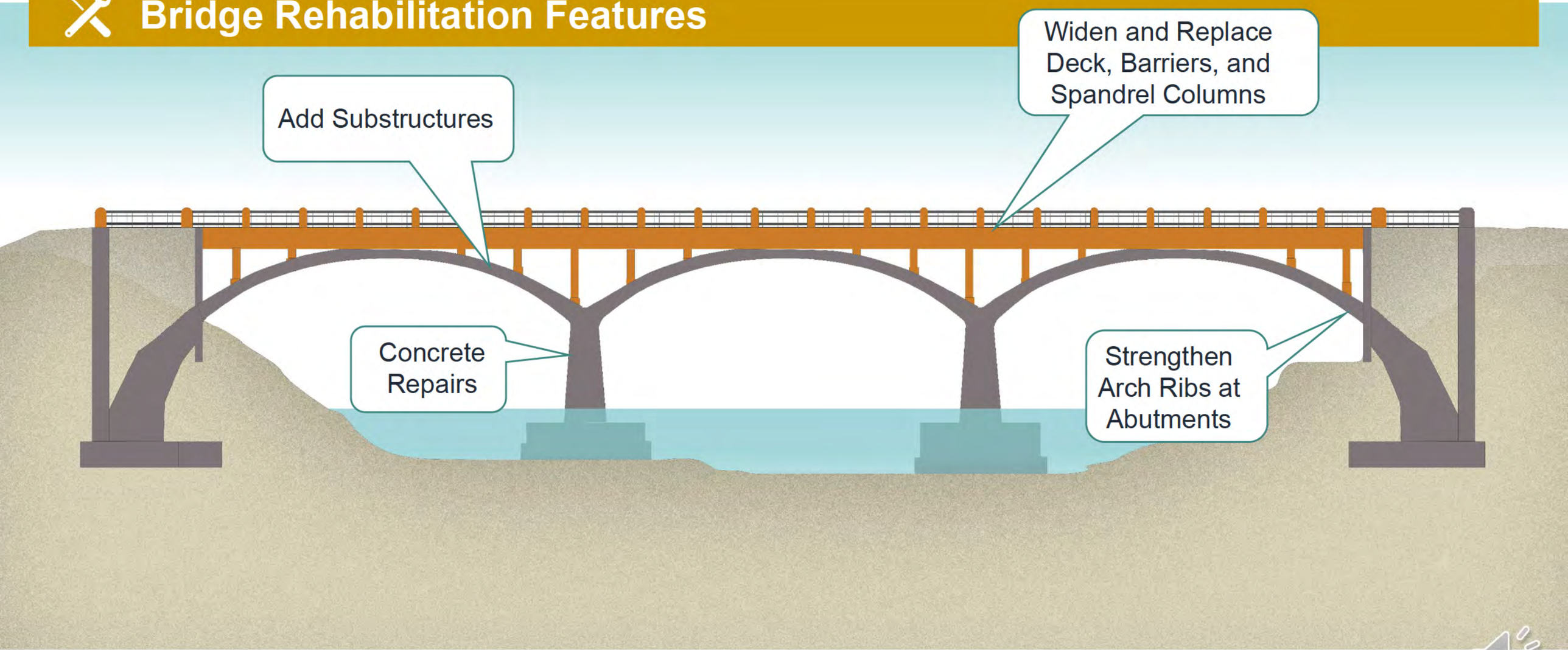
City of Austin Barton Springs Road Bridge

Bridge Rehabilitation Option



City of Austin Barton Springs Road Bridge

Bridge Rehabilitation Features



City of Austin Barton Springs Road Bridge

Bridge Structure Rehabilitation

1 Remove Existing Bridge Deck and Spandrel Columns

2 Remaining Portion of Existing Structure

3 New Components: Exterior Pairs of Arch Ribs, Spandrel Columns, Deck, and Abutment Extensions

Less than half of the original historical structure will remain

- ✓ Remaining historical structure will require refacing with new material surfaces
- ✓ View of historical structure will be mostly blocked by new structure

City of Austin Barton Springs Road Bridge

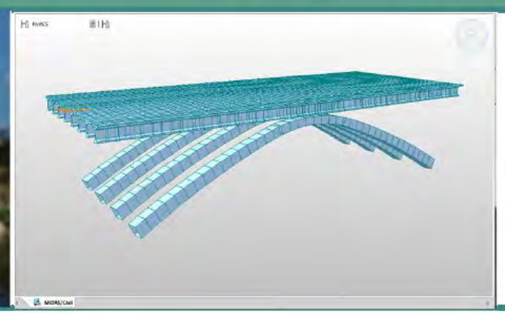
Bridge Rehabilitation Features

Rehabilitation Option Rendering

City of Austin Barton Springs Road Bridge

Bridge Replacement Options by Span Arrangement

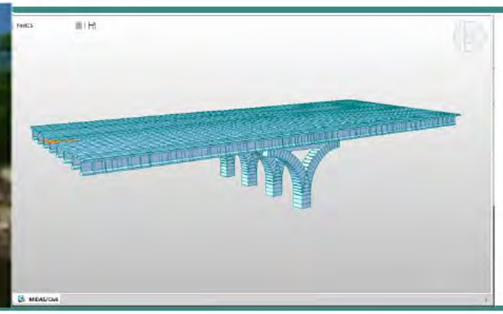
1
One-Span



Single Arch

- ✓ Four Arch ribs spanning creek
- ✓ Arch references existing bridge form

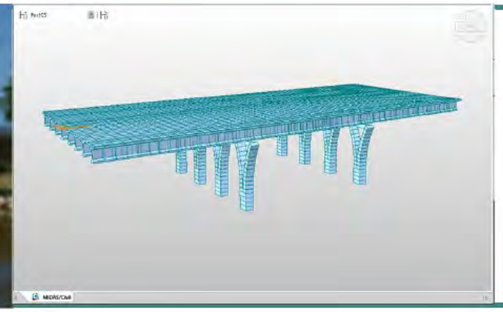
2
Two-Span



"Y" Pier Longitudinal

- ✓ Four Y-Piers in the center of the creek
- ✓ Arch-like Appearance

3
Three-Span

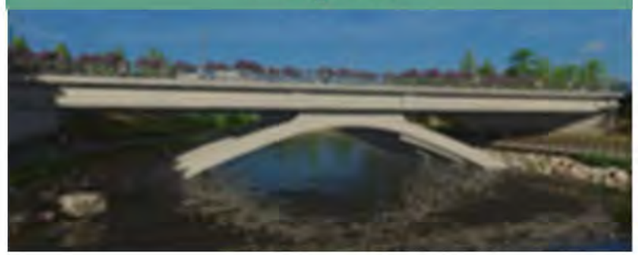


"Y" Pier Transverse

- ✓ Eight Y-Piers in two sets of four
- ✓ Opens center channel of the creek

City of Austin Barton Springs Road Bridge

Bridge Replacement Option Comparison

	1-Span	2-Span	3-Span
			
Structural Complexity	• Complex system	• Less complex • Uses conventional foundations	• Least Complex
Visual Openness	• Obstructed visuals • Views along center line maintained • Potential scour and bank/trail complexities	• More visually open than 1-span option • View along center of creek obstructed	• Most visually open • Clear views along center line of creek
Constructability	• Most complex to build • Requires temporary piers and falsework to make the arches	• Fewest number of foundations in water • Top of bridge requires specialty construction and falsework	• Specialty construction with fewest challenges
Initial Const. Cost (Bridge Only)	• $18.1M	• $13.6M	• $10.2M

RECOMMENDED OPTION RENDERINGS

City of Austin Barton Springs Road Bridge

Rendering of Recommended Bridge Replacement Option (3-span)

City of Austin Barton Springs Road Bridge

Rendering of Recommended Bridge Replacement Option (3-span)

City of Austin Barton Springs Road Bridge

Rendering of Recommended Bridge Replacement Option (3-span)

City of Austin Barton Springs Road Bridge

Environmental Analysis of Project Area

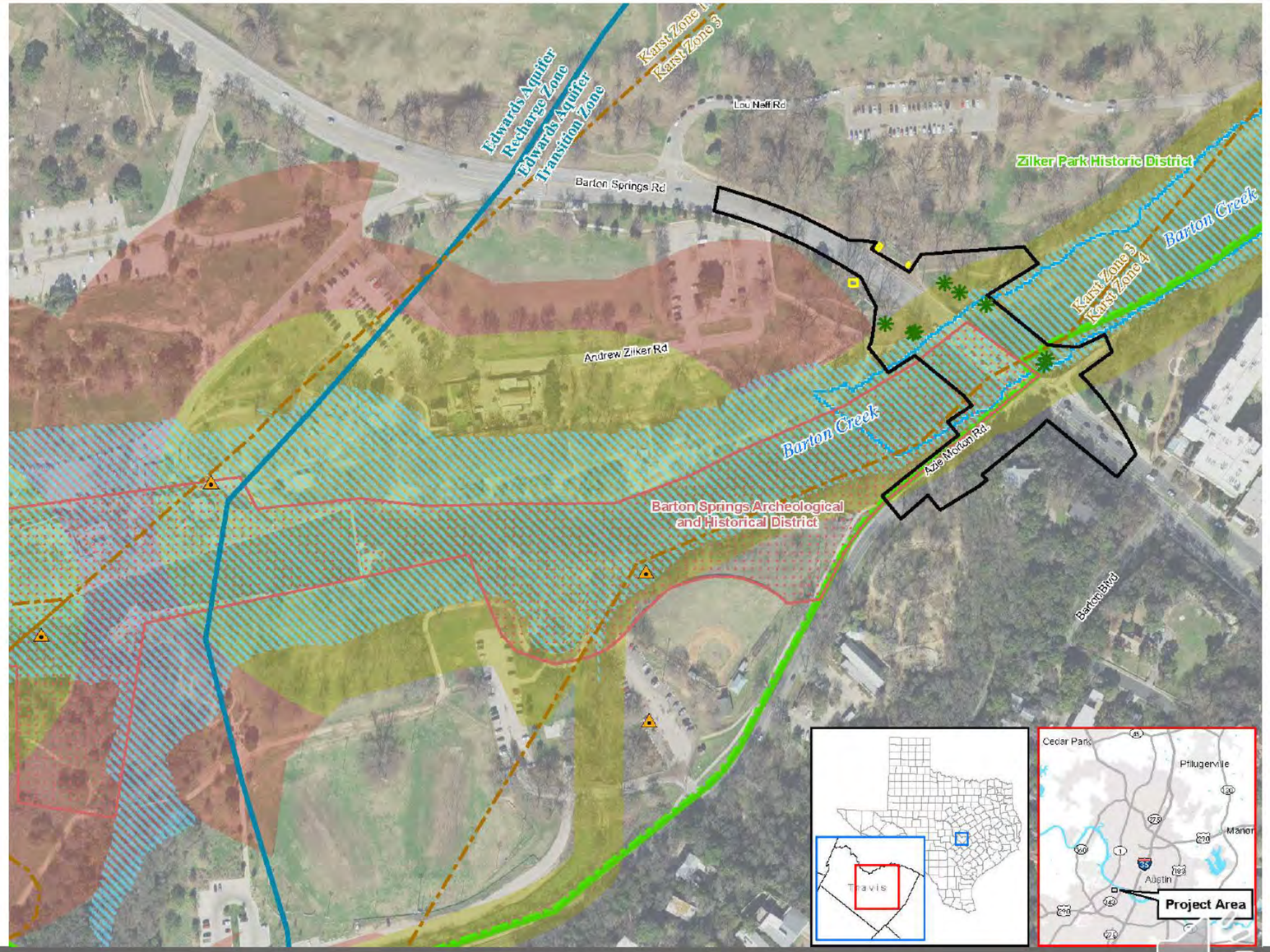
- ✓ Document understanding of environmentally sensitive areas
- ✓ Conduct detailed field investigations for critical environmental features
- ✓ Work with design engineers to avoid, minimize, or mitigate environmental impacts
- ✓ Coordinate with regulatory agencies

- US Fish and Wildlife Service
- US Army Corps of Engineers
- Texas Historical Commission
- Texas Commission on Environmental Quality
- Multiple City of Austin Departments

City of Austin Barton Springs Road Bridge

Environmental Issues / Constraints Map

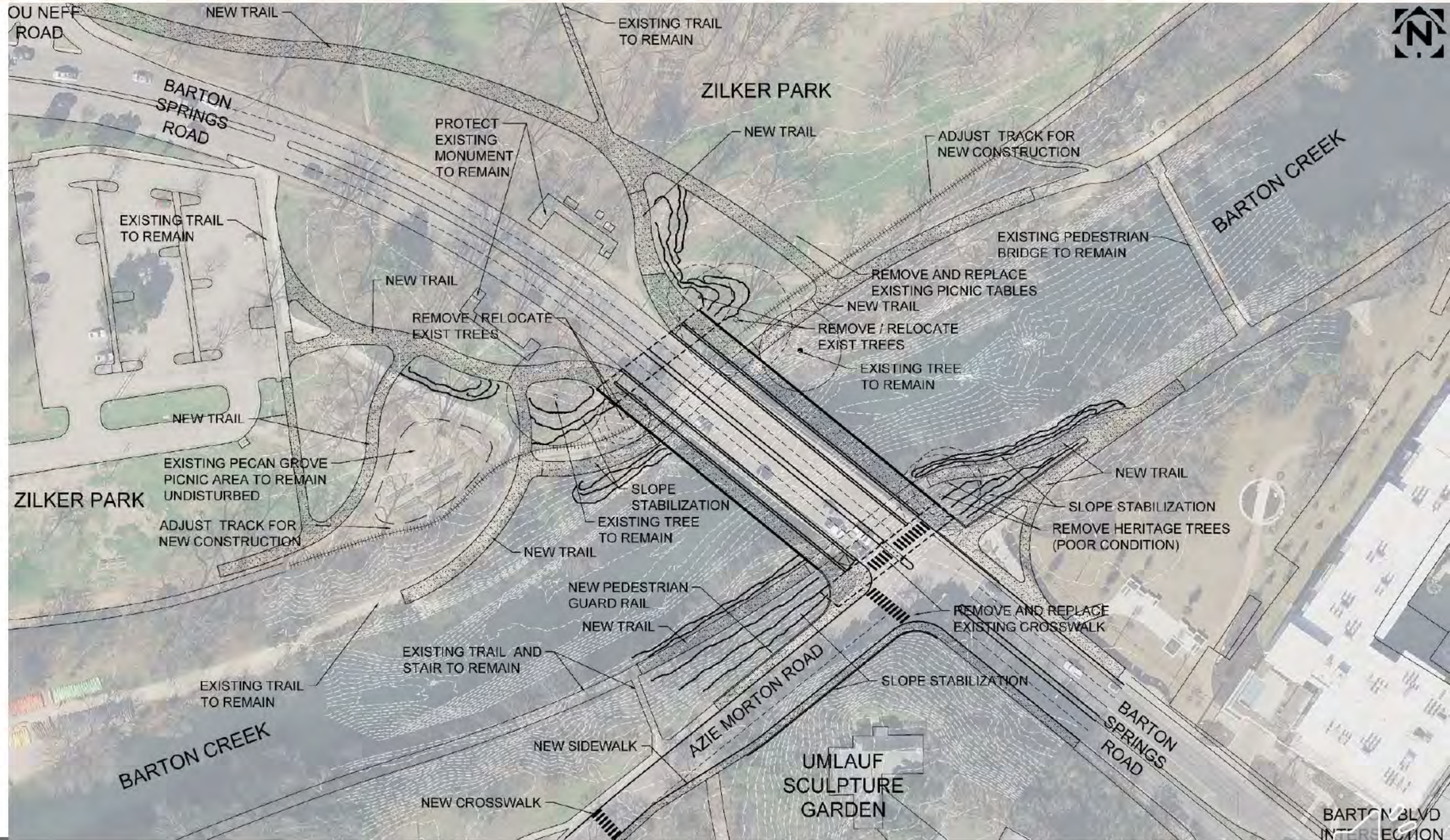
- Known Heritage Tree Location
- Spring
- Regulatory Floodplain (100-Year)
- City of Austin Fully Developed 100-Year Floodplain
- Karst Zone
- Edwards Aquifer Zone
- Preliminary Limits of Construction Operations
- Entrance Monuments
- Zilker Park Historic District
- Barton Springs Archeological and Historical District
- Critical Water Quality Zone
- Water Quality Transition Zone



City of Austin Barton Springs Road Bridge

Multi-modal Connectivity with Parks

- ✓ Protect Historic Landmarks
- ✓ Protect or move Heritage Trees
- ✓ **Flexibility and Connectivity with Zilker Park Vision Plan**



City of Austin Barton Springs Road Bridge

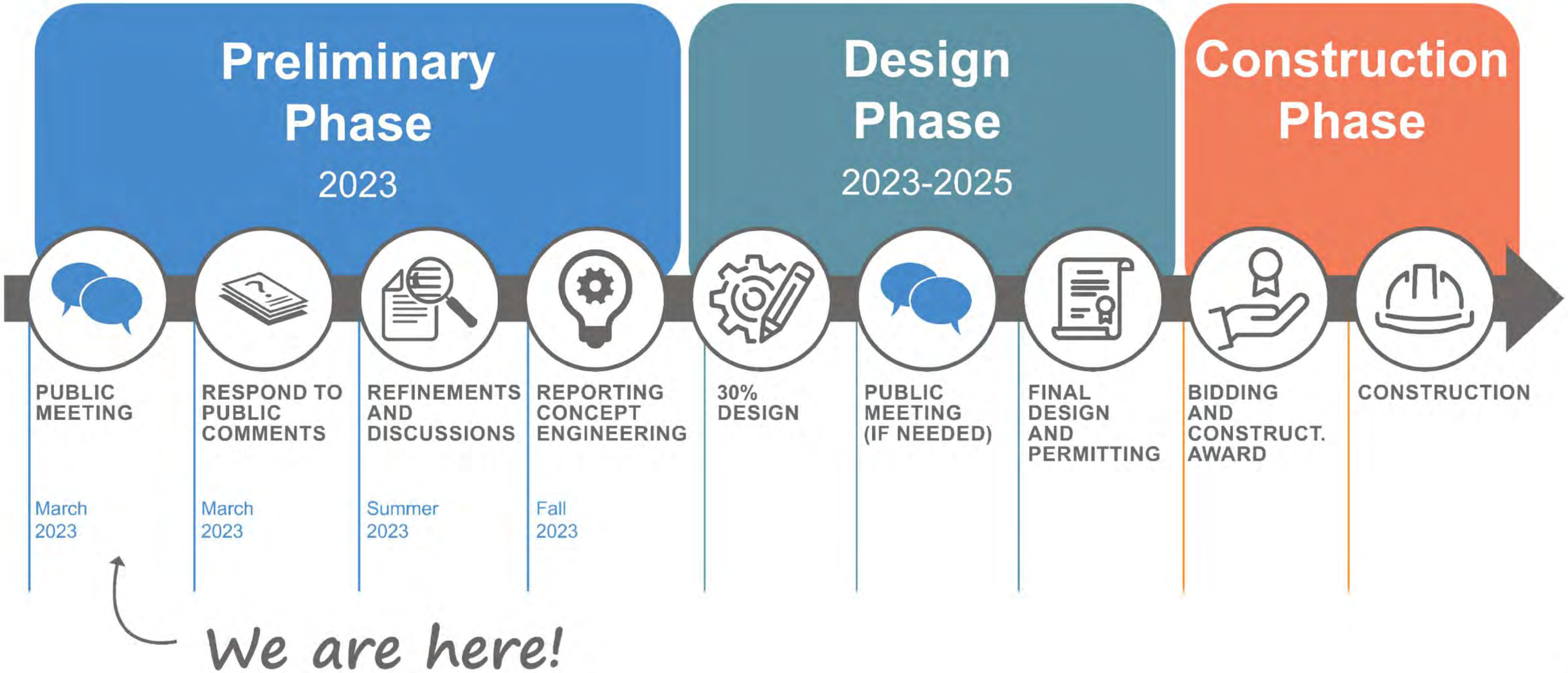
Comparison of Rehabilitation to Recommended Replacement Option

