U.S. Army Corps of Engineers (USACE)
Fort Worth District

Nationwide Permit (NWP) Pre-Construction Notification (PCN) Form

This form integrates requirements of the Nationwide Permit Program within the Fort Worth District, including General and Regional Conditions. Please consult instructions included at the end prior to completing this form.

Contents

DESCRIPTION OF NWP 14 – LINEAR TRANSPORTATION PROJECTS

Activities required for the construction, expansion, modification, or improvement of linear transportation projects (e.g., roads, highways, railways, trails, airport runways, and taxiways) in waters of the United States (U.S.). For linear transportation projects in non-tidal waters, the discharge cannot cause the loss of greater than 1/2-acre of waters of the U.S. For linear transportation projects in tidal waters, the discharge cannot cause the loss of greater than 1/3-acre of waters of the U.S. Any stream channel modification, including bank stabilization, is limited to the minimum necessary to construct or protect the linear transportation project; such modifications must be in the immediate vicinity of the project.

This NWP also authorizes temporary structures, fills, and work, including the use of temporary mats, necessary to construct the linear transportation project. Appropriate measures must be taken to maintain normal downstream flows and minimize flooding to the maximum extent practicable, when temporary structures, work, and discharges, including cofferdams, are necessary for construction activities, access fills, or dewatering of construction sites. Temporary fills must consist of materials, and be placed in a manner, that will not be eroded by expected high flows. Temporary fills must be removed in their entirety and the affected areas returned to pre-construction elevations. The areas affected by temporary fills must be revegetated, as appropriate.

This NWP cannot be used to authorize non-linear features commonly associated with transportation projects, such as vehicle maintenance or storage buildings, parking lots, train stations, or aircraft hangars.

Part I: NWP Conditions and Requirements Checklist

To ensure compliance with the General Conditions (GC), in order for an authorization by a NWP to be valid, please answer the following questions:

1. Navigation (Applies to Section 10 waters [i.e. navigable waters of the U.S.], see instruction 4 for link to list):

a. Does the project cause more than a minimal adverse effect on navigation?

☐ Yes ☐ No ☒ N/A

b. Does the project require the installation and maintenance of any safety lights and signals prescribed by the U.S. Coast Guard on authorized facilities in navigable waters of the U.S.?
☐ Yes ☐ No ☒ N/A

c. Does the Applicant understand and agree that if future operations by the U.S. require the removal, relocation, or other alteration of the structure or work herein authorized, or if, in the opinion of the Secretary of the Army or his authorized representative, said structure or work shall cause unreasonable obstruction to the free navigation of the navigable waters, the Applicant will be required, upon due notice from the USACE, to remove, relocate, or alter the structural work or obstructions caused thereby, without expense to the U.S.; and no claim shall be made against the U.S. on account of any such removal or alteration?
☐ Yes ☐ No ☒ N/A

If you answered yes to question a. or b. above, or if you answered no to question c. above, please explain how the project would be in compliance with this GC or be aware that the project would require an individual permit application: N/A

2. Aquatic Life Movements:

a. Does the project substantially disrupt the necessary life cycle movements of those species of aquatic life indigenous to the waterbody, including those species that normally migrate through the area? ☐ Yes ☒ No

b. Is the project's primary purpose to impound water? ☐ Yes ☒ No

c. Will culverts placed in streams be installed to maintain low flow conditions to sustain the movement of those aquatic species? ☒ Yes ☐ No ☐ N/A

If you answered yes to question a. or b. above, or if you answered no to question c. above, please explain how the project would be in compliance with this GC or be aware that the project would require an individual permit application: N/A

3. Spawning Areas:

a. Does the project avoid spawning areas during the spawning season to the maximum extent practicable? ☐ Yes ☐ No ☒ N/A

b. Does the project result in the physical destruction (e.g., through excavation, fill, or downstream smothering by substantial turbidity) of an important spawning area?
☐ Yes ☐ No ☒ N/A

If you answered no to question a. above, or if you answered yes to question b. above, please explain how the project would be in compliance with this GC or be aware that the project would require an individual permit application: N/A

4. Migratory Bird Breeding Areas:

a. Does the project avoid waters of the U.S. that serve as breeding areas for migratory birds to the maximum extent practicable? ☒ Yes ☐ No ☐ N/A

If you answered no to question a. above, please explain how the project would be in compliance with this GC or be aware that the project would require an individual permit application:
N/A

5. Shellfish Beds:

a. Does the project occur in areas of concentrated shellfish populations? ☐ Yes ☒ No

If you answered yes to question a. above, please explain how the project would be in compliance with this GC or be aware that the project would require an individual permit application:
N/A

6. **Suitable Material:**

a. Does the project use unsuitable material (e.g., trash, debris, car bodies, asphalt, etc.)?
☐ Yes ☒ No

b. Is the material used for construction or discharged in a water of the U.S. free from toxic pollutants in toxic amounts (see Section 307 of the Clean Water Act)? ☒ Yes ☐ No

If you answered yes to question a. above, or if you answered no to question b. above, please explain how the project would be in compliance with this GC or be aware that the project would require an individual permit application: **N/A**

7. **Water Supply Intakes:**

a. Does the project occur in the proximity of a public water supply intake? ☐ Yes ☒ No

If you answered yes to question a. above, please explain how the project would be in compliance with this GC or be aware that the project would require an individual permit application:
N/A

8. **Adverse Effects From Impoundments:**

a. Does the project create an impoundment of water? ☐ Yes ☒ No

b. If you answered yes to question a. above, are the adverse effects (to the aquatic system due to accelerating the passage of water, and/or restricting its flow) minimized to the maximum extent practicable? ☐ Yes ☐ No ☒ N/A

If you answered no to question b. above, please explain how the project would be in compliance with this GC or be aware that the project would require an individual permit application:
N/A

9. **Management of Water Flows:**

a. Does the project maintain the pre-construction course, condition, capacity, and location of open waters to the maximum extent practicable, for each activity, including stream channelization and storm water management activities? ☒ Yes ☐ No

b. Will the project be constructed to withstand expected high flows? ☒ Yes ☐ No

c. Will the project restrict or impede the passage of normal or high flows? ☐ Yes ☒ No

If you answered no to question a. or b. above, or if you answered yes to question c. above, please explain how the project would be in compliance with this GC or be aware that the project would require an individual permit application:
N/A

10. **Fills Within 100-Year Floodplains:**

a. Does the project comply with applicable FEMA-approved state or local floodplain management requirements? ☒ Yes ☐ No ☐ N/A

If you answered no to question a. above, please explain how the project would be in compliance with this GC or be aware that the project would require an individual permit application:
N/A

11. **Equipment:**

a. Will heavy equipment working in wetlands or mudflats be placed on mats, or other measures be taken to minimize soil disturbance? ☐ Yes ☐ No ☒ N/A

If you answered no to question a. above, please explain how the project would be in compliance with this GC or be aware that the project would require an individual permit application:
N/A

12. Soil Erosion and Sediment Controls:

a. Will the project use appropriate soil erosion and sediment controls and maintain them in effective operating condition throughout construction? ☒ Yes ☐ No

b. Will all exposed soil and other fills, as well as any work below the ordinary high water mark or high tide line, be permanently stabilized at the earliest practicable date? ☒ Yes ☐ No

c. Be aware that if work will be conducted within waters of the U.S., Applicants are encouraged to perform that work during periods of low-flow or no-flow.

If you answered no to question a. or b. above, please explain how the project would be in compliance with this GC or be aware that the project would require an individual permit application: **N/A**

13. Removal of Temporary Fills:

a. Will temporary fills be removed in their entirety and the affected areas returned to pre-construction elevations? ☒ Yes ☐ No ☐ N/A

b. Will the affected areas be revegetated, as appropriate? ☒ Yes ☐ No ☐ N/A

If you answered no to question a. or b. above, please explain how the project would be in compliance with this GC or be aware that the project would require an individual permit application: **N/A**

14. Proper Maintenance:

a. Will any authorized structure or fill be properly maintained, including maintenance to ensure public safety? ☒ Yes ☐ No

If you answered no to question a. above, please explain how the project would be in compliance with this GC or be aware that the project would require an individual permit application:
N/A

15. Single and Complete Project:

a. Does the Applicant certify that the project is a "single and complete project" as defined below? ☒ Yes ☐ No

Single and complete project:
Single and complete linear project: A linear project is a project constructed for the purpose of getting people, goods, or services from a point of origin to a terminal point, which often involves multiple crossings of one or more waterbodies at separate and distant locations. The term "single and complete project" is defined as that portion of the total linear project proposed or accomplished by one owner/developer or partnership or other association of owners/developers that includes all crossings of a single water of the United States (i.e., a single waterbody) at a specific location. For linear projects crossing a single or multiple waterbodies several times at separate and distant locations, each crossing is considered a single and complete project for purposes of NWP authorization. However, individual channels in a braided stream or river, or individual arms of a large, irregularly shaped wetland or lake, etc., are not separate waterbodies, and crossings of such features cannot be considered separately.

Single and complete non-linear project: For non-linear projects, the term "single and complete project" is defined at 33 CFR 330.2(i) as the total project proposed or accomplished by one owner/developer or partnership or other association of owners/developers. A single and complete non-linear project must have independent utility (see definition of "independent utility"). Single and complete non-linear projects may not be "piecemealed" to avoid the limits in an NWP authorization.

Independent utility: Defined as a test to determine what constitutes a single and complete non-linear project in the Corps regulatory program. A project is considered to have independent utility if it would be constructed absent the construction of other projects in the project area. Portions of a multi-phase project that depend upon other phases of the project do not have independent utility. Phases of a project that would be constructed even if the other phases were not built can be considered as separate single and complete projects with independent utility.

16. Wild and Scenic River:

There are no Wild and Scenic Rivers within the geographic boundaries of the Fort Worth District. Therefore, this GC does not apply.

17. Tribal Rights:

a. Will the project or its operation impair reserved tribal rights, including, but not limited to, reserved water rights and treaty fishing and hunting rights? ☐ Yes ☐ No ☒ N/A

If you answered yes to question a. above, please explain how the project would be in compliance with this GC or be aware that the project would require an individual permit application:
N/A

18. Endangered Species (see also Box 8 in Part III):

a. Is the project likely to directly or indirectly jeopardize the continued existence of a threatened or endangered species or a species proposed for such designation, as identified under the Federal Endangered Species Act (ESA), or will the project directly or indirectly destroy or adversely modify the critical habitat of such species? ☐ Yes ☒ No

b. Might the project affect any listed species or designated critical habitat? ☒ Yes ☐ No

c. Is any listed species or designated critical habitat in the vicinity of the project?
☒ Yes ☐ No

d. If the project "may affect" a listed species or critical habitat, has Section 7 consultation addressing the effects of the proposed activity been completed? ☒ Yes ☐ No ☐ N/A

If you answered yes to question a. or b. or c. above, or if you answered no to question d. above, please explain how the project would be in compliance with this GC or be aware that the project would require an individual permit application:
Please see Attachment F- Biological Assessment for the Sam Bass Road Widening Project within the USACE Fort Worth District that documents potential impacts, mitigation measures, and agency coordination for the Bone Cave harvestman (Texella reyesi) and Jollyville Plataeu salamander (Eurycea tonkawae).

19. Migratory Birds and Bald and Golden Eagles:

a. Does the project have the potential to impact nests, nesting sites, or rookeries of migratory birds, bald or golden eagles? ☐ Yes ☒ No ☐ N/A

If you answered yes to question a. above, you are responsible for contacting the appropriate local office of the U.S. Fish and Wildlife Service to obtain any "take" permits required under the U.S. Fish and Wildlife Service's regulations governing compliance with the Migratory Bird Treaty Act or the Bald and Golden Eagle Protection Act.

20. Historic Properties (see also Box 9 in Part III):

a. Does the project have the potential to cause effects to any historic properties listed, determined to be eligible for listing on, or potentially eligible for listing on the National Register of Historic Places, including previously unidentified properties?
☐ Yes ☒ No ☐ N/A

If you answered yes to question a. above, please explain how the project would be in compliance with this GC or be aware that the project would require an individual permit application:
N/A

21. Discovery of Previously Unknown Remains and Artifacts:
If you discover any previously unknown historic, cultural or archeological remains and artifacts while accomplishing the activity authorized by this permit, *you must immediately notify the district engineer of what you have found, and to the maximum extent practicable, avoid construction activities that may affect the remains and artifacts until the required coordination has been completed*. The district engineer will initiate the Federal, Tribal and state coordination required to determine if the items or remains warrant a recovery effort or if the site is eligible for listing in the National Register of Historic Places.

22. Designated Critical Resource Waters:
a. Will the project impact critical resource waters, which include NOAA-designated marine sanctuaries, National Estuarine Research Reserves, state natural heritage sites, and outstanding national resource waters or other waters officially designated by a state as having particular environmental or ecological significance and identified by the district engineer after notice and opportunity for public comment? ☐ Yes ☒ No

If you answered yes to question a. above, be aware that discharges of dredged or fill material into waters of the U.S. are not authorized by NWP 14 for any activity within, or directly affecting, critical resource waters, including wetlands adjacent to such waters.

23. Mitigation (see also Box 10 in Part III):
a. Will the project include appropriate and practicable mitigation necessary to ensure that adverse effects on the aquatic environment are minimal? ☐ Yes ☒ No

If you answered no to question a. above, please include an explanation in Box 10 of why no mitigation would be necessary in order to be in compliance with this GC or be aware that the project would require an individual permit application.

24. Safety of Impoundment Structures:
a. Has the impoundment structure been safely designed to comply with established state dam safety criteria or has it been designed by qualified persons?? ☐ Yes ☐ No ☒ N/A

If you answered yes to question a. above, non-federal applicants may be required to provide documentation that the design has been independently reviewed by similarly qualified persons with appropriate modifications to ensure safety. If you answered no, please include an explanation in Box 10 of why the structure is exempt from state dam safety criteria or be aware that the project may require an individual permit application.

25. Water Quality (see also Box 11 in Part III):
a. If in Texas, does the project comply with the conditions of the TCEQ water quality certification for NWP 14? ☒ Yes ☐ No ☐ N/A
b. If in "Indian Country," does the project comply with the conditions of the EPA water quality certification for NWPs? ☐ Yes ☐ No ☒ N/A
c. If in Louisiana, does the project comply with the conditions of the LADEQ water quality certification for NWP 14? ☐ Yes ☐ No ☒ N/A

If you answered no to question a. or b. above, please be aware that the project would require an individual permit application.

26. Coastal Zone Management:
The Fort Worth District does not cover any Coastal Zone; therefore, this GC does not apply.

27. Regional and Case-By-Case Conditions:
See the attached Regional Conditions checklist to ensure compliance with this GC.

28. Use of Multiple Nationwide Permits:

a. Does the project use more than one NWP for a single and complete project? ☐ Yes ☒ No

b. If you answered yes to question a. above, be aware that unless the project's acreage loss of waters of the U.S. authorized by the NWPs is below the acreage limit of the NWP with the highest specified acreage limit, no NWP can be issued and the project would require an individual permit application.

If you answered yes to question a. above, please explain how the project would be in compliance with this GC and what additional NWP number you intend to use:
N/A

29. Transfer of Nationwide Permit Verifications:

a. Does the Applicant agree that if he or she sells the property associated with the nationwide permit verification, the Applicant may transfer the nationwide permit verification to the new owner by submitting a letter to the appropriate USACE district office to validate the transfer?
☒ Yes ☐ No

30. Compliance Certification:

a. Does the Applicant agree that if he or she receives the NWP verification from the USACE, they must submit a signed certification regarding the completed work and any required mitigation (the certification form will be sent by the USACE with the NWP verification letter)?
☒ Yes ☐ No

31. Activities Affecting Structure or Works Built by the United States

a. Does the project temporarily or permanently alter and/or occupy a USACE federally authorized Civil Works project? ☐ Yes ☒ No

If you answered yes to question a. above, notification is required in accordance with general condition 32, for any activity that requires permission from the Corps. The district engineer may authorize activities under these NWPs only after a statement confirming that the project proponent has submitted a written request for section 408 permission from the Corps office having jurisdiction over that USACE project.

32. Notification:

a. Reason for notification:

☐ involves discharges into special aquatic sites; or
☐ is in excess of 500 feet in length; or
☐ will involve the discharge of greater than an average of one cubic yard per running foot along the bank below the plane of the ordinary high water mark or high tide line.

b. Does the Applicant agree that he or she will not begin the project until either:
1) He or she is notified in writing by the district engineer that the activity may proceed under the NWP with any special conditions imposed by the district or division engineer; or
2) 45 calendar days have passed from the district engineer's receipt of the complete PCN and the prospective permittee has not received written notice from the district or division engineer. However, if the permittee was required to notify the Corps pursuant to general condition 18 that listed species or critical habitat might be affected or in the vicinity of the project, or to notify the Corps pursuant to general condition 20 that the activity may have the potential to cause effects to historic properties, the permittee cannot begin the activity until receiving written notification from the Corps that there is "no effect" on listed species or "no potential to cause effects" on historic properties, or that any consultation required under Section 7 of the Endangered Species Act (see 33 CFR 330.4(f)) and/or Section 106 of the National Historic Preservation (see 33 CFR 330.4(g)) has been completed. ☒ Yes ☐ No

c. Does the Applicant agree that if the district or division engineer notifies the Applicant in writing that an individual permit is required within 45 calendar days of receipt of a complete PCN, the Applicant cannot begin the activity until an individual permit has been obtained?
☒ Yes ☐ No

NWP 14-specific requirements checklist:

1. Does the project involve the construction, expansion, modification, or improvement of a linear transportation project? ☒ Yes ☐ No

If you answered no to question 1. above, be aware that the project would not be authorized by a NWP 14 and may require an individual permit application.

2. Does the project cause the loss of greater than 1/2-acre non-tidal waters of the U.S. at any crossing considered a single and complete project? ☐ Yes ☒ No

If you answered yes to question 2. above, be aware that the project would not be authorized by a NWP 14 and would require an individual permit application.

3. If the project involves any stream channel modification, including bank stabilization, is it limited to the minimum necessary to construct or protect the linear transportation project, and are such modifications in the immediate vicinity of the project? ☒ Yes ☐ No ☐ N/A

If you answered no to question 3. above, be aware that the project would not be authorized by a NWP 14 and may require an individual permit application.

4. If the project involves non-linear features commonly associated with transportation projects, such as vehicle maintenance or storage buildings, parking lots, train stations, or aircraft hangars, would it use this NWP to authorize these features? ☐ Yes ☒ No

If you answered yes to question 4. above, be aware that the non-linear features of the project would not be authorized by a NWP 14 and may require an individual permit application.

5. Does each activity/crossing considered a single and complete project have independent utility?
☒ Yes ☐ No ☐ N/A

If you answered no to question 5. above, be aware that the project may require an individual permit application.

6. **a.** Will any temporary structures, fills, and work necessary to construct the project meet the criteria for maintaining flows, minimizing flooding, and withstanding high flows?
☒ Yes ☐ No ☐ N/A
b. Will temporary structures and fills be removed in their entirety, and the affected areas be returned to pre-construction elevations and revegetated, as appropriate?
☒ Yes ☐ No ☐ N/A

If you answered no to question 6a. or 6b. above, be aware that the project would not be authorized by a NWP 14 and may require an individual permit application.

REGIONAL CONDITIONS CHECKLIST

To ensure compliance with the Regional Conditions within the Fort Worth District, in the State of Texas, in order for an authorization by a NWP to be valid, please answer the following questions (for projects in Texas only):

1. Does the project involve a discharge into habitat types that are wetlands (typically referred to as pitcher plant bogs) that are characterized by an organic surface soil layer and include vegetation such as pitcher plants (*Sarracenia* sp.), sundews (*Drosera* sp.), and sphagnum moss (*Sphagnum* sp.) or wetlands (typically referred to as bald cypress-tupelo swamps) comprised predominantly of bald cypress trees (*Taxodium distichum*), and/or water tupelo (*Nyssa aquatica*)?
☐ Yes ☒ No

If you answered yes to question 1. above, notification of the District Engineer is required in accordance with NWP GC 32, and the USACE will coordinate with other resource agencies as specified in NWP GC 32(d).

2. Will the project include required compensatory mitigation at a minimum one-for-one ratio for all special aquatic sites that exceed 1/10 acre and require pre-construction notification, and for all losses to streams that exceed 300 linear feet and require pre-construction notification (unless the appropriate District Engineer determines in writing that some other form of mitigation would be more environmentally appropriate and provides a project-specific waiver of this requirement)?
☐ Yes ☐ No ☒ N/A

If you answered no to question 2. above, be aware that the project would not be authorized by a NWP and would require an individual permit application.

3. Is the project in the area of Caddo Lake within Texas that is designated as a "Wetland of International Importance" under the Ramsar Convention? ☐ Yes ☒ No

If you answered yes to question 3. above, notification of the District Engineer is required in accordance with NWP GC 32(d).

4. Is there is the risk of transferring invasive plants to or from your project site? ☐ Yes ☒ No

If you answered yes to question 4. above, information concerning state specific lists of invasive species and threats can be found at: http://www.invasivespeciesinfo.gov/unitedstates/tx.shtml. Best management practices can be found at Information concerning state specific lists and threats can be found at: http://www.invasivespeciesinfo.gov/unitedstates/tx.shtml. Known zebra mussel waters within can be found at: http://nas.er.usgs.gov/queries/zmbyst.asp.

5. Would your project meet the scope of work and conditions of NWPs 51 or 52? ☐ Yes ☒ No

If you answered yes to question 5. above, the Corps will provide the PCN to the US Fish and Wildlife Service as specified in NWP General Condition 32(d)(2) for its review and comments.

To ensure compliance with the Regional Conditions within the Fort Worth District, in the State of Louisiana, in order for an authorization by a NWP to be valid, please answer the following questions (for projects in Louisiana only):

1. Does the activity cause the permanent loss of greater than 1/2 acre of seasonally inundated cypress swamp and/or cypress-tupelo swamp? ☐ Yes ☐ No

If you answered yes to question 1. above, be aware that the project would not be authorized by a NWP 14 and would require an individual permit application.

2. Does the activity cause the permanent loss of greater than 1/2 acre of pine savanna, pine flatwoods, and/or pitcher plant bogs? ☐ Yes ☐ No

If you answered yes to question 2. above, be aware that the project would not be authorized by a NWP 14 and would require an individual permit application.

3. Has the activity been determined to have an adverse impact upon a federal or state designated rookery and/or bird sanctuary? ☐ Yes ☐ No

If you answered yes to question 3. above, be aware that the project would not be authorized by a NWP 14 and would require an individual permit application.

4. While Endangered Species Act Section 7 consultation is no longer required for the Louisiana black bear (which has been delisted due to recovery), permittees are advised that the Louisiana black bear is still protected under State of Louisiana law, and the Louisiana Department of Wildlife and Fisheries (LDWF) will continue to actively manage this subspecies. To learn more about State law requirements for Louisiana black bear protection and habitat conservation, permittees shall contact Maria Davidson (Louisiana Department of Wildlife and Fisheries - Large Carnivore Program Manager) at (337) 948-0255.

5. Does the project involve instream activities in the following waterways: Abita River and tributaries; Amite River (LA Highway 37 at Grangeville to Port Vincent); Bayou Bartholomew in Morehouse Parish; Bayou Boeuf and Bayou Rapides Tributaries in Rapides Parish: (Bayou Clear, Brown Creek, Burney Branch, Castor Creek, Clear Creek, Haikey's Creek, Little Bayou Clear, Little Brushy Creek, Loving Creek, Little Loving Creek, Long Branch, Mack Branch, Patterson Branch, Valentine Creek, and Williamson Branch), Bayou Rigolette tributaries in Grant Parish (Beaver Creek, Black Creek, Chandler Creek, Clear Branch, Coleman Branch, Cress Creek, Cypress Creek, Glady Hollow, Gray Creek, Hudson Creek, James Branch, Jordon Creek, Moccasin Branch, and Swafford Creek); Bogue Falaya River and Tributaries, Bogue Chitto River and Tributaries, Lake Borgne, Lake Pontchartrain and its tributaries, Lake Saint Catherine, Little Lake, Tchefuncta River, Little Tchefuncta River, the Rigolets and West Pearl River? ☐ Yes ☐ No

If you answered yes to question 5. above, notification of the District Engineer is required in accordance with NWP GC 32 due to the occurrence of threatened or endangered species.

6. To the best of the applicant's knowledge, is any excavated and/or fill material to be placed within wetlands free of contaminants? ☐ Yes ☐ No ☐ N/A

If you answered no to question 6. above, be aware that the project would not be authorized by a NWP 14 and would require an individual permit application.

7. Regional Condition 7 applies to work within the Louisiana Coastal Zone and/or the Outer Continental Shelf off Louisiana, and therefore does not apply in the USACE Fort Worth District. Work in these areas may require coordination with the USACE Galveston or New Orleans districts.

8. Does the activity adversely affect greater than 1/10 acre of wetlands, and/or adversely impact a designated Natural and Scenic River, a state or federal wildlife management area, and/or refuge?
☐ Yes ☐ No

If you answered yes to question 8. above, notification of the District Engineer is required in accordance with NWP GC 32.

9. For activities involving the installation of a culvert, is twenty percent (20%) of the culvert diameter (20 percent of the height of elliptical culverts) installed below the natural grade of the stream. ☐ Yes ☐ No

If you answered no to question 9. above, be aware that the project would not be authorized by a NWP 13 and would require an individual permit application.

10. Regional Condition 10 requires all linear transportation crossings to submit a PCN regardless of impact acreage, as defined in NWP GC 32. The U.S. Fish and Wildlife Service and National Marine Fisheries Service will be forwarded a copy of the PCN.

Additional Discussion:

The Pre-Construction Notification (PCN) is submitted in compliance with Nationwide Permit (NWP) General Condition 18 - Endangered Species. Specifically, this PCN represents the submittal by the non-federal permittee of a PCN to the district engineer when any listed species or designated critical habitat might be affected or is in the vicinity of the activity, or if the activity is located in designated critical habitat. The permittee shall not begin work on the activity until notified by the district engineer that the requirements of the Federal Endangered Species Act (ESA) have been satisfied and that the activity is authorized.

Part of the project area is located in Karst Zone 1, therefore, this will be coordinated under the ESA for potential direct or indirect impacts to Bone Cave harvestman and Jollyville Plateau salamander listed species. Additionally, the project is located within Critical Habitat Unit #1 (Krienke Spring) for the Jollyville Plateau salamander. The following discussion represents conformance with this coordination as outlined in NWP General Condition 18.

The name(s) of the endangered or threatened species that might be affected by the proposed activity or that utilize the designated critical habitat that might be affected by the proposed activity is/are Bone Cave harvestman and Jollyville Plateau salamander. Please see Attachment F- Biological Assessment for the Sam Bass Road Widening Project detailing identified conditions, pre- and post-construction best management practices to minimize impacts to the Bone Cave harvestman and Jollyville Plateau salamander, and project impact analysis for both species.

In cases where the non-Federal applicant has identified listed species or critical habitat that might be affected or is in the vicinity of the activity, and has so notified the Corps, the applicant shall not begin work until the Corps has provided notification that the proposed activity will have "no effect" on listed species or critical habitat, or until ESA section 7 consultation has been completed. If the non-Federal applicant has not heard back from the Corps within 45 days, the applicant must still wait for notification from the Corps.

Part II: Project Information

Box 1 Project Name: Corridor H- Sam Bass Road			**Applicant Name** Bill Gravell Jr.
Applicant Title County Judge			**Applicant Company, Agency, etc.** Williamson County
Mailing Address 710 S. Main Street, Ste. 101 Georgetown, TX 78626			Applicant's internal tracking number (if any)
Work Phone with area code 512-943-1550	Home Phone with area code	Fax #	E-mail Address
Relationship of applicant to property: ☐ Owner ☐ Purchaser ☐ Lessee ☒ Other: Owner Representative			
Application is hereby made for verification that subject regulated activities associated with subject project qualify for authorization under a USACE nationwide permit or permits as described herein. I certify that I am familiar with the information contained in this application, and that to the best of my knowledge and belief, such information is true, complete, and accurate. I further certify that I possess the authority to undertake the proposed activities. I hereby grant to the agency to which this application is made the right to enter the above-described location to inspect the proposed, in-progress, or completed work. I agree to start work only after all necessary permits have been received.			
Signature of applicant Bill Gravell Jr. Bill Gravell (Nov 24, 2021 07:33 CST)			Date (mm/dd/yyyy) Nov 24, 2021

Box 2 Authorized Agent/Operator Name and Signature: ***(If an agent is acting for the applicant during the permit process)*** Meghan P. Lind			
Agent/Operator Title Senior Ecologist/Project Manager		**Agent/Operator Company, Agency, etc.** Cox McLain Environmental Consulting, Inc.	
Mailing Address 8401 Shoal Creek Blvd., Suite 100, Austin, TX 78757			
E-mail Address meghanp@coxmclain.com			
Work Phone with area code (512) 338-2223	Home Phone with area code	Fax # (512) 338-2225	Cell Phone # (757) 376-9944
I hereby authorize the above-named agent to act in my behalf as my agent in the processing of this application and to furnish, upon request, supplemental information in support of this permit application. I understand that I am bound by the actions of my agent, and I understand that if a federal or state permit is issued, I, or my agent, must sign the permit.			
Signature of applicant			Date (mm/dd/yyyy)
I certify that I am familiar with the information contained in this application, and that to the best of my knowledge and belief, such information is true, complete, and accurate.			
Signature of authorized agent			Date (mm/dd/yyyy)

Box 3 Name of property owner, if other than applicant: See Attachment A ☒ Multiple Current Owners ***(If multiple current property owners, check here and include a list as an attachment)***	
Owner Title	**Owner Company, Agency, etc.**

Mailing Address	
Work Phone with area code	Home Phone with area code

Box 4 Project location, including street address, city, county, state, and zip code where proposed activity will occur:
South central Williamson County, north of Brushy Creek, south of Ranch-to-Market Road (RM) 1431, and generally located between Interstate Highway 35 and 183A. The project area runs along the existing Sam Bass Road between RM 1431 and Wyoming Springs Drive.

Nature of Activity (Description of project; include all features; see instructions)**:**
The proposed project would include widening the existing Sam Bass Road to accommodate additional travel lanes and a 10-foot wide shared use path. The shared use path is proposed north of Sam Bass Road from RM 1431 to east of Tonkawa Trail. The project would consist of approximately 25.7 acres of exisiting ROW and 14.4 acres of proposed ROW for a total of 40.1 acres.

Project Purpose (Description of the reason or purpose of the project; see instructions)**:**
The purpose of this project is to accommodate current and anticipated future traffic levels to provide reliable transportation for the citizens of Williamson County, TX.

Has a delineation of waters of the U.S., including wetlands, been completed? (see instructions)
☒ Yes, Attached ☐ No
If a delineation has been completed, has it been verified in writing by the USACE?
☐ Yes, Date of approved or preliminary jurisdictional determination (mm/dd/yyyy): USACE Project: SWF-2021-00230
☒ No

Are color photographs of the existing conditions available? ☒ Yes, Attached ☐ No
Are aerial photographs available? ☒ Yes, Attached ☐ No

☐ **Multiple Single and Complete Crossings** ***(If multiple single and complete crossings, check here and complete the table in Attachment D)***

Waterbody(ies) (if known; otherwise enter "an unnamed tributary to")**:** One waterbody, Dry Fork Creek, an intermittent tributary to Brushy Creek that exhibits a direct downstream connection to the Brazos River, a Navigable Water.

Tributary(ies) to what known, downstream waterbody(ies): Brushy Creek, San Gabriel River, Little River, Brazos River.

Latitude & longitude (Decimal Degrees):
30.538432, -97.751144

USGS Quad map name(s):
Round Rock and Leander, Texas

Watershed(s) and other location descriptions, if known:
The project is located within the San Gabriel (HUC 12070205) Basin.

Directions to the project location:
From the US Army Corps of Engineers Fort Worth Office, head south to I-35W South. Merge onto I-35 South south toward Austin and stay I-35 to Exit 256, RM-1431/Cedar Park. Merge south onto I-35 Service Road, then turn west on FM-1431/R. Whitestone Blvd for 4.1 miles. Turn left on Sam Bass Road, the existing Brushy Creek bridge is located 0.7 miles southeast the intersection of RM-1431 on Sam Bass Road.

Part III: Project Impacts and Mitigation

Box 5 Reason(s) for Discharge into waters of the U.S.:
To facilitate the project, a span type bridge will be constructed over Dry Fork Creek and the existing bridge class culverts will be removed to facilitate the expansion of the roadway.

Type(s) of material being discharged and the amount of each type in cubic yards:
Permanent impacts at Dry Fork Creek include 70 CY of clean native fill material for roadway embankment, channel re-alignment, and side slope construction, riprap, and bridge abutments.

Total surface area (in acres) of wetlands or other waters of the U.S. to be filled:
Permanent impacts at Dry Fork Creek include a total of 0.017 acres of impacts to intermittent stream. A total of 0.011 acres of current dry ground will be converted to stream bed to allow for the re-alignment of Dry Fork Creek at the bridge crossing.

Indicate the proposed impacts to **waters of the U.S.** in ACRES (for wetlands and impoundments) and LINEAR FEET (for rivers and streams), and identify the impact(s) as permanent and/or temporary for each waterbody type listed below. For projects with multiple single and complete crossings, the table below should indicate the cumulative totals of those single and complete crossings that require notification as outlined in Part I, GC question 32, and would not determine the threshold for whether a project qualifies for a NWP. The table below is intended as a tool to summarize impacts by resource type for planning compensatory mitigation and does not replace the summary table of single and complete crossings in Attachment D for those projects with multiple single and complete crossings.

	Permanent		**Temporary**	
Waterbody Type	**Acres**	**Linear feet**	**Acres**	**Linear feet**
Non-forested wetland	N/A	N/A	N/A	N/A
Forested wetland	N/A	N/A	N/A	N/A
Perennial stream	N/A	N/A	N/A	N/A
Intermittent stream	0.017	75	N/A	N/A
Ephemeral stream	N/A	N/A	N/A	N/A
Impoundment	N/A	N/A	N/A	N/A
Other:	N/A	N/A	N/A	N/A
Total:	0.017	75	N/A	N/A

Potential indirect and/or cumulative impacts of proposed discharge (if any):
Appropriate construction and stormwater BMPs will be utilized during construction and operation of the project to minimize indirect impacts to WOTUS.

Required drawings (see instructions):
Vicinity map: ☒ Attached
To-scale plan view drawing(s): ☒ Attached
To-scale elevation and/or cross section drawing(s): ☒ Attached

Is any portion of the work already complete? ☐ Yes ☒ No
If yes, describe the work: N/A

Box 6 Authority: (see instructions)
Is Section 10 of the Rivers and Harbors Act for projects affecting navigable waters applicable?
☐ Yes ☒ No ***(see Fort Worth District Navigable Waters list)***

Is Section 404 of the Clean Water Act applicable? ☒ Yes ☐ No

Box 7 Larger Plan of Development:
Is the discharge of fill or dredged material for which Section 10/404 authorization is sought intended for a linear transportation project which is part of a larger plan of development? ☐ Yes ☒ No ***(If yes, please provide the information in the remainder of Box 7)***
Does the linear transportation project have independent utility in addition to the larger plan of development (e.g., major arterial, through connection, etc.)? ☐ Yes ☐ No If yes, explain: N/A
If discharge of fill or dredged material is part of development, name and proposed schedule for that larger development (start-up, duration, and completion dates): N/A
Location of larger development (If discharge of fill or dredged material is part of a plan of development, a map of suitable quality and detail for the entire project site should be included): N/A
Total area in acres of entire project area (including larger plan of development, where applicable): N/A

Box 8 Federally Threatened or Endangered Species (see instructions)
Please list any federally-listed (or proposed) threatened or endangered species or critical habitat potentially affected by the project (use scientific names (i.e., genus species), if known): Bone Cave harvestman (Texella reyesi) and Jollyville Plateau salamander (Eurycea tonkawae). Critical Habitat Unit #1 at Krienke Spring for Jollyville Plataeu salamander.
Have surveys, using U.S. Fish and Wildlife Service (USFWS) protocols, been conducted? ☒ Yes, Report attached ☐ No (explain): Please see Attachment F- Biological Assessment for the Sam Bass Road Widening Project. SWCA conducted field assessments of the project area on March 7, 2019.
If a federally-listed species would potentially be affected, please provide a description and a biological evaluation. ☒ Yes, Report attached ☐ Not attached
Has Section 7 consultation been initiated by another federal agency? ☒ Yes, Initiation letter attached ☐ No
Has Section 10 consultation been initiated for the proposed project? ☒ Yes, Initiation letter attached ☐ No
Has the USFWS issued a Biological Opinion? ☐ Yes, Report attached ☒ No If yes, list date Opinion was issued (mm/dd/yyyy):

Box 9 Historic properties and cultural resources
Please list any historic properties listed (or eligible to be listed) on the National Register of Historic Places which the project has the potential to affect: Based on a review of THC's list of previously identified historic properties, no eligible properties have been recorded within the project vicinity.
Has an archaeological records search been conducted? ☒ Yes, Report attached ☐ No (explain): Please see Attachment G- Intensive Archeological Survey
Are any cultural resources of any type known to exist on-site? ☐ Yes ☒ No

Has an archaeological pedestrian survey been conducted for the site?
☒ Yes, Report attached ☐ No (explain): Please see Attachment G- Intensive Archeological Survey

Has Section 106 or SHPO consultation been initiated by another federal or state agency?
☐ Yes, Initiation letter attached ☒ No

Has a Section 106 MOA been signed by another federal agency and the SHPO?
☐ Yes, Attached ☒ No
If yes, list date MOA was signed (mm/dd/yyyy):

Box 10 Proposed Conceptual Mitigation Plan Summary (see instructions)

Measures taken to avoid and minimize impacts to waters of the U.S. (if any):
Impacts to WOTUS were avoided or minimized to the maximum extent practicable that still allowed for the construction of the project. These included locating bridge abutments, riprap, and native fill material outside of WOTUS where feasible. Where impacts were unavoidable, the impacts were minimized to the maximum extent practicable.

Applicant proposes combination of one or more of the following mitigation types:
☐ Mitigation Bank ☐ On-site ☐ Off-site (Number of sites:) ☒ None

Applicant proposes to purchase mitigation bank credits: ☐ Yes ☒ No
Mitigation Bank Name:
Number of Credits:

Indicate in ACRES (for wetlands and impoundments) and LINEAR FEET (for rivers and streams) the total quantity of waters of the U.S. proposed to be created, restored, enhanced, and/or preserved for purposes of providing compensatory mitigation. Indicate mitigation site type (on- or off-site) and number. Indicate waterbody type (non-forested wetland, forested wetland, perennial stream, intermittent stream, ephemeral stream, impoundment, other) or non-jurisdictional (uplands[1]).

Mitigation Site Type and Number	Waterbody Type	Created	Restored	Enhanced	Preserved
e.g., On-site 1	*Non-forested wetland*	*0.5 acre*			
e.g., Off-site 1	*Intermittent stream*		*500 LF*	*1000 LF*	
	Totals:				

[1] For uplands, please indicate if designed as an upland buffer.

Summary of Mitigation Work Plan (Describe the mitigation activities listed in the table above):
The project does not meet the NWP 14 impact threshold to require mitigation for aquatic resources, therefore, no compensatory mitigation is proposed.

If no mitigation is proposed, provide a detailed explanation of why no mitigation would be necessary to ensure that adverse effects on the aquatic environment are minimal:
No mitigation is required due to impacts to WOTUS not exceeding NWP 14 impact threshold.

Has a conceptual mitigation plan been prepared in accordance with the USACE regulations and guidelines?
☐ Yes, Attached ☒ No (explain): No mitigation is required.

Mitigation site(s) latitude & longitude (Decimal Degrees): N/A	USGS Quad map name(s): N/A
Other location descriptions, if known: N/A	
Directions to the mitigation location(s): N/A	

Box 11 Water Quality Certification (see instructions)**:**

For Texas:

Does the project meet the conditions of the Texas Commission on Environmental Quality (TCEQ) Clean Water Act Section 401 certification for NWP 14? ☒ Yes ☐ No

Does the project include soil erosion control and sediment control Best Management Practices (BMPs)? ☒ Yes ☐ No

Does the project include BMPs for post-construction total suspended solids control?
☒ Yes ☐ No

For Louisiana:

LDEQ has issued water quality certification for NWP 14 without conditions.

For Tribal Lands ("Indian Country"):

Does the project meet the conditions of the EPA water quality certification for NWPs?
☐ Yes ☐ No

Box 12 List of other certifications or approvals/denials received from other federal, state, or local agencies for work described in this application:

Agency	Approval Type[2]	Identification No.	Date Applied	Date Approved	Date Denied

[2] Would include but is not restricted to zoning, building, and floodplain permits

Part IV: Attachments

	Included
A. List of Property Owners	☒
B. Delineation of Waters of the U.S., Including Wetlands	☒
C. Color Photographs	☒
D. Summary Table of Single and Complete Crossings	☒
E. Required Drawings/Figures	☒
F. Threatened or Endangered Species Reports and/or Letters	☒
G. Historic Properties and Cultural Resources Reports and/or Letters	☒
H. Conceptual Mitigation Plan	☐
I. Other:	☐

End of Form

ATTACHMENT A
LIST OF PROPERTY OWNERS

Gessaman, Bruce and Carole
4500 Sam Bass Rd
Round Rock, TX 78681

Sibigtroth, James
2412 Walsh Road
Round Rock, TX 78681

Lindell, Kevin John
4605 Sam Bass Rd
Round Rock, TX 78681

ATTACHMENT B
DELINEATION OF WATERS OF THE U.S., INCLUDING WETLANDS

JURISDICTIONAL DETERMINATION REPORT: WILLIAMSON COUNTY CORRIDOR H – SAM BASS ROAD WILLIAMSON COUNTY, TEXAS

October, 2021

Prepared for USACE – Fort Worth District, K Friese and Associates, and Williamson County

COX | McLAIN Environmental Consulting

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1.0 Introduction and Purpose

Williamson County is studying Corridor H – Sam Bass Road between Ranch-to-Market (RM) 1431 and Wyoming Springs Drive as a part of their Long-Range Transportation Plan (hereafter referred to as the project area) (**Attachment A, Figure 1**).

The proposed project would include widening the existing Sam Bass Road to accommodate additional travel lanes and a 10-foot shared used path. The shared use path is proposed north of Sam Bass Road from RM 1431 to east of Tonkawa Trail. Right-of-Way (ROW) would be acquired from either side of the roadway. Several cross-drainage culverts would need to be extended to accommodate additional pavement width. The project would consist of approximately 25.70 acres of existing ROW and 14.40 acres of proposed ROW for a total of approximately 40.10 acres.

The purpose of this jurisdictional determination report (JD) is to identify, delineate, and describe potentially jurisdictional waters of the U.S., including wetlands, located within the project area and to request an approved jurisdictional determination from the United States Army Corps of Engineers (USACE) based on this assessment.

Section 404, subsection 330.5(a)(21) of the Clean Water Act regulates the discharge of dredged and fill material into wetlands and other waters of the U.S. Section 10 of the Rivers and Harbors Act of 1899 authorizes the USACE to regulate any work in or affecting navigable waters of the U.S. Authorization is required from the USACE for any activity that would result in the discharge of dredged or fill material into waters of the U.S.

<u>Project Information</u>

Project Location:	Western terminus: 30.543875, -97.760349 Eastern terminus: 30.5310888, -97.723037
Size:	2.38 mile in length, 46.29 acres
Counties:	Williamson County, Texas
USGS 7.5' Quads:	*Round Rock* and *Leander,* Texas (**Figure 2**)
Applicant:	Williamson County
Applicant Address:	710 S. Main Street, Georgetown, TX 78626
Applicant Contact:	Judge Bill Gravell, Jr. Phone: 512-943-1550

2.0 Methods

2.1 Data Review

Qualified wetland ecologists reviewed several published data resources prior to the field investigation to identify potentially jurisdictional waters of the U.S. within the limits of the project area. Sources consulted included: recent and historic aerial photography and topographic maps (**Figures 1** and **2**, and **Attachment E**), the U.S. Geological Survey (USGS) 7.5-minute quadrangle sheet (*Round Rock* and *Leander*, Texas) (**Figure 2**), a Geologic Atlas of Texas map (Austin sheet) (**Figure 3**), the Natural Resources Conservation Service (NRCS) Soil Survey for Williamson County (**Figure 4**), National Wetlands Inventory (NWI) maps (**Figure 5**), the National Hydrography Dataset (NHD) (**Figure 5**), and Federal Emergency Management Agency (FEMA) floodplain maps.

2.2 Field Delineation

Qualified wetland ecologists conducted field investigations within the project area in October 2018 and March 2019. The routine method of wetland delineation outlined in the *Field Guide for Wetland Delineation: 1987 Corps of Engineers Manual* (Wetland Training Institute [WTI] 1991) and updated in the Great Plains Regional Supplement (USACE 2010) was utilized for wetland determinations within the project area. Field activities focused on potential wetlands and waters of the U.S. delineation and documentation.

The *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987) defines wetlands based on three criteria: hydrophytic vegetation, hydric soils, and wetland hydrology. In general, all three criteria must be present for an area to qualify as a wetland. Some exceptions can occur in disturbed areas or in newly formed wetlands, where one indicator (such as hydric soils) might be lacking. These areas would be dealt with on an individual basis as outlined in *the Field Guide for Wetland Delineation* (WTI 1991) and the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Great Plains, Version 2.0* (USACE 2010).

For linear waters of the U.S., the Ordinary High Water Mark (OHWM) is determined by assessing a combination of factors at each site. In accordance with Section 328.3(e) of the Clean Water Act and Regulatory Guidance Letter 05-05 (USACE, December 7, 2005), the following factors were considered in determining the jurisdictional boundary:

- Natural line impressed on the bank
- Shelving
- Changes in the character of soil
- Destruction of terrestrial vegetation
- Presence of litter and debris
- Wracking
- Vegetation matted down, bent, or absent
- Sediment sorting
- Leaf litter disturbed or washed away
- Scour
- Deposition
- Multiple observed flow events

- Bed and banks
- Water staining
- Change in plant community
- Other appropriate means that consider the characteristics of the surrounding areas

Following the completion of preliminary data gathering and synthesis, the routine method of wetland determination was used to identify potential wetland areas within the proposed project area. Potential wetland sites were evaluated in the field, and localized hydrologic characteristics and the dominant vegetative species observed at the site were documented. Photographs of the evaluated wetland determination data points are provided in **Attachment B** of this report. Boundaries of potential waters of the U.S., including wetlands, were recorded using a handheld Trimble GeoXT Global Positioning System (GPS) unit and confirmed using aerial photography; these are shown on (**Figure 5** and **Figure 7**). GPS data was post-processed using Trimble Pathfinder Office software to achieve sub-meter accuracy.

2.3 Jurisdictional Determination

On August 29, 2021, the U.S. District Court for the District of Arizona decision in the Pasqua Yaqui Tribe et al v. United States Environmental Protection Agency et al. case, remanded and vacated the 2020 Navigable Waters Protection Rule defining "waters of the United States" under the Clean Water Act under an order on motion for summary judgement. In response to the decision in this case and in accordance with direction from the Department of the Army, Acting Assistant Secretary of Civil Works, the U.S. Army Corps of Engineers is returning to interpretation of "waters of the United States" consistent with the pre-2015 regulatory regime nationwide. Rulemaking efforts will continue at EPA on an updated definition of WOTUS to replace the Navigable Waters Protection Rule.

It should be noted that CMEC has no authority over the timing, implementation, or enforcement of regulatory Rules or any future injunctions or court cases that invalidate the regulatory Rules. The project proponent acknowledges that regulatory authority over waters of the U.S. lies with the appropriate federal agency. If new regulations are released by any agency with jurisdiction over the proposed project, it may be necessary to amend this report and the opinions contained within to account for updated regulations. CMEC reserves the right to amend any previous opinions and determination pending any regulatory change affecting this report.

"Rapanos" Ruling

Following two 2006 landmark cases (Rapanos v. United States and Carabell v. United States), the EPA and the USACE issued joint guidance in 2007 instructing their field staff on implementing the decision. Under the Rapanos Rule the USACE will assert jurisdiction over the following waters.

- Traditional navigable waters
- Wetlands adjacent to traditional navigable waters
- Non-navigable tributaries of traditional navigable waters that are relatively permanent where the tributaries typically flow year-round or have continuous flow at least seasonally (e.g., typically three months)
- Wetlands that directly abut such tributaries

The USACE will decide jurisdiction over the following waters based on a fact-specific analysis to determine whether they have a significant nexus with a traditional navigable water:

- Non-navigable tributaries that are not relatively permanent
- Wetlands adjacent to non-navigable tributaries that are not relatively permanent
- Wetlands adjacent to but that do not directly abut a relatively permanent non-navigable tributary

The USACE will generally not assert jurisdiction over the following aquatic features:

- Swales or erosional features (e.g., gullies, small washes characterized by low volume, infrequent, or short duration flows)
- Ditches (including roadside ditches) excavated wholly in and draining only uplands and that do not carry a relatively permanent flow of water

The USACE will apply the significant nexus standard as follows:

- A significant nexus analysis will assess the flow characteristics and functions of the tributary itself and the functions performed by all wetlands adjacent to the tributary to determine if they significantly affect the chemical, physical, and biological integrity of downstream traditional navigable waters.
- Significant nexus includes consideration of hydrologic and ecologic factors.

3.0 Results

3.1 General Description of the Project Area

Vicinity and Project Area

The existing ROW within the project area includes maintained roadside shoulders and woody fence line vegetation. Outside of the ROW and adjacent to the project area, land uses include unmaintained woodlands, low and high density residential, mixed commercial properties, churches, educational facilities, and parklands. Stormwater is currently conveyed via roadside ditches. The Sam Bass Road project corridor is intersected by several residential streets (**Figure 1** and **Figure 2**).

Geology

According to the Geologic Atlas of Texas, Austin Sheet, two bedrock formations, undivided Early Cretaceous Edwards and Comanche Peak Limestones, underlie the project area (**Figure 3**) (US Geological Survey [USGS] 2018a).

Soils

Information regarding soils within the project area was obtained from the United States Department of Agriculture NRCS Soil Survey for Williamson County, Texas (NRCS 2020a). Four soil map units are found within the proposed project area. The soils mapped in the area include Crawford clay on 0 to 1 and 1 to 3 percent slopes, Denton silty clay on 1 to 3 percent slopes, Eckrant extremely stony clay and cobbly clay on 0 to 3 percent and 1 to 8 percent slopes, respectively, and Georgetown clay loam and stony clay loam on 0 to 2 percent and 1-3 percent slopes, respectively (Natural Resources Conservation Service [NRCS] 2019). Crawford soils are moderately deep, well-drained, and very slowly permeable soils that formed in clayey sediments underlain by indurated limestone bedrock and are found on broad nearly level or gently sloping uplands. The Denton soils are deep, well-drained, and slowly permeable that formed in clayey materials over residuum weathered from limestone bedrock and are found on backslopes and footslopes of ridges. Eckrant soils are shallow, well-drained, moderately slowly permeable soils that formed in residuum from limestone and occurs on summits, shoulders, and backslopes of ridges on dissected plains. Georgetown soils are moderately deep, well-drained, and very slowly permeable soils formed over indurated limestone and found on nearly level to very gently sloping dissected plains. Generally, soils in close proximity to the current road surface and within existing ROW are likely to be heavily disturbed by road and utility construction and maintenance. However, proposed new ROW may contain relatively undisturbed soils. None of the project area soils are listed as hydric or as having hydric inclusions (**Figure 4**).

Hydrology

The project area is located within the Brazos River basin. Sam Bass Road crosses Dry Fork Creek, which flows southeast through the project area to its termination at Brushy Creek approximately two miles downstream of the project area (**Figure 3**). Both Dry Fork Creek and Brushy Creek are within the Turkey Creek-Brushy Creek watershed (HUC 12070205). The existing Sam Bass Road ROW is generally well-drained with no evidence of standing water. Dry Fork Creek and Brushy Creek flow into the San Gabriel River which flows into the Little River and finally the Brazos River. According to the Federal Emergency Management Agency's (FEMA) Flood Insurance Rate Map (FIRM), the proposed project intersects the

100-year floodplain associated with Dry Fork Creek (FEMA Map Panel Number 48491C0490E and 48491C0470E) (FEMA 2008) (**Figure 2, Figure 5**, and **Attachment E**).

The USACE-based Antecedent Precipitation Tool (APT), Version 1.0 was utilized to determine the normality of rainfall at the time of the field investigations. APT 1.0 results indicate wetter than normal climatic conditions were present for the October 2018 field visit and drier than normal climatic conditions were present for the March 2019 field visit. No wetland data was recorded during the other field visits. Data are provided in **Attachment C.**

Vegetation

Based on field investigations, the majority of the project area consists of relic Live Oak-Ashe Juniper Woodland. Much of this area has been manipulated for residential development but many large overstory trees adjacent to the ROW have been preserved. The dominant overstory components consisted of woody species such as, Ashe juniper (*Juniperus asheii*), plateau live oak (*Quercus fusiformis*), Texas oak (*Quercus buckleyi*), and cedar elm (*Ulmus crassifolia*). The majority of the midstory and understory species within the ROW have been removed to accommodate transportation infrastructure and residential development. The woody vine strata consisted of poison ivy (*Toxicodendron radicans*), and saw greenbriar (*Smilax bona-nox*), where present. The understory consisted primarily of mowed and maintained bermudagrass (*Cynodon dactylon*) and St. Augustine grass (*Stenotaphrum secundatum*) but additional species such as little bluestem (*Schizachyrium scoparium*), silver bluestem (*Bothriochloa saccaroides*), purple horsemint (*Mondarda citriodora*), silver-leaf nightshade (*Solanum elaeagnifolium*), Indian blanket (*Gaillardia pulchella*), milkweed (*Asclepias* sp.), and black-eyed Susan (*Rudbeckia hirta*) were observed. According to *The Vegetation Types of Texas*, vegetation within the project area is mapped as "Live Oak-Ashe Juniper Woods" and "Oak-Mesquite-Juniper Parks/Woods" (McMahan, et al. 1984) (**Figure 6**).

3.2 Descriptions of Evaluated Aquatic Features

Potential wetlands and waters of the U.S. were identified using aerial photos, FEMA floodplain maps (FEMA 2008), USGS topographic maps, NRCS county soil survey maps (NRCS 2009), National Wetland Inventory (NWI) maps (NWI 1991), and their potential occurrence was investigated in the field. The project area is mapped as crossing two U.S. Geological Survey (USGS) topographic quadrangles; the western edge is included on Leander and the eastern two thirds of the project occurs within the Round Rock quadrangle. The NWI maps classify Dry Fork Creek as riverine, seasonally flooded, intermittent streambed. No other wetlands or streams are mapped as occurring within the project area (**Figure 3**). Wetland and waters of the U.S. delineations were conducted in October 2018 and March 2019. A single feature, Dry Fork Creek (Crossing 1), is described below and shown on **Figure 5.**

Table 1 presents the findings of the delineation effort performed in October 2018 and March 2019.

Table 1: Summary of Aquatic Features within the Project Area

Single and Complete Crossing Number	Name	Aquatic Feature Class	Linear Feet/Acre Within Project Area	Water of the U.S.? (Yes/No)
1	Dry Fork Creek-Delineated Water	Intermittent Stream	128/0.041	Yes

1	Dry Fork Creek-Assumed Water	Intermittent Stream	80/0.025	Yes
		Total:	208/0.066	

Crossing 1 (Dry Fork Creek)

Dry Fork Creek is depicted on NWI maps as a riverine, seasonally flooded, intermittent streambed. It lies within the 100-year FEMA-designated floodplain. Approximately 6-12 inches of flowing water were observed within the channel at the time of the field visits. Dry Fork Creek within the project area is contained within a natural channel without reinforced banks. Dry Fork Creek flows from north of Sam Bass Road, through three corrugated pipe culverts, to the southeast where it eventually terminates at Brushy Creek. The average ordinary high-water mark (OHWM) was approximately 5-10 feet in width. A 3-foot-deep pool was present at the culvert outfall. The dominant vegetation at this location included an adjacent canopy of cedar elm (*Ulmus crassifolia*), live oak, and Ashe juniper, with an herbaceous layer of bermudagrass and St. Augustine grass. This crossing is presumed to be a jurisdictional water feature due to its intermittent flow regime and uninterrupted downstream connectivity to a Navigable Water. Two Wetland Determination Data Forms were completed at the crossing. These forms are included in **Appendix C** and this crossing is shown on **Figure 7**. No wetlands were identified at Crossing 1. See **Appendix B: Photos 5-9** and **19-20**.

Summary of Crossings

In all, approximately 0.05 acres of presumed jurisdictional channels would be crossed by the proposed project. However, actual impacts are unknown at this point in project development and will need to be calculated once schematic designs have been prepared. No wetlands exist within the project area. Acreages of waters of the U.S. within the project area are summarized in **Table 1.**

Due to a may affect determination to federally listed species, the project triggers General Condition 18. The project would be expected to be authorized by the USACE under NWP #14 for Linear Transportation Projects with Pre-Construction Notification (PCN).

3.3 Jurisdictional Determination

Waters of the U.S.

Crossing 1 (Dry Fork Creek) meets the definition of a water of the U.S. since it has a clearly defined bed and bank, OHWM, and is an intermittent flow regime that contributes to downstream Navigable Waters. Dry Fork Creek is a tributary to Brushy Creek, which flows directly into the San Gabriel River, approximately 44 miles northeast of the project area. The San Gabriel River flows into the Little River, and eventually the Brazos River, a category (a)(1) water, approximately 67 miles northeast of the project area.

Historic Aerial Imagery and Topographic Map Review

Table 2 summarizes the historical aerial photographs used to support jurisdictional determinations by viewing how features changed over time.

Table 2: Historical Aerial Photography Used for Jurisdictional Determination

Source	Dates
National Agriculture Information Program	2004
National Agriculture Information Program	2010
National Agriculture Information Program	2015

Environmental Risk Information Service (ERIS) Historical Aerials Package (**Attachment E**)

Little change occurs within the project area between the 2004, 2010, and 2015 aerials (**Attachment E**). In the aerial photographs from 2004-2015, Sam Bass Road is visible. An intermittent channel intersecting the roadway, Dry Creek Fork, is also visible. The creek channel is surrounded by woody vegetation. Dry Fork Creek is dammed immediately upstream/up valley by Soil Conservation Service Site 13a Reservoir. Various roadways and developments, including residential neighborhoods, surround the project area.

4.0 Conclusions

A delineation of waters of the U.S., including wetlands, was conducted within the project area for the proposed improvements to Sam Bass Road in Williamson County, Texas (**Figure 1**). The waters of the U.S. delineation resulted in the identification of one aquatic feature, an intermittent stream, within the project area during the field investigations performed in April 2017, October and November 2018, and March 2019. This feature meets the current definition of a Category (a)(2) Water of the U.S. Approximately 0.066 acres of presumed jurisdictional channels occurs within the proposed project area. However, final impacts are unknown at this point in project development and will be calculated once schematic designs have been prepared. No wetlands exist within the project area. **Table 1** provides a summary of waters of the U.S. within the project area.

Due to a may affect determination to federally listed species, the project triggers General Condition 18. The project would be expected to be authorized by the USACE under NWP #14 for Linear Transportation Projects with Pre-Construction Notification (PCN).

Table 3 presents the results of the determination of waters of the U.S. within the project area.

Table 3: Summary of Waters of the U.S within the Project Area

Single and Complete Crossing Number	Name	Aquatic Feature Class	Linear Feet/Acre Within Project Area
1	Dry Fork Creek- Delineated Water	Intermittent Stream	128/0.041
1	Dry Fork Creek- Assumed Water	Intermittent Stream	80/0.025
	Total	208/0.066	

5.0 Approved Jurisdictional Determination Request

We respectfully request USACE concurrence of this waters of the U.S., including wetlands, delineation and determination, which is detailed in the Approved Jurisdictional Determination Form (**Attachment F**).

This report was prepared by:

_____________________________ October 18, 2021

Meghan P. Lind, Senior Ecologist Date

Cox|McLain Environmental Consulting, Inc.

6.0 References

Environmental Laboratory. 1987. Corps of Engineers Wetlands Delineation Manual, http://www.wes.army.mil/el/wetlands/pdfs/wlman87.pdf U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. NTIS No. AD A176 912.

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_____. 1997. Hydrology tools for wetland determination. Chapter 19, Engineering field handbook. D.E. Woodward, ed. USDA-NRCS, Fort Worth, TX.

U.S. Army Corps of Engineers (USACE). 2010. *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Great Plains (Version 2.0)*, ed. J. S. Wakeley, R. W. Lichvar, and C. V. Noble. ERDC/EL TR-10-20. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

Wetland Training Institute, Inc. 1991. Field Guide for Wetland Delineation: 1987 Corps of Engineers Manual. WTI 91-2.

ATTACHMENT A: FIGURES

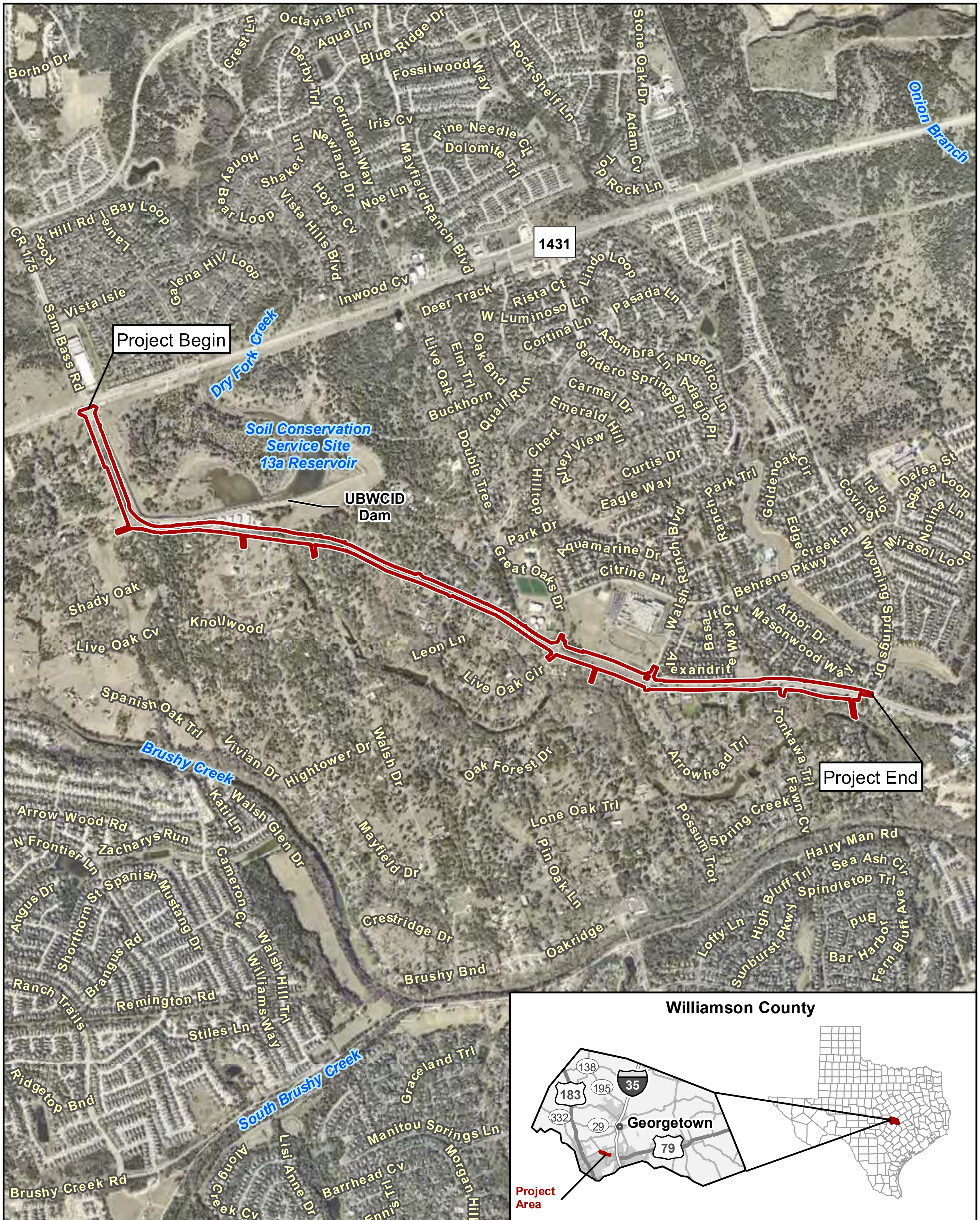

Figure 1.
Project Location (Aerial Base)

Project Location

COX | McLAIN Environmental Consulting

0 2,000 Feet
0 600 Meters

1 in = 2,000 feet
Scale: 1:24,000
Date: 10/18/2021

Williamson County Corridor H - Sam Bass Road

Aerial Source: Williamson County (2020)

G:\Projects\Williamson_County\H_Corridor\H_Corridor_all_Figure 1_Project Location_Aerial_20211018_TLS.mxd

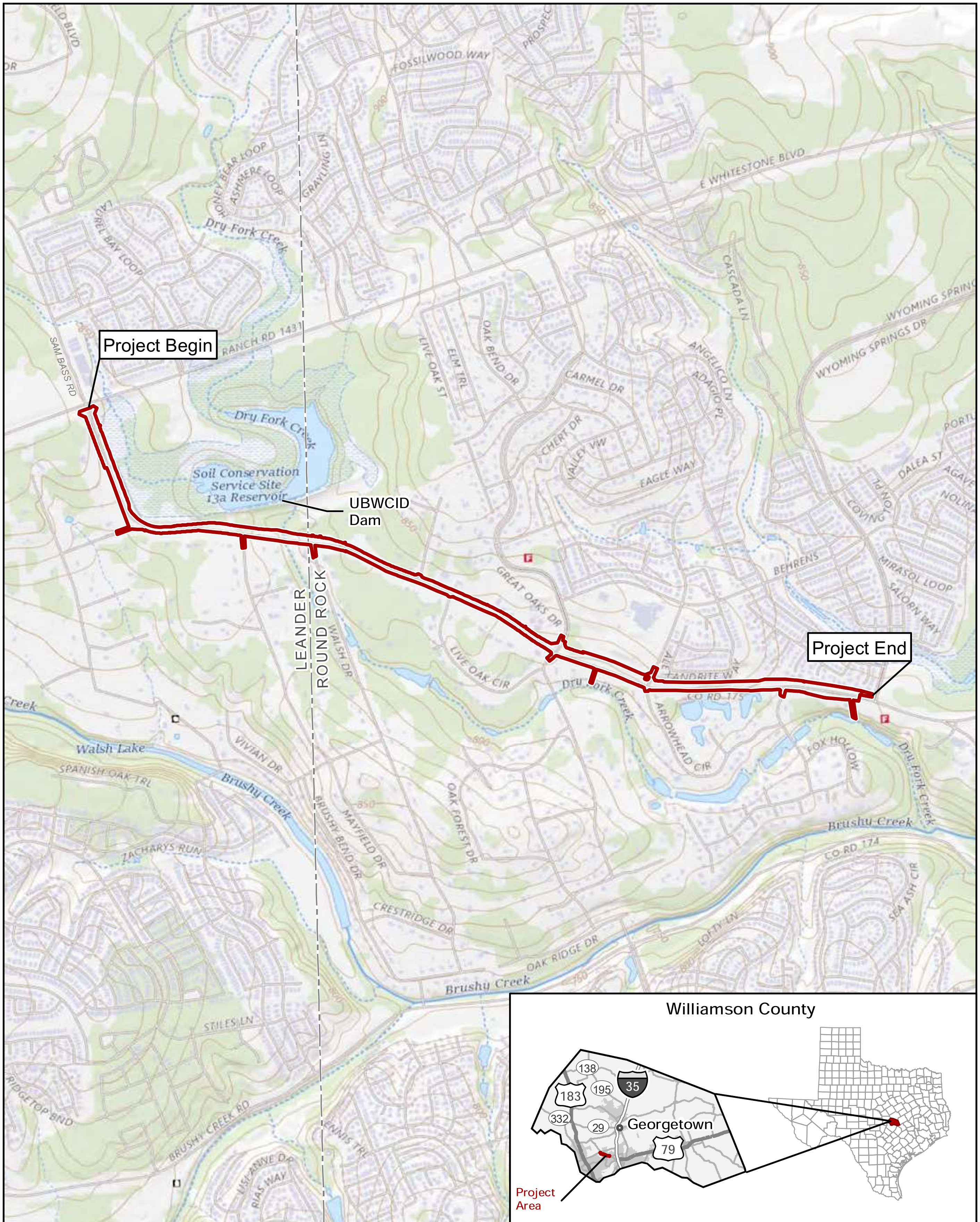

Figure 2.
Project Location (Topographic Base)

Project Location

Topographic Source: USGS (2021)
USGS 7.5' Quadrangles: Leander, Round Rock

COX | McLAIN Environmental Consulting

0 2,000 Feet
0 600 Meters

1 in = 2,000 feet
Scale: 1:24,000
Date: 10/18/2021

Williamson County Corridor H - Sam Bass Road

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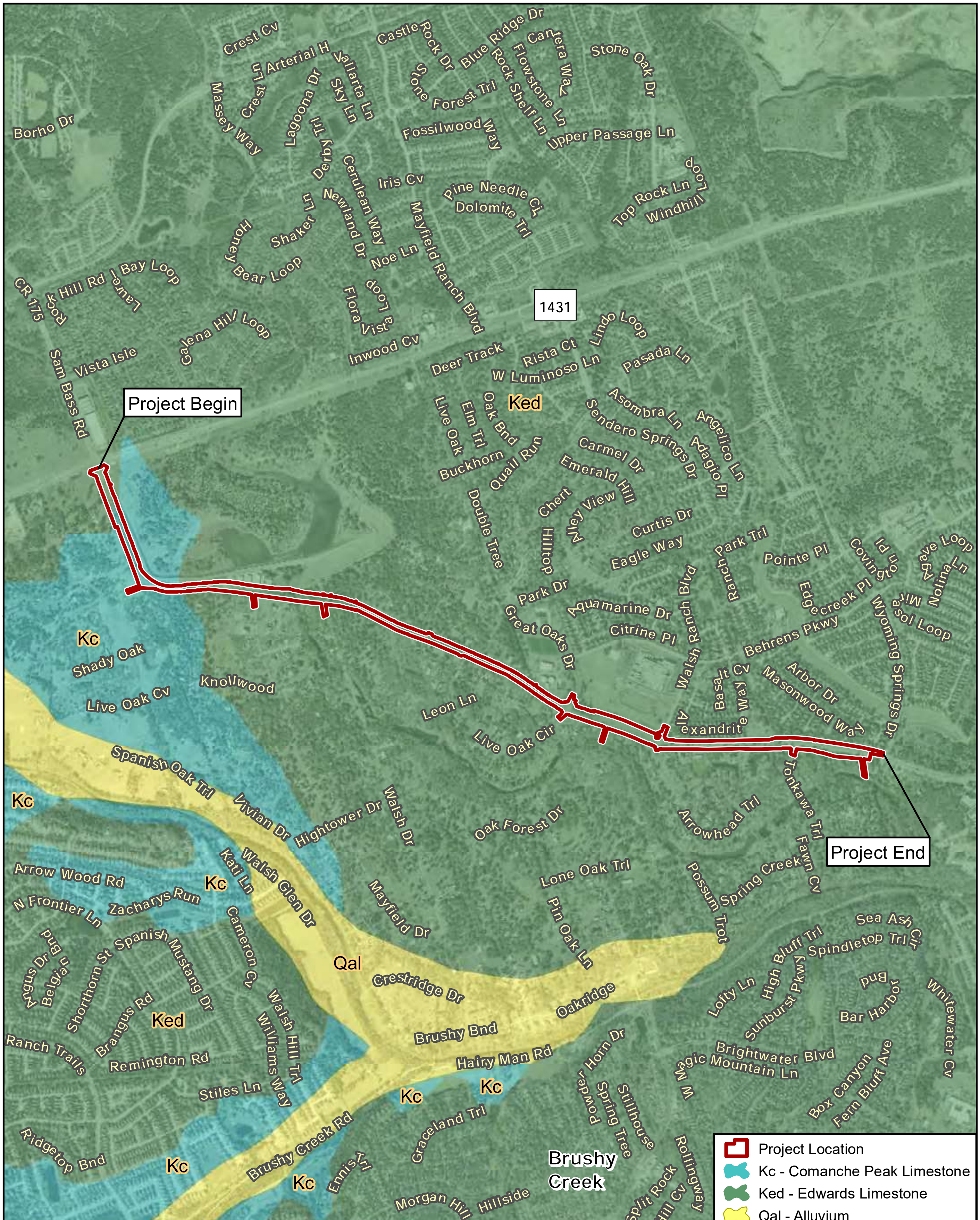


Figure 3.
Project Area Geology

Williamson County Corridor H - Sam Bass Road

Data Sources: Geologic Database of Texas (2007)/
Geologic Atlas of Texas Austin Sheet (1981)
Aerial Source: Williamson County (2020)

0 2,000 Feet
0 600 Meters

1 in = 2,000 feet
Scale: 1:24,000
Date: 10/18/2021

COX | McLAIN Environmental Consulting

G:\Projects\Williamson_County\H_Corridor\H_Corridor_Delineation_Figure 3_Geology_20211018_TLS.mxd

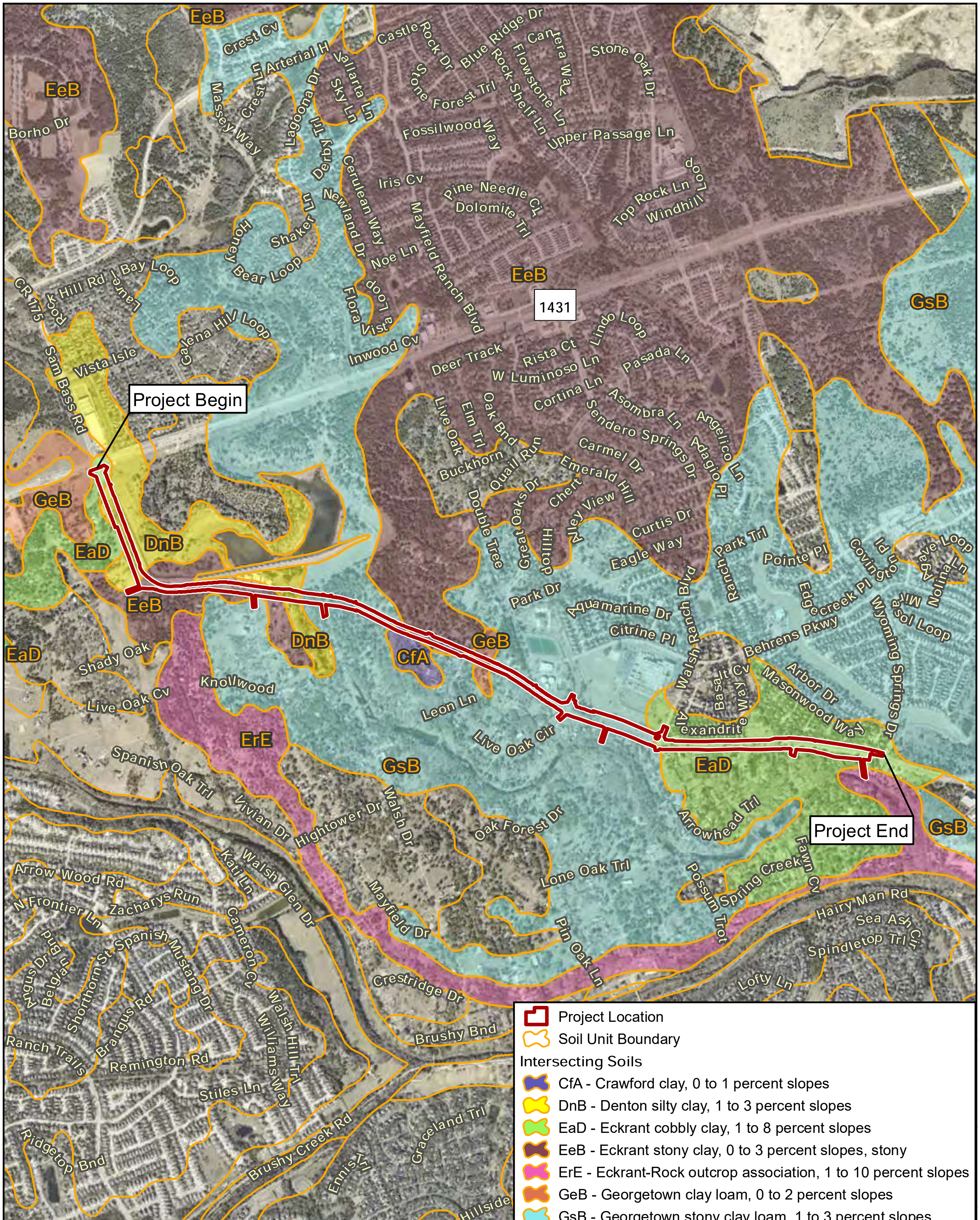


Figure 4.
Project Area Soils

Williamson County Corridor H - Sam Bass Road

Data Source: NRCS (2021)
Aerial Source: Williamson County (2020)