	Roadway Geometry		Park Amenities / Improvements			Bridge Structure								
	Right Turn lane onto Barton Springs Road	Alignment	Zilker Eagle Train	West bank hike/bike trail pedestrian bridges	Hike / Bike Trail below bridge	Architecture and Aesthetics	Impacts to Historic Structure	Length and Abutments	Foundation Work	Temporary Construction in Creek	Bicycles + Pedestrian	Service Life + Maintenance	Cost	Constructability / Risk
Rehab	✓	-	-	-	-	-	✓	-	-	-	-	-	-	-
Replace	✓	✓	✓	✓	✓	-	-	✓	-	-	-	✓	✓	✓

Comparison Highlights

Rehabilitation Options		Replacement Options
Fewer	Number of Benefits	MORE
More Expensive	Cost	40% Less
Riskier	Short and Long Term Risk	Less Risk
		Replacement Recommended

City of Austin Barton Springs Road Bridge



austin MOBILITY BONDS

E-1 - Open House Boards

Purpose of the meeting

- ✓ **Learn** about the project
- ✓ **Ask** questions about potential improvements
- ✓ **Share** your thoughts on the recommended option

City of Austin Barton Springs Road Bridge

austin MOBILITY BONDS

About the Bridge

Nearly
100
years old
built in 1926

20,000
Vehicles per day

1946
Bridge Expansion

Key Entrance
to Zilker Park and for Major City Events

$36 million
Preliminary Funding Estimate (Construction + Soft Costs)

FUNDING SOURCE:
- Preliminary Design: 2012, 2018 and 2020 Bonds
- Design: 2020 Bonds
- Construction: TBD

City of Austin Barton Springs Road Bridge

Park/Historic

1 Park - National Register of Historic Places
2 Landmark Monuments
3 Zilker Eagle Train
4 Umlauf Gardens
5 Parkland on All Sides
6 Continual Recreation - All Modes

Environmental

7 Critical Water Quality Zone - Lady Bird Lake
8 Park Heritage Trees
9 Critical Habitat for Austin Blind Salamander
10 Corps of Engineers Jurisdiction
11 FEMA Floodplain

Roadway/Intersection/ Utilities

12 Misaligned Roadway Approaches
13 Intersection Proximity with Obsolete Turning Radius
14 Extensive Sidewalk, Ramp Hike/Bike Trails
15 Instability/Safety of Azie Morton Hillside
16 Instability of Sidewalk Overhang
17 Overhead Electric

Bridge

18 Aging Bridge
19 Insufficient Bridge Width
20 Insufficient Bike Lanes
21 Obsolete/Narrow Sidewalks
22 Deteriorating Crash Barriers
23 Limited Construction Access

City of Austin Barton Springs Road Bridge

Roadway Alignment Issues

Public Meeting | March 2023

City of Austin Barton Springs Road Bridge

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Project Needs	Project Goals / Outcomes
Age of Structure ▪ 100 yrs old, Associated structural degradation	✓ Provide 75 Year Bridge Service Life
Safety ▪ Barton Springs roadway not aligned ▪ Hillside instability at Umlauf Gardens	✓ Improve Safety ✓ Stabilize Umlauf Gardens
Insufficient Paths ▪ Not enough bike or pedestrian paths on bridge	✓ Add Multi-modal and Connect with Park Trails
Intersection Congestion ▪ At Barton Springs / Azie Morton intersection	✓ Reduce Congestion with addition of right turn

City of Austin Barton Springs Road Bridge

Goal During Construction

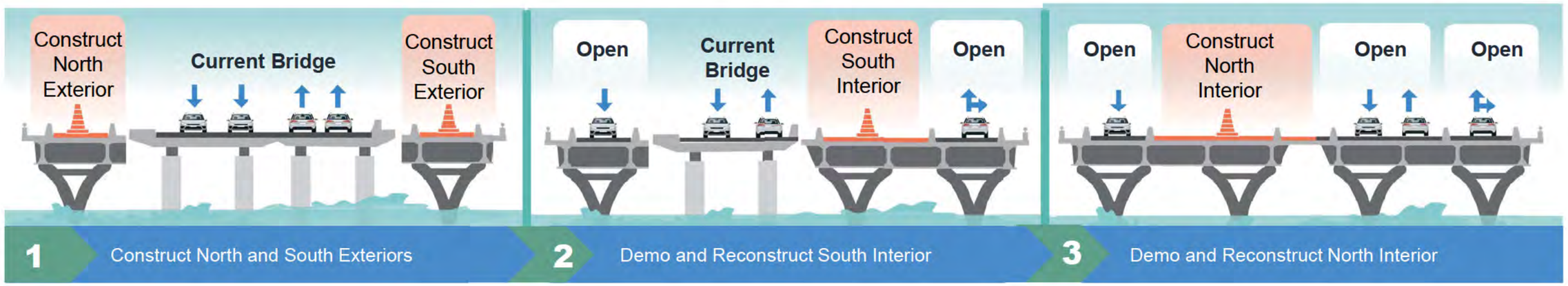
- ✓ Maintain all 4 lanes of traffic during construction
- ✓ Maintain the Azie Morton / Barton Springs intersection during construction

20,000
Vehicles per day on Barton Springs Road

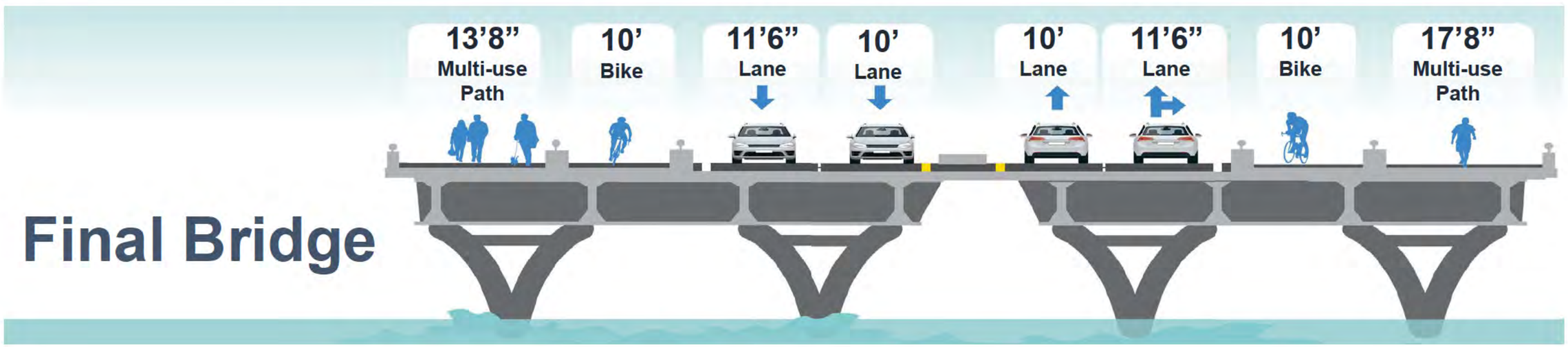
- Important commuter route
- Key access to Zilker Park
- Access to many special events (Trail of Lights, Austin City Limits, Blues on the Green, Zilker Park)
- Access to Zilker and Barton Hills neighborhoods

City of Austin Barton Springs Road Bridge

Bridge Construction Phasing: 4 lanes open through construction



Final Bridge



City of Austin Barton Springs Road Bridge

Rehabilitation Options

1. **PRESERVE** existing structure, consider separate bike/ped structure (minimal rework - light touch)
2. **REHABILITATE** and widen deck to include bike/ped

Replacement Options

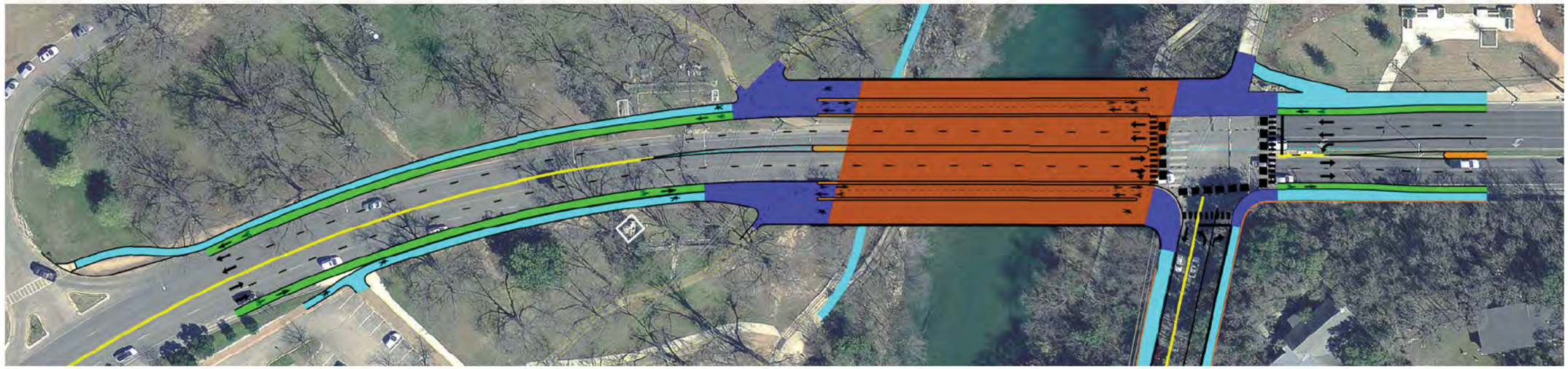
RECONSTRUCT BRIDGE completely and widen deck to include bike/ped

1. **One-Span** option

2. **Two-Span** option

3. **Three-Span** option

City of Austin Barton Springs Road Bridge



Elements Required for Rehabilitation or Replacement

Bike Lanes

- ✓ Widened Bike Lane
- ✓ Accommodate off-road biker trail users

Sidewalk / Path

- ✓ Accommodate hiking Trails
- ✓ Wider Ped. Paths
- ✓ Accommodate Pedestrians for Special Events

Shared Use Path

- ✓ Multimodal areas to accommodate off-road hike and bike trail users

Proposed Bridge

- ✓ Longer service life length
- ✓ Wider bridge
- ✓ Better alignment for safety
- ✓ Dedicated bike lanes

City of Austin Barton Springs Road Bridge

Bridge Inspection Findings

Rehabilitation for increased service life requires removal of deck, floor beams, and spandrel columns

- ✓ Demolish the structure to the arch ribs.
- ✓ Significant work is needed: major rehabilitation or bridge replacement.

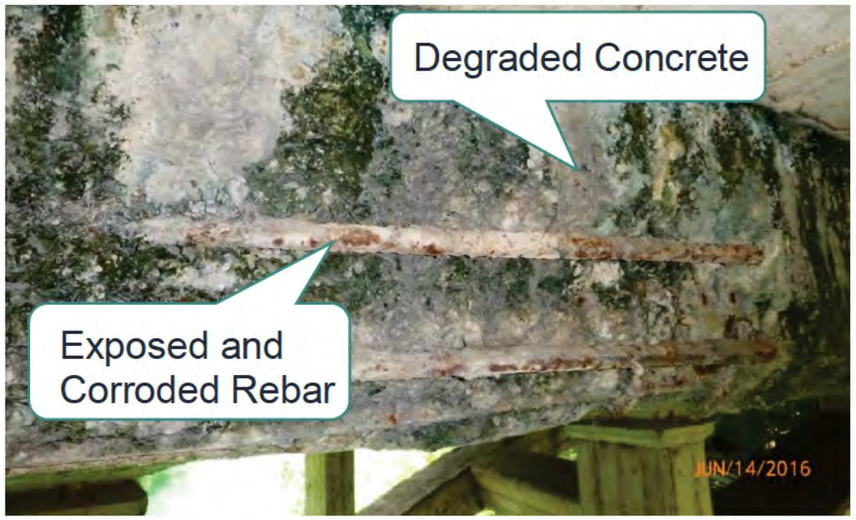
Do Nothing is not an option

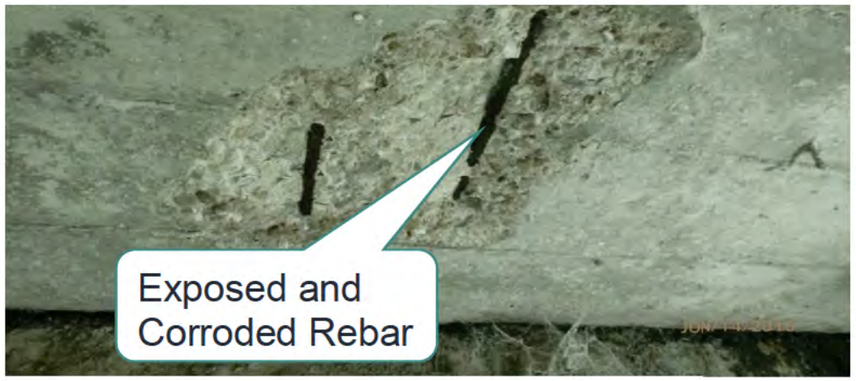
1 **Preserve** Rehabilitation Option 1 is not feasible

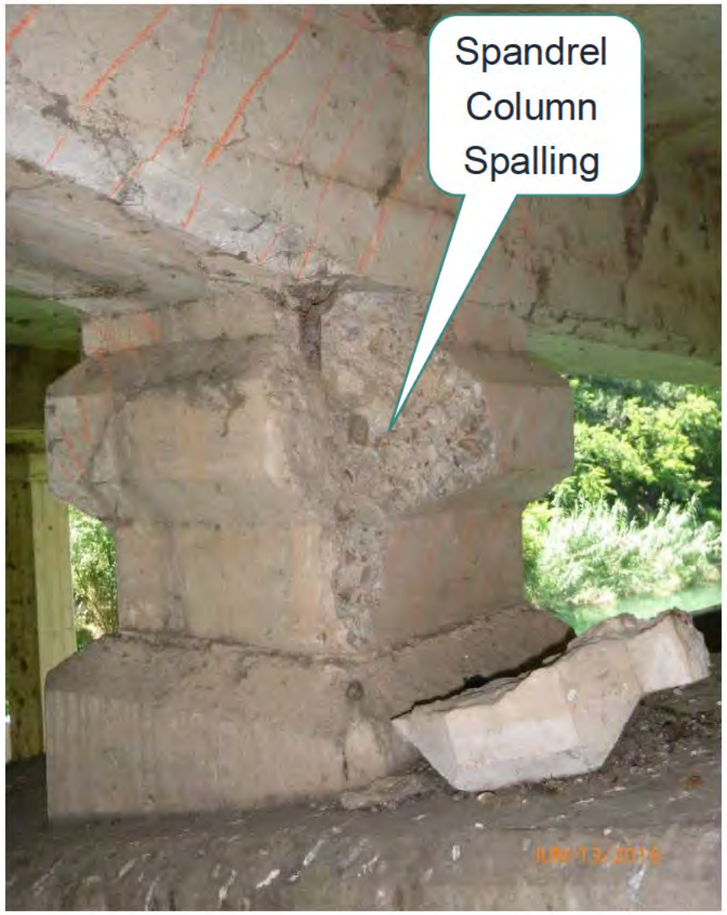
City of Austin Barton Springs Road Bridge

Bridge Inspection Findings

- ✓ Deck (with integral longitudinal joint), floor beams, and spandrel columns exhibited the most degradation.
- ✓ All structural components exhibited some degradation.





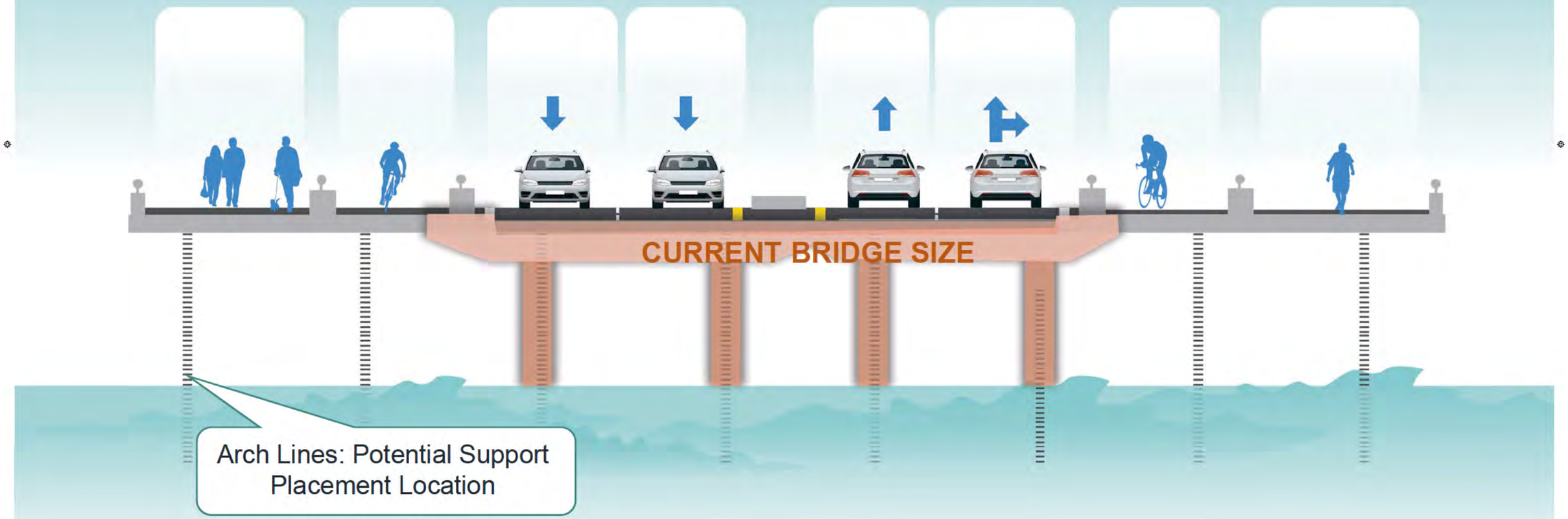


City of Austin Barton Springs Road Bridge

Bridge Rehabilitation Considerations

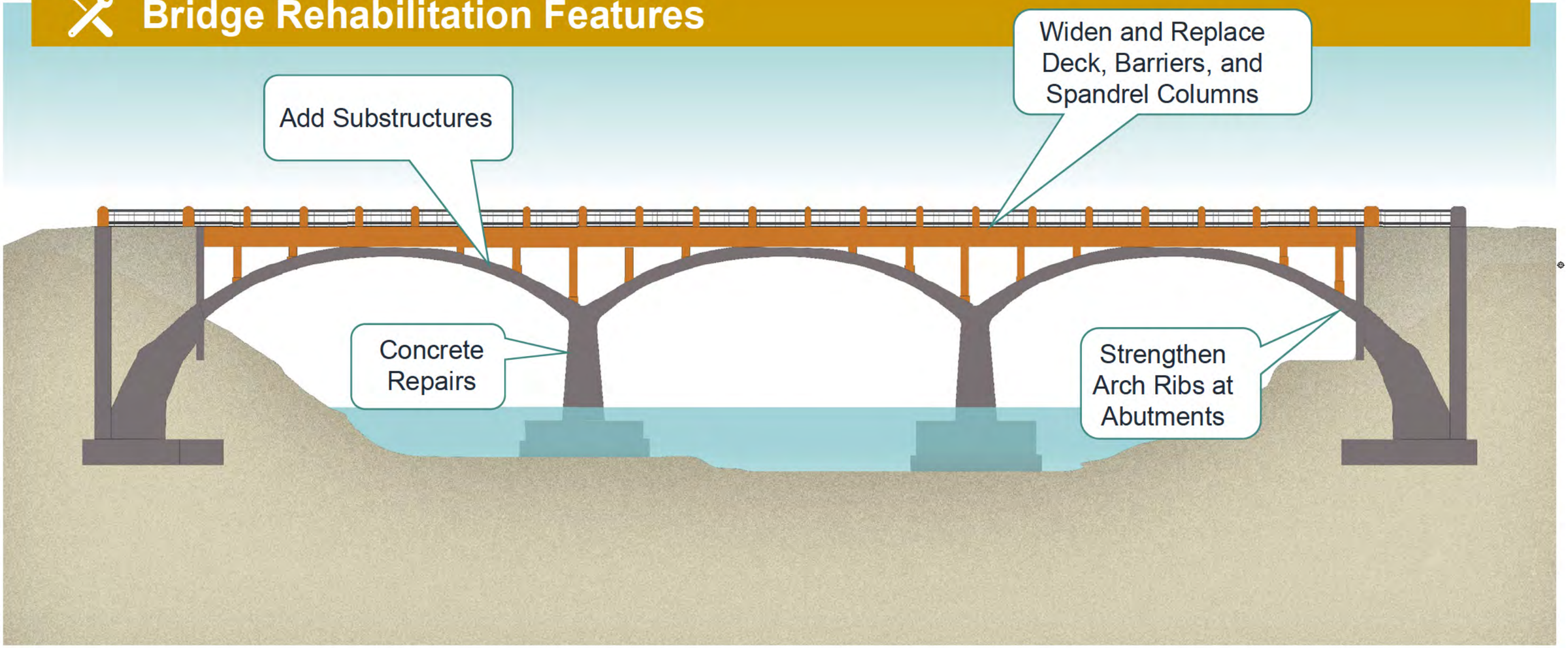
City of Austin Barton Springs Road Bridge