COX | McLAIN Environmental Consulting

1 in = 2,000 feet
Scale: 1:24,000
Date: 10/18/2021

G:\Projects\Williamson_County\H_Corridor\H_Corridor_Delineation_Figure 4_Soils_20211018_TLS.mxd

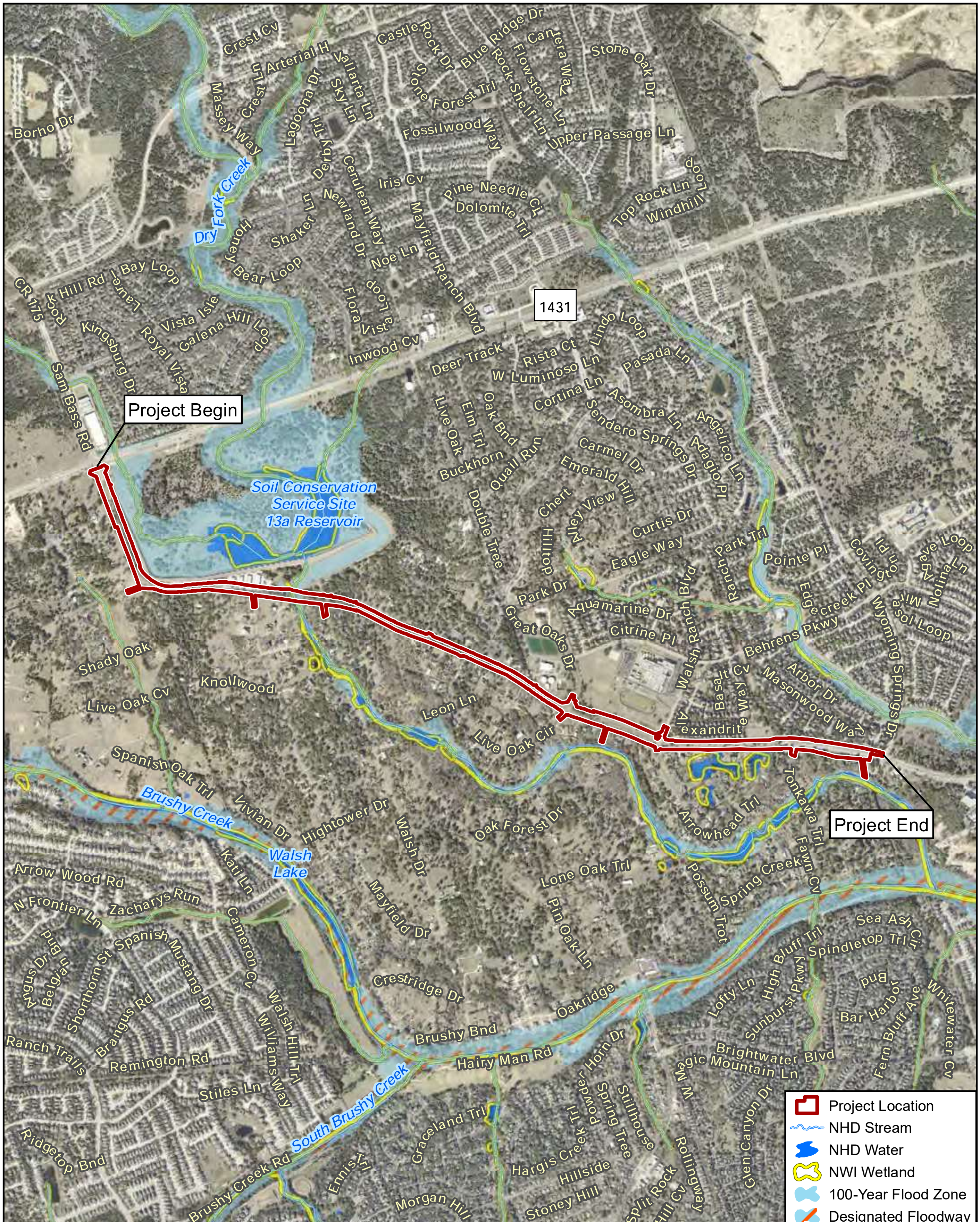


Figure 5.
Water Resources

Williamson County Corridor H - Sam Bass Road

Data Sources: NHD (2020), NWI (2020), FEMA NFHL (2021)
Aerial Source: Williamson County (2020)

COX | McLAIN Environmental Consulting

0 — 2,000 Feet
0 — 600 Meters

1 in = 2,000 feet
Scale: 1:24,000
Date: 10/18/2021

G:\Projects\Williamson_County\H_Corridor\H_Corridor_Delineation_Figure 5_Water Resources_20211018_TLS.mxd

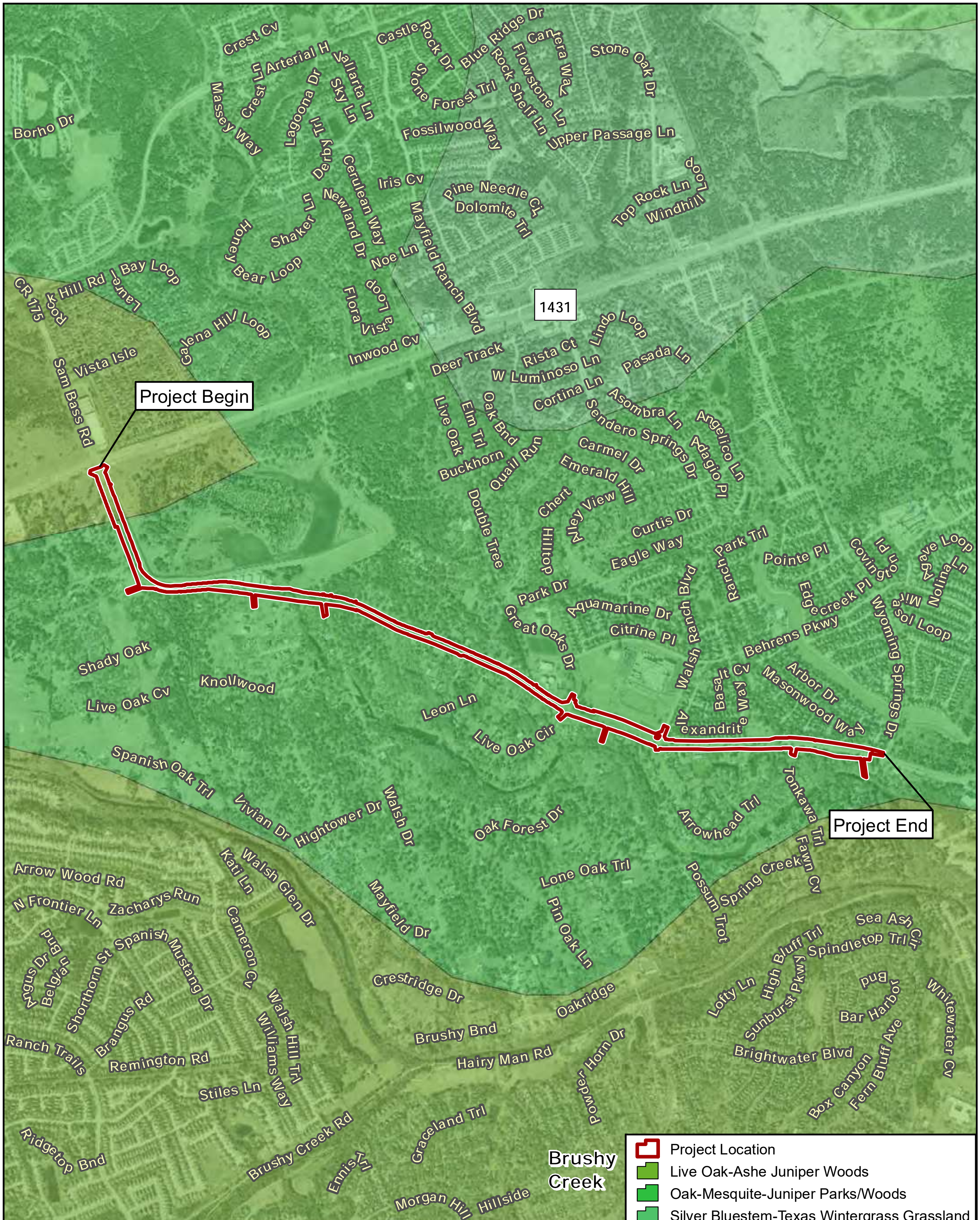


Figure 6.
Vegetation Types of Texas

COX | McLAIN Environmental Consulting

0 2,000 Feet
0 600 Meters

1 in = 2,000 feet
Scale: 1:24,000
Date: 10/18/2021

Data Source: TPWD (2003)/McMahan, et. al (1984)
Aerial Source: Williamson County (2020)

Williamson County Corridor H - Sam Bass Road

G:\Projects\Williamson_County\H_Corridor\H_Corridor_Delineation_Figure 6_Veg Types TX_20211018_TLS.mxd

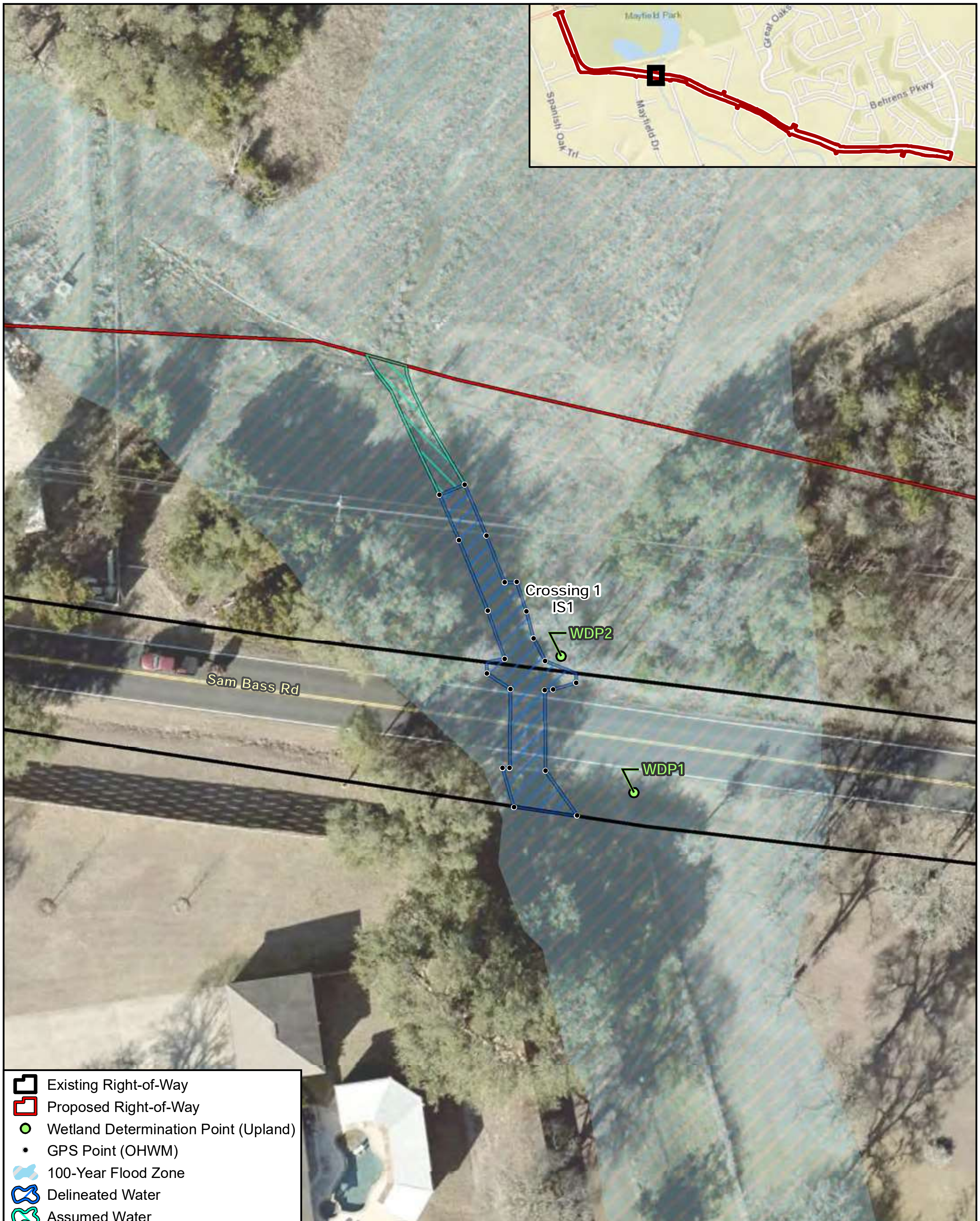


Figure 7.
Potential Waters of the U.S.

Williamson County Corridor H - Sam Bass Road

COX | McLAIN Environmental Consulting

Data Sources: CMEC (2018, 2019), FEMA (2021)
Aerial Source: Williamson County (2020)

1 in = 50 feet
Scale: 1:600
Date: 10/18/2021

G:\Projects\Williamson_County\H_Corridor\H_Corridor_Delineation_Figure 7_Potential WOUS_20211018_TLS.mxd

ATTACHMENT B: PROJECT AREA PHOTOGRAPHS

Photo 1: Project eastern terminus viewing RM 1431. Viewing north.

Photo 2: Typical view of the existing right-of-way at the Sam Bass Road/Tonkawa Trail intersection. Viewing northwest.

Photo 3: Undeveloped land associated with Mayfield Park, near eastern terminus. Viewing north.

Photo 4: Typical right-of-way and maintained vegetation along Sam Bass Road. Viewing south.

Photo 5: Crossing 1 (Dry Fork Creek), south side of roadway at culvert outfall. Viewing east.

Photo 6: Crossing 1 (Dry Fork Creek). Viewing south, downstream from culvert outfall.

Photo 7: Crossing 1 (Dry Fork Creek), north side of roadway. Viewing north.

Photo 8: Crossing 1 (Dry Fork Creek), south side of roadway at culvert outfall. View of metal pipe culverts and decorate rock berm.

Photo 9: Ordinary High Water Mark (OHWM) of Dry Fork Creek from private property, facing south.

Photo 10: OHWM of Dry Fork Creek on private property, facing south.

Photo 11: Wetland Determination Datapoint 1 at Crossing 1; not a wetland location. Viewing southwest.

Photo 12: Dry detention pond on private church property; mowed and maintained vegetation. Viewing southeast.

Photo 13: Typical right-of-way along Sam Bass Road; open, mowed understory with a manicured canopy of live oaks. Viewing east.

Photo 14: Typical right-of-way along Sam Bass Road; open, mowed understory with a manicured canopy of live oaks. Viewing west.

Photo 15: Project terminus at Wyoming Springs Drive. Viewing east.

Photo 16: Quarry adjacent to the project area, facing south.

Photo 17: Utilities between the project area and Walsh Middle School.

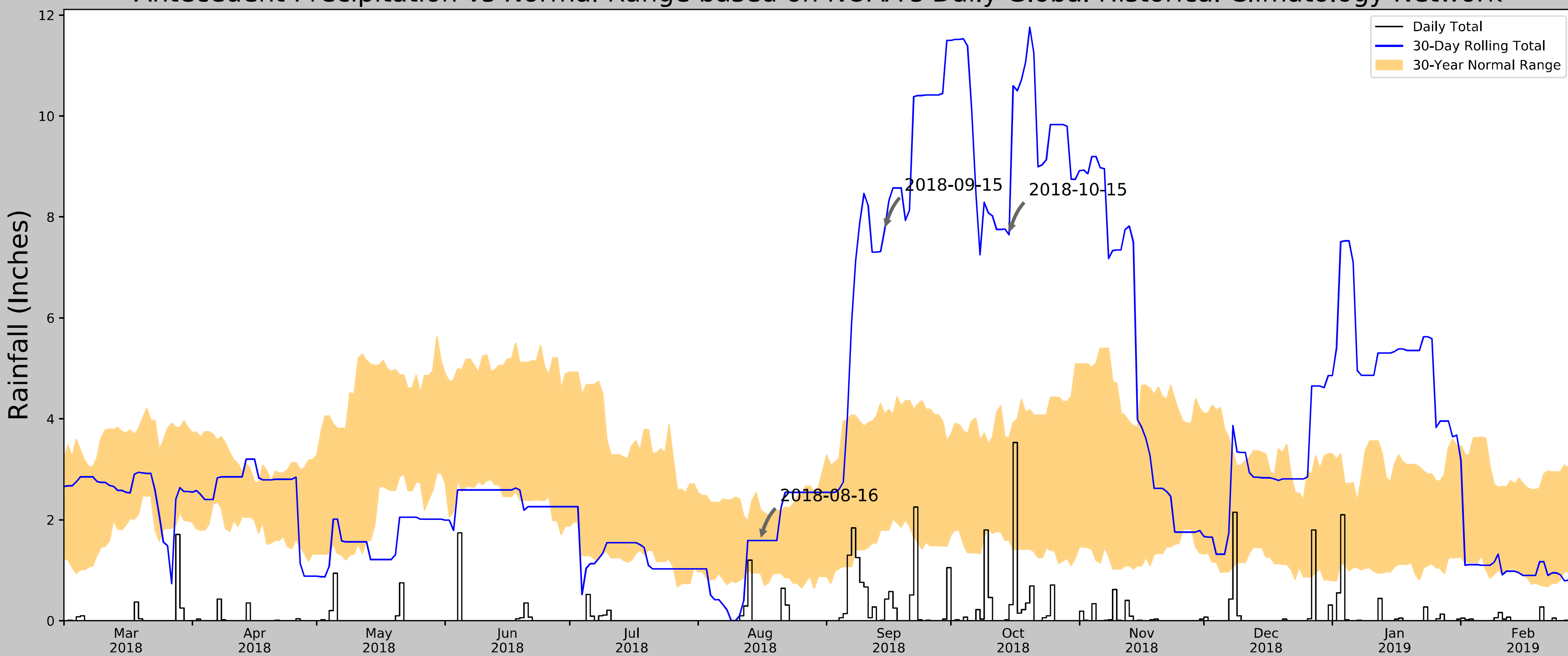
Photo 18: Walsh Middle School adjacent to the project area, facing north.

Photo 19: Waste water treatment plant adjacent to the project area, facing northeast.

Photo 20: Soil Conservation Site Reservoir adjacent to the project area, facing northeast.

ATTACHMENT C: NRCS CLIMATE ANALYSIS FOR WETLANDS TABLE (WETS):

Antecedent Precipitation vs Normal Range based on NOAA's Daily Global Historical Climatology Network



Coordinates	30.538454, -97.751154
Observation Date	2018-10-15
Elevation (ft)	819.24
Drought Index (PDSI)	Severe wetness
WebWIMP H_2O Balance	Dry Season

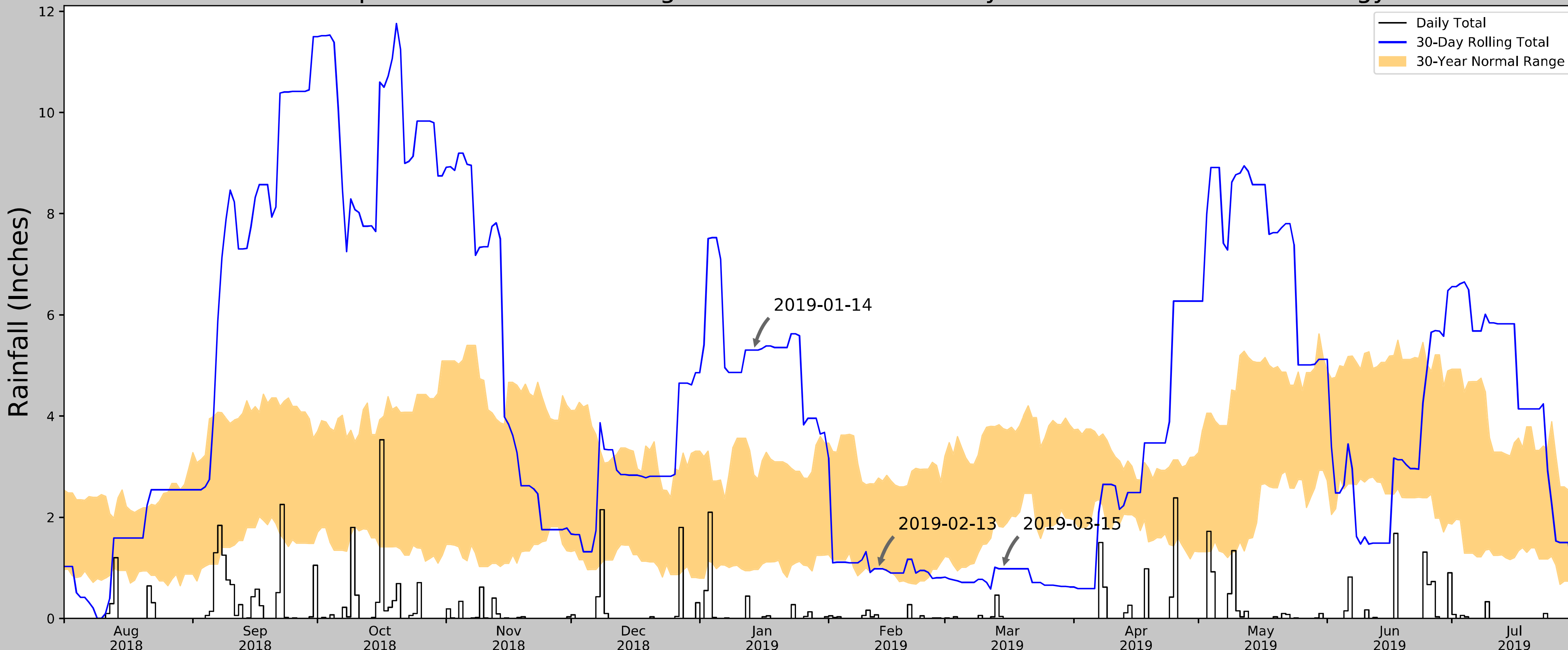
30 Days Ending	30^{th} %ile (in)	70^{th} %ile (in)	Observed (in)	Wetness Condition	Condition Value	Month Weight	Product
2018-10-15	1.594488	3.633071	7.649607	Wet	3	3	9
2018-09-15	1.796457	4.095276	7.744095	Wet	3	2	6
2018-08-16	0.949213	2.212598	1.590551	Normal	2	1	2
Result							Wetter than Normal - 17

Weather Station Name	Coordinates	Elevation (ft)	Distance (mi)	Elevation Δ	Weighted Δ	Days (Normal)	Days (Antecedent)
GEORGETOWN LAKE	30.6764, -97.7208	874.016	9.701	54.776	4.897	11220	82
CEDAR PARK 4.6 E	30.5191, -97.7529	818.898	1.341	0.342	0.604	7	3
ROUND ROCK 2.5 WNW	30.5252, -97.7129	779.856	2.454	39.384	1.201	8	0
ROUND ROCK 2.2 W	30.5171, -97.7097	776.903	2.875	42.337	1.415	1	0
ROUND ROCK 4.3 WSW	30.4922, -97.7387	889.108	3.281	69.868	1.706	2	0
BRUSHY CREEK 1.4 S	30.493, -97.7373	895.997	3.247	76.757	1.71	3	0
BRUSHY CREEK 2.3 SW	30.4929, -97.7708	900.919	3.358	81.679	1.785	14	0
BRUSHY CREEK 2.4 SW	30.4859, -97.7644	875.984	3.716	56.744	1.883	7	5
ROUND ROCK 3.8 NNW	30.5689, -97.6946	778.871	3.968	40.369	1.946	33	0
ROUND ROCK 1.6 WSW	30.5083, -97.6972	748.032	3.828	71.208	1.995	6	0
ROUND ROCK 3 NE	30.5414, -97.635	721.129	6.915	98.111	3.79	52	0

Figure and tables made by the **Antecedent Precipitation Tool** Version 1.0

Written by Jason Deters
U.S. Army Corps of Engineers

Antecedent Precipitation vs Normal Range based on NOAA's Daily Global Historical Climatology Network



Coordinates	30.538454, -97.751153
Observation Date	2019-03-15
Elevation (ft)	819.24
Drought Index (PDSI)	Severe wetness
WebWIMP H_2O Balance	Wet Season

30 Days Ending	30^{th} %ile (in)	70^{th} %ile (in)	Observed (in)	Wetness Condition	Condition Value	Month Weight	Product
2019-03-15	1.805906	3.748425	0.980315	Dry	1	3	3
2019-02-13	1.020866	2.773228	0.980315	Dry	1	2	2
2019-01-14	0.967323	2.836614	5.30315	Wet	3	1	3
Result							Drier than Normal - 8

Weather Station Name	Coordinates	Elevation (ft)	Distance (mi)	Elevation Δ	Weighted Δ	Days (Normal)	Days (Antecedent)
GEORGETOWN LAKE	30.6764, -97.7208	874.016	9.701	54.776	4.897	11220	79
CEDAR PARK 4.6 E	30.5191, -97.7529	818.898	1.341	0.342	0.604	7	1
ROUND ROCK 2.5 WNW	30.5252, -97.7129	779.856	2.454	39.384	1.201	8	0
ROUND ROCK 2.2 W	30.5171, -97.7097	776.903	2.875	42.337	1.415	1	0
ROUND ROCK 4.3 WSW	30.4922, -97.7387	889.108	3.281	69.868	1.706	2	0
BRUSHY CREEK 1.4 S	30.493, -97.7373	895.997	3.247	76.757	1.71	3	0
BRUSHY CREEK 2.3 SW	30.4929, -97.7708	900.919	3.358	81.679	1.785	14	0
BRUSHY CREEK 2.4 SW	30.4859, -97.7644	875.984	3.716	56.744	1.883	7	5
ROUND ROCK 3.8 NNW	30.5689, -97.6946	778.871	3.968	40.369	1.946	33	1
ROUND ROCK 1.6 WSW	30.5083, -97.6972	748.032	3.828	71.208	1.995	6	4
ROUND ROCK 3 NE	30.5414, -97.635	721.129	6.915	98.111	3.79	52	0

Figure and tables made by the
Antecedent Precipitation Tool
Version 1.0

Written by Jason Deters
U.S. Army Corps of Engineers

ATTACHMENT D: WETLAND DETERMINATION DATA FORMS

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: Sam Bass Road City/County: Williamson Sampling Date: 10/23/2018

Applicant/Owner: Williamson County State: TX Sampling Point: WDP1

Investigator(s): Jeff Allen & Meghan Lind Section, Township, Range: None

Landform (hillslope, terrace, etc.): Embankment - ROW Local relief (concave, convex, none): None Slope (%): 1-2

Subregion (LRR): J Lat: 30.538305 Long: -97.751004 Datum: NAD 83

Soil Map Unit Name: Denton silty clay, 1 to 3 percent slopes NWI classification: None

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ____ No ✓ (If no, explain in Remarks.)

Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes ____ No ✓

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

	Yes	No
Hydrophytic Vegetation Present?		✓
Hydric Soil Present?		✓
Wetland Hydrology Present?		✓

Is the Sampled Area within a Wetland? Yes ____ No ✓

Remarks:

This point did not meet the criteria for a wetland. APT 1.0 results indicate wetter than normal climatic conditions were present for the October 2018 field visit.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. Juniperus asheii	5	Y	UPL
2.			
3.			
4.			
	5 = Total Cover		
Sapling/Shrub Stratum (Plot size: 15')			
1. None			
2.			
3.			
4.			
5.			
	= Total Cover		
Herb Stratum (Plot size: 5')			
1. Cynodon dactylon	95	Y	UPL
2. Stenotaphrum secundatum	5	N	FAC
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	100 = Total Cover		
Woody Vine Stratum (Plot size: 15')			
1. None			
2.			
	= Total Cover		

% Bare Ground in Herb Stratum 0

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): 0 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 0 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A = ____

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

___ 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ____ No ✓

Remarks:

This point does not have hydrophytic vegetation.

SOIL

Sampling Point: 1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-4	10YR 3/1	100	None				Clay Loam	No mottles
4-18	10YR 3/2	100	None				Clay Loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Stratified Layers (A5) (**LRR F**)
___ 1 cm Muck (A9) (**LRR F, G, H**)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ 2.5 cm Mucky Peat or Peat (S2) (**LRR G, H**)
___ 5 cm Mucky Peat or Peat (S3) (**LRR F**)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)
___ High Plains Depressions (F16) (**MLRA 72 & 73 of LRR H**)

Indicators for Problematic Hydric Soils[3]:

___ 1 cm Muck (A9) (**LRR I, J**)
___ Coast Prairie Redox (A16) (**LRR F, G, H**)
___ Dark Surface (S7) (**LRR G**)
___ High Plains Depressions (F16) (**LRR H outside of MLRA 72 & 73**)
___ Reduced Vertic (F18)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ______
Depth (inches): ______

Hydric Soil Present? Yes ______ No ✓

Remarks:

Lots of gravel present; likely this area is roadside fill material. Does not display hydric soil indicators.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Inundation Visible on Aerial Imagery (B7)
___ Water-Stained Leaves (B9)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Dry-Season Water Table (C2)
___ Oxidized Rhizospheres on Living Roots (C3) (**where not tilled**)
___ Presence of Reduced Iron (C4)
___ Thin Muck Surface (C7)
___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

___ Surface Soil Cracks (B6)
___ Sparsely Vegetated Concave Surface (B8)
___ Drainage Patterns (B10)
___ Oxidized Rhizospheres on Living Roots (C3) (**where tilled**)
___ Crayfish Burrows (C8)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ FAC-Neutral Test (D5)
___ Frost-Heave Hummocks (D7) (**LRR F**)

Field Observations:

Surface Water Present? Yes ______ No ✓ Depth (inches): ______
Water Table Present? Yes ______ No ✓ Depth (inches): ______
Saturation Present? (includes capillary fringe) Yes ______ No ✓ Depth (inches): ______

Wetland Hydrology Present? Yes ______ No ✓

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Point taken adjacent to the stream. Flowing water in creek likely due to the recent rainfall (last 24 hours). Wetland hydrology not present at this data point.

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: Sam Bass Road City/County: Williamson Sampling Date: 3/27/2019

Applicant/Owner: Private Landowner- Gesseman State: TX Sampling Point: WDP2

Investigator(s): Meghan P Lind Section, Township, Range: None

Landform (hillslope, terrace, etc.): Streambank Local relief (concave, convex, none): None Slope (%): 0-1

Subregion (LRR): J Lat: 30.32'18.45 Long: 97.45'4.04 Datum: NAD 83

Soil Map Unit Name: Denton silty clay, 1 to 3 percent slopes NWI classification: None

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ____ No ✓ (If no, explain in Remarks.)

Are Vegetation ✓, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ____

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

	Yes	No
Hydrophytic Vegetation Present?		✓
Hydric Soil Present?		✓
Wetland Hydrology Present?		✓
Is the Sampled Area within a Wetland?		✓

Remarks:

Site lacks the wetland characteristics; site is routinely mowed and grazed. APT 1.0 results indicate drier than normal climatic conditions were present for the March 2019 field visit.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: 30')			
1. Ulmus crassifolia	50	Y	FAC
2.			
3.			
4.			
= Total Cover	50		
Sapling/Shrub Stratum (Plot size: 15')			
1. None			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: 5')			
1. Lolium perenne	10	Y	FACU
2. Nothoscordum bivalve	5	Y	FACU
3. Oxalis stricta	5	Y	FACU
4. Rumex crispus	5	Y	FAC
5. Alium sp.	5	Y	FACU
6.			
7.			
8.			
9.			
10.			
= Total Cover	30		
Woody Vine Stratum (Plot size: 15')			
1. None			
2.			
= Total Cover			

% Bare Ground in Herb Stratum 0

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): 1 (A)

Total Number of Dominant Species Across All Strata: 6 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 17 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A = ____

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ___ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ____ No ✓

Remarks:

No hydrophytic vegetation present.

SOIL

Sampling Point: 2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-18	10YR 3/2	100	None				Clay	No mottles

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Stratified Layers (A5) (**LRR F**)
___ 1 cm Muck (A9) (**LRR F, G, H**)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ 2.5 cm Mucky Peat or Peat (S2) (**LRR G, H**)
___ 5 cm Mucky Peat or Peat (S3) (**LRR F**)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)
___ High Plains Depressions (F16)
(**MLRA 72 & 73 of LRR H**)

Indicators for Problematic Hydric Soils[3]:

___ 1 cm Muck (A9) (**LRR I, J**)
___ Coast Prairie Redox (A16) (**LRR F, G, H**)
___ Dark Surface (S7) (**LRR G**)
___ High Plains Depressions (F16)
(**LRR H outside of MLRA 72 & 73**)
___ Reduced Vertic (F18)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):
Type: ________
Depth (inches): ________

Hydric Soil Present? **Yes** ___ **No** ✓

Remarks:

No hydric soil indicators present/ rocks present.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Inundation Visible on Aerial Imagery (B7)
___ Water-Stained Leaves (B9)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Dry-Season Water Table (C2)
___ Oxidized Rhizospheres on Living Roots (C3)
(**where not tilled**)
___ Presence of Reduced Iron (C4)
___ Thin Muck Surface (C7)
___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

___ Surface Soil Cracks (B6)
___ Sparsely Vegetated Concave Surface (B8)
___ Drainage Patterns (B10)
___ Oxidized Rhizospheres on Living Roots (C3)
(**where tilled**)
___ Crayfish Burrows (C8)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ FAC-Neutral Test (D5)
___ Frost-Heave Hummocks (D7) (**LRR F**)

Field Observations:

Surface Water Present? Yes ___ No ✓ Depth (inches): ___
Water Table Present? Yes ___ No ✓ Depth (inches): ___
Saturation Present? Yes ___ No ✓ Depth (inches): ___
(includes capillary fringe)

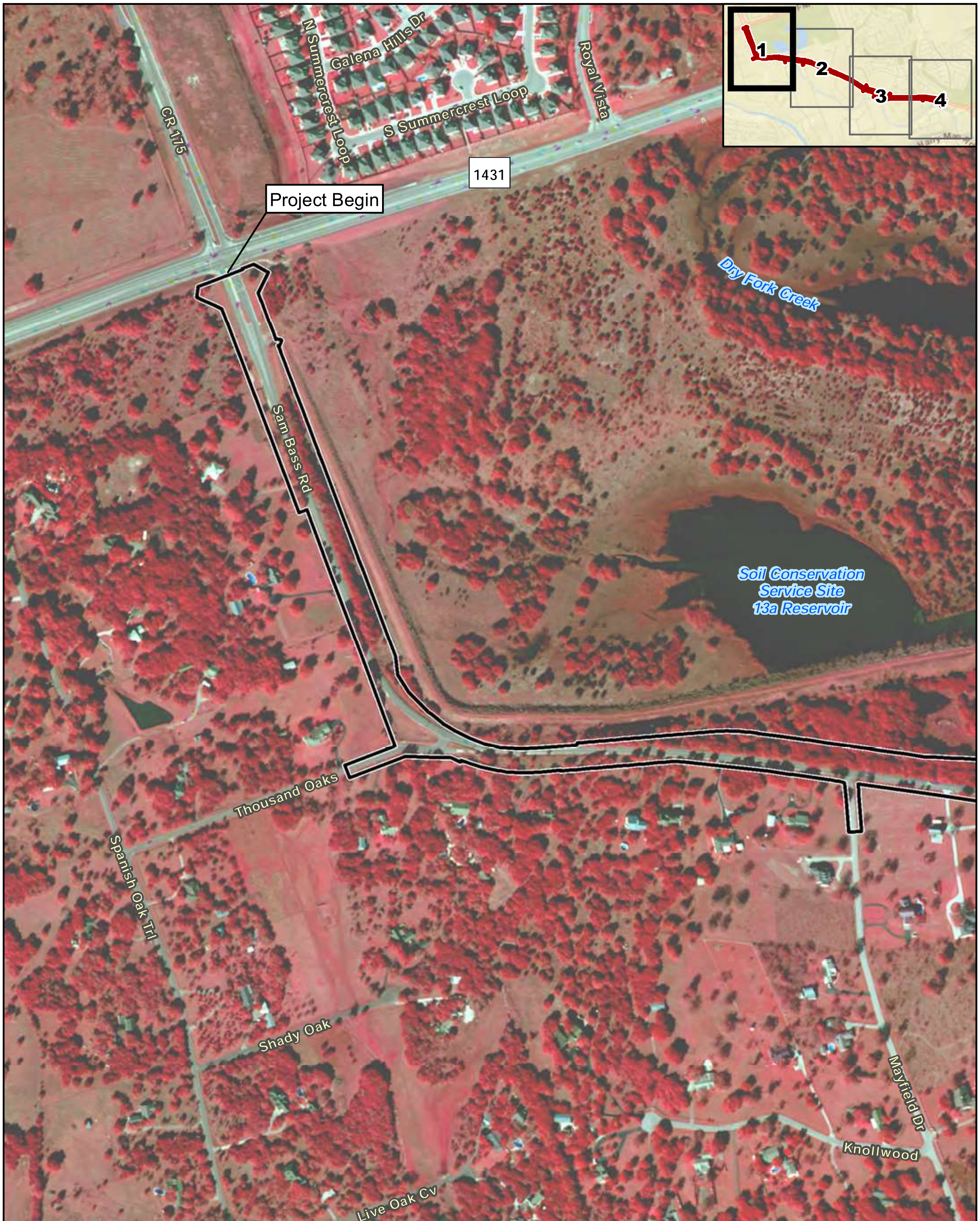
Wetland Hydrology Present? **Yes** ___ **No** ✓

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

No hydrology indicators present. Stagnant + low flowing water in the adjacent stream.

ATTACHMENT E: HISTORICAL AERIAL PHOTOGRAPHS



2004 Color Infrared Aerial Imagery
Sheet 1 of 4

Project Location

COX | McLAIN Environmental Consulting

0 500 Feet
0 150 Meters

1 in = 500 feet
Scale: 1:6,000
Date: 10/18/2021

Williamson County Corridor H - Sam Bass Road

Aerial Source: NAIP (2004)

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2004 Color Infrared Aerial Imagery
Sheet 2 of 4

Project Location

COX | McLAIN Environmental Consulting

0 500 Feet
0 150 Meters

1 in = 500 feet
Scale: 1:6,000
Date: 10/18/2021

Williamson County Corridor H - Sam Bass Road

Aerial Source: NAIP (2004)

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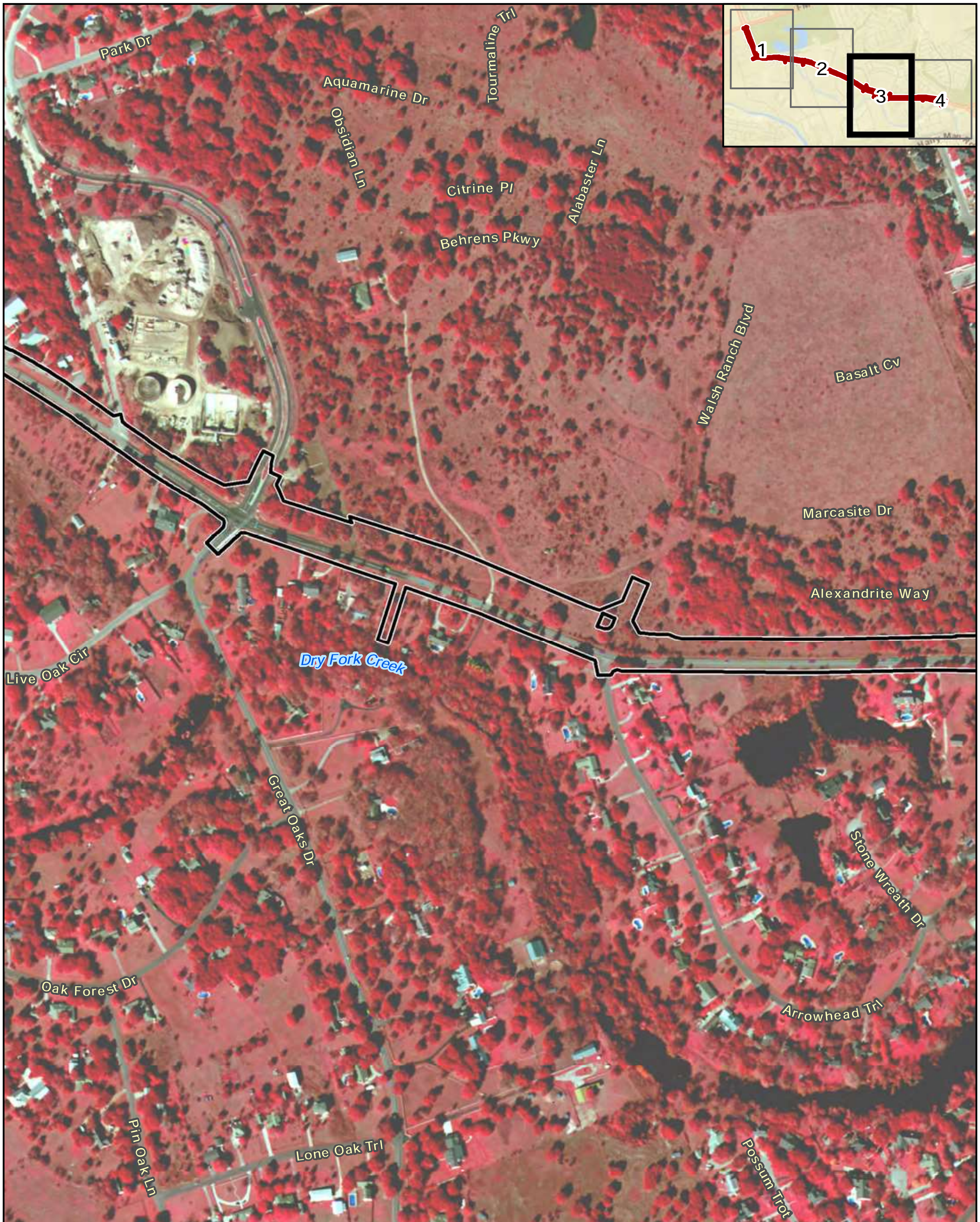

2004 Color Infrared Aerial Imagery
Sheet 3 of 4

Project Location

COX | McLAIN Environmental Consulting

0 500 Feet
0 150 Meters

1 in = 500 feet
Scale: 1:6,000
Date: 10/18/2021

Williamson County Corridor H - Sam Bass Road

Aerial Source: NAIP (2004)

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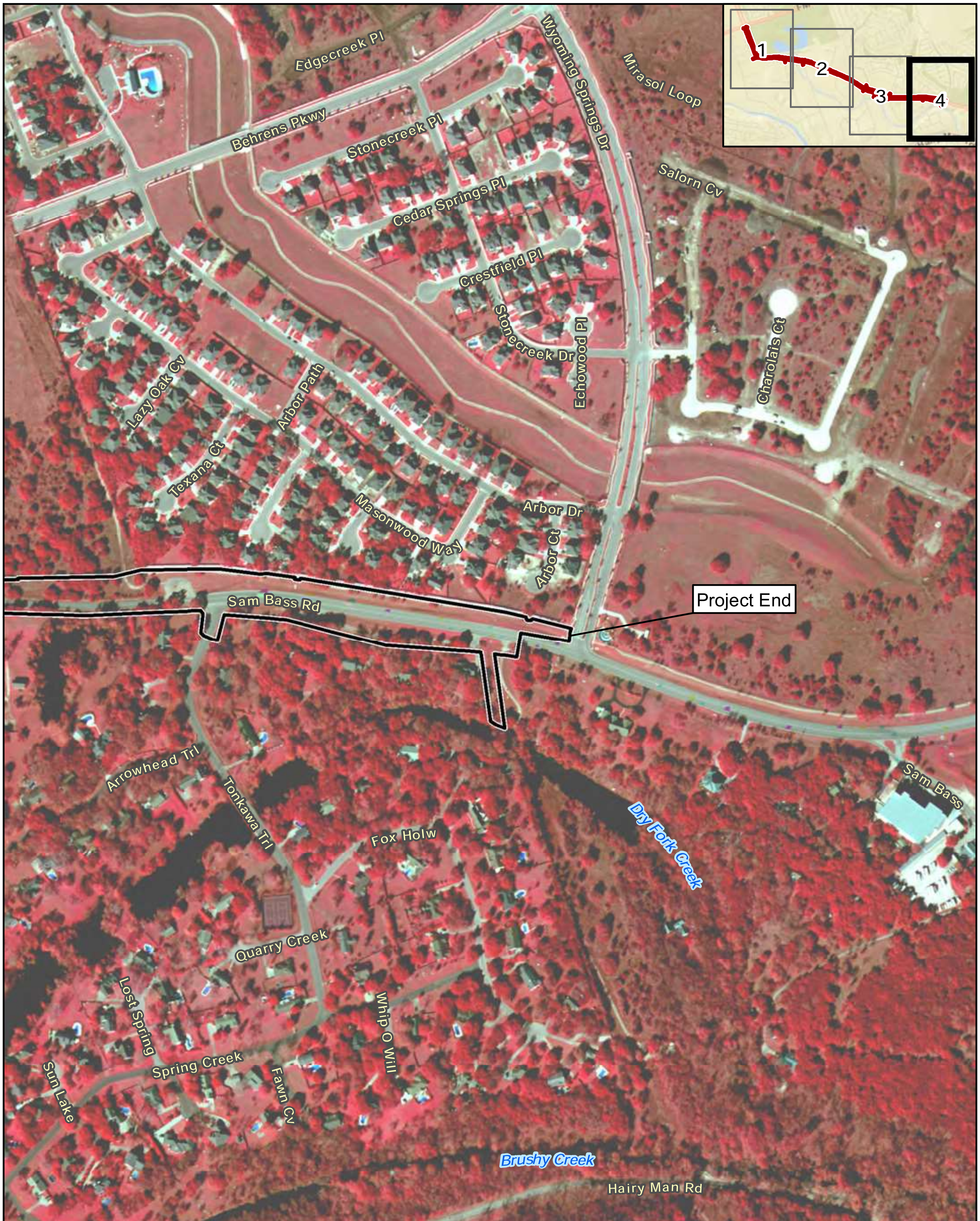

2004 Color Infrared Aerial Imagery
Sheet 4 of 4

Williamson County Corridor H - Sam Bass Road

Project Location

Aerial Source: NAIP (2004)

COX | McLAIN Environmental Consulting

0 500 Feet
0 150 Meters

1 in = 500 feet
Scale: 1:6,000
Date: 10/18/2021

G:\Projects\Williamson_County\H_Corridor\H_Corridor_Delineation_IR Imagery_20211018_TLS.mxd

2010 Color Infrared Aerial Imagery
Sheet 1 of 4

Project Location

COX | McLAIN
Environmental Consulting

0 500 Feet
0 150 Meters

1 in = 500 feet
Scale: 1:6,000
Date: 10/18/2021

Williamson County Corridor H - Sam Bass Road

Aerial Source: NAIP (2010)

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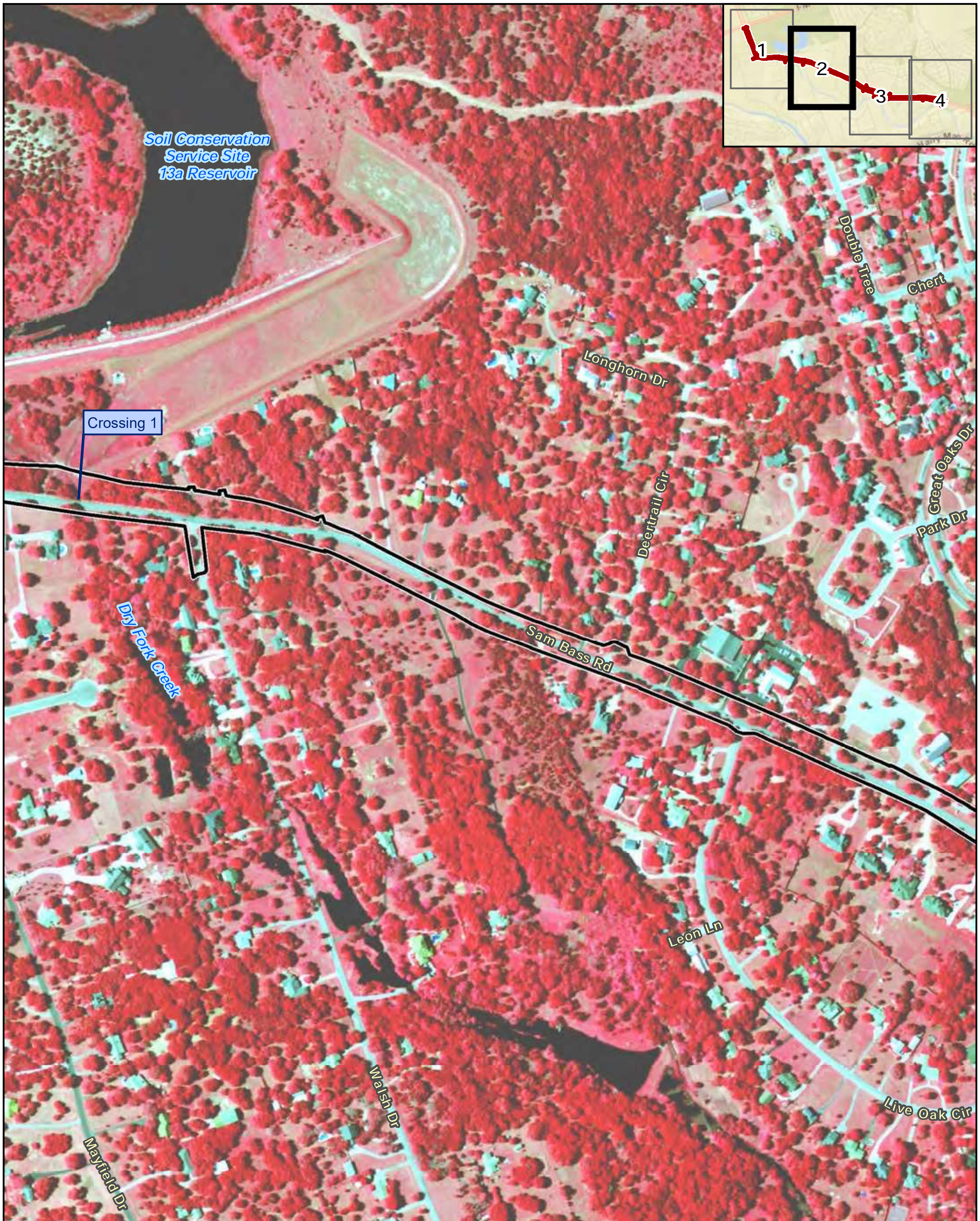

2010 Color Infrared Aerial Imagery
Sheet 2 of 4

Project Location

COX | McLAIN Environmental Consulting

0 500 Feet
0 150 Meters

1 in = 500 feet
Scale: 1:6,000
Date: 10/18/2021

Williamson County Corridor H - Sam Bass Road

Aerial Source: NAIP (2010)

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2010 Color Infrared Aerial Imagery
Sheet 3 of 4

Project Location

COX | McLAIN
Environmental Consulting

0 — 500 Feet	1 in = 500 feet
	Scale: 1:6,000
0 — 150 Meters	Date: 10/18/2021

Williamson County Corridor H - Sam Bass Road

Aerial Source: NAIP (2010)

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2010 Color Infrared Aerial Imagery
Sheet 4 of 4

Project Location

COX | McLAIN
Environmental Consulting

0 500 Feet	1 in = 500 feet
0 150 Meters	Scale: 1:6,000
	Date: 10/18/2021

Williamson County Corridor H - Sam Bass Road

Aerial Source: NAIP (2010)

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2015 Color Infrared Aerial Imagery
Sheet 1 of 4

Project Location

COX | McLAIN
Environmental Consulting

0 — 500 Feet		1 in = 500 feet
0 — 150 Meters		Scale: 1:6,000
		Date: 10/18/2021

Williamson County Corridor H - Sam Bass Road

Aerial Source: TOP (2015)

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2015 Color Infrared Aerial Imagery
Sheet 2 of 4

Project Location

COX | McLAIN Environmental Consulting

0 500 Feet
0 150 Meters

1 in = 500 feet
Scale: 1:6,000
Date: 10/18/2021

Williamson County Corridor H - Sam Bass Road

Aerial Source: TOP (2015)

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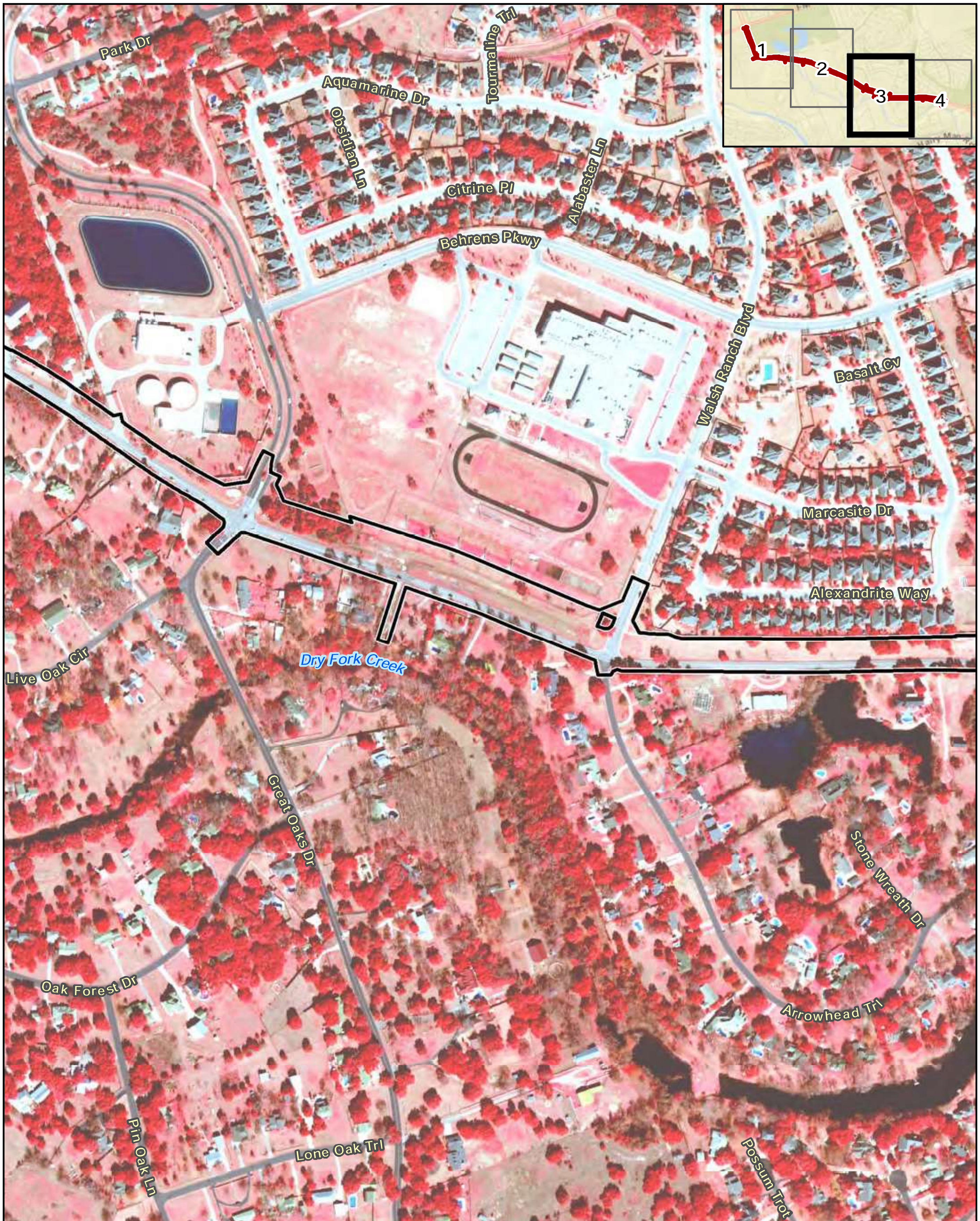

2015 Color Infrared Aerial Imagery
Sheet 3 of 4

Project Location

COX | McLAIN Environmental Consulting

0 — 500 Feet
0 — 150 Meters

1 in = 500 feet
Scale: 1:6,000
Date: 10/18/2021

Williamson County Corridor H - Sam Bass Road

Aerial Source: TOP (2015)

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2015 Color Infrared Aerial Imagery
Sheet 4 of 4

Project Location

COX | McLAIN Environmental Consulting

0 500 Feet
0 150 Meters

1 in = 500 feet
Scale: 1:6,000
Date: 10/18/2021

Williamson County Corridor H - Sam Bass Road

Aerial Source: TOP (2015)

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ATTACHMENT C

COLOR PHOTOGRAPHS

Please see photographs in Attachment B

ATTACHMENT D
SUMMARY TABLE OF SINGLE AND COMPLETE CROSSINGS

Attachment D: Summary Table of Single and Complete Crossings

Waterbody ID[1]	Latitude and Longitude (Decimal Degrees)	Resource Type[2]	Linear Feet in Project Area	Acres in Project Area	Impact Type[3]	Linear Feet of Impact	Average Width and Length of Impact	Acres of Impact	Cubic Yards of Material to be Discharged	PCN Required	Reason[4]
e.g., W-1	*32.755°N, -97.755°W*	*NFW*	-	*0.25*	*D/P*	-	-	*0.15*	*1210*	*Yes*	*A, B*
Dry Fork Creek	30.538479N, -97.751160W	IS	208	0.066	D/P	75	6/75	0.017	70	Yes	H

[1] Waterbody ID may be the name of a feature or an assigned label such as "W-1" for a wetland.

[2] Resource Types: NFW – Non-forested wetland, FW – Forested wetland, PS – Perennial Stream, IS – Intermittent Stream, ES – Ephemeral Stream, I – Impoundment

[3] Impact Types: D/P – Direct* and Permanent, D/T – Direct and Temporary, I/P – Indirect** and Permanent, I/T – Indirect and Temporary

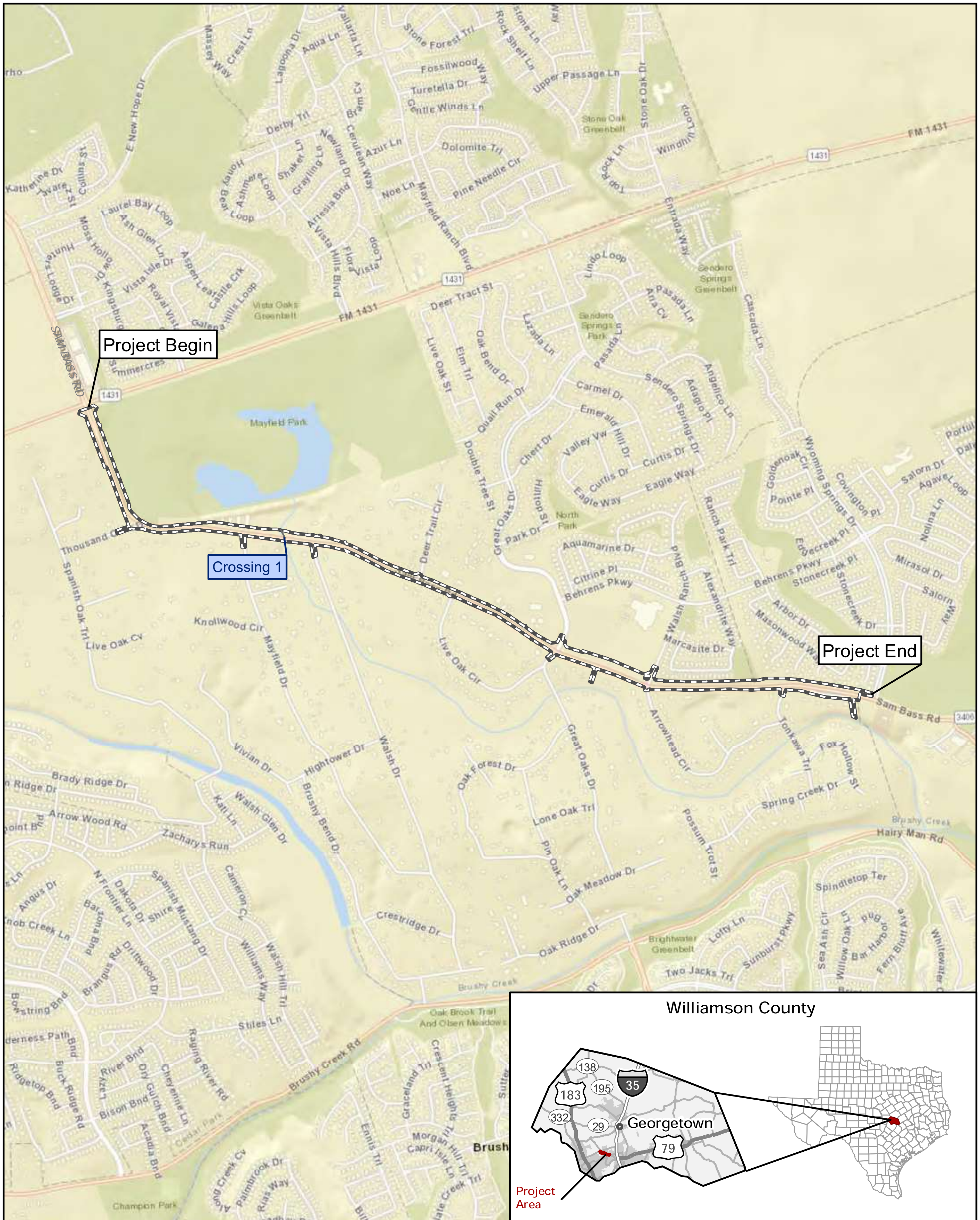
* Direct impacts are here defined as those adverse affects caused by the proposed activity, such as discharge or excavation.

** Indirect impacts are here defined as those adverse affects caused subsequent to the proposed activity, such as flooding or effects of drainage on adjacent waters of the U.S.

[4] Reasons for PCN requirement:

A – The loss of waters of the U.S. exceeds 1/10 acre
B – There is a discharge in a special aquatic site (e.g., wetlands)
C – Potential endangered species
D – Potential historic properties
E – Discharge into pitcher plant bog or bald cypress-tupelo swamp
F – Discharge into the area of Caddo Lake within Texas that is designated as a "Wetland of International Importance" under the Ramsar Convention
G – Required by Louisiana Regional Conditions
H – Other

ATTACHMENT E
REQUIRED DRAWINGS/FIGURES



Sheet 1 of 3
Project Location (Road Base)

Williamson County Corridor H - Sam Bass Road

Project Location

Data Source: CMEC (2018, 2019)
Basemap Source: Esri (2021)

N

COX | McLAIN Environmental Consulting

0 2,000 Feet
0 600 Meters

1 in = 2,000 feet
Scale: 1:24,000
Date: 10/18/2021

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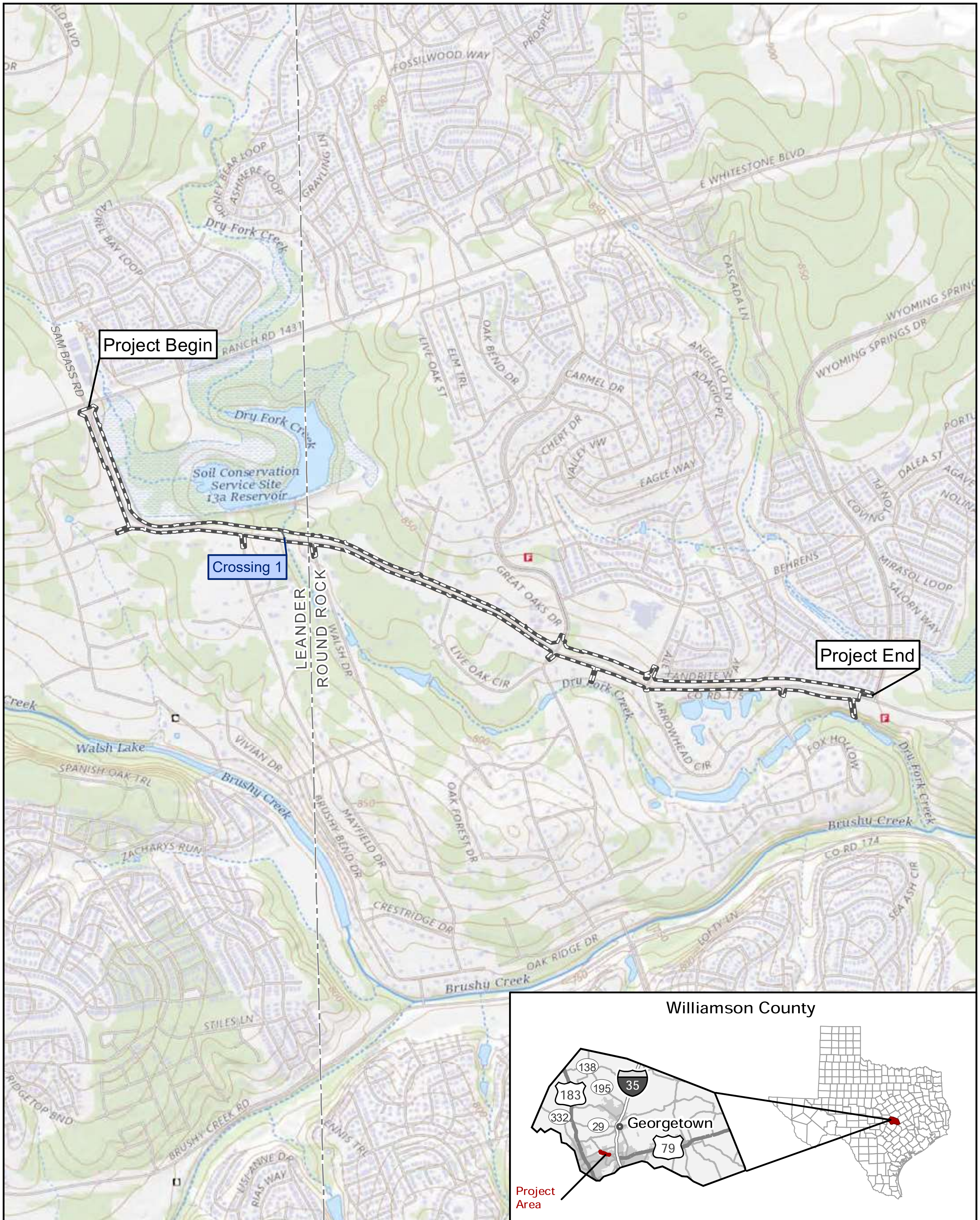

Sheet 2 of 3

Project Location (Topographic Base)

Williamson County Corridor H - Sam Bass Road

Project Location

COX | McLAIN Environmental Consulting

Data Source: CMEC (2018, 2019)
Topographic Source: USGS (2021)
USGS 7.5' Quadrangles: Leander, Round Rock

0 2,000 Feet
0 600 Meters

1 in = 2,000 feet
Scale: 1:24,000
Date: 10/18/2021

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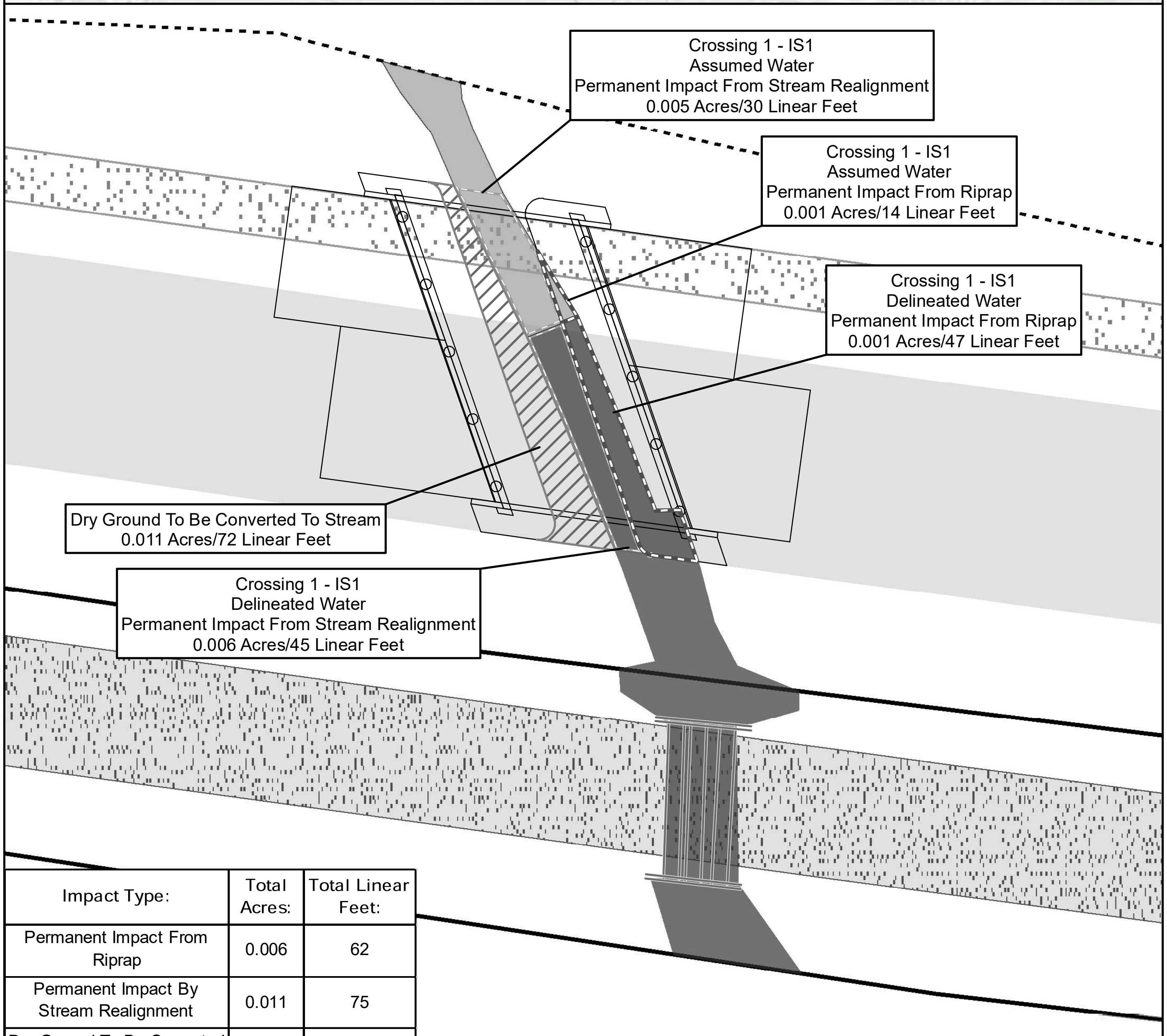

Impact Type:	Total Acres:	Total Linear Feet:
Permanent Impact From Riprap	0.006	62
Permanent Impact By Stream Realignment	0.011	75
Dry Ground To Be Converted To Stream	0.011	72

- Existing Right-of-Way
- Proposed Right-of-Way
- Proposed Roadway
- Proposed Sidewalk
- Road Removal
- Proposed Bridge
- Existing Culvert
- Assumed Water
- Delineated Water
- Permanent Impact From Riprap
- Permanent Impact By Stream Realignment
- Dry Ground To Be Converted To Stream

Sheet 3 of 3
Crossings

COX | McLAIN
Environmental Consulting

0 30 Feet
0 8 Meters

1 in = 30 feet
Scale: 1:360
Date: 10/18/2021

Williamson County Corridor H - Sam Bass Road

Data Sources: CMEC (2018-2019), KFA (2021)

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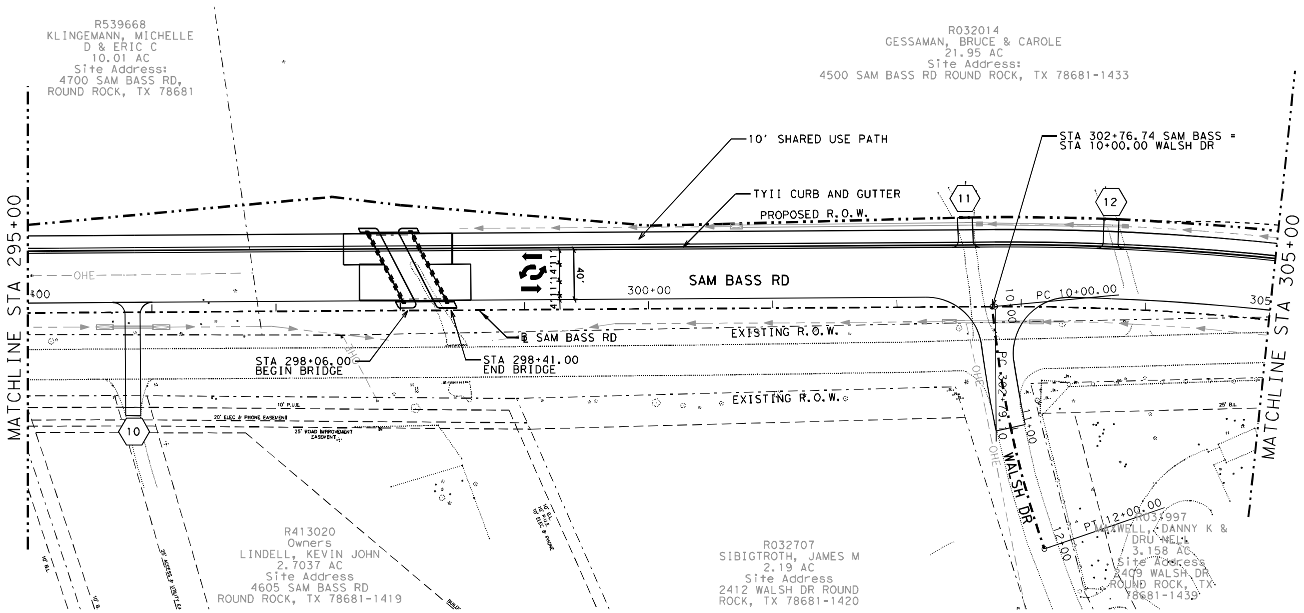


0 50 100(H)

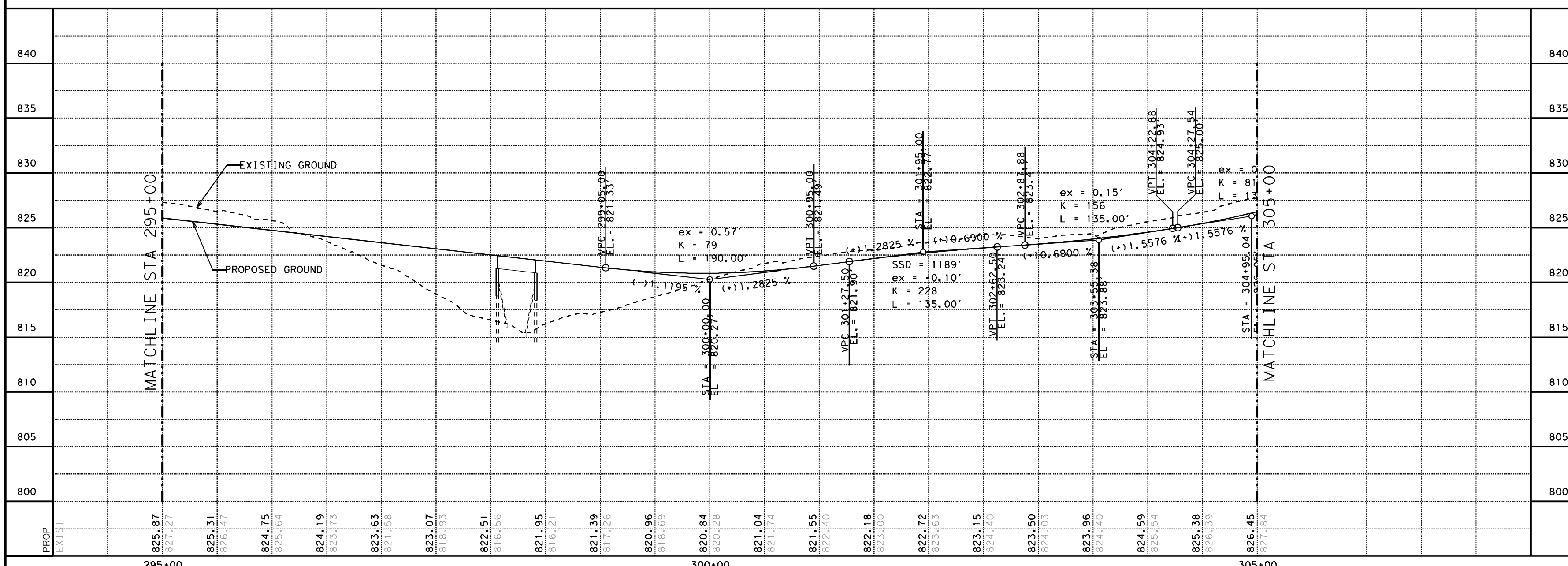
0 5 10 (V)

LEGEND

- EXIST EDGE OF PAVEMENT
- PROP EDGE OF PAVEMENT
- EXIST RIGHT OF WAY
- PROP RIGHT OF WAY
- EXIST EASEMENT
- PROP EASEMENT
- EXIST LANE
- PROP LANE
- BASELINE
- BRIDGE
- DITCH
- XX DRIVEWAY ID

NOTES

1. ALL UTILITIES SHALL BE FIELD VERIFIED PRIOR TO CONSTRUCTION. NOTIFY ENGINEER IMMEDIATELY IF CONFLICTS EXIST.



REV. NO.	BY	DATE	REVISION DESCRIPTION

THESE DOCUMENTS ARE FOR INTERIM REVIEW AND NOT FOR CONSTRUCTION, BIDDING OR PERMIT PURPOSES.

RESPONSIBLE ENGINEER: $ENGR$
TBPE NO. $ENGNO$
10/23/2020
DATE

K FRIESE + ASSOCIATES, INC.
1120 S. CAPITAL OF TEXAS HWY, II-100, AUSTIN, TX 78746

$CLIENT$
$PROJECT$
$SHTTITLE$
$SHTDESCRIP$

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING
(FIRM # 6535)

WILLIAMSON COUNTY 1848

$CLIENTS

SHEETGNOFGT

SCALE	$SCALE$
DATE	10/23/2020
SHEET NUMBER	$SN$$STS

10/23/2020 3:37:15 PM

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ATTACHMENT F
THREATENED OR ENDANGERED SPECIES REPORTS AND/OR LETTERS

Biological Assessment for the Sam Bass Road Widening Project Within the U.S. Army Corps Of Engineers Fort Worth District

USACE Fort Worth District File No. SWF-2021-00230

OCTOBER 2021

PREPARED FOR

U.S. Army Corps of Engineers
and
Williamson County

PREPARED BY

SWCA Environmental Consultants

BIOLOGICAL ASSESSMENT FOR THE SAM BASS ROAD WIDENING PROJECT WITHIN THE U.S. ARMY CORPS OF ENGINEERS FORT WORTH DISTRICT

USACE Fort Worth District File No. SWF-2021-00230

Prepared for

U.S. Army Corps of Engineers
Fort Worth District
819 Taylor Street
Fort Worth, Texas 76102
Attn: Joseph Shelnutt

and

Williamson County
701 Main Street, Suite 101
Georgetown, Texas 78726
Attn: Judge Bill Gravell, Jr.

Prepared by

SWCA Environmental Consultants
4407 Monterey Oaks Boulevard
Building 1, Suite 110
Austin, Texas 78749
(512) 476-0891
www.swca.com

SWCA Project No. 30932.26

October 2021

EXECUTIVE SUMMARY

Williamson County (Applicant) proposes to widen and make improvements to Corridor H (Sam Bass Road), an existing road in Round Rock, Williamson County, Texas (project). The project would cause the discharge of dredged or fill material into waters of the United States (WOTUS), activities that are regulated by the U.S. Army Corps of Engineers (USACE) under Section 404 of the Clean Water Act (CWA). The Applicant seeks verification from the USACE that certain of these regulated discharges of dredged or fill material into WOTUS are authorized under Nationwide Permit 14 for Linear Transportation Projects (USACE Proposed Action). The project has a single proposed WOTUS crossing within the USACE Fort Worth District that would require notification and review under Nationwide Permit General Condition 18 related to Endangered Species.

The project crosses documented habitat of two species that are listed as threatened or endangered under the Endangered Species Act, including a critical habitat unit (CHU) for one of those species. The project may affect the endangered Bone Cave harvestman (*Texella reyesi;* BCH) and the threatened Jollyville Plateau salamander (*Eurycea tonkawae*; JPS). The project may also affect the subsurface portion of the JPS CHU at Krienke Spring (CHU #1). The project is unlikely to adversely affect the JPS and adverse modification to CHU #1 is not anticipated. The project is also unlikely to adversely affect the BCH.

Table ES-1 summarizes the effect determinations for each of the species that may be affected by the project and the amount or extent of incidental take (or adverse effect for species where take is not applicable) for the project.

Table ES–1. Effects and Incidental Take Summary

Species	USACE Fort Worth District Action Areas	Applicant Action Areas	Total Proposed Project
Bone Cave Harvestman—Listed Endangered	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Jollyville Plateau Salamander—Listed Threatened	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Jollyville Plateau Salamander—CHU #1	None	3.1 acres of additional impact to subsurface portion of CHU #1	3.1 acres of additional impact to subsurface portion of CHU #1

The USACE and the Applicant request initiation of informal consultation with the U.S. Fish and Wildlife Service to receive concurrence that the project is not likely to adversely affect the BCH, the JPS, or CHU #1. The Applicant also proposes to obtain incidental take coverage for the BCH through the Williamson County Regional Habitat Conservation Plan.

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CONTENTS

Appendices

Figures

Tables

1 INTRODUCTION

1.1 Purpose

The purpose of this biological assessment (BA) is to support a federal interagency consultation between the U.S. Army Corps of Engineers (USACE) and the U.S. Fish and Wildlife Service (USFWS) in accordance with Section 7(a)(2) of the Endangered Species Act (ESA). The USACE evaluates requests for Nationwide Permit verifications to ensure that activities regulated under Clean Water Act (CWA) Section 404 comply with all specific, regional, and general conditions of the Nationwide Permits. The Applicant seeks verification from the USACE that certain of these regulated discharges of dredged or fill material into WOTUS are authorized under Nationwide Permit 14 for Linear Transportation Projects (USACE Proposed Action). The USACE Proposed Action includes a single proposed WOTUS crossing within the USACE Fort Worth District that would require notification and review under Nationwide Permit General Condition 18 related to Endangered Species. This BA evaluates the effects of the USACE Proposed Action, as defined in 50 Code of Federal Regulations (CFR) 402.02, taken by the USACE to authorize discharges of project-related dredged or fill material (in this case, widening a culvert) into waters of the United States (WOTUS) in the vicinity of federally protected species and near designated critical habitat. The culvert widening is a component of the Sam Bass Road improvement project (project), proposed for construction and implementation by Williamson County (Applicant). This BA provides the USACE with determinations of effects for the threatened and endangered species addressed herein and their designated critical habitat, as applicable.

1.2 Project Background

SWCA Environmental Consultants (SWCA) prepared this BA on behalf of the USACE Fort Worth District and the Applicant. The Applicant proposes to widen and make improvements along an approximately 2.5-mile-long portion of Corridor H (Sam Bass Road) between Ranch-to-Market Road (RM) 1431 and Wyoming Springs Drive in southern Williamson County (Figure 1). More specifically, the Applicant proposes to improve the two-lane portion of Sam Bass Road to a three-lane roadway and the four-lane roadway to include shoulders with much of the alignment reconstructed north of the existing roadway (project). The project would also include installation of a 10-foot-wide shared-use path north of the Sam Bass Road and intersection improvements at RM 1431, Walsh Ranch Boulevard, and Great Oaks Drive. The proposed construction footprint would cover approximately 38.3 acres (project area). Current land use is mostly existing roadway serving suburban residential communities. The project area is located primarily within the Northern Segment of the Edwards Aquifer Recharge Zone (EARZ) with the westernmost project extent occurring within the Northern Segment of the Edwards Aquifer Contributing Zone (EACZ) (Texas Commission on Environmental Quality [TCEQ] 2021).

Construction of the project is expected to cause the discharge of dredged or fill material into Dry Fork Creek, an intermittent stream that qualifies as a jurisdictional WOTUS. This activity is regulated by the USACE under Section 404 of the CWA. The Applicant seeks verification from the USACE that this regulated discharge of dredged or fill material into WOTUS would be authorized under Nationwide Permit 14 for Linear Transportation Projects. The Applicant made this request prior to the submittal of Pre-construction Notification (PCN) package to the USACE Fort Worth District. The PCN would be submitted to comply with Nationwide Permit General Condition 18 related to Endangered Species because the project area overlaps critical habitat that has been designated at Krienke Spring for the federally threatened Jollyville Plateau salamander (*Eurycea tonkawae*; JPS) and because the proposed project traverses potential habitat for the federally endangered Bone Cave harvestman (*Texella reyesi*; BCH).

Figure 1. Project location map.

1.3 Regulatory Background

Section 7(a)(2) of the ESA addresses federal agency actions and consultations. This section of the ESA states that:

> *…Each Federal agency shall, in consultation with and with the assistance of the Secretary [of the Interior], insure that any action authorized, funded, or carried out by such agency (hereinafter in this section referred to as an "agency action") is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined by the Secretary, after consultation as appropriate with affected States, to be critical…In fulfilling the requirements of this paragraph each agency shall use the best scientific and commercial data available.*

Federal agencies have the responsibility and obligation to determine whether their activities "may affect" listed species or designated critical habitats. As currently defined in 50 CFR 402.02 and amended on August 27, 2019, by USFWS and the National Marine Fisheries Service (NMFS) (Federal Register 84:44976), this evaluation of effects addresses "…all effects on the listed species or critical habitat that are caused by the proposed action, including the effects of other activities that are caused by the proposed action. An effect or activity is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include effects occurring outside the immediate area involved in the action."

If a federal agency determines that its activity would have "no effect" on listed species or designated critical habitats, then no coordination with or concurrence from the USFWS is necessary under ESA Section 7(a). However, if the federal action "may affect" listed species or designated critical habitats, even if the effect is entirely beneficial, then some degree of consultation or conference with the USFWS is required.

The USFWS and NMFS are responsible for administering the ESA and have published guidance for implementing the ESA Section 7 consultation process in a handbook entitled *Endangered Species Consultation Handbook: Procedures for Conducting Consultation and Conference Activities under Section 7 of the Endangered Species Act* (Consultation Handbook; USFWS and NMFS 1998). The Consultation Handbook identifies the following potential outcomes for evaluating the effects of a proposed federal action (see USFWS and NMFS 1998:x-xix):

No Effect—The appropriate conclusion when the federal agency determines its proposed action would not affect listed species or designated critical habitat.

May Affect—The appropriate conclusion when a proposed federal action may pose any effects on listed species or designated critical habitat. When the federal agency proposing the action determines that a "may affect" situation exists, then it must either initiate formal consultation/conference or seek written concurrence from the USFWS that the action "is not likely to adversely affect" listed species or designated critical habitat.

Is Not Likely to Adversely Affect—The appropriate conclusion when effects on listed species or designated critical habitat are expected to be discountable, insignificant, or completely beneficial. Beneficial effects are contemporaneous positive effects without any adverse effects to the species. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur. Based on the best judgment, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur.

Is Likely to Adversely Affect—The appropriate conclusion if any adverse effect to listed species or designated critical habitat may occur as a direct or indirect result of the proposed federal action, and the effect is not discountable, insignificant, or beneficial. In the event the overall effect of a proposed action is beneficial to listed species or designated critical habitat, but is also likely to cause some adverse effect, then the proposed federal action "is likely to adversely affect" the listed species or designated critical habitat. If incidental take is anticipated to occur as a result of the proposed federal action, a determination of "is likely to adversely affect" should be made. An "is likely to adversely affect" determination requires the initiation of formal consultation.

When evaluating whether a proposed federal action may affect listed species or designated critical habitat, the USFWS considers the effects of the proposed federal action in concert with the effects of any interrelated or interdependent actions. Interrelated actions are those that have no independent utility apart from the proposed federal action. Interdependent actions are those that are part of a larger action and depend on the larger action for their justification (50 CFR 402.02).

During consultation, the action agency (here, USACE) determines if the proposed federal action "may affect" but is "not likely to adversely affect" listed species or designated critical habitats or if the activity "may affect" and is "likely to adversely affect" listed species or designated critical habitats. If the action agency determines adverse effects are not likely, then consultation may be completed informally with written concurrence from the USFWS. If the action agency determines adverse effects are likely or USFWS does not concur in the action agency's determination that the federal action is not likely to adversely affect listed species or result in the destruction or adverse modification of designated critical habitat, then a formal consultation between the action agency and the USFWS may be warranted. A BA (or similar document) provides the action agency's assessment of likely effects to listed species and designated critical habitat associated with its proposed federal action.

If formal consultation is necessary, the USFWS prepares a biological opinion (BO) wherein the agency determines whether the effects of the proposed federal action are expected to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. In the event the USFWS determines jeopardy of a species or destruction or adverse modification of critical habitat would occur, the agency proposes Reasonable and Prudent Alternatives to the proposed federal action, if available, that would avoid these outcomes. In a BO, the USFWS also describes the amount and extent of take that is likely to occur, identifies Reasonable and Prudent Measures to minimize take, and includes an Incidental Take Statement (ITS) with terms and conditions needed to implement the Reasonable and Prudent Measures. The ITS authorizes take of listed species that otherwise would be prohibited under Section 9 of the ESA. The action agency then implements the terms and conditions of the BO and ITS.

The ESA defines *take* as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" (16 United States Code 1532 [19]). *Harm* is defined by USFWS regulations as an "act which actually kills or injures wildlife and may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns including breeding, feeding or sheltering" (50 CFR 17.3). The USFWS issued guidance to its Regional Directors on April 26, 2018, further clarifying that a demonstration of harm via habitat modification must find that habitat modification is likely to be significant, that the significant habitat modification also is likely to significantly impair an essential behavior pattern of a listed species, and that the significant behavioral impairment is likely to result in the actual killing or injuring of listed wildlife (USFWS 2018a).

As required by Section 7(c) of the ESA, this BA includes the information required to initiate formal interagency consultation with the USFWS, should it be necessary, including:

- a description of the action being considered;
- a description of the specific area that may be affected by the action;
- a description of the listed species and critical habitat that may be affected by the action;
- relevant reports, including dye trace studies and geotechnical investigation; and
- other relevant studies and information available on the action, listed species, and critical habitat.

1.4 Action Areas

The JPS and BCH are the focus species of this BA due to their likely occurrence within the project area. Based on recommendations provided to SWCA by the Fort Worth District Regulatory Division of the USACE, this BA defines the ***USACE Action Area*** (UAA) for the proposed project as the segment of Dry Fork Creek channel within the limits of its ordinary high-water marks in which the new culvert installation would be installed plus a buffer of 300 feet in all directions. The proposed culvert installation would be approximately 65 feet long and result in up to 0.03 acre of new impacts within the UAA portion of Dry Fork Creek. The UAA also includes a 300-foot buffer around the proposed culvert installation at Dry Fork Creek, which covers approximately 8.4 acres. The project would remove an existing culvert within the UAA portion of Dry Fork Creek that serves the current Sam Bass Road and occupies approximately 46 linear feet (approximately 0.01 acre) of channel.

Under these same recommendations, this BA defines the ***Applicant's Action Area*** (AAA) as all lands occurring within the proposed construction footprint plus the entirety of the JPS Critical Habitat Unit (CHU) around Krienke Spring (CHU #1), excluding the land and water within the UAA. The AAA encompasses approximately 102.1 acres. Combined, ***Action Areas*** is the term used in this BA to describe both the UAA and AAA. Figure 2 depicts the location and extent of the UAA and AAA.

1.5 Jollyville Plateau Salamander (*Eurycea tonkawae*) – Background

The JPS is an entirely aquatic, lungless salamander that retains external gills for the duration of its life cycle (Bendik et al. 2013). The USFWS listed the JPS as a threatened species in 2013 due to its restricted known range and threats associated with the rapid expansion of development around the city of Austin (USFWS 2013a). The USFWS identified threats to the JPS that include decreased water quality, decreased water quantity, increased sedimentation, habitat modification via urbanization and development, and hazardous spills into the EARZ (USFWS 2013a).

Bowles et al. (2006) and Bendik et al. (2014) indicate the JPS occupies both surface and aquifer habitats that are typically characterized by clear, flowing waters derived from the Edwards Aquifer; substrates composed of gravel, cobble, aquatic plants, and leaf litter; and typical water temperature ranging between 61.7 and 73.4 degrees Fahrenheit. The JPS is dependent upon on springs and subterranean aquatic karst habitat in the Edwards Aquifer (Bowles et al. 2006). Karst refers to a landscape formed through modification of bedrock by chemical dissolution that is characterized by caves, sinkholes and springs. The species is known from approximately 125 locations (Adcock, MacLaren, Bendik, et al. 2020) near the cities of Austin and Round Rock, in both Travis and Williamson Counties.

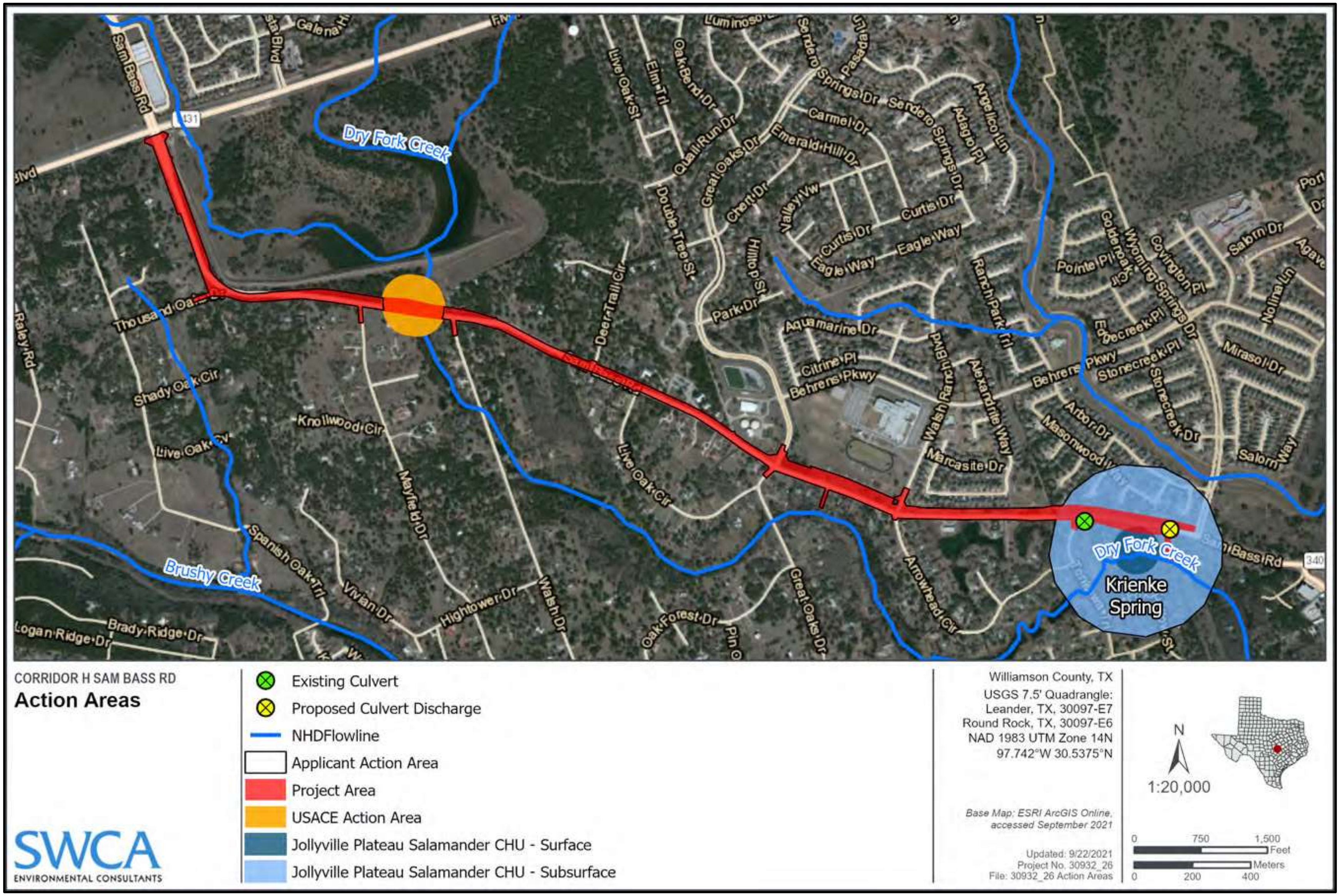

Figure 2. Location Map Depicting Culvert Relocation Site, Action Areas, Krienke Spring Critical Habitat Unit (CHU), National Hydrography Dataset (NHD) flowlines (U.S. Geological Survey 2018a).

Aside from documented spring localities, little is known about the extent of the range of the JPS within the Edwards Aquifer itself. In fact, the extent to which JPS (and other related salamanders in Texas) inhabit the Edwards Aquifer is not well known due to the inaccessibility of the subterranean habitat and the poor understanding of subsurface aquifer connectivity and the ecology of these salamanders (USFWS 2013b). Krienke Spring was once thought to be northernmost range extent for the species; however, Devitt et al. (2019) posit that a single individual collected in Georgetown, Williamson County, is genetically more closely related to JPS than to its nearest congener, the Georgetown salamander. The Georgetown locality is approximately 8.9 miles northeast of the Krienke Spring and if this individual is accepted as a JPS, it would greatly expand the range of the JPS and suggest its range could overlap that of the Georgetown salamander.

USFWS (2013b) designated critical habitat for the JPS in Williamson and Travis Counties. This includes CHU #1 around Krienke Spring, which is divided into a surface unit and subsurface unit. The surface unit includes the spring portal and associated spring run extending upstream and downstream 262 feet (80 meters). The subsurface portion of CHU #1 is drawn as a circle that extends 984 feet (300 meters) from Krienke Spring.

1.6 Bone Cave Harvestman (*Texella reyesi*) – Background

The BCH occurs in caves and other karst features formed in the Edwards Formation in Williamson and Travis Counties. This species typically occurs in karst features lacking sunlight and that possess high humidity, relatively constant temperature, and receive nutrients from surface plant and animal communities (USFWS 2018a). However, detailed life history information (e.g., diet, reproduction) is currently unknown (USFWS 2018a).

Cave crickets (*Ceuthophilus* spp.) are thought to represent a vital nutrition source for karst environments because these insects forage on the surface at night and deposit valuable nutrients in the subterranean environment in the form of waste products (USFWS 2012). The Williamson County Regional Habitat Conservation Plan (WCRHCP) considers the 345-foot “cricket foraging area” around a cave to represent the maximum distance these species utilize when foraging for food (SWCA et al. 2008). As such, the WCRHCP indicates the cricket foraging area of importance for the BCH.

The USFWS commissioned George Veni and Associates (1992) to perform a study that ultimately delineated four geographic zones (the Veni Karst Zones) according to their potential to provide suitable habitat for karst invertebrates. Veni and Martinez (2007) later updated these results using electronic mapping techniques. The zones were based on lithology, distributions of known caves and cave fauna, and geologic controls on cave development. The zones were delineated as follows.

Zone 1: Areas known to contain endangered cave species.

Zone 2: Areas having a high probability of endangered or other endemic invertebrate cave fauna.

Zone 3: Areas that probably do not contain endangered cave species.

Zone 4: Areas that do not contain endangered cave species.

2 DESCRIPTION OF THE PROPOSED PROJECT

2.1 Existing Conditions

Sam Bass Road within the project area is a generally east/west thoroughfare with pavement that varies in width from approximately 22 to 45 feet and a ROW width of approximately 50 feet. Sam Bass road is currently a two-lane (one lane in each direction) roadway with no shoulders and no center turn lane from RM 1431 to Tonkawa Trail; however, there is a center turn lane at the intersection with Great Oaks Drive. Sam Bass Road currently widens from two travel lanes to four travel lanes (two in either direction) from Tonkawa Trail to Wyoming Springs Drive. The widening portion of the project area extends for a linear distance of approximately 2.5 miles from approximately 875 feet west of Wyoming Springs Drive on the east end to RM 1431 on the west end. Several cross streets intersect this segment of Sam Bass Road; from east to west these include Tonkawa Trail, Walsh Ranch Boulevard, and Great Oaks Drive. Surface elevation of the road in the Action Areas ranges from approximately 785 to 865 feet above mean sea level (amsl), with elevations generally decreasing from west to east. Grassy swales are present along both sides of Sam Bass Road along the entirety of the project area. These swales convey or treat stormwater and may also serve as roadside buffers.

From the west end of the project area to Tonkawa Trail (approximately 2.3 miles), Sam Bass Road currently has one 11-foot-wide travel lane in each direction with no shoulders on either side. Over this segment, left-turn lanes are present at the Great Oaks Drive intersection in each direction. No shoulders currently exist within any portion of the project area. A single shared-use path runs on the north side of Sam Bass Road from the east end of the project area to Walsh Ranch Boulevard, a distance of approximately 0.6 mile. No shared-use paths or center-turn lanes occur within the project area.

Drainage of surface water runoff from Sam Bass Road and across the project area is conveyed through roadside ditches, where present. Six cross culverts are located within the project area. The roadside ditches, along with driveway and intersection culverts, form a parallel system that convey water to the cross culverts. One of the culverts directs untreated stormwater from land north of Sam Bass Road south, onto a property adjacent to Sam Bass Road. The stormwater then flows south along a vegetated depression in the landscape for approximately 570 feet towards Dry Fork Creek, where it enters that drainage approximately 380 feet upstream of the Krienke Spring run (see Figure 2). This culvert consists of two 24-inch corrugated metal pipes, which are undersized for its catchment area; therefore, stormwater frequently overtops the road at this location, creating a safety hazard (K Friese & Associates 2019). Current runoff from existing pavement within the project area is left untreated.

2.2 Proposed Project

The proposed project entails reconstructing Sam Bass Road to a three-lane section from 875 feet west of Wyoming Springs Boulevard to RM 1431. Sam Bass Road would essentially be shifted north (see Figure 1) and the existing roadway would be removed and vegetated. This portion of the proposed project would consist of the following components:

- Construction of two 11-foot-wide lanes (one in either direction) and a 14-foot-wide, two-way left-turn lane with a 4-foot-wide shoulder on its south side.
- Construction of a new 10-foot-wide shared-use path along the north side of Sam Bass Road from RM 1431 to Wyoming Spring Drive.
- The width of the new Sam Bass Road ROW would increase from 50 feet and would range between 94 and 136 feet between RM 1431 to Tonkawa Trail.

- At RM 1431: A second turn lane would be added for northbound traffic on Sam Bass Road.
- At Great Oaks Drive: Traffic signals would be installed to replace current stop sign.
- At Walsh Ranch Boulevard: Traffic signals would be installed to replace current stop sign.
- An existing drainage easement on the south side of Sam Bass and approximately 625 feet east of the intersection with Great Oaks Drive will be widened to approximately 30 feet. Grading will likely remove 2-3 feet of substrate (soil/rock) from this location and will occur across approximately 0.2 acre. This drainage easement will continue moving treated runoff from Walsh Middle School towards Dry Fork Creek.
- One culvert directing untreated stormwater upstream from Krienke Spring would be relocated 1,180 feet to the east and downstream from Krienke Spring. See Section 2.3.4 for additional details.
- Removing 8.9 acres of existing pavement along Sam Bass Road after completion of the proposed project.
- Revegetating areas where pavement is removed.

Design plans from Tonkawa Trail would not include road widening since Sam Bass Road is already four lanes; however, the shared-use path would extend through this area. Project design plans are not completely finalized and some changes to the proposed project may still occur. Proposed project activities may include the following:

- Vegetation removal
- Temporary construction easements
- Grading
- Roadway construction including excavation
- Storm drain construction
- Drilled shafts for signal foundations
- Adding shared-use path
- Installation of detention ponds
- Installation of vegetative filter strips for water quality treatment
- Revegetating areas disturbed during construction
- Pavement removal
- Revegetating areas where pavement is removed

Project activities would result in alterations of the surface and, to some extent, subsurface environment within the project area. Surface alterations would include the reconfiguration of existing road surfaces and disturbance of existing grassy swales. Temporarily disturbed areas are likely to be replanted with grasses, but some of the swales currently present in the existing ROW would be replaced with new impervious cover in the form of additional travel lanes and supporting infrastructure (e.g., stoplights, signage, water quality treatment facilities, etc.). Subsurface activities are likely to include shallow excavations/grading at or near the surface to reshape the topography and provide appropriate surfaces, grades, and elevations for road construction. Roadway construction generally requires excavation between 2 and 5 feet deep, with storm sewer trunk lines (storm drains) requiring excavations 5 to 8 feet deep. Anticipated excavation volumes for various project activities are shown in Table 1.

Table 1. Anticipated excavation depths and volumes within CHU #1

Project Component	Maximum Excavation Depth (Feet)	Excavation (Cubic Yards)
Roadway (e.g., grading and road widening)	3	24,010
Storm Drain System	8	245
Total Excavation		**24,255**

Overall, the proposed project area covers approximately 38.3 acres, with 24.3 acres of that area previously disturbed by construction of Sam Bass Road and by excavation outside the roadway for drainage work. The amount of impervious cover in the project area would increase from approximately 11.3 acres to 18.7 acres due to road widening and the addition of a shared-use path. The project would add approximately 3.1 acres of impervious cover within the area designated as critical habitat for the JPS.

2.2.1 Project Timeline

The project duration is anticipated to be approximately 20 months, starting in spring or summer 2022.

2.2.2 Construction Access and Staging

Construction access and staging would likely occur within existing ROW, proposed ROW, and temporary construction easements. The proposed project would be constructed while traffic continues to utilize the existing Sam Bass Road. Traffic would then shift to the newly constructed project and pavement would be removed from those areas of Sam Bass Road no longer designated for traffic use. The current Sam Bass Road may provide construction access and staging after the proposed project is constructed. However, full details on access and staging cannot be determined until the design is finalized and a construction contractor is selected.

2.2.3 Post-Project Site Restoration

All disturbed areas would be revegetated to the standard practices of the Applicant, including its *Protocol for Sustainable Roadsides* (TBG Partners et al. 2010), which will include areas where pavement is removed from the existing Sam Bass Road.

2.2.4 Water Quality and Controls

K Friese & Associates (2019) reported that surface water runoff from Sam Bass Road within the project area is untreated and, therefore, does not meet water quality standards currently required for new roadways constructed atop the EACZ, as regulated by the Edwards Aquifer Protection Program (EAPP) of the TCEQ. Current TCEQ water quality standards require roadway runoff be treated to achieve 80% removal of total suspended solids (TSS). K Friese & Associates (2019) indicates that vegetation filter strips would be installed during the interim project phase to remove 5,631 pounds of TSS along 7,365 linear feet of roadway and that 12,421 pounds of TSS would be removed upon project completion using various water quality methods.

Because the project area is located within the EARZ and EACZ, a Water Pollution Abatement Plan (WPAP) would be prepared and submitted to the TCEQ and then implemented during the construction phases of the project. Surface water runoff from the additional impervious cover would be treated by vegetative filter strips. K Friese & Associates (2019) indicates the additional impervious cover is anticipated to contribute a total TSS load of 6,415 pounds and the proposed water quality controls are anticipated to remove a total TSS load of 8,009 pounds.

Stormwater discharge activities atop the EARZ and EACZ must also comply with the EAPP. As such, a Stormwater Pollution Prevention Plan, a Notice of Intent, and Notice of Termination would be prepared and submitted to TCEQ in accordance with the Texas Pollutant Discharge Elimination System (TPDES) requirements. Temporary erosion and sedimentation controls (e.g., perimeter silt fences, stabilized construction entrances) and construction control measures (e.g., rock berms, silt fencing, slope stabilization, permanent erosion prevention measures, site restoration) would be installed, per TPDES guidelines.

TCEQ enforces construction adherence to the EAPP for regulated activities performed atop the EARZ (see 30 Texas Administrative Code [TAC] 2013.3[28] and 30 TAC 213.22[6] for definition of regulated activities). To ensure contaminated runoff does not enter the Edwards Aquifer, the EAPP requires use of best management practices (BMPs) as part of the Texas Surface Water Quality Standards, which are designed to protect Texas' surface waters along with accompanying aquatic life, recreation, and public water supply sources. Stream segments capable of recharging the Edwards Aquifer are subject to compliance with the Texas Surface Water Quality Standards. The Applicant anticipates implementing BMPs detailed within Barrett (2005) for full EAPP compliance to minimize potential impacts to groundwater and surface waters.

Design plans indicate the following temporary and permanent BMPs would be applied to the Project, although this list is not necessarily comprehensive:

- Mulch socks
- Fiber mulching
- Silt fencing
- Erosion control logs
- Rock filter dams
- Permanent sodding
- Grassy swales

Surface water runoff from impervious cover would be treated to 80% removal efficiency of TSS, and other water quality degradation measures would meet minimum standards set by TCEQ EAPP, discussed above.

2.2.5 Operation and Maintenance

The Applicant's standard practices for roadway operations and maintenance would be implemented following the completion of post-project site restoration. Ongoing activities performed by the Applicant would be restricted to standard maintenance practices for intersections and roadways. These activities are expected to include (but are not restricted to) mowing, pothole repair, repainting the road, resealing the road, maintenance of traffic signs and signals, storm drain system maintenance, water quality pond maintenance, and repairing storm damage. Standard maintenance activities typically do not require vegetation clearing or excavation.

2.3 Applicant-proposed Conservation Measures

The project is being designed to minimize the need for excavation and maximize the use of existing fill material within the project area to reduce impacts to subsurface limestone, which is a major component of BCH and JPS habitat. As part of the project, the Applicant proposes to implement certain voluntary conservation measures to minimize the likelihood and magnitude of adverse effects of the project on listed species. The beneficial effects of these voluntary conservation measures are considered in the analyses of the effects of the USACE Proposed Action. The voluntary conservation measures are discussed more fully below in Sections 2.3.1 – 2.3.4 and include:

- Participation in the WCRHCP to provide incidental take coverage of the BCH
- Contractor education/awareness
- Implementation of void discovery protocols
- Relocation of an existing culvert system that directs runoff towards Dry Fork Creek to downstream location from Krienke Spring

2.3.1 Participation in Williamson County Regional Habitat Conservation Plan (WCRHCP)

The Applicant and the Williamson County Conservation Foundation are the permittees under the federal ESA incidental take permit number TE-181840-1 dated October 21, 2008 (as amended August 30, 2013) that established the WCRHCP. The permit authorizes the incidental "take" of "covered" listed species of wildlife in Williamson County expected to result from road construction, maintenance, land clearing, or land development projects in exchange for implementation of permanent conservation measures. Covered species in the WCRHCP are the golden cheeked warbler (*Setophaga chrysoparia*), BCH, and another karst invertebrate, the Inner Space Caverns mold beetle (*Batrisodes texanus*). Participation in the WCRHCP funds protection of caves with documented occurrence of endangered karst invertebrates, including their intact associated surface communities.

The Applicant would seek WCRHCP enrollment for karst impacts across Karst Zone 1 within the project area, which totals approximately 15.7 acres. However, WCRHCP participation is rounded up to the nearest whole acre, so the Applicant would apply for Karst Zone 1 coverage across 16 acres. Participation in the WCRHCP would occur prior to commencement of construction.

2.3.2 Contractor Awareness/Education

The Applicant would hold a preconstruction meeting with employees and contractors involved with the project to provide training and instructions regarding BMPs and conservation measures. The Applicant would provide an information packet to contractors, including information on karst species and karst habitat that may occur inside of the ROW and requirements to avoid impacts to species of concern and their habitats.

2.3.3 Void Discovery Protocol

In the event subsurface void space is encountered during excavation, all activities would stop around the void. The Applicant would then notify TCEQ and follow guidance from Barrett (2005) to maintain compliance with the EAPP. This guidance instructs the Applicant to contact the relevant TCEQ regional office and not resume activities until the TCEQ executive director has reviewed and approved protection methods to protect the feature and underlying Edwards Aquifer from potentially adverse impacts to water quality. For the purpose of this protocol, a void shall be defined as any open space in bedrock greater than 6 inches across in any direction or greater than 1 square foot along any plane, or any void that blows air, continually receives water during a rain event, or has water flowing through or out of it.

As indicated in Section 2.3.1, the Applicant would enroll the project within the WCRHCP to authorize incidental take of the BCH. The WCRHCP states that “Impacts to previously undetected voids occupied by covered karst species are covered by the Karst Zone fee, as are any impacts to a known cave’s ecosystem resulting from surface disturbance more than 345 feet from the cave’s footprint.” Therefore, if karst voids are encountered during excavation in previously undisturbed bedrock, the Applicant would not be obligated to evaluate it for karst invertebrate habitat or occupation.

2.3.4 Culvert Relocation

An existing culvert directs untreated stormwater from Sam Bass Road southwards towards Dry Fork Creek, where it enters that drainage approximately 380 feet upstream of the Krienke Spring run. The current culvert location is approximately 80 east of the intersection with Tonkawa Trail. The Applicant proposes to relocate that same culvert 1,180 feet eastward (approximately 50 feet west of the intersection with Wyoming Springs Drive) so that treated stormwater enters Dry Fork Creek approximately 460 feet downstream from Krienke Spring. There is an existing culvert and drainage easement at this location. The drainage easement would be widened to approximately 30 feet and grading would remove 2-3 feet of substrate (soil/rock) across approximately 0.3 acre to accommodate the increased flow. Figure 2 shows the location of the existing culvert and proposed relocation site relative to Krienke Spring. The Applicant has committed to not placing any storm drains or water quality ponds within the limits of CHU #1.

2.4 Prior Agency Coordination

The Applicant coordinated with the USACE Fort Worth District while planning for the project and in the preparation of this BA. The Applicant also informally coordinated with the USFWS Austin Ecological Services Field Office (ESFO) regarding matters pertaining to listed species and designated critical habitat. Coordination efforts included: meetings and teleconferences between the Applicant, USACE and/or USFWS representatives, and the Applicant’s representatives (i.e., environmental consultants, outside legal counsel, and others); written correspondence between the Applicant or its representatives and the USACE and USFWS; and numerous informal communications by telephone or e-mail. The dates and a summary of meetings, teleconferences, and written communications between the Applicant and the USACE and/or USFWS are listed below. Where relevant, informal communications are cited herein as personal communications.

September 25, 2020— HNTB Corporation requested coordination with Tanya Sommer (USFWS) regarding the project and potential strategies for maintaining compliance with the ESA.

October 21, 2020— Phone conversation between the Applicant and Applicant representatives and Paige Najvar and Michael Warriner of the USFWS to discuss the project, a dye tracing study (see Section 3.3.2 for more detail), possible minimization measures, and potential authorization scenarios (i.e., Section 7 consultation, acquisition of a Section 10 permit). USFWS representatives agreed that proposed minimization measures were likely adequate to maintain compliance with the ESA.

April 16, 2021— USACE Fort Worth district assigns Project No. SWF-2021-00230 via email.

April 27, 2021— Pre-application meeting with USACE Fort Worth District. USACE representatives included Joseph Shelnutt and Fred Land. Discussion of USACE PCN requirements and USFWS requirements for listed species.

3 DESCRIPTION OF THE ACTION AREAS

SWCA visited the project area on March 7, 2019, to perform a habitat assessment for karst invertebrates and the JPS.

3.1 Land Use

The Action Areas have significant development within them, primarily comprising residential development (see Figure 2). Residential development along the south side of the project area ranges from approximately 1 to 28 acres in size, with most lots ranging from 1 to 3 acres. The north side of the project area includes more densely constructed residential lots (approximately 0.1 acre each) along the easternmost project extent. This includes CHU #1, which is crossed by Sam Bass Road. Residential lots within CHU #1 and north of Sam Bass Road are built on approximately 0.1-acre lots, while residential development south of Sam Bass Road are on larger lots, approximately 0.5 to 2.2 acres. Walsh Middle School, public water facilities owned by the Brushy Creek Municipal Utility District, and two churches occupy the center of the project area north of Sam Bass Road. Large lot (1 to 22 acres) residences occupy the rest of the project area from Deer Trail Circle to the Soil Conservation Service Site 13a Reservoir dam.

3.2 Geology

The Action Areas occur along the Balcones Fault Zone (BFZ) within the Edwards Aquifer Contributing and Recharge Zones (TCEQ 2021). The majority of the Action Areas occur within the EARZ, with a portion of the Action Areas occurring over the EACZ. During the middle Tertiary, structural down-warping associated with the formation of the ancestral Gulf of Mexico occurred southeast of the project area. The earth's crust was stretched in response, and the BFZ formed along a zone of weakness, which today marks the boundary between the Edwards Plateau and the Gulf Coastal Plain throughout central Texas. This zone consists of a series of northeast-trending, predominantly normal, nearly vertical, en echelon faults (Ferrill et al. 2010).

As mapped by Collins (1997, 2005), the Lower Cretaceous Edwards Formation is exposed at the surface throughout the eastern two thirds of the Action Areas. The Edwards Formation has eroded away leaving the Comanche Peak Formation within the western third of the Action Areas. This was confirmed by the field survey performed in March 2019.

Barnes et al. (1974) describe the Edwards Formation thusly:

> Edwards Limestone, Ked, limestone, dolomite, and chert; limestone aphanitic to fine grained, massive to thin bedded, hard, brittle, in part rudistid biostromes, much miliolid biosparate; dolomite fine to very fine grained, porous, medium gray to grayish brow; chert, nodules and plates common, varies in amount from bed to bed, some intervals free of chert, mostly white to light gray; in zone of weathering considerably recrystallized, "honeycombed," and cavernous forming an aquifer; forms flat areas and plateaus bordered by scarps; thickness 60-350 feet, thins northward

Barnes et al. (1974) describe the Comanche Peak Formation thusly:

> Comanche Peak Limestone, Kc, fine to very fine grained, fairly hard, nodular, light gray, weathers white, extensively burrowed, burrow fillings slightly coarser and darker, typically crops out in scarp face beneath Edwards Limestone; thickness up to 80 feet, feathers out southward near Williamson-Travis County line

SWCA noted many locations where exposed Edwards Formation occurs within the project area. SWCA was unable to fully investigate the Action Areas for presence of exposures of the Edwards Formation owing to lack of land access outside of the project area.

Figure 3 depicts the surface geology of the Action Areas. Based on SWCA (2019), the elevation of the contact between the Edwards and Comanche Peak Formations where exposed in the Action Areas is approximately 841 feet amsl and is located within the western portion of the project area. Elevation of this contact must decline to the east because of regional dip since elevations in the Action Areas decrease below the 841-foot level to the east but the overlying Edwards Formation is exposed in those areas, not the underlying Comanche Peak Formation.

3.3 Hydrology

3.3.1 Surface Water

Dry Fork Creek passes through the west side of the project area directly below its outflow from a Natural Resources Conservation Service (NRCS) soil conservation reservoir (Soil Conservation Service Site 13a Reservoir) that is north of Sam Bass Road. After crossing under Sam Bass Road, Dry Fork Creek drains generally to the southeast, winding in and out of the AAA through a series of small impoundments (see Figure 2). Surface water runoff within the Action Areas drains into Dry Fork Creek, which then flows into Brushy Creek approximately 0.4 linear mile southeast of the east end of the AAA. Brushy Creek eventually empties into the San Gabriel River, which feeds into the Brazos River (U.S. Geological Survey [USGS] 2018b).

Dry Fork Creek is released from Soil Conservation Service Site 13a Reservoir and currently passes underneath Sam Bass within the UAA. USGS (2018a) indicates the Dry Fork Creek is intermittent at this location and, therefore, likely runs dry for some portion of the year. Dry Fork Creek flows south through the UAA and underneath Sam Bass Road via three corrugated pipe culverts (Figures 4 and 5). Cox/McClain Environmental Consulting (2019) indicates the Dry Fork Creek channel is approximately 5 to 10 feet wide within the UAA. Cox/McClain Environmental Consulting (2019) noted dominant plant species at the Sam Bass Road crossing included cedar elm (*Ulmus crassifolia*), live oak (*Quercus fusiformis*), Ashe juniper (*Juniperus ashei*), Bermudagrass (*Cynodon dactylon*), and St. Augustine grass (*Stenotaphrum secundatum*).

3.3.2 Groundwater

Recharge into the Edwards Aquifer primarily occurs in areas where the Edwards Formation and overlying Georgetown Formation are exposed at the surface (Jones 2003). The Northern Segment of the Edwards Aquifer is a hydrologically distinct groundwater system with fault-influenced, rapid-flow paths and local recharge primarily resulting from rainfall on the exposed outcrop of the aquifer itself (Jones 2003). Most recharge is from direct infiltration via precipitation and streamflow loss (Jones 2003). Recharge occurs predominantly along secondary porosity features such as faults, fractures, and karst features (caves, solution cavities, sinkholes, etc.). Karst features are commonly formed along joints, fractures, and bedding plane surfaces in the Edwards and Georgetown Formations (Clark et al. 2016). The amount of recharge occurring on any given site can vary tremendously, but a groundwater availability model for the Northern Segment estimates that, on average, 20% of annual rainfall on the recharge zone becomes groundwater (Jones 2003).

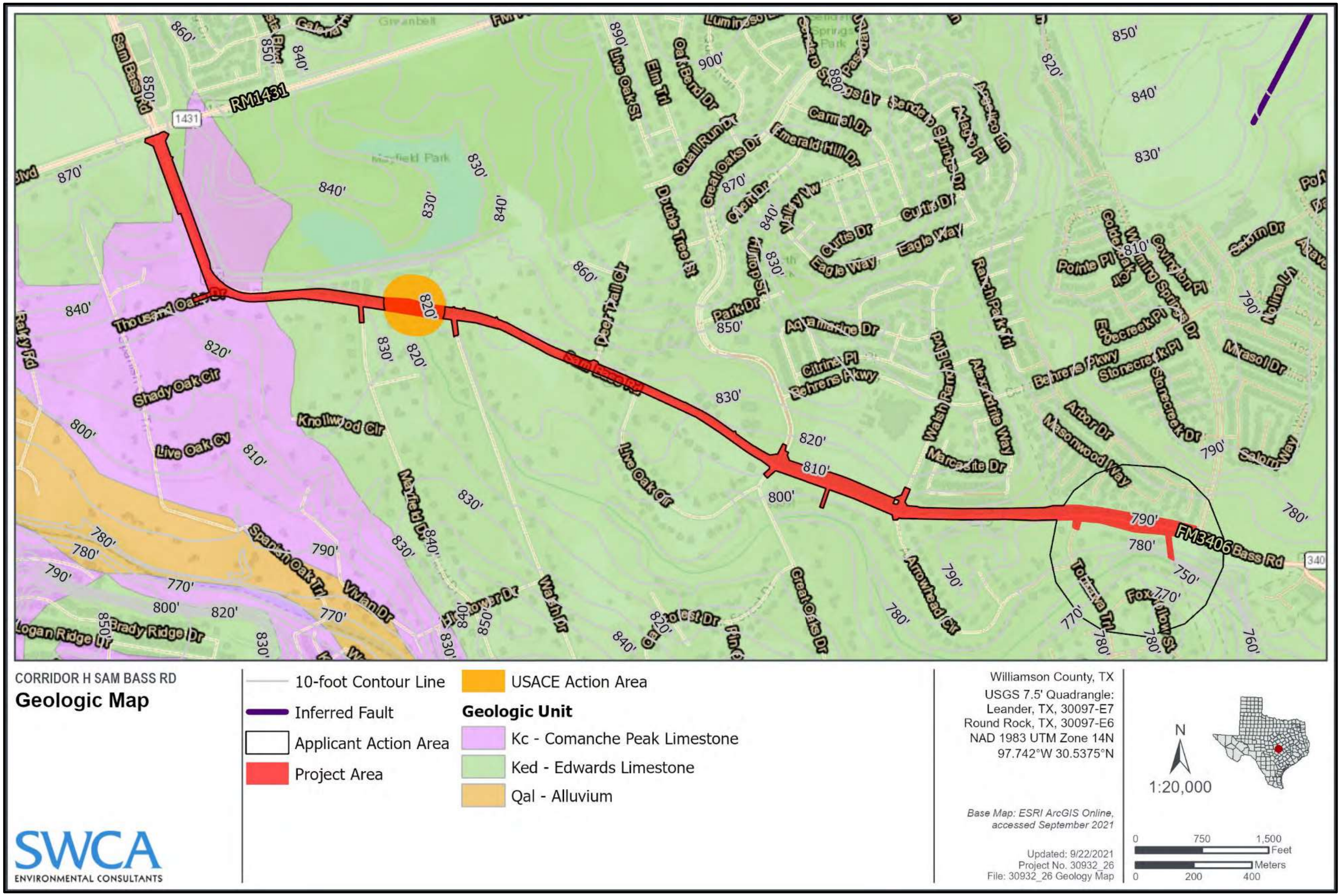

Figure 3. Geology of the Action Areas (Collins 1997, 2005).

Figure 4. Dry Fork Creek flowing south, towards Sam Bass Road from the Soil Conservation Services Site 13a Reservoir.

Figure 5. Dry Fork Creek flowing underneath Sam Bass Road.

The Edwards Aquifer is a primary focus of conservation concern, due to its ecological significance and vulnerability to contamination as a karst aquifer. The Northern Segment of the Edwards Aquifer is a discrete aquifer that is entirely isolated from the other segments of the Edwards Aquifer, which include the nearby Barton Springs Zone, the San Antonio Segment, and the Edwards Plateau Aquifer (Jones 2003). In Williamson County, the Northern Segment of the Edwards Aquifer overlies the Trinity Aquifer, which consists of groundwater held in the Glen Rose Formation (Jones 2003).

Krienke Spring

The karstic Edwards Formation is exposed at the surface throughout most of the Action Areas and surface waters within the Action Areas may enter the Edwards Formation through fractures, joint planes, or other connected void spaces. Numerous spring outlets have formed at or near the exposed contact between the Edwards Formation and underlying Comanche Peak Formation (Jones 2003). Krienke Spring is not spring formed at the contact between these two formations. It is unclear if Krienke Spring was formed when Dry Fork Creek eroded through an active aquifer conduit or if it is the result of Edwards Aquifer-derived water moving to the surface because of a fault-induced fissure in the limestone. At least one inferred fault is close to Krienke Spring and may even continue south through Krienke Spring (see Figure 3). Additionally, the water in Dry Fork Creek disappears into the ground approximately 1,100 feet downstream from Krienke Spring, further indicating local faulting may be present.

The direction of groundwater flow within the Northern Segment of the Edwards Aquifer is typically to the north and east in the direction of regional dip (Brune and Diffin 1983; Senger et al. 1990). However, local influences, such as the presence of faults and locally high hydraulic gradients, can modify that general pattern. For example, Krienke Spring occurs on the north bank of Dry Fork Creek and so may be the discharge point for groundwater that flows to the south or southeast.

Review of 1995 – 2020 aerial imagery via Google Earth (2021) indicates that the impoundments present along Dry Fork Creek are perennial or nearly so, with many having retained water through the severe drought of 2011 – 2013 (Heim 2017). This suggests the water in these impoundments is maintained, at least in part, by seepage from the Edwards Formation and that Dry Fork Creek adjacent to the Action Areas is a gaining reach.

The elevation of Krienke Spring is approximately 750.0 feet amsl (USGS 2018b). Raba Kistner (2019) drilled 19 geotechnical bores within the project area to evaluate subsurface conditions to 10 feet below grade (Figure 6). Raba Kistner (2019) attempted to bore to 10 feet at each location; however, some bores were unable to penetrate the underlying limestone. Therefore, the bores ranged from 5.5 to 10.0 feet below the surface.

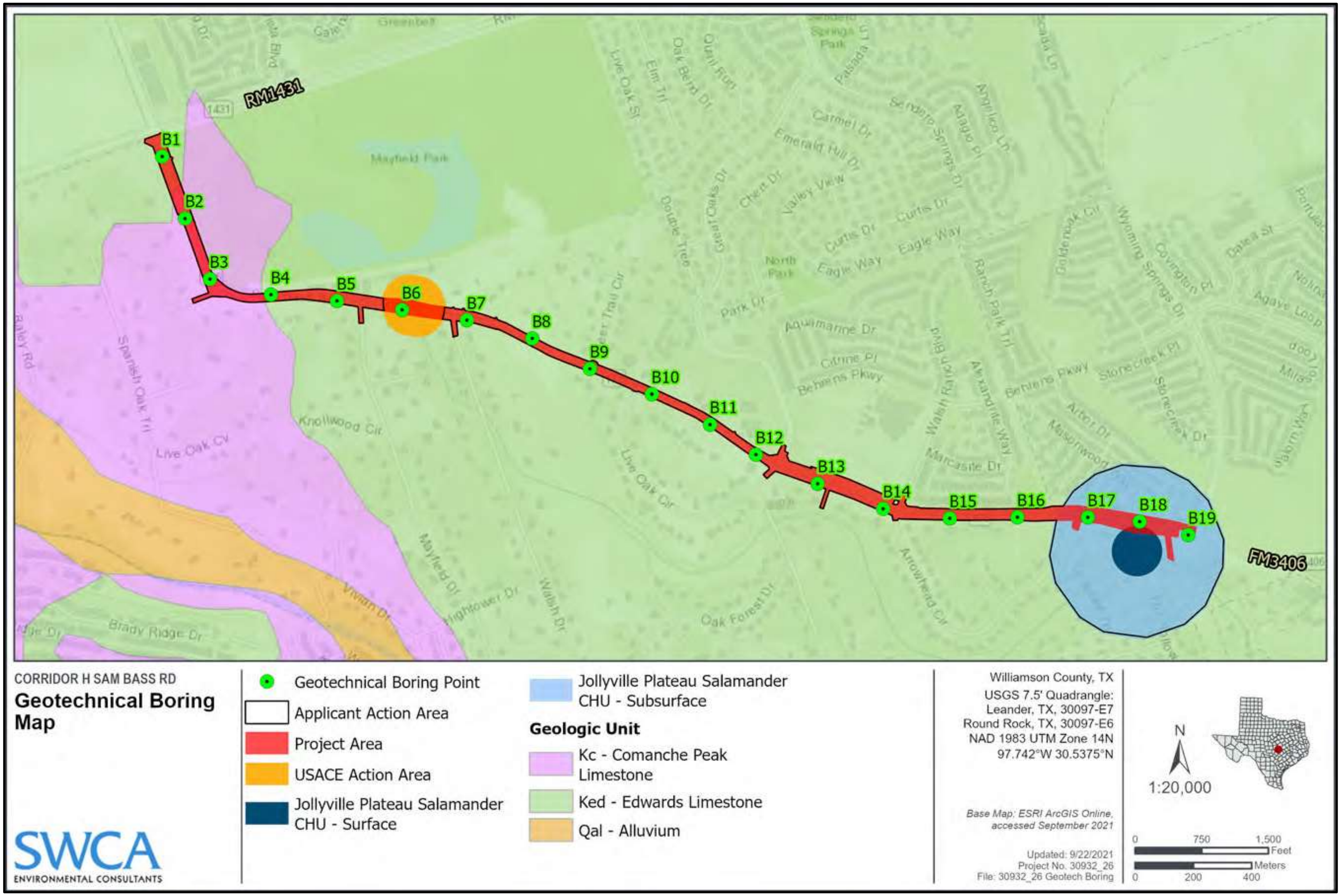

Figure 6. Locations of geotechnical borings.

Table 2 provides the results of the borings and identifies the distance of each borehole to Krienke Spring. Groundwater was encountered in three of the 19 boreholes (B-2, B-3, and B-7), at depths of less than 8 feet (see Table 2).

Table 2. Geotechnical Borings within Project Area and Depth Encountered Groundwater

Boring Number	Surface Elevation (feet above mean sea level)	Bore Depth (Feet)	Depth to Water (Feet)	Distance from Krienke Spring (Feet)	Direction from Krienke Spring
B-1	858.2	7.0	Not Reached	11,616.0	Northwest
B-2	839.1	10.0	8.7	11,088.0	Northwest
B-3	836.6	10.0	7.8	10,612.8	Northwest
B-4	839.1	6.0	Not Reached	9,926.4	Northwest
B-5	832.5	6.5	Not Reached	9,187.2	Northwest
B-6	821.5	6.5	Not Reached	8,448.0	Northwest
B-7	824.7	10.0	7.6	7,761.6	Northwest
B-8	830.0	6.5	Not Reached	6,969.6	Northwest
B-9	828.5	10.0	Not Reached	6,230.0	Northwest
B-10	828.3	8.5	Not Reached	5,491.2	Northwest
B-11	818.8	10.0	Not Reached	4,752.0	Northwest
B-12	815.3	5.5	Not Reached	4,171.2	Northwest
B-13	806.7	10.0	Not Reached	3,432.0	Northwest
B-14	808.7	10.0	Not Reached	2,640.0	Northwest
B-15	809.0	10.0	Not Reached	1,900.8	Northwest
B-16	800.5	10.0	Not Reached	1,161.6	Northwest
B-17	789.3	10.0	Not Reached	422.4	Northwest
B-18	790.5	10.0	Not Reached	52.8	North
B-19	789.8	10.0	Not Reached	369.6	Northeast

Source: Raba Kistner (2019)

SWCA assumes that the underlying Edwards Aquifer travels along the contact between the Edwards and Comanche Peak Formations in some locations, but that the Edwards Aquifer also likely travel within Edwards Formation conduits in some locations. As such, estimating the location of the Edwards Aquifer in this area is difficult and likely subject to error. However, SWCA estimated Edwards Formation depth and then estimated associated depth to the Edwards Aquifer by drawing lines from the Krienke Spring perpendicular to the roadway profile and plotting a point on the profile at the elevation of the spring, where the assumed depth to the Edwards Aquifer is zero. The impoundments just south of the project area were also assumed to represent the general elevation of the Edwards Aquifer since they appear to be strongly influenced by groundwater. The elevation of the water level in the impoundments may represent the static pressure (and therefore the elevation) of the Edwards Aquifer, which would also represent a zero value for depth to water. Finally, it is possible to plot the elevations of groundwater table elevations measured in Geotech borings. We can then connect the depth of each borehole on the profile with a dashed line to represent the approximate elevation of the water table at these locations or at least estimate the approximate Edwards Aquifer depth as it travels within the subterranean matrix, likely along a bumpy path towards Krienke Spring. Figure 7 depicts the estimated depth of the Edwards Aquifer beneath the project area, which may range from 814 to 750 feet amsl or approximately 8 to 25 feet below the surface.

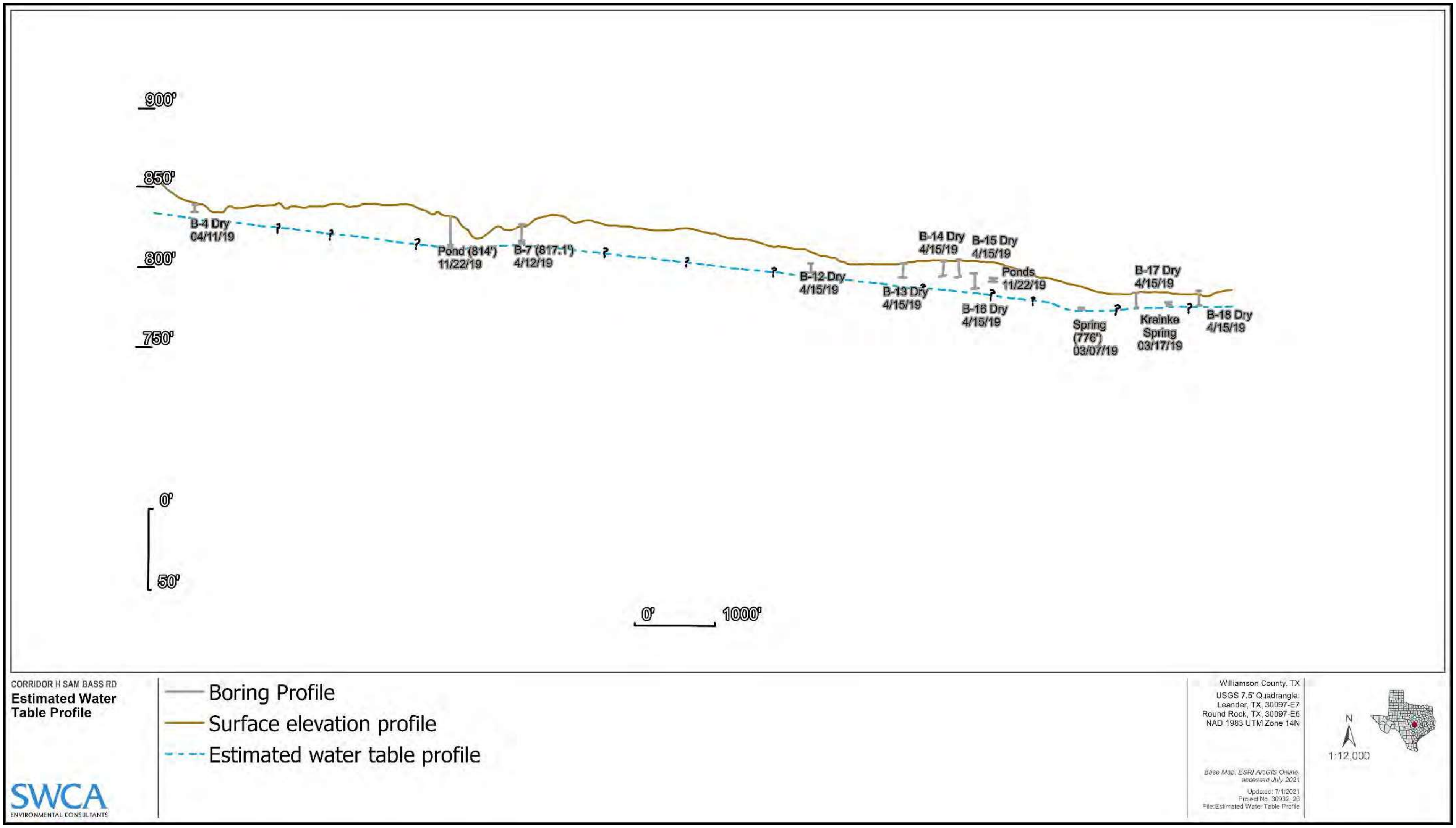

Figure 7. Estimated groundwater profile from borehole B-4 to B-18.

Groundwater was detected in Boreholes B-2 and B-3, which were drilled into the Comanche Peak Formation (see Table 2, Figure 6). However, these locations were not drilled within the Edwards Formation and are not useful for attempting to determine the depth to Edwards Aquifer within the project area. Borehole B-7 was drilled into the Edwards Formation and water was detected 7.6 feet below the surface, at 817.1 amsl.

Boreholes 17, 18, and 19 were the three closest bores to Krienke Spring and occurred within 422, 53, and 370 feet of the outlet, respectively. The surface elevation of each of the bore holes was approximately 789.3, 790.5, and 789.8 feet amsl, respectively, meaning the deepest elevation reached by these three bores was 779.3 feet amsl, or approximately 29.3 feet above the elevation of Krienke Spring (750.0 amsl). The depth reached by all 16 of the dry boreholes ranged in elevation from 779.3 to 851.2 feet amsl.

Raba Kistner (2019) did not discuss the possible origin of the groundwater encountered in boreholes B-2, B-3, and B-7. It is noted that these three boreholes were drilled in the vicinity of Soil Conservation Service Site 13a Reservoir, but so were boreholes B-4, B-5, and B-6. The surface elevations of boreholes B-4, B-5, and B-6 were 839.1, 832.5, and 824.7 feet above amsl, respectively, and so comparable to the surface elevations of boreholes B-2, B-3, and B-7. The Raba Kistner (2019) report is attached as Appendix A.

The Texas Water Development Board (TWDB) maintains an online database of water wells with locations and depth to water (TWDB 2020). The TWDB (2020) well data indicates that the depth to groundwater in the local area can range from 16 to 90 feet below the surface (Table 3; Figure 8). Well 5827712, located approximately 2,171 feet west of Krienke Spring and in the general location of borehole B14, showed a depth to groundwater of 90 feet in 1976. The surface elevation of this well is approximately 808 feet amsl, suggesting the water table in 1976 was at an elevation of approximately 718 feet amsl.

Table 3. Depth to Water at Five Nearby Water Wells

Water Well	Elevation (amsl)	Depth to Water (feet)	Year Measured	Distance from Applicant Action Area (feet)	Distance from Krienke Spring (feet)
5827712	808	90.0	1976	50	21,710
5827706	833	50.4	1977	706	33,276
5827702	796	16.1	1972	2,053	2,329
5827715	731	16.4	1981	2,471	2,532
5827705	850	63.0	1976	2,800	70,643

Source: Texas Water Development Board (2020)

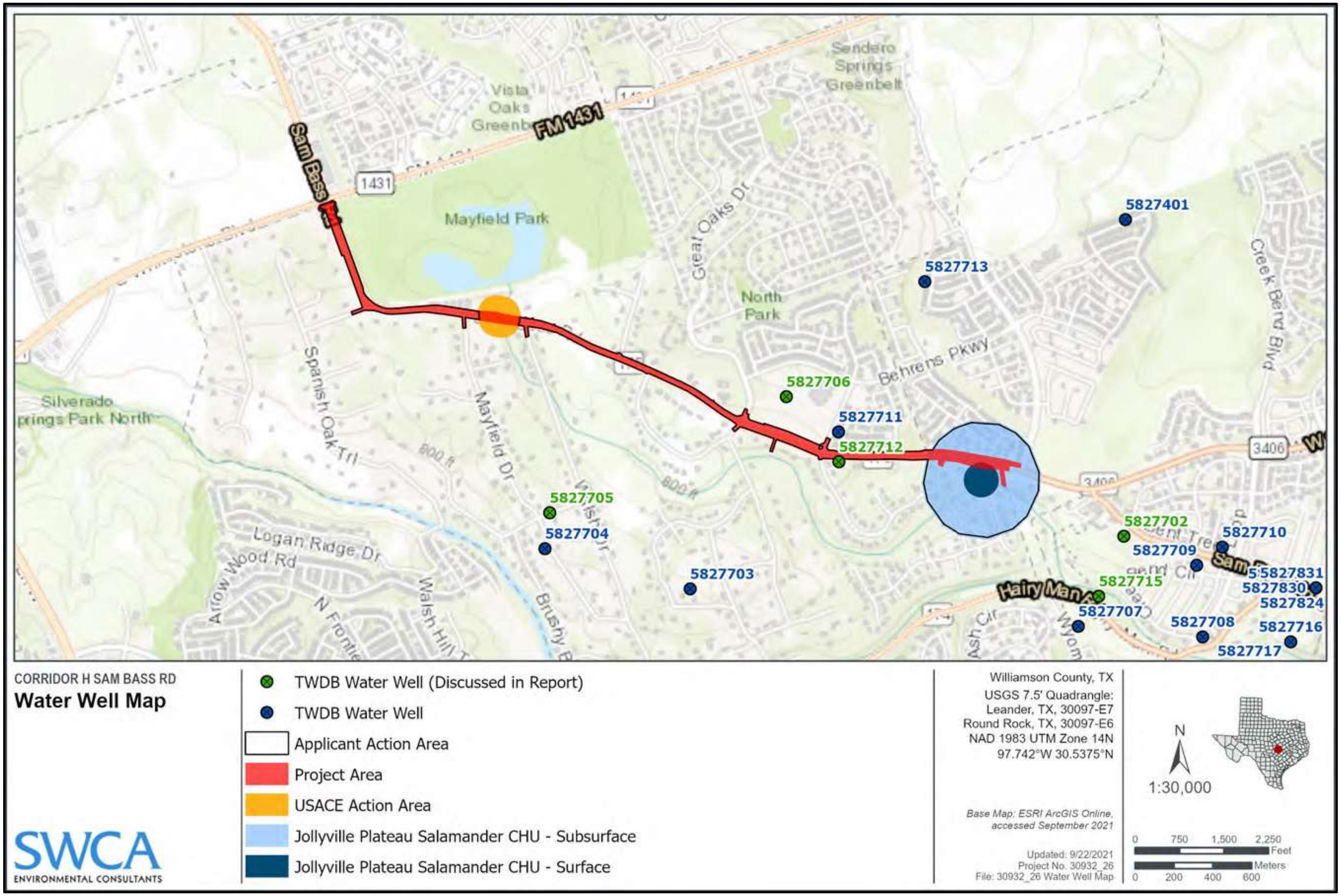

Figure 8. Water well map with Texas Water Development Board (TWDB) wells

Well 5827706, located near well 5827712 but at a surface elevation of approximately 833 feet amsl, showed a depth to groundwater of approximately 50 feet in 1977, equivalent to 783 feet amsl. This depth suggests this well was drilled into the Edwards Aquifer, as elevation of the water was above the elevation of Krienke Spring. The depth of groundwater in these two wells and the results of the Raba Kistner (2019) geotechnical investigations suggests that the groundwater encountered in boreholes B-2, B-3, and B-7 may have percolated out from below from Soil Conservation Service Site 13a Reservoir, although why groundwater was not then also encountered in boreholes B-4, B-5, and B-6 is uncertain.

Wells 5827702 and 5827715, located approximately 2,000 to 2,500 feet southeast of Krienke Spring, showed depths to groundwater of approximately 16 feet in 1972 and 1981, respectively (see Table 3). The surface elevations of Wells 5827702 and 5827715 suggest the water table in their locations was at an elevation of approximately 796 and 731 feet amsl in 1972 and 1981, respectively (see Table 3). Since Krienke Spring is at approximately 750 feet amsl, these wells were likely drilled into the Edwards Aquifer.

Note that Well 582711 is very close to the project area and is approximately 2,580 feet northwest of Krienke Spring (see Figure 8) but is not discussed in Table 3. This well was dug in 1977 and records from TWDB (2020) do not indicate depth to water; therefore, this well is not included in the analysis.

On behalf of the Applicant, Cambrian Environmental (Cambrian) performed dye testing studies at two caves near the project area in an effort to better understand the extent of the recharge zone for Krienke Spring (Beatty and White 2021). Cambrian injected dye at the informally named Walsh Ranch Cave 1 (approximately 3,400 feet northeast of Krienke Spring) and Walsh Ranch Cave 2 (approximately 1,500 feet northwest of Krienke Spring) in February and July 2020. They were unable to secure access to Krienke Spring; however, they sampled at a publicly accessible location approximately 350 feet downstream from where Krienke Spring enters an impounded segment of Dry Fork Creek (Beatty and White 2021). Additionally, Cambrian sampled at 10 other locations within Dry Fork Creek, Brushy Creek, and a single location on an unnamed tributary to Onion Branch within the Hidden Glen Greenbelt (approximately 6,600 feet northeast of the project area and 5,730 feet from Krienke Spring). Despite the two dye injections into each cave and the robust sampling network, Cambrian was unable to detect the dye at any sampling location (Beatty and White 2021). At this time, it is unclear why the dye was not detected at any sampling location, but failure to detect the dye suggests it traveled away from Krienke Spring, Dry Fork Creek, and Brushy Creek. Conversely, the dye may have simply stayed within the caves due to local construction that may have blocked the flow path to the underlying Edwards Aquifer. The full Beatty and White (2021) memorandum is attached as Appendix B.

Based on the elevation of Krienke Spring, the results of the Raba Kistner (2019) geotechnical investigations, the TWDB (2020) water well data, and evidence that water seeps into Dry Fork Creek from the Edwards Formation, water may pool beneath the Action Areas within the Edwards Formation up to an elevation of approximately 750 feet amsl, and perhaps temporarily higher during extended periods of wet weather. Water is expected to be prevented from pooling at higher elevation because of the presence of Krienke Spring and loss of water to seepage into Dry Fork Creek. Groundwater beneath the west end of the AAA, such as that detected in borehole B-7, likely travels as perched sheet flow across the upper surface of the Comanche Peak Formation, perhaps emerging as seepage along Dry Fork Creek, traveling southeastward to contribute to the pool of water that drains at Krienke Spring, or traveling northeast in the direction of regional dip.

3.4 Soils

The NRCS (2019) identifies seven soil units within the Action Areas (Table 4; Figure 9). Eckrant cobbly clay, 1 to 8 percent slopes (EaD), and Georgetown stony clay loam, 1 to 3 percent slopes (GsB), occupy most of the eastern two-thirds of the Action Area. The western third of the Action Areas includes portions of all seven soil types. Table 4 provides additional details for these soil types.

Table 4. Soils of the Action Areas

Soil Name	Hydric	Hydrologic Soil Group*	Drainage Class	Frequency of Flooding/Ponding	Depth to Water Table (inches)
CfA: Crawford clay, 0 to 1 percent slopes	No	D	Well drained	None	80+
DnB: Denton silty clay, 1 to 3 percent slopes					
EaD: Eckrant cobbly clay, 1 to 8 percent slopes					
EeB: Eckrant extremely stony clay, 0 to 3 percent slopes					
ErE: Eckrant-Rock outcrop complex, rolling					
GeB: Georgetown clay loam, 0 to 2 percent slopes					
GsB: Georgetown stony clay loam, 1 to 3 percent slopes					

Source: Natural Resources Conservation Service 2019.
* Group D – Soils have very slow infiltration rates when thoroughly wetted and exhibit the highest potential for runoff.

3.5 Vegetation

The relative abundance of vegetation communities and land cover types within the Action Areas as mapped by TPWD's Texas Ecological Systems Database (TESD) is summarized in Table 5 (Elliott et al. 2014). Dominant vegetation communities within the Action Areas include urban low intensity (63.8%), deciduous oak / evergreen motte and woodland (17.8%), and riparian hardwood / Ashe juniper forest (3.4%). Field surveys confirm the TESD mapping is generally accurate and indicate the land use within the Action Areas is mostly developed with suburban residential lots and vegetation communities dominated by oak (*Quercus* sp.) with smaller patches of grassland.

Vegetation within the Action Areas is primarily restricted to roadway shoulders, residential development, and commercial development. However, there is an undeveloped area within CHU #1 just south of the easternmost project area and adjacent to the western side of the project area near Soil Conservation Service Site 13a Reservoir. Herbaceous vegetation within the Sam Bass shoulders and within developed areas includes Bermudagrass, King Ranch bluestem (*Bothriochloa ischaemum*), and Mexican hat (*Ratibida columnifera*). Common woody plants within these areas also include live oak, Texas oak (*Quercus buckleyi*), Ashe juniper, cedar elm, sugar hackberry (*Celtis laevigata*), privet (*Ligustrum* sp.), chinaberry (*Melia azedarach*), Texas prickly-pear (*Opuntia engelmannii*), saw greenbrier (*Smilax bona-nox*), poison ivy (*Toxicodendron radicans*), and elbowbush (*Forestiera pubescens*). These same species are common within the undeveloped portions of the Action Areas. However, the riparian areas around Dry Fork Creek within CHU #1 also include American sycamore (*Platanus occidentalis*), Chinese tallow (*Triadica sebifera*), elephant ears (*Colocasia antiquorum*), Johnsongrass (*Sorghum halepense*), and switchgrass (*Panicum virgatum*).

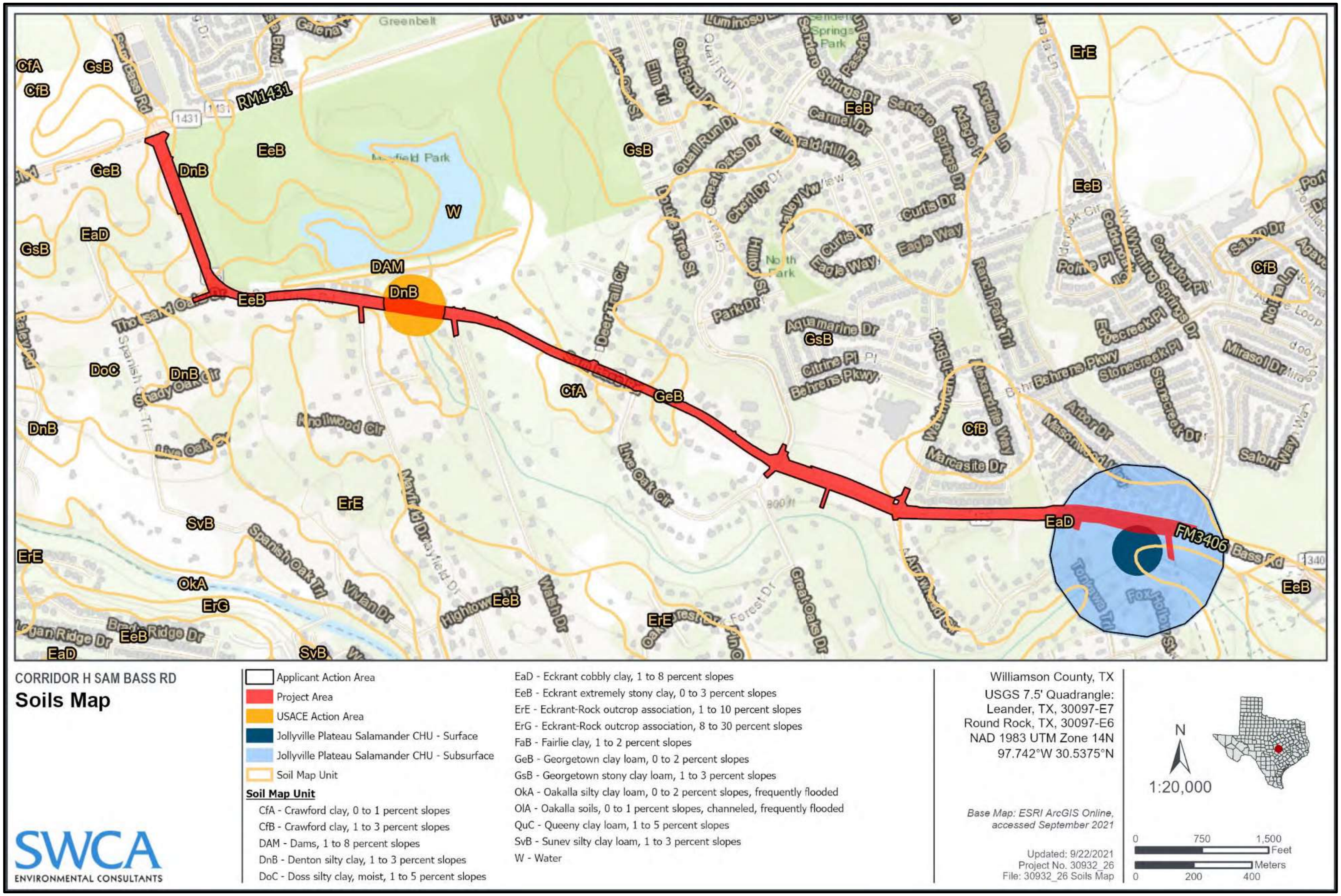

Figure 9. Action Areas soils map.