Bridge Rehabilitation Option



City of Austin Barton Springs Road Bridge

Bridge Rehabilitation Features



City of Austin Barton Springs Road Bridge

Bridge Structure Rehabilitation

1 Remove Existing Bridge Deck and Spandrel Columns

2 Remaining Portion of Existing Structure

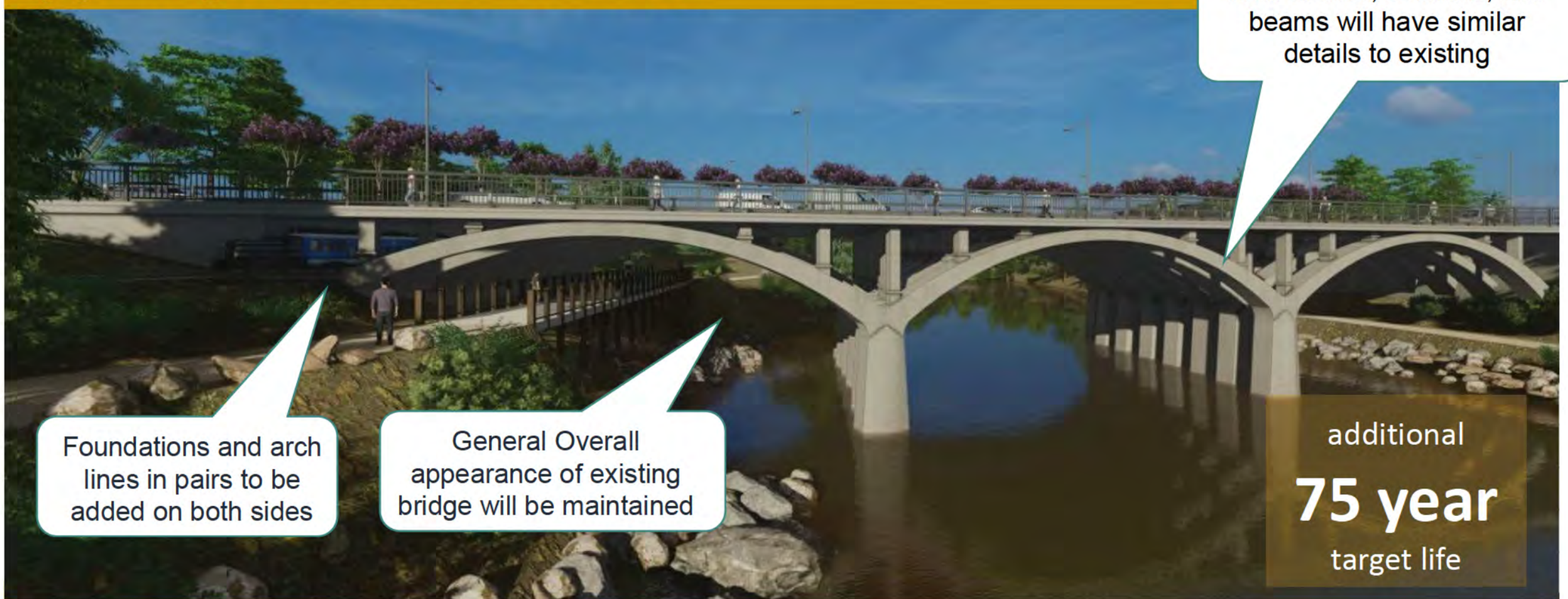
3 New Components: Exterior Pairs of Arch Ribs, Spandrel Columns, Deck, and Abutment Extensions

Less than half of the original historical structure will remain

- ✓ Remaining historical structure will require refacing with new material surfaces
- ✓ View of historical structure will be mostly blocked by new structure

City of Austin Barton Springs Road Bridge

Bridge Rehabilitation Features

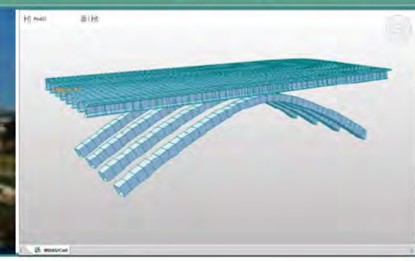


Rehabilitation Option Rendering

City of Austin Barton Springs Road Bridge

Bridge Replacement Options by Span Arrangement

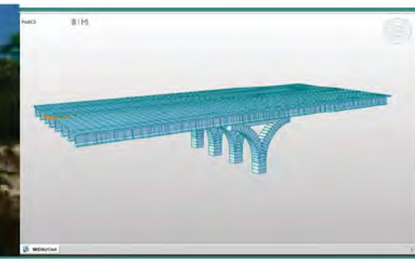
1
One-Span



Single Arch

- ✓ Four Arch ribs spanning creek
- ✓ Arch references existing bridge form

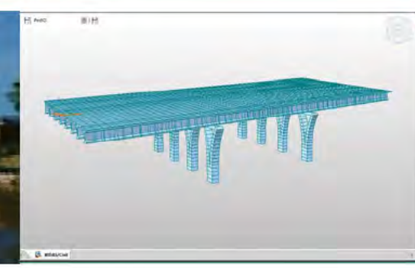
2
Two-Span



"Y" Pier Longitudinal

- ✓ Four Y-Piers in the center of the creek
- ✓ Arch-like Appearance

3
Three-Span

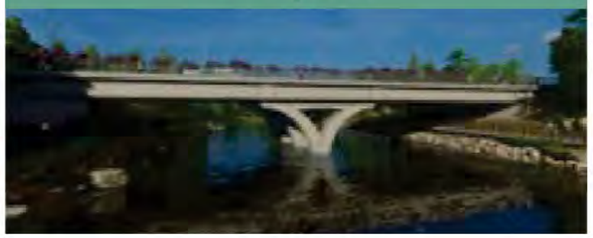


"Y" Pier Transverse

- ✓ Eight Y-Piers in two sets of four
- ✓ Opens center channel of the creek

City of Austin Barton Springs Road Bridge

Bridge Replacement Option Comparison

	1-Span	2-Span	3-Span
			
Structural Complexity	• Complex system	• Less complex • Uses conventional foundations	• Least Complex
Visual Openness	• Obstructed visuals • Views along center line maintained • Potential scour and bank/trail complexities	• More visually open than 1-span option • View along center of creek obstructed	• Most visually open • Clear views along center line of creek
Constructability	• Most complex to build • Requires temporary piers and falsework to make the arches	• Fewest number of foundations in water • Top of bridge requires specialty construction and falsework	• Specialty construction with fewest challenges
Initial Const. Cost (Bridge Only)	• $18.1M	• $13.6M	• $10.2M

City of Austin Barton Springs Road Bridge

Rendering of Recommended Bridge Replacement Option (3-span)

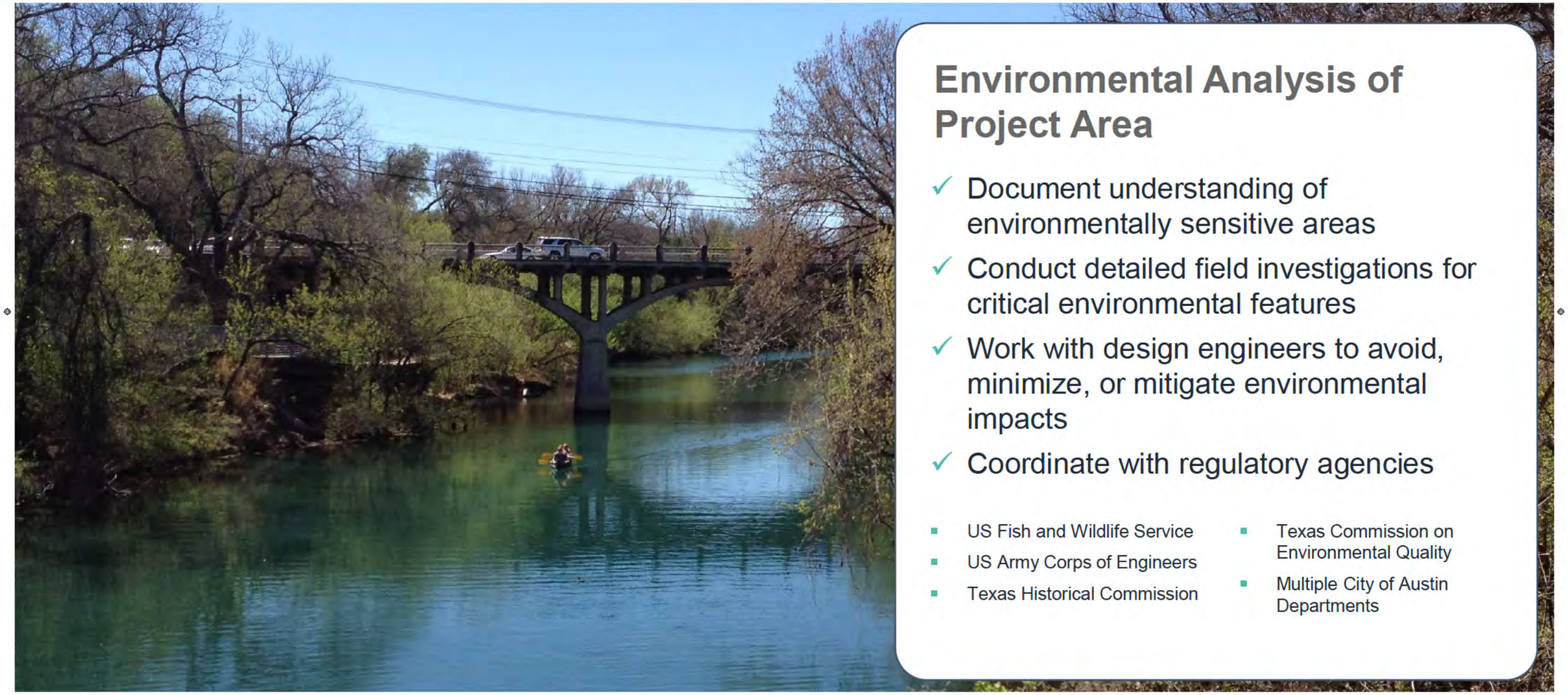
City of Austin Barton Springs Road Bridge

Rendering of Recommended Bridge Replacement Option (3-span)

City of Austin Barton Springs Road Bridge

Rendering of Recommended Bridge Replacement Option (3-span)

City of Austin Barton Springs Road Bridge

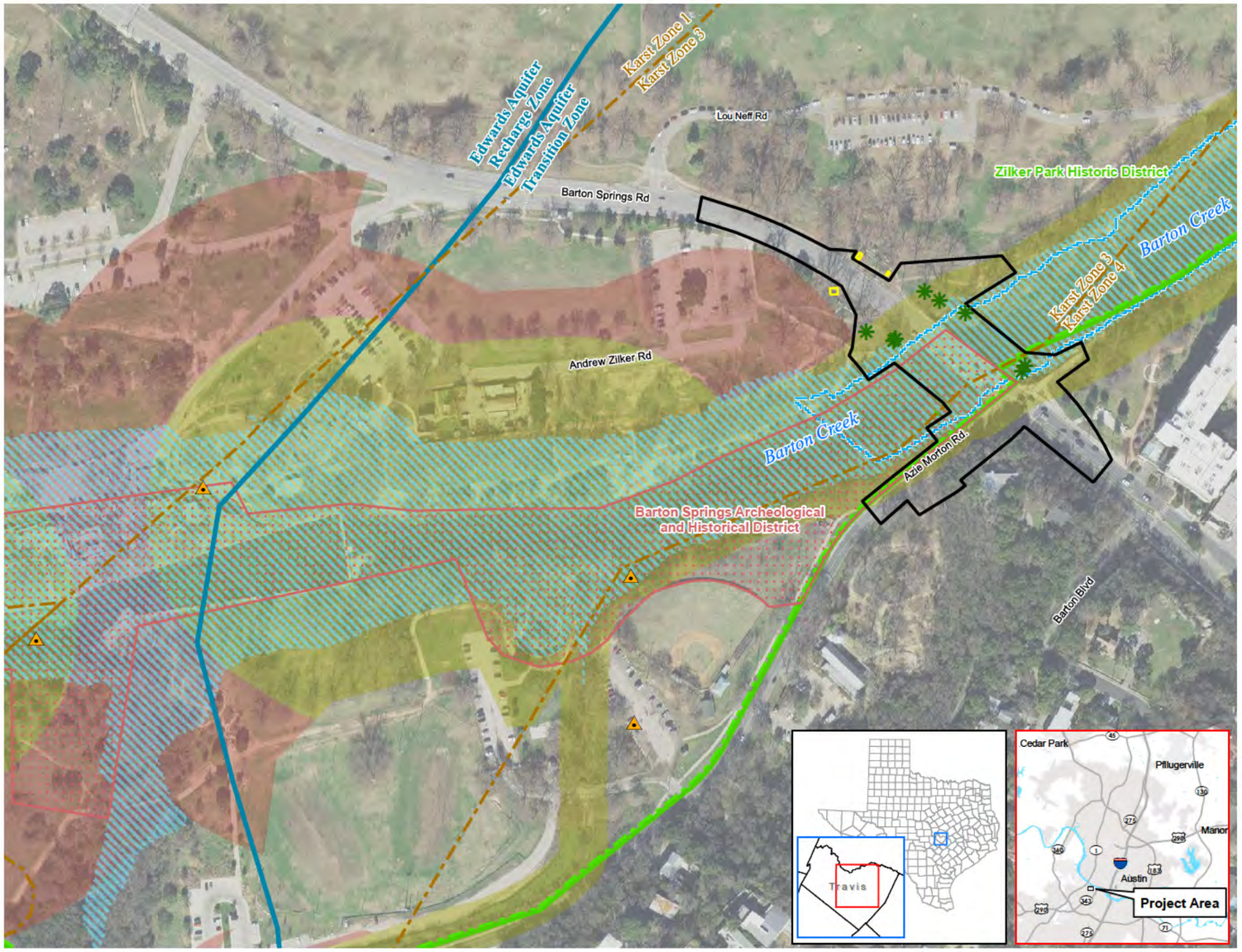


Environmental Analysis of Project Area

- ✓ Document understanding of environmentally sensitive areas
- ✓ Conduct detailed field investigations for critical environmental features
- ✓ Work with design engineers to avoid, minimize, or mitigate environmental impacts
- ✓ Coordinate with regulatory agencies

- US Fish and Wildlife Service
- US Army Corps of Engineers
- Texas Historical Commission
- Texas Commission on Environmental Quality
- Multiple City of Austin Departments

City of Austin Barton Springs Road Bridge



0 200 400
SCALE IN FEET

- Known Heritage Tree Location
- Spring
- Regulatory Floodplain (100-Year)
- City of Austin Fully Developed 100-Year Floodplain
- Karst Zone
- Edwards Aquifer Zone
- Preliminary Limits of Construction Operations
- Entrance Monuments
- Zilker Park Historic District
- Barton Springs Archeological and Historical District
- Critical Water Quality Zone
- Water Quality Transition Zone

KARST ZONE KEY	
Karst Zone	Description
1	Areas known to contain endangered cave fauna
3	Areas that probably do not contain endangered cave fauna.
4	Areas which do not contain endangered cave fauna

Data Sources: City of Austin, Texas Historical Commission, Federal Emergency Management Agency, US Fish and Wildlife Service, National Hydrography Dataset, Texas Parks and Wildlife Department

Imagery: TNRIS 2020.