Table 5. Texas Ecological Systems Database (TESD) Land Cover within the Action Areas (TESD)

Common Name	Acres*	Percent of Total
Urban Low Intensity	70.5	63.8%
Edwards Plateau: Deciduous Oak / Evergreen Motte and Woodland	19.7	17.8%
Edwards Plateau: Riparian Hardwood / Ashe Juniper Forest	3.7	3.4%
Edwards Plateau: Live Oak Motte and Woodland	3.0	2.8%
Native Invasive: Mesquite Shrubland	2.8	2.5%
Edwards Plateau: Oak / Hardwood Motte and Woodland	2.2	2.0%
Edwards Plateau: Riparian Hardwood Forest	2.1	1.9%
Edwards Plateau: Savanna Grassland	1.5	1.4%
Edwards Plateau: Post Oak Motte and Woodland	1.3	1.1%
Edwards Plateau: Ashe Juniper / Live Oak Shrubland	1.2	1.1%
Edwards Plateau: Shin Oak Shrubland	0.9	0.8%
Edwards Plateau: Oak / Ashe Juniper Slope Forest	0.8	0.8%
Edwards Plateau: Oak / Hardwood Slope Forest	0.6	0.6%
Barren	0.1	0.1%
Edwards Plateau: Ashe Juniper Motte and Woodland	0.0	0.0%
Total	**110.5**	**100%**

Source: Elliot et al. 2014
* Due to rounding, total may not correspond with the sum.

4 LISTED SPECIES AND DESIGNATED CRITICAL HABITAT

The USFWS (2021) Information for Planning and Consultation (IPaC) database identifies five federally listed threatened species and six endangered species as known or having potential to occur in Williamson County (Appendix C). These species include three amphibians, four cave-dwelling arthropods, and four birds. The USFWS (2021a) indicates that two of the bird species, the threatened piping plover (*Charadrius melodus*) and red knot (*Calidris canutus rufa*), need only be considered for wind energy projects in Williamson County and are, therefore, omitted from discussion in this report.

The USFWS (2021) indicates four freshwater mussels that are proposed for protection (three species proposed endangered and one species proposed threatened) under the ESA have some potential to occur within Williamson County. The USFWS (2021a) also identifies two candidate species (insect, plant) as having potential for occurrence in Williamson County. Candidate species do not receive a “may affect” designation under the ESA until they are proposed for federal protection.

The USFWS has designated several units of critical habitat for the threatened JPS in Travis and Williamson Counties (USFWS 2020b) and has proposed to designate critical habitat for the threatened Georgetown salamander (*Eurycea naufragia*) and Salado salamander (*E. chisholmensis*) in Williamson and Bell Counties (USFWS 2020b). Critical habitat (CHU #1) designated for the JPS occurs within the east end of the AAA, including within the project area (see Figure 2). The USFWS (2021b) has proposed critical habitat within far eastern Williamson County for the false spike.

Table 6 identifies the species addressed in this BA and summarizes their likelihood of occurrence in the Action Areas. Determination of the potential for local species occurrence was based on: 1) existing information on controls on distribution; and 2) qualitative comparisons of the habitat requirements of each species within the Action Areas. SWCA identified the potential for occurrence of species using the following categories:

- *Known to occur*: The species has been documented in the Action Areas either during or prior to the habitat assessment by a reliable observer.
- *May occur*: The Action Areas are within the species' currently known range, and vegetation communities, soils, and water quality conditions, among other factors, resemble those known to be used by the species.
- *Unlikely to occur:* The Action Areas are within the species' currently known range, but vegetation communities, soils, and water, among other factors, do not resemble those known to be used by the species.
- *None:* The Action Areas are clearly outside the species' currently known and expected range.

Table 6 includes an initial effects determination of "no effect" or "may affect" for each of the listed and candidate species included in the IPaC list (USFWS 2021), excluding piping plover and red knot, based on an assessment of each species' range, distribution, and habitat, as compared to the location and environmental setting of the Action Areas and the impacts expected from the project.

Listed species for which the USACE Proposed Action would have "no effect" are not addressed any further in this BA based on the information provided in Table 6. If the USACE agrees with these "no effect" determinations, it is noted that USFWS concurrence for a "no effect" determination is not necessary under Section 7 of the ESA. The USFWS Austin ESFO states on its website that "Service concurrence with a no effect determination is not required under the ESA and would not be provided by the Austin Field Office" (USFWS 2019). Listed species that may be affected by the USACE Proposed Action are addressed in detail in the following sections. In addition to these species, the USACE Proposed Action "may affect" critical habitat designated for the JPS in CHU #1.

Table 6. Listed Species, Candidate Species, and Designated Critical Habitats

Common Name	Scientific Name	Status	Range or Habitat Requirements	Potential for Occurrence in Action Areas	Effect Determination
Amphibians					
Georgetown salamander	*Eurycea naufragia*	T	This species is restricted to springs, spring runs, and the Edwards Aquifer in the North Fork San Gabriel River drainages south of Lake Georgetown in Williamson County (Devitt et al. 2019). This range excludes Brushy Creek and its tributaries.	**None** because Action Areas are outside known range. Surface water runoff from the project area cannot reach sites occupied by this species.	No effect
Jollyville Plateau salamander	*Eurycea tonkawae*	T	This species occurs in springs, spring runs, caves, and Edwards Aquifer associated with the Jollyville Plateau in northwestern Travis County and southwestern Williamson County, including within the Brushy Creek system (USFWS 2013a).	**Known to occur** at Krienke Spring within the AAA. CHU #1 overlaps the east end of the AAA. See Section 5.1 for additional details.	May affect

Common Name	Scientific Name	Status	Range or Habitat Requirements	Potential for Occurrence in Action Areas	Effect Determination
Salado Springs salamander	*Eurycea chisholmensis*	T	This species is restricted to springs, spring runs, and underlying Edwards Aquifer in Bell County and northern Williamson County, north of Lake Georgetown (Devitt et al. 2019). This range excludes Brushy Creek and its tributaries.	**None** because the Action Areas are outside known range. Surface water runoff from the Action Areas cannot reach sites occupied by this species.	No effect
Arthropods					
Bone Cave harvestman	*Texella reyesi*	E	Inhabits Edwards limestone caves, enlarged rock joints, sinkholes, and smaller karst conduits where subsurface voids are in permanent darkness (USFWS 2018a). This species' range includes central Williamson County and northwestern Travis County and extends across the Action Areas (USFWS 2018a).	**May occur** because the UAA and much of the AAA occur within Karst Zone 1 (areas known to contain endangered cave species). See Section 5.2 for additional details.	May affect
Inner Space Caverns mold beetle (syn. Coffin Cave mold beetle)	*Batrisodes texanus*	E	Inhabits Edwards limestone caves, enlarged rock joints, sinkholes, and smaller karst conduits where subsurface voids are in permanent darkness (USFWS 2018b). This species' known range is limited to central Williamson County, northeast of the Action Areas (USFWS 2018b).	**None** because Action Areas are outside known range.	No effect
Monarch butterfly	*Danaus plexippus*	C	Monarchs may be found statewide in a variety of habitats including native prairies, pastures, open woodlands and savannas, desert scrub, roadsides, and other habitats with abundant nectar plants, including urbanized areas. Caterpillars are found on various species of the milkweed family. Common host plants in Texas include milkweeds (*Asclepias* sp.), milkweed vines (*Matelea* sp.), climbing milkweeds (*Funastrum* spp.), swallowworts (*Cynanchum* spp.), and Anglepod (*Gonolobus suberosus*). Caterpillars are most frequently observed between April and September (Texas Department of Transportation 2021).	**May occur** due to the species state-wide distribution.	No effect
Tooth Cave ground beetle	*Rhadine persephone*	E	Inhabits Edwards limestone caves, enlarged rock joints, sinkholes, and smaller karst conduits where subsurface voids are in permanent darkness (USFWS 2018c). This species' known range includes southwestern Williamson County and northwestern Travis County, west of the Action Areas (USFWS 2018c).	**None** because Action Areas are outside known range.	No effect

Common Name	Scientific Name	Status	Range or Habitat Requirements	Potential for Occurrence in Action Areas	Effect Determination
Tooth Cave spider	*Tayshaneta myopica*	E	Inhabits Edwards limestone caves, enlarged rock joints, sinkholes, and smaller karst conduits where subsurface voids are in permanent darkness (USFWS 2018d). This species' range includes central Williamson County and northwestern Travis County, southeast of the Action Areas (USFWS 2018d).	**None** because Action Areas are outside known range.	No effect
Birds					
Golden-cheeked warbler	*Setophaga* (syn. *Dendroica*) *chrysoparia*	E	Occurs on the Edwards Plateau during the breeding season (early to mid-March to July/August) (Lockwood and Freeman 2014). Inhabits areas with mature woodlands having a high percentage of canopy closure and composed of a mixture of Ashe juniper (*Juniperus ashei*), broad-leafed deciduous trees, and plateau live oak (*Quercus fusiformis*) (Campbell 2003).	**None** due to lack of preferred breeding habitat within the Action Areas.	No effect
Whooping crane	*Grus americana*	E	Migrates across central Texas during spring and fall, may stop over in suitable habitat (Campbell 2003; Lockwood and Freeman 2014). Campbell (2003) indicates suitable habitat for migration stopovers includes cropland and large wetland areas, and that the species roosts far from human disturbance.	**None** due to heavily developed character of the Action Areas and lack of large wetlands, rivers, and croplands.	No effect
Mollusks					
Texas pimpleback	*Cyclonaias petrina*	PE	Occurs in moderate to large streams in the Colorado River basin (Randklev et al. 2017).	**None** because not known from Brazos River basin or Williamson County (Randklev et al. 2017).	No effect
Texas fatmucket	*Lampsilis bracteata*	PE	Occurs in moderate to large streams in the Colorado River basin (Randklev et al. 2017).	**None** because not known from Brazos River basin or Williamson County (Randklev et al. 2017).	No effect
Texas fawnsfoot	*Truncilla macrodon*	PT	Occurs in moderate to large streams and rivers in Brazos and Colorado River basins (Randklev et al. 2017).	**None** because species is intolerant of impoundments. Randklev et al. (2017, 2020) report this species is not known from Williamson County.	No effect
False spike	*Fusconaia mitchelli*	PE	Occurs in moderate to large streams and rivers in Brazos and Colorado River drainages (Randklev et al. 2017).	**None** because this is intolerant of impoundments. Randklev et al. (2017, 2020) report this species is known only from eastern Williamson County.	No effect

Common Name	Scientific Name	Status	Range or Habitat Requirements	Potential for Occurrence in Action Areas	Effect Determination
Plants					
Bracted twistflower	*Streptanthus bracteatus*	C	Occurs in rocky hillsides and slopes on the Edwards Plateau, but not known from Williamson County (Leonard and Van Auken 2014). Species occurs on Tarrant, Brackett, or Speck soils over the Edwards, Glen Rose, and Walnut geologic formations (TPWD 2021).	**None** because species is not known to occur in Williamson County and preferred soil type does not occur in Action Areas.	No effect

* USFWS Status Definitions: E = Endangered. T = Threatened. PE = Proposed Endangered. PT = Proposed Threatened. C = Candidate

5 EFFECTS OF THE ACTION

The initial analysis identified two listed species that may be affected by the USACE Proposed Action, the threatened JPS and endangered BCH (see Table 6). Designated critical habitat for the JPS occurs within the AAA and project area and might be affected by the USACE Proposed Action (see Table 6). In this section, the BA provides background information on the biology and baseline status of these two listed species and provides an evaluation of the expected effects of the project on the JPS and its designated critical habitat and on the BCH.

This BA uses the following definitions adapted from the guidance in the Consultation Handbook (USFWS and NMFS 1998), and consistent with the October 2019 ESA regulation revisions (Federal Register 84:44976), to describe the types of consequences to JPS and BCH that may arise from activities performed within the Action Areas:

- **Effects of the Action –** Includes all consequences to JPS, CHU #1, and BCH caused by the actions of the proposed project. Effects of the action include consequences that may occur later in time and may include consequences occurring outside of the immediate area of the proposed project.
- **Consequences –** Effects of the actions of the proposed project that would not occur but for the proposed project and are reasonably certain to occur.
- **Cumulative Effects –** Effects of other future state or private activities that are reasonably certain to occur within the Action Areas.

5.1 Jollyville Plateau Salamander (*Eurycea tonkawae*)

5.1.1 Status in the Action Areas

SWCA conducted a desktop review of known JPS surface localities within the vicinity of the project. As indicated, Krienke Spring is a documented JPS locality and CHU #1 for the species has been designated around it. Krienke Spring is within the AAA approximately 207 feet south of the project area. Critical habitat for the JPS includes two components:

- USFWS (2013b) states the surface component is delineated "…by starting with the spring point locations that are occupied by the salamanders and extending a line upstream and downstream 262 ft (80 m)."
- USFWS (2013b) states the subsurface component is delineated starting at known occupied sites and that "From these cave or spring points, we delineated an area with a 984-ft (300-m) radius to

> create the polygons that capture the extent to which we believe the salamander populations exist through underground habitat."

All 68 acres of CHU #1 occur within the AAA and approximately 6.1 acres of the project area overlap the subsurface portion of CHU #1. However, those 6.1 acres of project area within CHU#1 are broken into two categories: 3.0 acres are existing roadway and 3.1 acres of proposed additional impervious cover. Since the surface component starts with the spring and extends along the spring run, no part of the surface component traverses the project area.

The subterranean distribution of JPS beneath the Action Areas is unknown and documentation regarding inhabited conduits within the Edwards Aquifer is unavailable. Based on the rationale used by the USFWS (2013b) to designate critical habitat for the species, JPS appear to have potential to occur beneath the AAA within the limits of the designated critical subsurface habitat, and perhaps have potential to occur more widely beneath the Action Areas as well. No springs are present in the project area based on a geologic assessment performed by SWCA (2019) on March 7, 2019 (Appendix D). SWCA did not have access to the private property beyond the project area. Potential exists that undocumented springs inhabited by the JPS occur within the Action Areas outside of the project area, though this potential appears to be very low given the overall developed nature of the area.

Water at Krienke Spring emanates from a portal that arises in the backyard of a residence and then flows southwestward approximately 30 feet before going down an embankment and into Dry Fork Creek. However, once the spring flow enters Dry Fork Creek, the remaining surface component of CHU #1 is contained within a small impoundment that was created prior to 1995 (Google Earth 2021). The subsurface component of CHU #1 is situated beneath an urbanized area that contains several residential neighborhoods on either side of the existing Sam Bass Road. The subsurface component of CHU #1 is also beneath approximately 3,051 feet of the existing neighborhood roadway (Wyoming Springs Drive, Tonkawa Trail, Arrowhead Circle, Fox Hollow, and Quarry Creek) and approximately 1,910 feet of existing Sam Bass Road. The subsurface component of CHU #1 is also beneath approximately 1,890 feet of Dry Fork Creek and associated riparian habitat.

No other documented JPS localities are within or adjacent to the Action Areas. The next-closest locality is Avery Deer Spring, part of the Avery Spring critical habitat unit (CHU #6), approximately 2.1 miles southwest of CHU #1 (Figure 10). Another locality, Brushy Creek Spring (CHU #2), is approximately 4.0 miles east-southeast of CHU #1. Figure 10 shows the locations of known JPS sites relative to the project area.

5.1.2 Effects of the Action

The proposed project is widening and improvement of Sam Bass Road. The effects of the action include excavation for roadway lanes and stormwater removal, installing a culvert, installing paved roadways and shared-use paths, and drilling shafts for signal foundations. Each of these effects and potential consequences to the JPS are discussed in detail below.

Sam Bass Road is approximately 9 feet above the elevation of Krienke Spring where it overlaps the designated surface and subsurface critical habitat. The deepest excavations for the project are expected to be 8 feet for storm drains. The Applicant has committed to not placing any storm drains or water quality ponds within the limits of the subsurface critical habitat, and so excavations above the designated subsurface critical habitat would be for road base only and no deeper than 5 feet. This coupled with the results of the geotechnical borings suggest that project activities performed within the designated critical habitat would not reach groundwater.

Within the project area outside CHU #1, it is unclear if water documented in boreholes 3 and 7 is derived from surface runoff trapped by unmapped alluvial deposits, from water percolating out below Soil Conservation Service Site 13a Reservoir, or if it is Edwards Aquifer derived. Therefore, determining proximity to potential JPS habitat at these locations is not currently possible. However, anticipated excavation depths are primarily limited to approximately 2 to 5 feet deep and with only storm sewer trunk lines reaching 5 to 8 feet deep at specific locations. These data indicate that project activities are not reasonably certain to encounter wetted Edwards Aquifer conduits and therefore, are not reasonably certain to directly encounter JPS. The results of the geotechnical borings and the TWDB (2020) water well data also suggest that excavations performed elsewhere in the project area are unlikely to encounter groundwater horizons occupied by JPS.

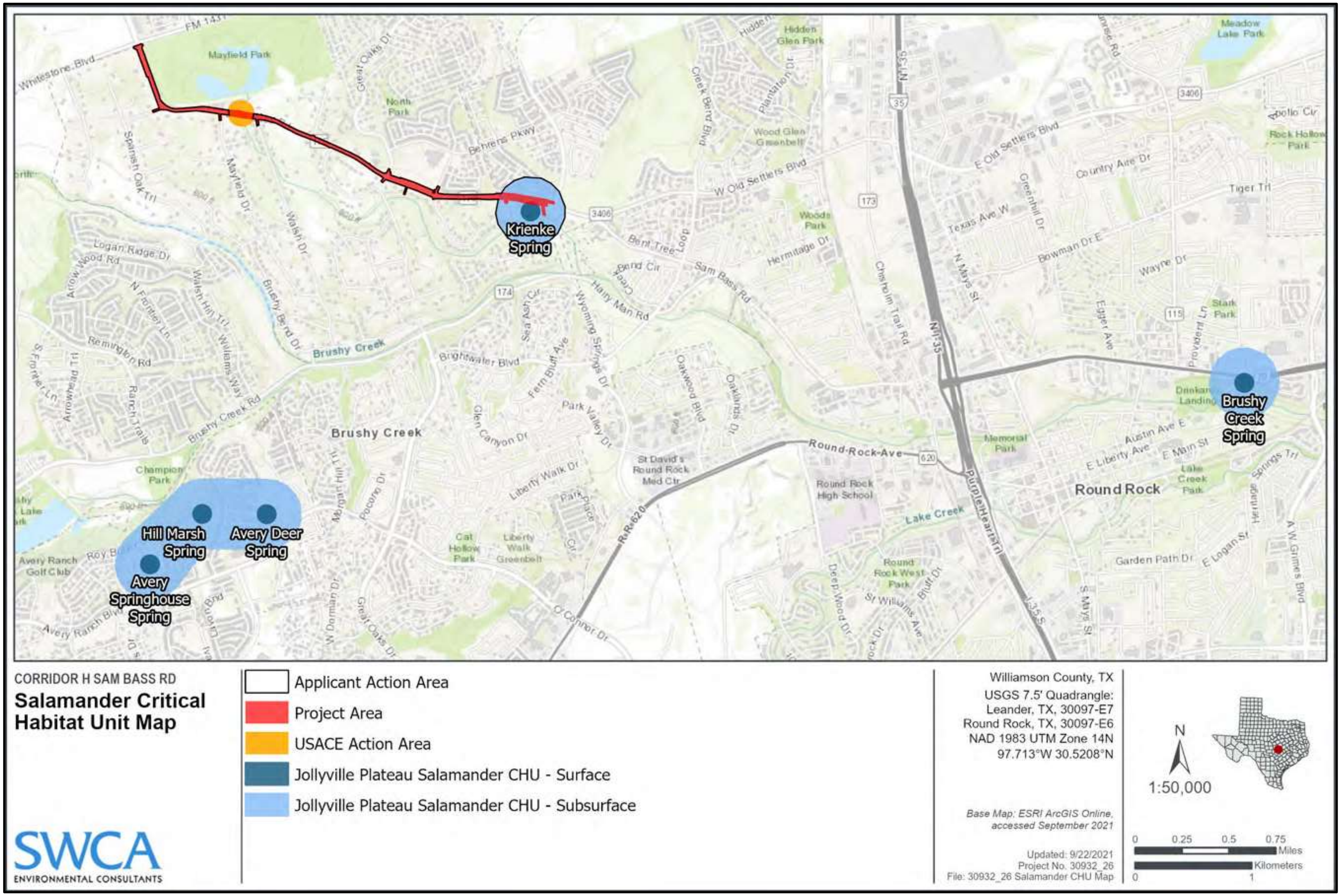

Figure 10. Salamander critical habitat unit (CHU) map depicting nearest CHUs to the Applicant Action Area.

However, there is some potential for excavation activities to accidentally encounter an aquifer conduit and mechanically injure a JPS since the deepest excavation is anticipated to be 8 feet deep. The primary conceivable pathway for project-related direct consequences to the JPS involves encountering an unknown aquifer conduit during excavation and physically wounding an individual. The potential that encountering a void that is: a) filled with water, and b) contains JPS at the time of construction is possible, but not certain. The lack of data regarding subterranean aquifer conduit locations renders any such prediction impossible. Conceivably, the potential for such an encounter likely increases with proximity to Krienke Spring.

A secondary conceivable pathway for project-related consequences to the JPS involves encountering an unknown karst feature lacking surface expression that provides a direct pathway into the underlying Edwards Aquifer inhabited by the species. An accidental chemical spill or other pollutant directly reaching such a conduit could potentially impact an individual or population of JPS inhabiting the Edwards Aquifer at this location. Pollutants may enter the salamander metabolic processes via direct skin contact or absorption through the gills. The chance that a void is encountered and a chemical spill is directed towards it is technically possible, but not reasonably certain.

Indirect consequences to JPS are conceivable if pollutants from construction enter the Edwards Aquifer ecosystem and negatively impact the food web. Any interruption of normal metabolic processes to either bacterial or algal colonies that form the base of the Edwards Aquifer food web could reduce the invertebrate quality or quantity available for salamander consumption. In turn, the reduced ecosystem productivity could reduce the reproductive fitness of individuals inhabiting the area. This would require pollutants to bypass the storm drain system and enter a conduit into the Edwards Aquifer, which is at least greater than 10 feet below the surface of CHU #1, according to Raba Kistner (2019). Therefore, the potential for pollutants to enter the underlying Edwards Aquifer is highly unlikely due to the limited nature and relatively shallow excavation depth of the project. Direct Edwards Aquifer infiltration from the project is further limited due to the stormwater pollution controls enacted before, during, and after construction efforts.

The next closest JPS localities are within the Avery Spring Unit (CHU #6) and are upgradient (southwest) from the project area; therefore, it is unlikely any groundwater from the project area would reach these springs (see Figure 10). Brushy Creek Spring (CHU #2) is the next closest downgradient JPS locality, which is southeast of the project area (see Figure 10). Since groundwater within the Northern Segment generally move north and east (Brune and Diffin 1983; Senger et al. 1990), it is unlikely any groundwater from the project area would reach this spring. Moreover, Brushy Creek Spring is situated above Brushy Creek and discharges from a spring outlet entirely encased in concrete, which then flows over a gabion and into a deep pool before entering a spring run that empties into Brushy Creek (Adcock, MacLaren, and White 2020). Therefore, it is unlikely that pollutants from the project area would reach other designated CHUs for the JPS.

As such, the effects of the proposed project are anticipated to be discountable to the JPS and to CHU #1 based on the status of the species in the Action Areas and the Applicant's proposed conservation measures.

5.2 Bone Cave Harvestman (*Texella reyesi*)

5.2.1 Status in the Action Areas

Desktop analysis indicates approximately 90.5 acres of the Action Areas occurs within Karst Zone 1, which is an area “known to contain endangered cave species.” The only endangered karst invertebrate with a range that overlaps the Actions Areas is the BCH (USFWS 2018a, 2018b, 2018c, 2018d); therefore, this is the only species with potential to occur there. No documented BCH localities are known to occur within the Action Areas. However, the true extent of the BCH’s inhabitation within the underlying karst matrix is unknown. USFWS (2018a) indicates that mesocaverns (small voids and cracks 0.4 to 0.8 inch in diameter, as described by Howarth 1983) may be the “preferred” habitat for karst invertebrates and that they may occur throughout the three-dimensional karst matrix formed within the Edwards Formation.

The project area traverses 15.7 acres within Karst Zone 1 and traverses 2.9 acres of Karst Zone 3 (Figure 11) (Veni and Martinez 2007). No caves with surface expression are present in the project area based on a geologic assessment performed by SWCA (2019) on March 7, 2019 (Appendix D). While the lack of caves encountered by SWCA (2019) indicates that such features may not occur within the project area, it is still possible for subsurface void spaces that lack surface expression to be encountered during construction.

The TXNDD (2020) shows a single BCH locality approximately 2,200 feet north of the Action Areas, but the TXNDD does not name the locality (Figure 12). USFWS (2018a) indicates the nearest BCH locality is Brown’s Cave, which is currently underneath the median of a suburban neighborhood road and that Brown’s Cave is impaired with 75% to 100% of the cricket foraging area impacted. SWCA’s internally maintained database concurs that Brown’s Cave is the closest confirmed BCH locality to the Action Areas; therefore, the project is not expected to have any impact on documented BCH localities.

Beatty and White (2021) also discuss Walsh Ranch Cave 1 (approximately 3,400 feet northeast of Krienke Spring and 2,280 feet north of the project area) and Walsh Ranch Cave 2 (approximately 1,500 feet northwest of Krienke Spring and approximately 320 feet north of the project area) as hypothesized recharge features to the local segment of the EARZ. These voids have at least some potential to lead to BCH habitat within the interstitial voids inherent to caves; however, these features are not documented to contain the species. Regardless, the proposed project is not expected to have any effects to these caves.

Due to their cryptic nature and inhabitation within relatively inaccessible habitat, overall population estimates and distribution profiles are not currently available. Therefore, a population snapshot or estimate within the Action Areas is not possible. At this time, it is thought the species inhabits at least some portion of the three-dimensional karst matrix within Karst Zone 1.

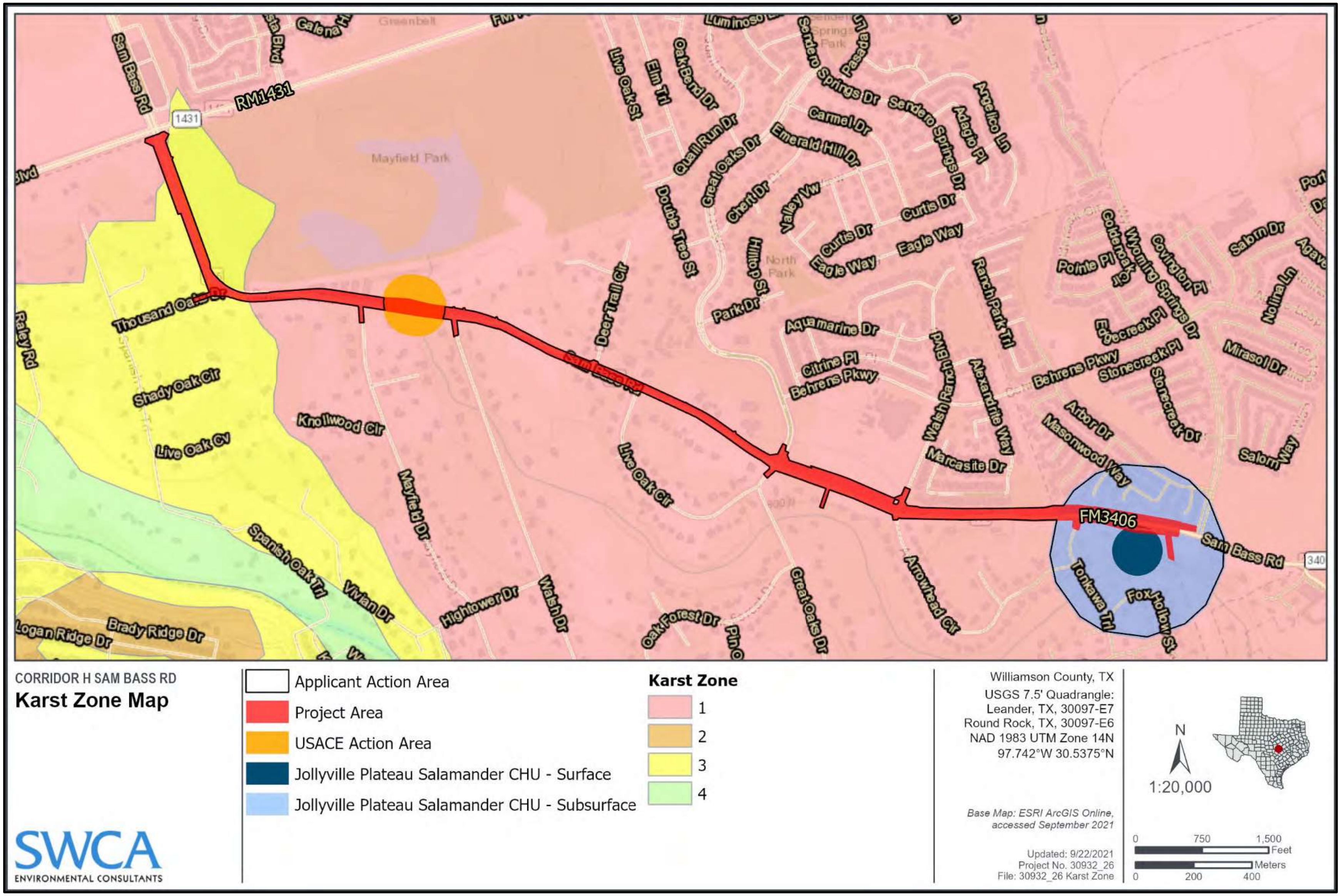

Figure 11. Mapped invertebrate karst zones (Veni and Martinez 2007).

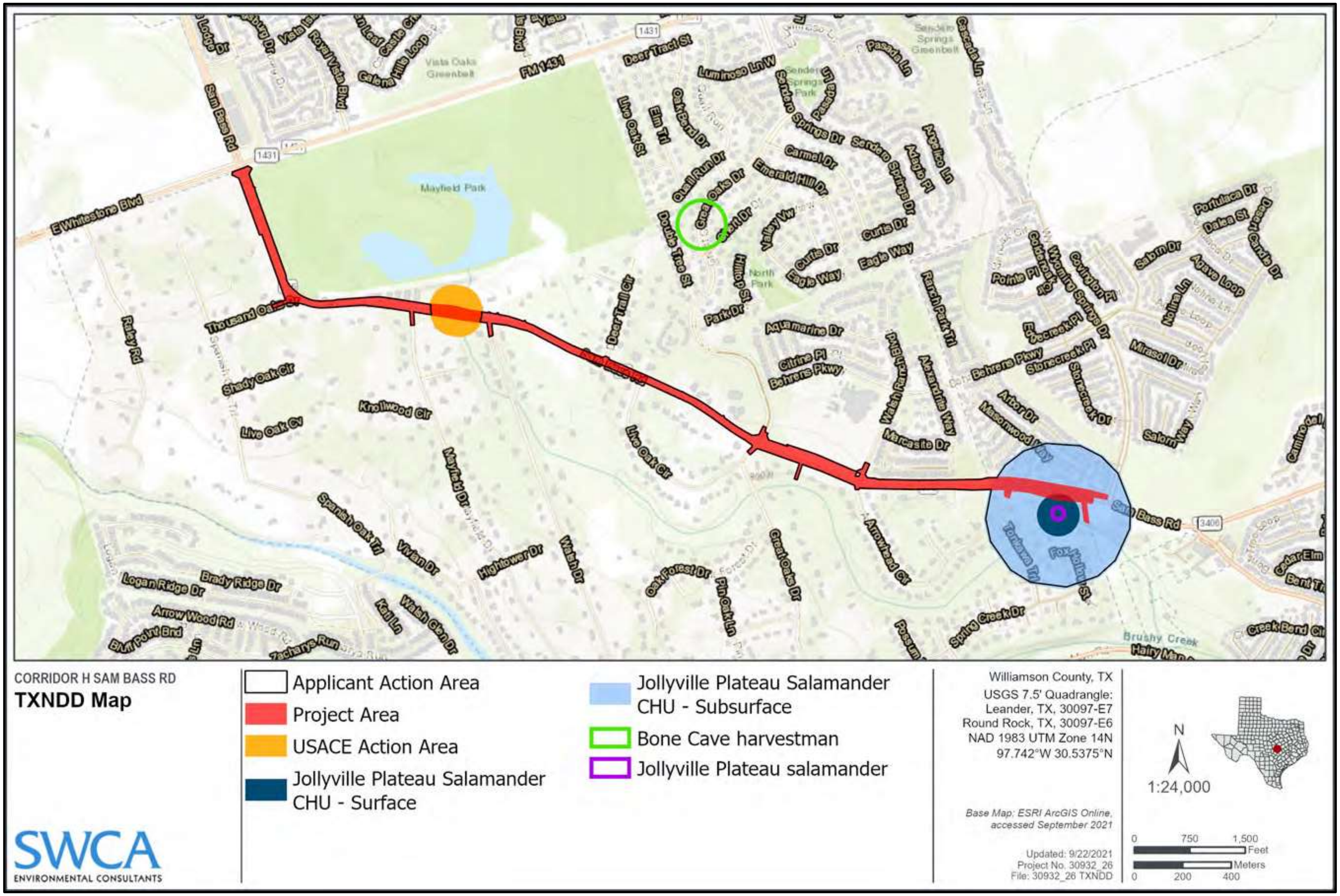

Figure 12. Texas Natural Diversity Database (TXNDD) map depicting nearest threatened and endangered species localities.

5.2.2 Effects of the Action

The proposed project is widening and improvement of Sam Bass Road. The effects of the action include excavation for roadway lanes and stormwater removal, installing paved roadways and shared-use paths, and drilling shafts for signal foundations. Each of these effects and potential consequences to the BCH are discussed in detail below.

Excavation-related construction activities, such as grading, drilling, and installing a storm drainage system, illumination, traffic signal poles, retaining walls, and culverts may encounter previously undetected voids. A planing/milling machine could be used to cut to subgrade. A trackhoe with a hoe-ram or a dozer with a ripper would generally be used to remove any rock encountered when cutting subgrade. Once the rough grading is completed, a loader and blade/grader would be used to finish grading. Graders are also used to scrape materials from the ground surface after rough grading to achieve a particular slope. When the area is scraped free of debris, the void should become apparent, unless the void is completely destroyed by milling or grading equipment. Impacts to voids encountered by milling and grading activities would vary depending on the vertical and horizontal extent of the void, and whether the void is situated in the floor of the milled or graded area or in the wall. If a large portion of a void is exposed, climate alteration would be exacerbated. If only a narrow opening to void is created, climate alteration may be minimal. In either case, flooding can still occur on the floor of the down-cut area, especially if it has the aspect of a large trench, channeling floodwaters.

Drilling equipment would be used for excavating drilled shaft for traffic signal foundation. During drilling, voids can generally be seen if they are encountered; however, depending on the depth a void is encountered in the shaft, the magnitude of the void may not be obvious. If a large of a void is drilled through, climate alteration could be exacerbated.

Ground disturbance adjacent to karst invertebrate habitat may not encounter humanly observable voids; however, smaller interstitial spaces inhabited by endangered species can collapse via dislodged rocks, soil, or dust due to local, machine-related vibration. Such incidents are conceivable and could cause mechanical injury and/or mortality to karst invertebrates as their habitat is physically altered.

Karst feature surveys cannot rule out the presence of void with no surface expression; therefore, it is conceivable that suitable karst invertebrate habitat could be encountered during construction. However, conservation measures discussed in Section 2.3 reduce the potential for impacts to listed karst invertebrates and participation within the WCRHCP mitigates incidental take, should it occur.

Indirect consequences to the BCH may occur via contaminated surface water runoff by transporting sediment or water-borne contaminants into the subterranean environment from project construction activities. Sediment or contaminants may harm lower tropic-level food or prey species such as fungi or springtails (Collembolans) and thereby result in negative impacts to the BCH. However, the void discovery protocol (discussed in Section 2.3) would minimize potential subsurface runoff into the subsurface if an undetected void is discovered.

The proposed project would be expanding existing impervious cover within an already urbanized landscape. It is unlikely that the proposed project would affect hydrologic patterns within local macrocaverns (voids smaller than 8 inches) already impacted by existing impervious cover. The potential for impacts to unanticipated karst features would be minimized from both construction activities and from post-construction spills on the proposed roadway by the implementation of a WPAP and the use of BMPs in accordance with the EAPP and associated Edwards Rules for the entire project area, as detailed by Barrett (2005). As such, the effects of the proposed project are anticipated to be discountable to the BCH based on the status of the species in the Action Areas and the Applicant's proposed conservation measures.

6 CONCLUSIONS

The USFWS (2021) IPaC database indicates 11 listed species have some potential for occurrence in Williamson County. Of these listed species, the proposed project may affect the endangered BCH and the threatened JPS. The proposed project may affect but is not likely to adversely affect either of these species. The proposed project would result in 3.1 acres of additional impacts within the subsurface portion of JPS CHU #1.

Table 7 summarizes the effect determinations and the amount (acreage) or extent of incidental take (or adverse effect for species where take is not applicable) for the BCH and JPS by area of responsibility.

Table 7. Effects and Incidental Take Summary by Area of Responsibility

Species	USACE Fort Worth District Action Areas	Applicant Action Areas	Total Proposed Project
Bone Cave Harvestman—Listed Endangered	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Jollyville Plateau Salamander—Listed Threatened	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Jollyville Plateau Salamander—CHU #1	None	3.1 acres of additional impact to subsurface portion of CHU #1	3.1 acres of additional impact to subsurface portion of CHU #1

The USACE and the Applicant request concurrence from the USFWS that the project is not likely to adversely affect the JPS. The USACE, with the Applicant, also requests initiation of informal consultation with the USFWS to receive concurrence regarding the effects of the project on the JPS and the BCH. The Applicant proposes to obtain incidental take coverage for the BCH through the WCRHCP.

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APPENDIX A

Raba Kistner

Geotechnical Engineering Study for Corridor H – Sam Bass Road From RM 1431 to Wyoming Springs Drive

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GEOTECHNICAL ENGINEERING STUDY

FOR

CORRIDOR H - SAM BASS ROAD
FROM FM 1431 TO WYOMING SPRINGS DRIVE
WILLIAMSON COUNTY, TEXAS

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Project No. AAA19-026-00
March 16, 2020

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K Friese & Associates
1120 South Capital of Texas Highway, CityView 2, Suite 100
Austin, Texas 78746

RE: Geotechnical Engineering Study
Corridor H - Sam Bass Road
From FM 1431 to Wyoming Springs Drive
Williamson County, Texas

Dear Mr. Bell:

RABA KISTNER Consultants Inc. (RKCI) is pleased to submit the report of our Geotechnical Engineering Study for the above-referenced project. This study was performed in accordance with Subcontracts for Professional Services for KFA Project No. 0501, dated March 29, 2019 and KFA Project No. 0652, dated December 4, 2019, and RKCI Proposals No. PAA17-090-00, Revision No. 1, and RKCI Proposal No. PAA17-090-00a, Revision No. 1, dated October 3, 2019. The purpose of this study was to drill 21 borings, to perform laboratory testing to classify and characterize subsurface conditions, and to prepare an engineering report presenting pavement design recommendations and construction guidelines for the reconstruction of a segment of Sam Bass Road from Farm to Market Road 1431 to Wyoming Springs Drive in Williamson County, Texas.

The following report contains our design recommendations and considerations based on our current understanding of information provided to us at the time of this study. There may be alternatives for value engineering of the pavement systems. RKCI recommends that a meeting be held with the Owner and design team to evaluate if alternatives are available.

We appreciate the opportunity to be of service to you on this project. Should you have any questions about the information presented in this report, or if we may be of additional assistance with value engineering or on the materials testing-quality control program during construction, please call.

Very truly yours,

RABA KISTNER CONSULTANTS, INC.

Richard T. Shimono, P.E.
Project Engineer

Yvonne Garcia Thomas, P.E.
Vice President

STATE OF TEXAS
YVONNE GARCIA THOMAS
111414
LICENSED
PROFESSIONAL ENGINEER
03/16/2020

RTS/YGT: tlc
Attachments
Copies Submitted: Above (1-electronic)

GEOTECHNICAL ENGINEERING STUDY

For

CORRIDOR H – SAM BASS ROAD
FROM FM 1431 TO WYOMING SPRINGS DRIVE
WILLIAMSON COUNTY, TEXAS

Prepared for

K FRIESE & ASSOCIATES
Austin, Texas

Prepared by

RABA KISTNER CONSULTANTS, INC.
Austin, Texas

PROJECT NO. AAA19-026-00

March 16, 2020

RABAKISTNER

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ATTACHMENTS

The following figures are attached and complete this report:

Important Information About Your Geotechnical Engineering Report

INTRODUCTION

RABA-KISTNER Consultants Inc. (RKCI) has completed the authorized subsurface exploration and pavement analysis for the reconstruction of Williamson County Corridor H – Sam Bass Road from Farm-to-Market Road (FM) 1431 to Wyoming Springs Drive in Williamson County, Texas. This report briefly describes the procedures utilized during this study and presents our findings along with our pavement recommendations and construction guidelines.

PROJECT DESCRIPTION

Under consideration in this study is the reconstruction of a segment of Sam Bass Road, from its intersection with FM 1431 to Wyoming Springs Drive, in Williamson County, Texas.

Based on phone correspondence with the project civil engineer Mr. B. Ryan Bell, P.E., with K Friese & Associates, we understand that the existing pavements are failing prematurely. The reconstruction of Sam Bass Road will be performed in multiple phases, ultimately resulting in a roadway with 3 traffic lanes in each direction. Based on the "2040 Hour Volume Figure - 2040 Volumes by Scenario" sheet, prepared by Alliance Transportation Group, dated March 26, 2018, average daily traffic at the site ranged from 9,100 to 13,600 vehicles per day in the year 2017, and project traffic in 2040 ranges from 65,950 to 72,400 vehicles per day.

Additional design parameters were taken from the Williamson County Design Criteria Manual, City of Round Rock Transportation Criteria Manual, and City of Austin Transportation Criteria Manual are presented in the table below.

Initial Average Daily Traffic (ADT) in Year 2017	Percent Trucks	Truck Factor	Lane Distribution Factor	ATHWLD (lbs)*	Percent Tandem Axles in ATHWLD*
9,100 to 13,600	7.2**	0.84 (flexible)** 0.97 (rigid)**	70%	11,000	60%

*ATHWLD = average ten heaviest wheel loads daily
**Default value from City of Austin Transportation Criteria Manual for 4-lane Major Arterials

Additionally, there is a single-span bridge planned at this site. Based on a 60% Submittal "Bridge Layout and Typical Section" for *Williamson County Corridor H – Sam Bass Road,* prepared by WSP, dated January 9, 2020, we understand the single-span bridge will extend from approximate STA 298+06 to STA 298+41, supported by a bridge abutment on either end.

LIMITATIONS

This engineering report has been prepared in accordance with accepted Geotechnical Engineering practices in the region of central Texas and for the use of K Friese & Associates (CLIENT) and its representatives for design purposes. This report may not contain sufficient information for purposes of other parties or other uses. This report is not intended for use in determining construction means and methods. The attachments and report text should not be used separately.

The recommendations submitted in this report are based on the data obtained from 21 borings drilled at this site, our understanding of the project information provided to us, and the assumption that site grading will result in only minor changes in the existing topography. If the project information described in this report is incorrect, is altered, or if new information is available, we should be retained to review and modify our recommendations.

This report may not reflect the actual variations of the subsurface conditions across the site. This is particularly true of this site where there exists the potential presence of solution cavities and/or voids that were not encountered in our test borings. The nature and extent of variations across the site may not become evident until construction commences. The construction process itself may also alter subsurface conditions. If variations appear evident at the time of construction, it may be necessary to reevaluate our recommendations after performing on-site observations and tests to establish the engineering impact of the variations.

The scope of our Geotechnical Engineering Study does not include an environmental assessment of the air, soil, rock, or water conditions either on or adjacent to the site. No environmental opinions are presented in this report.

BORINGS AND LABORATORY TESTS

Subsurface conditions at the site were evaluated by 21 borings drilled at the locations shown on the Boring Location Map, Figures 1A through 1C. Boring locations were documented in the field utilizing a hand-held GPS device, and drilled to the approximate depths presented in the table below. The borings were drilled using a truck-mounted drilling rig to a target depth of 10 ft below the existing ground surface, with several borings terminated above the target depth due to auger refusal in limestone.

During drilling operations, 4 Shelby Tube samples and 85 split-spoon samples (with Standard Penetration Testing) were collected. Additionally, 20 Texas Cone Penetrometer tests were performed.

Each sample was visually classified in the laboratory by a member of our geotechnical engineering staff. The geotechnical engineering properties of the strata were evaluated by the following tests:

Type of Test	Number Conducted
Natural Moisture Content	89
Atterberg Limits	14
No. 200 Sieve Wash	4
Sulfate Concentration	3
Soil-Lime Relationship Analysis	1

The results of all laboratory tests are presented in graphical or numerical form on the boring logs illustrated on Figures 2 through 22. A key to classification terms and symbols used on the logs is presented on Figure 23. The results of the laboratory and field testing are also tabulated on Figure 24 for ease of reference.

Standard Penetration Test results (N-values) are noted as “blows per ft” on the boring logs and Figure 24. The N-value is the number of blows required to drive a split-spoon sampler 1 ft into soil/weak rock with a falling, 140-lb hammer. Where hard or dense materials were encountered, the tests were terminated at 50 blows even if one foot of penetration had not been achieved. When all 50 blows fall within the first 6 in. (seating blows), refusal “ref” for 6 in. or less will be noted on the boring logs and on Figure 24.

Texas Cone Penetrometer (TCP) test results are noted as “blows per foot” on the boring log (divided into 6 in. increments) where “blows per ft” refers to the number of blows required to drive a conical driving point 1 ft into soil/weak rock with a falling, 170-lb hammer following seating blows equal to the lesser of 12 blows and 6 inches of penetration. Where hard or dense materials were encountered, each increment was terminated at 50 blows even if 6 in. of penetration had not been achieved in that increment.

Samples will be retained in our laboratory for 30 days after submittal of this report. Other arrangements may be provided at the request of the Client.

RESILIENT MODULUS TESTING

In addition to the above listed testing and sampling, bulk samples of the surficial soils near Boring B-3 were collected for use in resilient modulus testing. Additional testing on the bulk samples includes an Atterberg Limits test, sieve analysis, moisture-density relationship curve, and soil-lime testing pH relationship. The results of resilient modulus testing are presented in Appendix A. The soil-lime pH relationship curves are presented in Appendix B.

The resilient modulus tests were performed by Boudreau Engineering, Inc., at 95 percent of the maximum dry density as determined using TxDOT Tex-114-E, at optimum moisture and 2 percentage points above optimum moisture content.

SULFATE TESTING

Sulfate testing was performed on selected samples. The purpose of the sulfate testing was to determine the concentration of soluble sulfates in the subgrade soils, in order to investigate the potential for an adverse reaction to lime in sulfate-containing soils. The adverse reaction, referred to as sulfate-induced heave, has been known to cause cohesive subgrade soils to swell in short periods of time, resulting in pavement heaving and possible failure.

Boring	Depth Below Existing Ground Surface (ft)	Type of Soil	Sulfate Concentration (ppm)
B-5	1 to 2-1/2	Reddish-Brown Fat Clay	< 100
B-13	1 to 2-1/2	Dark Reddish-Brown Fat Clay	1,480
B-18	1 to 2-1/2	Brown and Tan Sandy Lean Clay	< 100

Based on the laboratory test results, the reported sulfate concentration values in the near surface subgrade were generally determined to be on the order of 100 to 1,500 parts per million (ppm). Reported sulfate concentrations above 3,000 ppm are known to cause sulfate induced heaving when the soils are mixed with lime. It should be understood that the identification of sulfates based on discrete soil samples cannot totally identify sulfates in all areas. If the option for lime, cement, or other pozzolans is considered, a quality assurance program should be implemented to assist in minimizing the risk of sulfate induced heaving.

SCOUR ANALYSIS

Two bulk samples, Samples GS-1 and GS-2, were gathered at the proposed bridge crossing, to the north and south of the existing roadway, respectively, for use in determining the median particle size diameter, D50, for calculating scour at the bridge. The D50 values are also presented on the Grain Size Curves, Figure 25.

Identification	D_{50} (mm)
GS-1	0.042
GS-2	0.033

GENERAL SITE CONDITIONS

GEOLOGY

A review of the *Geologic Atlas of Texas, Austin Sheet*, indicates that this site is naturally underlain with the soils/rock of the Edwards and Comanche Peak Limestone formations. Edwards limestone is generally considered hard in induration and typically contains harder zones/seams of chert and dolomite. Comanche Peak limestone is generally hard to moderately hard, is fine to very fine grained with chert and nodules, weathers gray to light tan, and is extensively burrowed and/or vuggy. Both the Edwards and Comanche Peak limestone formations may contain karstic features in the form of open and/or clay-filled vugs, voids, and/or solution cavities that form as a result of solution movement through fractures in the rock mass.

Key geotechnical engineering considerations for development supported on this formation will be the depth to rock, the expansive nature of the overlying clays, the condition of the rock, and the presence/absence of karstic features.

ASPHALT AND BASE THICKNESSES

The existing pavement sections measured in the field during drilling operations are summarized in the following table:

Boring	Asphalt Thickness (in.)	Base Thickness (in.)
B-1	4	9
B-2	5	7
B-3	6	9
B-4	4	7
B-5	4	8
B-6	5	9
BR-1	4	10

Boring	Asphalt Thickness (in.)	Base Thickness (in.)
BR-2	5	10
B-7	4	9
B-8	6	5
B-9	4	9
B-10	4	8
B-11	4	11
B-12	10	0
B-13	6	6
B-14	4	8
B-15	4	5
B-16	4	5
B-17	5	7
B-18	5-1/2	6-1/2
B-19	4	4-1/2

Generally, existing asphalt sections ranged from 4 to 6 in., and flexible base sections ranged from 5 to 11 in. in thickness, with the exception of B-12 which encountered a full depth asphalt pavement section.

STRATIGRAPHY

The specific subsurface conditions encountered at each boring location are shown on the boring logs, Figures 2 through 22. These boring logs represent our interpretation of the subsurface conditions based on the field logs, visual examination of field samples by our personnel, and test results of selected field samples. Each stratum has been designated by grouping soils that possess similar physical and engineering characteristics. The lines designating the interfaces between strata on the boring logs represent approximate boundaries. Transitions between strata may be gradual.

Generally, the subsurface may be divided into three generalized strata. Stratum I consists of dark brown, fat clay, with occasional limestone fragments. Stratum II ranges from light tan, sandy lean clay to lean clay with limestone fragments, layers, and seams to clayey sand and clayey gravel. Stratum III generally consists of light tan limestone and marl, and contains clay layers and seams.

Possible fill was encountered in several borings. The boring logs should be consulted for more specific stratigraphic information for any particular location. Lateral transitions in strata across borings may not be gradual or continuous; abrupt changes in lithology may exist between borings.

GROUNDWATER

Groundwater seepage was observed in four borings at the site, particularly near the clay/limestone interface. All borings not presented in the table below remained dry during the field exploration phase.

Boring	Depth to Groundwater Seepage During Drilling* (ft)	Depth to Groundwater Upon Completion of Drilling* (ft)
B-2	6.5	8.7
B-3	8.0	7.8
B-7	8.5	7.6
BR-2	3.0	-

*Depth below the existing pavement surface at the time of our study

Based on the findings in our borings and on our experience in this region, we believe that groundwater seepage encountered during shallow depth site earthwork activities may be controlled using temporary earthen berm and conventional sump-and-pump dewatering methods. For excavations to depths greater than about 2 ft, particularly west of the intersection of Sam Bass Road and Live Oak Circle, provisions should be made to handle water entering excavations during construction.

BRIDGE FOUNDATION RECOMMENDATIONS

DRILLED, STRAIGHT-SHAFT PIERS

Straight-shaft piers should be designed as combination friction and end bearing units using the allowable pressures presented on the drilled pier capacity curves, Appendix E. Side shear resistance was neglected to the elevations noted on the drilled pier capacity curves. We recommend a minimum penetration of one shaft diameter into limestone rock. Additionally, a minimum total pier length of three shaft diameters is recommended.

Pier capacity curves were developed using the TxDOT Geotechnical Manual, dated March 2018. The curves are based on the TCP blow count data from our borings. This allowable side shear resistance was evaluated using a calculated factor of safety of at least 2. Based on the 50-ft maximum depth of exploration, pier depths should not exceed a depth of 50 ft below the ground surface existing at the time of our study. The indicated capacities on these figures are for total loads. Dead loads should not exceed two-thirds of the computed capacities.

Potential Uplift Forces

The pier shafts will be subjected to potential uplift forces if the surrounding expansive soils within the active zone are subjected to alternating drying and wetting conditions. The maximum potential uplift force acting on the shaft may be estimated by:

$$F_u = 25 * D;$$

Where: F_u = uplift force in kips; and
D = diameter of the shaft in feet.

Reinforcing steel will be required in each pier shaft to withstand a net force equal to the uplift force minus the sustained compressive load carried by that pier. We recommend that each pier be reinforced to withstand this net force or an amount equal to 0.5 percent of the cross-sectional area of the shaft, whichever is greater.

PIER SPACING

Where possible, we recommend that the piers be spaced at a center to center distance of at least three shaft diameters on-center for straight-shaft piers. Such spacing will not require a reduction in the load carrying capacity of the individual piers.

If design and/or construction restraints require that piers be spaced closer than the recommended three shaft diameters, RKCI must re-evaluate the allowable bearing capacities presented above for the individual piers. Reductions in load carrying capacities may be required depending upon individual loading and spacing conditions.

LATERAL RESISTANCE

Resistance to lateral loads and the expected pier behavior under the applied loading conditions will depend not only on subsurface conditions, but also on loading conditions, the pier size, and the engineering properties of the pier. Once pier sizes, concrete strength, and reinforcement are finalized, piers should be analyzed to determine the resulting lateral deflection, maximum bending moment, and ultimate bending moment. This type of analysis is typically performed utilizing a computer analysis program and usually requires a trial and error procedure to appropriately size the piers and meet project tolerances.

To assist the design engineer in this procedure, we are providing the following soil parameters for use in analysis. These parameters are in accordance with the input requirements of one of the more commonly used computer programs for laterally loaded piles, the LPile program. If a different program is used for analysis, different parameters and limitations may be required than what were assumed in selecting the parameters given below. Thus, if a program other than LPile is used, RKCI must be notified of the analysis method, so that we can review and revise our recommendations if required. Evaluating the lateral resistance on different pier sizes is outside our scope of work at this time.
The soil-related parameters required for input into the LPile program are summarized in the tables below:

Assumed Behavior for Analysis	**Elevation* (ft)**	**c (psf)**	**k_s (pci)**	**ε_{50}**	**γ (pcf)**	**UCS (psi)**
Soft Clay (Matlock)	816 to 811	500	30	0.02	110	-
Strong Rock (Vuggy Limestone)	811 to 766	-	-	-	145	1,050

Where: **c** = undrained cohesion
k_s = p-y modulus (static)
ε_{50} = strain factor
γ = effective unit weight
UCS = unconfined compressive strength

The parameters presented in the above table do not include factors of safety. Per the general procedures of Section 1810.3.3.2 of the IBC 2015 edition, the allowable lateral capacity shall not exceed one-half of the lateral load that produces a lateral movement of 1-inch at the ground surface.

It should be noted that where piers are spaced closer than three shaft diameters center to center, a modification factor should be applied to the p-y curves to account for a group effect. We recommend the following p-Multipliers for the corresponding center to center pier spacings.

Spacing (in shaft diameters)	p-Multiplier
3	1.0
2	0.75
1	0.50

DRILLED PIER CONSTRUCTION RECOMMENDATIONS

Each drilled pier excavation must be examined by an RKCI representative who is familiar with the geotechnical aspects of the soil stratigraphy, the structural configuration, foundation design details and assumptions, prior to placing concrete. This is to observe that:

- The shaft has been excavated to the specified dimensions at the correct depth established by the previously mentioned criteria;
- The pier excavation remains dry prior to concrete placement, with less than 2 inches of water at the base of the excavation;
- The shaft has been drilled plumb within specified tolerances along its total length; and
- Excessive cuttings, buildup and soft, compressible materials have been removed from the bottom of the excavation.

If pier excavations are unable to be kept dry prior to placement of concrete, the tremie method should be used to place concrete. Utilization of the tremie method does not replace our recommendation of pier casing.

REINFORCEMENT AND CONCRETE PLACEMENT

Reinforcing steel should be checked for size and placement prior to concrete placement. Placement of concrete should be accomplished as soon as possible after excavation to reduce changes in the moisture content or the state of stress of the foundation materials. No foundation element should be left open overnight without concreting.

TEMPORARY CASING

Groundwater seepage was observed in the Boring BR-2 at a depth of 3 ft. Groundwater seepage and/or side sloughing is likely to be encountered at the time of construction, depending on climatic conditions prevalent at the time of construction. Therefore, we recommend that the bid documents require the foundation contractor to specify unit costs for different lengths of casing that may be required.

EXCAVATION EQUIPMENT

The need for drilled pier rigs capable of excavating through hard limestone rock should be anticipated for bridge pier construction at this site. Our boring logs are not intended for use in determining construction means and methods and may therefore be misleading if used for that purpose. We recommend that earth-work and utility contractors interested in bidding on the work perform their own tests in the form of test pits to determine the quantities of the different materials to be excavated, as well as the preferred excavation methods and equipment for this site.

PAVEMENT RECOMMENDATIONS

We understand the pavements at this site will consist of flexible and/or rigid pavements. The flexible pavement options being considered include an asphalt, flexible base, and stabilized subgrade option and a full-depth asphalt option. The rigid pavement option under consideration consists of a continually reinforced concrete pavement (CRCP) with a hot mix asphalt concrete (HMAC) bond breaker. The Owner and/or design team may select any of the presented pavement types depending on the performance criteria established for the project. In general, flexible pavement systems have a lower initial construction cost as compared to rigid pavements. However, maintenance requirements over the life of the pavement are typically much greater for flexible pavements. This typically requires regularly scheduled observation and repair, as well as overlays and/or other pavement rehabilitation at approximately one-half to two-thirds of the design life. Rigid pavements are generally more "forgiving", and therefore tend to be more durable and require less maintenance after construction.

For either pavement type, drainage conditions will have a significant impact on long term performance, particularly where permeable base materials are utilized in the pavement section. Drainage considerations are discussed in more detail in a subsequent section of this report.

EXPANSIVE SOIL-RELATED MOVEMENTS

The anticipated ground movements due to swelling of the underlying soils at the site were estimated according to the empirical procedure, Texas Department of Transportation (TxDOT) Tex-124-E, Method for Determining the Potential Vertical Rise (PVR). PVR values ranging from less than 1 in. to 1-3/4 in. were estimated for the stratigraphic conditions encountered across all borings. A surcharge load of 1 psi, an active zone extending to the lesser of 15 ft and the depth of limestone, and dry moisture conditions were assumed in estimating the above PVR values.

The TxDOT method of estimating expansive soil-related movements is based on empirical correlations utilizing the measured plasticity indices and assuming typical seasonal fluctuations in moisture content. If desired, other methods of estimating expansive soil-related movements are available, such as estimations based on swell tests and/or soil-suction analyses. However, the performance of these tests and the detailed analysis of expansive soil-related movements were beyond the scope of the current study. It should also be noted that actual movements can exceed the calculated PVR values due to isolated changes in moisture content or if water seeps into the soils to greater depths than the assumed active zone depth due to deep trenching or excavations.

SWELL/HEAVE POTENTIAL

The subgrade soils at this site are generally classified as plastic to highly plastic, and the potential exists for the soils to expand or heave when water is introduced, causing the pavement to become rough or uneven over time. Pavement roughness is generally defined as an expression of irregularities in the pavement surface that adversely affect the ride quality of a vehicle (and thus the user). Roughness is an important pavement characteristic because it affects not only ride quality but also vehicle costs, fuel consumption, and maintenance costs. Pavement heave can be reduced through various measures but cannot be totally eliminated without full removal of the problematic soil. Measures available for reducing heave include:

- Soil Treatment with Lime or Other Chemicals
- Removal and Replacement of Moderate to High PI Soils
- Drains or Barriers to Collect or Inhibit Moisture Infiltration

Soil treatment with lime (or other chemicals) is typically used to reduce the swelling potential of the upper portion of the pavement subgrade containing plastic soils. Lime and water are mixed with the top 6 to 12 inches (or possibly more) of the subgrade and allowed to mellow or cure for a period of time. After mellowing the soil-lime mixture is compacted to form a relatively strong soil matrix that can improve pavement performance and potentially reduce soil heave. However, the chemical reaction between the calcium-based additives and the sulfates and/or sulfide minerals in the soil can create a heaving problem on the pavement. Based on the results of our sulfate concentration tests, the on-site soils have sulfate content on the order of 1,480 ppm or less. However, we recommend that additional laboratory testing be performed on site and on any imported fills to determine the concentration of soluble sulfates in these soils.

If the sulfate content exceeds 3,000 ppm, the use of lime to treat the soils should be reconsidered. Furthermore, in highly plastic soils, lime treatment of only the top portion of the expansive subgrade may not provide an acceptable reduction in PVR. For a more substantial reduction in PVR, removal and replacement or treatment of the high PI soil may be the only method available to reduce the potential vertical rise of the pavement to an acceptable level. It must be recognized that partial removal of expansive clay soil only reduces the potential (or risk) of the damage swell can cause to a pavement and does not completely eliminate this risk.

In addition, capturing water infiltration via French drains or pavement edge drains would reduce the potential for heave since one important component of the heaving mechanism, water, would be reduced. Geogrid is also another tool available that may help reduce the damage that heaving subgrades cause to flexible pavements and may be considered in addition to or as an alternative to other mitigation techniques.

It should be noted that the pavement sections recommended in subsequent sections of this report are structurally adequate for the given traffic levels and subgrade strength, but do not consider the long-term effects of pavement roughness due to heave, which can be addressed by the measures discussed in this section.

TRAFFIC DATA AND ASSUMPTIONS

Traffic loading and frequencies were calculated based on the average daily traffic (ADT) values provided by Alliance Transportation Group and the design parameters summarized in the *Project Description* section of this report. Based on the Alliance Transportation Group ADT values, we calculated an average traffic growth rate of 7.5 percent per year over 23 years from 2017 to 2020. Based on this growth rate and the 2017 ADTs presented in the Alliance Transportation Group plans, equivalent 18-kip Equivalent Single-Axle Loads (ESALs) were estimated for a design life of 20 years for both flexible and rigid pavements. Start of construction has been assumed to be in the year 2020.

ADT in 2020*	16,900
Average Traffic Growth Rate (%/year)*	7.5
ADT in 2040, Estimated by Alliance Transportation Group	72,400
18-kip Equivalent Single Axle Loads (ESALs) – Flexible Pavements	6,115,000
18-kip Equivalent Single Axle Loads (ESALs) – Rigid Pavements	6,985,000

*Calculated based on data from Alliance Transportation Group

SUBGRADE STRENGTH CHARACTERIZATION

The natural subgrade conditions are generally anticipated to consist of native, dark brown to reddish-brown, Stratum I clay or tan lean clay to limestone subgrade. However, we understand that Williamson County intends to completely remove the dark brown to reddish-brown clay from subgrade areas at this site and replace it with high quality fill. Based on our experience with similar subgrade soils, we have assigned subgrade resilient moduli of 13 ksi for tan lean clay to clayey sand/clayey gravel subgrade, and 20 ksi for imported embankment fill and limestone subgrade conditions. This 20 ksi subgrade condition is the maximum allowable subgrade condition according to the Williamson County Design Criteria Manual (Table 5-5).

PAVEMENT DESIGN PARAMETERS – ASPHALTIC CONCRETE PAVEMENTS

The following input variables are utilized to design flexible pavements (commonly referred to as Asphaltic Cement Concrete or Asphalt pavements) when using the procedures detailed in the TxDOT Pavement Guide:

- Performance Period
- Roadbed Soil Resilient Modulus psi
- Serviceability Indices
- Reliability, %
- Design Traffic, 18-kip ESALs

Performance Period

The pavement structure was designed for a 20-year performance period which is typical for most flexible pavements.

Serviceability Indices

Initial serviceability is a measure of the pavement's smoothness or rideability immediately after construction. Terminal serviceability is the minimum tolerable serviceability of a pavement. When the serviceability of a pavement reaches its terminal value, rehabilitation is required. An initial serviceability value of 4.5 and a terminal serviceability value of 2.5 were used for this pavement design.

Reliability, %

The reliability value represents a "safety factor," with higher reliabilities representing pavement structures with less chance of failure. A reliability of 95 percent was used for this pavement design in accordance with the Williamson County *Design Criteria Manual*.

RECOMMENDED FLEXIBLE PAVEMENT SECTIONS – HOT MIX ASPHALT PAVEMENTS

Utilizing the pavement design parameters discussed above along with TxDOT's pavement design program FPS 21, v.1.5, the pavement sections presented below are recommended. The FPS 21 output files are attached at the end of this report.

The following two pavement options may be utilized for construction on clay subgrade.

Option 1: Asphalt and Flexible Base Section

Subgrade	Layer Description	Layer Thickness	
		Option 1	Option 2
Tan Clay/Clayey Sand/ Clayey Gravel	HMAC Surface Course, Type D HMAC Binder Course, Type B or C Flexible (Granular) Base **Total Pavement Thickness**	2.0 in. 6.0 in. 15.0 in. **23.0 in.**	2.0 in. 4.5 in. 19.0 in. **25.5 in.**
Imported Embankment Fill/Limestone	HMAC Surface Course, Type D HMAC Binder Course, Type B or C Flexible (Granular) Base **Total Pavement Thickness**	2.0 in. 6.0 in. 14.0 in. **22.0 in.**	2.0 in. 4.5 in. 18.0 in. **24.5 in.**

All previously presented pavement sections above pass FPS 21's mechanistic and triaxial checks. The results are attached to this document.

Option 2: Full-Depth Asphalt Section

Subgrade	Layer Description	Layer Thickness
Tan Clay/Clayey Sand/ Clayey Gravel	HMAC Surface Course, Type D HMAC Binder Course, Type B or C **Total Pavement Thickness**	2.0 in. 11.0 in. **13.0 in.**
Imported Embankment Fill/Limestone	HMAC Surface Course, Type D HMAC Binder Course, Type B or C **Total Pavement Thickness**	2.0 in. 10.5 in. **12.5 in.**

Compacted flexible base may be utilized as a leveling layer with a minimum thickness of 4 in. if included.

RIGID PAVEMENT

We understand rigid pavements at this site are anticipated to consist of a CRCP pavement with asphalt bond breaker and flexible base subbase. Rigid pavements are less sensitive to subgrade types than flexible pavements are; thus, a single design is provided below for both clay and limestone subgrades.

The following recommendations were prepared using TxDOT's TxCRCP-ME program, version 07b.

Layer Description	Layer Thickness
Portland Cement Concrete	10.0 in.
HMAC Bond Breaker	2.0 in.
Lime Treated Subbase	8.0 in.
Total Pavement Thickness	**20.0 in.**

If possible, the pavement should develop a minimum slope of 0.015 ft/ft to promote surface drainage. Reinforced concrete pavement should cure a minimum of 3 and 7 days before allowing automobile and truck traffic, respectively.

PAVEMENT CONSTRUCTION CONSIDERATIONS

SUBGRADE PREPARATION

The roadways and all areas to support fill should be stripped of all vegetation, organic topsoil, existing pavement sections and associated backfill. Exposed clay subgrades should be thoroughly proofrolled in order to locate any weak, compressible zones. A fully-loaded dump truck or a similar heavily-loaded piece of construction equipment should be used for planning purposes. Proofrolling operations should be observed by the Geotechnical Engineer or his/her representative to document subgrade condition and preparation and be performed in accordance with TxDOT, Item 216. Weak or soft areas identified during proofrolling should be removed and replaced with a suitable, compacted backfill.

After completion of the proofrolling operations and just prior to flexible base placement, the exposed subgrade should be moisture conditioned by scarifying to a minimum depth of 6 in. and recompacting to a minimum of 95 percent of the maximum density determined from the Texas Department of Transportation Compaction Test (TxDOT, Tex-114-E). The moisture content of the subgrade should be maintained within the range of optimum moisture content to 3 percentage points above optimum until permanently covered.

In areas of exposed competent and intact limestone rock subgrade, the subgrade shall be proofrolled in order to locate and densify any weak compressible zones. Scarification and moisture conditioning will not be required on competent and intact limestone rock.

EMBANKMENT FILL

Select Borrow Fill

Materials used as borrow fill for final site grading preferably shall consists of the following as indicated in the plans:

- 2014 TxDOT Item 132, Type A - Granular fill

Select borrow fill should be placed in accordance to TxDOT Item 132 and should be placed in loose lifts not exceeding 8 in. in thickness and compacted to at least 95 percent of maximum density as determined by TxDOT, Tex-113-E, Compaction Test. The moisture content of the fill should be maintained within the range of 2 percentage points below to 2 percentage points above the optimum moisture content until final compaction.

LIME TREATMENT OF SUBGRADE

Lime treatment of the subgrade soils, if utilized, should be in accordance with the TxDOT Standard Specifications, Item 260. A sufficient quantity of hydrated lime should be mixed with the subgrade soils until either the pH of the soil-lime mixture is at least 12.4 or higher concentrations of lime do not increase the pH, as specified in Part III of TxDOT procedure Tex-121-E, *Soil Lime Testing.* For estimating purposes, we recommend that 5 percent lime by weight be assumed for treatment. For construction purposes, we recommend that the optimum lime content of the subgrade soils be determined by laboratory testing.

Lime-treated subgrade soils should be compacted to a minimum of 95 percent of the maximum density at a moisture content within the range of optimum moisture content to 3 percentage points above the optimum moisture content as determined by Tex-113-E. We recommend that lime treatment extend at least 3 ft beyond the curb.

If lime treatment is considered as a method to improve pavement subgrade conditions, it is also recommended to perform additional laboratory testing to determine the concentration of soluble sulfates in the subgrade soils, in order to investigate the potential for a recently reported adverse reaction to lime in certain sulfate-containing soils. The adverse reaction, referred to as sulfate-induced heave, has been known to cause cohesive subgrade soils to swell in short periods of time, resulting in pavement heaving and possible failure.

FLEXIBLE BASE COURSE

The flexible base course should be crushed limestone conforming to 2014 TxDOT Standard Specifications for Construction and Maintenance of Highways, Streets and Bridges, Item 247, Flexible Base, Type A, Grade 1-2. The base course should be placed in loose lifts not exceeding 8 in. in thickness and compacted to at least 100 percent of maximum density as determined by TxDOT, Tex-113-E, Compaction Test. The moisture content should be maintained within the range of 2 percentage points below to 2 percentage points above the optimum moisture content until final compaction.

ASPHALTIC CONCRETE SURFACE AND BINDER COURSES AND BOND BREAKER

The asphaltic concrete surface and/or binder courses should conform to 2014 TxDOT Standard Specifications, Item 340 – Dense Graded Hot Mix Asphalt (Method). Type D asphalt should be utilized for the surface course, and Type B or C asphalt should be utilized for the binder course. Type D asphalt should be utilized for the bond breaker. The asphaltic concrete should be compacted to a minimum of 92 percent of the maximum theoretical specific gravity (Rice) of the mixture determined according to Test Method Tex-227-F. Pavement specimens, which shall be either cores or sections of asphaltic pavement, will be tested according to Test Method Tex-207-F. The nuclear-density gauge or other methods which correlate satisfactorily with results obtained from project roadway specimens may be used when approved by the Engineer. Unless otherwise shown on the plans, the Contractor shall be responsible for obtaining the required roadway specimens at their expense and in a manner and at locations selected by the Engineer.

PORTLAND CEMENT CONCRETE

The Portland cement concrete should be air entrained to result in a 4 percent plus/minus 1 percent air, should have a maximum slump of 5 inches, and should have a minimum 28-day compressive strength of 4,000 psi. A liquid membrane-forming curing compound should be applied as soon as practical after broom finishing the concrete surface. The curing compound will help reduce the loss of water from the concrete. The reduction in the rapid loss in water will help reduce shrinkage cracking of the concrete.

MISCELLANEOUS PAVEMENT RELATED CONSIDERATIONS

Drainage Considerations

As with any soil-supported structure, the satisfactory performance of a pavement system is contingent on the provision of adequate surface and subsurface drainage. Insufficient drainage which allows saturation of the pavement subgrade and/or the supporting granular pavement materials will greatly reduce the performance and service life of the pavement systems.

Surface and subsurface drainage considerations crucial to the performance of pavements at this site include (but are not limited to) the following:

- Any known natural or man-made subsurface seepage at the site which may occur at sufficiently shallow depths as to influence moisture contents within the subgrade should be intercepted by drainage ditches or below grade French drains.
- Final site grading should eliminate isolated depressions adjacent to curbs, which may allow surface water to pond and infiltrate into the underlying soils. Curbs, if any, should be installed to a sufficient depth to reduce infiltration of water beneath the curbs and into the pavement base materials.
- Pavement surfaces should be maintained to help minimize surface ponding and to provide rapid sealing of any developing cracks. These measures will help reduce infiltration of surface water downward through the pavement section.

Utilities

Our experience indicates that significant settlement of backfill can occur in utility trenches, particularly when trenches are deep, when backfill materials are placed in thick lifts with insufficient compaction, and when water can access and infiltrate the trench backfill materials. The potential for water to access the backfill is increased where water can infiltrate flexible base materials due to insufficient penetration of curbs, and at sites where geological features can influence water migration into utility trenches (such as fractures within a rock mass or at contacts between rock and clay formations). It is our belief that another factor which can significantly impact settlement is the migration of fines within the backfill into the open voids in the underlying free-draining bedding material.

To reduce the potential for settlement in utility trenches, we recommend that consideration be given to the following:

- All backfill materials should be placed and compacted in controlled lifts appropriate for the type of backfill and the type of compaction equipment being utilized and all backfilling procedures should be tested and documented.
- Consideration should be given to wrapping free-draining bedding gravels with a geotextile fabric (similar to Mirafi 140N) to reduce the infiltration and loss of fines from backfill material into the interstitial voids in bedding materials.

Pavement Maintenance

Regular pavement maintenance is critical in maintaining pavement performance over a period of several years. All cracks that develop in asphalt pavements should be regularly sealed. Areas of moderate to severe fatigue cracking (also known as alligator cracking) should be sawcut and removed. The underlying base should be checked for contamination or loss of support and any insufficiencies fixed or removed and the entire area patched. All cracks that develop in concrete pavements should be routed and sealed regularly. Joints in concrete pavements should be maintained to reduce the influx of incompressible materials that restrain joint movement and cause spalling and/or cracking. Other typical TxDOT maintenance techniques should be followed as required.

Construction Traffic

Construction traffic on prepared subgrade or granular base should be restricted as much as possible until the protective asphalt surface pavement is applied. Significant damage to the underlying layers resulting in weakening may occur if heavily loaded vehicles are allowed to use these areas.

CONSTRUCTION RELATED SERVICES

CONSTRUCTION MATERIALS TESTING AND OBSERVATION SERVICES

As presented in the attachment to this report, *Important Information About Your Geotechnical Engineering Report*, subsurface conditions can vary across a project site. The conditions described in this report are based on interpolations derived from a limited number of data points. Variations will be encountered during construction, and only the geotechnical design engineer will be able to determine if these conditions are different than those assumed for design.

Construction problems resulting from variations or anomalies in subsurface conditions are among the most prevalent on construction projects and often lead to delays, changes, cost overruns, and disputes. These variations and anomalies can best be addressed if the geotechnical engineer of record, RKCI is retained to perform construction observation and testing services during the construction of the project. This is because:

- RKCI has an intimate understanding of the geotechnical engineering report's findings and recommendations. RKCI understands how the report should be interpreted and can provide such interpretations on site, on the client's behalf.
- RKCI knows what subsurface conditions are anticipated at the site.
- RKCI is familiar with the goals of the owner and project design professionals, having worked with them in the development of the geotechnical workscope. This enables RKCI to suggest remedial measures (when needed) which help meet the owner's and the design teams' requirements.
- RKCI has a vested interest in client satisfaction, and thus assigns qualified personnel whose principal concern is client satisfaction. This concern is exhibited by the manner in which contractors' work is tested, evaluated and reported, and in selection of alternative approaches when such may become necessary.

- RKCI cannot be held accountable for problems which result due to misinterpretation of our findings or recommendations when we are not on hand to provide the interpretation which is required.

BUDGETING FOR CONSTRUCTION TESTING

Appropriate budgets need to be developed for the required construction testing and observation activities. At the appropriate time before construction, we advise that RKCI and the project designers meet and jointly develop the testing budgets, as well as review the testing specifications as it pertains to this project.

Once the construction testing budget and scope of work are finalized, we encourage a preconstruction meeting with the selected contractor to review the scope of work to make sure it is consistent with the construction means and methods proposed by the contractor. RKCI looks forward to the opportunity to provide continued support on this project, and would welcome the opportunity to meet with the Project Team to develop both a scope and budget for these services.

* * * * * * * * * * * * * * * * * *

ATTACHMENTS

RABA KISTNER

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(512)339-1745 TEL
(512)339-6174 FAX

TBPE Firm F-3257

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

BORING LOCATION MAP

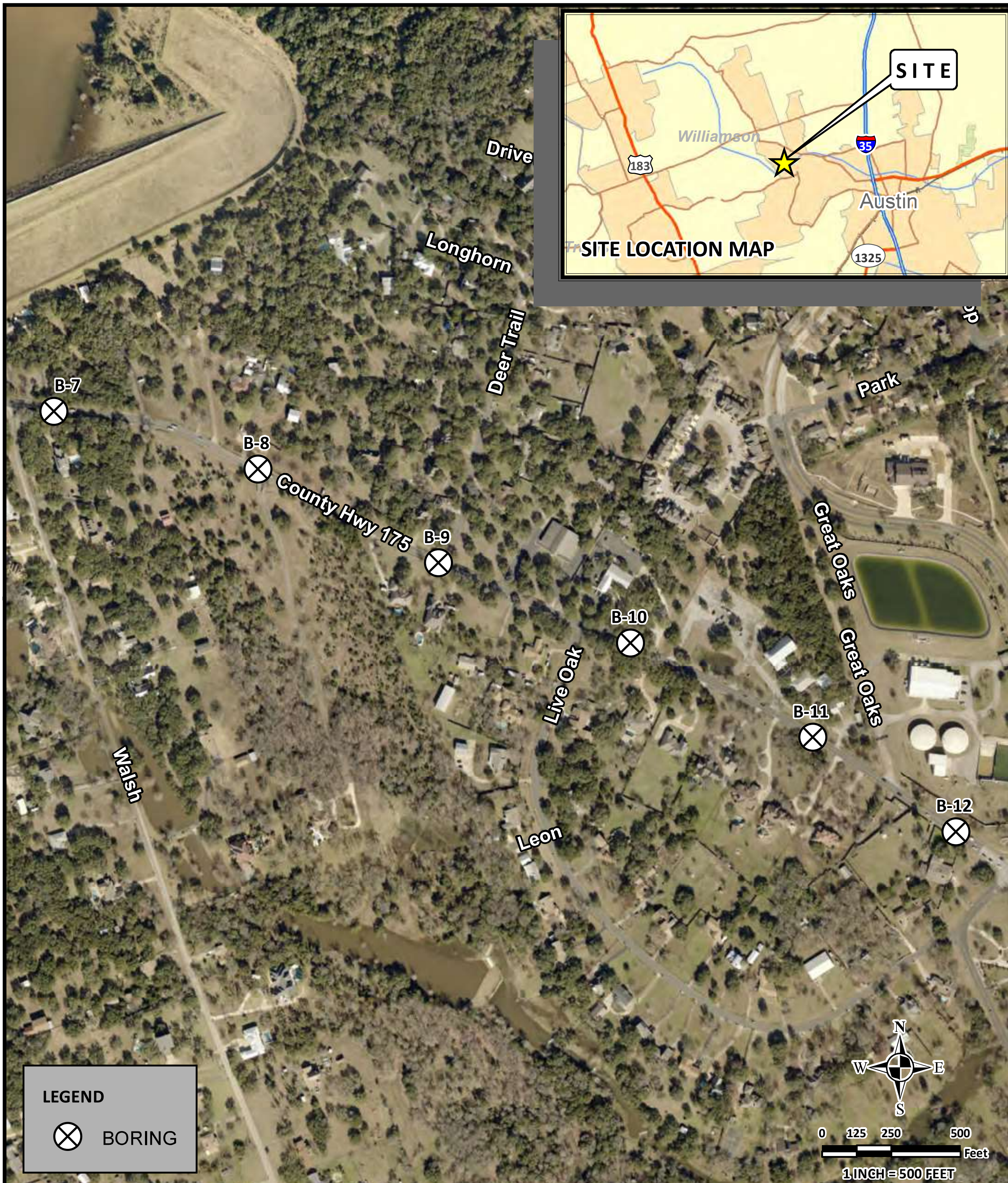
SAM BASS ROADWAY IMPROVEMENTS
FROM FM 1431 TO WYOMING SPRINGS DRIVE
WILLIAMSON COUNTY, TEXAS

PROJECT No.:	AAA19-026-00
ISSUE DATE:	02/05/2020
DRAWN BY:	KRB
CHECKED BY:	ZYB
REVIEWED BY:	RTS

FIGURE

1A

NOTE: This Drawing is Provided for Illustration Only, May Not be to Scale and is Not Suitable for Design or Construction Purposes



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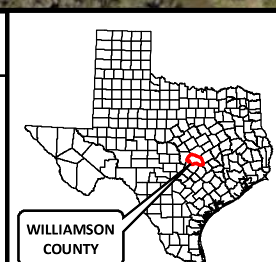
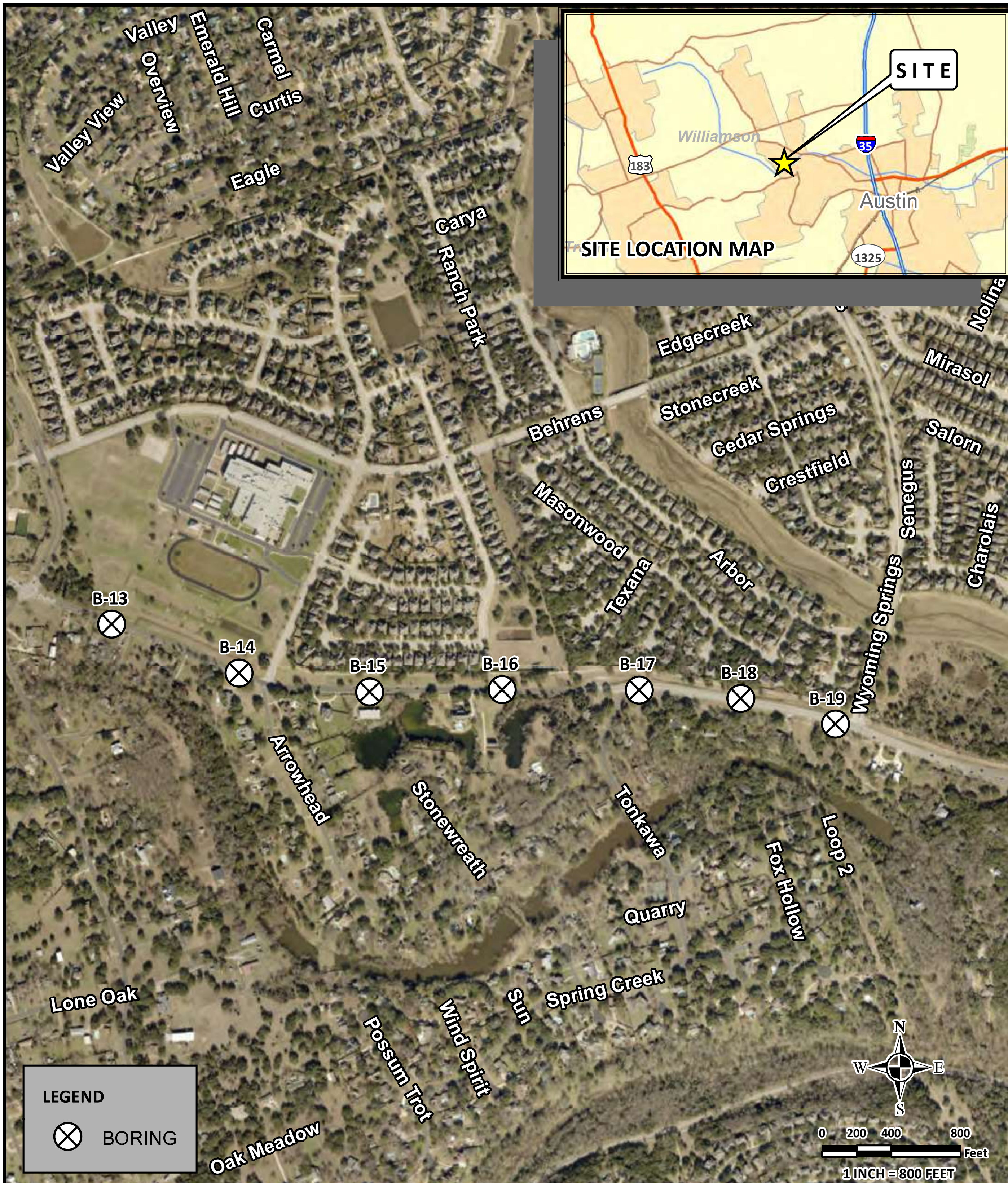
BORING LOCATION MAP

SAM BASS ROADWAY IMPROVEMENTS
FROM FM 1431 TO WYOMING SPRINGS DRIVE
WILLIAMSON COUNTY, TEXAS



PROJECT No.:	AAA19-026-00
ISSUE DATE:	02/05/2020
DRAWN BY:	KRB
CHECKED BY:	ZYB
REVIEWED BY:	RTS
FIGURE	1B

NOTE: This Drawing is Provided for Illustration Only, May Not be to Scale and is Not Suitable for Design or Construction Purposes



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BORING LOCATION MAP

SAM BASS ROADWAY IMPROVEMENTS
FROM FM 1431 TO WYOMING SPRINGS DRIVE
WILLIAMSON COUNTY, TEXAS

PROJECT No.:	AAA19-026-00
ISSUE DATE:	02/05/2020
DRAWN BY:	KRB
CHECKED BY:	ZYB
REVIEWED BY:	RTS
FIGURE	1C

NOTE: This Drawing is Provided for Illustration Only, May Not be to Scale and is Not Suitable for Design or Construction Purposes

LOG OF BORING NO. B-1

Williamson County Corridor H
Sam Bass Road
Williamson County, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 30.54331; W 97.76016

SHEAR STRENGTH, TONS/FT^2: 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10, 20, 30, 40, 50, 60, 70, 80

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
	ASPHALT (4 inches)				
	BASE (9 inches)				
	LEAN CLAY (CL), Hard, Dark Brown, with limestone fragments (possibly fill)	50/11"		23	
	LIMESTONE, Hard, Tan	ref/1"			
5		ref/0.5"			
	Boring Terminated				
10					

NOTES:
1. Groundwater not encountered during drilling operations.
2. Borehole backfilled with auger cuttings.

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	7.0 ft	**DEPTH TO WATER:**	Dry	**PROJ. No.:**	AAA19-026-00
DATE DRILLED:	4/11/2019	**DATE MEASURED:**	4/11/2019	**FIGURE:**	2

LOG OF BORING NO. B-2

Williamson County Corridor H
Sam Bass Road
Williamson County, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 30.54138; W 97.75936

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
	ASPHALT (5 inches)				
	BASE (7 inches)				
	FAT CLAY (CH), Firm, Black, with limestone fragments	5		53	
	LEAN CLAY (CL), Very Stiff to Hard, Light Tan, with limestone fragments, ferrous staining, and calcareous deposits	15			
5		19			
	- groundwater seepage noted at 6-1/2 ft	50/8.5"			
	LIMESTONE, Hard, Tan	ref/3"			
10	Boring Terminated				

SHEAR STRENGTH, TONS/FT^2: 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10, 20, 30, 40, 50, 60, 70, 80

NOTES:
1. Groundwater not encountered during drilling operations.
2. Borehole backfilled with auger cuttings.

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	10.0 ft	**DEPTH TO WATER:**	8.7 ft	**PROJ. No.:**	AAA19-026-00
DATE DRILLED:	4/11/2019	**DATE MEASURED:**	4/11/2019	**FIGURE:**	3

LOG OF BORING NO. B-3

Williamson County Corridor H
Sam Bass Road
Williamson County, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 30.53949; W 97.75849

SHEAR STRENGTH, TONS/FT^2: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10 20 30 40 50 60 70 80

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
	ASPHALT (6 inches)				
	BASE (9 inches)				
	FAT CLAY (CH), Stiff, Dark Brown, with sand and limestone fragments (possibly fill)	9			
	GRAVELLY FAT CLAY (CL), Very Stiff, Light Tan, with sand (possibly fill)	24			
5	**SANDY LEAN CLAY (CL),** Very Stiff, Tan, with gravel limestone fragments and ferrous staining	25 29			
	LIMESTONE, Hard, Tan, with ferrous staining	ref/1"			
10	Boring Terminated				

NOTES:
1. Groundwater encountered at 7.8 ft during drilling operations.
2. Borehole backfilled with auger cuttings.

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 10.0 ft
DATE DRILLED: 4/11/2019
DEPTH TO WATER: 7.8 ft
DATE MEASURED: 4/11/2019
PROJ. No.: AAA19-026-00
FIGURE: 4

LOG OF BORING NO. B-4
Williamson County Corridor H
Sam Bass Road
Williamson County, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 30.53899; W 97.75631

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT² (0.5–4.0) / PLASTIC LIMIT – WATER CONTENT – LIQUID LIMIT (10–80)	PLASTICITY INDEX	% -200
			ASPHALT (4 inches)					
			BASE (7 inches)					
			FAT CLAY (CH), Hard, Dark Brown	50/2"		●		
			LIMESTONE, Hard, Tan					
			- with soft clay seams above 2-1/2 ft	ref/0.5"		●		
5				ref/1"		●		
			Boring Terminated					
10								

NOTES:
1. Groundwater not encountered during drilling operations.
2. Borehole backfilled with auger cuttings.

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 6.0 ft	**DEPTH TO WATER:** Dry	**PROJ. No.:** AA19-026-00	
DATE DRILLED: 4/11/2019	**DATE MEASURED:** 4/11/2019	**FIGURE:** 5	

LOG OF BORING NO. B-5

Williamson County Corridor H
Sam Bass Road
Williamson County, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger
LOCATION: N 30.53877; W 97.75395

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT² (0.5–4.0) / PLASTIC LIMIT – WATER CONTENT – LIQUID LIMIT (10–80)	PLASTICITY INDEX	% -200
			ASPHALT (4 inches)					
			BASE (9 inches)					
			FAT CLAY (CH), Hard, Reddish-Brown	30				
			SANDY LEAN CLAY (CL) Very Stiff, Tan, with gravel , ferrous staining, calcareous deposits, and limestone fragments	28				
			LIMESTONE, Hard, Tan	ref/2"				
5				ref/1.5"				
			Boring Terminated					
10								

NOTES:
1. Groundwater not encountered during drilling operations.
2. Borehole backfilled with auger cuttings.

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	6.5 ft	**DEPTH TO WATER:**	Dry	**PROJ. No.:**	AAA19-026-00
DATE DRILLED:	4/11/2019	**DATE MEASURED:**	4/11/2019	**FIGURE:**	6

LOG OF BORING NO. B-6

Williamson County Corridor H
Sam Bass Road
Williamson County, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 30.53847; W 97.75162

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT² / PLASTIC LIMIT – WATER CONTENT – LIQUID LIMIT	PLASTICITY INDEX	% -200
			ASPHALT (5 inches)					
			BASE (9 inches)					
			LEAN CLAY (CL), Hard, Brown, with limestone fragments (possibly fill)	ref/4"			10	
			Driller's Note: Blowcounts on gravel at 1-1/2 ft					
			LIMESTONE, Hard, Gray	ref/1"				
5				ref/1"				
			Boring Terminated					

NOTES:
1. Groundwater not encountered during drilling operations.
2. Borehole backfilled with auger cuttings.

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 6.5 ft	**DEPTH TO WATER:** Dry	**PROJ. No.:** AA19-026-00	
DATE DRILLED: 4/11/2019	**DATE MEASURED:** 4/11/2019	**FIGURE:** 7	

LOG OF BORING NO. B-7

Williamson County Corridor H
Sam Bass Road
Williamson County, Texas

TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 30.53813; W 97.74930

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
	ASPHALT (4 inches)				
	BASE (9 inches)				
	FAT CLAY (CH), Hard, Dark Brown, with limestone fragments	31			
	LIMESTONE, Hard, Tan, with reddish-brown clay seams and layers	ref/2.5"			
5	- clay layer at 4-1/2 ft	35		9	
		ref/0.5"			
	Driller's Note: Groundwater seepage noted at 8-1/2 ft during drilling	ref/6"			
10	Boring Terminated				

SHEAR STRENGTH, TONS/FT²: 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10, 20, 30, 40, 50, 60, 70, 80

NOTES:
1. Groundwater encountered at 7.6 ft during drilling operations.
2. Borehole backfilled with auger cuttings.

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	10.0 ft	**DEPTH TO WATER:**	7.5 ft	**PROJ. No.:**	AAA19-026-00
DATE DRILLED:	4/12/2019	**DATE MEASURED:**	4/12/2019	**FIGURE:**	8

LOG OF BORING NO. B-8

Williamson County Corridor H
Sam Bass Road
Williamson County, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 30.53754; W 97.74697

SHEAR STRENGTH, TONS/FT²: 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10, 20, 30, 40, 50, 60, 70, 80

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
	ASPHALT (6 inches)				
	BASE (5 inches)				
	FAT CLAY (CH), Stiff to Hard, Dark Brown, with limestone seams	9			
	LIMESTONE, Hard, Gray, with intermittent clay seams	50/9.75"			
		ref/4.25"			
5		ref/0"			
	Boring Terminated				

NOTES:
1. Groundwater not encountered during drilling operations.
2. Borehole backfilled with auger cuttings.

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	6.5 ft	**DEPTH TO WATER:**	Dry	**PROJ. No.:**	AAA19-026-00
DATE DRILLED:	4/12/2019	**DATE MEASURED:**	4/12/2019	**FIGURE:**	9

LOG OF BORING NO. B-9

Williamson County Corridor H
Sam Bass Road
Williamson County, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 30.53658; W 97.74491

SHEAR STRENGTH, TONS/FT^2: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10 20 30 40 50 60 70 80

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
	ASPHALT (4 inches)				
	BASE (9 inches)				
	FAT CLAY (CH), Very Stiff, Dark Reddish-Brown, with limestone fragments	16			
		26			
5	**LEAN CLAY (CL),** Very Stiff, Reddish-Tan, with sand and limestone fragments (decomposed limestone)	50/9.5"		14	
	LIMESTONE, Hard, Gray	ref/1.5"			
		ref/1"			
10	Boring Terminated				

NOTES:
1. Groundwater not encountered during drilling operations.
2. Borehole backfilled with auger cuttings.

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	10.0 ft	**DEPTH TO WATER:**	Dry	**PROJ. No.:**	AAA19-026-00
DATE DRILLED:	4/12/2019	**DATE MEASURED:**	4/12/2019	**FIGURE:**	10

LOG OF BORING NO. B-10

Williamson County Corridor H
Sam Bass Road
Williamson County, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 30.53577; W 97.74271

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	WATER CONTENT / ATTERBERG LIMITS	PLASTICITY INDEX	% -200
	ASPHALT (4 inches)					
	BASE (8 inches)					
	LEAN CLAY (CL), Hard, Tan, with limestone fragments	44		● ×−−×	15	
	FAT CLAY (CH), Hard, Reddish-Brown	50/3.5"		●		
	LIMESTONE, Hard, Gray, with intermittent clay layers and seams	ref/4"		●		
5						
		ref/0.5"		●		
		ref/0"		●		
	Boring Terminated					
10						

SHEAR STRENGTH, TONS/FT²: 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10, 20, 30, 40, 50, 60, 70, 80

NOTES:
1. Groundwater not encountered during drilling operations.
2. Borehole backfilled with auger cuttings.

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	8.5 ft	**DEPTH TO WATER:**	Dry	**PROJ. No.:**	AAA19-026-00
DATE DRILLED:	4/12/2019	**DATE MEASURED:**	4/12/2019	**FIGURE:**	11

LOG OF BORING NO. B-11

Williamson County Corridor H
Sam Bass Road
Williamson County, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger
LOCATION: N 30.53481; W 97.74064

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT² / PLASTIC LIMIT – WATER CONTENT – LIQUID LIMIT	PLASTICITY INDEX	% -200
	ASPHALT (4 inches)					
	BASE (8 inches)					
	FAT CLAY (CH), Stiff, Reddish-Brown	13		PL ≈ 18; WC ≈ 27; LL ≈ 58	40	
		50/3.5"		WC ≈ 10		
	SANDY LEAN CLAY (CL), Hard, Light Tan, with limestone seams (decomposed limestone)	ref/5"		WC ≈ 9		
5	**LIMESTONE,** Hard, Light Gray, with intermittent clay layers and seams	ref/1"		WC ≈ 18		
		ref/1.5"		WC ≈ 17		
10	Boring Terminated					

Shear strength scale: 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0
Water content scale: 10, 20, 30, 40, 50, 60, 70, 80

NOTES:
1. Groundwater not encountered during drilling operations.
2. Borehole backfilled with auger cuttings.

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	10.0 ft	**DEPTH TO WATER:**	Dry	**PROJ. No.:**	AAA19-026-00
DATE DRILLED:	4/12/2019	**DATE MEASURED:**	4/12/2019	**FIGURE:**	12

LOG OF BORING NO. B-12

Williamson County Corridor H
Sam Bass Road
Williamson County, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 30.53386; W 97.73901

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT^2 (0.5–4.0) / PLASTIC LIMIT – WATER CONTENT – LIQUID LIMIT (10–80)	PLASTICITY INDEX	% -200
			ASPHALT (10 inches)					
			LEAN CLAY (CL), Hard, Dark Brown and Gray, silty, with limestone fragments (possibly fill)	50/1"			14	
			LIMESTONE, Hard, Gray, with intermittent clay layers and seams	ref/0.5"				
				ref/0.5"				
5								
			Boring Terminated					
10								

NOTES:
1. Groundwater not encountered during drilling operations.
2. Borehole backfilled with auger cuttings.

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	5.5 ft	**DEPTH TO WATER:**	Dry	**PROJ. No.:**	AAA19-026-00
DATE DRILLED:	4/12/2019	**DATE MEASURED:**	4/12/2019	**FIGURE:**	13

LOG OF BORING NO. B-13

Williamson County Corridor H
Sam Bass Road
Williamson County, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 30.53294; W 97.73681

SHEAR STRENGTH, TONS/FT² — 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10, 20, 30, 40, 50, 60, 70, 80

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
	ASPHALT (6 inches)				
	BASE (6 inches)				
	FAT CLAY (CH), Stiff, Dark Reddish-Brown, with limestone fragments	14			
	SANDY LEAN CLAY (CL), Hard, Tan and Gray, with calcareous deposits and limestone fragments	50/3.5"			55
5	**LIMESTONE,** Hard, Tan, with intermittend clay layers and seams	ref/4.5"			
		50/7.5"			
		ref/0.5"			
10	Boring Terminated				

NOTES:
1. Groundwater not encountered during drilling operations.
2. Borehole backfilled with auger cuttings.

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 10.0 ft
DATE DRILLED: 4/12/2019
DEPTH TO WATER: Dry
DATE MEASURED: 4/12/2019
PROJ. No.: AAA19-026-00
FIGURE: 14

LOG OF BORING NO. B-14

Williamson County Corridor H
Sam Bass Road
Williamson County, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 30.53214; W 97.73448

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
	ASPHALT (4 inches)				
	BASE (8 inches)				
	FAT CLAY (CH), Hard, Reddish-Brown, with limestone fragments	50/11"			
	SANDY LEAN CLAY (CL) Hard, Light Gray, with limestone fragments	ref/5"		14	
	LIMESTONE Decomposed, Moderately Hard to Hard, Tan, with clay layers and seams	ref/5.5"			
5	**LIMESTONE,** Hard, Gray, with intermittent clay layers and seams	ref/0.5"			
		ref/4.5"			
10	Boring Terminated				

SHEAR STRENGTH, TONS/FT^2: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10 20 30 40 50 60 70 80

NOTES:
1. Groundwater not encountered during drilling operations.
2. Borehole backfilled with auger cuttings.

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 10.0 ft	**DEPTH TO WATER:** Dry	**PROJ. No.:** AAA19-026-00	
DATE DRILLED: 4/15/2019	**DATE MEASURED:** 4/15/2019	**FIGURE:** 15	

LOG OF BORING NO. B-15

Williamson County Corridor H
Sam Bass Road
Williamson County, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger **LOCATION:** N 30.53182; W 97.73210

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT² / PLASTIC LIMIT – WATER CONTENT – LIQUID LIMIT	PLASTICITY INDEX	% -200
	ASPHALT (4 inches)					
	BASE (5 inches)					
	FAT CLAY (CH), Hard, Reddish-Brown, with limestone fragments	50/7"			40	
	LIMESTONE, Decomposed, Hard, Light Tan, with intermittent clay layers and seams	ref/2"				
5	**LIMESTONE,** Hard, Gray, with intermittent clay layers and seams	ref/0.5"				
		ref/4"				
		ref/4.5"				
10	Boring Terminated					

Shear strength scale: 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0
Plastic limit / water content / liquid limit scale: 10, 20, 30, 40, 50, 60, 70, 80

NOTES:
1. Groundwater not encountered during drilling operations.
2. Borehole backfilled with auger cuttings.

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	10.0 ft	**DEPTH TO WATER:**	Dry	**PROJ. No.:**	AAA19-026-00
DATE DRILLED:	4/15/2019	**DATE MEASURED:**	4/15/2019	**FIGURE:**	16

LOG OF BORING NO. B-16

Williamson County Corridor H
Sam Bass Road
Williamson County, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 30.53183; W 97.72966

SHEAR STRENGTH, TONS/FT^2: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT: 10 20 30 40 50 60 70 80

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
	ASPHALT (4 inches)				
	BASE (5 inches)				
	FILL: SANDY LEAN CLAY (CL), Hard, Tan and Brown, with gravel limestone fragments	50/5"			50
	LIMESTONE, Hard, Light Gray, chalky, with ferrous staining, and intermittent clay layers and seams	ref/2"			
5	- clay layer at 4-1/2 ft	50/4"			
		ref/1.5			
		ref/0"			
10	Boring Terminated				

NOTES:
1. Groundwater not encountered during drilling operations.
2. Borehole backfilled with auger cuttings.

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	10.0 ft	**DEPTH TO WATER:**	Dry	**PROJ. No.:**	AAA19-026-00
DATE DRILLED:	4/15/2019	**DATE MEASURED:**	4/15/2019	**FIGURE:**	17

LOG OF BORING NO. B-17

Williamson County Corridor H
Sam Bass Road
Williamson County, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger **LOCATION:** N 30.53180; W 97.72714

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT² / PLASTIC LIMIT – WATER CONTENT – LIQUID LIMIT	PLASTICITY INDEX	% -200
			ASPHALT (5 inches)					
			BASE (7 inches)					
			FILL: SANDY LEAN CLAY (CL), Very Stiff to Hard, Brown and Tan, gravel, ferrous staining, limestone fragments	17			12	
				50/2"				
			LIMESTONE, Hard, Gray, with intermittent clay layers and seams	ref/2.25"				
5				50/1"				
				ref/0.5"				
10			Boring Terminated					

NOTES:
1. Groundwater not encountered during drilling operations.
2. Borehole backfilled with auger cuttings.

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 10.0 ft	**DEPTH TO WATER:** Dry	**PROJ. No.:** AAA19-026-00	
DATE DRILLED: 4/15/2019	**DATE MEASURED:** 4/15/2019	**FIGURE:** 18	

LOG OF BORING NO. B-18

Williamson County Corridor H
Sam Bass Road
Williamson County, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 30.53165; W 97.72529

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT² / PLASTIC LIMIT – WATER CONTENT – LIQUID LIMIT	PLASTICITY INDEX	% -200
			ASPHALT (5-1/2 inches)					
			BASE (6-1/2 inches)					
			FILL: SANDY LEAN CLAY (CL), Very Stiff, Brown and Tan, with gravel, ferrous staining, and limestone fragments	17			26	
			LEAN CLAY (CL), Hard, Light Tan, with sand, calcareous deposits, and limestone fragments	50/8.5"				
				ref/5"				
5			**LIMESTONE,** Decomposed, Moderately Hard to Hard, Tan					
				50/4.5"				
			LIMESTONE, Moderately Hard, Light Gray, Severely Weatherd, with clay layers and seams					
				ref/0"				
10			Boring Terminated					

NOTES:
1. Groundwater not encountered during drilling operations.
2. Borehole backfilled with auger cuttings.

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	10.0 ft	**DEPTH TO WATER:**	Dry	**PROJ. No.:**	AAA19-026-00
DATE DRILLED:	4/15/2019	**DATE MEASURED:**	4/15/2019	**FIGURE:**	19

LOG OF BORING NO. B-19

Williamson County Corridor H
Sam Bass Road
Williamson County, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger **LOCATION:** N 30.53122; W 97.72355

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	WATER CONTENT (approx.)	PLASTICITY INDEX	% -200
	ASPHALT (4 inches)					
	BASE (4-1/2 inches)					
	CLAYEY SAND (SC), Dense to Very Dense, Reddish-Brown, with gravel, clayey layers, and limestone fragments	36		●		
		ref/5"		●		22
	LIMESTONE, Decomposed, Moderately Hard to Hard, Tan	50/2"		●		
5	**LIMESTONE,** Moderately Hard, Light Gray, Severely Weathered, with ferrous staining, and clay layers and seams	50/2"		●		
		ref/0.5"		●		
10	Boring Terminated					

SHEAR STRENGTH, TONS/FT²: 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0
PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10, 20, 30, 40, 50, 60, 70, 80

NOTES:
1. Groundwater not encountered during drilling operations.
2. Borehole backfilled with auger cuttings.

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	10.0 ft	**DEPTH TO WATER:**	Dry	**PROJ. No.:**	AAA19-026-00
DATE DRILLED:	4/15/2019	**DATE MEASURED:**	4/15/2019	**FIGURE:**	20

DRILLING LOG

WinCore
Version 3.0

County	Williamson County	Hole	BR-1	District	
Highway		Structure		Date	01/9/20
CSJ		Station	298+05	Grnd. Elev.	817.00 ft
		Offset	40 ft South	GW Elev.	N/A

Elev. (ft)	Depth	Texas Cone Penetrometer	Strata Description	Triaxial Test Lateral Press. (psi)	Triaxial Test Deviator Stress (psi)	MC	LL	PI	Wet Den. (pcf)	Additional Remarks
816.7			ASPHALT, (4 inches)							
815.8			BASE, (10 inches)			9	26	13		- % Passing #200 Sieve: 45
	2		SAND, Clayey, Brown and Tan, with gravel and ferrous staining (SC)							
814.0			CLAY, Fat, Dark Brown, with gravel and calcareous deposits (CH)			19				- P.P.: 2.0 tsf
813.0	4	50 (2) 50 (0.5)	LIMESTONE, Hard to Very Hard, Tan							
	6									
	8									
	10	50 (0) 50 (0)								
805.0	12		LIMESTONE, Very Hard, Light Gray							
	14	50 (1) 50 (0.5)								
	16									
	18									
	20	50 (0) 50 (0)								
	22									
	24	50 (1) 50 (0)								
	26									
	28									
	30	50 (1.5) 50 (0.5)								

Remarks:
(30.538414, -97.751264)

The ground water elevation was not determined during the course of this boring.

Driller: **Logger:** **Organization: Raba-Kistner Consultants, Inc.**

FIGURE: 21a

DRILLING LOG

WinCore
Version 3.0

County	Williamson County	Hole	BR-1	District	
Highway		Structure		Date	01/9/20
CSJ		Station	298+05	Grnd. Elev.	817.00 ft
		Offset	40 ft South	GW Elev.	N/A

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test: Lateral Press. (psi)	Triaxial Test: Deviator Stress (psi)	Properties: MC	Properties: LL	Properties: PI	Properties: Wet Den. (pcf)	Additional Remarks
32			LIMESTONE, Very Hard, Light Gray							
34		50 (0) 50 (0)								
36										
38										
40		50 (0) 50 (1)								
42										
44		50 (0) 50 (0)								
46										
48										
767.0 50		50 (0.25) 50 (0)								
52										
54										
56										
58										
60										

Remarks:
(30.538414, -97.751264)

The ground water elevation was not determined during the course of this boring.

Driler: **Logger:** **Organization: Raba-Kistner Consultants, Inc.**

FIGURE: 21b

DRILLING LOG

WinCore
Version 3.0

County	Williamson County	Hole	BR-2	District	
Highway		Structure		Date	01/9/20
CSJ		Station	298+66	Grnd. Elev.	816.00 ft
		Offset	50 ft South	GW Elev.	N/A

Elev. (ft)	Depth (ft)	Texas Cone Penetrometer	Strata Description	Triaxial Test: Lateral Press. (psi)	Triaxial Test: Deviator Stress (psi)	MC	LL	PI	Wet Den. (pcf)	Additional Remarks
815.6			ASPHALT, (5 inches)							
814.8			BASE, (10 inches)			28	65	38		- P.P.: 2.0 tsf
			CLAY, Fat, Sandy, Brown, with gravel (CH)			11				- P.P.: 4.5 tsf
	5	50 (0.5) 50 (0)								
811.0			LIMESTONE, Very Hard, Tan							
	10	50 (0) 50 (0)								
804.0	12		LIMESTONE, Very Hard, Light Gray							
	15	50 (0.25) 50 (0)								
	18	50 (0) 50 (0)								
	23.5	50 (0) 50 (0)								
	28	50 (0.5) 50 (0)								
	30									

Remarks:
(30.538363, -97.751076)
Groundwater seepage noted at 3 ft during drilling operations.

The ground water elevation was not determined during the course of this boring.

Driller: **Logger:** **Organization: Raba-Kistner Consultants, Inc.**

DRILLING LOG

WinCore
Version 3.0

County	Williamson County	Hole	BR-2	District	
Highway		Structure		Date	01/9/20
CSJ		Station	298+66	Grnd. Elev.	816.00 ft
		Offset	50 ft South	GW Elev.	N/A

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test: Lateral Press. (psi)	Triaxial Test: Deviator Stress (psi)	Properties: MC	Properties: LL	Properties: PI	Properties: Wet Den. (pcf)	Additional Remarks
			LIMESTONE, Very Hard, Light Gray							
32										
		50 (1) 50 (0)								
34										
36										
		50 (0.5) 50 (0)								
38										
40										
42										
		50 (0.25) 50 (0)								
44										
46										
		50 (0) 50 (0)								
48										
766.0 50										
52										
54										
56										
58										
60										

Remarks:
(30.538363, -97.751076)
Groundwater seepage noted at 3 ft during drilling operations.

The ground water elevation was not determined during the course of this boring.

Driller: Logger: Organization: Raba-Kistner Consultants, Inc.

KEY TO TERMS AND SYMBOLS

MATERIAL TYPES

SOIL TERMS

- CALCAREOUS
- CALICHE
- CLAY
- CLAYEY
- GRAVEL
- GRAVELLY
- PEAT
- SAND
- SANDY
- SILT
- SILTY
- FILL

ROCK TERMS

- CHALK
- CLAYSTONE
- CLAY-SHALE
- CONGLOMERATE
- DOLOMITE
- IGNEOUS
- LIMESTONE
- MARL
- METAMORPHIC
- SANDSTONE
- SHALE
- SILTSTONE

OTHER

- ASPHALT
- BASE
- CONCRETE/CEMENT
- BRICKS / PAVERS
- WASTE
- NO INFORMATION

WELL CONSTRUCTION AND PLUGGING MATERIALS

- BLANK PIPE
- SCREEN
- BENTONITE
- CEMENT GROUT
- BENTONITE & CUTTINGS
- CONCRETE/CEMENT
- CUTTINGS
- GRAVEL
- SAND
- VOLCLAY

SAMPLE TYPES

- AIR ROTARY
- GRAB SAMPLE
- CORE
- GEOPROBE SAMPLER
- ROTOSONIC -DAMAGED
- MUD ROTARY
- NO RECOVERY
- NX CORE
- PITCHER
- ROTOSONIC -INTACT
- SHELBY TUBE
- SPLIT BARREL
- SPLIT SPOON
- TEXAS CONE PENETROMETER
- DISTURBED

STRENGTH TEST TYPES

- POCKET PENETROMETER
- TORVANE
- UNCONFINED COMPRESSION
- TRIAXIAL COMPRESSION UNCONSOLIDATED-UNDRAINED
- TRIAXIAL COMPRESSION CONSOLIDATED-UNDRAINED

NOTE: VALUES SYMBOLIZED ON BORING LOGS REPRESENT SHEAR STRENGTHS UNLESS OTHERWISE NOTED

PROJECT NO. AA19-026-00

KEY TO TERMS AND SYMBOLS (CONT'D)

TERMINOLOGY

Terms used in this report to describe soils with regard to their consistency or conditions are in general accordance with the discussion presented in Article 45 of SOILS MECHANICS IN ENGINEERING PRACTICE, Terzaghi and Peck, John Wiley & Sons, Inc., 1967, using the most reliable information available from the field and laboratory investigations. Terms used for describing soils according to their texture or grain size distribution are in accordance with the UNIFIED SOIL CLASSIFICATION SYSTEM, as described in American Society for Testing and Materials D2487-06 and D2488-00, Volume 04.08, Soil and Rock; Dimension Stone; Geosynthetics; 2005.

The depths shown on the boring logs are not exact, and have been estimated to the nearest half-foot. Depth measurements may be presented in a manner that implies greater precision in depth measurement, i.e 6.71 meters. The reader should understand and interpret this information only within the stated half-foot tolerance on depth measurements.

RELATIVE DENSITY

Penetration Resistance Blows per ft	Relative Density
0 - 4	Very Loose
4 - 10	Loose
10 - 30	Medium Dense
30 - 50	Dense
> 50	Very Dense

COHESIVE STRENGTH

Resistance Blows per ft	Consistency	Cohesion TSF
0 - 2	Very Soft	0 - 0.125
2 - 4	Soft	0.125 - 0.25
4 - 8	Firm	0.25 - 0.5
8 - 15	Stiff	0.5 - 1.0
15 - 30	Very Stiff	1.0 - 2.0
> 30	Hard	> 2.0

PLASTICITY

Plasticity Index	Degree of Plasticity
0 - 5	None
5 - 10	Low
10 - 20	Moderate
20 - 40	Plastic
> 40	Highly Plastic

ABBREVIATIONS

B = Benzene
T = Toluene
E = Ethylbenzene
X = Total Xylenes
BTEX = Total BTEX
TPH = Total Petroleum Hydrocarbons
ND = Not Detected
NA = Not Analyzed
NR = Not Recorded/No Recovery
OVA = Organic Vapor Analyzer
ppm = Parts Per Million

Qam, Qas, Qal = Quaternary Alluvium
Qat = Low Terrace Deposits
Qbc = Beaumont Formation
Qt = Fluviatile Terrace Deposits
Qao = Seymour Formation
Qle = Leona Formation
Q-Tu = Uvalde Gravel
Ewi = Wilcox Formation
Emi = Midway Group
Mc = Catahoula Formation
El = Laredo Formation
Kknm = Navarro Group and Marlbrook Marl
Kpg = Pecan Gap Chalk
Kau = Austin Chalk

Kef = Eagle Ford Shale
Kbu = Buda Limestone
Kdr = Del Rio Clay
Kft = Fort Terrett Member
Kgt = Georgetown Formation
Kep = Person Formation
Kek = Kainer Formation
Kes = Escondido Formation
Kew = Walnut Formation
Kgr = Glen Rose Formation
Kgru = Upper Glen Rose Formation
Kgrl = Lower Glen Rose Formation
Kh = Hensell Sand

KEY TO TERMS AND SYMBOLS (CONT'D)

TERMINOLOGY

SOIL STRUCTURE

Slickensided	Having planes of weakness that appear slick and glossy.
Fissured	Containing shrinkage or relief cracks, often filled with fine sand or silt; usually more or less vertical.
Pocket	Inclusion of material of different texture that is smaller than the diameter of the sample.
Parting	Inclusion less than 1/8 inch thick extending through the sample.
Seam	Inclusion 1/8 inch to 3 inches thick extending through the sample.
Layer	Inclusion greater than 3 inches thick extending through the sample.
Laminated	Soil sample composed of alternating partings or seams of different soil type.
Interlayered	Soil sample composed of alternating layers of different soil type.
Intermixed	Soil sample composed of pockets of different soil type and layered or laminated structure is not evident.
Calcareous	Having appreciable quantities of carbonate.
Carbonate	Having more than 50% carbonate content.

SAMPLING METHODS

RELATIVELY UNDISTURBED SAMPLING

Cohesive soil samples are to be collected using three-inch thin-walled tubes in general accordance with the Standard Practice for Thin-Walled Tube Sampling of Soils (ASTM D1587) and granular soil samples are to be collected using two-inch split-barrel samplers in general accordance with the Standard Method for Penetration Test and Split-Barrel Sampling of Soils (ASTM D1586). Cohesive soil samples may be extruded on-site when appropriate handling and storage techniques maintain sample integrity and moisture content.

STANDARD PENETRATION TEST (SPT)

A 2-in.-OD, 1-3/8-in.-ID split spoon sampler is driven 1.5 ft into undisturbed soil with a 140-pound hammer free falling 30 in. After the sampler is seated 6 in. into undisturbed soil, the number of blows required to drive the sampler the last 12 in. is the Standard Penetration Resistance or "N" value, which is recorded as blows per foot as described below.

SPLIT-BARREL SAMPLER DRIVING RECORD

Blows Per Foot	Description
25	25 blows drove sampler 12 inches, after initial 6 inches of seating.
50/7"	50 blows drove sampler 7 inches, after initial 6 inches of seating.
Ref/3"	50 blows drove sampler 3 inches during initial 6-inch seating interval.

NOTE: To avoid damage to sampling tools, driving is limited to 50 blows during or after seating interval.

RESULTS OF SOIL SAMPLE ANALYSES

PROJECT NAME: Williamson County Corridor H
Sam Bass Road
Williamson County, Texas

FILE NAME: AAA19-026-00.GPJ 5/31/2019

Boring No.	Sample Depth (ft)	Blows per ft	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	USCS	Dry Unit Weight (pcf)	% -200 Sieve	Shear Strength (tsf)	Strength Test
B-1	1.5 to 2.9	50/11"	7	36	13	23					
	3.5 to 3.6	ref/1"	6								
	5.5 to 5.5	ref/0.5"	5								
B-2	0.0										
	1.0 to 2.5	5	29	79	26	53					
	3.0 to 4.5	15	13								
	4.5 to 6.0	19	11								
	6.5 to 7.7	50/8.5"	16								
	8.5 to 8.8	ref/3"	18								
B-3	1.0 to 2.5	9	28								
	2.5 to 4.0	24	9								
	4.5 to 6.0	25	11								
	6.5 to 8.0	29	17								
	8.5 to 8.6	ref/1"	7								
B-4	1.0 to 1.7	50/2"	25								
	2.5 to 2.5	ref/0.5"	9								
	4.5 to 4.6	ref/1"	5								
B-5	1.0 to 2.5	30	28								
	2.5 to 4.0	28	18								
	4.5 to 4.7	ref/2"	8								
	5.0 to 5.1	ref/1.5"	18								
B-6	1.5 to 1.8	ref/4"	11	25	15	10					
	3.5 to 3.6	ref/1"	10								
	5.0 to 5.1	ref/1"	11								
B-7	1.0 to 2.5	31	24								
	2.5 to 2.7	ref/2.5"	11								
	4.5 to 6.0	35	6	22	13	9					
	6.5 to 6.6	ref/0.5"	9								
	8.5 to 9.0	ref/6"	18								
B-8	1.0 to 2.5	9	21								
	2.5 to 3.8	50/9.75"	20								
	4.5 to 4.9	ref/4.25"	15								
	5.0 to 5.0	ref/0"	5								
B-9	1.0 to 2.5	16	25								
	2.5 to 4.0	26	21								
	4.5 to 5.8	50/9.5"	17	30	16	14					
	6.5 to 6.6	ref/1.5"	18								
	8.5 to 8.6	ref/1"	9								
B-10	1.0 to 2.5	44	4	28	13	15					

PP = Pocket Penetrometer TV = Torvane UC = Unconfined Compression FV = Field Vane UU = Unconsolidated Undrained Triaxial

CU = Consolidated Undrained Triaxial

RESULTS OF SOIL SAMPLE ANALYSES

PROJECT NAME: Williamson County Corridor H
Sam Bass Road
Williamson County, Texas

FILE NAME: AAA19-026-00.GPJ 5/31/2019

Boring No.	Sample Depth (ft)	Blows per ft	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	USCS	Dry Unit Weight (pcf)	% -200 Sieve	Shear Strength (tsf)	Strength Test
B-10	2.5 to 3.3	50/3.5"	12								
	4.5 to 4.8	ref/4"	13								
	6.5 to 6.5	ref/0.5"	13								
	7.0 to 7.0	ref/0"	11								
B-11	1.0 to 2.5	13	27	58	18	40					
	2.5 to 3.3	50/3.5"	10								
	4.5 to 5.0	ref/5"	9								
	6.5 to 6.6	ref/1"	18								
	8.5 to 8.6	ref/1.5"	17								
B-12	1.0 to 1.6	50/1"	14	29	15	14					
	2.5 to 2.5	ref/0.5"	7								
	4.0 to 4.0	ref/0.5"									
B-13	1.0 to 2.5	14	19								
	2.5 to 3.3	50/3.5"	19						55		
	4.5 to 4.9	ref/4.5"	11								
	6.5 to 7.6	50/7.5"	9								
	8.5 to 8.5	ref/0.5"	9								
B-14	1.0 to 2.8	50/11"	13								
	2.5 to 3.0	ref/5"	12	28	14	14					
	4.5 to 5.0	ref/5.5"	22								
	6.5 to 6.5	ref/0.5"	6								
	8.5 to 8.9	ref/4.5"	13								
B-15	1.0 to 2.1	50/7"	17	54	14	40					
	2.5 to 2.7	ref/2"	8								
	4.5 to 4.5	ref/0.5"	10								
	6.5 to 6.8	ref/4"	12								
	8.5 to 8.9	ref/4.5"	13								
B-16	1.0 to 2.0	50/5"	19						50		
	2.5 to 2.7	ref/2"	10								
	4.5 to 5.3	50/4"	11								
	6.5 to 6.6	ref/1.5	12								
	8.5 to 8.5	ref/0"	12								
B-17	1.0 to 2.5	17	10	25	13	12					
	2.5 to 3.2	50/2"	13								
	4.5 to 4.7	ref/2.25"	7								
	6.5 to 7.1	50/1"	27								
	8.5 to 8.5	ref/0.5"	13								
B-18	1.0 to 2.5	17	19	41	15	26					
	2.5 to 3.7	50/8.5"	17								

PP = Pocket Penetrometer TV = Torvane UC = Unconfined Compression FV = Field Vane UU = Unconsolidated Undrained Triaxial

CU = Consolidated Undrained Triaxial

RESULTS OF SOIL SAMPLE ANALYSES

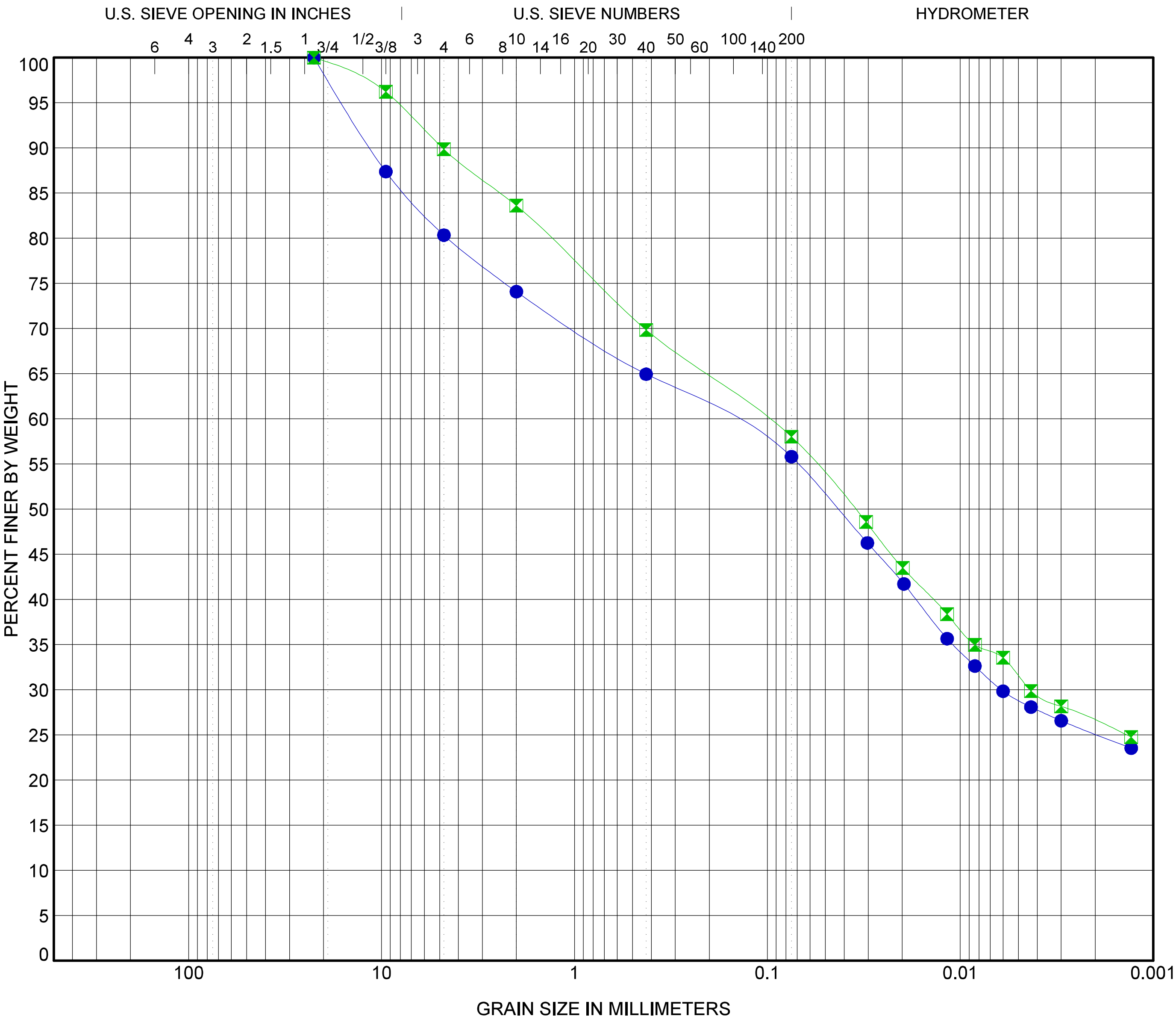
PROJECT NAME: Williamson County Corridor H
Sam Bass Road
Williamson County, Texas

FILE NAME: AAA19-026-00.GPJ 5/31/2019

Boring No.	Sample Depth (ft)	Blows per ft	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	USCS	Dry Unit Weight (pcf)	% -200 Sieve	Shear Strength (tsf)	Strength Test
B-18	4.5 to 5.0	ref/5"	21								
	6.5 to 7.4	50/4.5"	21								
	8.5 to 8.5	ref/0"	11								
B-19	1.0 to 2.5	36	7								
	2.5 to 3.0	ref/5"	8						22		
	4.5 to 5.2	50/2"	7								
	6.5 to 7.2	50/2"	4								
	8.5 to 8.5	ref/0.5"	5								

PP = Pocket Penetrometer TV = Torvane UC = Unconfined Compression FV = Field Vane UU = Unconsolidated Undrained Triaxial

CU = Consolidated Undrained Triaxial



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**GS-1**	**0.0**						
⧗	**GS-2**	**0.0**						
▲								
★								
⊙								

	Specimen Identification		G_s	2 mm	0.425 mm	0.075 mm	0.02 mm	0.002 mm	0.001 mm
●	**GS-1**	**0.0**	**2.650**	**74.1**	**65.0**	**55.8**	**41.9**	**25.1**	
⧗	**GS-2**	**0.0**	**2.650**	**83.6**	**69.9**	**58.0**	**43.5**	**26.5**	
▲									
★									
⊙									

R-K GRAIN SIZE - AMRL AAA19-026-00 - BRIDGE BORINGS.GPJ RKCI.GDT 3/16/20

RABA KISTNER
TBPE Firm Registration No. F-3257

8100 Cameron Road
Suite B-150
Austin, Texas 78754
(512) 339-1745
(512) 339-6174 fax
www.rkci.com

GRAIN SIZE DISTRIBUTION

Williamson County Corridor H
Sam Bass Road
Williamson County, Texas

APPENDIX A

Boudreau Engineering, Inc.

AASHTO T 307-99

Resilient Modulus of Subgrade Soils and Untreated Base/Subbase Materials

(RECOMPACTED / THINWALL TUBE SAMPLES)

LABORATORY: Boudreau Engineering, Inc.
Lawrenceville, Georgia

PROJECT NAME: Sam Bass Road

PROJECT NO.: Raba #AAA19-026-00

DATE RECEIVED: 05-17-2019

QUANTITY (REPRESENTED): N.A.

IDENTIFICATION MARKS: Sam Bass

SOURCE OF MATERIAL: Sam Bass at OMC

1.	*SAMPLING DATE:*	N.R.
2.	*SAMPLE NUMBER:*	Sam Bass
3.	*LAYER TYPE* (1 - Subgrade, 2 - Base/Subbase)	1
4.	*MATERIAL TYPE* (Type 1 or Type 2)	2
5.	*APPROX. DISTANCE FROM TOP OF SUBGRADE TO SAMPLE, ft (for tube samples)*	N/A
6.	*TEST INFORMATION*	
	PRECONDITIONING - GREATER THAN 5% PERM. STRAIN? (Y = YES OR N = NO)	N
	TESTING - GREATER THAN 5% PERM. STRAIN? (Y = YES OR N = NO)	N
	TESTING - NUMBER OF LOAD SEQUENCES COMPLETED (0 - 15)	15
7.	*SPECIMEN INFO.:*	
	SPECIMEN DIAM., inch	
	TOP	2.9
	MIDDLE	2.9
	BOTTOM	2.9
	AVERAGE	2.9
	MEMBRANE THICKNESS (1), inch	0.00
	MEMBRANE THICKNESS (2), inch	0.00
	NET DIAM., inch	2.9
	HEIGHT OF SPECIMEN, CAP AND BASE, inch	5.63
	HEIGHT OF CAP AND BASE, inch	0.0
	INITIAL LENGTH, Lo , inch	5.6
	INITIAL AREA, Ao , in^2	6.5
	INITIAL VOLUME Ao Lo , in^3	36.7
	INITIAL WEIGHT , grams (for tube samples)	N/A
8.	*SOIL SPECIMEN WEIGHT(for remolded samples) :*	
	INITIAL WEIGHT OF CONTAINER AND WET SOIL, grams	1093.76
	FINAL WEIGHT OF CONTAINER AND WET SOIL, grams	0.00
	WEIGHT OF WET SOIL USED , grams	1093.76
9.	*SOIL PROPERTIES .:*	
	For Remolded Samples:	
	IN SITU MOISTURE CONTENT (NUCLEAR), %	N/A
	IN SITU WET DENSITY (NUCLEAR), pcf	N/A
	or	
	OPTIMUM MOISTURE CONTENT, %	19.1
	MAX. DRY DENSITY, pcf	101.5
	For Tube Samples:	
	IN SITU MOISTURE CONTENT , %	N/A
	MOISTURE CONTENT AFTER RESILIENT MODULUS TESTING, %	N/A
	WET DENSITY, pcf	N/A
	DRY DENSITY, pcf	N/A
10.	*SPECIMEN PROPERTIES (for remolded samples):*	
	COMPACTION MOISTURE CONTENT, %	19.1
	MOISTURE CONTENT AFTER RESILIENT MODULUS TESTING, %	18.9
	COMPACTION DRY DENSITY, $\gamma_{d,}$ *pcf*	95.3
	TARGET DRY DENSITY, $\%\gamma_d$ 95 *TARGET MOISTURE CONTENT, %*	19.1
	COMPACTION LEVEL ACHIEVED	93.9%
11.	*QUICK SHEAR TEST*	
	STRESS - STRAIN PLOT ATTACHED (Y = YES, N = NO)	Y
	TRIAXIAL SHEAR MAXIMUM STRENGTH (MAX. LOAD/X-SECTION AREA), psi	25
	SPECIMEN FAIL DURING TRIAXIAL SHEAR? (Y = YES, N = NO)	N
12.	*TEST DATE*	05-29-2019

13. GENERAL REMARKS:

TESTED BY RLB DATE 05-29-2019

Report Form X1.2/X1.3

Boudreau Engineering, Inc.

AASHTO T307-99 REPORT FORM X1.1
Resilient Modulus of Subgrade Soils and Untreated Base/Subbase Materials

LABORATORY: Boudreau Engineering, Inc.
Lawrenceville, Georgia

1. ***PROJECT NO(S):*** Raba #AAA19-026-00
2. ***PROJECT NAME:*** Sam Bass Road
3. ***SOURCE OF MATERIAL:*** Sam Bass at OMC
4. ***REMOLDING TARGETS:*** 95% Maximum Dry Density at 19.1% Moisture Content
5. ***LAYER TYPE (1 - subgrade, 2 - base/subbase)*** 1
6. ***MATERIAL TYPE (Type 1 or Type 2)*** 2
7. ***TEST DATE*** 05-29-2019
8. ***RESILIENT MODULUS TESTING***

COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
PARAMETER	*Chamber Confining Pressure*	*Nominal Maximum Axial Stress*	*Cycle No.*	*Actual Applied Max. Axial Load*	*Actual Applied Cyclic Load*	*Actual Applied Contact Load*	*Actual Applied Max. Axial Stress*	*Actual Applied Cyclic Stress*	*Actual Applied Contact Stress*	*Recov. Def. LVDT #1 Reading*	*Recov. Def. LVDT #2 Reading*	*Average Recov Def. LVDT 1 and 2*	*Resilient Strain*	*Resilient Modulus*
DESIGNATION	S_3	S_{cyclic}	c_1	P_{max}	P_{cyclic}	$P_{contact}$	S_{max}	S_{cyclic}	$S_{contact}$	H_1	H_2	H_{avg}	ε_r	M_r
UNIT	psi	psi	---	lbs	lbs	lbs	psi	psi	psi	in	in	in	in/in	psi
PRECISION	_ _ _ ._	_ _ _ ._	_	_ _ _ _ ._	_ _ _ ._	_ _ _ ._	_ _ _ ._	_ _ _ ._	_ _ ._	_ ._ _ _ _ _	_ ._ _ _ _ _	_ ._ _ _ _ _	_ ._ _ _ _ _	_ _ _ .
SEQUENCE 1	6.0	2.0	96	13.0	11.9	1.1	2.0	1.8	0.2	0.00113	0.00111	0.00112	0.00020	9,204
			97	13.0	11.8	1.2	2.0	1.8	0.2	0.00113	0.00112	0.00112	0.00020	9,118
			98	13.2	12.0	1.2	2.0	1.8	0.2	0.00113	0.00111	0.00112	0.00020	9,217
			99	13.1	11.8	1.3	2.0	1.8	0.2	0.00113	0.00112	0.00112	0.00020	9,072
			100	13.0	11.8	1.3	2.0	1.8	0.2	0.00113	0.00111	0.00112	0.00020	9,054
	COLUMN AVERAGE			13.1	11.9	1.2	2.0	1.8	0.2	0.00113	0.00111	0.00112	0.00020	9,133
	STANDARD DEV.			0.1	0.1	0.1	0.0	0.0	0.0	0.00000	0.00000	0.00000	0.00000	75

Project Name: Sam Bass Road Identification Marks: Sam Bass Material Source: Sam Bass at OMC

SEQUENCE 2	6.0	4.0	96	25.4	23.1	2.3	3.9	3.5	0.4	0.00245	0.00239	0.00242	0.00043	8,240
			97	25.5	23.2	2.3	3.9	3.6	0.4	0.00246	0.00238	0.00242	0.00043	8,287
			98	25.4	23.1	2.3	3.9	3.5	0.4	0.00245	0.00238	0.00241	0.00043	8,263
			99	25.3	23.0	2.3	3.9	3.5	0.4	0.00246	0.00238	0.00242	0.00043	8,234
			100	25.4	23.2	2.3	3.9	3.6	0.3	0.00246	0.00238	0.00242	0.00043	8,273
	COLUMN AVERAGE			25.4	23.1	2.3	3.9	3.5	0.4	0.00246	0.00238	0.00242	0.00043	8,259
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00000	0.00000	0.00000	0.00000	22
SEQUENCE 3	6.0	6.0	96	37.4	33.8	3.6	5.7	5.2	0.5	0.00404	0.00390	0.00397	0.00070	7,372
			97	37.5	33.9	3.6	5.7	5.2	0.6	0.00404	0.00390	0.00397	0.00070	7,377
			98	37.5	33.9	3.6	5.8	5.2	0.6	0.00403	0.00390	0.00396	0.00070	7,386
			99	37.6	34.0	3.6	5.8	5.2	0.6	0.00404	0.00390	0.00397	0.00070	7,399
			100	37.4	33.9	3.6	5.7	5.2	0.5	0.00404	0.00390	0.00397	0.00070	7,374
	COLUMN AVERAGE			37.5	33.9	3.6	5.7	5.2	0.6	0.00404	0.00390	0.00397	0.00070	7,381
	STANDARD DEV.			0.1	0.0	0.0	0.0	0.0	0.0	0.00001	0.00000	0.00000	0.00000	11
SEQUENCE 4	6.0	8.0	96	49.2	44.3	4.9	7.5	6.8	0.7	0.00592	0.00569	0.00580	0.00103	6,600
			97	49.3	44.4	4.9	7.6	6.8	0.7	0.00593	0.00568	0.00581	0.00103	6,603
			98	49.4	44.5	4.9	7.6	6.8	0.7	0.00593	0.00568	0.00581	0.00103	6,622
			99	49.2	44.3	4.9	7.5	6.8	0.7	0.00593	0.00569	0.00581	0.00103	6,598
			100	49.3	44.5	4.8	7.6	6.8	0.7	0.00592	0.00569	0.00580	0.00103	6,634
	COLUMN AVERAGE			49.3	44.4	4.9	7.6	6.8	0.7	0.00593	0.00569	0.00581	0.00103	6,611
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00000	0.00000	0.00000	16
SEQUENCE 5	6.0	10.0	96	61.0	54.8	6.2	9.4	8.4	0.9	0.00797	0.00766	0.00782	0.00139	6,066
			97	61.1	55.0	6.1	9.4	8.4	0.9	0.00797	0.00766	0.00782	0.00139	6,079
			98	60.9	54.7	6.2	9.3	8.4	0.9	0.00797	0.00765	0.00781	0.00139	6,060
			99	61.0	54.8	6.2	9.4	8.4	0.9	0.00797	0.00765	0.00781	0.00139	6,069
			100	61.0	54.8	6.2	9.4	8.4	0.9	0.00798	0.00765	0.00781	0.00139	6,061
	COLUMN AVERAGE			61.0	54.8	6.2	9.4	8.4	0.9	0.00797	0.00765	0.00781	0.00139	6,067
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00000	0.00001	0.00000	0.00000	8

Report Form X1.1

Project Name: Sam Bass Road | Identification Marks: Sam Bass | Material Source: Sam Bass at OMC

SEQUENCE 6	4.0	2.0	96	13.3	11.7	1.6	2.0	1.8	0.2	0.00126	0.00123	0.00124	0.00022	8,117
			97	13.4	11.7	1.7	2.0	1.8	0.3	0.00126	0.00123	0.00125	0.00022	8,112
			98	13.4	11.7	1.7	2.1	1.8	0.3	0.00125	0.00124	0.00125	0.00022	8,112
			99	13.4	11.7	1.7	2.0	1.8	0.3	0.00126	0.00124	0.00125	0.00022	8,103
			100	13.4	11.7	1.6	2.1	1.8	0.2	0.00127	0.00123	0.00125	0.00022	8,139
	COLUMN AVERAGE			13.3	11.7	1.6	2.0	1.8	0.3	0.00126	0.00123	0.00125	0.00022	8,117
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00000	0.00001	0.00000	0.00000	14
SEQUENCE 7	4.0	4.0	96	25.0	22.6	2.4	3.8	3.5	0.4	0.00275	0.00266	0.00271	0.00048	7,222
			97	25.1	22.7	2.3	3.8	3.5	0.4	0.00273	0.00268	0.00270	0.00048	7,271
			98	25.1	22.7	2.4	3.8	3.5	0.4	0.00273	0.00266	0.00270	0.00048	7,281
			99	25.1	22.7	2.3	3.8	3.5	0.4	0.00276	0.00266	0.00271	0.00048	7,256
			100	25.2	22.8	2.4	3.9	3.5	0.4	0.00275	0.00268	0.00271	0.00048	7,283
	COLUMN AVERAGE			25.1	22.7	2.3	3.8	3.5	0.4	0.00274	0.00267	0.00271	0.00048	7,263
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	25
SEQUENCE 8	4.0	6.0	96	37.1	33.4	3.7	5.7	5.1	0.6	0.00442	0.00425	0.00433	0.00077	6,669
			97	37.1	33.5	3.6	5.7	5.1	0.5	0.00441	0.00424	0.00433	0.00077	6,700
			98	37.0	33.4	3.6	5.7	5.1	0.6	0.00441	0.00424	0.00432	0.00077	6,672
			99	37.1	33.4	3.6	5.7	5.1	0.6	0.00441	0.00425	0.00433	0.00077	6,668
			100	37.0	33.4	3.6	5.7	5.1	0.6	0.00441	0.00424	0.00433	0.00077	6,668
	COLUMN AVERAGE			37.1	33.4	3.6	5.7	5.1	0.6	0.00441	0.00425	0.00433	0.00077	6,675
	STANDARD DEV.			0.0	0.1	0.0	0.0	0.0	0.0	0.00000	0.00000	0.00000	0.00000	14
SEQUENCE 9	4.0	8.0	96	49.0	44.1	4.9	7.5	6.8	0.8	0.00628	0.00602	0.00615	0.00109	6,194
			97	49.0	44.1	4.9	7.5	6.8	0.7	0.00628	0.00603	0.00616	0.00109	6,192
			98	48.8	43.9	4.9	7.5	6.7	0.8	0.00628	0.00603	0.00615	0.00109	6,167
			99	48.9	44.0	4.9	7.5	6.8	0.7	0.00629	0.00603	0.00616	0.00109	6,182
			100	49.0	44.1	4.9	7.5	6.8	0.8	0.00628	0.00602	0.00615	0.00109	6,196
	COLUMN AVERAGE			48.9	44.0	4.9	7.5	6.8	0.8	0.00628	0.00602	0.00615	0.00109	6,186
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00000	0.00000	0.00000	0.00000	12

Project Name: Sam Bass Road | Identification Marks: Sam Bass | Material Source: Sam Bass at OMC

SEQUENCE 10	4.0	10.0	96	61.0	54.8	6.2	9.4	8.4	0.9	0.00831	0.00802	0.00817	0.00145	5,801
			97	60.9	54.7	6.2	9.3	8.4	0.9	0.00831	0.00800	0.00816	0.00145	5,800
			98	60.9	54.7	6.1	9.3	8.4	0.9	0.00831	0.00801	0.00816	0.00145	5,798
			99	60.8	54.7	6.2	9.3	8.4	0.9	0.00831	0.00801	0.00816	0.00145	5,791
			100	61.0	54.8	6.2	9.4	8.4	0.9	0.00830	0.00801	0.00815	0.00145	5,809
	COLUMN AVERAGE			60.9	54.7	6.2	9.3	8.4	0.9	0.00831	0.00801	0.00816	0.00145	5,800
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00000	0.00000	0.00000	7
SEQUENCE 11	2.0	2.0	96	13.7	11.7	2.0	2.1	1.8	0.3	0.00138	0.00135	0.00136	0.00024	7,437
			97	13.6	11.6	2.0	2.1	1.8	0.3	0.00137	0.00134	0.00136	0.00024	7,374
			98	13.7	11.6	2.0	2.1	1.8	0.3	0.00137	0.00135	0.00136	0.00024	7,392
			99	13.6	11.6	2.0	2.1	1.8	0.3	0.00137	0.00135	0.00136	0.00024	7,394
			100	13.7	11.6	2.1	2.1	1.8	0.3	0.00137	0.00135	0.00136	0.00024	7,395
	COLUMN AVERAGE			13.7	11.6	2.0	2.1	1.8	0.3	0.00137	0.00135	0.00136	0.00024	7,398
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00000	0.00000	0.00000	0.00000	23
SEQUENCE 12	2.0	4.0	96	24.7	22.4	2.4	3.8	3.4	0.4	0.00299	0.00291	0.00295	0.00052	6,549
			97	24.8	22.4	2.4	3.8	3.4	0.4	0.00298	0.00290	0.00294	0.00052	6,585
			98	24.8	22.5	2.3	3.8	3.5	0.4	0.00299	0.00290	0.00295	0.00052	6,597
			99	24.7	22.3	2.4	3.8	3.4	0.4	0.00299	0.00291	0.00295	0.00052	6,541
			100	24.7	22.4	2.3	3.8	3.4	0.4	0.00299	0.00291	0.00295	0.00052	6,550
	COLUMN AVERAGE			24.8	22.4	2.3	3.8	3.4	0.4	0.00299	0.00291	0.00295	0.00052	6,564
	STANDARD DEV.			0.0	0.1	0.0	0.0	0.0	0.0	0.00000	0.00001	0.00000	0.00000	25
SEQUENCE 13	2.0	6.0	96	36.7	33.1	3.6	5.6	5.1	0.5	0.00477	0.00462	0.00470	0.00083	6,101
			97	36.8	33.2	3.6	5.6	5.1	0.5	0.00477	0.00462	0.00469	0.00083	6,122
			98	36.7	33.1	3.6	5.6	5.1	0.5	0.00477	0.00462	0.00470	0.00083	6,093
			99	36.8	33.1	3.6	5.6	5.1	0.6	0.00477	0.00462	0.00469	0.00083	6,101
			100	36.6	33.1	3.6	5.6	5.1	0.5	0.00477	0.00462	0.00469	0.00083	6,090
	COLUMN AVERAGE			36.7	33.1	3.6	5.6	5.1	0.5	0.00477	0.00462	0.00469	0.00083	6,101
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00000	0.00000	0.00000	0.00000	13

Report Form X1.1

Project Name: Sam Bass Road | Identification Marks: Sam Bass | Material Source: Sam Bass at OMC

SEQUENCE 14	2.0	8.0	96	48.4	43.5	4.9	7.4	6.7	0.8	0.00675	0.00653	0.00664	0.00118	5,661
			97	48.5	43.6	4.8	7.4	6.7	0.7	0.00676	0.00652	0.00664	0.00118	5,680
			98	48.5	43.7	4.8	7.4	6.7	0.7	0.00676	0.00652	0.00664	0.00118	5,682
			99	48.5	43.6	4.9	7.4	6.7	0.7	0.00674	0.00653	0.00664	0.00118	5,684
			100	48.5	43.6	4.9	7.4	6.7	0.8	0.00675	0.00653	0.00664	0.00118	5,679
	COLUMN AVERAGE			48.5	43.6	4.9	7.4	6.7	0.7	0.00675	0.00653	0.00664	0.00118	5,677
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00000	0.00000	0.00000	9
SEQUENCE 15	2.0	10.0	96	60.6	54.4	6.1	9.3	8.4	0.9	0.00892	0.00860	0.00876	0.00156	5,371
			97	60.4	54.3	6.1	9.3	8.3	0.9	0.00893	0.00861	0.00877	0.00156	5,354
			98	60.5	54.4	6.2	9.3	8.3	0.9	0.00893	0.00861	0.00877	0.00156	5,360
			99	60.4	54.3	6.1	9.3	8.3	0.9	0.00893	0.00860	0.00877	0.00156	5,355
			100	60.7	54.6	6.1	9.3	8.4	0.9	0.00892	0.00860	0.00876	0.00156	5,390
	COLUMN AVERAGE			60.5	54.4	6.1	9.3	8.3	0.9	0.00893	0.00860	0.00877	0.00156	5,366
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00000	0.00000	0.00000	0.00000	15

TESTED BY RLB DATE 05-29-2019

Report Form X1.1

Boudreau Engineering, Inc.

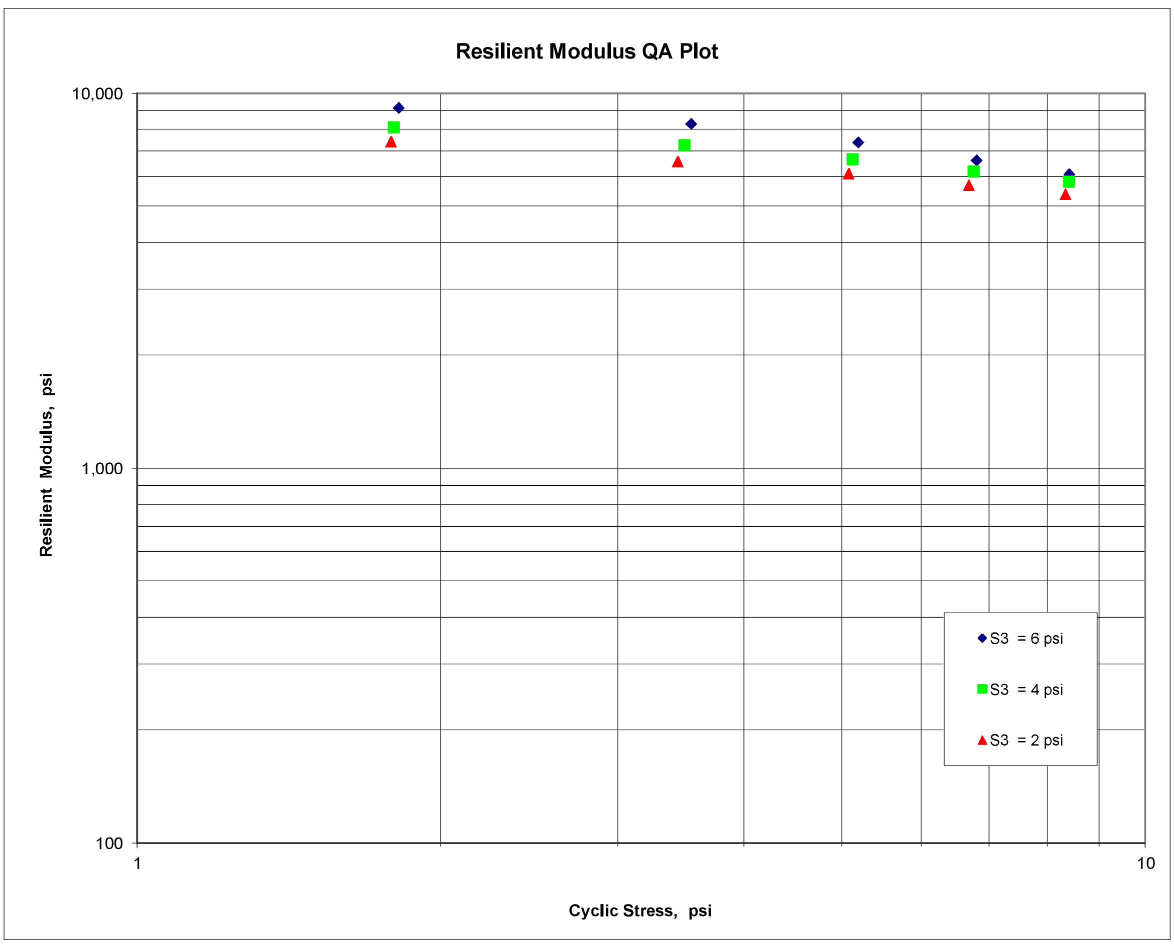
AASHTO T307-99

FIGURE 1 - Logarithmic Plot of Resilient Modulus (M_R) vs Cyclic Stress (S_C)

1. PROJECT NO(S):	Raba #AAA19-026-00
2. PROJECT NAME:	Sam Bass Road
3. SOURCE OF MATERIAL:	Sam Bass at OMC
4. REMOLDING TARGETS:	95% Maximum Dry Density at 19.1% Moisture Content
5. LAYER TYPE (1 - subgrade, 2 - base/subbase)	1
6. MATERIAL TYPE (Type 1 or Type 2)	2
7. TEST DATE	05-29-2019

$$M_R = K1\,(S_C)^{K2}\,(S_3)^{K5}$$

K1 =	7,713
K2 =	-0.22900
K5 =	0.16498
R^2 =	0.96

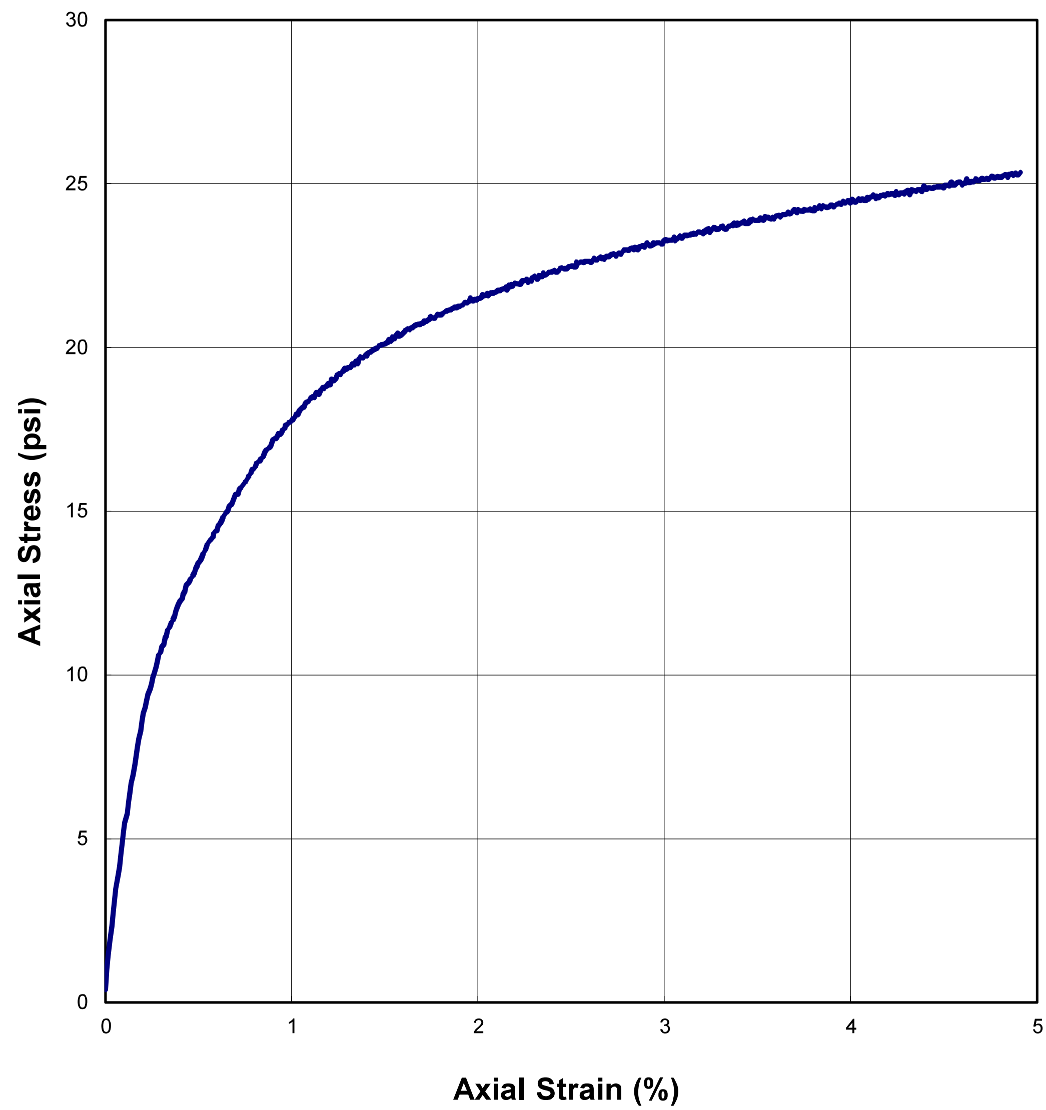


Boudreau Engineering, Inc.