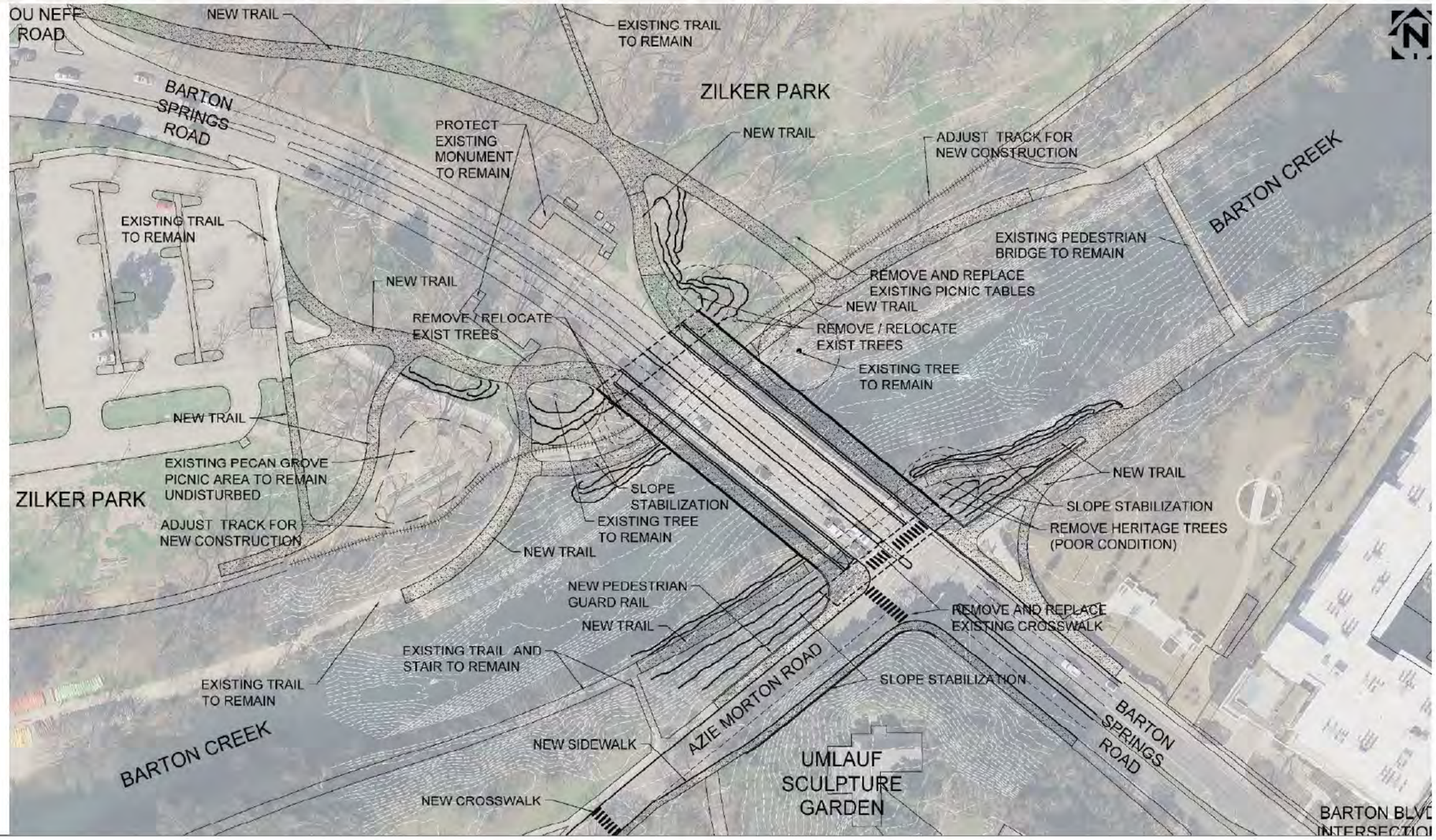
Barton Springs Road Bridge
City of Austin

Preliminary Environmental Constraints Map

City of Austin Barton Springs Road Bridge

Multi-modal Connectivity with Parks

- ✓ Protect Historic Landmarks
- ✓ Protect or move Heritage Trees
- ✓ **Flexibility and Connectivity with Zilker Park Vision Plan**



City of Austin Barton Springs Road Bridge

	Rehabilitation	Replacement
ROADWAY GEOMETRY		
Azie Morton Road – Extended Right Turn Lane	✔	✔
Barton Springs Road Alignment	• Improved but still unaligned • Less abrupt "zig zag"	✔ • Straight intersection with no "zig zag" • No east/westbound conflicts
PARK AMENITIES / IMPROVEMENTS		
Zilker Eagle Train	• Train replacement under bridge similar to current layout	✔ • Train replacement similar to current layout or relocation for additional space and safety
West Back Hike / Bike Trail / Pedestrian Bridge	• Pedestrian bridge replaced	✔ • Pedestrian bridge replaced or relocated
Hike / Bike Trail Passage Below Bridge	• Passage roughly twice as wide • Passage space and headroom similar to existing	✔ • Passage roughly twice as wide • Passage space increased vertically and horizontally
BRIDGE STRUCTURE		
Bridge Architecture and Aesthetics	• Existing arches and foundation remain • Structures undergo cathodic protection • New arches up/downstream complementary to existing arches • 8 arch lines	• Existing arches removed • 4 substructure elements at two locations • New bridge aesthetic complementary to existing arrangement • 4 arch lines
Impacts to Historic Structure	✔ • Preserves some existing historic bridge elements	• Removes historic elements • Mitigation strategies offset impacts
Bridge Length and Abutment Locations	• Existing abutment remains • Expansion to north and south for additional arches	✔ • Shift west abutment further west • Provides more space and safety for pedestrian trail and train
Bridge Foundation Work	• Existing foundations receive cathodic protection, concrete mitigation and re-surfacing • 8 new foundations • 4 new arch lines with two piers	• Existing arches and foundations removed down to creek bed • 8 foundations • 4 substructure elements at 2 locations
Temporary Construction	• Foundations for temporary works required	✔ • Construction by barge mounted cranes, no foundations for temporary works required
Bicycle Elements	• 10-ft wide bike lanes on each side • 2-way bike operation	• 10-ft wide bike lanes on each side • 2-way bike operation
Pedestrian Elements	• 14-ft wide sidewalk on south side • 18-ft wide sidewalk on north side	• 14-ft wide sidewalk on south side • 18-ft wide sidewalk on north side
Service Life	• Target Service Life Extension: 50-75 years • Dependent on additional sampling/testing of existing bridge	✔ • Target Service Life: 75 years • Can be extended to 100 years with enhancements to design basis and materials. 10%+ increase in cost
Bridge Maintenance	• Increased long term maintenance cost and requirements	✔ • Less maintenance cost and staffing labor required
Cost (Range including 50% inflation over course of project)	$14.5M - $22M	✔ $10.2M – 15.5M
Constructability / Risk	• Constructability difficult due to precision-demolition and protection of remaining existing structures • Greater project risk with unknown material and subsurface foundation conditions	✔ • Comparatively less construction and project risk

City of Austin Barton Springs Road Bridge

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Comparison of Rehabilitation to Recommended Replacement Option

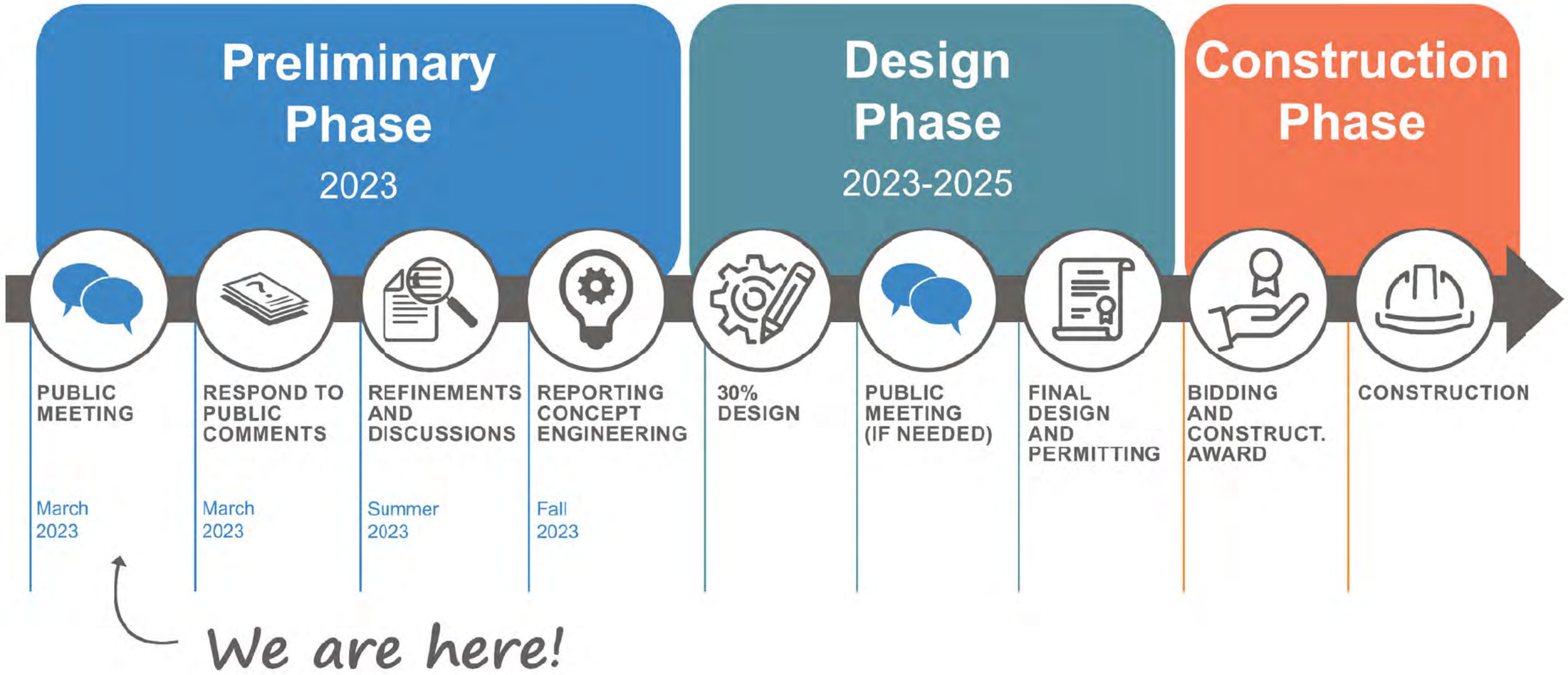
	Roadway Geometry		Park Amenities / Improvements			Bridge Structure								
	Right Turn lane onto Barton Springs Road	Alignment	Zilker Eagle Train	West bank hike/bike trail pedestrian bridges	Hike / Bike Trail below bridge	Architecture and Aesthetics	Impacts to Historic Structure	Length and Abutments	Foundation Work	Temporary Construction in Creek	Bicycles + Pedestrian	Service Life + Maintenance	Cost	Constructability / Risk
Rehab	✓	-	-	-	-	-	✓	-	-	-	-	-	-	-
Replace	✓	✓	✓	✓	✓	-	-	✓	-	-	-	✓	✓	✓

City of Austin Barton Springs Road Bridge

Comparison Highlights

Rehabilitation Options		Replacement Options
Fewer	Number of Benefits	MORE
More Expensive	Cost	40% Less
Riskier	Short and Long Term Risk	Less Risk
		Replacement Recommended

City of Austin Barton Springs Road Bridge



E-2 - Public Comments – April 2023

Barton Springs Road Bridge Over Barton Creek Project

Public Meeting Summary (April 2023)

Contents

Public Engagement Process 2
Public Comment Results 2
Overall Sentiment Analysis 2
Public Comments 3
No Changes to Bridge - roughly 20% 3
Against Replacement - roughly 5% 3
In Favor of Rehabilitation - roughly 30% 3
In Favor of Replacement – 30% 3
Undetermined/Miscellaneous – 10% 3
Results for Optional Demographic Questions 3
Appendix: All Comments 8

MobilityBonds@AustinTexas.gov 512-974-2300 /ATXMobility @AustinMobility

Public Engagement Process

On April 4, 2023, the Austin Transportation & Public Works Department (TPW) conducted its first in-person public meeting on the Barton Springs Road Bridge Project. Although this meeting was postponed from March 2, 2023, due to local weather conditions, the virtual public meeting went online on March 2 as planned and remained live through April 18 when all public comments were due.

The purpose of this in-person and virtual meeting was to present the project and to gather community feedback on various alternatives for improving safety and mobility for the Barton Springs Road Bridge. Many of the existing bridge's features are functionally obsolete and require rehabilitation or replacement to ensure safety and longevity.

Promotion of the public meeting (both in-person and virtual) included a flyer mailout to the project stakeholder list of individuals and organizations; placement of meeting signs in the neighborhoods in and around the project area; postings on social media sites (NextDoor, Facebook, and Twitter); and a media advisory.

Public Comment Results

Public comments were gathered in two ways: on paper during the in-person public meeting on April 4, 2023 and online as part of the virtual public meeting that started on March 2. All comments were due on April 18.

Both in-person and online, meeting participants were asked to share their feedback in one open-ended question: Do you have any comments or questions for the project team? The online version also included optional demographic questions.

The online survey was open from March 2 – April 18 whereas the in-person public meeting took place on one evening (April 4). A total of 187 comments were received during the comment period; 11 of those comments were gathered during the in-person meeting while the remainder were submitted online. Overall there were 1,677 views of the virtual public meeting, 189 participated in the online survey and made 446 overall responses. The total number of comments received was 187 (includes the comments received at the in-person public meeting.)

The project team reviewed all of the public comments to better understand how people feel about replacing versus rehabilitating the Barton Springs Road Bridge and to see how they reacted to the recommended alternative (replacement).

For the responses to the single open-ended question, the project team read and tagged each comment for themes, sometimes multiple themes when applicable.

Overall Sentiment Analysis

To better understand overall sentiments regarding replacement versus rehabilitation of the bridge, the project

team counted each sentiment category (in favor of no changes to the bridge, support for rehabilitation, support for replacement, against replacement, and miscellaneous) once per respondent.

Public Comments

The public comments received for this project have been reviewed and addressed. They are shown below according to general sentiment categories and the percentages are approximate - rounded to nearest 5%.

No Changes to Bridge - roughly 20%

This type of comment included phrases such as "bridge is fine" "leave it alone," "wasted project," "spend money on other things," "no need for construction."

Against Replacement - roughly 5%

Commenters were not necessarily in favor of rehabilitation but were anti-replacement. Some of the comment wording was hard to distinguish from "leave it alone."

In Favor of Rehabilitation - roughly 30%

Many of these comments were very similar and appeared to be standard comments generated by an advocacy group.

In Favor of Replacement – 30%

Some of these comments specifically expressed support for replacement whereas three-quarters of this group of commenters acknowledged replacement but focused on a desire for a different bridge design (than the design in the recommended alternative), one that has more of an Austin aesthetic.

It should be noted that a majority of the people attending the in-person open house were in favor of replacement, which may be related to the fact that these individuals were able to interact and ask questions of the project team in real time.

Undetermined/Miscellaneous – 10%

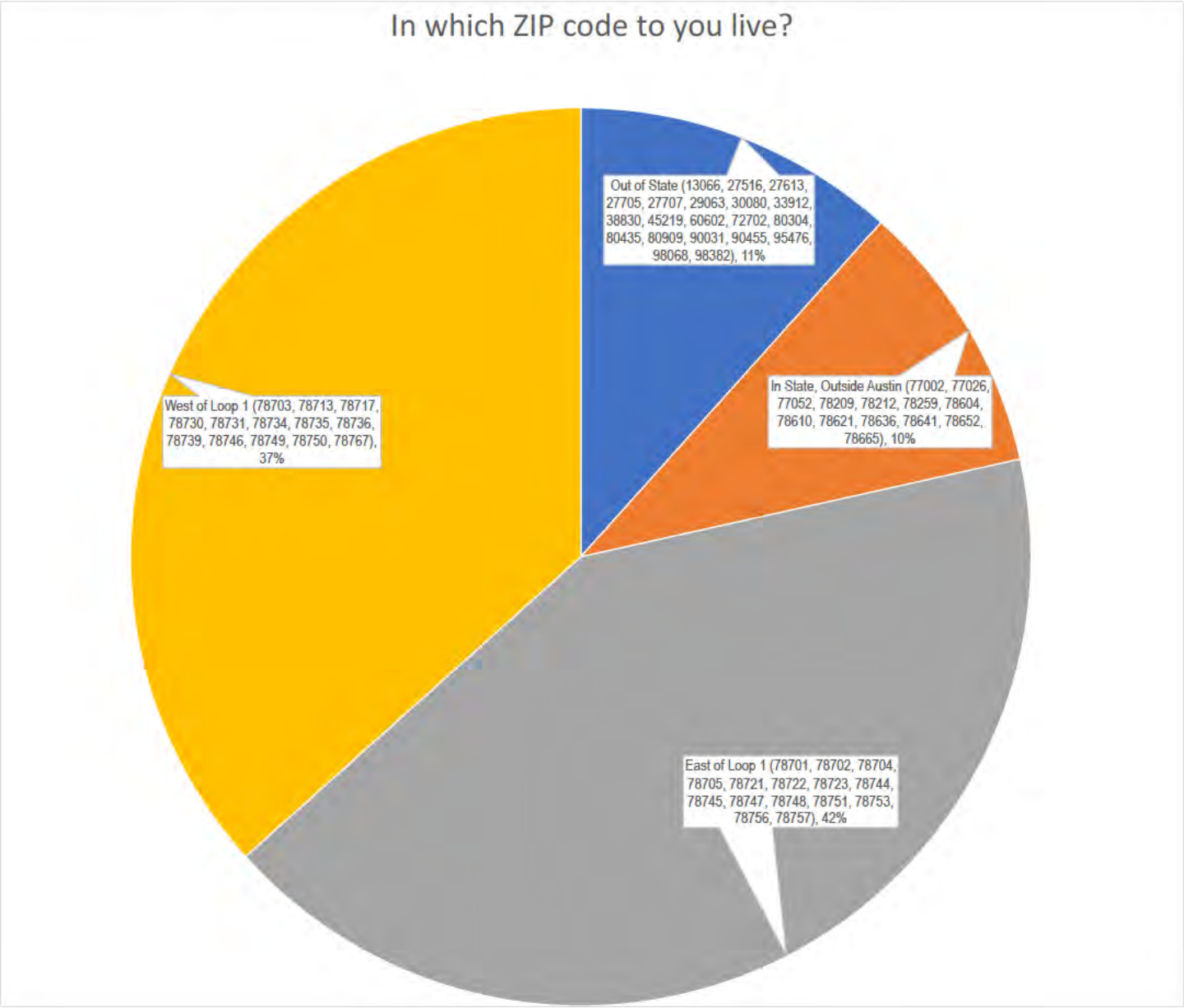
Comments in this category mentioned a concern for the bridge's impact on the environment, issues with adjacent roadways, or access for water craft, bicycles or pedestrians but did not contain any opinion of the bridge itself. A few comments were so vague that they could not be categorized.

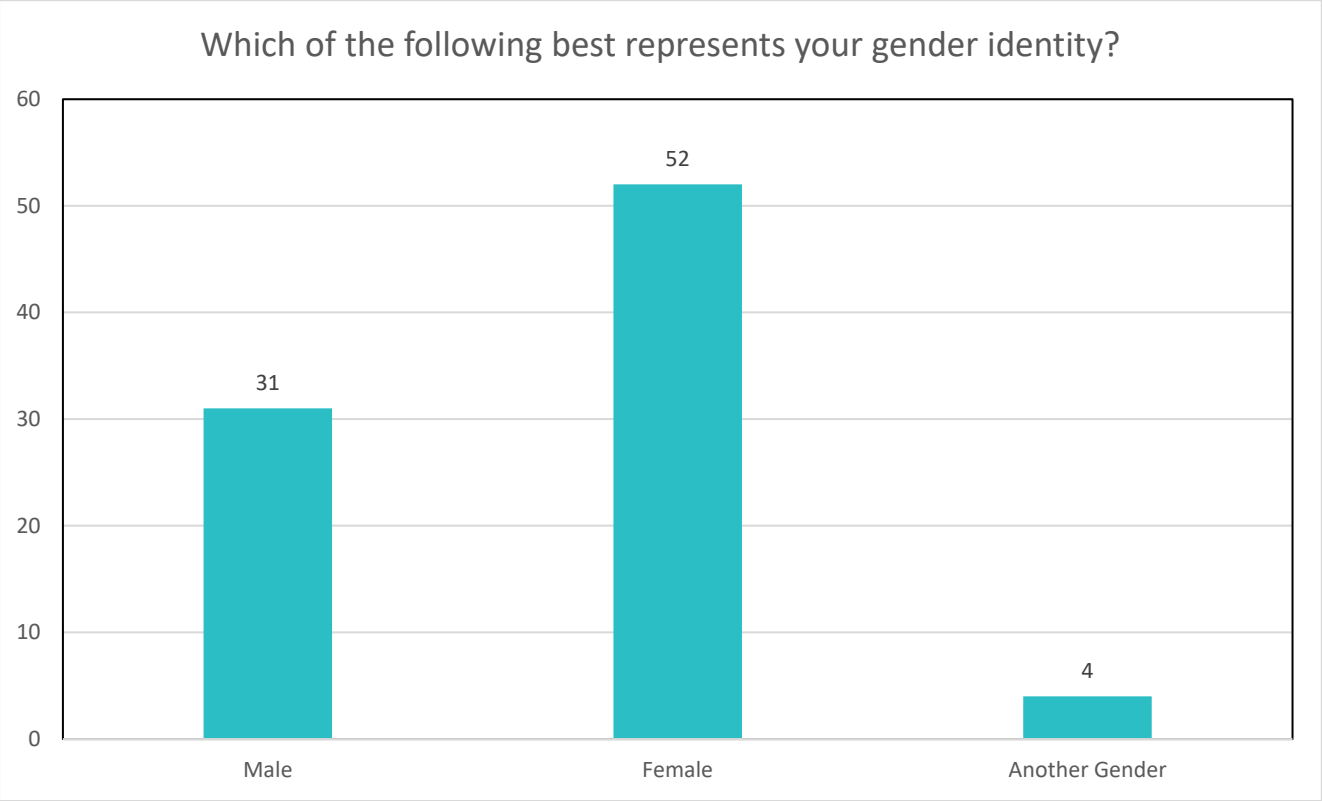
Results for Optional Demographic Questions

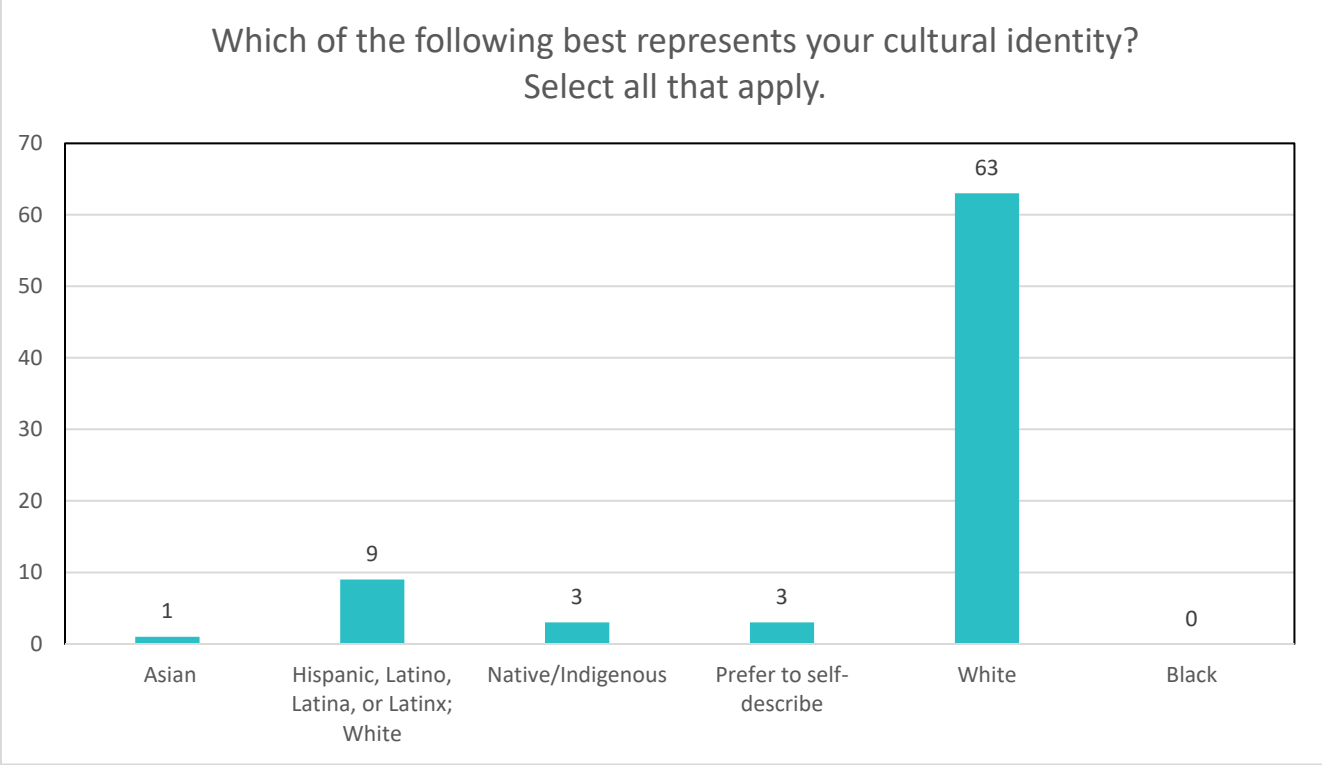
The survey also included optional demographic questions that would offer the project team insight into whom

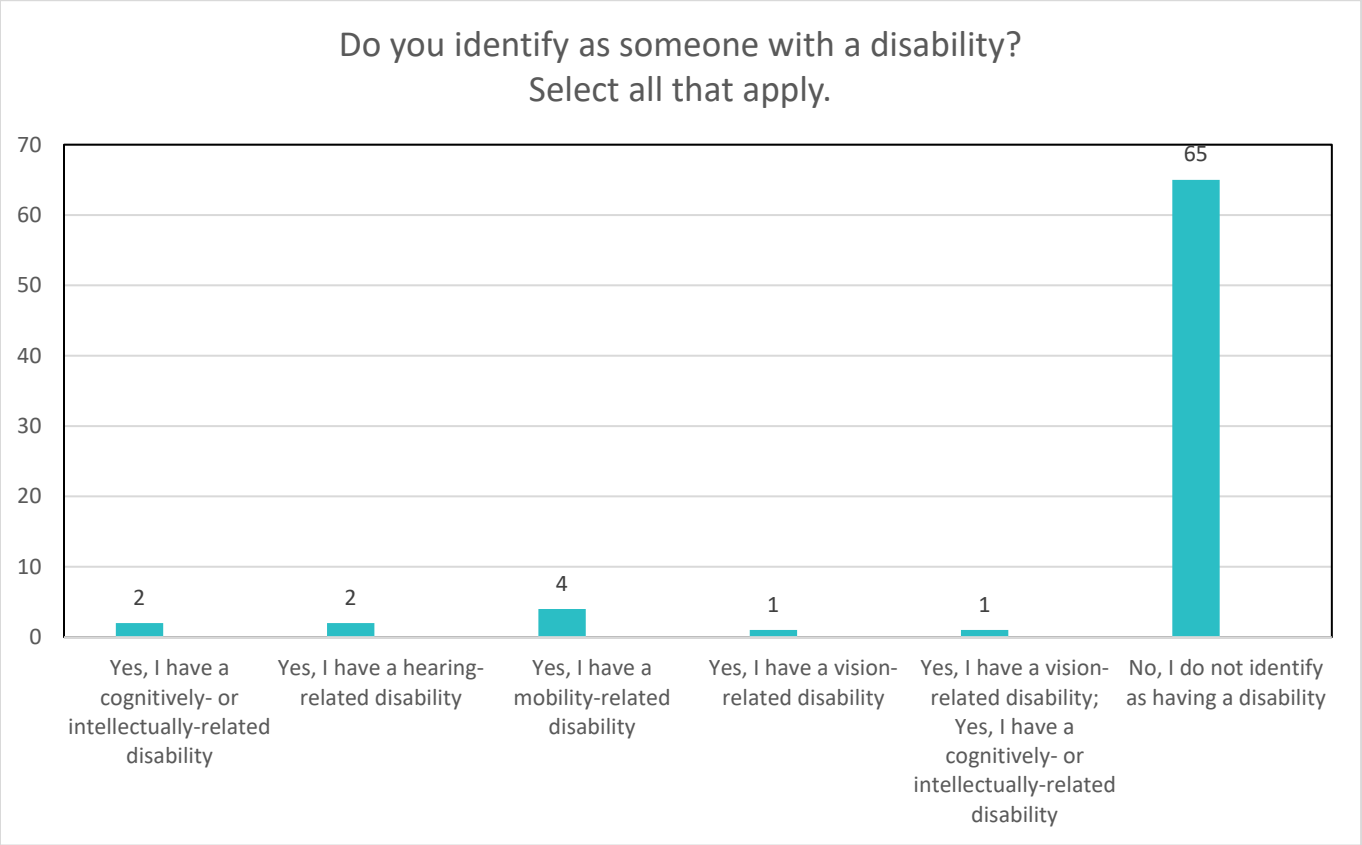
they reached in the public engagement process.

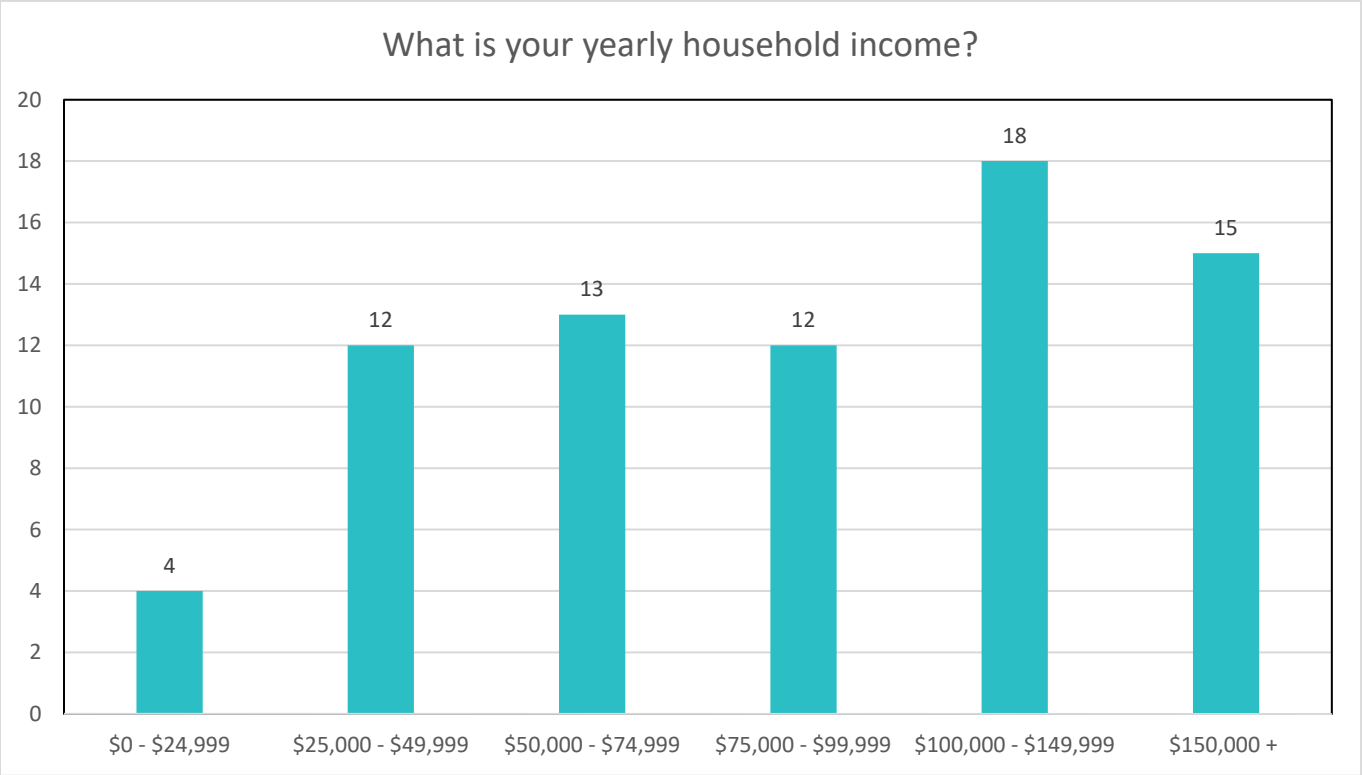
- In which ZIP code do you live?
- Which of the following best represents your gender identity?
- Which of the following best represents your cultural identity?
- Do you identify as someone with a disability?
- What is your yearly household income?
- What is your age?

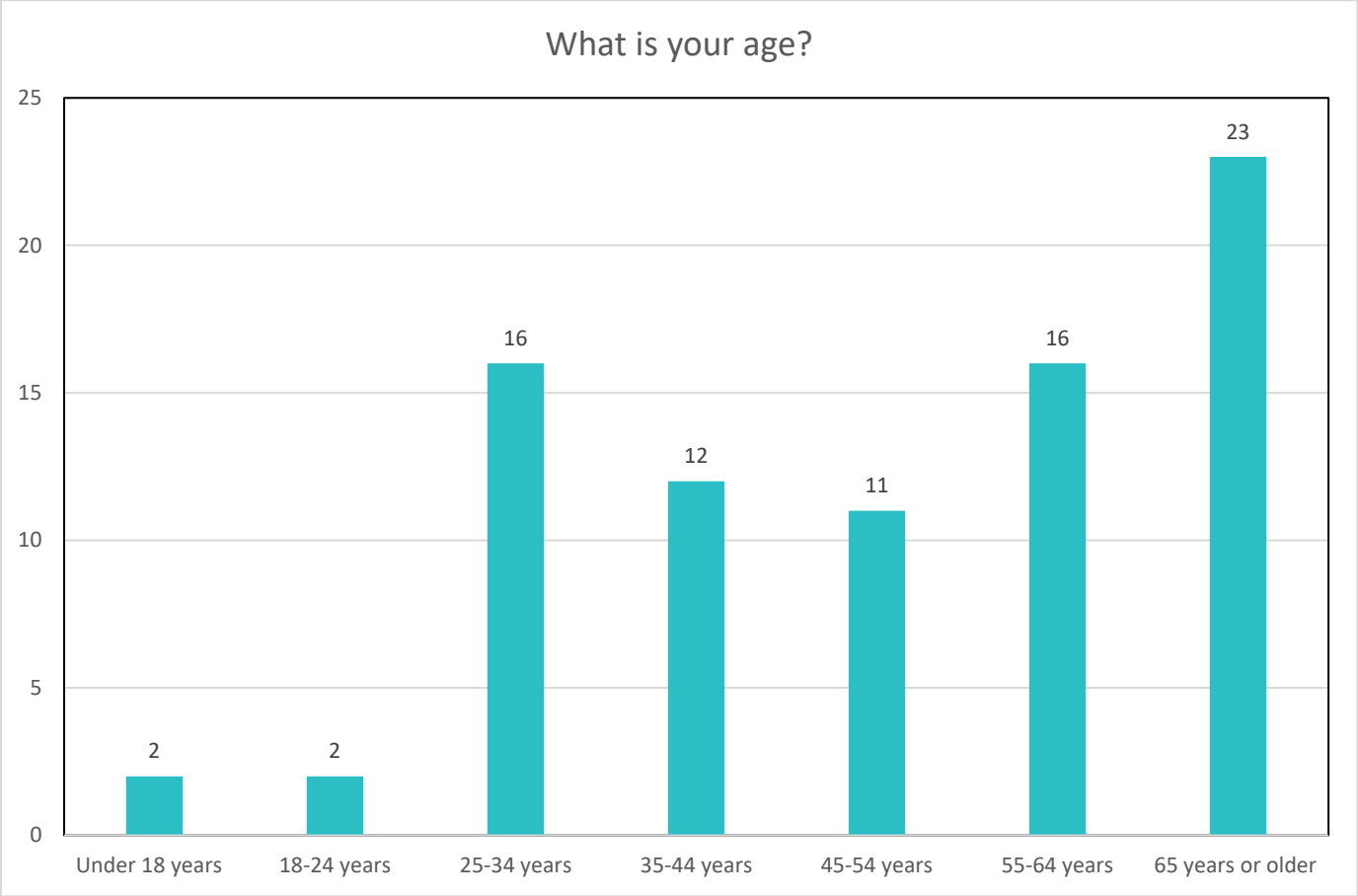



Which of the following best represents your gender identity?
60
50
40
30
20
10
0
31
52
4
Male
Female
Another Gender


Which of the following best represents your cultural identity?
Select all that apply.
70
60
50
40
30
20
10
0
1
9
3
3
63
0
Asian
Hispanic, Latino, Latina, or Latinx; White
Native/Indigenous
Prefer to self-describe
White
Black


Do you identify as someone with a disability?
Select all that apply.
70
60
50
40
30
20
10
0
2
2
4
1
1
65
Yes, I have a cognitively- or intellectually-related disability
Yes, I have a hearing-related disability
Yes, I have a mobility-related disability
Yes, I have a vision-related disability
Yes, I have a vision-related disability; Yes, I have a cognitively- or intellectually-related disability
No, I do not identify as having a disability


What is your yearly household income?
20
18
16
14
12
10
8
6
4
2
0
4
12
13
12
18
15
$0 - $24,999
$25,000 - $49,999
$50,000 - $74,999
$75,000 - $99,999
$100,000 - $149,999
$150,000 +


What is your age?
25
20
15
10
5
0
2
2
16
12
11
16
23
Under 18 years
18-24 years
25-34 years
35-44 years
45-54 years
55-64 years
65 years or older

Appendix: All Comments

Respondent ID	Response
2248697	Please maintain the history and infrastructure of Austin so we can show our children and enjoy the walking and biking paths. In this choice you will be able to be climate friendly and maintain what is working rather than knock it down and add to the climate crisis by producing unnecessary waste and construction. Thank you for being climate forward and respecting Austin's history!
2248872	This bridge is one of the main ways to get out of the city for a bike ride. In its current state and given the speed of the cars that cross it, it is a danger for cyclists and pedestrians. Thank you for taking this project forward.
2250181	If Barton Springs Road is planned to go to one lane each way through the park, why not start that at the bridge? The ped and bike paths could also be combined with different shades/type of pavement. There will be higher demand for each group at different times (group bike rides early in the morning, all pedestrians for ACL.
2250710	I agree the bridge needs to be redone however please don't ruin the charm / integrity of the area .the Potholes are awful! The horrible proposal of cutting Barton Springs road down to one lane is preposterous! We already have a traffic issue daily! The city is undergoing so many changes & not necessarily for the better!
2250719	The proposed design for the bridge is hideous! You have taken away any charm or esthetic that Zilker area is known for ! Modernizing it to death! Awful. I do agree the road needs repair but at what cost financially and visually!?? Stop the madness!
2251178	The existing bridge is great. The proposed replacement is not. I understand the need for better bike and ped access, its important. But this design is ugly. Of all the bridges in town to cheap out on, don't do it to this one.
2251544	The bridge must keep four lanes and expand to safely handle cyclists and pedestrians. Rehab of existing bridge is far too costly. We can make much better use of bond dollars by building a new, safe structure
2251639	Although I like expanding the bridge for walkers and bikers, I am unhappy with the new bridge design proposals. They are forgettable and, as others have said, do not have any charm. I understand that rehab is too expensive, however I implore you to listen to the community feedback about the designs and use tax dollars to propose something more iconic that properly respects such an important part of the city. You are investing in a historical piece of Austin that touches both locals and tourists. It is as central as you get. It will be around long after we've all passed away. We need something more remarkable than what is being suggested.
2269625	Two comments. First, as others have noted, the design needs work. The bridge is a gateway to Zilker Park, and the design should reflect that fact. The proposed milquetoast designs in the presentation are better suited for purely functional projects, and they'd make this project a missed opportunity. It doesn't need to be the Pennybacker Bridge, but something similarly iconic would be closer to what we need. Second, how will this project integrate with the proposed capacity changes along Barton Springs Road? Wouldn't it make more sense to begin reducing the number of vehicular travel lanes at the bridge?
2270532	The bridge condition is poor and the right thing to do as stewards of the city is to replace and plan for the future with an acknowledgement of the past. I'm partial to the 2-span option but I am fine with 3-span option as well. If the 3-span option is used based on views, constructability, and budget; then use some of the savings from the 2-span option to recreate (and possibly incorporate) the concrete bridge railing currently represented at street level. Also, investigate moving the project forward with the goal of seeking SITES certification.
2270799	An "Environmental Constraints Map" is no substitute for actually studying the construction methodologies needed to build the various options, which has a substantial impact to the process of choosing the design option that least impacts the creek environment, being by far the most important consideration here. Recommending an option that requires demolishing 8 existing bridge piers and adds 8 new bridge piers in the creek is an absurd outcome to this process. Preservation of the existing historic bridge must be a priority, and any widening should avoid touching the creek. There are absolutely ways to do this, and they will absolutely cost more than the basic "TxDOT bridge + aesthetics" recommended here that is no doubt the cheapest option, in every sense of that