AASHTO T307-99

FIGURE 2 - Quick Shear Stress vs Strain

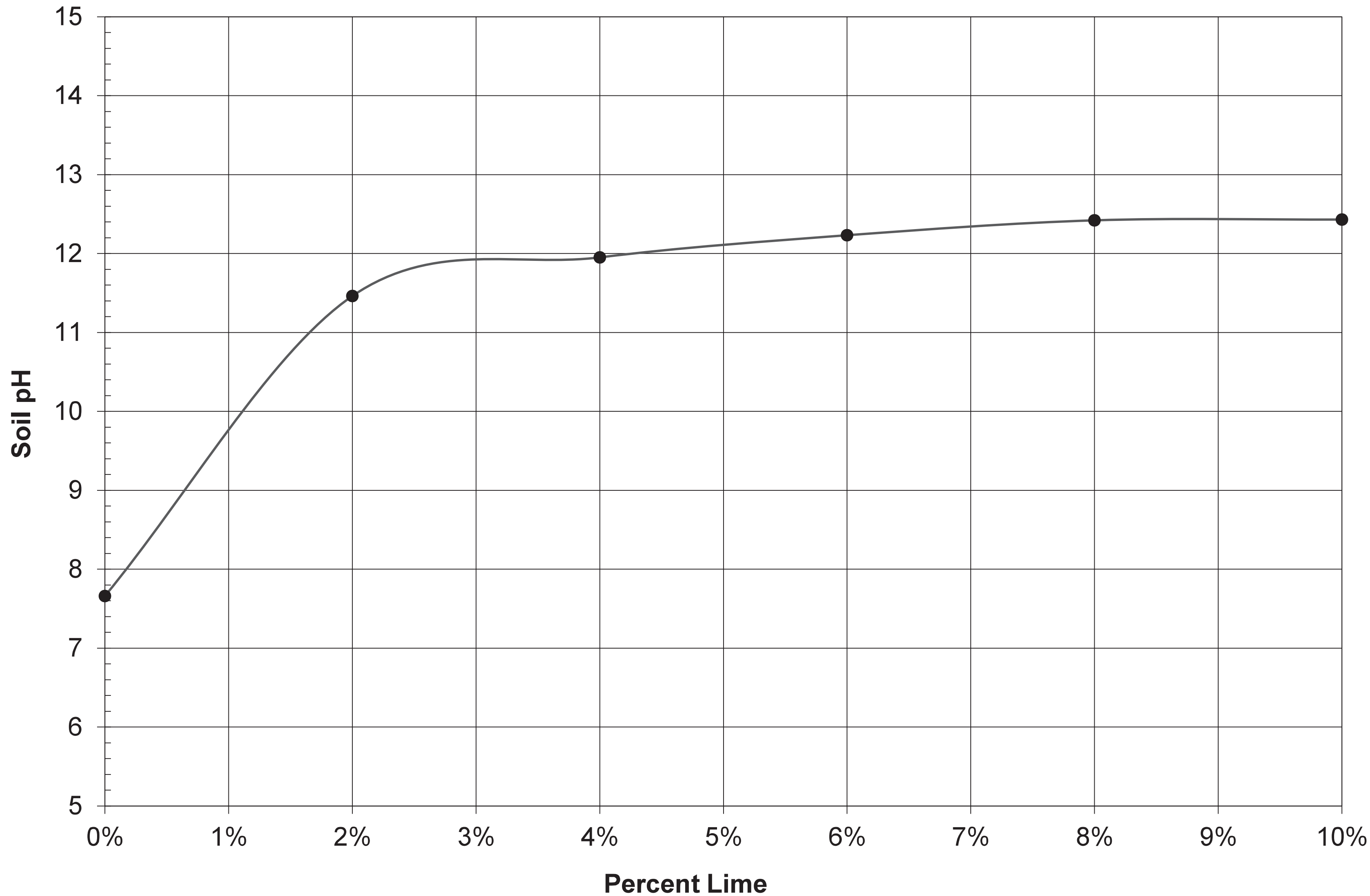
1. PROJECT NO(S):	Raba #AAA19-026-00
2. PROJECT NAME:	Sam Bass Road
3. SOURCE OF MATERIAL:	Sam Bass at OMC
4. REMOLDING TARGETS:	95% Maximum Dry Density at 19.1% Moisture Content
5. LAYER TYPE (1 - subgrade, 2 - base/subbase)	1
6. MATERIAL TYPE (Type 1 or Type 2)	2
7. TEST DATE	05-29-2019



APPENDIX B

pH SERIES CURVE

Corridor H - Sam Bass Road



APPENDIX C

INPUT DATA

A. Project Identification

District	AUS
County	Williamson
Highway	Sam Bass
CSJ	N/A
Direction	N/A
Station (Begin)	
Station (End)	

B. Design Parameters

Design Life (year)	20
Number of Punchouts per Mile	10

C. Design Traffic

Total Number of Lanes in One Direction	3
Total Design Traffic in One Direction (million ESALs)	7

CRCP PERFORMANCE

Number of Punchouts per Mile	8.3

D. Concrete Layer Information

Thickness of Concrete Layer (in.)	10
28-Day Modulus of Rupture (psi)	570

E. Support Layers Information

Soil Classification System	USCS
Soil Classification of Subgrade	CL
Base Type	CTB
Base Thickness (in.)	6
Modulus of Base Layer (ksi)	50

Composite K (psi/in.)	115

FLEXIBLE PAVEMENT DESIGN SYSTEM (FPS-21) OUTPUT FILES

Texas Department of Transportation

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.5 | *FLEXIBLE PAVEMENT SYSTEM* | *Release:12-12-2018*

PAVEMENT DESIGN TYPE # 2 -- ACP + FLEX BASE OVER SUBGRADE

PROB	DIST.-14	COUNTY-246	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
006	**Austin**	**WILLIAMSON**	**0000**	**00**	**000**	**Sam Bas**	**3/9/2020**	**1**

COMMENTS ABOUT THIS PROBLEM

Sam Bass Road - 20 yr Design

BASIC DESIGN CRITERIA

LENGTH OF THE ANALYSIS PERIOD (YEARS)	20.0
MINIMUM TIME TO FIRST OVERLAY (YEARS)	20.0
MINIMUM TIME BETWEEN OVERLAYS (YEARS)	8.0
DESIGN CONFIDENCE LEVEL (95.0%)	C
SERVICEABILITY INDEX OF THE INITIAL STRUCTURE	4.5
FINAL SERVICEABILITY INDEX P2	2.5
SERVICEABILITY INDEX P1 AFTER AN OVERLAY	4.2
DISTRICT TEMPERATURE CONSTANT	31.0
SUBGRADE ELASTIC MODULUS by COUNTY (ksi)	13.00
INTEREST RATE OR TIME VALUE OF MONEY (PERCENT)	7.0

PROGRAM CONTROLS AND CONSTRAINTS

NUMBER OF SUMMARY OUTPUT PAGES DESIRED (8 DESIGNS/PAGE)	3
MAX FUNDS AVAILABLE PER SQ.YD. FOR INITIAL DESIGN (DOLLARS)	99.00
MAXIMUM ALLOWED THICKNESS OF INITIAL CONSTRUCTION (INCHES)	69.0
ACCUMULATED MAX DEPTH OF ALL OVERLAYS (INCHES) (EXCLUDING LEVEL-UP)	6.0

TRAFFIC DATA

ADT AT BEGINNING OF ANALYSIS PERIOD (VEHICLES/DAY)	16900.
ADT AT END OF TWENTY YEARS (VEHICLES/DAY)	72400.
ONE-DIRECTION 20YEAR 18 kip ESAL (millions)	6.115
AVERAGE APPROACH SPEED TO THE OVERLAY ZONE(MPH)	45.0
AVERAGE SPEED THROUGH OVERLAY ZONE (OVERLAY DIRECTION)(MPH)	45.0
AVERAGE SPEED THROUGH OVERLAY ZONE (NON-OVERLAY DIRECTION) (MPH)	45.0
PROPORTION OF ADT ARRIVING EACH HOUR OF CONSTRUCTION (PERCENT)	6.0
PERCENT TRUCKS IN ADT	7.2

PAVEMENT DESIGN TYPE # 2 -- ACP + FLEX BASE OVER SUBGRADE

PROB	DIST.-14	COUNTY-246	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
006	**Austin**	**WILLIAMSON**	**0000**	**00**	**000**	**Sam Bas**	**3/9/2020**	**2**

INPUT DATA CONTINUED

CONSTRUCTION AND MAINTENANCE DATA

MINIMUM OVERLAY THICKNESS (INCHES)	1.5
OVERLAY CONSTRUCTION TIME (HOURS/DAY)	12.0
ASPHALTIC CONCRETE COMPACTED DENSITY (TONS/C.Y.)	1.90
ASPHALTIC CONCRETE PRODUCTION RATE (TONS/HOUR)	200.0
WIDTH OF EACH LANE (FEET)	12.0
FIRST YEAR COST OF ROUTINE MAINTENANCE (DOLLARS/LANE-MILE)	0.00
ANNUAL INCREMENTAL INCREASE IN MAINTENANCE COST (DOLLARS/LANE-MILE)	0.00

DETOUR DESIGN FOR OVERLAYS

TRAFFIC MODEL USED DURING OVERLAYING	3
TOTAL NUMBER OF LANES OF THE FACILITY	4
NUMBER OF OPEN LANES IN RESTRICTED ZONE (OVERLAY DIRECTION)	1
NUMBER OF OPEN LANES IN RESTRICTED ZONE (NON-OVERLAY DIRECTION)	2
DISTANCE TRAFFIC IS SLOWED (OVERLAY DIRECTION) (MILES)	0.60
DISTANCE TRAFFIC IS SLOWED (NON-OVERLAY DIRECTION) (MILES)	0.60
DETOUR DISTANCE AROUND THE OVERLAY ZONE (MILES)	0.00

PAVING MATERIALS INFORMATION

LAYER	CODE	MATERIALS NAME	COST PER CY	E MODULUS	POISSON RATIO	MIN. DEPTH	MAX. DEPTH	SALVAGE PCT.
1	A	ASPH CONC PVMT	150.00	500000.	0.35	5.50	13.00	30.00
2	B	FLEXIBLE BASE	54.00	40000.	0.35	10.00	25.00	75.00
3	C	SUBGRADE(200)	2.00	13000.	0.35	200.00	200.00	90.00

NOTE -- THE CALCULATED BASE VALUE WAS OVER-WRITTEN BY THE USER FOR PAVEMENT DESIGN TYPE #1

NOTE -- THE CALCULATED BASE VALUE WAS OVER-WRITTEN BY THE USER FOR PAVEMENT DESIGN TYPE #1

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.5 *FLEXIBLE PAVEMENT SYSTEM* *Release:12-12-2018*

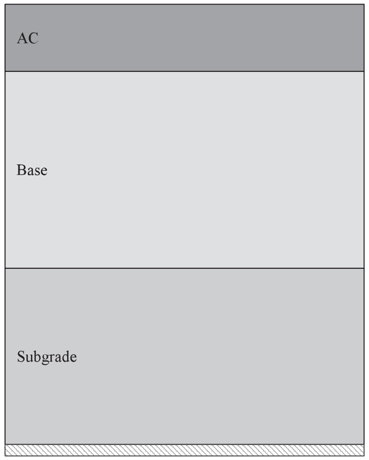
PAVEMENT DESIGN TYPE # 2 -- ACP + FLEX BASE OVER SUBGRADE

PROB	DIST.-14	COUNTY-246	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
006	**Austin**	**WILLIAMSON**	**0000**	**00**	**000**	**Sam Bas**	**3/9/2020**	**3**

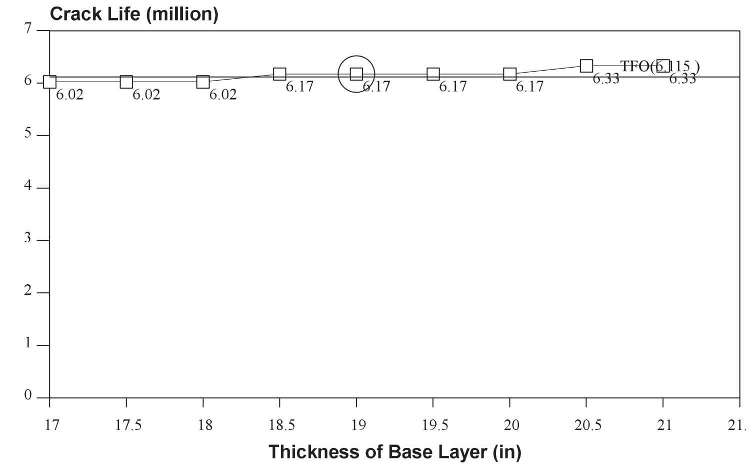
C. LEVEL C SUMMARY OF THE BEST DESIGN STRATEGIES
IN ORDER OF INCREASING TOTAL COST

	1	2	3	4	5	6	7	8
MATERIAL ARRANGEMENT	AB	AB	AB	AB	AB	AB	AB	AB
INIT. CONST. COST	54.42	52.50	55.00	55.58	55.42	54.92	56.00	55.83
OVERLAY CONST. COST	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
USER COST	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ROUTINE MAINT. COST	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SALVAGE VALUE	-7.88	-5.81	-7.75	-7.62	-7.35	-6.53	-7.22	-6.95
TOTAL COST	46.53	46.69	47.25	47.96	48.07	48.39	48.78	48.89
NUMBER OF LAYERS	2	2	2	2	2	2	2	2
LAYER DEPTH (INCHES)								
D(1)	5.50	9.00	6.00	6.50	7.00	8.50	7.50	8.00
D(2)	21.00	10.00	20.00	19.00	17.50	13.00	16.50	15.00
NO.OF PERF.PERIODS	1	1	1	1	1	1	1	1
PERF. TIME (YEARS)								
T(1)	21.	20.	21.	21.	20.	20.	20.	20.
OVERLAY POLICY(INCH) (INCLUDING LEVEL-UP)								

THE TOTAL NUMBER OF FEASIBLE DESIGNS CONSIDERED WAS 392



Thickness (inches)	Modulus (ksi)	Poisson's Ratio	Material Name
6.50	500.00	0.35	ASPH CONC PVMT
19.00	40.00	0.35	FLEXIBLE BASE
200.00	13.00	0.35	SUBGRADE(200)



Fatigue Crack Model:

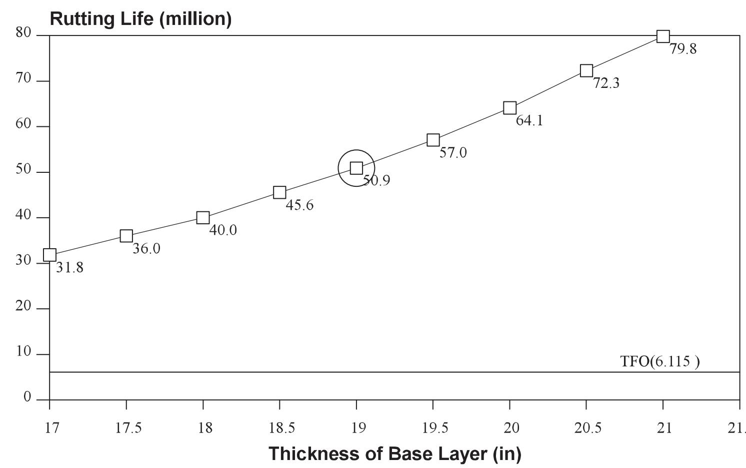
$$N_f = f_1 (\varepsilon_t)^{-f_2} (E_1)^{-f_3}$$

f_1 =7.96E-02
f_2 = 3.291
f_3 = .854

Rutting Model:

$$N_d = f_4 (\varepsilon_v)^{-f_5}$$

f_4 =1.37E-09
f_5 = 4.477



TFO(Traffic to 1st Overlay): 6.12 (million)

Crack Life: 6.17 (million) ε_τ = 133.00 ($\mu\varepsilon$)

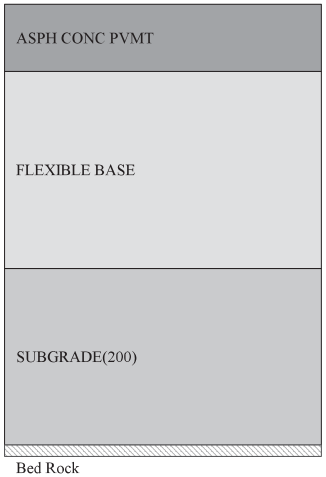
Rut Life: 50.90 (million) ε_v = -199.00 ($\mu\varepsilon$)

Traffic to 1st Overlay is calculated by analysis period: 20years and 18 kips:6.12millions.
Also the start ADT:16900.0 and ending ADT:72400.0

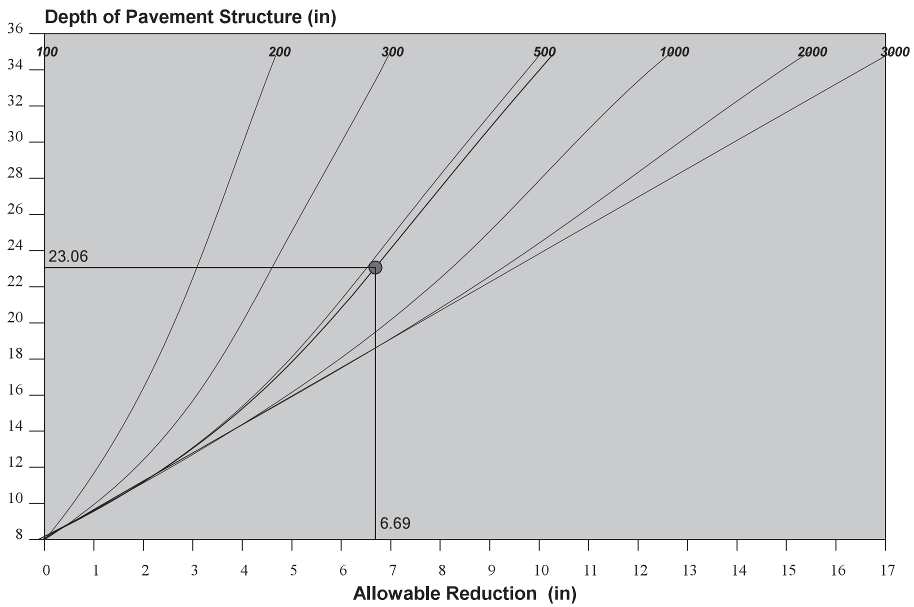
Mechanistic Check Conclusion:

The design is OK !

FPS 21 Mechanistic Design Check Output (FPS21-1.5Release:12-12-2018)			
Highway	Sam Bas	Problem	006
C-S-J	0000 - 00 - 000	Date	3/9/2020
District	Austin	County	WILLIAMSON
Design Type:Asphalt concrete + Flexible Base over Subgrade			



Thickness (inches)	Modulus (ksi)	Poisson's Ratio	Material Name
6.50	500.00	0.35	ASPH CONC PVMT
19.00	40.00	0.35	FLEXIBLE BASE
200.00	13.00	0.35	SUBGRADE(200)
	1300.00	0.15	Bed Rock



Thickness Reduction Chart for Stabilized Layers

INPUT PARAMETERS:

The Heaviest Wheel Loads Daily (ATHWLD)	11000.0 (lb)
Percentage of TandemAxles	60.0 (%)
Modified Cohesionmeter Value	550.0
Design Wheel Load	14300.0 (lb)
Subgrade Texas Triaxial Class Number (TTC)	5.22
Calculated TTC based on input soil PI	
User Input Sub-Grade Plasticity Index (PI)	25.00

RESULT:

Triaxial Thickness Required	23.1 (in)
The FPS Design Thickness	25.5 (in)
Allowable Thickness Reduction	6.7 (in)
Modified Triaxial Thickness	16.4 (in)

TRIAXIAL CHECK CONCLUSION:

The Design OK !

FPS 21 Triaxial Design Check Output	(FPS21-1.5Release:12-12-2018)		
Highway	Sam Bas	Problem	006
C-S-J	0000 - 00 - 000	Date	3/9/2020
District	Austin	County	WILLIAMSON

Design Type:Asphalt concrete + Flexible Base over Subgrade

Texas Department of Transportation

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.5 *FLEXIBLE PAVEMENT SYSTEM* *Release:12-12-2018*

PAVEMENT DESIGN TYPE # 2 -- ACP + FLEX BASE OVER SUBGRADE

PROB	DIST.-14	COUNTY-246	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
006	**Austin**	**WILLIAMSON**	**0000**	**00**	**000**	**Sam Bas**	**3/9/2020**	**1**

COMMENTS ABOUT THIS PROBLEM

Sam Bass Road - 20 yr Design - LS subgrade

BASIC DESIGN CRITERIA

LENGTH OF THE ANALYSIS PERIOD (YEARS)	20.0
MINIMUM TIME TO FIRST OVERLAY (YEARS)	20.0
MINIMUM TIME BETWEEN OVERLAYS (YEARS)	8.0
DESIGN CONFIDENCE LEVEL (95.0%)	C
SERVICEABILITY INDEX OF THE INITIAL STRUCTURE	4.5
FINAL SERVICEABILITY INDEX P2	2.5
SERVICEABILITY INDEX P1 AFTER AN OVERLAY	4.2
DISTRICT TEMPERATURE CONSTANT	31.0
SUBGRADE ELASTIC MODULUS by COUNTY (ksi)	20.00
INTEREST RATE OR TIME VALUE OF MONEY (PERCENT)	7.0

PROGRAM CONTROLS AND CONSTRAINTS

NUMBER OF SUMMARY OUTPUT PAGES DESIRED (8 DESIGNS/PAGE)	3
MAX FUNDS AVAILABLE PER SQ.YD. FOR INITIAL DESIGN (DOLLARS)	99.00
MAXIMUM ALLOWED THICKNESS OF INITIAL CONSTRUCTION (INCHES)	69.0
ACCUMULATED MAX DEPTH OF ALL OVERLAYS (INCHES) (EXCLUDING LEVEL-UP)	6.0

TRAFFIC DATA

ADT AT BEGINNING OF ANALYSIS PERIOD (VEHICLES/DAY)	16900.
ADT AT END OF TWENTY YEARS (VEHICLES/DAY)	72400.
ONE-DIRECTION 20YEAR 18 kip ESAL (millions)	6.115
AVERAGE APPROACH SPEED TO THE OVERLAY ZONE(MPH)	45.0
AVERAGE SPEED THROUGH OVERLAY ZONE (OVERLAY DIRECTION)(MPH)	45.0
AVERAGE SPEED THROUGH OVERLAY ZONE (NON-OVERLAY DIRECTION) (MPH)	45.0
PROPORTION OF ADT ARRIVING EACH HOUR OF CONSTRUCTION (PERCENT)	6.0
PERCENT TRUCKS IN ADT	7.2

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.5 *FLEXIBLE PAVEMENT SYSTEM* *Release:12-12-2018*

PAVEMENT DESIGN TYPE # 2 -- ACP + FLEX BASE OVER SUBGRADE

PROB	DIST.-14	COUNTY-246	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
006	**Austin**	**WILLIAMSON**	**0000**	**00**	**000**	**Sam Bas**	**3/9/2020**	**2**

INPUT DATA CONTINUED

CONSTRUCTION AND MAINTENANCE DATA

MINIMUM OVERLAY THICKNESS (INCHES)	1.5
OVERLAY CONSTRUCTION TIME (HOURS/DAY)	12.0
ASPHALTIC CONCRETE COMPACTED DENSITY (TONS/C.Y.)	1.90
ASPHALTIC CONCRETE PRODUCTION RATE (TONS/HOUR)	200.0
WIDTH OF EACH LANE (FEET)	12.0
FIRST YEAR COST OF ROUTINE MAINTENANCE (DOLLARS/LANE-MILE)	0.00
ANNUAL INCREMENTAL INCREASE IN MAINTENANCE COST (DOLLARS/LANE-MILE)	0.00

DETOUR DESIGN FOR OVERLAYS

TRAFFIC MODEL USED DURING OVERLAYING	3
TOTAL NUMBER OF LANES OF THE FACILITY	4
NUMBER OF OPEN LANES IN RESTRICTED ZONE (OVERLAY DIRECTION)	1
NUMBER OF OPEN LANES IN RESTRICTED ZONE (NON-OVERLAY DIRECTION)	2
DISTANCE TRAFFIC IS SLOWED (OVERLAY DIRECTION) (MILES)	0.60
DISTANCE TRAFFIC IS SLOWED (NON-OVERLAY DIRECTION) (MILES)	0.60
DETOUR DISTANCE AROUND THE OVERLAY ZONE (MILES)	0.00

PAVING MATERIALS INFORMATION

LAYER	CODE	MATERIALS NAME	COST PER CY	E MODULUS	POISSON RATIO	MIN. DEPTH	MAX. DEPTH	SALVAGE PCT.
1	A	ASPH CONC PVMT	150.00	500000.	0.35	5.50	13.00	30.00
2	B	FLEXIBLE BASE	54.00	40000.	0.35	10.00	25.00	75.00
3	C	SUBGRADE(200)	2.00	20000.	0.35	200.00	200.00	90.00

NOTE -- THE CALCULATED BASE VALUE WAS OVER-WRITTEN BY THE USER FOR PAVEMENT DESIGN TYPE #1

NONE

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.5 *FLEXIBLE PAVEMENT SYSTEM* *Release:12-12-2018*

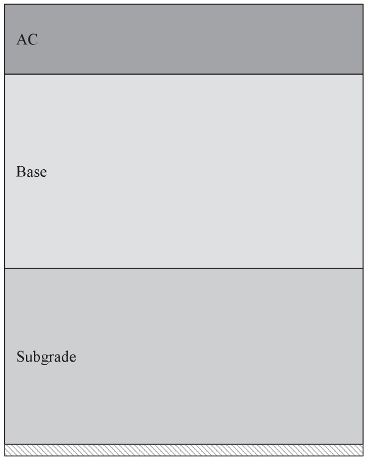
PAVEMENT DESIGN TYPE # 2 -- ACP + FLEX BASE OVER SUBGRADE

PROB	DIST.-14	COUNTY-246	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
006	**Austin**	**WILLIAMSON**	**0000**	**00**	**000**	**Sam Bas**	**3/9/2020**	**3**

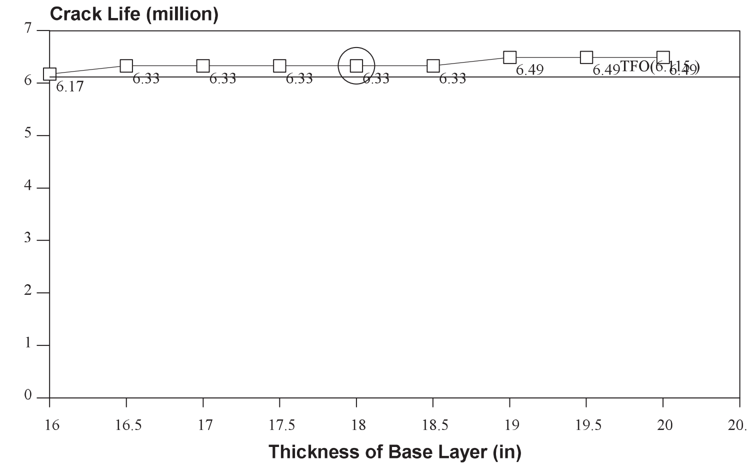
C. LEVEL C SUMMARY OF THE BEST DESIGN STRATEGIES
IN ORDER OF INCREASING TOTAL COST

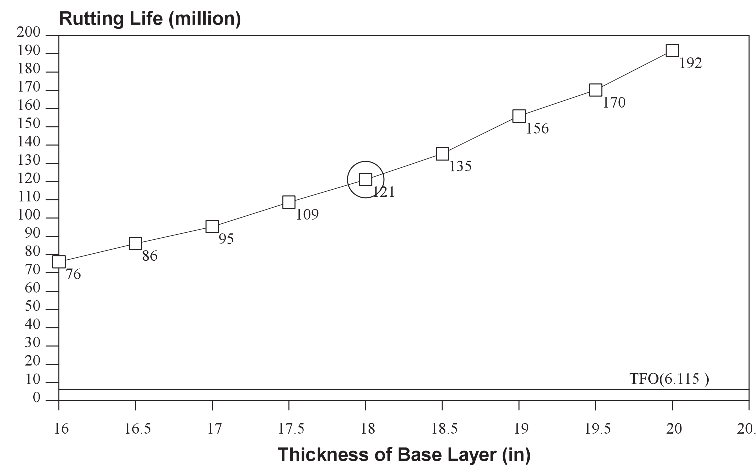
	1	2	3	4	5	6	7	8
MATERIAL ARRANGEMENT	AB	AB	AB	AB	AB	AB	AB	AB
INIT. CONST. COST	51.17	53.67	54.25	52.50	54.08	53.58	54.67	54.50
OVERLAY CONST. COST	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
USER COST	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ROUTINE MAINT. COST	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SALVAGE VALUE	-5.80	-7.74	-7.61	-5.81	-7.33	-6.51	-7.20	-6.93
TOTAL COST	45.37	45.93	46.64	46.69	46.75	47.07	47.46	47.57
NUMBER OF LAYERS	2	2	2	2	2	2	2	2
LAYER DEPTH (INCHES)								
D(1)	8.50	5.50	6.00	9.00	6.50	8.00	7.00	7.50
D(2)	10.50	20.50	19.50	10.00	18.00	13.50	17.00	15.50
NO.OF PERF.PERIODS	1	1	1	1	1	1	1	1
PERF. TIME (YEARS)								
T(1)	20.	21.	21.	22.	20.	20.	20.	20.
OVERLAY POLICY(INCH) (INCLUDING LEVEL-UP)								

THE TOTAL NUMBER OF FEASIBLE DESIGNS CONSIDERED WAS 407



Thickness (inches)	Modulus (ksi)	Poisson's Ratio	Material Name
6.50	500.00	0.35	ASPH CONC PVMT
18.00	40.00	0.35	FLEXIBLE BASE
200.00	20.00	0.35	SUBGRADE(200)





Fatigue Crack Model:

$$N_f = f_1(\varepsilon_t)^{-f_2}(E_1)^{-f_3}$$

f_1 =7.96E-02

f_2 = 3.291

f_3 = .854

Rutting Model:

$$N_d = f_4(\varepsilon_v)^{-f_5}$$

f_4 =1.37E-09

f_5 = 4.477

TFO(Traffic to 1st Overlay): 6.12 (million)

Crack Life: 6.33 (million) ε_τ = 132.00 ($\mu\varepsilon$)

Rut Life: 121.02 (million) ε_v = -164.00 ($\mu\varepsilon$)

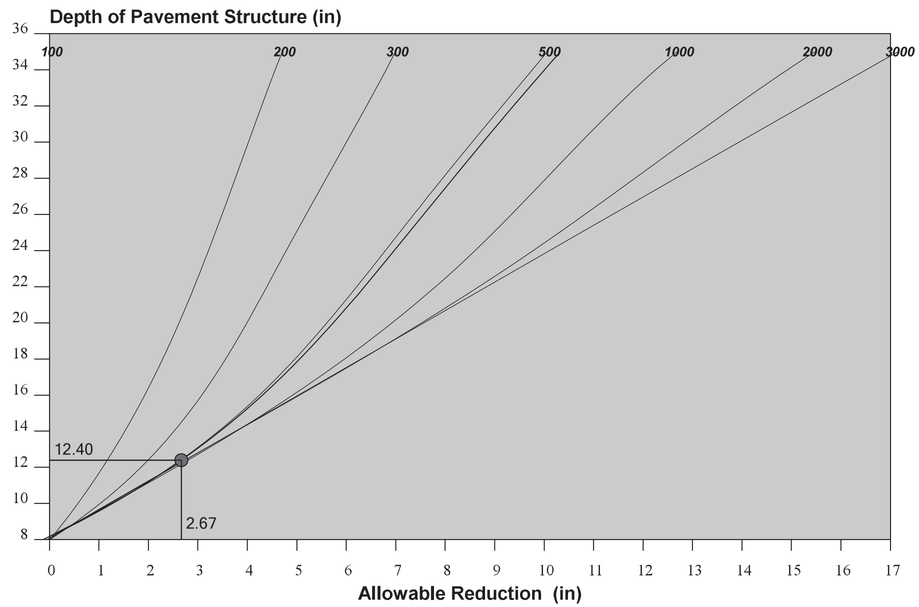
Traffic to 1st Overlay is calculated by analysis period: 20years and 18 kips:6.12millions.
Also the start ADT:16900.0 and ending ADT:72400.0

Mechanistic Check Conclusion:

The design is OK !

FPS 21 Mechanistic Design Check Output (FPS21-1.5Release:12-12-2018)			
Highway	Sam Bas	Problem	006
C-S-J	0000 - 00 - 000	Date	3/9/2020
District	Austin	County	WILLIAMSON
Design Type:Asphalt concrete + Flexible Base over Subgrade			

Layer	Thickness (inches)	Modulus (ksi)	Poisson's Ratio	Material Name
ASPH CONC PVMT	6.50	500.00	0.35	ASPH CONC PVMT
FLEXIBLE BASE	18.00	40.00	0.35	FLEXIBLE BASE
SUBGRADE(200)	200.00	20.00	0.35	SUBGRADE(200)
Bed Rock		2000.00	0.15	Bed Rock



Thickness Reduction Chart for Stabilized Layers

INPUT PARAMETERS:

The Heaviest Wheel Loads Daily (ATHWLD)	11000.0 (lb)
Percentage of TandemAxles	60.0 (%)
Modified Cohesionmeter Value	550.0
Design Wheel Load	14300.0 (lb)
Subgrade Texas Triaxial Class Number (TTC)	3.91
Calculated TTC based on input soil PI	
User Input Sub-Grade Plasticity Index (PI)	15.00

RESULT:

Triaxial Thickness Required	12.4 (in)
The FPS Design Thickness	24.5 (in)
Allowable Thickness Reduction	2.7 (in)
Modified Triaxial Thickness	9.7 (in)

TRIAXIAL CHECK CONCLUSION:

The Design OK !

FPS 21 Triaxial Design Check Output (FPS21-1.5Release:12-12-2018)

Highway	Sam Bas	Problem	006
C-S-J	0000 - 00 - 000	Date	3/9/2020
District	Austin	County	WILLIAMSON

Design Type:Asphalt concrete + Flexible Base over Subgrade

DRILLED PIER AXIAL CAPACITY CURVES

STRAIGHT SHAFT PIERS

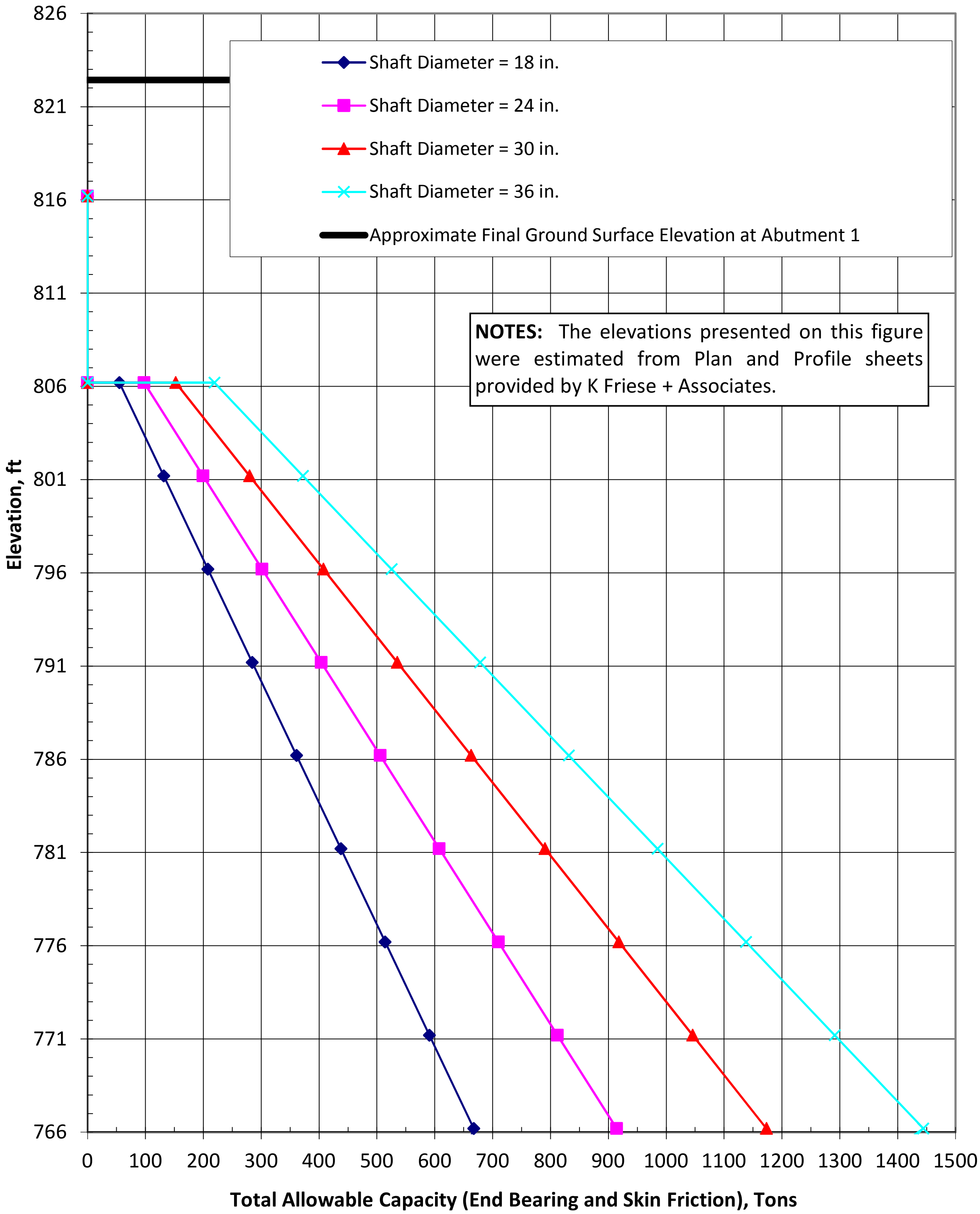
DRILLED PIER AXIAL CAPACITY CURVE

Straight Shaft Piers

Williamson County Corridor H - Bridge

Sam Bass Road, Williamson County, Texas

Abutment 1



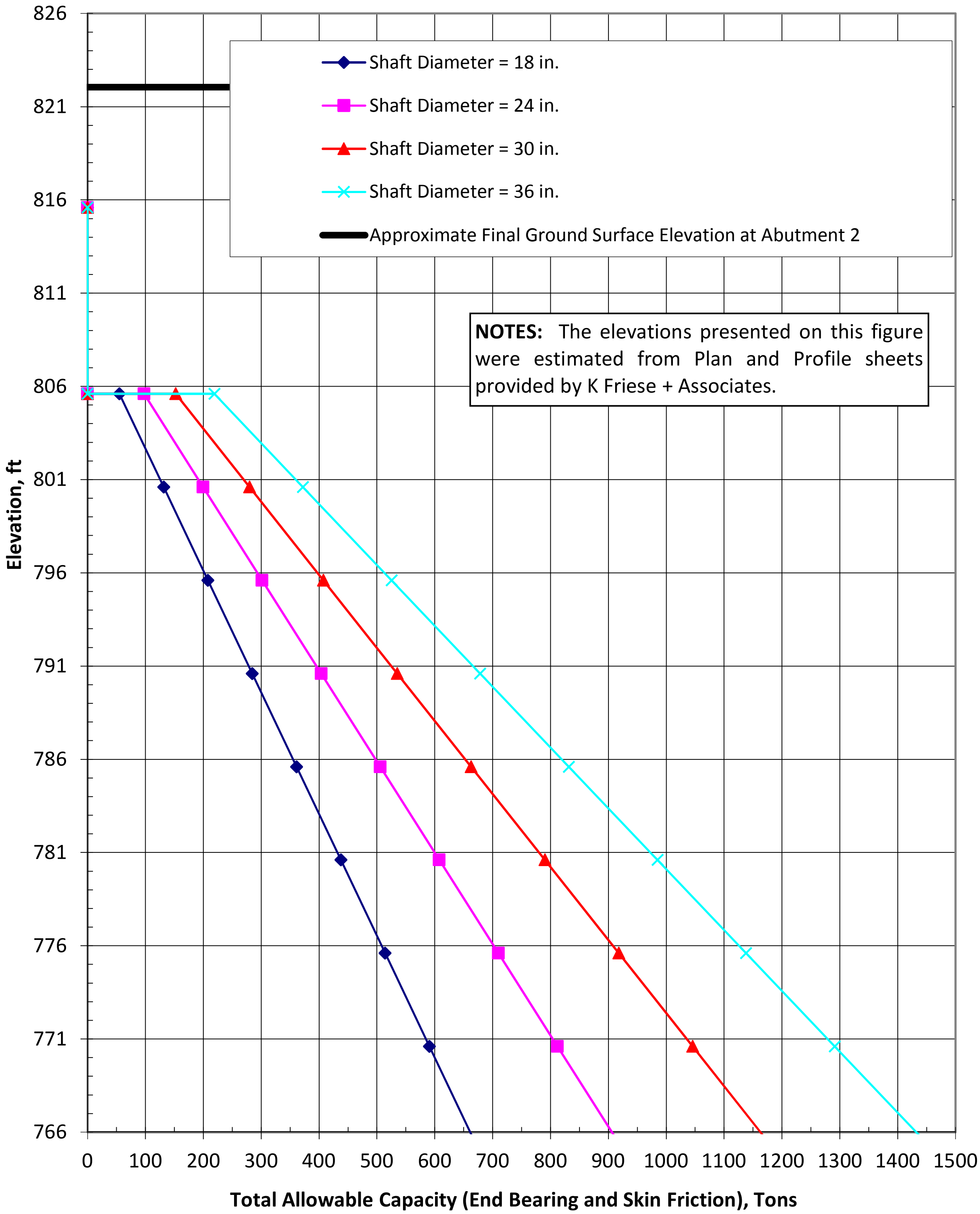
DRILLED PIER AXIAL CAPACITY CURVE

Straight Shaft Piers

Williamson County Corridor H - Bridge

Sam Bass Road, Williamson County, Texas

Abutment 2



AAA19-026-00

DRILLED PIER UPLIFT CAPACITY CURVES

STRAIGHT SHAFT PIERS

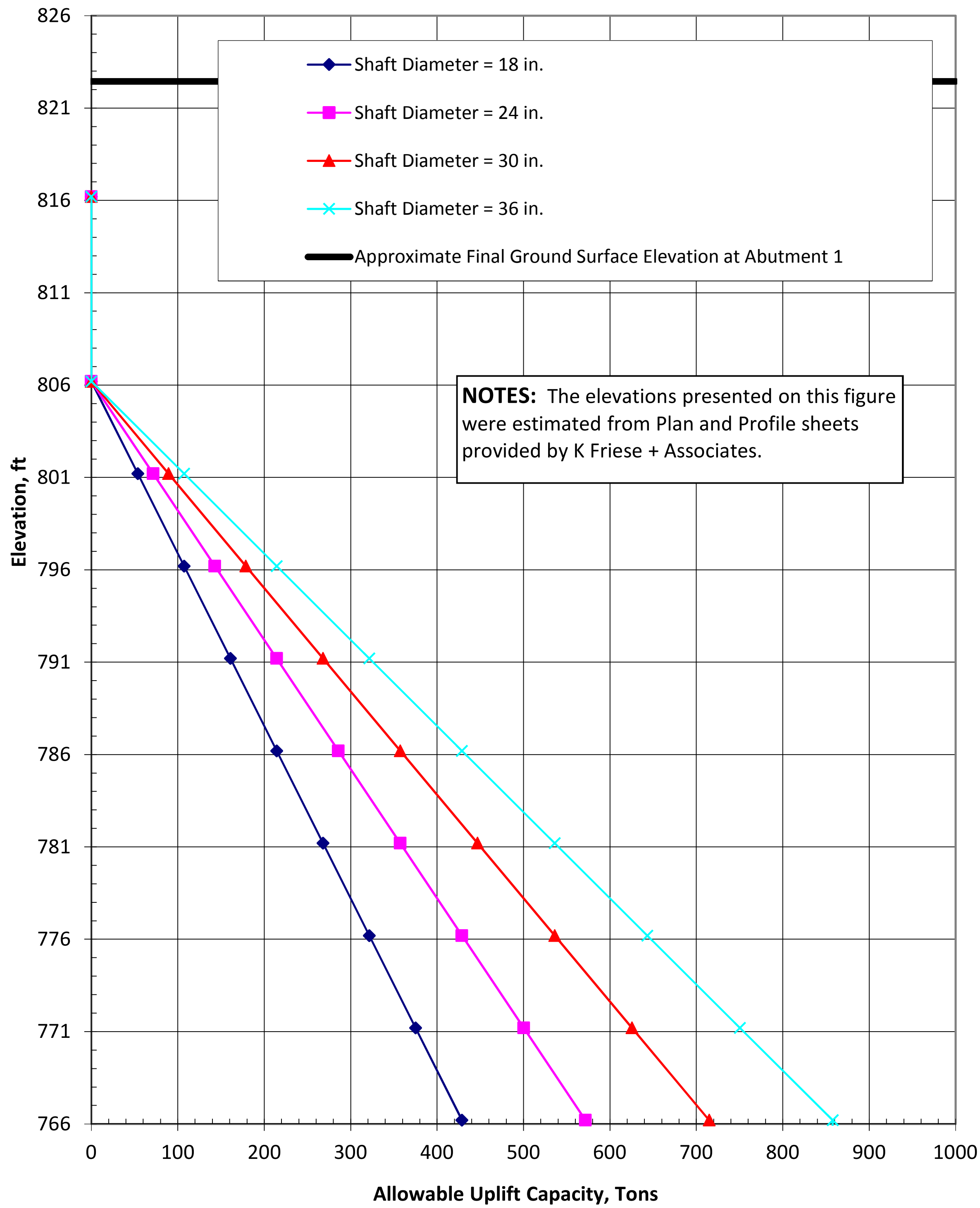
DRILLED PIER UPLIFT CAPACITY CURVE

Straight Shaft Piers

Williamson County Corridor H - Bridge

Sam Bass Road, Williamson County, Texas

Abutment 1



AAA19-026-00

2/5/2020

Raba Kistner

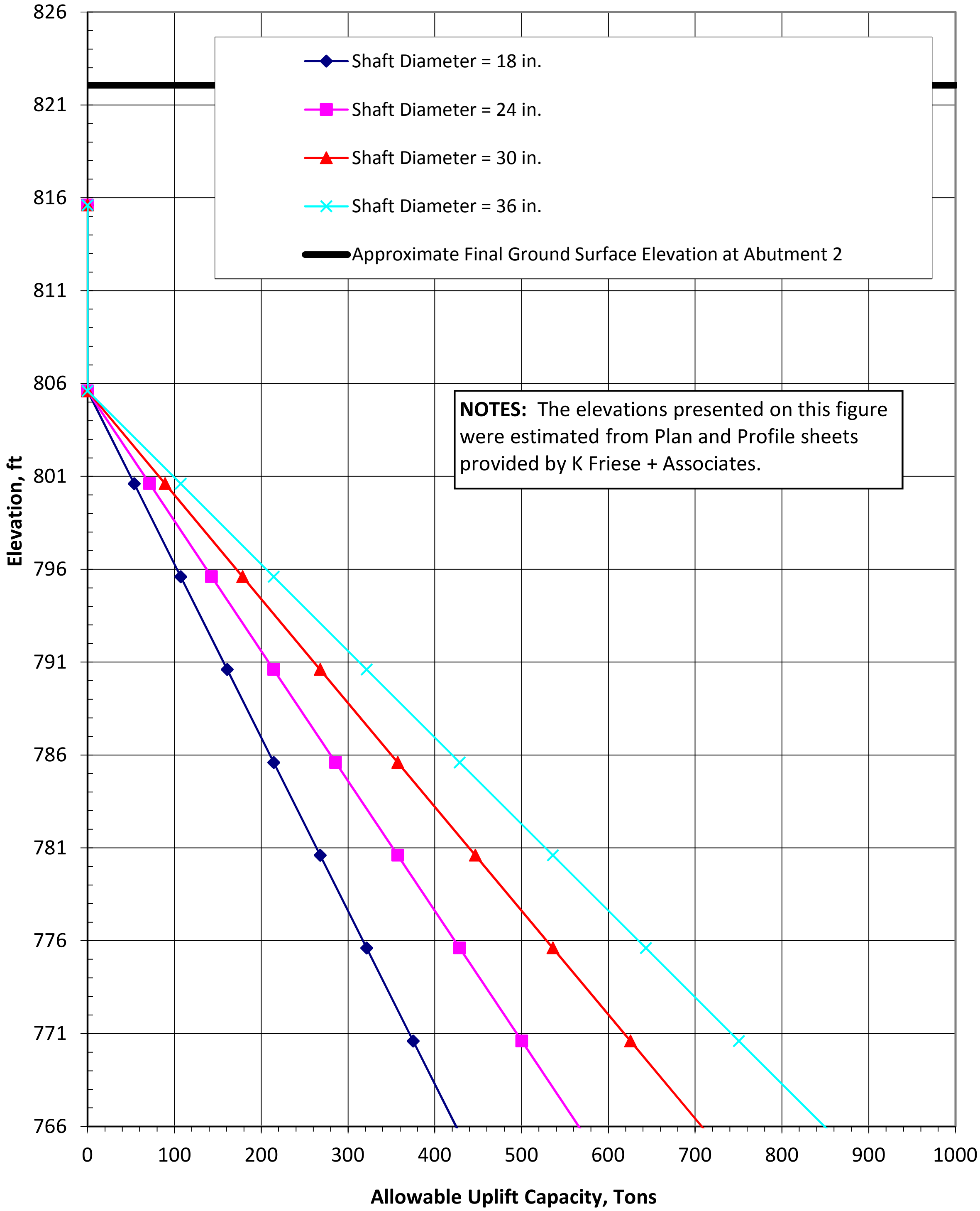
DRILLED PIER UPLIFT CAPACITY CURVE

Straight Shaft Piers

Williamson County Corridor H - Bridge

Sam Bass Road, Williamson County, Texas

Abutment 2



AAA19-026-00

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a civil engineer may not fulfill the needs of a constructor — a construction contractor — or even another civil engineer. Because each geotechnical- engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. No one except you should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply this report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical-engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

Geotechnical Engineers Base Each Report on a Unique Set of Project-Specific Factors

Geotechnical engineers consider many unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk-management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical-engineering report that was:

- not prepared for you;
- not prepared for your project;
- not prepared for the specific site explored; or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical-engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical-engineering report is based on conditions that existed at the time the geotechnical engineer performed the study. *Do not rely on a geotechnical-engineering report whose adequacy may have been affected by*: the passage of time; man-made events, such as construction on or adjacent to the site; or natural events, such as floods, droughts, earthquakes, or groundwater fluctuations. *Contact the geotechnical engineer before applying this report to determine if it is still reliable.* A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ — sometimes significantly — from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide geotechnical-construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are Not Final

Do not overrely on the confirmation-dependent recommendations included in your report. *Confirmation-dependent recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations *only* by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's confirmation-dependent recommendations if that engineer does not perform the geotechnical-construction observation required to confirm the recommendations' applicability.*

A Geotechnical-Engineering Report Is Subject to Misinterpretation

Other design-team members' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Constructors can also misinterpret a geotechnical-engineering report. Confront that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing geotechnical construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical-engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make constructors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give constructors the complete geotechnical-engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise constructors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure constructors have sufficient time* to perform additional study. Only then might you be in a position to give constructors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and constructors fail to recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Environmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform an *environmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold-prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, many mold- prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical- engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; *none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.*

Rely, on Your GBC-Member Geotechnical Engineer for Additional Assistance

Membership in the Geotechnical Business Council of the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you GBC-Member geotechnical engineer for more information.

GBC GEOTECHNICAL BUSINESS COUNCIL
of the Geoprofessional Business Association

8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone: 301/565-2733 Facsimile: 301/589-2017
e-mail: info@geoprofessional.org www.geoprofessional.org

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RABA KISTNER

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APPENDIX B

Cambrian Environmental

Preliminary Results of a Dye Trace Study for Krienke Spring

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Gary Boyd
Environmental Program Coordinator
Williamson County Conservation Foundation
219 Perry Mayfield
Leander, Texas 78641

9 March 2021

Re: Preliminary Results of a Dye Trace Study for Krienke Spring, Round Rock, Williamson County, Texas

Dear Gary,

This letter report summarizes our preliminary results for a dye trace study conducted between August 2019 and September 2020, in support of the Williamson County road bond program. The dye trace study was designed to establish groundwater connections between nearby recharge features and Tonkawa Spring (also known as Krienke Spring) which is within Jollyville Plateau Salamander (JPS) critical habitat unit (CHU 1) as mapped by the U.S. Fish and Wildlife Service (the Service). Groundwater tracing using non-toxic dyes to characterize recharge areas, as well as groundwater flow paths and velocities, is a common diagnostic tool in karst aquifers worldwide, and has been used successfully within the Barton Springs segment of the Edwards Aquifer[1]. Little dye trace work has been done in the northern segment of the Edwards Aquifer, and virtually none has been done in Williamson County prior to this work.

Krienke Spring is located in the Tonkawa Springs neighborhood north of Brushy Creek and south of Sam Bass Road approximately two miles west of IH 35 in Round Rock. The alternate name for the Tonkawa Spring (Krienke Spring) is after the Krienke family, some of whom settled in the Round Rock area. This historic site is described in The Springs of Texas[2] as being 5 km (3.11 miles) west-northwest of the town of Round Rock with a discharge rate of 1.9 liters per second (30 gallons per minute) in 1940 and 1978. Presence of the JPS at the spring was cited by the Service when they listed the salamander as threatened and designated critical habitat in 2013. The Service stated with their listing that they seek to understand more about this spring site and other JPS springs sites because "*hydrology in Central Texas is very complex and information on hydrology of specific spring sites is largely unknown*". Because of this uncertainty, the Service designated a 300 m (984 ft) circular subsurface critical habitat unit around the spring. This preliminary dye trace study was intended to provide some clarity to the hydrogeology of Krienke Spring. Local hydrogeology and the reported constant flow dynamic of the spring indicate that the spring-shed must be large, extending well beyond the boundaries of CHU 1.

Cambrian Environmental began the study in August 2019 by developing a hydrogeological model of the subsurface drainage basin taking into account structural geology, surface topography and the prevailing groundwater flow direction (Figure 1). Krienke Spring issues from the water table portion of the Edwards

---

[1] Summary of Groundwater Tracing in the Barton Springs Edwards Aquifer from 1996 to 2017. https://bseacd.org/uploads/Zappitello-et-al.-2019-Dye-Tracing-Summary.pdf

[2] Brune, G. M. (2002). *Springs of Texas* (Vol. 1). Texas A&M University Press.

Aquifer where the Edwards and Georgetown Limestones are exposed at the surface. Rainfall can infiltrate on these outcropping units and recharge the Edwards Aquifer. Krienke Spring is one of many low-flow springs in this setting that discharges from the base of Edwards Limestone above the Comanche Peak Formation which is stratigraphically below the Edwards Limestone and serves as the lower confining unit of the Edwards Aquifer. Flow at the spring is thought to also be bounded by the intersection with the Onion Fault, although we established sampling locations on the opposite side of the fault. Topographically our model confines recharge to the north side of the Dry Fork Creek since the spring issues from the north bank and because the Edwards Limestone has been removed by erosion along the bed of the creek. Honey Bear and Vista Oaks (HB/VO) springs to the north provide a logical place to draw a divide between spring sites since surface drainage flows south towards these springs in the upper drainages of Dry Fork Creek. Downstream of HB/VO springs, surface water flows to a reservoir (SCS Site 13a) where an outlet re-joins the Dry Fork Branch. The western boundary of our presumed Krienke springshed coincides with the westmost tributary of Dry Fork Branch above the base of the Edwards Aquifer outcropping units. We make the eastern boundary for both the Krienke and the HB/VO springsheds coincide with a topographic divide between the Dry Fork and Onion branches of Brushy Creek. Based on regional studies of the northern Edwards Aquifer and on potentiometric surface mapping conducted for a nearby hydrocarbon plume from an underground storage tank located at 1901 Hermitage Dr.[3], we accept that the prevailing groundwater flow direction in the unconfined aquifer of Williamson County is northeasterly north of Brushy Creek. Our small-scale hydrogeologic model has a southern groundwater flow direction proximal to selected recharge features, and southeastern flow direction along the dip of Edwards Aquifer strata to the Krienke Spring outlet.

We discussed our model with Jason Krothe of Hydrogeology, Inc. who then developed protocols for a dye trace study. Sampling protocols, injection logistics and laboratory analyses were all provided by Hydrogeology, Inc. The study was designed to include injection into two recharge features, four sampling locations, three surface water locations and one well location. We selected two caves in the Walsh Ranch neighborhood that were 0.28 and 0.65 miles north of Krienke Spring. Walsh Ranch (WR) Cave 1 and Cave 2 are informally assigned names and not registered cave names in Williamson County (Figure 2). We were able to access these recharge features with permission from the Walsh Rach municipal utility district (MUD). These two caves are the most proximal known potential recharge features to the spring.

The Williamson County Public Information Office assisted with communications with the local community and request for access to private land for water sampling. While permission for direct access to the spring was denied, receptors were deployed within the impounded section of Dry Berry Creek just downstream of the pond.

Sampling Methods

The primary sampling method for the dye traces was activated charcoal samples (ACS). An ACS consists of 10 grams of coconut shell carbon in a fiberglass mesh pouch. To establish a sampling station, an ACS packet was suspended by wire within the portion of the spring or stream with the highest visible flow. The

[3] Hall Southwest, 1994. Potentiometric surface map for 7-Eleven store 25945 on 7/26/94. Available from the Texas Commission on Environmental Quality, LPST File 106895.

ACS were typically left in place for one week. Grab water samples were the secondary sample method. Water samples were typically collected when an ACS packet was missing. Figures 3 and 4 are representative photos of Krienke Spring and of selected sampling locations.

Results

Pre-injection field reconnaissance site visits and initial background sampling were conducted in late 2019. The first round of dye trace work (dye trace 1) was conducted between January and March of 2020 (Tables 1 and 2). In accordance with the project plan, two rounds of background sampling were conducted before dye injections. Based on the results of the background sampling, the dyes Fluorescein and Rhodamine WT were selected for injection. Since the likely resurgence point (Krienke Spring) for these dye traces is in a neighborhood and flows into a recreational water body, the volume of dye used for injection was selected to prevent a strong dye visual at Krienke Spring. On the dates of the injections, the Williamson County road and bridge department provided valuable assistance by delivering a water truck that was used to flush the dye into the karst system during the injection. The dye injections were conducted in coordination with the Texas Commission on Environmental Quality (TCEQ) Edwards Aquifer Protection Program, the U.S. Fish and Wildlife Service, and coordination with the Texas Parks and Wildlife Department. TCEQ sent junior investigators to observe the dye injection on the 19th February. That day one pound of Rhodamine WT liquid dye was injected into Walsh Ranch Cave 2. Prior to injecting the dye, 1000 gallons of potable water was flushed into the cave. The dye was then mixed with 4000 gallons of potable water and injected into the cave. On the 20th of February, 0.6 pounds of Fluorescein liquid dye was injected into Walsh Ranch Cave 1. Prior to injecting the dye, 1000 gallons of potable water was flushed into the cave. The dye was then mixed with 2000 gallons of potable water and injected into the cave. Post-injection visual observations did not reveal colored water at any of the nearby surface water bodies.

Injection Date	Recharge Feature	Non-Toxic Dye	Overall Result
2/19/2020	Walsh Ranch Cave 2	Rhodamine WT	No positive detection
2/20/2020	Walsh Ranch Cave 1	Fluorescein	No positive detection
7/28/2020	Walsh Ranch Cave 2	Rhodamine WT	No positive detection

Table 1. Dye injection summary. Dye trace 1No positive dye detections were made from these injections.

Study modifications were implemented in the summer of 2020 based on initial negative results. Additional sites were added to the sampling network in conjunction with a second dye trace (dye trace 2). A new set of background samples were analyzed in preparation for a re-injection into Walsh Ranch Cave 2. The goal was to increase the mass of the dye used in the closest feature to Krienke Spring. In conjunction with adding more dye into the closest feature, another slug of water was flushed into Walsh Ranch Cave 1. Sampling found no positive laboratory detections from these dye injections (Table 3).

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Monitoring Site ID	Description	Status
#1 Krienke Spring PO	Pond outlet below spring	Monitored since Oct. 2019
#2 Brushy Creek WS	South bank at Wyoming Springs	Monitored since Oct. 2019
#3 Brushy Creek CB	Close to north bank below Creek Bend	Monitored since Oct. 2019
#4 Brushy Creek LO	South bank near Ledbetter Oaks subdivision	Monitored since Oct. 2019
#5 Pond on Fault	Hidden Glen greenbelt semi-perennial pond	Monitored since Oct. 2019
#6 Krienke Pond	Weighted float within pond	Abandoned location
#7 West Seep	Weighted rock at seep	Added summer 2020
#8 Tree Stump	Near south bank on pond	Added summer 2020
#9 South Pond FS	Pond south of Fire Station	Added summer 2020
#10 Pond BR	Stormwater pond in Behrens Ranch subdiv.	Abandoned location
#11 Aqua TX	Near a Tonkawa Springs neighborhood pond	Not used
#12 Brushy Creek at AW	Beneath AW Grimes Blvd overpass	Added summer 2020
#13 Kinney Fort	Downstream of Kinney Fort Spring	Possible future location
#14 Westinghouse Seep	Issues from concrete culvert at IH 35	Possible future location

Table 2. Monitoring network summary. Direct access to Krienke Spring has not been granted. ID #8 was used once for a north bank seep and re-located to the tree stump within the main body of the Krienke pond. The seep at IH 35 and Westinghouse Road could be added to monitor possible northeastern groundwater flow.

Limitations and Recommended Next Steps

A major limitation to the dye trace study was the lack of access to Krienke Spring. Standard water quality and flow measurements of spring water would inform our hydrogeological model, although the amount of dye used in this study was sufficient to detect a color change at the outlet and at the downstream pond outlet as well as at locations further downgradient.

Sampling one or more water wells would enable detection of groundwater flow directions that might be outside the hypothesized springshed. It is possible the recharging groundwater upgradient of Krienke Spring is transmitted along mapped or unmapped faults and that groundwater might remain in the body of the aquifer for a long distance. Having sampling sites such as at the Westinghouse seep or wells/springs located northeast of the area may increase the dye detection probability. Coordination with Brushy Creek MUD for access to their Edwards Aquifer wells was limited. Access to sample at one or more of the groundwater-sustained ponds in the Tonkawa Springs neighborhood would be helpful.

Given the close proximity between the spring and the injection sites, the lack of a successful dye detection was unexpected. We believe that the most likely explanation for this result is related to the history of construction in the area (Figure 6). A large water quality pond occurs between the injection sites and the spring which would have required significant excavation to construct. We also know from personal experience that karst voids have been encountered and mitigated beneath the pond adjacent to Alexandrite Way and south of Walsh Ranch Cave 2. As a result of construction, it is possible that a blockage in the Walsh Ranch cave network prevents a groundwater connection to Krienke Spring even though there is sufficient recharge capability at the entrances. Some degree of excavation of one or more of these caves may be necessary. The idea of a subsurface blockage is supported given the short distance between the

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recharge features and spring. We hypothesize that nearby stormwater ponds could be acting as a barrier to flow. Conversely, different injection sites may be considered to test other recharge features.

Another compounding issue relates to the history of the Tonkawa Springs neighborhood, which sits on the location of a former limestone quarry. Homes on the north side of Dry Berry Creek are constructed around as series of ponds which are old quarry pits filled with groundwater. The hydrological relationship between the ponds and the spring is unknown, but presumable they are both fed by the same source of groundwater. Permission to sample the ponds for dye was not granted. Clearly the hydrogeology of Tonkawa Springs is more complicated than represented by the boundaries of JPS CHU 1.

Please let us know if you have any questions regarding the dye trace study or associated next step recommendations.

Sincerely,

Heather L. Beatty, P.G.
Senior Karst Geoscientist
hbeatty@cambrianenvironmental.com

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STATE OF TEXAS
KEMBLE WHITE
GEOLOGY
NO. 3863
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Attachments:
Figure 1. Geologic map with hypothesized Krienke and Honey Bear springsheds.
Figure 2. Location map showing Krienke Spring, dye injection sites (recharge features) and sampling network.
Figure 3. Representative photos of Krienke Spring.
Figure 4. Photos of selected sampling locations.
Figure 5. Injection site photos.
Figure 6. Injection site maps.
Table 3. Dye Trace Analytical Results.

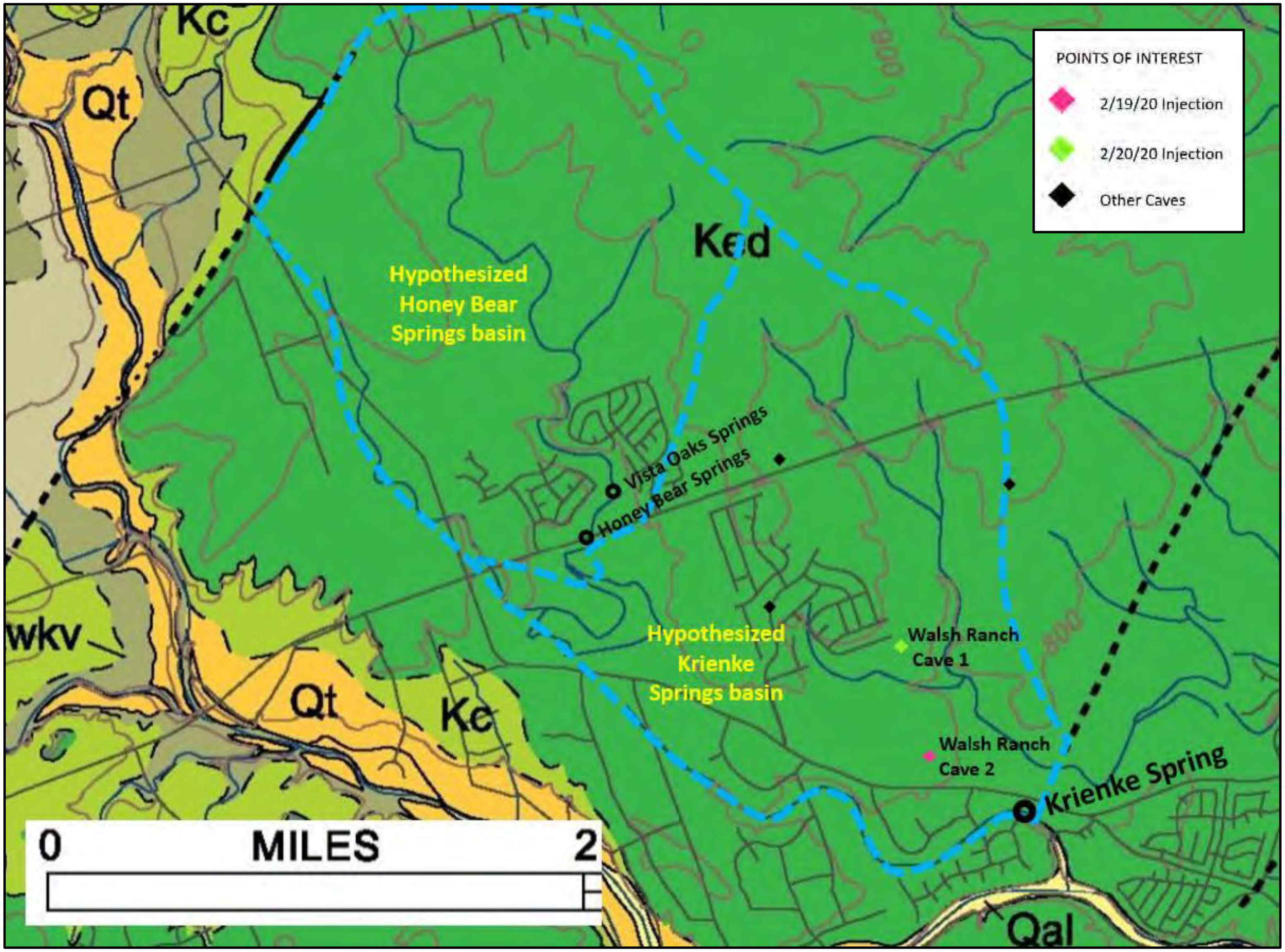

Figure 1. Presumed catchment basin for Krienke Spring south of Honey Bear and Vista Oaks Springs. Diamond shapes represent nearby caves or potential recharge features. The two closest known caves were selected for dye injection.

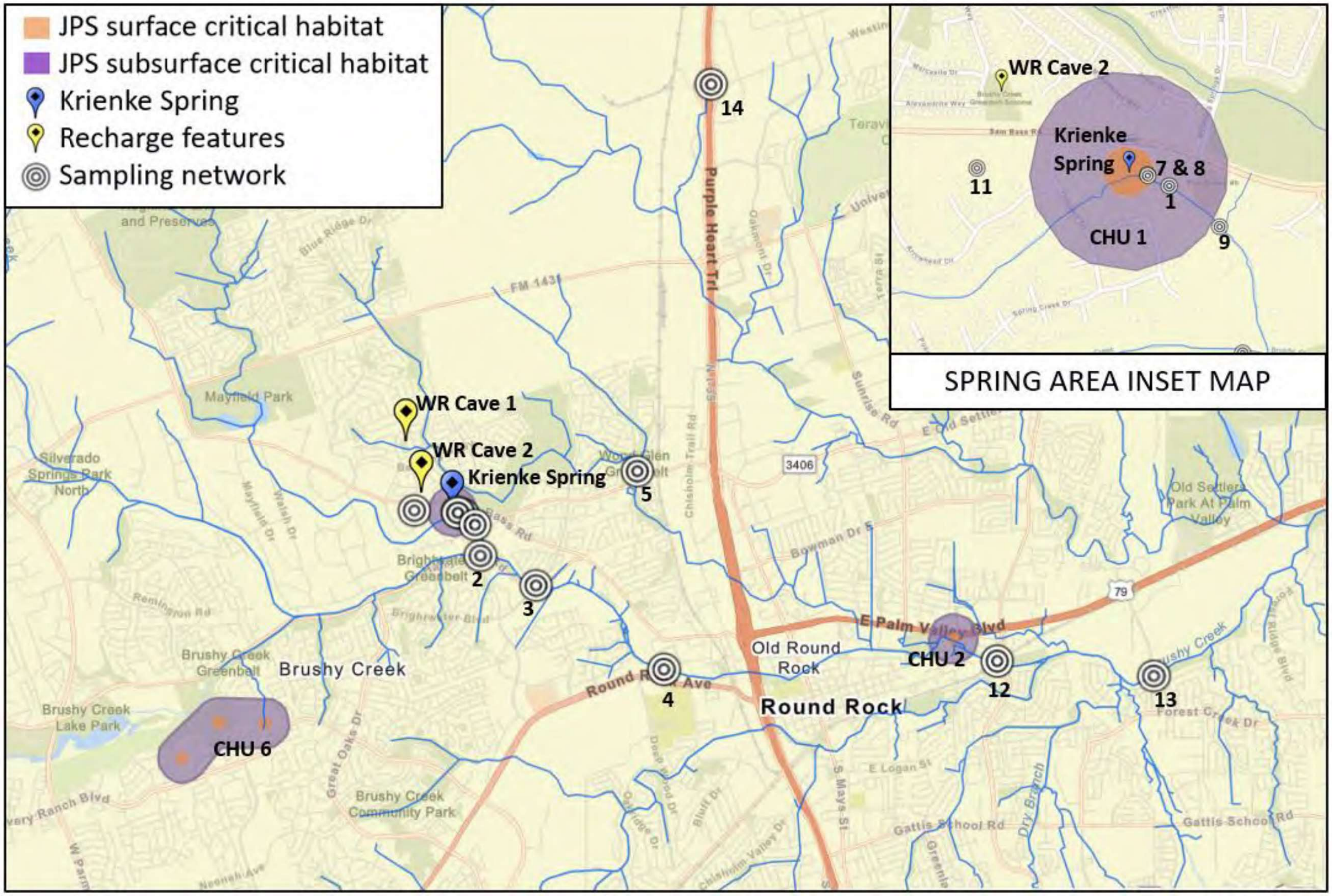

Figure 2. Krienke Spring, dye injection sites (caves/recharge features) and sampling network. JPS critical habitat units in the Round Rock area of Williamson County.

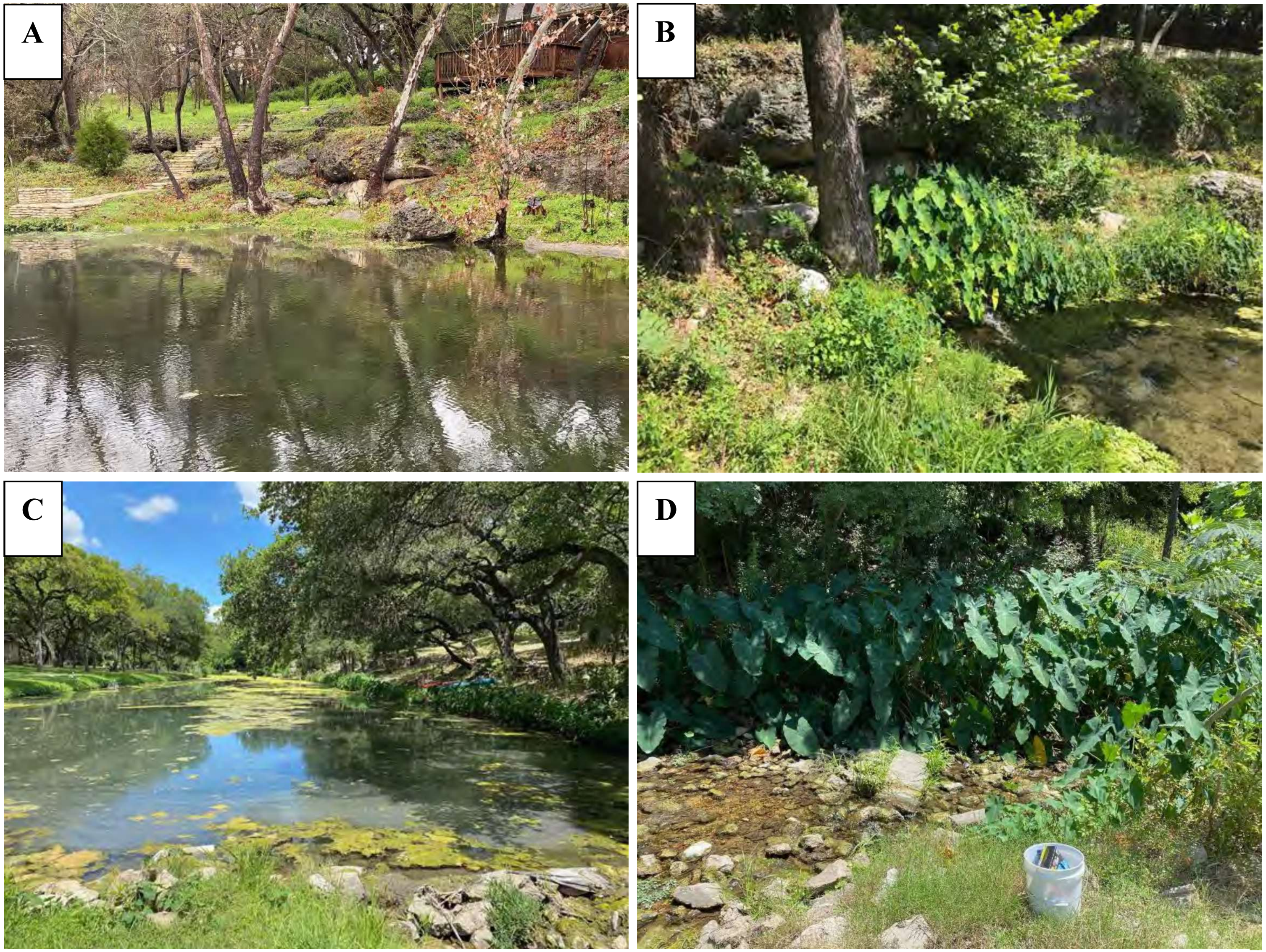

Figure 3. Representative photos of Krienke Spring. **A.** Spring issues from the north bank. **B.** Flowing Krienke Spring below elephant ear plants. **C.** Pond downstream of the spring (facing west). **D.** Rifles that form the Krienke pond outlet.

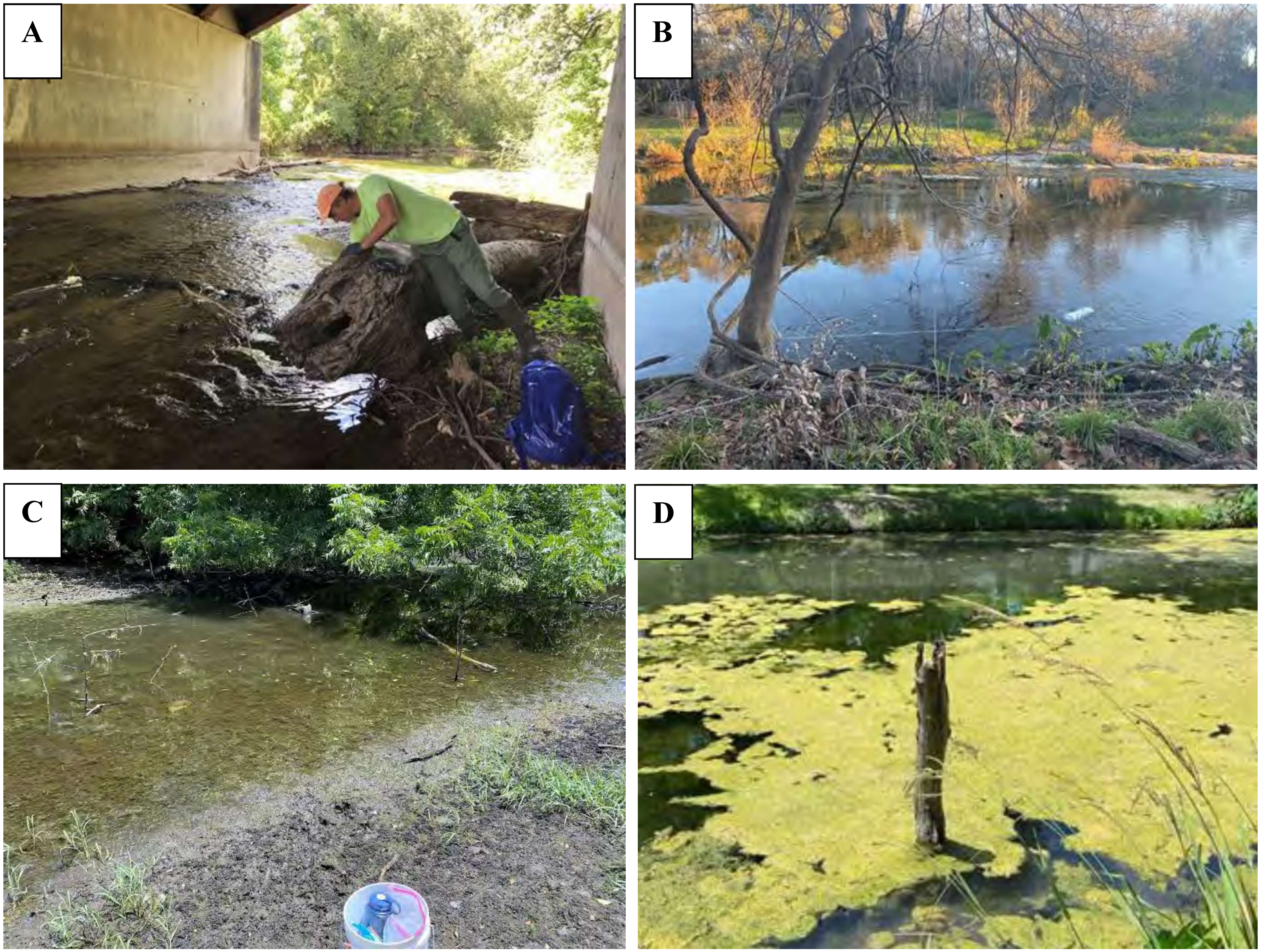

Figure 4. Photos of selected sampling locations. **A.** #3 Brushy Creek **B.** #4 Ledbetter Oaks (LO) protected in a white perforated canister. **C.** #5 Pond on Fault nearly dry in summer 2020. **D.** #8 packet was attached to the tree stump in the Krienke pond, the closest sampling point with access to the spring during the study.

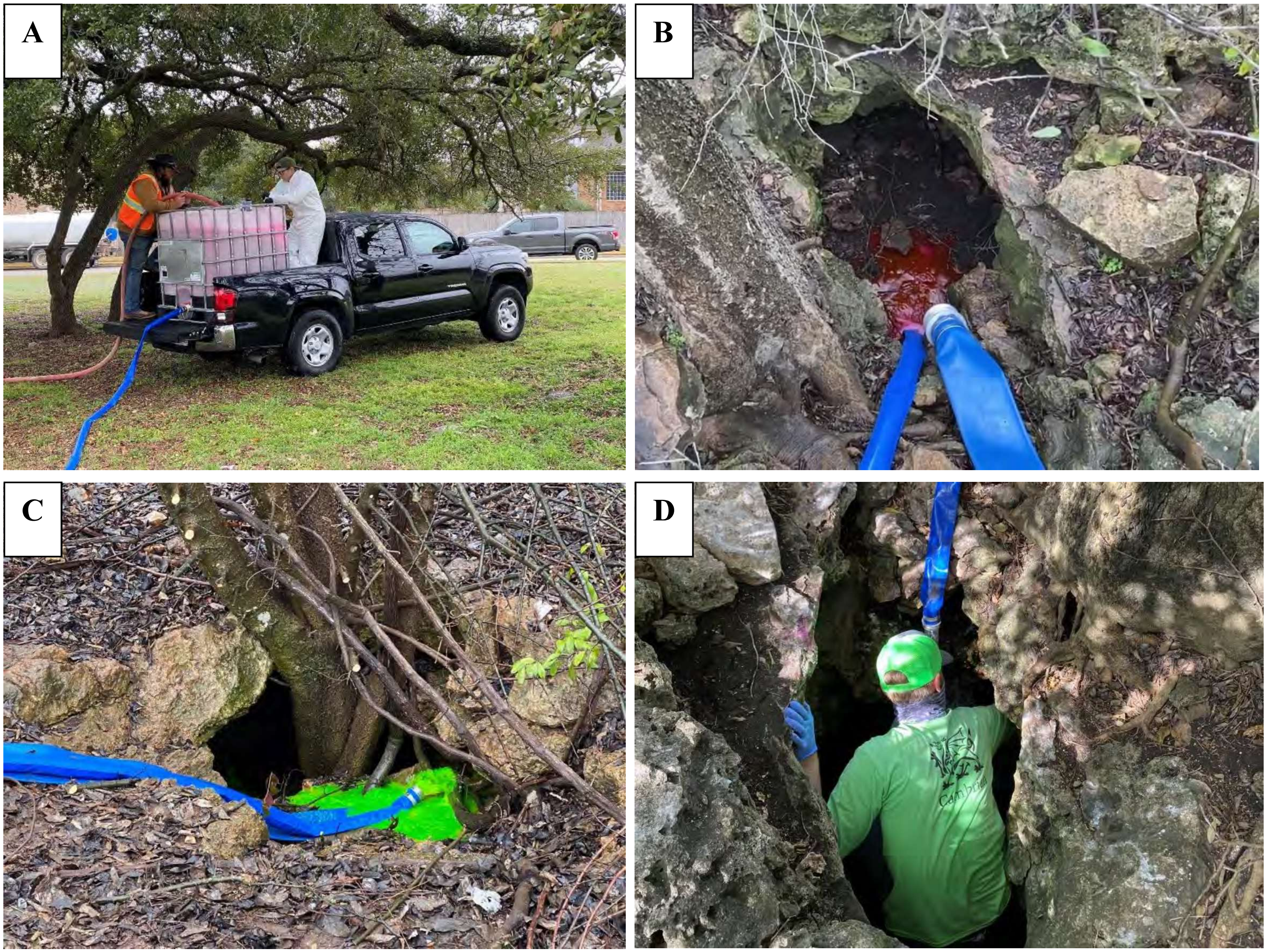

Figure 5. Injection site photos. **A.** Dye mixing operation. **B.** Walsh Ranch cave 2 injection 19 February 2020. **C.** Walsh Ranch cave 1 injection 20 February 2020. **D.** Re-injection of Walsh Ranch cave 2 on 28 July 2020.

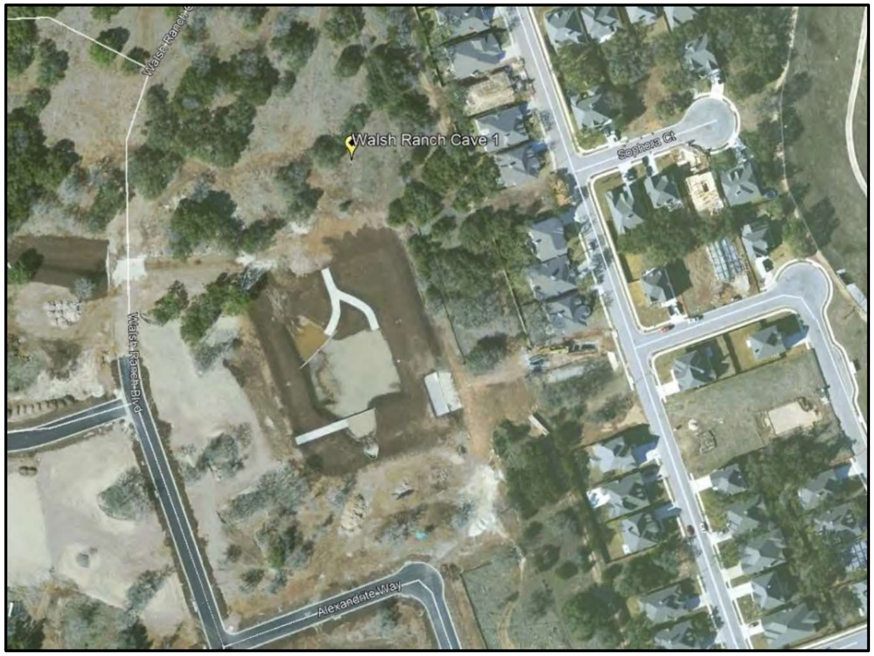

Figure 6. Injection site maps. The image on the left (April 2006) illustrates construction progress in the Walsh Ranch Subdivision (left side). The bottom of a water quality pond to the south of Walsh Ranch Cave 1 is approximately 12 feet below the cave entrance. The image on the right (November 2009) shows exposed karst void on the north end of the gabion wall. The bottom of the water quality pond is approximately 15 feet below the cave entrance. These caves were selected as injection points because they are the closest caves to Krienke Spring. Negative dye detections may indicate a blockage in the karst network such as from pond structures.

TABLE 3: DYE TRACE ANALYTICAL RESULTS

DYE TRACE 1					
Location	Date	Fluorescein (ppb)	Rhodamine WT (ppb)	Sample Type	Comments
1	1/31/2020	ND	ND	ACS	
2	1/31/2020	ND	ND	ACS	
3	1/31/2020	ND	ND	ACS	
4	1/31/2020	ND	ND	ACS	
1	2/7/2020	ND	ND	ACS	
2	2/7/2020	ND	ND	ACS	
3	2/7/2020	ND	ND	ACS	
4	2/7/2020	ND	ND	ACS	
5	2/7/2020	ND	ND	ACS	
1	2/28/2020	ND	ND	ACS	
2	2/28/2020	ND	N	ACS	
3	2/28/2020	ND	ND	ACS	
4	2/28/2020	ND	ND	ACS	
5	2/28/2020	ND	ND	ACS	
1	3/6/2020	No sample	No sample	No sample	ACS missing
2	3/6/2020	No sample	No sample	No sample	ACS missing
3	3/6/2020	ND	ND	ACS	
4	3/6/2020	ND	ND	ACS	
5	3/6/2020	ND	ND	ACS	
1	3/12/2020	ND	ND	ACS	
2	3/12/2020	ND	ND	ACS	
3	3/12/2020	ND	ND	ACS	
4	3/12/2020	No sample	No sample	No sample	ACS missing
5	3/12/2020	ND	ND	ACS	
6	3/12/2020	ND	ND	ACS	
1	3/26/2020	ND	ND	ACS	
2	3/26/2020	ND	ND	ACS	
3	3/26/2020	ND	ND	ACS	
4	3/26/2020	ND	ND	ACS	
5	3/26/2020	ND	ND	ACS	
6	3/26/2020	ND	ND	ACS	
7	3/26/2020	ND	ND	ACS	
8	3/26/2020	ND	ND	ACS	
9	3/26/2020	ND	ND	ACS	
10	3/26/2020	ND	ND	ACS	

DYE TRACE 2				
Loaction	Date	Rhodamine WT (ppb)	Sample Type	Comments
1	7/28/2020	ND	ACS	
2	7/28/2020	ND	ACS	
3	7/28/2020	ND	ACS	
4	7/28/2020	ND	ACS	
5	7/28/2020	ND	ACS	
7	7/28/2020	ND	ACS	
8	7/28/2020	ND	ACS	
9	7/28/2020	ND	ACS	
1	8/2/2020	ND	ACS	
2	8/2/2020	ND	ACS	
3	8/2/2020	ND	ACS	
4	8/2/2020	ND	ACS	
5	8/2/2020	ND	ACS	
7	8/2/2020	ND	ACS	
8	8/2/2020	ND	ACS	
9	8/2/2020	ND	ACS	
1	8/9/2020	ND	ACS	
2	8/9/2020	ND	ACS	
3	8/9/2020	ND	ACS	
4	8/9/2020	ND	ACS	
5	8/9/2020	ND	ACS	
7	8/9/2020	ND	ACS	
8	8/9/2020	ND	ACS	
9	8/9/2020	ND	ACS	
1	8/20/2020	ND	ACS	
2	8/20/2020	No sample	No sample	ACS missing
3	8/20/2020	ND	ACS	
4	8/20/2020	ND	ACS	
5	8/20/2020	ND	ACS	
7	8/20/2020	ND	ACS	
8	8/20/2020	ND	ACS	
9	8/20/2020	ND	ACS	
12	8/20/2020	ND	Water	
13	8/20/2020	ND	Water	
1	9/10/2020	ND	ACS	
7	9/10/2020	ND	ACS	
8	9/10/2020	ND	ACS	
9	9/10/2020	ND	ACS	
13	9/10/2020	ND	Water	

BACKGROUND SAMPLE

POST-INJECTION SAMPLE

ACS = ACTIVATED CHARCOAL SAMPLE
ND = NON-DETECT

APPENDIX C

U.S. Fish and Wildlife Service

Information for Planning and Consultation List

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IPaC **U.S. Fish & Wildlife Service**

IPaC resource list

IPaC is experiencing an issue with documents being slow to generate. We are working on the issue and hope to have it resolved soon. ×

This re abitat (collec jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Location

Williamson County, Texas

Local office

Austin Ecological Services Field Office

(512) 490-0057
(512) 490-0974

10711 Burnet Road, Suite 200
Austin, TX 78758-4460

http://www.fws.gov/southwest/es/AustinTexas/
http://www.fws.gov/southwest/es/EndangeredSpecies/lists/

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species[1] and their critical habitats are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service (USFWS) and the fisheries division of the National Oceanic and Atmospheric Administration (NOAA Fisheries[2]).

Species and critical habitats under the sole responsibility of NOAA Fisheries are **not** shown on this list. Please contact NOAA Fisheries for species under their jurisdiction.

---

1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information. IPaC only shows species that are regulated by USFWS (see FAQ).
2. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following species are potentially affected by activities in this location:

Birds

NAME	STATUS

Golden-cheeked Warbler (=wood) Dendroica chrysoparia — Endangered

Wherever found

No critical habitat has been designated for this species.
http://ecos.fws.gov/ecp/species/33

Piping Plover Charadrius melodus — Threatened

This species only needs to be considered if the following condition applies:

- Wind Energy Projects

There is **final** critical habitat for this species. The location of the critical habitat is not available.
http://ecos.fws.gov/ecp/species/6039

Red Knot Calidris canutus rufa — Threatened

Wherever found

This species only needs to be considered if the following condition applies:

- Wind Energy Projects

There is **proposed** critical habitat for this species. The location of the critical habitat is not available.
http://ecos.fws.gov/ecp/species/1864

Whooping Crane Grus americana — Endangered

There is **final** critical habitat for this species. The location of the critical habitat is not available.
http://ecos.fws.gov/ecp/species/758

Amphibians

NAME	STATUS
Georgetown Salamander Eurycea naufragia Wherever found There is **final** critical habitat for this species. Your location overlaps the critical habitat. http://ecos.fws.gov/ecp/species/7278	Threatened
Jollyville Plateau Salamander Eurycea tonkawae Wherever found There is **final** critical habitat for this species. Your location overlaps the critical habitat. http://ecos.fws.gov/ecp/species/3116	Threatened
Salado Salamander Eurycea chisholmensis Wherever found There is **final** critical habitat for this species. Your location overlaps the critical habitat. http://ecos.fws.gov/ecp/species/3411	Threatened

Clams

NAME	STATUS
False Spike Fusconaia mitchelli Wherever found There is **proposed** critical habitat for this species. Your location overlaps the critical habitat. http://ecos.fws.gov/ecp/species/3963	Proposed Endangered
Texas Fatmucket Lampsilis bracteata Wherever found There is **proposed** critical habitat for this species. The location of the critical habitat is not available. http://ecos.fws.gov/ecp/species/9041	Proposed Endangered
Texas Fawnsfoot Truncilla macrodon Wherever found There is **proposed** critical habitat for this species. The location of the critical habitat is not available. http://ecos.fws.gov/ecp/species/8965	Proposed Threatened
Texas Pimpleback Cyclonaias petrina Wherever found There is **proposed** critical habitat for this species. The location of the critical habitat is not available. http://ecos.fws.gov/ecp/species/8966	Proposed Endangered

Insects

NAME	STATUS
Coffin Cave Mold Beetle Batrisodes texanus Wherever found No critical habitat has been designated for this species. http://ecos.fws.gov/ecp/species/6234	Endangered
Monarch Butterfly Danaus plexippus Wherever found No critical habitat has been designated for this species. http://ecos.fws.gov/ecp/species/9743	Candidate
Tooth Cave Ground Beetle Rhadine persephone Wherever found No critical habitat has been designated for this species. http://ecos.fws.gov/ecp/species/5625	Endangered

Arachnids

NAME	STATUS

Bone Cave Harvestman *Texella reyesi* — Endangered
Wherever found
No critical habitat has been designated for this species.
http://ecos.fws.gov/ecp/species/5306

Tooth Cave Spider *Neoleptoneta myopica* — Endangered
Wherever found
No critical habitat has been designated for this species.
http://ecos.fws.gov/ecp/species/2360

Flowering Plants

NAME	STATUS
Bracted Twistflower Streptanthus bracteatus Wherever found No critical habitat has been designated for this species. http://ecos.fws.gov/ecp/species/2856	Candidate

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

This location overlaps the critical habitat for the following species:

NAME	TYPE
False Spike Fusconaia mitchelli http://ecos.fws.gov/ecp/species/3963#crithab	Proposed
Georgetown Salamander Eurycea naufragia http://ecos.fws.gov/ecp/species/7278#crithab	Final
Jollyville Plateau Salamander Eurycea tonkawae http://ecos.fws.gov/ecp/species/3116#crithab	Final
Salado Salamander Eurycea chisholmensis http://ecos.fws.gov/ecp/species/3411#crithab	Final

Migratory birds

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats should follow appropriate regulations and consider implementing appropriate conservation measures, as described below.

1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.

Additional information can be found using the following links:

- Birds of Conservation Concern http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php
- Measures for avoiding and minimizing impacts to birds http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php
- Nationwide conservation measures for birds http://www.fws.gov/migratorybirds/pdf/management/nationwidestandardconservationmeasures.pdf

MIGRATORY BIRD INFORMATION IS NOT AVAILABLE AT THIS TIME

Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Conservation Measures describes measures that can help avoid and minimize impacts to all birds at any location year round. Implementation of these measures is particularly important when birds are most likely to occur in the project area. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is a very helpful impact minimization measure. To see when birds are most likely to occur and be breeding in your project area, view the Probability of Presence Summary. Additional measures or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the migratory birds potentially occurring in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the AKN Phenology Tool.

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets .

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering, migrating or present year-round in my project area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may refer to the following resources: The Cornell Lab of Ornithology All About Birds Bird Guide, or (if you are unsuccessful in locating the bird of interest there), the Cornell Lab of Ornithology Neotropical Birds guide. If a bird on your migratory bird species list has a breeding season associated with it, if that bird does occur in your project area, there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?

Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Eagle Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to try to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially eagles and BCC species of rangewide concern. For more information on conservation measures you can implement to help avoid and minimize migratory bird impacts and requirements for eagles, please see the FAQs for these topics.

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Bird tracking data can also provide additional details about occurrence and habitat use throughout the year, including migration. Models relying on survey data may not include this information. For additional information on marine bird tracking data, see the Diving Bird Study and the nanotag studies or contact Caleb Spiegel or Pam Loring.

What if I have eagles on my list?

If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the Eagle Act should such impacts occur.

Proper Interpretation and Use of Your Migratory Bird Report

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated, and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please also look carefully at the survey effort (indicated by the black vertical bar) and for the existence of the "no data" indicator (a red horizontal bar). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list helps you know what to look for to confirm presence, and helps guide you in knowing when to implement conservation measures to avoid or minimize potential impacts from your project activities, should presence be confirmed. To learn more about conservation measures, visit the FAQ "Tell me about conservation measures I can implement to avoid or minimize impacts to migratory birds" at the bottom of your migratory bird trust resources page.

Facilities

Wildlife refuges and fish hatcheries

REFUGE AND FISH HATCHERY INFORMATION IS NOT AVAILABLE AT THIS TIME

Wetlands in the National Wetlands Inventory

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

WETLAND INFORMATION IS NOT AVAILABLE AT THIS TIME

This can happen when the National Wetlands Inventory (NWI) map service is unavailable, or for very large projects that intersect many wetland areas. Try again, or visit the NWI map to view wetlands at this location.

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

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APPENDIX D

SWCA

Geologic Assessment for the Corridor H – Sam Bass Road Improvement Project, Williamson County, Texas

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Geologic Assessment for the Corridor H – Sam Bass Road Improvement Project, Williamson County, Texas

APRIL 2019

PREPARED FOR

Prime Strategies, Inc.

and

HNTB Corporation

PREPARED BY

SWCA Environmental Consultants

Texas Board of Professional Geoscientists, Firm Registration No. 50159

GEOLOGIC ASSESSMENT FOR THE CORRIDOR H – SAM BASS ROAD IMPROVEMENT PROJECT, WILLIAMSON COUNTY, TEXAS

Prepared for

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On behalf of
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SWCA Project No. 30932.26

April 2019

CONTENTS

Appendices

Figures

Tables

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1 INTRODUCTION

Williamson County proposes lane widening and other improvements along 2.5 miles of Sam Bass Road in southern Williamson County (Project). The Project includes the construction of a three-lane roadway with a 10-foot shared use path and traffic signal improvements at East Whitestone Boulevard, Walsh Ranch Boulevard, and Great Oaks Drive (Figure 1; Project Area). SWCA Environmental Consultants (SWCA) investigated the limits of construction, which covers approximately 45.0 acres. The Project will increase local mobility and is referred to as Corridor H in the Williamson County mobility plan[1]. The Project is funded through the Williamson County Road Bond Program, and the total acreage of disturbance is to-be-determined based upon the final Project design.

2 METHODOLOGY

SWCA scientists studied information sources pertaining to all reputed caves from the Project Area to gather information related to documented caves in the vicinity prior to conducting field work. These information sources include:

- Internal, SWCA data;
- Unpublished data related to SWCA et al. (2008);
- ESRI® ArcGIS® Online Basemap Map Services;
- U.S. Geological Survey (2013) 7.5-minute topographic digital raster graphics;
- Geologic maps (Barnes 1974); and
- Mapped fault lines (Collins 1997, 2005).

SWCA licensed geoscientist Philip Pearce, P.G. and SWCA biologist Stephen Van Kampen-Lewis conducted a field survey for a Geologic Assessment on March 7, 2019. The pedestrian survey was completed by traversing parallel transects spaced approximately 30 to 50 feet apart as directed by the Texas Commission on Environmental Quality (TCEQ) (2004) in the *Instructions to Geologists for Geologic Assessments on the Edwards Aquifer Recharge/Transition Zones* (Rev. 10-01-04). The Project Area is centered on an existing paved road and landscaped parkway. The Project Area includes both disturbed and undisturbed ground.

[1] https://www.wilco.org/corridors

Figure 1. Project Area location map.

3 RESULTS

3.1 Project Area Overview

The Project Area lies within the Contributing and Recharge Zones of the Northern Segment of the Edwards Aquifer (TCEQ 2018). Topography within and surrounding the Project Area lacks significant elevation changes. Project Area topography ranges from approximately 865 feet above mean sea level (amsl) at the west side of Project Area, to 785 feet amsl near the eastern extent of the Project Area, with a gentle undulation of elevation from the western to eastern Project Area extent.

The Project Area includes existing roadway and open space adjacent to suburban residential development. The western 2.25-mile Project extent is an existing two-lane thoroughfare that transitions to four-lanes for the Project's eastern 0.25-mile extent. A soil conservation reservoir is adjacent to the western Project extent, a water treatment facility, school, and churches occur adjacent to the Project core, and residential developments are directly adjacent to the Project throughout its extent. Sam Bass Road connects several suburban residential developments of varying ages to several major arterials.

3.2 Geology

Quaternary-age alluvium and terrace deposits cover much of the Project Area. The Cretaceous-age Edwards Limestone (Ked) and Comanche Peak Formation (Kc) underly alluvial and terrace deposits (Figure 2). Project Area geology has been mapped most recently at a useful scale by Collins (1997, 2005) and SWCA finds his interpretation of the geology to be generally accurate. The Stratigraphic Column is included as Attachment B within Appendix A.

The Project Area occurs along the Balcones Fault Zone (BFZ) within the Edwards Aquifer Contributing and Recharge Zones (TCEQ 2018). Structural down-warping occurred with the Gulf of Mexico's ancestral formation during the middle Tertiary. The earth's crust was stretched in response and the BFZ formed along a zone of weakness, which currently marks the boundary between the Edwards Plateau and the Gulf Coastal Plain in central Texas. The BFZ is characterized by a series of northeast-trending, predominantly normal, nearly vertical, en echelon faults.

Recharge into the Edwards Aquifer primarily occurs in areas where the Edwards Group and Georgetown Formation are exposed at the surface. Most recharge is from direct infiltration via precipitation and streamflow loss. Recharge occurs predominantly along secondary porosity features such as faults, fractures, and karst features (caves, solution cavities, sinkholes, etc.). Karst features are commonly formed along joints, fractures, and bedding plane surfaces in the Edwards Group and Georgetown Formation. Water that recharges the Edwards Aquifer in the vicinity of the project site commonly discharges near the contact between the Edwards Limestone and underlying Comanche Peak Formation.

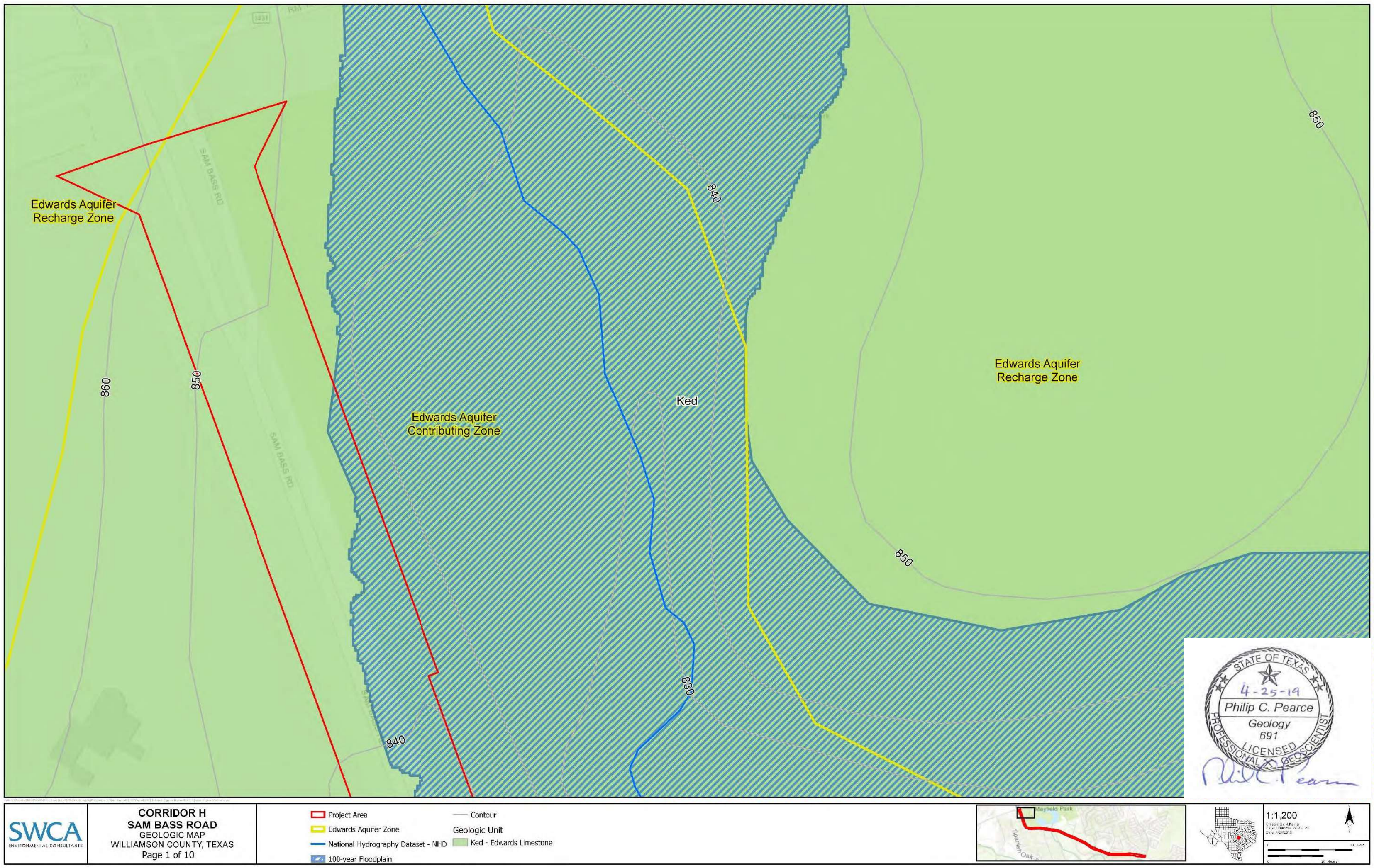

Figure 2a. Project Area geologic map (1 of 10)

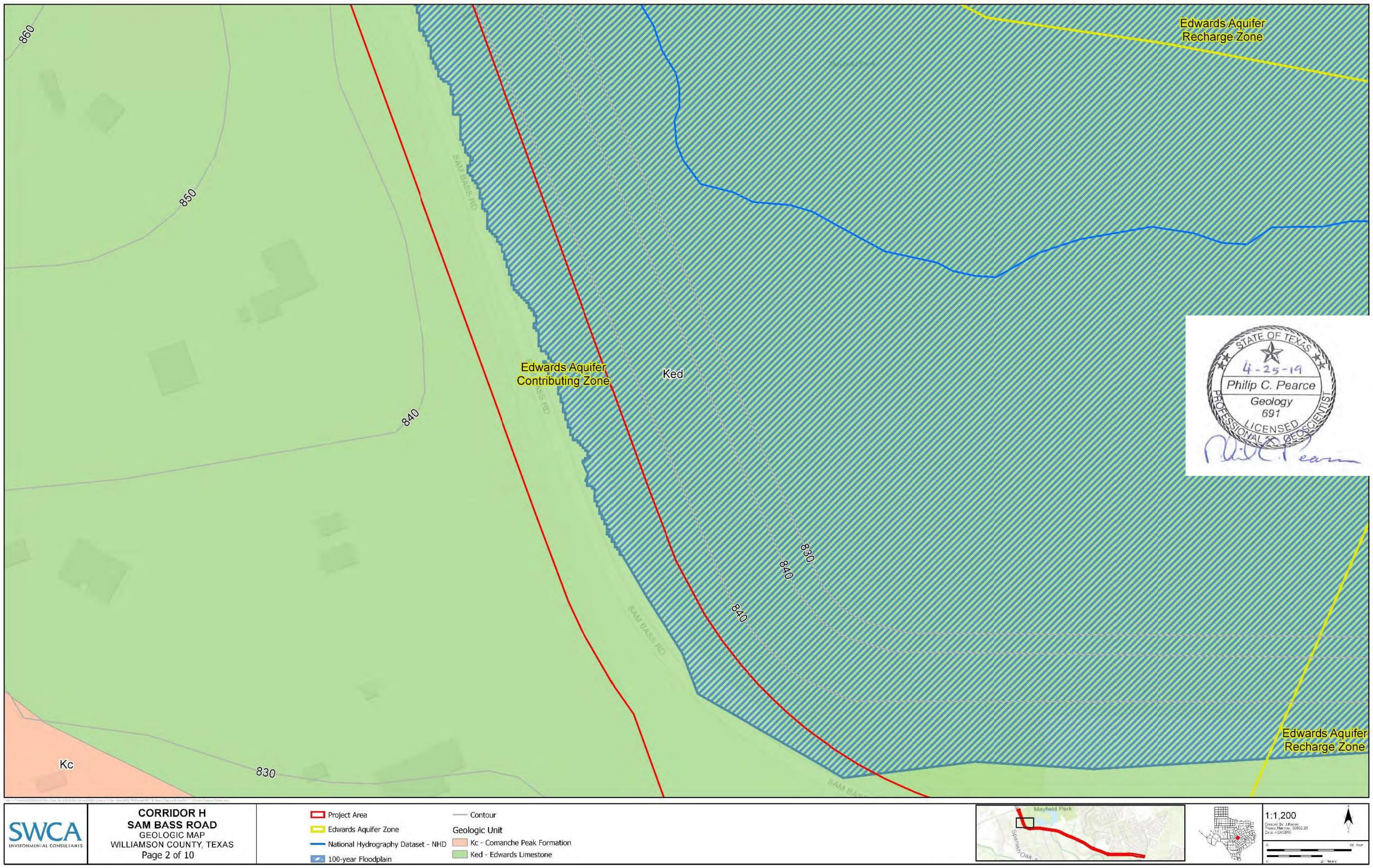

Figure 2b. Project Area geologic map (2 of 10)

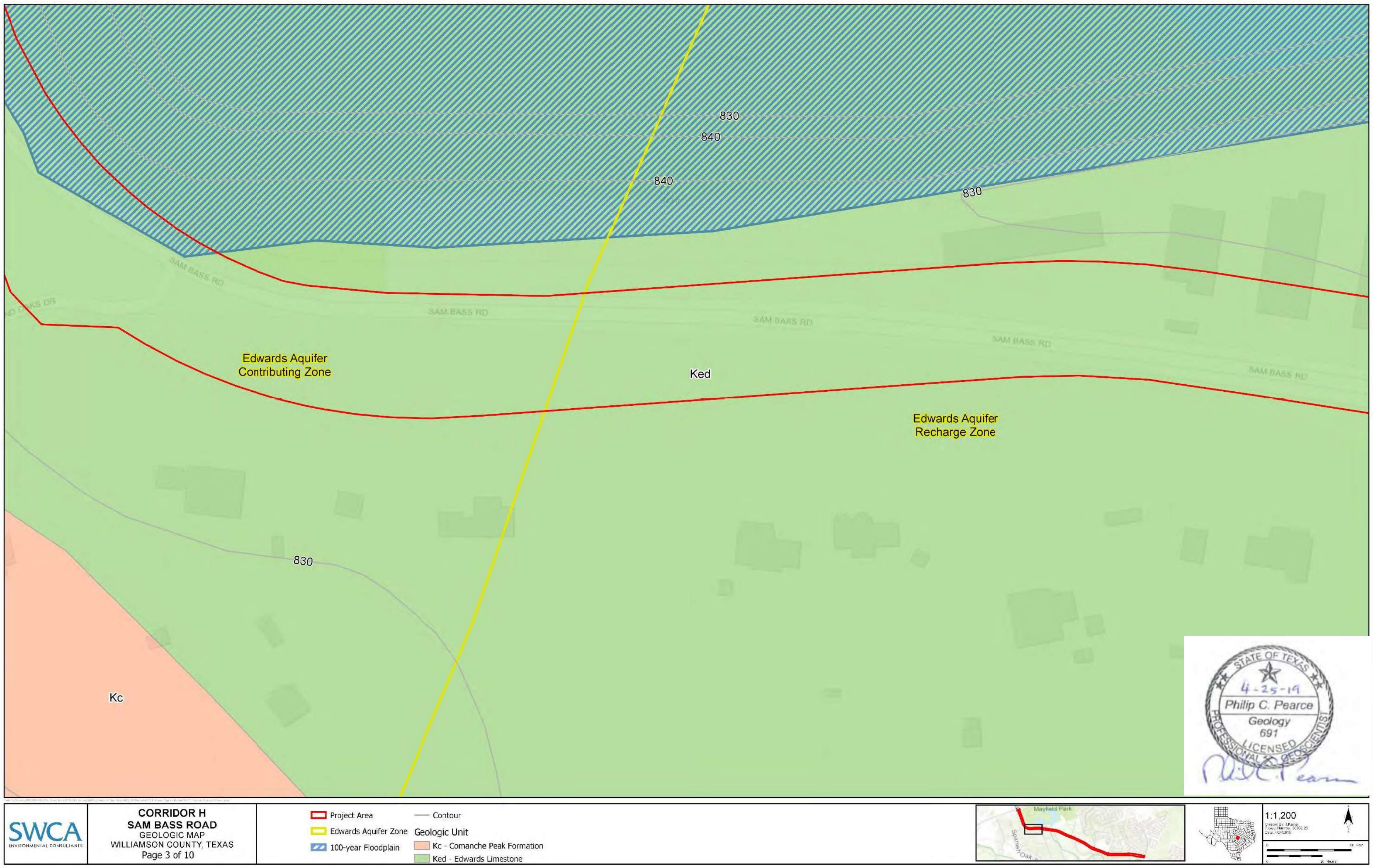

Figure 2c. Project Area geologic map (3 of 10)

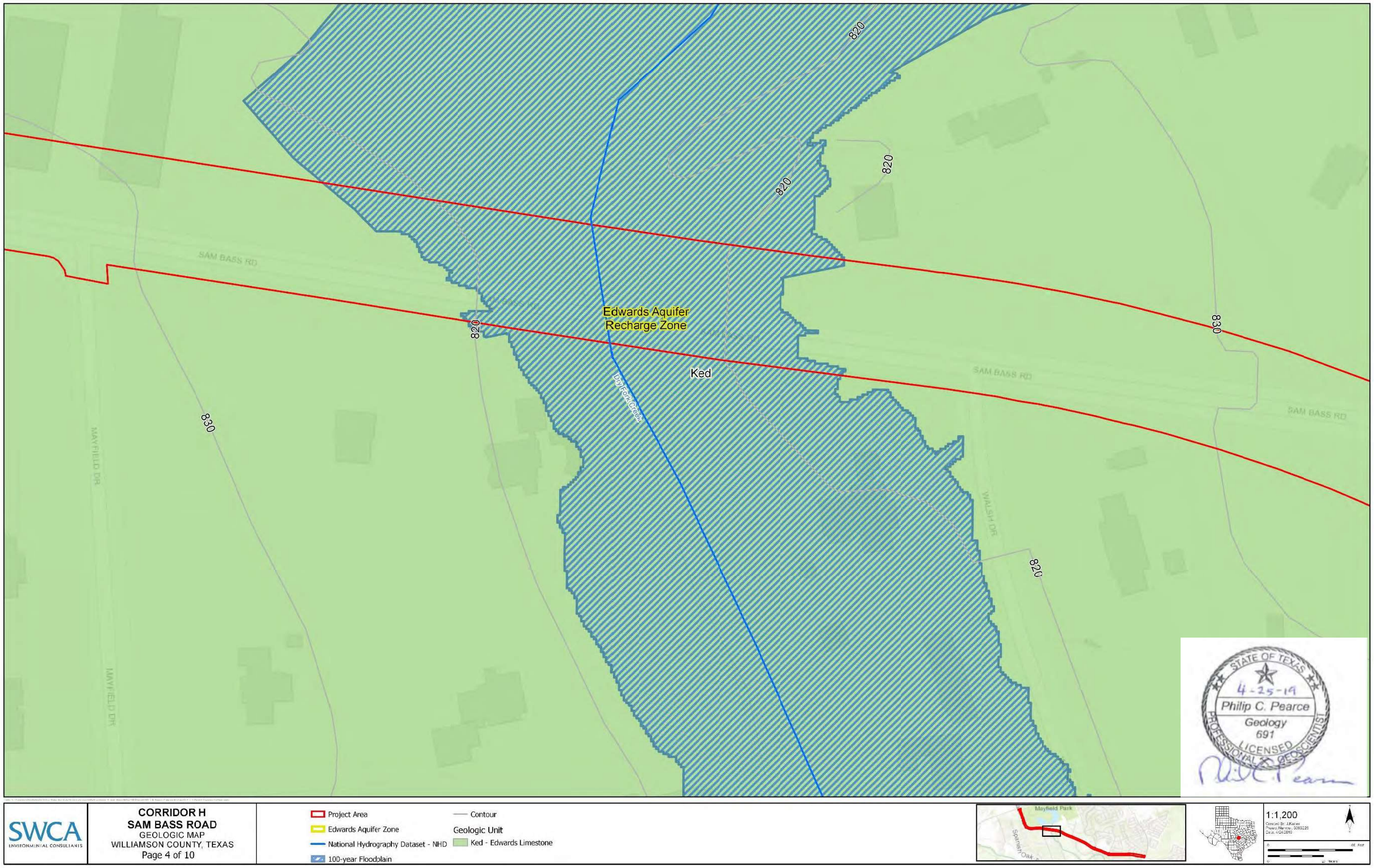

Figure 2d. Project Area geologic map (4 of 10)

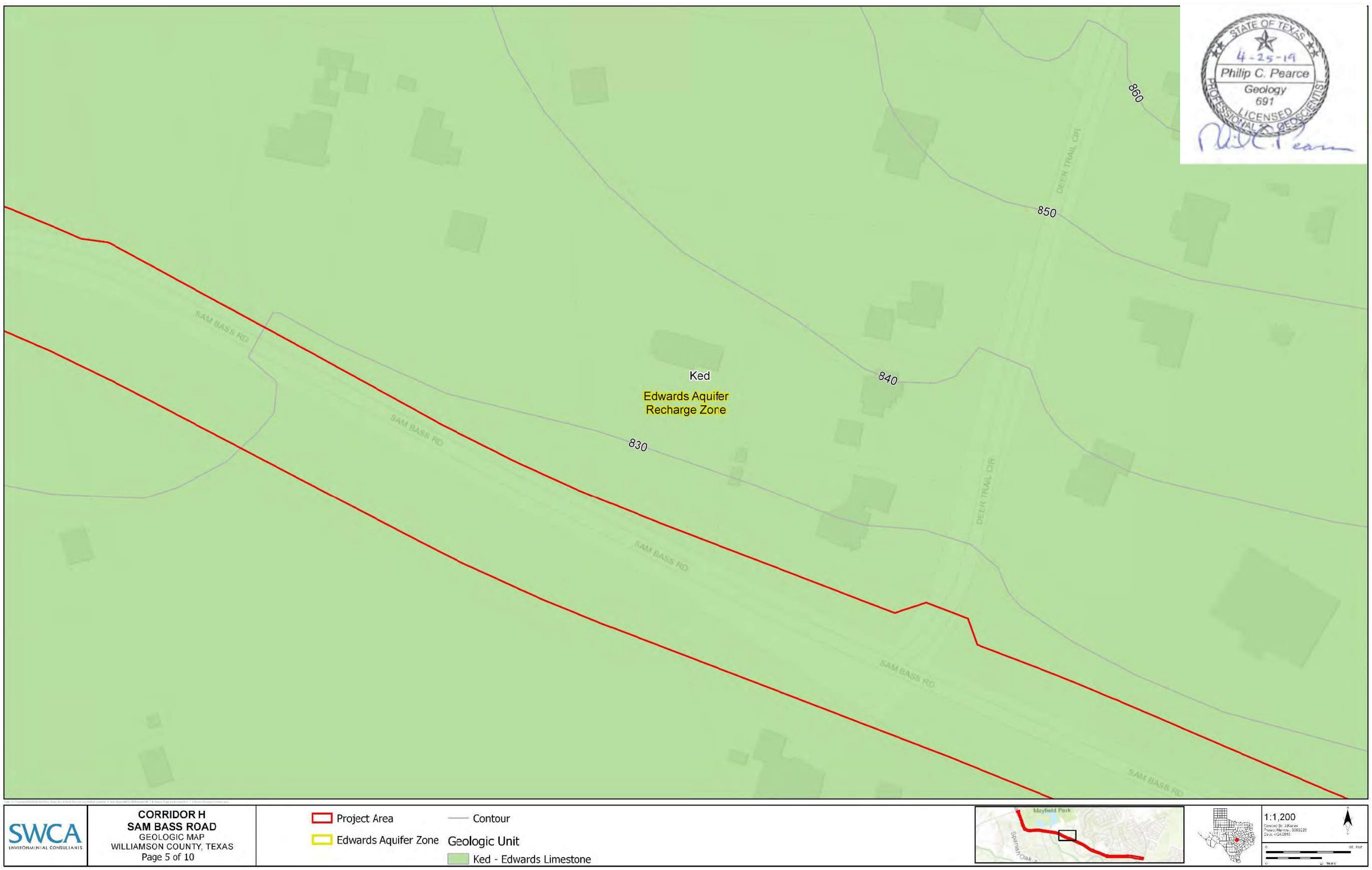

Figure 2e. Project Area geologic map (5 of 10)

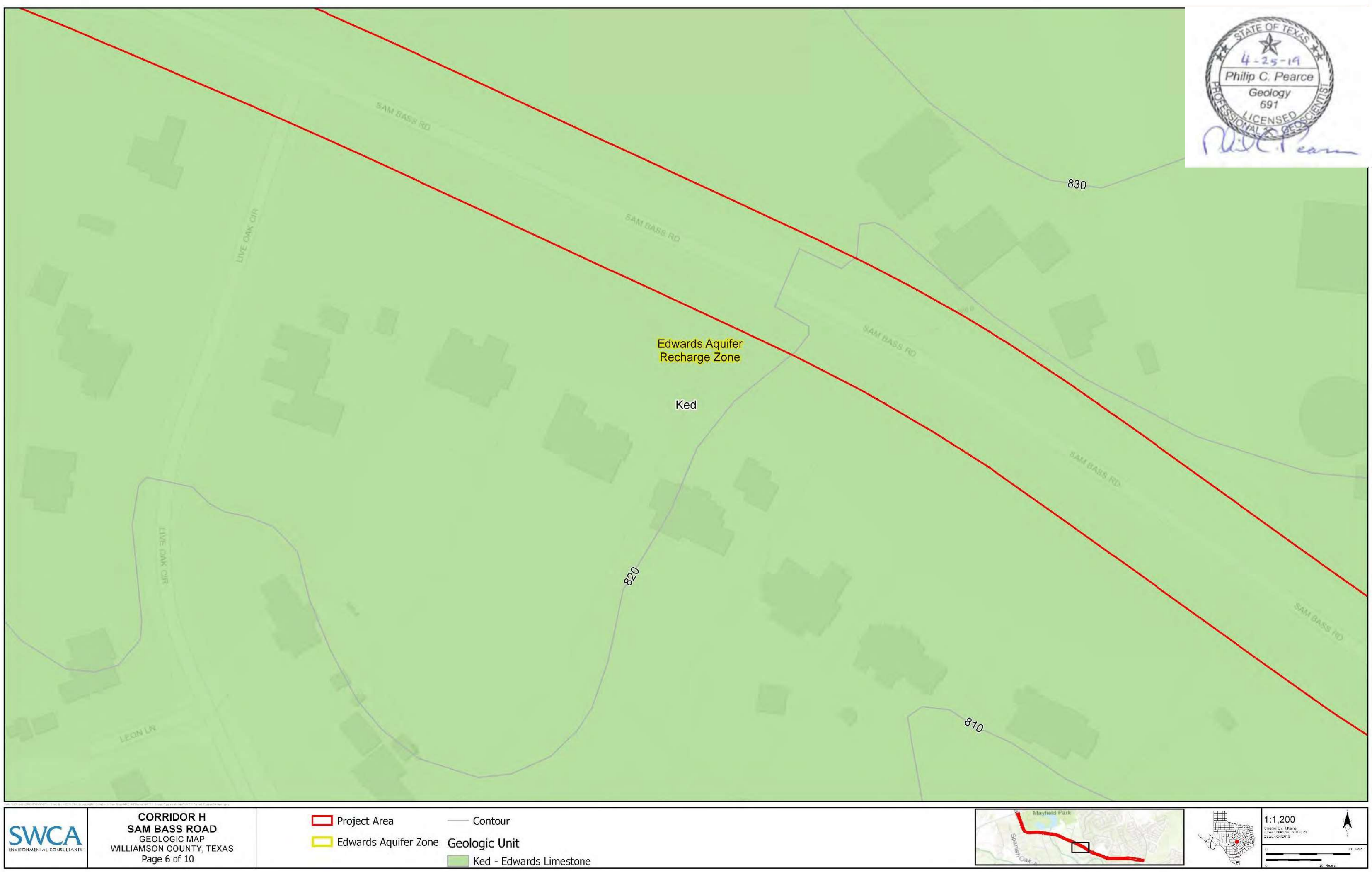

Figure 2f. Project Area geologic map (6 of 10)

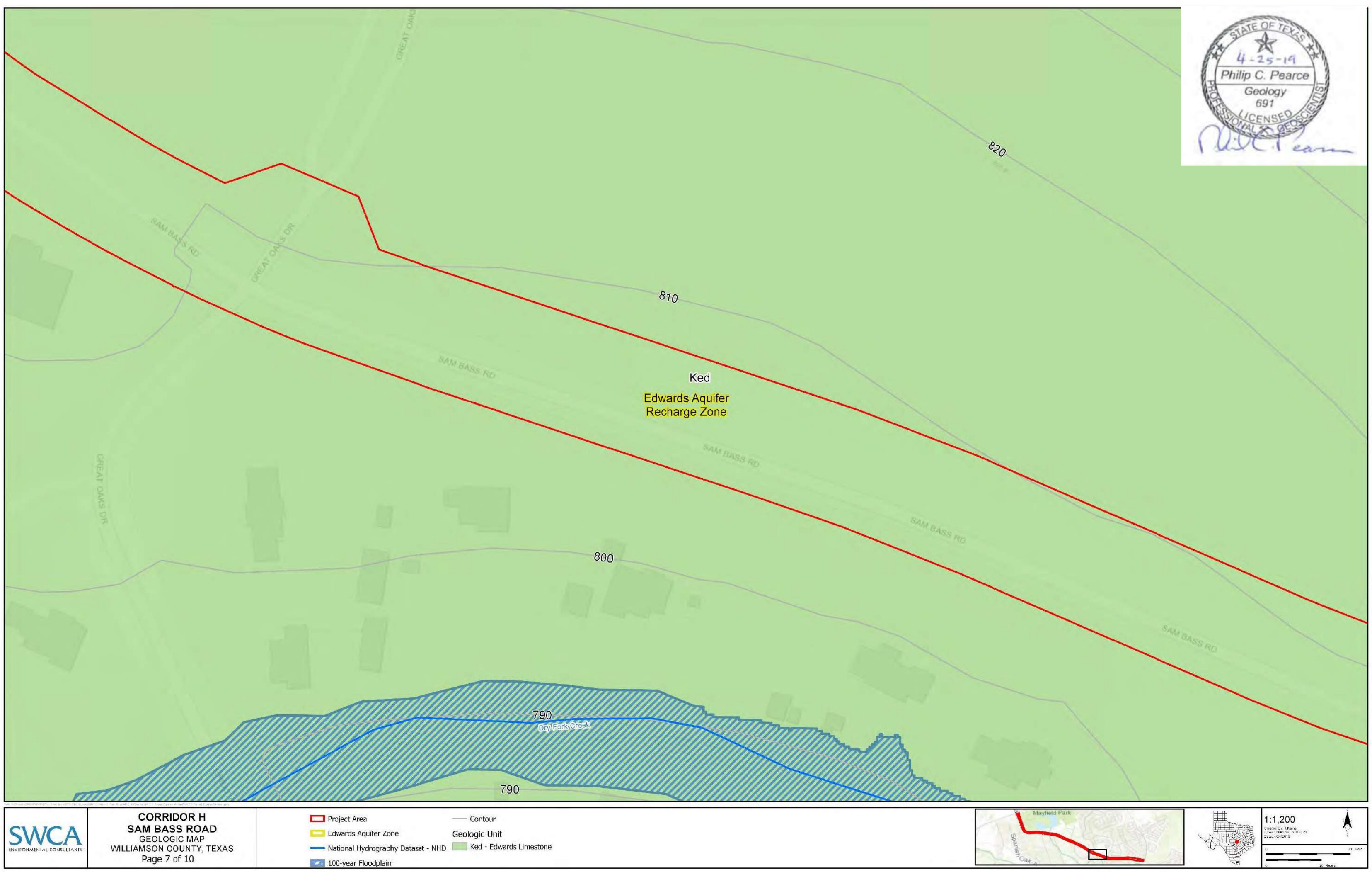

Figure 2g. Project Area geologic map (7 of 10)

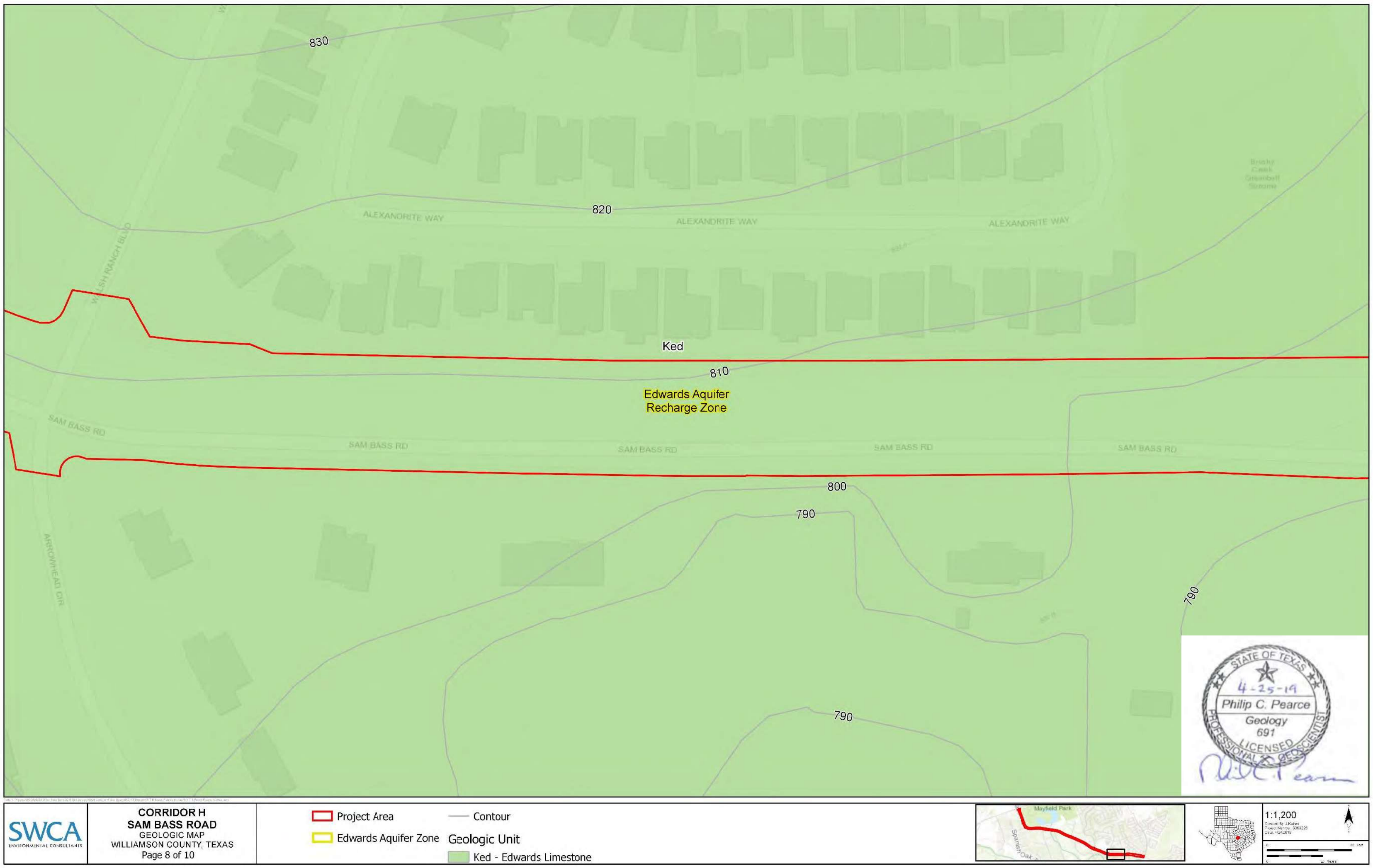

Figure 2h. Project Area geologic map (8 of 10)

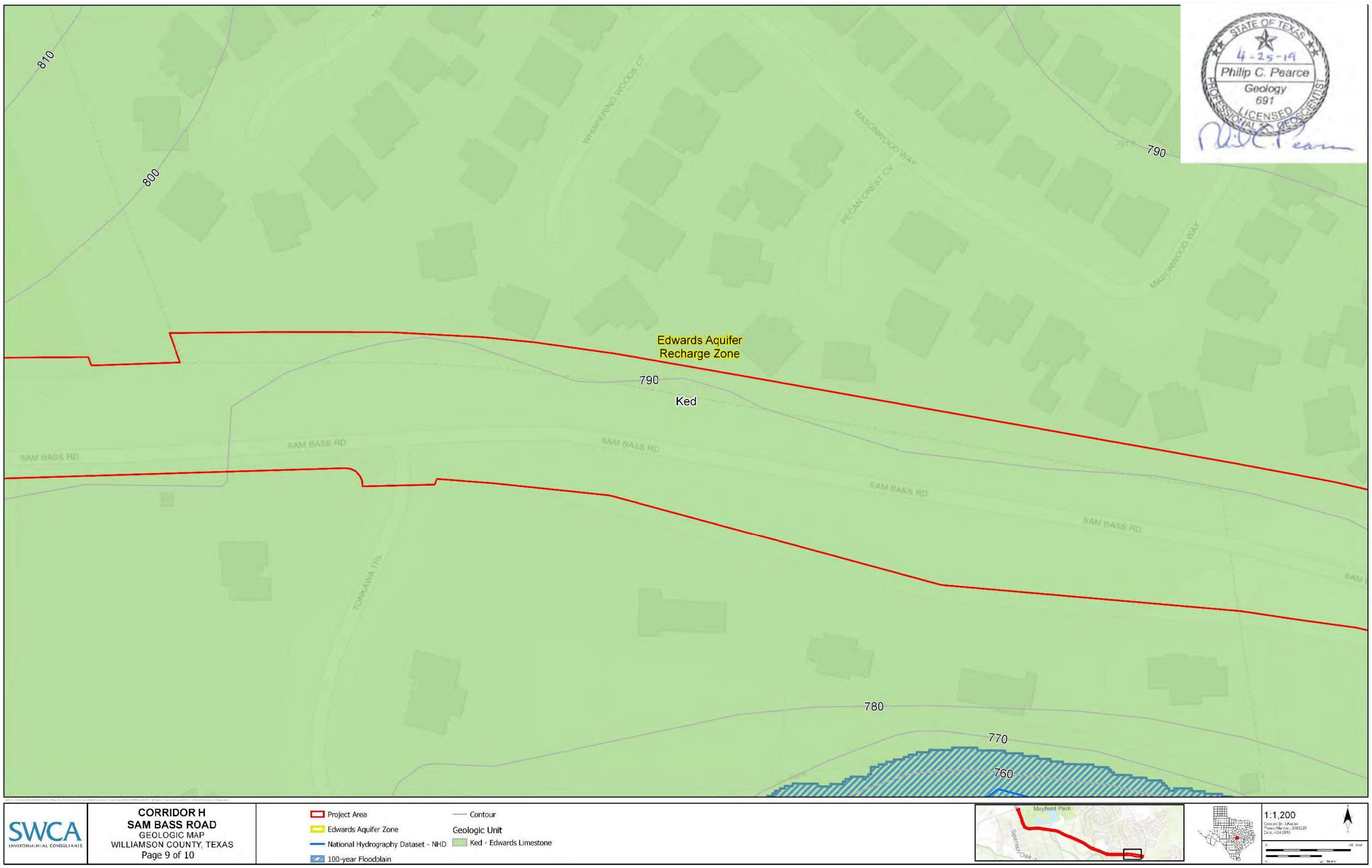

Figure 2i. Project Area geologic map (9 of 10)

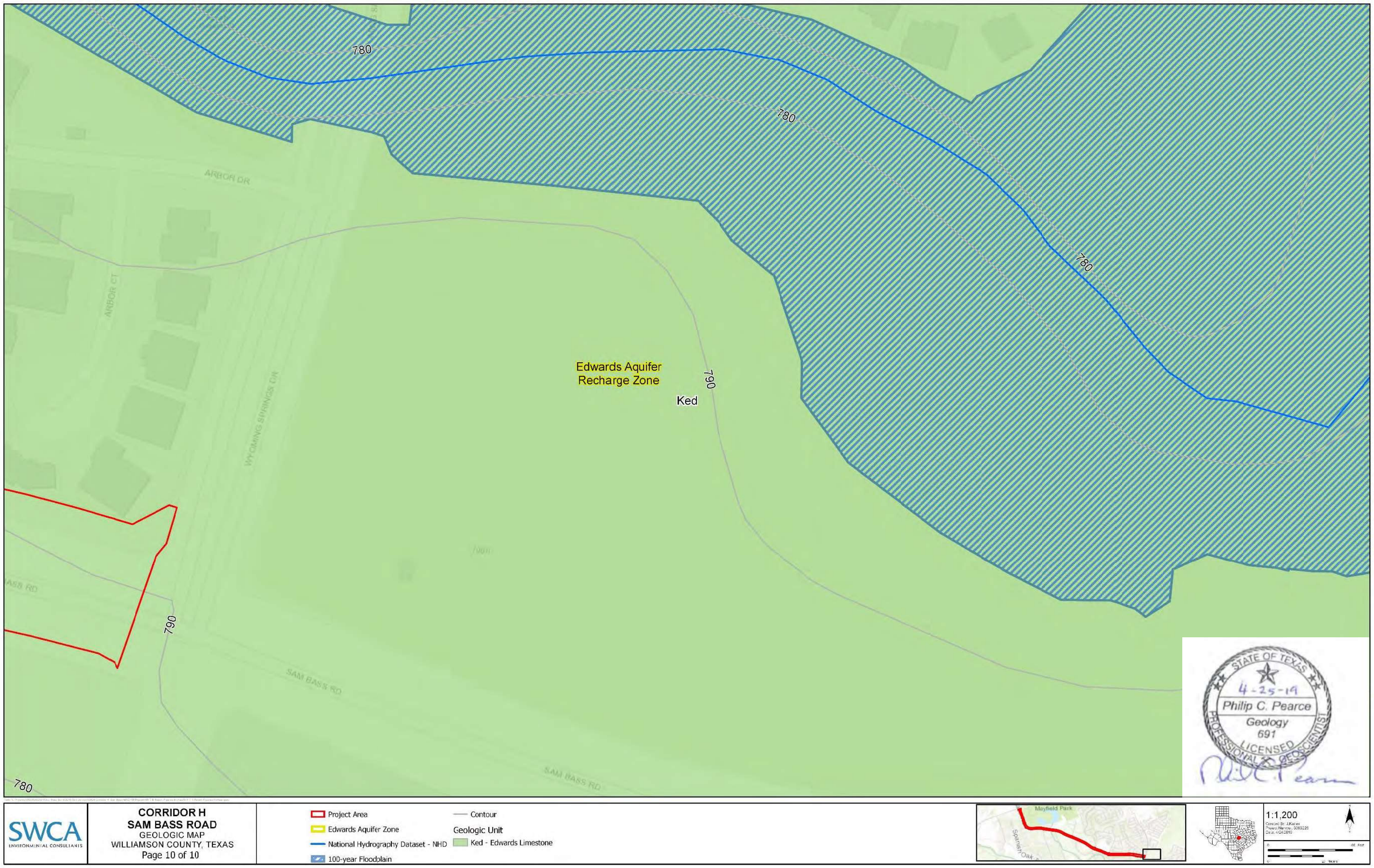

Figure 2j. Project Area geologic map (10 of 10)

3.3 Soils

The Natural Resources Conservation Service (2018) identifies six soil units within the Project Area (Figure 3). Table 1 provides additional detail for these soil types.

Table 1. Project Area Soils Detail

Soil Name	Hydric	Hydrologic Soil Group*	Drainage Class	Frequency of Flooding/ Ponding	Depth to Water Table (inches)
CfA: Crawford clay, 0 to 1 percent slopes	No	D	Well drained	None	80+
DnB: Denton silty clay, 1 to 3 percent slopes					
EaD: Eckrant cobbly clay, 1 to 8 percent slopes					
EeB: Eckrant extremely stony clay, 0 to 3 percent slopes					
GeB: Georgetown clay loam, 0 to 2 percent slopes					
GsB: Georgetown stony clay loam, 1 to 3 percent slopes					

Data Source: Natural Resources Conservation Service 2018.

* Group D – Soils had very slow infiltration rates when thoroughly wetted and exhibit the highest potential for runoff.

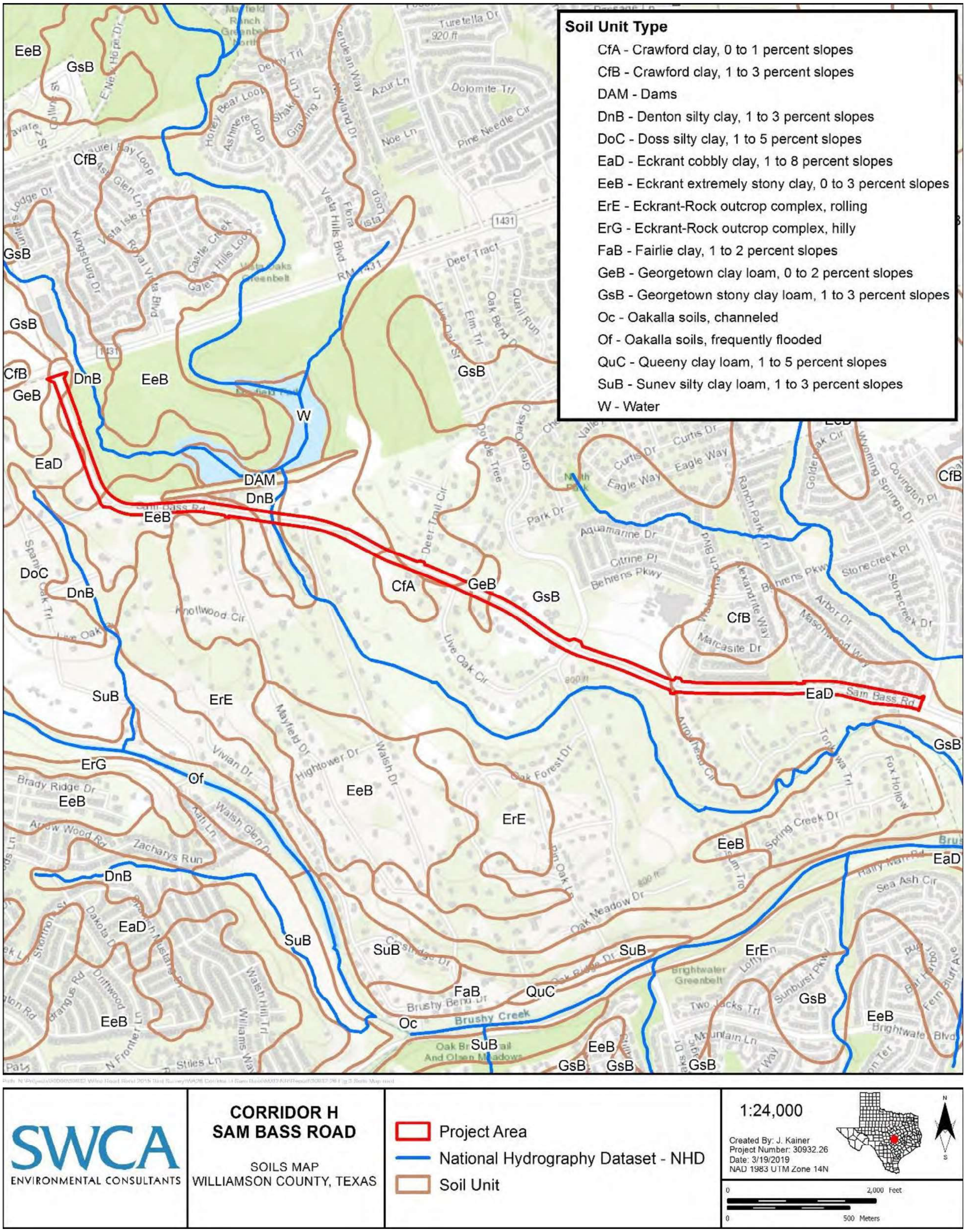

Figure 3. Project Area soils map (Natural Resources Conservation Service 2018).

4 HYDROGEOLOGIC ASSESSMENT

The overall potential for fluid migration to the Edwards Aquifer for the Project Area appears relatively low compared to background infiltration rates, due to the presence of paved and landscaped surfaces and a lack of geologic features. The Comanche Peak Limestone outcrop occurs at the western Project extent, at an elevation roughly 20–40 feet lower than the higher portions of the Project Area. Five wells near the Project Area are drilled through the Edwards Aquifer and into the underlying Trinity Aquifers (Figure 4). Table 1 shows water well number, depth to water and distance from the Project (TCEQ 2018). Wells 5827702 and 5827715 were cased very shallow and had very shallow water depths.

Several ponds occur near the central Project extent and aerial imagery indicates high water clarity with no observable water level change over time, even during the extreme drought of 2011 and 2012. There is strong possibility these ponds derive at least some flow from a groundwater source. SWCA specialists examined Dry Fork Creek crossings south of the Project Area and noticed a significant streamflow increase, which may indicate Dry Fork Creek is a gaining stream. SWCA specialists also observed active springs within Tonkawa Springs Park, approximately 870-feet south of the Project Area. SWCA also observed flowing water along a bar ditch of Arrowhead Circle. The source of the flowing water in the bar ditch appeared to come from ponds located upslope of the street. These ancillary observations suggest groundwater within the Edwards aquifer perched on the Comanche Peak is shallow and discharges at the ground surface in many locations in the site vicinity.

Table 2. Nearby water wells showing depth to water (TCEQ 2018).

Water Well	Depth To Water	Year Measured	Distance From Project (feet)
5827712	90	1976	50
5827706	50.4	1977	706
5827702	16.1	1972	2,053
5827715	16.4	1981	2,471
5827705	63	1976	2,800

SWCA identified no manmade or geologic features (including faults) within the Project Area. TCEQ (2018) indicates the Project Area intersects both the Edwards Aquifer Contributing and Recharge Zones.

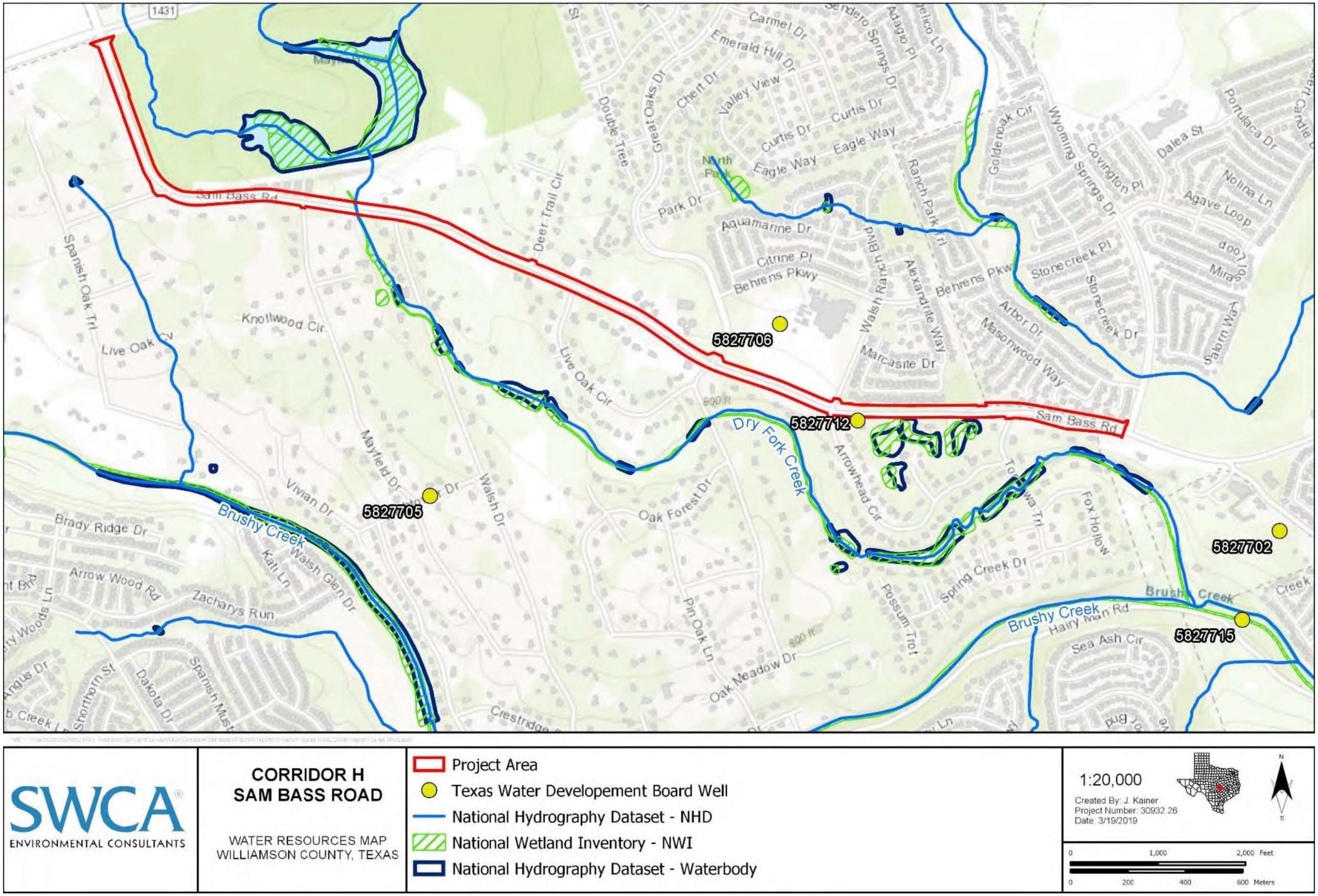

Figure 4. Project Area with well locations and surface waters.