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	word. This study fails to look at the important issues at one of the most treasured sites in Austin. Try again and do better.
2272482	The bridge is the entrance to Zilker Park, the primary jewel in Austin's wonderful park system. Many Austin visitors and residents come to the city to go to events and festivals in Zilker. This bridge is completely unmemorable. It looks like any other drab bridge across an expressway and there has been zero effort to recapture the historic beauty of the bridge. Given that was a primary objective for the bridge design, why was there no effort to replace the bridge with something everyone in Austin will be proud of? Couldn't materials from the original bridge be used in the replacement to play homage the historic bridge. I've seen many architects who have incorporated historic houses into new building designs. There was no effort to creatively come with a solution that replaced and kept some of the historic structure. Please go back to the drawing board. IMO, all of the replacement concepts are failures.
2272487	Prefer not to describe
2274796	I agree that we need a new bridge. I love the emphasis on bike / pedestrian transit in the new plan. However, I would like to see a more artistic design. It's very plain, with nothing interesting about it. Very TXDOT. This is hardly the iconic bridge that this location demands. Please send the designers back to the drawing boards and show us something that will add to the city's beauty for the next century.
2279414	Love love love properly protected bike lanes - more space for bikes is better! Prioritizing pedestrians and cyclists is essential to beautifying Austin. The structural design of the bridge should consider material usage and embodied carbon emissions - go with what's most materially efficient with low-emission concrete that minimizes cement content.
2279649	The considerations of the bridge and pedestrian mobility design appears to be excellent. The design team has taken various factors into consideration which should benefit the users and community for years to come. As the structural elements of the proposed bridge are concrete it is imperative that the reduction of embodied carbon (cement consumption) through concrete mix-design be undertaken by the design team for climate betterment.
2285017	First, please post on this website all the supporting documentation for your estimates of the higher costs for rehab of the existing bridge. Second, please also post any environmental and cultural resource impact analyses that have been done, along with the engineering/structural inspection reports on the existing bridge. The bridge is a contributing feature to the National Register Historic District in Zilker Park. It is also a state recognized archeological district because of the extensive Native American relics that have been found, the records of Native Americans at the springs, and the creek is a unique habitat for fish, water birds, and other species. All of these would be damaged or lost if the current bridge is replaced with a new one. Demolition and construction of a new bridge will cause substantial harm and this needs to be fully evaluated in advance and subject to public input. The current historic bridge is beautiful and much loved, especially by all of those who walk, paddle, and swim below the bridge. It should be preserved and rehabilitated. I don't see how it would be necessary to completely rip up the decking with explosives rather than reinforce what is there. Heavy truck traffic should be directed to other routes so that such extreme measures are not needed. More can be done to route bike and ped traffic away from the bridge, including to the expanded bike/ped bridge proposed downstream of the Barton Springs Road bridge. We are losing too much of Austin to the generic, construction obsessed engineering/construction/debt financing industry that has too much influence on local government. Please preserve this bridge -- and change your presentation to emphasize its historic value instead of your obvious message of it being "old" and needing replacement.
2285026	The fact that the presentation completely fails to feature or even mention that the bridge is a contributing feature to the Zilker Park National Register Historic District makes abundantly clear that entire presentation is biased and untrustworthy. Shame!!!

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2285555	I urge the City to replicate the bridge crossing Barton Creek, entering Zilker Park from the east. It is a historic structure and deserves that kind of respect. Also, I would ask that the city follow the beam design used in the Ann Richards bridge over Lady Bird Lake to make it appealing to Mexican free-tailed bats as a roost site.
2285559	We urge consideration of alternatives to demolishing the bridge, including rehabilitation of the current bridge structure. Barton Springs Road Bridge is an important contributing resource to the Zilker Park Historic District, and any construction in this environmentally sensitive area is ill advised and damaging.
2285561	Why would you destroy a historic bridge and risk damaging the springs when it's more cost effective, more aesthetically pleasing and appropriate, and far and away the more popular option to repair it?
2285562	The bridge is a work of art and a historical landmark. This would be the first move to reconstruct the entire historic park. Fix it yes, but leave the design as is. It's a work of art.
2285565	Please don't destroy this historic bridge.
2285568	The bridge must be preserved and NO widening of the space, this would be a disastrous impact on the natural space. We should be encouraging people to use fewer cars in this environmental jewel not more.
2285569	Please don't destroy.
2285576	I abhor the thought of construction over Barton Creek. Please keep it at a minimum to avoid further damage to the ecology of the creek and its surroundings. The historic character of the bridge should be saved!
2285578	I would prefer to see the existing bridge restored as I feel it part if the history for Zilker Park and the Zilker neighborhood. Any proposal should put focus on making sure the project is safe for this environmentally sensitive area above all else. I believe a complete demolition and redesign would be a loss of history and have negative effects on the spring/waterway.
2285584	I would prefer the city fix up the existing Barton Springs Road bridge than wasting money on a new one.
2285602	As someone who was born and raised in Austin, and who has lived here my whole life, it saddens me to see such a strong desire by the city to turn Zilker park and the surrounding area into a hideous commercial zone. Austin is rapidly growing and obviously change comes with that growth, but your recommendations all look like bridges you would see driving down an interstate highway. These designs take away an iconic part of one of the most beautiful locations in all of Austin. Those who hike the trail and kayak Barton creek will have to put up with this ugly design, and the obliteration of a historical site for generations to come. please do not let that happen.
2285616	Please don't change the Barton Springs/Zilker bridge!
2285635	The historic bridge is deeply beautiful - a monumental vestige valued by residents and well worth historic preservation treatment. I agree with the commenters below who urge you to rise to the engineering challenge of renovation to combine efficiency while conserving the iconic arches and the original bridge over Barton Creek. The much loved bridge and park signal human recreation and the thrill of adventure on the City's cherished, spring fed waterway.
2285644	I would like to see a replacement that is visually appealing including from the water - so many people spend time floating and paddling on Barton Creek, on the trail, etc. The existing bridge design is iconic and if it can't be restored and updated, please choose a design that is a fitting entrance to Zilker
2285653	The new bridge design purposed doesn't reflect the standard of the current bridge and would diminish the beauty of Zilker. Please rehab the current bridge or if it needs replaced, add more architecture like arches to better reflect the creek/park. A basic bridge at a non basic location isn't acceptable.
2285669	The bridge is amazing, a treasure. It has character, seems to be functioning just fine, and there's no need for construction in this area. Do things that make sense! Not just doing stuff for the sake of doing! It makes no sense to remove a functioning bridge that has history and character and replace it with some modern generic architecture. It will cause massive headaches for traffic and distress to the ecosystem. Horrible plan—unnecessary, wasteful, irreverent. Scrap the plan, not the bridge.
2285704	For me, the proposed new designs are not compatible with the history and charm of the park and springs. For one it would be impossible to see the creek when crossing as one can now with the old bridge. I also believe it to be counter productive to narrow the road to two lanes and unwise to have any and especially parallel parking on the side of Barton Springs Road. In my opinion most of the park is just fine as it is.

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2285705	Yes, the new bridge design proposal is not in synch with the character of the park or the city. It would eliminate an historic structure and replace it with something that is ugly, cold and out of scale. Please consider alternatives to demolishing the bridge, including 1.) rehabilitation of the current bridge structure. Barton Springs Road Bridge is an important contributing resource to the Zilker Park Historic District. Finally, any construction in this environmentally sensitive area is risky and potentially damaging. Let's find a new solution that embraces and preserves and enhances what is already there rather than destroys it. thank you.
2285720	Please stop the destruction! Do not tear down Barton Springs Rd bridge. just stop everything. no move pavement. no.
2285721	Do not replace the historic bridge. If people need more access, let the city planners put a remote parking area in Westlake Hills and have a consistent shuttle bus that takes people in and out of the park. Just because Austin is booming, doesn't mean that we have to destroy beautiful things that we know and love.
2285735	Please consider alternatives to demolishing the bridge, including rehabilitation of the current bridge structure. The Barton Springs Road Bridge is an important contributing resource to the Zilker Park Historic District, and any construction in this environmentally sensitive area is ill advised and damaging.
2285765	I love the new lanes for bikers and walkers! I hope the City can improve the looks of the new bridge. The proposed one lacks charm and design elements fitting for our great city.
2285788	I know Austin can do better than to replace a bridge with character with one utterly devoid of same.
2285917	Please consider not demolishing the bridge, but instead rehabilitating it. The Barton Springs Road Bridge is an important contributing resource to the Zilker Park Historic District. Also there may be environmental damage if the city tears down the current bridge. These changes will also hinder access to the park.
2286077	It's great that the new bridge will have safe, separated bike and pedestrian/multiuser lanes. However, it's dismaying that Austin is proposing to replace the current beautifully designed bridge with a boring, unremarkable design. If it's too costly to restore and expand the original bridge, at least invest in rethinking the lackluster designs and presenting one with character that befits this important location as a gateway to Zilker Park.
2286080	As a native Austininte, I've always adored this beautiful bridge! My vote would be to maintain the historic bridge rather than tearing it down. Others have made intelligent comments I agree with as to why that is the best path forward.
2286096	Please consider alternatives to demolishing the bridge, including rehabilitation of the current bridge structure, the Barton Springs Road Bridge is an important contributing resource to the Zilker Park Historic District, and caution them that any construction in this environmentally sensitive area is ill advised and damaging. Thanks you , Amansa.
2286113	I don't mean to be disrespectful, but I really don't understand how the city of Austin keeps proposing to do cheap, tacky things with and around bridges. Bridges are key signifiers of character; they make the difference between feeling that you're in a noble human city or a martian asylum. It's like civic design 101... Please respect the spirits of the citizens & visitors here and renovate, reproduce, or elaborate on the current bridge's design. Thank you.
2286122	I urge the city to please take a step back and try again. The designs presented, and particularly option three that is recommended, are uninspiring and a disappointing design for such a culturally and environmentally significant area of our city. From an environmental perspective the team should account for the full environmental risks of building in the creek, and well as the lifecycle environmental (and carbon) burden of what is demolished and the materials that must be created in a new design. Does the current pricing of demolishing the existing bridge address the complexity of demolishing the existing bridge over the creek? Does it address any social cost of downtime to the creek and trail? From an aesthetic perspective "paying homage" to the original bridge should involve far more than simply incorporating curves into the sub structure of what is otherwise a fairly standard TxDOT deck structure. The resulting design is something that can be found at suburban freeway interchange, not the gateway to a park

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	visited by thousands and a span that is experienced on foot or on water from both above and below. The level of design should be commensurate with significance of this location. I encourage the city to study precedents for saving, or recreating, high profile historic bridges (for example the rehabilitation of the Swift Island Arch Bridge in North Carolina, or the widening of the Thurston Avenue arch bridge in New York – both of which are award winning). Here it feels like the team tried to find reasons to demolish the existing bridge rather than save or supplement it. The city of Austin can, and should, do better than this. Yes, the selected alternative may be the cheapest of those presented, but is the gateway to Zilker Park and over Baron Creek the place where we want to leave our future generations the cheapest solution? One place to start would be to convene a peer review, by a design team experienced in historic bridge rehabilitation to ensure that all solutions have been adequately addressed.
2286178	Please consider to augment the existing bridge to give better walking and bike access. I strongly suggest unwise, more costly and more waste of materials and environmental negative impact building a new bridge.
2286206	Please do not tear down the historic Barton Springs Road Bridge. It has welcomed Austinites and visitors to the soul of the city. Each loss of a bit of fabric of Austin's soul makes it easier for developers to pillage our fair city. The generic replacement proposed is a travesty.
2286334	I'm going to repeat the wise words I read below if for no other reason you will read them twice for it extra deep consideration: An "Environmental Constraints Map" is no substitute for actually studying the construction methodologies needed to build the various options, which has a substantial impact to the process of choosing the design option that least impacts the creek environment, being by far the most important consideration here. Recommending an option that requires demolishing 8 existing bridge piers and adds 8 new bridge piers in the creek is an absurd outcome to this process. Preservation of the existing historic bridge must be a priority, and any widening should avoid touching the creek. There are absolutely ways to do this, and they will absolutely cost more than the basic "TxDOT bridge + aesthetics" recommended here that is no doubt the cheapest option, in every sense of that word. This study fails to look at the important issues at one of the most treasured sites in Austin. Try again and do better!!
2286338	AMEN
2286341	Do not touch our delicate Creek!
2286356	Clearly written by a bridge rebuild team member.
2286361	Yes! Transparency and non-biased approach would be appreciated by those of us who love this park, it's historic relics and it's delicate environment.
2286369	WTF? City of Austin! Can't we celebrate something with character that still actually exists for a change in this Poor old one horse town with too many people in it…?
2286370	Everything is become a fight with this city to maintain its character. That's what's really weird about Austin Texas.
2286371	Thank you for the thoughtful reply!
2286377	Your design idea looks terrible. Where is the creativity? If this needs to be done, please create something better than that beautiful bridge we currently have.
2286466	Park of the beauty of Zilker Park is the history. Park of the charm of Austin is also our history. One of the reasons people visit Zilker is for the beauty. Please don't replace a lovely historical structure with the structure that is planned.
2286534	Please do not deconstruct this bridge in this area. It will harm the water quality and likely hurt species who depend on the lake and the bridge.
2286544	I prefer rehabilitation/reconstruction of existing bridge, and separate bridge for pedestrians, bikes. The Historic arches Must be preserved/replicated... The drawings of the various alternatives were hard to decipher on my computer screen... I could not distinguish the current location of the Zilker Zephyr tracks on the drawings, and the existing walkways, trails were also difficult to discern. Are there any archived documents about the ORIGINAL Bridge, and who designed it and who built it???? (Seeing the proposed "NEW" bridge, I am reminded of the drawings of the proposed replacement for the Emmet Shelton Low Water bridge ... drawings

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	that I strongly oppose as absolutely too big, and not complementary to the "environment" of that upper portion of Lady Bird Lake).
2286572	Please make necessary repairs to the road and bridge but consider maintaining what is currently in place. The area is a main thoroughfare for residents and is environmentally sensitive. Please consider repair over demolition. Barton Springs Road Bridge is an important contributing resource to the Zilker Park Historic District and construction in this environmentally sensitive area should be kept to a minimum! Period.
2286863	One of The main reasons that Austin has such a unique personality is because of the charm and original esthetics that the city is slowly but surely eradicating! It's so shameful this modernization of the bridge design is hideous and definitely not in sync with the whole natural/ green esthetic of Zilker park & the cool vibe of Barton Springs, stop ! It's become evident allover Austin , the modernization and overbuilding including the Rainey Street mess of skyscrapers and the eradication of cool venues and stores from Congress St . Now the city is going to ruin Zilker area!
2286911	Please reconsider destroying our beautiful bridge and consider improvements. I live in Barton Hills and I see the bridge on a daily basis. I hate that new looking bridge. Thanks for your consideration. Debra Austin
2287173	So there's plenty of money to spend on Waterloo Park and other parks around Austin but not on the Crown Jewel silker Park? This is ridiculous. Please reconsider your plan to replace this historic Bridge with yet another generic overpass type structure
2287743	It's always important to remember Austin's historic roots. Physical structures play a literally concrete role in keeping these beginnings alive! The Barton Creek Bridge is such a structure that should be preserved as it is part of the Zilker Park Historic District. Instead of eliminating history, by replacing this bridge with a generic piece of meaningless concrete, rehabilitation of the current bridge would have less harmful impact to this environmentally sensitive and keep Austin's history alive and in public view.
2287811	Do not take away the bridge. It is part of the charm of Zilker.
2287876	Please do not take out the historic bridge! Boring new holes for a new bridge poses serious environmental risks. Additionally public works projects take an eternity to complete, especially downtown, and it will only make traffic by every method worse.
2287880	Think of the environmental damage of constructing a new bridge??? NO
2287886	Please make the RIGHT decision here, and maintain the old bridge! A new bridge will unnecessarily upset the Barton Springs ecosystem, and the updates design is boring and doesn't contribute to Austin's character.
2287887	Don't do it please. We don't need a need bridge. At least let the bridge turn 100 years old. -Lifelong Austinite.
2287890	How about, NO! Quit changing everything that makes Austin, Austin.
2287907	Oh wow so we can fix the bridge for that's been just fine for 100 YEARS for a minimal amount of money!! In trade for a modern generic design that cost 36 million dollars and a 75 year guarantee, yea, that makes tons of sense.
2287911	This bridge is our heritage. Provide regular maintenance. Don't replace the bridge. Contractors surely salivating at a bridge replacement contract, don't buckle to the pressure. Honor and respect our heritage and our historical architecture.
2287919	My biggest concern is the impact this will have on our already polluted waterways and ecosystems. If Austin is actually invested in protecting our green areas, they will do as minimal work as possible on this bridge and redirect those funds towards runoff and erosion mitigation. Our riparian areas are such delicate, yet extremely important pieces to our waterways. Water is literally life and we are doing nothing to protect it, then have the audacity to wonder why the world is in the state that it is. This is preventable. Keep the historic bridge, repair the areas that TRULY need the most amount of help, and apply the money saved towards protecting our parks—not capitalizing on them.
2287921	Agreed
2287925	The bridge will be a historical marker in just 3 years! It would be a shame to tear down a piece of history.
2287932	The current bridge is historic and beautiful and set in the heart of so many who enjoy the area. The new bridge design is pretty bleak by comparison. It will be a substantial loss if it goes ahead per current intentions, just

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	another piece of classic Austin demolished to make way for something with substantially less personality and heart.
2287948	Over the past 25 years, my family and I have frequently enjoyed all the wonders of Zilker, Barton Springs (and still do) and feel strongly against the generic design proposal. Please don't threaten this already over-used ecosystem with unnecessary building just for the sake of commercial ventures who want to do more business in the park. Please preserve at least a bit of the quirky old Austin. The rest is getting coiffed pretty quickly. Thank you.
2287970	I have been an Austin resident for 29 years and think this plan (along with the entire Zilker "vision plan") is the biggest waste of city resources that I have ever seen. Leave Zilker alone!
2287987	Please make the environmentally responsible decision to make upgrades to the current structure of the bridge vs completely replacing. It's important to maintain the history as well. Thank you.
2288004	Austin is drenched in character. When you start to remove old, historic fixtures like this bridge, the character will go away with it. When unnecessary changes are made to infrastructure like this, the bones of this city's character begin to chip away, unrecoverable. We do not want this new bridge. We love the old bridge. The people of this town love Austin like family. We need to treat it like an old family member, and not a like a bachelor pad for weekend visitors. Please please do not make this city into something it isn't for the sake of money (or anything else). There are bigger issues at hand. If you change the bridge and the park and everything else sacred to this town, then there will be no Austin left. There will just be a shell of a town that was once really special.
2288006	Seriously, no one from this town wants a historic bridge ripped out. Visitors like historic infrastructure too. That's something to visit. Also the best thing for the environment would be to leave it alone and not build anything else, ESPECIALLY if it isn't needed.
2288007	To take down any historic and still functional part of this beautiful town's history would be a huge misstep. Austin is a captivating and welcoming city to people who love and appreciate nature, history, and community. Do not take away part of what makes this town what it is. The new bridge design is a rude slap in the face to those who first crafted this wonderful city scape. Listen to the people and do what's right for this community. Build up the current bridge to accommodate the new needs of the city. Please do not keep trying to tear down, pollute, and ruin what makes Austin amazing.
2288026	Please do not destroy our sacred Springs for your financial gain. Our waters have already endured enough pain and suffering. enough is enough.
2288059	This bridge has been around for nearly 100 years. Please don't replace such a beautiful bridge with another soulless insulation of the new Austin. Please preserve the history instead of tearing it down.
2288061	The proposed design lacks creativity and community which are things Austin is known for. Please reconsider the design while keeping in mind transit friendly options. I don't want my tax dollars wasted.
2288084	Reassess removal and hire a different designer-this proposed bridge is not worthy.
2288085	The bridge design must be part of the greater Zilker Park Vision Plan and Austin transit strategy. There are too many conflicting things here (e.g., Barton Springs down to one lane with a two land bridge?). Zilker Park and Barton Springs are the crown jewel of Austin, why not make it beautiful? These designs are not beautiful.
2288086	I am opposed to the design of the new bridge. The historic bridge should be maintained, not demolished.
2288088	Very unhappy to hear about the new proposal. This bridge is such a beautiful piece of Austin's wonder park. Please don't tear this down
2288090	I'm on it or under it at least twice a week. Bridge needs to be widen for everyone - vehicles, runners, bikers, etc. safety. Span structure can be made more aesthetically pleasing from below and above. Have a contest and popular vote!
2288091	Not only is the proposal of the new bridge aesthetically horrible looking, this is a completely unnecessary undertaking and use of tax funds. The current bridge functions well, is structurally sound, and serves the needs of the area. Let's use these funds for more time sensitive matters that would improve the lives of Austinites vs yet another meaningless project that would divert traffic away from local businesses there on Barton Springs road for who knows how long. This is ridiculous.

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2288127	You people really want to get fired. First, you want to turn Zilker Park into a commercial entertainment center at the behest of Live Nation. Now this.
2288129	I like the idea of expanding the bridge for walkers and bikers, I am unhappy with the new bridge design though. I also don't think the construction of an entire new bridge would be ideal with the waterways/ecosystem below. Maybe rehab is too expensive, however I implore you to listen to the community feedback and find a way to do this sustainably and with minimal impact to the ecosystem without having to tear the bridge out completely and adding a new one.
2288130	Instead of a re-do, this feels like an opportunity to give the current historic structure a lift/rehab for far less money and build a proper pedestrian crossing with low environmental impact for bikes and walkers next to or near the bridge. The concerns in this community are safety for pedestrians and cyclists, and the environmental impact of any new construction.
2288143	Austin has lost SO MUCH of its character. Let's not whittle away at historic Barton Springs and Zilker Park areas. Rehab the old bridge and don't bore any new holes into this sacred, environmentally sensitive area.
2288152	I have been a resident of Austin and area for a half century. My children and grandchildren have been raised in Zilker Park. It is without doubt the crown of Austin. The bridge, which is the entrance to the park, is iconic. Replacing it with something modern and utilitarian will diminish the beautiful ambiance of the area. Please find a way to strengthen it without destroying its lovely character.
2288155	This is a bad idea. Don't do it! The standing bridge is a thing of beauty. Don't let it slip from our fingers.
2288156	This is a waste of public funds and should be rejected. Public funds should go towards construction that is NEEDED. We should not be wasting money to tear down historic landmarks that offer sufficient function.
2288163	The historic Barton Springs Road Bridge should be diligently rehabilitated and carefully maintained to preserve its architecture and beauty. The Bridge should facilitate pedestrian and bicycle access to and from Zilker Metropolitan Park. The Bridge and traffic lanes should not be widened or increased to expedite more vehicles or higher traffic speeds. Sidewalks to and from the Park should be widened and updated to meet ADA regulations. These sidewalks should include sidewalks on Barton Blvd. from Sunset Drive to Barton Springs Road and sidewalks on Lund Street from Bluebonnet Street to Azie Morton Road. A pedestrian hybrid beacon should be installed at the pedestrian crossing at Barton Blvd and Barton Springs Road. A pedestrian hybrid beacon should be installed at the pedestrian crossing at Lund Street and Azie Morton Road. Azie Morton Road should be updated to include a protected bicycle lane and ADA compliant sidewalks from Collier Street to Barton Springs Road.
2288164	Please preserve the current historic bridge. Make whatever minimum adjustments needed with utmost priority on environmental impact
2288167	Enough gentrification has been approved in the city which I have lived in for forty years . PLEASE DO NOT risk doing more harm to Barton Springs . Improve rather than destroy. Thank you.
2288169	As everyone else has already said, the design for the new bridge truly strips away what is beautiful about it. There is no homage to the historic district of our city in the new design. If we continue to make all new repairs of historic structures with this dull and boring aesthetic, we will have nothing left of the beautiful architecture of the past. Please do not underestimate the importance of aesthetics in architecture as some trivial matter that can be cut out for cost effectiveness; it is part of what makes a city unique and what makes the city's inhabitants happy to walk around and enjoy the land. Even more important than the aesthetics, however, is the environmental impact to the creek. This creek is a natural resource whose value is incalculable to the city and central Texas at large. Please, be more thorough with environmental impact studies and MINIMIZE new disturbances to the creek bed, such as boring new holes, etc. Out of all potential construction projects to skimp on these areas (environmental cautiousness, historical architecture preservation) this is NOT the one to choose. Please, for the sake of the community members who have voiced their opinions here and Austin's large

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	community of people concerned about the preservation of our beautiful groundwater resources - reconsider this proposal and do not go with the cheapest option which will endanger our water and city history.
2288190	Noting the historic character of the bridge, and realizing the the current bridge could be upgrade, I urge you not to replace the bridge with a generic design that will only encourage more traffic in the area.
2288203	please maintain the history and aesthetic of the bridge. Austin in unique. it's what we love about it. don't make everything here look like any other city. and please take into account the impact on the environment the construction would cause by replacing rather than repairing. not just the nature but all residents of Austin 2 and 4 legged spend time in the park and the water. we don't need any more pollution or harsh chemicals. my vote is no.
2288215	Thank you for wanting to improve this area. I have lived here since 66, and this intersection needs vast improvements. The new bridge drawing is awful. Adding a pedestrian bridge like Lamar /Pluger bridge seems better. Additionally the pedestrian areas needs improvement. Good luck
2288221	Although I like expanding the bridge for walkers and bikers, I am unhappy with the new bridge design proposals. They are forgettable and, as others have said, do not have any charm. I understand that rehab is too expensive, however I implore you to listen to the community feedback about the designs and use tax dollars to propose something more iconic that properly respects such an important part of the city. You are investing in a historical piece of Austin that touches both locals and tourists. It is as central as you get. It will be around long after we've all passed away. We need something more remarkable than what is being suggested.
2288238	Rehab the old bridge, no new bridge please.
2288258	I'm saddened by removal of historic infrastructure. Why do we need to create something less significant to everyone. Please preserve our beautiful and meaningful structures. Thanks.
2288307	Please don't eliminate this piece of Austin. So much is now unrecognizable.
2288320	I second this!
2288321	I agree!
2288322	I agree!
2288325	Please make every effort to maintain the existing bridge as is, it is a part of Austin and provides character to that spot.
2288326	Agree!
2288387	Hopefully, the historic bridge will be saved. Why not build a small pedestrian and bike bridge?
2288518	I just want to know why all of y'all are so damn hellbent on making Austin the most BANAL place on the face of the planet! It's pretty clear that none of y'all are actually FROM HERE because if y'all were then y'all would know better. And if y'all are from here and this is y'all's plan then…yikes. I guess you're basic as hell. This NATIVE AUSTINITE is irate and y'all are breaking my heart. Making this place more bland than white rice. Y'all SUCK.
2288585	Please do not replace the historic bridge into Zilker Park.
2288607	Yes, please leave this bridge just as it is. It's lovely and is historical. Leave it alone!
2288615	We need to preserve the identity and history of the Barton Springs bridge. The proposed replacement is an eyesore and would represent a big loss to the city.
2288781	Please reconsider the design of the bridge. It is my hope the design reflects the beauty and history of the Zilker Park. There are ways to move forward while honoring the history of the park and the history.
2288807	Please leave this jewel alone.
2288861	Please rehabilitate the current historical bridge. This will cause less environmental degradation than tearing out the bridge and boring holes in Barton Creek for a new bridge. The present bridge, built in 1926 is an important contributing feature of the Zilker Park National Register Historic District and should be rehabbed instead of

Respondent ID	Response
	being replaced. Preserving the present bridge is the most environment- and climate-friendly solution, in addition to preserving our local history.
2288889	Unless there is an engineering report that indicates that the bridge is unsafe and irreparable, the historic bridge must be repaired and preserved. Replacing the bridge will involve unacceptable levels of damage to the surrounding environment and wildlife and destroy a beautiful architectural treasure.
2288932	If the bridge is structurally sound leave it alone. The current bridge is iconic and beautiful. The proposed bridge is cold and lifeless. Leave it alone or at least redesign it. Of all the things Austin spends money on don't cheap out on the bridge. Do it right.
2288949	Just repair the existing bridge, there's no reason to destroy history for "modernization".
2289002	Please stop destroying our city, it's history and environment. Please restore the historic Barton springs bridge. Please plan for things like increasing population and climate change. Use our resources wisely. Care for our citizenry, land and other natural resources.
2289041	I am a born and raised austinite and i disagree with this!!!! Keep our history!
2289089	Rehabilitate the existing historical bridge!!! It's a defining feature of the park.
2289104	Why do we want to spend scarce money on replacing a beautiful and historic bridge that would damage Barton Creek in the process?!
2289206	I strongly discourage the reconstruction of the Barton Springs bridge. Not only will it lose the charm of the current bridge, but this will strongly impact the climate and ecosystem of one of the most important and sacred fresh water spring systems in Austin and Central Texas.
2289213	Keep the existing bridge: it is functional, beautiful, and of historic value. Keeping it will also reduce construction costs and environmental degradation which a new bridge would create.
2289243	While I think there should be changes made to the existing bridge, I don't think that the proposed design is the solution.
2289317	Please restore the old bridge or redesign this proposed, soulless eyesore; and /or add improvements to it rather than to destroy an attractive, historical bridge.
2289318	I wholeheartedly disagree with this project. It's Austin history, and I'd be willing to bet it's been in Austin longer than most of the project team! Please consider maintaining this fundamental and historic landmark that is a vital part of our beloved city. Keep Austin weird! Keep the bridge!!!
2289470	I am writing to request an extension of the comment period for the proposed demolition of the historic Barton Springs Road Bridge. As a person with disabilities and an advocate for disability rights, I am deeply concerned about the lack of compliance with ADA standards in the provided PDF documentation. Under the Americans with Disabilities Act (ADA) Title II regulations, public entities are required to ensure that their communications with individuals with disabilities are as effective as communications with others. The provided PDF documentation is not accessible for individuals with disabilities who rely on assistive technology to access digital content, including screen readers or text-to-speech software. This omission violates Section 508 of the Rehabilitation Act and the Web Content Accessibility Guidelines (WCAG) 2.0. As a result, I and others with disabilities are unable to access the information needed to provide informed feedback on the proposed demolition of the historic Barton Springs Road Bridge. This is a significant issue because we care deeply about this project and its impact on the environment and our community. Therefore, I respectfully request an extension of the comment period to allow for sufficient time to remedy the accessibility issues and provide accessible PDF documentation. This will ensure that all members of the public, including those with disabilities, have the opportunity to review the information and submit their comments on this important issue. Thank you for your attention to this matter.
2289474	I am writing to request an extension of the comment period for the proposed demolition of the historic Barton Springs Road Bridge. As a person with disabilities and a disability rights advocate, I am deeply concerned about the lack of compliance with ADA standards in the provided PDF documentation. Under the Americans with Disabilities Act (ADA) Title II regulations, public entities are required to ensure that their communications with individuals with disabilities are as effective as communications with others. The

Respondent ID	Response
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2289694	I oppose replacing the current historic bridge with the proposed planned design, it not worthy of the beauty of the creek or Zilker park. The existing bridge design is far superior not only aesthetically but also historically, please incorporate those materials and design into the new bridge.
2289784	I grew up in Austin and visiting Barton Springs and the bridge is not only a monument in my lifetime but many others as well, it has served as not only a work of art but an important part of the history of Austin. If the city of Austinis willing to spend more money replacing the whole bridge, I'd say instead of replacing it just repair the bridge and build a smaller bridge to the side for pedestrians/bikes. Thank you! From a concerned Austin native.
2289803	The existing bridge is more attractive than anything you're likely to produce in 2023. Austin is aces at putting things off - how many public processes for restoration/reimagining/simply sprucing up Zilker have come and gone over the decades, for the most part without result! - so if that's the best you can do, design-wise, best believe you should blow this project off for now.
2290047	30 year Austinite. I'm okay with a new bridge, but the new design is ugly. Y'all can do better. Please do better.
2290260	Make the environmentally responsible decision and maintain the current bridge structure
2290404	Don't tear it out and build a new one. That would disrupt Barton Springs. Just rehab the existing bridge.
2290627	Do not tear down a historic bridge! This is a fixture of Austin. Plus this kind of work will pose environmental hazards to the creek below. Seems like nothing is sacred in Austin anymore.
2290647	Did TXDOT provide the design for the replacement bridge? What an eyesore.
2290655	Whatever the city does, it should replace the light at the intersection of Azie Morton and BSR with a traffic rotary. This would make the intersection much safer and increase traffic flow. A rotary should also be installed on the west side of the bridge on Barton Springs Road to regulate traffic flow. With the use of multiple rotaries it would be possible to reduce BPR to one lane on each side through the park without slowing down the flow of traffic.
2290699	Please please please do not replace this beautiful and historic bridge! Please reinforce the original bridge rather than tear it down for a new one.
2290928	The entire existing point of the bridge is that it brings a collective recollection to what was before. It makes sense to update for bike usage for example, but an effort should be made to preserve its historic beauty above else. Let us be frank in saying that very few of what made Austin truly Austin remains. Efforts by our city to modernize have been confused with an erasure to our culture, and the reconstruction of this bridge with a soulless modern prop furthers this reality. I would like the bridge to remain as much as possible. It is unnecessary to replace a functioning part of history. This city doesn't need to be changed like those that are new to it demand. If you look to the locals, the ones who have been here you'll find one consistent consensus, we don't agree with this plan. Our voices have been silenced otherwise; we hope for this one historic landmark that you will allow them to be amplified.

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2291370	Wow ! I am going to join in with those folks writing in about how sad this "replacement bridge" is - it's challenging to describe how disturbingly ugly this bridge is. Especially as others mention that it is the "entrance" to Zilker park. If cost does not prohibit, simply rehab the old bridge - or as someone else mentioned, replicate the old bridge, with the addition of more walking/biking area. With all our modern technology this should certainly be a possibility.
2291720	Yes, Agreed!
2292113	The proposal to alter the character of the bridge entrance to Zilker Park is extremely short sighted. The original designers at least had the foresight to recognize the natural beauty of the creek and reflect that in their design.
2292176	Hello all - I would encourage all of you who have so eloquently commented here on the failures of this proposal to contact our local media outlets...Statesman, Texas Tribune, etc. and get some attention on this process so your voices are not ignored.
2292817	The bridge project should include provisions to accommodate future possibilities for the corridor cross-sections to the east and to the west. For example, the draft Zilker Park plan includes a two-lane roadway concept, which is a reduction from the current four-lane roadway. To the east, the painted bike lanes and narrow sidewalks don't adequately accommodate the current pedestrian and bicycle traffic, so a new configuration will be needed to meet existing and future needs. One proposal for Barton Springs Road to the east would be to convert one half of the roadway to ped & bike only and the other half (on the other side of the existing median) to a two-lane roadway.
2292832	Please maintain the beautiful bridge that holds so much charm and so many memories for so many families and individuals. Please reconsider.
2298318	Hello, I am in favor of making adjustments to the current historical bridge, without redesigning it totally. Marilyn Faulkner, 78704.
2301781	Thank you for moving forward with expanding and updating this bridge. I think the design is consistent with what is there and there is a need for the update!
2301831	Austin deserves an iconic, innovative bridge design, not a generic ugly industrial eyesore in the middle of a beautiful park. Also, please ensure that 2 lanes of traffic remain in both directions to avoid constant traffic jams and a hellish situation leaving and entering the neighborhood.
2310332	If you can just address the aesthetics of the selected option, you'll have a winner.
2314875	I agree with the following comment: An "Environmental Constraints Map" is no substitute for actually studying the construction methodologies needed to build the various options, which has a substantial impact to the process of choosing the design option that least impacts the creek environment, being by far the most important consideration here. Recommending an option that requires demolishing 8 existing bridge piers and adds 8 new bridge piers in the creek is an absurd outcome to this process. Preservation of the existing historic bridge must be a priority, and any widening should avoid touching the creek. There are absolutely ways to do this, and they will absolutely cost more than the basic "TxDOT bridge + aesthetics" recommended here that is no doubt the cheapest option, in every sense of that word. This study fails to look at the important issues at one of the most treasured sites in Austin. Try again and do better. The piers and the bridge can be rehabbed . Those who find the bridge difficult can walk their bikes on the historic bridge or cross the Lady Bird Lake/river at the Congress Bridge. Thank you for asking!
2315429	As someone who passes through over this bridge both for both recreational and commuting purposes, I like the proposal to create more space and make the bridge wider. I live in an adjacent neighborhood, and I know some of my neighbors are extremely attached to this bridge. Personally, I don't see any charm either passing underneath or passing over the current bridge. I think the replacement proposal is pretty solid, except that it doesn't include an eastbound right turn lane to access Azie Morten, which was something mentioned in the earlier slides. It would be a disappointment if that were left out. I'm also wondering how you expect to expand

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	so much to south without accounting for the steep and poorly retained slope on the SE corner of Azie Morten and Barton Springs Dr.
2321916	I think the new bridge looks fine. It's not anything special, but I think that people are overstating the significance of the existing bridge as some sort of gateway or notable location. It's nice, for sure, but I don't think it warrants several million dollars worth of decoration. The very wide sidewalk is excellent, along with the protected bike lanes. Seems like a worthwhile project to me.
2321955	Totally agree with thoughts on the aesthetics... although I don't think the Azie Morton right turn lane is necessary, given you'd have to give up pedestrian space or a bike lane for it, without widening the bridge even further. I like the new proposal, though!
2321970	For the well-being of all Austin citizens, please do not have ongoing construction on the Zilker Park bridge at the same time you are rebuilding the Red Bud bridge, and the traffic nightmare of rebuilding IH35 is in full swing, and there is major work on West Ben White Blvd ! Cross town traffic is already bad, but you could make it impossible for those who live, work, and/or shop in west Austin!
2321975	In my view as this project has been ongoing it really seems that the ZPVP is out of sync with this project. The proposal on Barton Springs Road to shrink the roadway then these thoughts of a new bridge. I do believe that bike ped bridges could be added that would allow the bridge to be rehabilitated. I had planned on going to the meeting tonight but it just isn't happening today. I have been aware for at least 15 years of this project and it seems odd about timing. I know the bridge isn't in the best of shape, but I would still rehab over replacement.
2321992	Why does bike ped have to be attached to the bridge. Could there not be adjacent bike ped bridges. I still am for rehabilitation.
2321998	Please do not jump on the "tear down all things old and replace them with an obnoxious modern design" band wagon. And yes, I'm in the demographic that you are tired of hearing from -- but, guess what--my demographic cares enough to respond!
2322008	Great to see the option to keep the road open throughout the construction, what about plans to ensure waterway route remains open throughout the construction? Has that been considered and will that occur to allow kayaks and canoes to continue throughout as well as those on run or bike paths under the bridge.
2322014	I attended the open house on 4/4 and thought the team presented a lot of great info on why they recommend replacing the bridge. The old one is falling apart and all things taken into consideration (cost, time, design, safety, environmental concerns) the recommended option is a new bridge. Lots of people are saying it's "historic " but it's also falling apart and dangerous. The design is nothing special, as it's a common bridge type of the era seen all over Texas. The reasons for building new far outweigh the reasons for keeping it. I have to use the bridge often and I for one am looking forward to a safer bridge, a safer intersection, and a bridge that has more room for bikes and ped traffic.
2322018	Make sure to coordinate the bridge improvements with the outcomes of the Zilker Park Vision Plan. Barton Springs Road is envisioned to be one lane in each direction, with a protected bike lane on each side. It is critical that the team coordinate so that the two projects are seamless.
2318177	Looks fine to me for the budget. It's not like we're designing the world trade center here. This is a good evolution of the design because a revolutionary design would probably be too unaffordable. Approved. Get it built.
2318182	I support this improvement project. I very much am fond of the current design and really would like to see the new bridge replicate as closely as possible the columns and arches that support the bridge. I would really be disappointed if the aesthetic changed, as it is part of the enjoyment of the trails to look up at that bridge.
2318291	Excellent Presentation! As a Zilker resident who lives off of Azie Morton, I STRONGLY prefer the replacement option. It gives for more flexibility to reallocating space and allows for some much-needed upgrades to the area. Plus it's the more cost-effective solution.
2318629	A primary traffic flow issue is the lack of a right-turn lane from Eastbound Barton Springs Road onto Azie Morton. Many, many people make this turn, and as the population of Zilker/Barton Hills increases with more intense building, even more will do so. It takes only one driver in the right-hand lane to stop all these turners at

Respondent ID	Response
	a red light, and at rush hour, the backup can (and usually does) extend beyond the garden center entrance. Can you find a way to accommodate a right-turn-only lane? The span designs under the bridge are all very stark and modernistic, particularly seen from upstream and downstream, where most people experience it visually. The modernistic styling is at odds with the design aesthetic of the park. Please search for a design that is more harmonious. The large trees at the west end of the bridge really set the aesthetic tone of entering the park. They are scheduled for removal or moving. If they could be moved minimally so that their presence still serves as a gateway, that would qualify as a very good thing. This is not to disparage the stone monuments. Those are wonderful too, and I'm glad to see them preserved.
2318666	There's virtually nothing mentioned in consideration to the impact on the environment that either plan will have. I highly doubt that the construction required for a replacement will remain in bounds. The idea that there is "probably no endangered cave ferns" in an area is insulting. Be certain.
2319068	All bridge options look good, so would prefer the cheapest option. Two-way bicycle lanes are also great. Having a large enough sidewalk down Azie Morton to bike on and connect to the all-ages networks. Physical protection for the bicycle lanes. I like the design that moves the sidewalk away from the road. Would like less car lanes if Zilker vision plan does a road
2319218	I favor the bridge replacement option; less costly, longer life expectancy, better constructability, improved mobility for bikes and pedestrians. I favor the 3-span replacement option. Definitely support the additional que for right turn traffic on Azie Morton to Barton Springs Road. Both the bridge and Barton Springs Road through Zilker Park need to remain four lanes of vehicular traffic (not the two-lane choke-down being proposed in the Zilker Vision Plan). Construction funding needs the city's priority, without further delay.
2320161	LEAVE THE BRIDGE ALONE! As Bob Anderson, who designed the new bridges told me, the old bridge isn't crying to be replaced or repaired right now. But a new one would be nice. I think the old bridge should be repaired because it's not beyond it. I also don't think the bike ped lances need to be added to the bridge since the bridge gets closed during ACL for bike ped only. Collisions don't happen at that intersection any more often than anywhere else. Do a study if you don't believe me.
2321060	Please consider the impacts to people and business that travel by water on Barton Creek to and from Ladybird Lake. Planning demolition during the colder seasons and not during spring and summer would help prevent massive changes to the use of the creek.
2321342	I really prefer any of the replacement options as this is really needed. Replacement is not only more functional - it's cost-effective.
2321555	Replacement solution seems optimal. It looks like 6 heritage trees are in the footprint of the new proposed bridge. Where are they to be relocated? Hopefully within the sight line of the bridge or in an area where the shared path users can benefit from the canopy shade. The renderings of the replacement are appealing. The more bike/ped traffic we can accommodate on the Barton Springs/Zilker Corridor, the better the experience for all. Thanks for hosting.
2321960	There's a lot of info here. I wish more people had come. To provide more info for the people who are against a new bridge, have you considered providing crash/accident statistics for the current intersection and creek crossing but they're having trouble envisioning how much safer and better it would be. BTW- I think the plans look great. A new bridge would be awesome.

Respondent ID	Response
	I would just like some info on timeline and potential impacts to park users so people can get used to the idea that there may be disruptions. The boating concessions on the creek and park activities need time to change programming.
2321994	I am a concerned citizen of Austin and I would like to voice my opposition to the Barton Springs Road Bridge proposed project. Austin has higher priorities for our infrastructure, such as making so many of our roads safer for pedestrians, transit riders, cyclists, and other micro-transit users like scooters. This bridge is structurally sound, making this project unnecessary. Rebuilding it would also have a detrimental environmental impact on our sacred Barton Springs Creek. We also don't want to induce demand for more polluting car traffic across Barton Creek and through the Zilker Park area, which would be a by-product of expanding/rebuilding this bridge. Thank you for your time and consideration of my comments.
2325011	The two existing bridges are well built and have a lot of remaining life. At several locations water has penetrated shallow cover over the rebar. The rebar has rusted and spalled the concrete. This is common for older concrete and can easily and economically be repaired. The required repairs represent less than $100,000 of work and, if maintained, the bridges can last for many more decades with very little maintenance. Tom Kam P.E.
2334451	As a part of this project - please please please widen the side path on Azie Morton as it approaches the bridge - cyclist/pedestrian conflicts there are super frequent and there is ample space to widen. A 10-foot shared use path would be enough!
2335209	Do not waste money and ruin a perfectly good setup. If the bridge needs shoring up, go for it, but don't lose the charm of the existing bridge.
2335210	How can we get the city to STOP trying to ruining Zilker park??? Build some restrooms. Put in a few water faucets. Stop trying to ruin an Austin gem!!!

austin MOBILITY BONDS

E-3 - Mobility Committee Presentation - May 2023

BARTON SPRINGS RD. BRIDGE
Mobility Committee Meeting

May 11, 2023

CAPITAL DELIVERY SERVICES

"Effectively and Efficiently Deliver Quality Projects with the Concept of Speed"

Barton Springs Rd. Bridge

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Nearly
100
years old
built in 1926

20,000
Vehicles per day

1946
Bridge Expansion

Key Entrance
to Zilker Park and for Major City Events

$36 million
Preliminary Funding Estimate (Construction + Soft Costs)

FUNDING SOURCE:
- Preliminary Design: 2012, 2018 and 2020 Bonds
- Design: 2020 Bonds
- Construction: TBD

Barton Springs Rd. Bridge

CAPITAL DELIVERY SERVICES

Goal During Construction

- ✓ Maintain all 4 lanes of traffic during construction
- ✓ Maintain the Azie Morton / Barton Springs intersection during construction

20,000
Vehicles per day on Barton Springs Road

- Important commuter route
- Key access to Zilker Park
- Access to many special events (Trail of Lights, Austin City Limits, Blues on the Green, Zilker Park)
- Access to Zilker and Barton Hills neighborhoods

Barton Springs Rd. Bridge

CAPITAL DELIVERY SERVICES

Coordination With Zilker Park Vision Plan

Team Coordination	✓ Project Managers for both projects attend meetings and provide updates to each other
Project Alignment	✓ Ensure preliminary bridge plans align with Zilker Park Vision Plan
Design Considerations	✓ Widen bike lanes and sidewalks on bridge ✓ Improve multi-modal connection into park
Public Input	✓ Completed public input (online and in person) for the initial recommendation

Barton Springs Rd. Bridge

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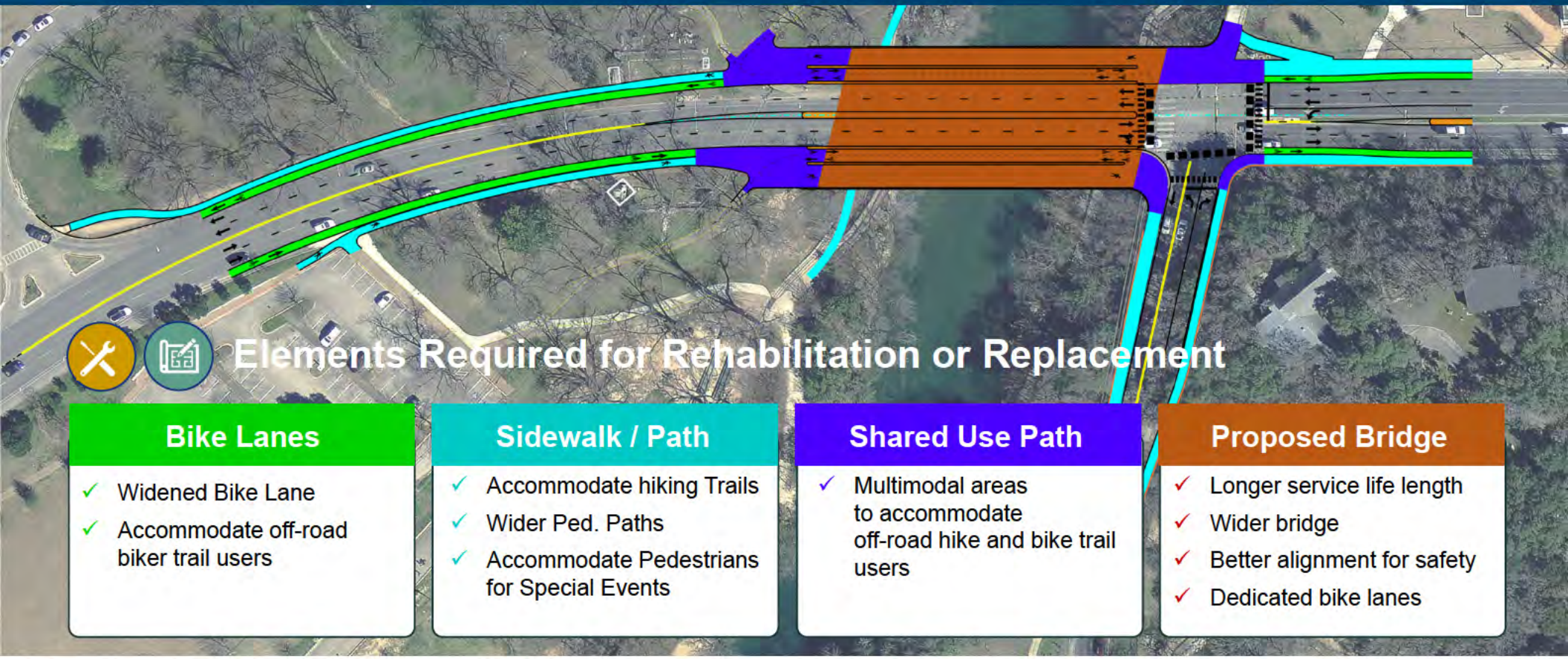


Elements Required for Rehabilitation or Replacement

Bike Lanes

- ✓ Widened Bike Lane
- ✓ Accommodate off-road biker trail users

Sidewalk / Path

- ✓ Accommodate hiking Trails
- ✓ Wider Ped. Paths
- ✓ Accommodate Pedestrians for Special Events

Shared Use Path

- ✓ Multimodal areas to accommodate off-road hike and bike trail users

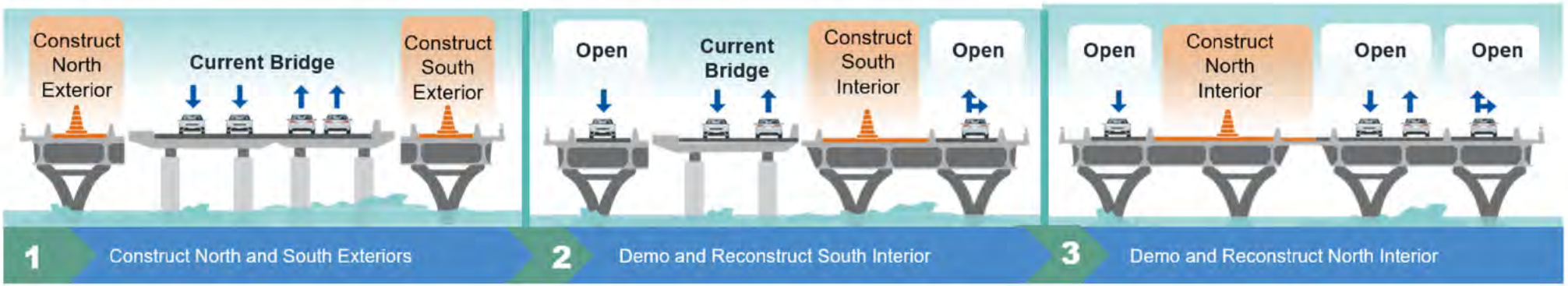
Proposed Bridge

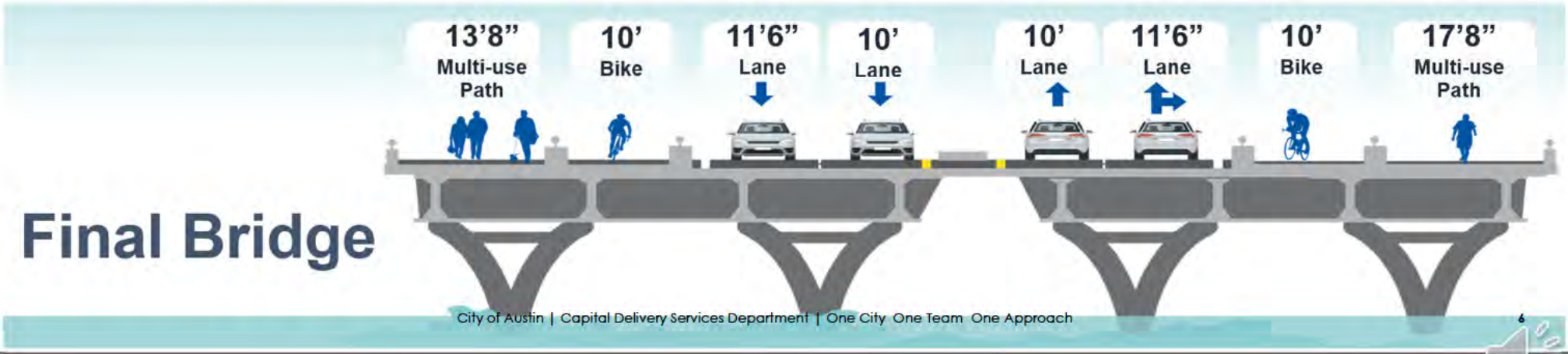
- ✓ Longer service life length
- ✓ Wider bridge
- ✓ Better alignment for safety
- ✓ Dedicated bike lanes

Barton Springs Rd. Bridge

CAPITAL DELIVERY SERVICES

Bridge Construction Phasing: 4 lanes open through construction





Barton Springs Rd. Bridge

CAPITAL DELIVERY SERVICES

PROJECT OPTIONS

Barton Springs Rd. Bridge

CAPITAL DELIVERY SERVICES

Rehabilitation Options

1. **PRESERVE** existing structure, consider separate bike/ped structure (minimal rework - light touch)
2. **REHABILITATE** and widen deck to include bike/ped

Replacement Options

RECONSTRUCT BRIDGE completely and widen deck to include bike/ped

1. **One-Span** option

2. **Two-Span** option

3. **Three-Span** option

Barton Springs Rd. Bridge

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Bridge Structure Rehabilitation

1 Remove Existing Bridge Deck and Spandrel Columns

2 Remaining Portion of Existing Structure

3 New Components: Exterior Pairs of Arch Ribs, Spandrel Columns, Deck, and Abutment Extensions

Less than half of the original structure will remain

- ✓ Remaining historical structure will require refacing with new material surfaces
- ✓ View of historical structure will be mostly blocked by new structure
- ✓ Estimated cost of $19M

Barton Springs Rd. Bridge

CAPITAL DELIVERY SERVICES

Bridge Replacement Option Comparison

	1-Span	2-Span	3-Span
Structural Complexity	• Complex system	• Less complex • Uses conventional foundations	• Least Complex
Visual Openness	• Obstructed visuals • Views along center line maintained • Potential scour and bank/trail complexities	• More visually open than 1-span option • View along center of creek obstructed	• Most visually open • Clear views along center line of creek
Constructability	• Most complex to build • Requires temporary piers and falsework to make the arches	• Fewest number of foundations in water • Top of bridge requires specialty construction and falsework	• Specialty construction with fewest challenges
Initial Const. Cost (Bridge Only)	• $18.1M	• $13.6M	• $10.2M

Barton Springs Rd. Bridge

CAPITAL DELIVERY SERVICES

Rendering of Initial Recommended Bridge Replacement Option

Barton Springs Rd. Bridge

CAPITAL DELIVERY SERVICES

Rendering of Initial Recommended Bridge Replacement Option

Barton Springs Rd. Bridge

CAPITAL DELIVERY SERVICES

Preliminary Phase
2023

- PUBLIC MEETING — April 2023
- RESPOND TO PUBLIC COMMENTS — May 2023
- REFINEMENTS AND DISCUSSIONS — Summer 2023
- REPORTING CONCEPT ENGINEERING — Fall 2023

Design Phase
2023-2025

- 30% DESIGN
- PUBLIC MEETING (IF NEEDED)
- FINAL DESIGN AND PERMITTING

Construction Phase

- BIDDING AND CONSTRUCT. AWARD
- CONSTRUCTION

We are here!

QUESTIONS + ANSWERS

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"Effectively and Efficiently Deliver Quality Projects with the Concept of Speed"