5 REFERENCES

Barnes, V.E. 1974. Geologic Atlas of Texas, Austin Sheet. University of Texas at Austin, Bureau of Economic Geology. Scale 1:250,000.

Collins, E.W. 1997. Geologic map of the Round Rock quadrangle, Texas: University of Texas at Austin, Bureau of Economic Geology, Open-File Map OFM0013D, scale 1:24,000.

Collins, E.W. 2005. Geologic Map of the West Half of the Taylor, Texas, 30 x 60 Minute Quadrangle: Central Texas Urban Corridor, Encompassing Round Rock, Georgetown, Salado, Briggs, Liberty Hill, and Leander. Miscellaneous Map: Bureau of Economic Geology, No. 43, p. 16.

Natural Resources Conservation Service (NRCS). 2018. United States Department of Agriculture. Soil Survey Geographic (SSURGO) Database. Available at: http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm. Accessed September 10, 2018.

SWCA Environmental Consultants (SWCA), Smith, Robertson, Elliott, Glen, Klein, & Bell, LLP, Prime Strategies, Inc., Texas Perspectives, Inc. 2008. Williamson County Regional Habitat Conservation Plan. Prepared for Williamson County Conservation Foundation and The Honorable Lisa Birkman.

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———. 2018. Edwards Aquifer Viewer v3.8. Available online at: https://www.tceq.texas.gov/gis/edwards-viewer.html. Accessed March 2019.

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U.S. Geological Survey. 2013. Round Rock, Texas 7.5-minute quadrangle topographic map.

APPENDIX A

Texas Commission on Environmental Quality (TCEQ) Forms

Geologic Assessment

Texas Commission on Environmental Quality

For Regulated Activities on The Edwards Aquifer Recharge/transition Zones and Relating to 30 TAC §213.5(b)(3), Effective June 1, 1999

To ensure that the application is administratively complete, confirm that all fields in the form are complete, verify that all requested information is provided, consistently reference the same site and contact person in all forms in the application, and ensure forms are signed by the appropriate party.

Note: Including all the information requested in the form and attachments contributes to more streamlined technical reviews.

Signature

To the best of my knowledge, the responses to this form accurately reflect all information requested concerning the proposed regulated activities and methods to protect the Edwards Aquifer. My signature certifies that I am qualified as a geologist as defined by 30 TAC Chapter 213.

Print Name of Geologist: Philip C. Pearce, P.G.

Telephone: 210-877-2847

Fax: 210-877-2848

Date: 4-29-19

Representing: SWCA Environmental Consultants; TBPG Firm Registration No. 50159 (Name of Company and TBPG or TBPE registration number)

Signature of Geologist:

STATE OF TEXAS
4-29-19
Philip C. Pearce
Geology
691
LICENSED
PROFESSIONAL GEOSCIENTIST

Regulated Entity Name: Sam Bass Road Improvement Project

Project Information

1. Date(s) Geologic Assessment was performed: March 8, 2019
2. Type of Project:

   ☒ WPAP
   ☐ SCS
   ☐ AST
   ☐ UST

3. Location of Project:

   ☒ Recharge Zone
   ☐ Transition Zone
   ☐ Contributing Zone within the Transition Zone

4. ☒ **Attachment A - Geologic Assessment Table**. Completed Geologic Assessment Table (Form TCEQ-0585-Table) is attached.

5. ☒ Soil cover on the project site is summarized in the table below and uses the SCS Hydrologic Soil Groups* (Urban Hydrology for Small Watersheds, Technical Release No. 55, Appendix A, Soil Conservation Service, 1986). If there is more than one soil type on the project site, show each soil type on the site Geologic Map or a separate soils map.

Table 1 - Soil Units, Infiltration Characteristics and Thickness

Soil Name	Group*	Thickness(feet)
CfA	D	2-3
DnB	D	2-5
EaD/EaB	D	0.5-1.5
GeB	D	2-3
GsB	D	2-3

** Soil Group Definitions (Abbreviated)*

A. Soils having a high infiltration rate when thoroughly wetted.

B. Soils having a moderate infiltration rate when thoroughly wetted.

C. Soils having a slow infiltration rate when thoroughly wetted.

D. Soils having a very slow infiltration rate when thoroughly wetted.

6. ☒ **Attachment B – Stratigraphic Column**. A stratigraphic column showing formations, members, and thicknesses is attached. The outcropping unit, if present, should be at the top of the stratigraphic column. Otherwise, the uppermost unit should be at the top of the stratigraphic column.

7. ☒ **Attachment C – Site Geology**. A narrative description of the site specific geology including any features identified in the Geologic Assessment Table, a discussion of the potential for fluid movement to the Edwards Aquifer, stratigraphy, structure(s), and karst characteristics is attached.

8. ☒ **Attachment D – Site Geologic Map(s)**. The Site Geologic Map must be the same scale as the applicant's Site Plan. The minimum scale is 1”: 400'

   Applicant's Site Plan Scale: 1" = 100'
   Site Geologic Map Scale: 1" = 100'
   Site Soils Map Scale (if more than 1 soil type): 1" = 2,000'

9. Method of collecting positional data:

   ☒ Global Positioning System (GPS) technology.
   ☐ Other method(s). Please describe method of data collection: _____

10. ☒ The project site and boundaries are clearly shown and labeled on the Site Geologic Map.

11. ☒ Surface geologic units are shown and labeled on the Site Geologic Map.

12. ☐ Geologic or manmade features were discovered on the project site during the field investigation. They are shown and labeled on the Site Geologic Map and are described in the attached Geologic Assessment Table.

☒ Geologic or manmade features were not discovered on the project site during the field investigation.

13. ☒ The Recharge Zone boundary is shown and labeled, if appropriate.

14. All known wells (test holes, water, oil, unplugged, capped and/or abandoned, etc.): If applicable, the information must agree with Item No. 20 of the WPAP Application Section.

☐ There are 0 (#) wells present on the project site and the locations are shown and labeled. (Check all of the following that apply.)
- ☐ The wells are not in use and have been properly abandoned.
- ☐ The wells are not in use and will be properly abandoned.
- ☐ The wells are in use and comply with 16 TAC Chapter 76.

☒ There are no wells or test holes of any kind known to exist on the project site.

Administrative Information

15. ☒ Submit one (1) original and one (1) copy of the application, plus additional copies as needed for each affected incorporated city, groundwater conservation district, and county in which the project will be located. The TCEQ will distribute the additional copies to these jurisdictions. The copies must be submitted to the appropriate regional office.

ATTACHMENT A

Geologic Assessment Table

GEOLOGIC ASSESSMENT TABLE

PROJECT NAME: Corridor H - Sam Bass Road Improvement Project

LOCATION			FEATURE CHARACTERISTICS													EVALUATION			PHYSICAL SETTING		
1A	1B*	1C*	2A	2B	3	4			5	5A	6	7	8A	8B	9	10		11		12
FEATURE ID	LATITUDE	LONGITUDE	FEATURE TYPE	POINTS	FORMATION	DIMENSIONS (FEET)			TREND (DEGREES)	DOM	DENSITY (NO/FT)	APERTURE (FEET)	INFILL	RELATIVE INFILTRATION RATE	TOTAL	SENSITIVITY		CATCHMENT AREA (ACRES)		TOPOGRAPHY
						X	Y	Z		10						<40	≥40	<1.6	≥1.6	
			No geologic or manmade features observed in the field or from desktop analysis.																	

* DATUM: NAD83

2A TYPE	TYPE	2B POINTS
C	Cave	30
SC	Solution cavity	20
SF	Solution-enlarged fracture(s)	20
F	Fault	20
O	Other natural bedrock features	5
MB	Manmade feature in bedrock	30
SW	Swallow hole	30
SH	Sinkhole	20
CD	Non-karst closed depression	5
Z	Zone, clustered or aligned features	30

8A INFILLING	
N	None, exposed bedrock
C	Coarse - cobbles, breakdown, sand, gravel
O	Loose or soft mud or soil, organics, leaves, sticks, dark colors
F	Fines, compacted clay-rich sediment, soil profile, gray or red colors
V	Vegetation. Give details in narrative description
FS	Flowstone, cements, cave deposits
X	Other materials

12 TOPOGRAPHY

Cliff, Hilltop, Hillside, Drainage, Floodplain, Streambed

I have read, I understood, and I have followed the Texas Commission on Environmental Quality's Instructions to Geologists. The information presented here complies with that document and is a true representation of the conditions observed in the field. My signature certifies that I am qualified as a geologist as defined by 30 TAC Chapter 213.

Date

Sheet 1 of 1

STATE OF TEXAS
4-29-19
Philip C. Pearce
Geology
691
LICENSED
PROFESSIONAL GEOSCIENTIST

ATTACHMENT B

Stratigraphic Column

Stratigraphic Column

Upper Cretaceous	Upper Confining Units	Navarro and Taylor Groups, undivided; 600 feet thick
		Austin Group; 325–420 feet thick
		Eagle Ford Group; 25–65 feet thick
		Buda Limestone; 40–50 feet thick
		Del Rio Clay; 40–70 feet thick
Lower Cretaceous	Edwards Aquifer	Georgetown Formation; 30–80 feet thick
		Edwards Limestone; Up to 200 feet thick
		Comanche Peak Formation; 80 feet thick
	Lower Confining Units	Walnut Formation; Up to 120 feet thick
		Upper member of Glen Rose Limestone; 500 feet thick

Note: The shaded areas represent the lithology that outcrops in the Project Area.

ATTACHMENT C

Narrative Description of Geology

Please refer to section 3.2 of this report for geologic narrative description.

ATTACHMENT D

Site Geologic Map and Soils Map

Please refer to section 3.3 of this report for geologic and soils maps.

ATTACHMENT E

Photographic Log

Photograph 1. Representative view of western Project Area extent, at the Dry Fork Creek crossing.

Photograph 2. Representative view of central Project extent, in front of Walsh Middle School.

Photograph 3. Representative view of ponds near central Project extent.

Photograph 4. Representative photograph of typical residential development, just south of Project Area.

ATTACHMENT G
HISTORIC PROPERTIES AND CULTURAL RESOURCES REPORTS AND/OR LETTERS

INTENSIVE ARCHEOLOGICAL SURVEY FOR WILLIAMSON COUNTY CORRIDOR H - SAM BASS ROAD FROM RANCH-TO-MARKET ROAD 1431 TO WYOMING SPRINGS DRIVE, WILLIAMSON COUNTY, TEXAS

Prepared by:
David Sandrock, MA, RPA (Principal Investigator)
Cox|McLain Environmental Consulting, Inc.
8410 Shoal Creek Boulevard, Suite 100
Austin, Texas 78757

For:
Williamson County
710 Main Street
Georgetown, Texas 78626

And:
K Friese & Associates, Inc.
1120 South Capital of Texas Highway
Austin, Texas 78746

Under
Texas Antiquities Permit 8793

Cox|McLain Environmental Consulting, Inc. Archeological Report 237
(CMEC-AR-237)

July 23, 2021

This report contains archeological site location information (not for public disclosure).

MANAGEMENT SUMMARY

Williamson County proposes improvements to Sam Bass Road between Ranch-to-Market (RM) 1431 and Wyoming Springs Drive in northwest Round Rock in south-central Williamson County. These improvements are located along Sam Bass Road, spanning approximately 2.38 miles or 3.83 kilometers. The project would consist of 27.27 acres of existing right-of-way, 1.72 acres of existing easements, 17.08 acres of proposed right-of-way, and 0.23 acres of temporary construction easements for a total of 46.30 acres. The project area, or area that would be disturbed or affected by the proposed project, is the entire 46.30-acre footprint. Depths of construction impacts will likely extend at least 1 meter (3.28 feet) below ground surface in some areas.

The project is owned and funded entirely by Williamson County, rendering it subject to the Antiquities Code of Texas. No federal nexus is currently known, so the project is not subject to Section 106 of the National Historic Preservation Act, as amended.

In March 2019, Cox|McLain Environmental Consulting, Inc. (CMEC) archeologists conducted a pedestrian survey and excavated a total of 18 shovel tests within the 46.30-acre proposed project area. None of these shovel tests contained cultural materials. Results of the survey indicate that disturbances are present within the project area, mostly caused by roadway, residential, and utility development. Additionally, soils within the project area are generally thin and stony, and the project area is located on variably-sloping terrain without access to any major drainages.

The site boundary for 41WM721, which is recorded as a prehistoric-age lithic procurement site, is mapped adjacent to the eastern terminus of the project area. CMEC archeologists examined the portion of the project area closest to the site's mapped location near the intersection of Sam Bass Road and Wyoming Springs Drive. No evidence of this site was observed and the area containing this site has been severely disturbed by nearby development. If any portion of the site once extended into the proposed project area, it has very likely been destroyed.

As the project is subject to the Antiquities Code of Texas, the project area was assessed only for direct impacts to archeological resources. No cultural material was encountered on the ground surface or in any of the excavated shovel test units, and no evidence of archeological features or sites was observed. No evidence was found of preserved deposits with a high degree of integrity, associations with distinctive architectural and material culture styles, rare materials and assemblages, the potential to yield data important to the study of preservation techniques and the past in general, or potential attractiveness to relic hunters (3 TAC 26.10).

Thus, CMEC recommends that no further work is required within the proposed project area, and construction should be allowed to continue as planned. If any unanticipated discoveries of archeological materials, deposits, or features are made during construction, work should halt immediately, and both Williamson County and the Archeology Division of the Texas Historical Commission should be notified.

No artifacts were collected during this survey, but field forms, photographs, and other project records will be curated at the Center for Archaeological Studies at Texas State University in San Marcos per 13 TAC 26.16 and 26.17.

WILLIAMSON COUNTY CORRIDOR H - SAM BASS ROAD FROM RANCH-TO-MARKET ROAD 1431 TO WYOMING SPRINGS DRIVE, WILLIAMSON COUNTY, TEXAS

TABLE OF CONTENTS

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Appendices

1.0 INTRODUCTION

Overview of the Project

The purpose of the investigation described in this document is to identify archeological resources within the footprint of the proposed Williamson County study of Corridor H – Sam Bass Road between Ranch-to-Market (RM) 1431 and Wyoming Springs Drive in northwest Round Rock in south-central Williamson County (**Figures 1, 2**, and **3a–d**). As a part of their Long-Range Transportation Plan, this corridor study will identify opportunities to enhance safety and mobility and use public input to develop a plan that is in line with community needs. One of the primary purposes of this project is to accommodate current and anticipated future traffic levels to provide reliable transportation as Williamson County continues to grow. These improvements are located along Sam Bass Road, spanning approximately 2.38 miles or 3.83 kilometers.

The proposed project would include widening the existing facility of Sam Bass Road to accommodate additional travel lanes and a 10-foot-wide shared-use path. The shared-use path is proposed north of Sam Bass Road from RM 1431 to east of Tonkawa Trail. Right-of-way would be acquired from either side of the roadway. Several cross-drainage culverts would need to be extended to accommodate any additional pavement width. The project would consist of 27.27 acres of existing right-of-way, 1.72 acres of existing easements, 17.08 acres of proposed right-of-way, and 0.23 acres of temporary construction easements for a total of 46.30 acres. The project area, or area that would be disturbed or affected by the proposed project, is the entire 46.30-acre footprint. Depths of construction impacts will likely extend at least 1 meter (3.28 feet) below ground surface in some areas.

Regulatory Context

The proposed project's footprint was defined in the approved scope of Texas Antiquities Permit 8793 as the 46.30-acre area along Sam Bass Road between RM 1431 and Wyoming Springs Drive in northwest Round Rock in south-central Williamson County (see **Figure 1**). The project is owned and funded entirely by Williamson County, rendering it subject to the Antiquities Code of Texas. No federal nexus is currently known, so the project is not subject to Section 106 of the National Historic Preservation Act, as amended (NHPA).

Methodological and Logistical Considerations

David Sandrock (Principal Investigator) of Cox|McLain Environmental Consulting, Inc. (CMEC) performed the fieldwork for this project in March 2019. Fieldwork consisted of archeological survey augmented with shovel testing across the entirety of the project area. The weather was generally clear and warm during the survey, and no major access or logistical constraints were encountered.

Structure of the Report

Following this introduction, Chapter Two presents environmental parameters and known cultural resources in the study area; Chapter Three discusses research goals, relevant methods, and the regulatory considerations underlying them; and Chapter Four presents field results and recommendations. References cited are listed in Chapter Five.

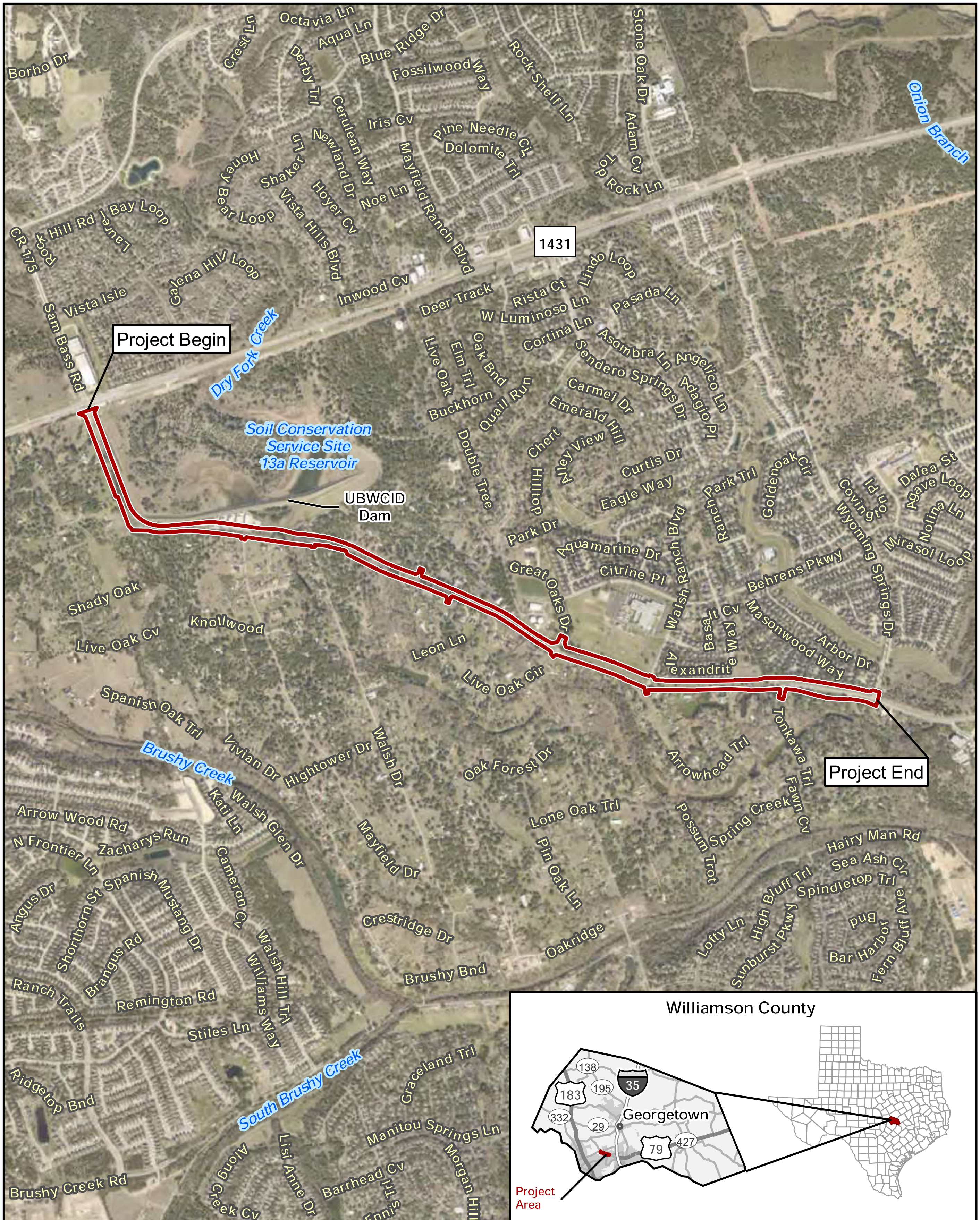

Figure 1.
Project Location (Aerial Base)

Williamson County Corridor H - Sam Bass Road

Project Location

COX | McLAIN Environmental Consulting

0 2,000 Feet
0 600 Meters

1 in = 2,000 feet
Scale: 1:24,000
Date: 4/13/2021

Aerial Source: Williamson County (2019)

G:\Projects\Williamson_County\H_Corridor\H_Corridor_all_Figure 1_Project Location_Aerial_20210413_TLS.mxd

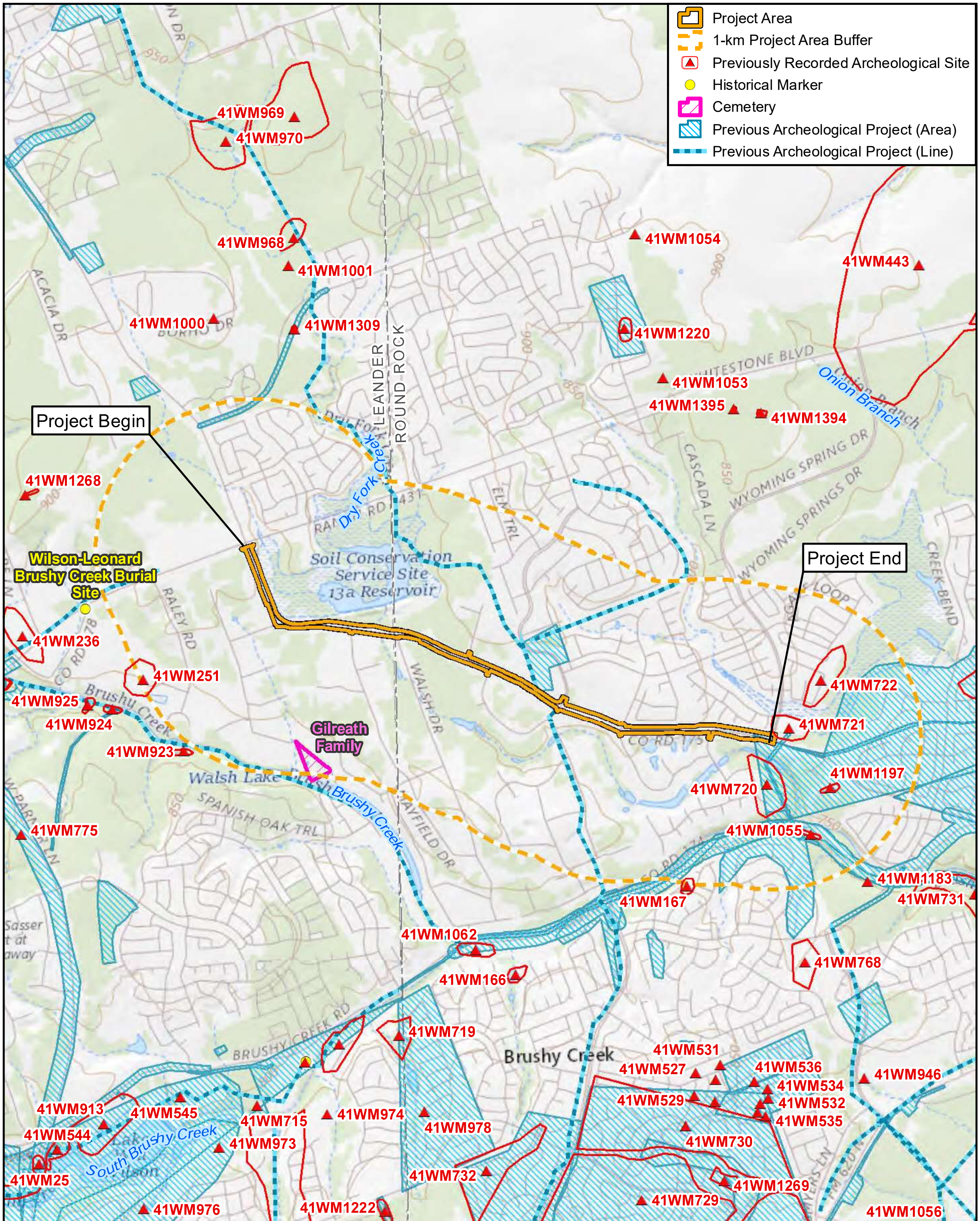

Figure 2.
Location of Archeological Project Area

Williamson County Corridor H – Sam Bass Road

Data Sources: THC (2021), TARL (2020), NHD (2020)
Topographic Source: USGS (2021)
USGS 7.5' Quadrangles: Leander, Round Rock

0 — 3,000 Feet
0 — 800 Meters

1 in = 3,000 feet
Scale: 1:36,000
Date: 7/23/2021

COX | McLAIN Environmental Consulting

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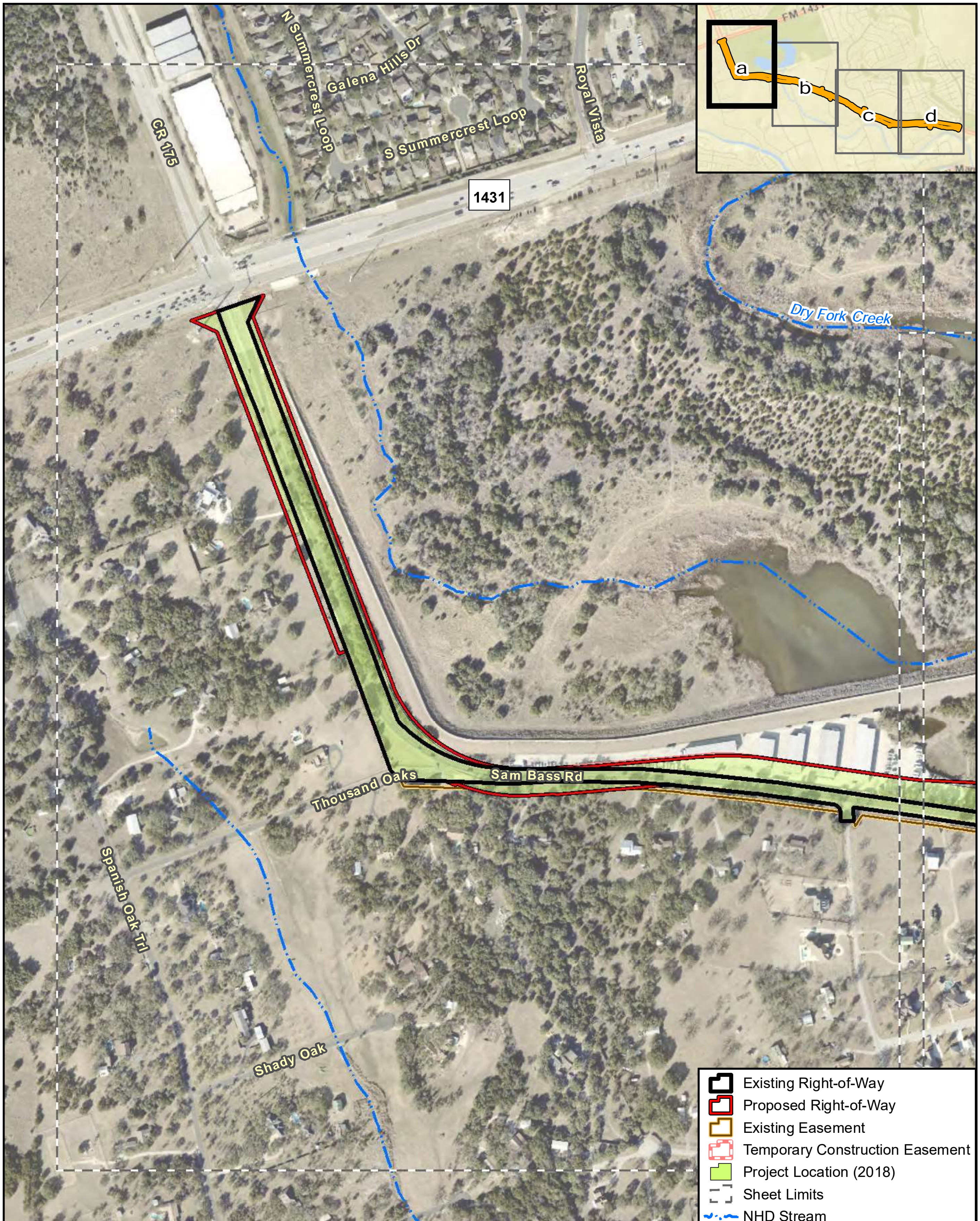

Figure 3a.
Project Area Detail (Aerial Base)

Williamson County Corridor H – Sam Bass Road

Data Sources: TARL (2021), THC (2021), NHD (2020)
Aerial Source: Williamson County (2020)

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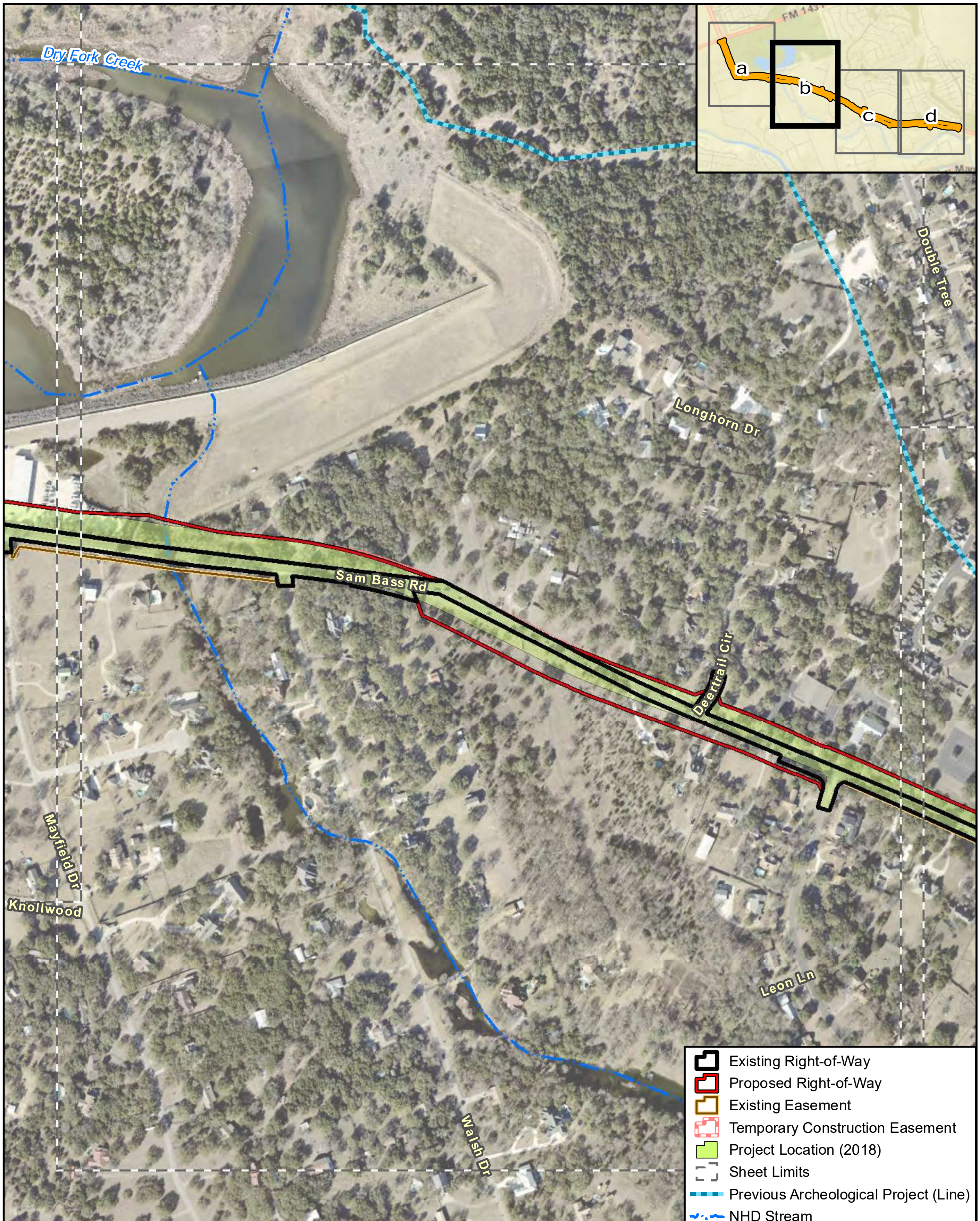

Figure 3b.
Project Area Detail (Aerial Base)

Williamson County Corridor H – Sam Bass Road

Data Sources: TARL (2021), THC (2021), NHD (2020)
Aerial Source: Williamson County (2020)

COX | McLAIN Environmental Consulting

0 500 Feet
0 150 Meters

1 in = 500 feet
Scale: 1:6,000
Date: 7/23/2021

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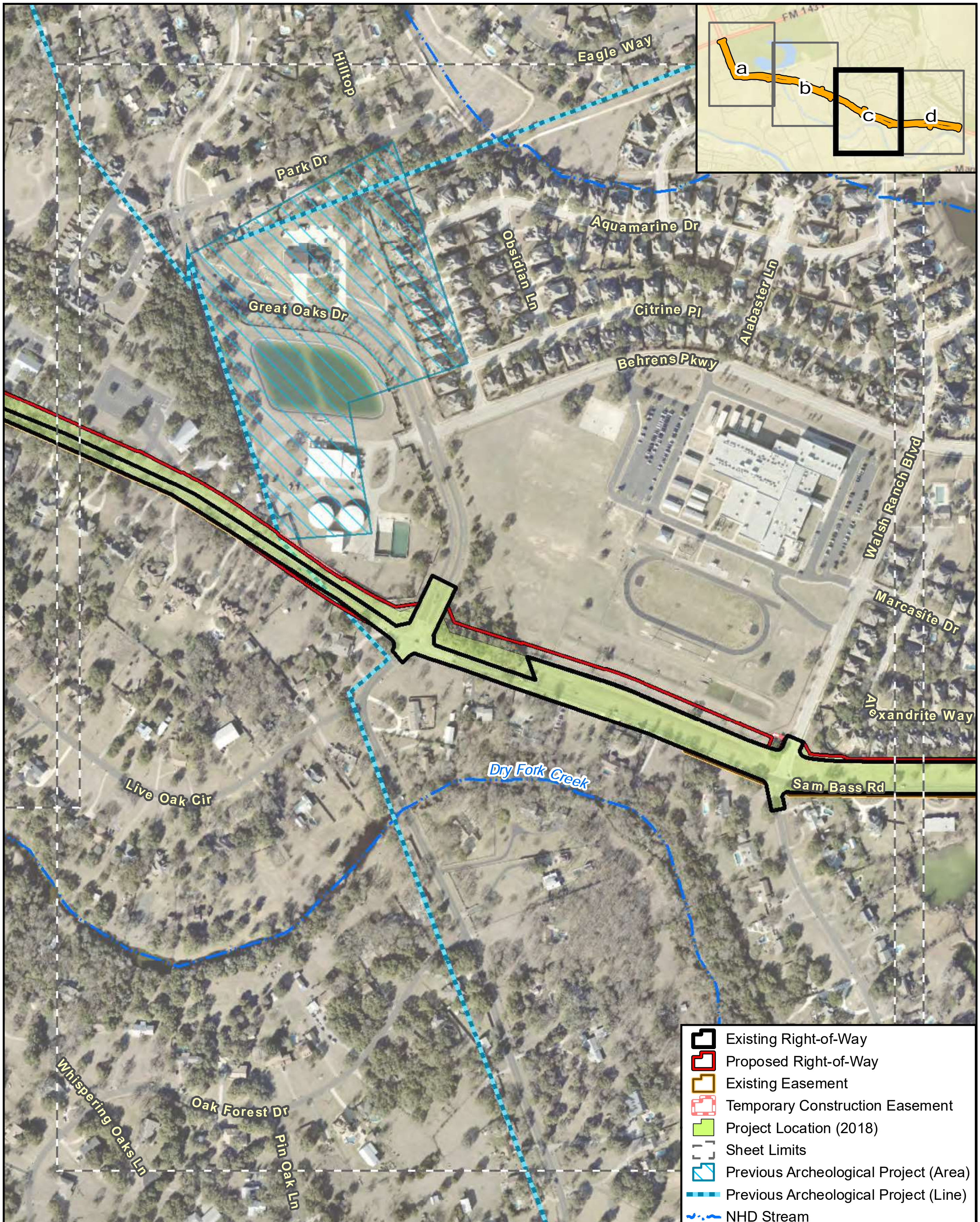

Figure 3c.
Project Area Detail (Aerial Base)

Williamson County Corridor H – Sam Bass Road

Data Sources: TARL (2021), THC (2021), NHD (2020)
Aerial Source: Williamson County (2020)

COX | McLAIN Environmental Consulting

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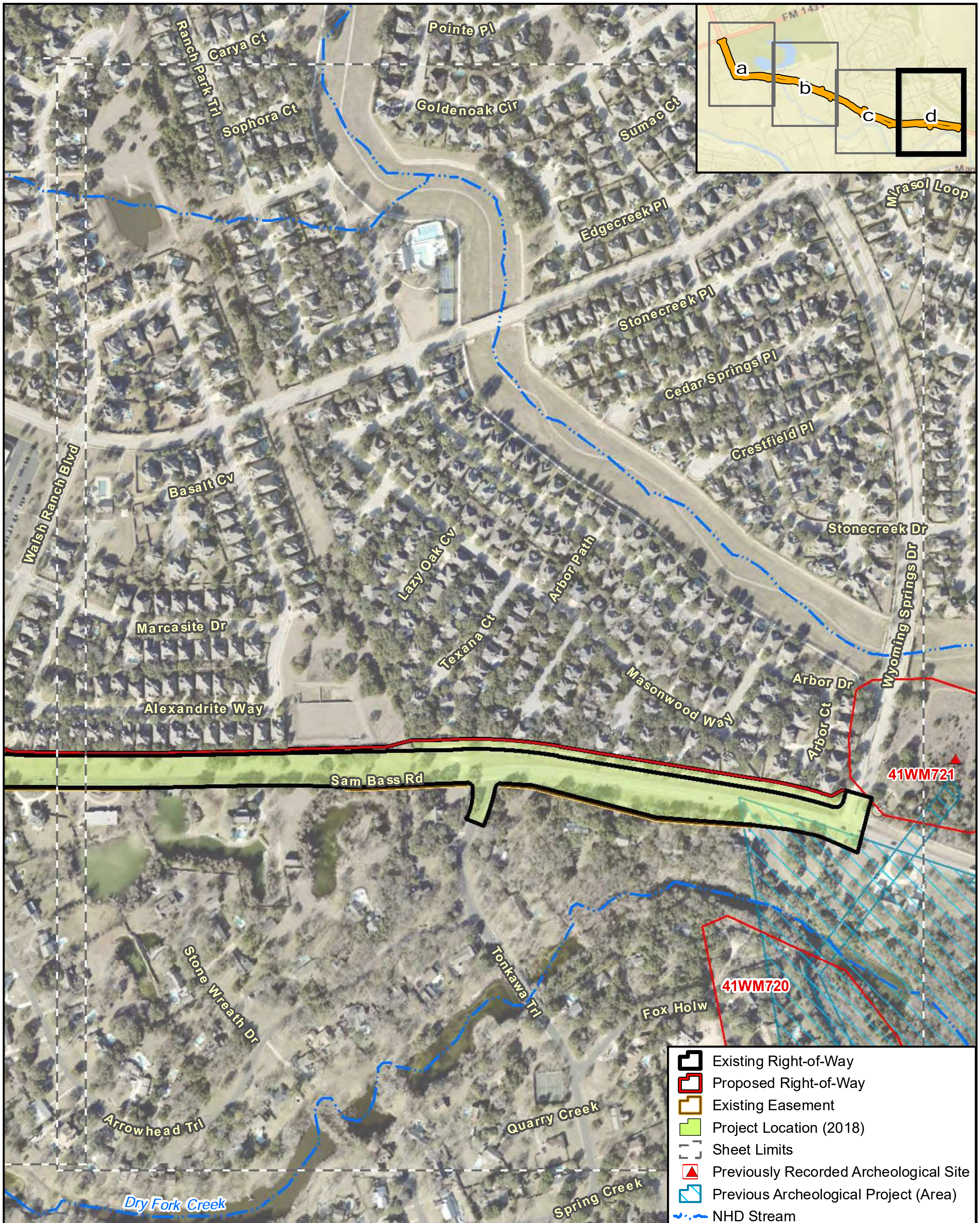

Figure 3d.
Project Area Detail (Aerial Base)

Williamson County Corridor H – Sam Bass Road

Data Sources: TARL (2021), THC (2021), NHD (2020)
Aerial Source: Williamson County (2020)

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2.0 ENVIRONMENTAL AND CULTURAL BACKGROUND

Topography, Geology, Soils, and Land Use

The 46.3-acre project area is situated at elevations ranging from 788 to 865 feet (240 to 263 meters) in the Balcones Canyonland subregion of the Edwards Plateau ecoregion of Texas (Griffith et al. 2004). The Edwards Plateau is a dissected plateau with a sparse network of perennial streams and extensive karst topography. The geology in this area is dominated by undivided Early Cretaceous Edwards and Comanche Peak Limestones (United States Geological Survey [USGS] 2021a).

The soils mapped in the area include Crawford clay on 0 to 1 and 1 to 3 percent slopes, Denton silty clay on 1 to 3 percent slopes, Eckrant extremely stony clay and cobbly clay on 0 to 3 percent and 1 to 8 percent slopes, respectively, and Georgetown clay loam and stony clay loam on 0 to 2 percent and 1 to 3 percent slopes, respectively (Soil Survey Staff 2021).

Crawford soils are moderately deep, well drained, and very slowly permeable sediments that formed in clayey parent material underlain by indurated limestone bedrock and are found on broad, nearly level or gently sloping uplands. The Denton soils are deep, well drained, and slowly permeable sediments that formed in clayey parent materials over residuum weathered from limestone bedrock and are found on backslopes and footslopes of ridges. Eckrant soils are shallow, well drained, moderately slowly permeable, formed in residuum from limestone and occur on summits, shoulders, and backslopes of ridges on dissected plains. Georgetown soils are moderately deep, well drained, and very slowly permeable sediments formed over indurated limestone and found on nearly level to very gently sloping dissected plains. Generally, soils in close proximity to the current road surface and within existing right-of-way are likely to be heavily disturbed by road and utility construction and maintenance. However, proposed new right-of-way may contain relatively undisturbed soils (Soil Survey Staff 2021).

Archeological Chronology for Central Texas

The project area lies within the Central Texas archeological region, which is based on a combination of archeological patterns and geologic, geographic, climatic, pedologic, and other environmental factors (Perttula 2004). The Central Texas region is understood to include the eastern half of the Edwards Plateau, the Llano Uplift, and the portion of the Blackland Prairie that borders the Balcones Escarpment (Black 1989; Collins 2004; Prewitt 1981). As with all archeological regions, which are interpretive devices and therefore somewhat arbitrary, the applicability of these boundaries may vary across periods.

Central Texas is generally considered to have a high probability for prehistoric archeological sites and materials, due in large part to the suitability and availability of native Edwards Plateau chert. This toolmaking material is typically found as large cobbles within limestone beds. The region contains thousands of chert quarrying and tool-production sites, some of which are hundreds of acres in size (Texas Historical Commission [THC] 2021). In addition to a rich expression of chipped stone toolmaking, the region is characterized by the near ubiquity of burned-rock middens, which were used prehistorically for earth oven cooking (Black 1989; Collins 2004).

Despite the distinctiveness of Central Texas burned-rock middens and lithic technology, the archeological chronology typically used in the region is broadly similar to that used in the rest of Texas, and indeed throughout North America, with the first well-established human occupations occurring in the Paleoindian Period approximately 11,500 radiocarbon years before present (BP), or approximately 13,000 years ago (**Table 1**).

Table 1: Archeological Chronology for Central Texas

Period	Years Before Present (BP)*
Paleoindian	11,500–8,800
Early	11,500–10,000
Late	10,000–8,800
Archaic	8,800–1,200
Early	8,800–6,000
Middle	6,000–4,000
Late	4,000–1,200
Late Prehistoric	1,200–400
Early (Austin Phase)	1,200–800
Late (Toyah Phase)	800–400
Historic	400–50

Source: After Collins 2004:113, Figure 3.9a.
*Based on uncalibrated radiocarbon dates, typically used in earlier archeological chronology building in Texas (see Perttula 2004:14, Note 1).

Paleoindian artifacts and sites are common in Central Texas. The association of Paleoindian artifacts (e.g., Folsom and Clovis points) with mammoth remains led to the characterization of these people as big game hunters (Collins 2004). However, that notion is rapidly changing to a more nuanced view that Paleoindian people were more generalized hunter-gatherers with specialized technology at their disposal to allow for the hunting of big game. Texas represents the southernmost extent of the Great Plains, which at times supported large herds of bison (Foster 2012; Kenmotsu and Boyd 2012; Mauldin et al. 2012). In addition, the Blackland Prairie supported many other mammals, including deer and antelope (Mauldin et al. 2012).

The bulk of the prehistoric record is contained within a long Archaic Period, with recently proposed Archaic sub-periods given in **Table 2** (from Lohse et al. 2014). The Archaic is differentiated from the Paleoindian Period by increased hunting and gathering of locally available resources, diversity of material culture, and the widespread use of heated rocks for cooking, creating the classic Central Texas burned-rock midden (Black 1989; Black et al.1998; Collins 2004; Prewitt 1981).

During the Late Prehistoric Period (termed Terminal Late Archaic by Lohse et al. 2014), hunting and gathering continued. During the latter portion of the Late Prehistoric, a distinct shift in material culture occurs. This assemblage has been dubbed Toyah (Arnn 2012; Kenmotsu and Boyd 2012).

Table 2: Revised Archaic Chronology for Central Texas

Archaic Sub-Period	Years Before Present (BP)*
Calf Creek (Terminal Early Archaic)	5,955–5,815
Middle Archaic	5,800–4,200/4,100
Late Archaic 1	4,200/4,100–3,100
Late Archaic 2	3,100–2,150
Late Archaic 3	2,150–1,270
Late Archaic 4 (Terminal Late Archaic or Austin Phase)	1,270–650

Source: After Lohse, et al. 2014
*Based on calibrated radiocarbon dates from wood charcoal and treated bison remains; only assays that are reliably associated with diagnostic projectile points were used.

Documented changes in material culture include Perdiz arrow points, beveled bifacial knives, unifacial scrapers, pottery (the earliest appearance of ceramics in Central Texas), and bison remains. The change in lithic technology and the presence of bison remains at many archeological sites suggest that the material culture change was brought about by the appearance (or increased presence, or perhaps merely increased utilization) of bison, possibly indicating a focus on this particularly high-ranking resource. However, others suggest that this notion is untrue, as evidenced by the utilization of other technologies (i.e., hot-rock cooking) and resources (i.e., deer, small mammals, plants, and seeds). This suggests Toyah people continued to exploit the rich environment of Central Texas while adapting their technology to take advantage of a resource available in greater density than during the preceding Early Late Prehistoric period (Black 1989; Dering 2008; Kenmotsu and Boyd 2012; Rush 2013).

Previous Investigations and Previously Identified Cultural Resources

A search of the Texas Archeological Sites Atlas (Atlas) maintained by the THC and the Texas Archeological Research Laboratory (TARL) was conducted in order to identify archeological sites, historical markers (Recorded Texas Historic Landmarks), properties or districts listed on the National Register of Historic Places (NRHP), State Antiquities Landmarks (SAL), cemeteries, or other cultural resources that may have been previously recorded in or near the project area, as well as previous surveys undertaken in the area. A larger 1-kilometer (0.62-mile) study area around the project area was also examined.

According to Atlas mapped data, only a small portion of the proposed project alignment (near the eastern terminus) has been previously surveyed (**Figure 2**), and eight additional surveys have been conducted within the 1-kilometer study area around the project area; additionally, seven recorded archeological sites and one historic cemetery are mapped in the study area (THC 2021). A small portion of the 1987 areal survey conducted for the United States Army Corps of Engineers, Fort Worth District clips the southern portion of the eastern terminus of the proposed project area. Other surveys recorded within the study area include: an areal survey located south of the eastern terminus conducted in 1984 for the Veterans Administration; a survey for the Brushy Creek Interceptor along Brushy Creek conducted in 1987; a survey along FM 1431 west of this project's northern terminus for the City of Cedar Park conducted in 2000; a survey located on the south side of Brushy Creek conducted in 2000 by the Texas

Parks and Wildlife Department; a survey conducted by Paul Price and Associates in 2002 for the Brushy Creek Municipal Utility District (MUD) located in the northwest quadrant of the Sam Bass Road and Great Oaks Drive intersection; a pipeline survey for the Brushy Creek MUD conducted by Hicks and Associates in 2003; a survey conducted by Lower Colorado River Authority (LCRA) in 2004 that crosses Sam Bass Road just south of this project's eastern terminus; and a survey conducted for Williamson County by SWCA in 2012 (THC 2021).

As mentioned above, there are seven mapped archeological sites and one historic cemetery located within the 1-kilometer study area. Only one of these sites' boundaries (41WM721) extend into the far eastern terminus of the proposed project area (see **Figure 2**). Sites 41WM720, 41WM721, and 41WM722 were originally recorded in 1986 as part of the Brushy Creek WCID archeological survey conducted by Espey, Huston and Associates (now Atkins); all three are prehistoric lithic procurement sites. Two of the sites, 41WM720 and 41WM721, were revisited in 2004 as part of the LCRA survey mentioned above; THC determined both of these sites to be ineligible for inclusion on the NRHP in 2005. Although the site boundary of 41WM721 extends within the proposed project area, the site was determined to be ineligible for listing on the NRHP or as a SAL (THC 2021). Further, recent aerial imagery indicates that the portion of this site within the current project area has very likely been destroyed by construction of the existing Sam Bass Road and Wyoming Springs Drive roadway and right-of-way.

Limited information was available for sites 41WM167, an "old house site" with a possible fireplace foundation and stone fences, 41WM251, a burned rock midden and carvings on a flat ledge, and 41WM1055, an unknown prehistoric site that is "ineligible in the right-of-way" (THC 2021). Site 41WM1197 was recorded as part of a cell tower survey conducted in 2008 by Anthony & Brown Consulting. The site is a lithic scatter of unknown prehistoric-age and was recommended not eligible for the NRHP (THC 2021).

The Gilreath Family Cemetery is located west of the project area on the east bank of Brushy Creek along Spanish Oak Trail. There are seven markers in the cemetery: four members of the Gilreath family, two Clanton family members, and one Cook family member. All of the graves date between 1858 and 1885 (Tipton 2021).

Historic topographic maps and aerial imagery were also reviewed to examine how the project locale and surrounding area have been used over time. Reviewed materials include historic topographic maps from the years 1893, 1928, 1945, 1949, 1951, 1954, 1967, 1974, 1982, 1985, 1987, 2013, and 2016 (National Environmental Title Research [NETR] 2021; USGS 2021b) and aerial imagery from the years 1954, 1962, 1973, 1985, 1995, 2002–2006, 2008, and 2010–2018 (Google Earth™ Pro 2021; NETR 2021).

The earliest topographic map reviewed (Georgetown 1:125,000 quadrangle map; 1893) shows this area as completely undeveloped with the exception of a roadway in the general vicinity and orientation as current Sam Bass Road. Subsequent early maps show the road, labeled Leander Road (now Sam Bass Road), and depict the general project area to be completely undeveloped with no structures depicted. This remains the case until 1945, when less than five were extant along the roadway. By

1982, some residential development had begun along the south side of Leander Road (Sam Bass Road), but was still very sparse, and a quarry was noted between the roadway and Dry Brushy Creek. By 1987, extensive residential occupation had occurred south of the road, including over the former quarry, and the first appearance of FM 1431 at the northern terminus extends east beyond Sam Bass Road (old Leander Road; NETR 2021; USGS 2021b).

The available aerial imagery mirrors the topographic maps very closely. The earliest imagery sets (1954, 1962, and 1973) indicate that the area was undeveloped but the quarry between Leander Road (Sam Bass Road) and Dry Brushy Creek is shown in early stages with some smaller roads connecting it to Leander Road (Sam Bass Road) is apparent on the 1973 imagery (Google Earth™ Pro 2021; NETR 2021).

Known and perceived disturbances within the project area include those associated with roadway construction and maintenance, installation of overhead and underground utilities, contoured and/or excavated drainages, ingress/egress driveways, and clear cutting of vegetation. These types of disturbances are evident on aerial imagery of the project area and were observed during an initial environmental constraints field visit, when the existing Sam Bass right-of-way was found to be heavily disturbed. Most of the project area falls within the existing, disturbed Sam Bass Road right-of-way, and the majority of the project area has not been subjected to previous archeological survey.

In December 2018, a background letter regarding the proposed project was prepared for the THC. For the 25.679-acre portion of the project area that is within existing right-of-way, no further work was recommended. However, the acquisition of roughly 14.356 acres of proposed new right-of-way is planned along the project corridor. These areas are largely unsurveyed, and portions of these areas appear to be relatively undisturbed in aerial imagery. Therefore, an archeological survey augmented by judgmental shovel testing was recommended for the 14.356 acres of proposed new right-of-way, and pedestrian inspection was recommended for the 25.679 acres of existing right-of-way (see **Figures 2** and **3a–d**). The THC concurred with these recommendations on December 27, 2018.

Following the issuance of the initial permit, design changes shortened the project area to approximately 2.38 miles or 3.83 kilometers. The project would consist of 27.27 acres of existing right-of-way, 1.72 acres of existing easements, 17.08 acres of proposed right-of-way, and 0.23 acres of temporary construction easements for a total of 46.30 acres. The project area, or area that would be disturbed or affected by the proposed project, is the entire 46.30-acre footprint.

3.0 Research Goals and Methods

Purpose of the Research

The present study was carried out to accomplish three major goals:

1. To identify all historic and prehistoric archeological resources located within the project area defined in Chapter One;

2. To perform a preliminary evaluation of the identified resources' potential for inclusion in the NRHP and/or for designation as a SAL (typically performed concurrently);

3. To make recommendations about the need for further research concerning the identified resources based on the preliminary NRHP/SAL evaluation and with guidance on methodology and ethics from the THC and Council of Texas Archeologists (CTA).

NRHP Eligibility

The National Historic Preservation Act of 1966, as amended, provides a statement of federal authority, an administrative framework for agency coordination, and general principles for the assessment of cultural resources, including archeological sites (called "historic properties" in this regulatory context, regardless of actual historic or prehistoric dates), for their eligibility for inclusion in the NRHP (36 CFR 800; 9 TNRC 191; 13 TAC 26.24). Although no federal nexus for this project is currently known, state-level compliance in Texas (see next section) is dependent on principles established during the development of the NRHP and its implementing regulations.

More specific rules relating to the NRHP nomination process, list management, relevant definitions, and other matters are described in 36 CFR 60. Most important to the present investigation are the criteria for significance (and therefore potential NRHP eligibility):

> …The quality of significance in American history, architecture, archeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, material, workmanship, feeling, and association and
>
> (a) that are associated with events that have made a significant contribution to the broad patterns of our history; or
> (b) that are associated with the lives of persons significant in our past; or
> (c) that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
> (d) that have yielded or may be likely to yield, information important in prehistory or history. (36 CFR 60.4)

Note that significance and NRHP eligibility are determined by two primary components: integrity and one of the four types of association and data potential listed under 36 CFR 60.4(a–d). The criterion most often applied to archeological sites is the last—and arguably the broadest—of the four (36 CFR 60.4[d]).

The Antiquities Code of Texas

Because the project is currently owned and funded by Williamson County, a political subdivision of the State of Texas, the project is subject to the Antiquities Code of Texas (9 TNRC 191), which requires consideration of effects on properties designated as—or eligible to be designated as—SALs, which are defined as:

> ...sites, objects, buildings, structures and historic shipwrecks, and locations of historical, archeological, educational, or scientific interest including, but not limited to, prehistoric American Indian or aboriginal campsites, dwellings, and habitation sites, aboriginal paintings, petroglyphs, and other marks or carvings on rock or elsewhere which pertain to early American Indian or other archeological sites of every character, treasure imbedded in the earth, sunken or abandoned ships and wrecks of the sea or any part of their contents, maps, records, documents, books, artifacts, and implements of culture in any way related to the inhabitants, prehistory, history, government, or culture in, on, or under any of the lands of the State of Texas, including the tidelands, submerged land, and the bed of the sea within the jurisdiction of the State of Texas. (13 TAC 26.2)

Guidelines for the evaluation of cultural resources as SALs and/or for listing on the NRHP, which is also explicitly referenced at the state level, are detailed in 13 TAC 26. An archeological site identified on lands owned or controlled by the State of Texas may be of sufficient significance to allow designation as a SAL if at least one of the following criteria applies:

1. the site has the potential to contribute to a better understanding of the prehistory and/or history of Texas by the addition of new and important information;
2. the site's archeological deposits and the artifacts within the site are preserved and intact, thereby supporting the research potential or preservation interests of the site;
3. the site possesses unique or rare attributes concerning Texas prehistory and/or history;
4. the study of the site offers the opportunity to test theories and methods of preservation, thereby contributing to new scientific knowledge; and
5. there is a high likelihood that vandalism and relic collecting has occurred or could occur, and official landmark designation is needed to ensure maximum legal protection, or alternatively further investigations are needed to mitigate the effects of vandalism and relic collecting when the site cannot be protected. (13 TAC 26.10)

For archeological resources, the state-level process requires securing and maintaining a valid Texas Antiquities Permit from the THC, the lead state agency for Antiquities Code compliance, throughout all stages of investigation, analysis, and reporting.

Survey Methods and Protocols

With the goals and guidelines above in mind, CMEC personnel conducted an intensive survey in March 2019, per category 6 under 13 TAC 26.15 and using the definitions in 13 TAC 26.3. CMEC personnel searched for previously identified and unidentified archeological sites. Field methods complied with the coverage requirements of 13 TAC 26.15, as elaborated by the THC and the CTA.

All areas of proposed new right-of-way for which access was granted were subjected to pedestrian survey. Shovel test units (**Figure 4a–d**) were placed throughout the project area and excavated in natural levels to major color/texture changes or restrictive features, as allowed by compaction and hardness of the deposits and as prescribed by local ground surface conditions. Excavated matrix was screened through 0.635-centimeter (0.25-inch) hardware cloth as allowed by moisture and clay content, which often required that the removed sediment be crumbled/sorted by hand, trowel, and/or shovel point. Deposits were described using conventional texture classifications and Munsell color designations, and all observations were recorded on standard CMEC shovel test forms. The testing protocol detailed in the approved scope for Texas Antiquities Permit 8793 called for radial shovel tests to be placed at 5-meter (roughly 16-foot) intervals around each shovel test positive for cultural material until two negative units were established in each cardinal direction. None of the excavated shovel tests were positive for cultural materials.

Each site located was to be recorded using a handheld Global Positioning System unit and given an identifying number in the form of "FS-XX". This number is a temporary field number, to be superseded by a formal site trinomial obtained following the completion of fieldwork. CMEC personnel kept a complete record of field notes supplemented by digital photographs, with observations including (but not limited to): archeological contextual integrity, vegetation, topography, hydrology, land use, soil exposures, general conditions at the time of the survey, and field techniques employed.

No artifacts were collected during this investigation. All field forms, photographs, and other project records will be curated at the Center for Archaeological Studies at Texas State University in San Marcos per 13 TAC 26.16 and 26.17.

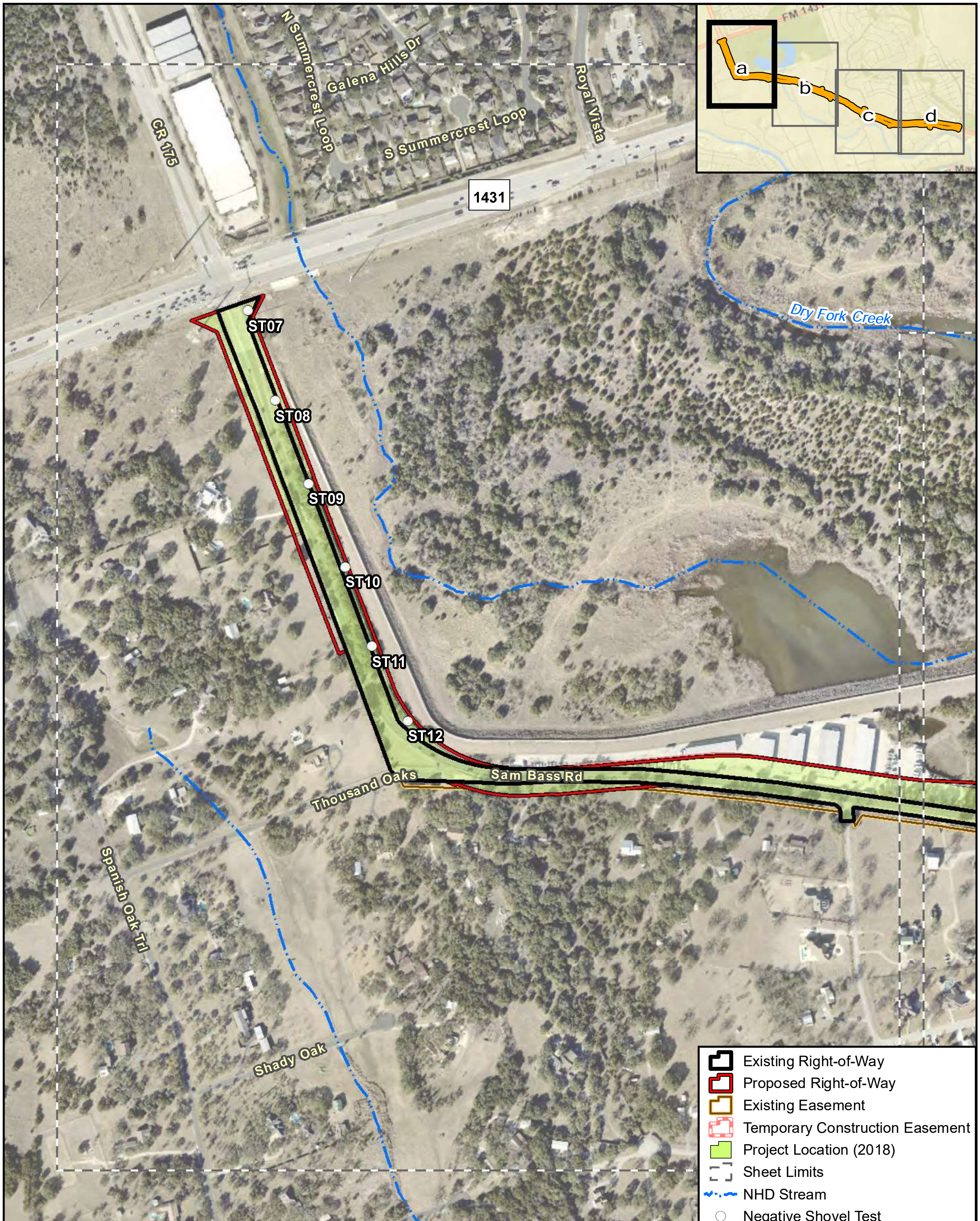

Figure 4a.
Survey Results

Williamson County Corridor H – Sam Bass Road

Data Sources: TARL (2021), THC (2021), NHD (2020)
Aerial Source: NETR (2021)

COX | McLAIN Environmental Consulting

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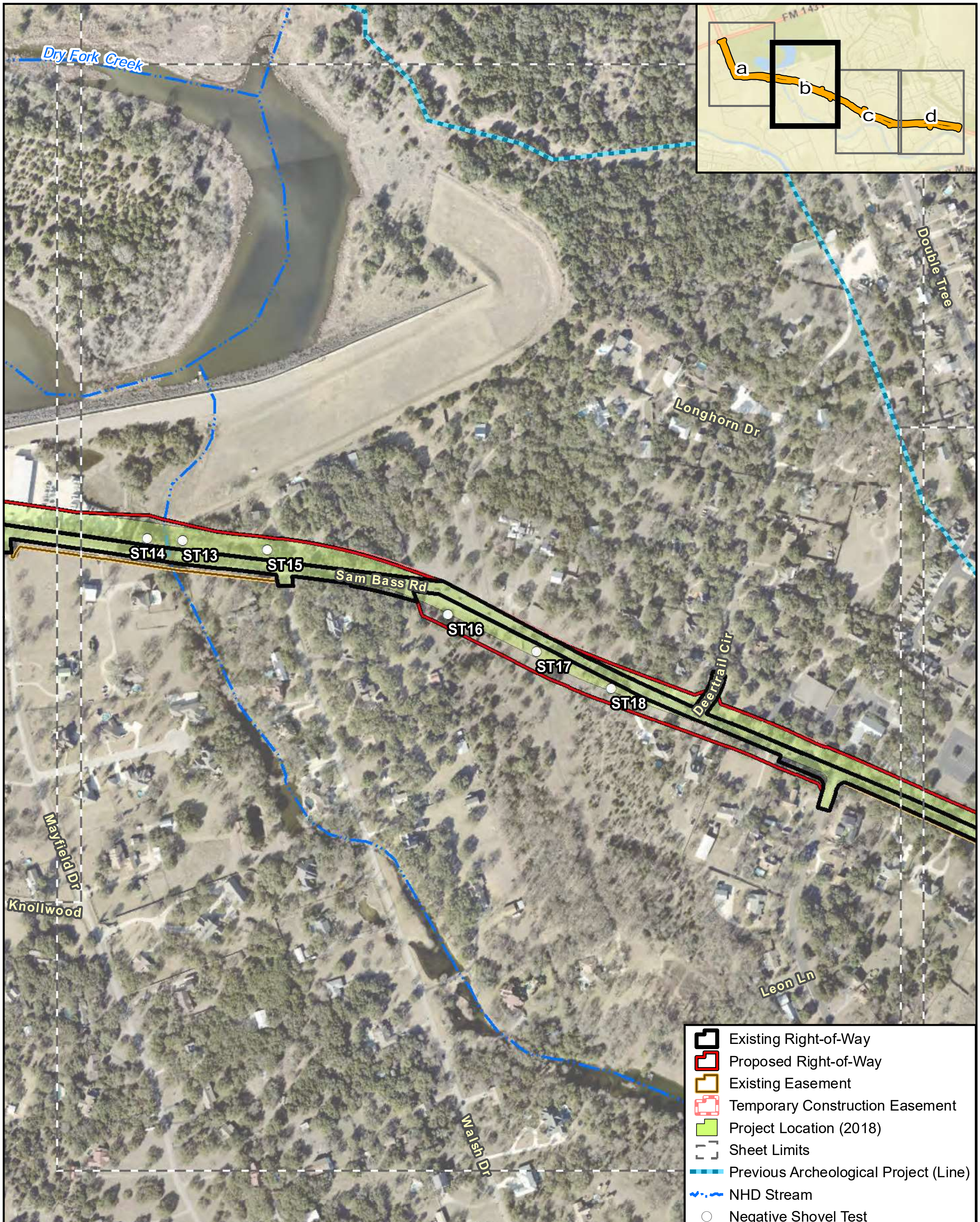

Figure 4b.
Survey Results

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1 in = 500 feet
Scale: 1:6,000
Date: 7/23/2021

Data Sources: TARL (2021), THC (2021), NHD (2020)
Aerial Source: NETR (2021)

Williamson County Corridor H – Sam Bass Road

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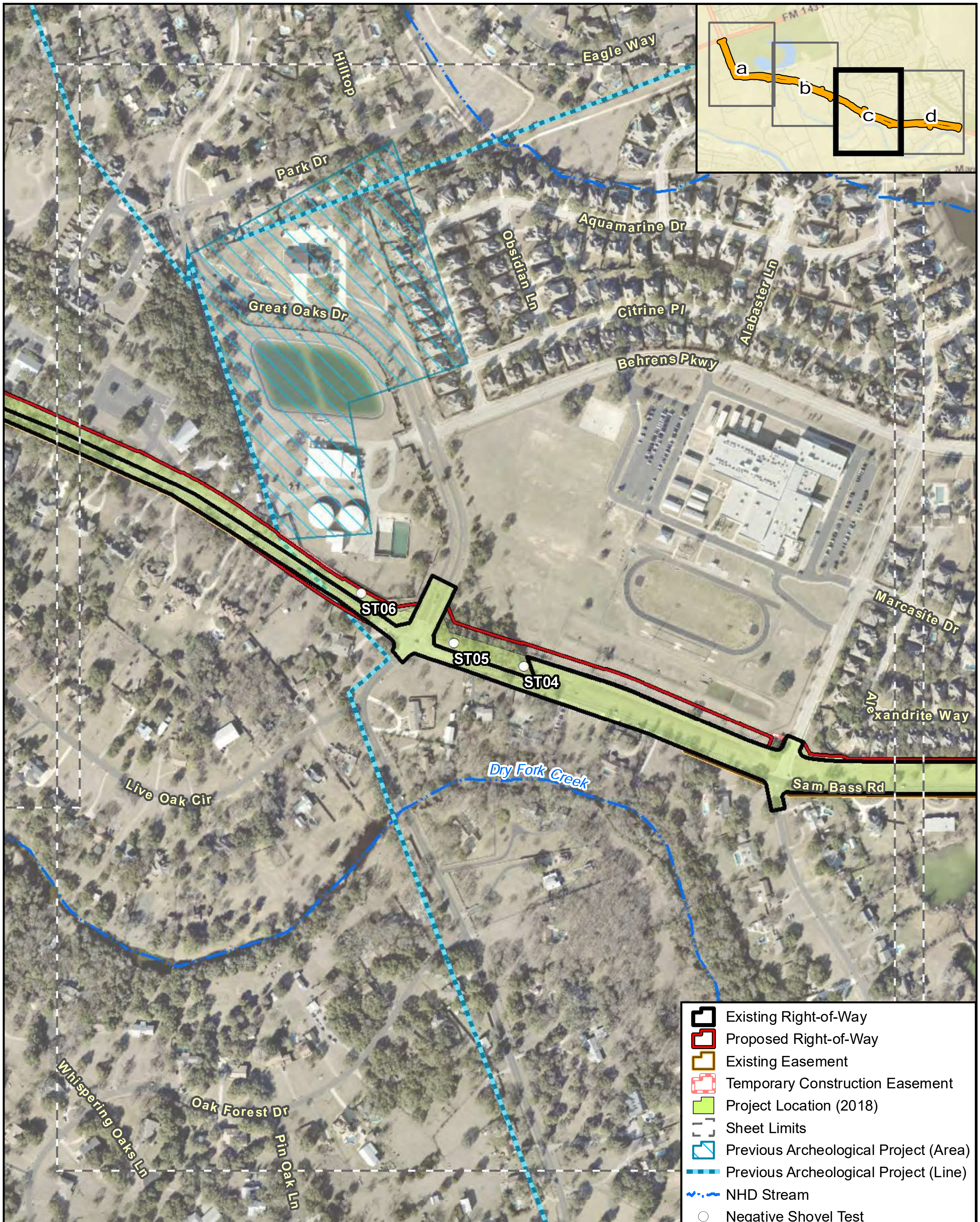

Figure 4c.
Survey Results

Williamson County Corridor H – Sam Bass Road

Data Sources: TARL (2021), THC (2021), NHD (2020)
Aerial Source: NETR (2021)

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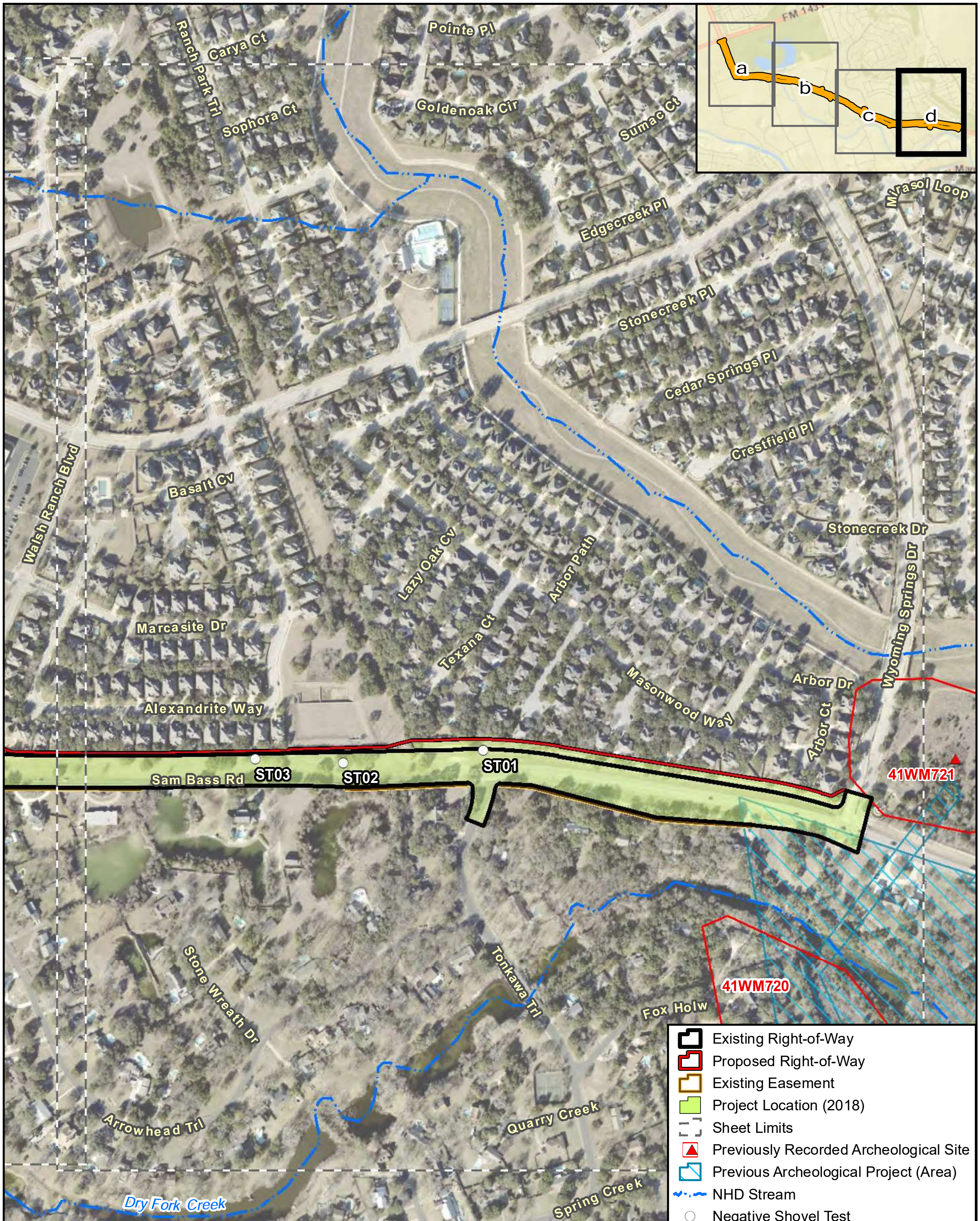

Figure 4d.
Survey Results

Williamson County Corridor H – Sam Bass Road

Data Sources: TARL (2021), THC (2021), NHD (2020)
Aerial Source: NETR (2021)

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4.0 RESULTS AND RECOMMENDATIONS

Field Observations

In March 2019, David Sandrock (Principal Investigator) of CMEC conducted archeological survey augmented with the excavation of shovel test units within the footprint of the proposed roadway improvements. These improvements cover approximately 46.30 acres along 2.38 miles (3.83 kilometers) of the Sam Bass Road roadway, all of which was subjected to pedestrian survey.

The majority of the proposed project area is currently in use as the existing Sam Bass Road roadway. Disturbances observed within the project area include those associated with roadway and driveway construction and maintenance (**Figures 5, 6,** and **7**), residential development including a mixed-use path (**Figures 8** and **9**), buried and overhead utility line construction and maintenance (**Figure 10**), some small areas of commercial development (**Figure 11**), and publicly-owned water management facilities (**Figure 12**). A single drainage intersects with the project area (**Figure 13).**

The northern/western portion of the project area generally exhibits more topographic relief than the rest of the project area, and soils in this area are typically thin and stony. The portion of the project area that runs roughly east-west is generally flatter, and soils encountered in this area were variable. Typical vegetation in the project area includes cedars, oaks, mesquites, and some short grasses. Ground surface visibility was generally low in most of the project area (below 30 percent) due to vegetation cover (**Figure 14**), but many areas featured much higher visibility (above 45 percent) due to the presence of exposed bedrock and more sparse vegetation cover (**Figure 15**).

Figure 5: View near project area's eastern terminus at Wyoming Springs Drive; facing southeast.

Figure 6: View near project area's northern terminus at RM 1431; facing northwest.

Figure 7: View along Sam Bass Road near Deer Trail Circle; facing east.

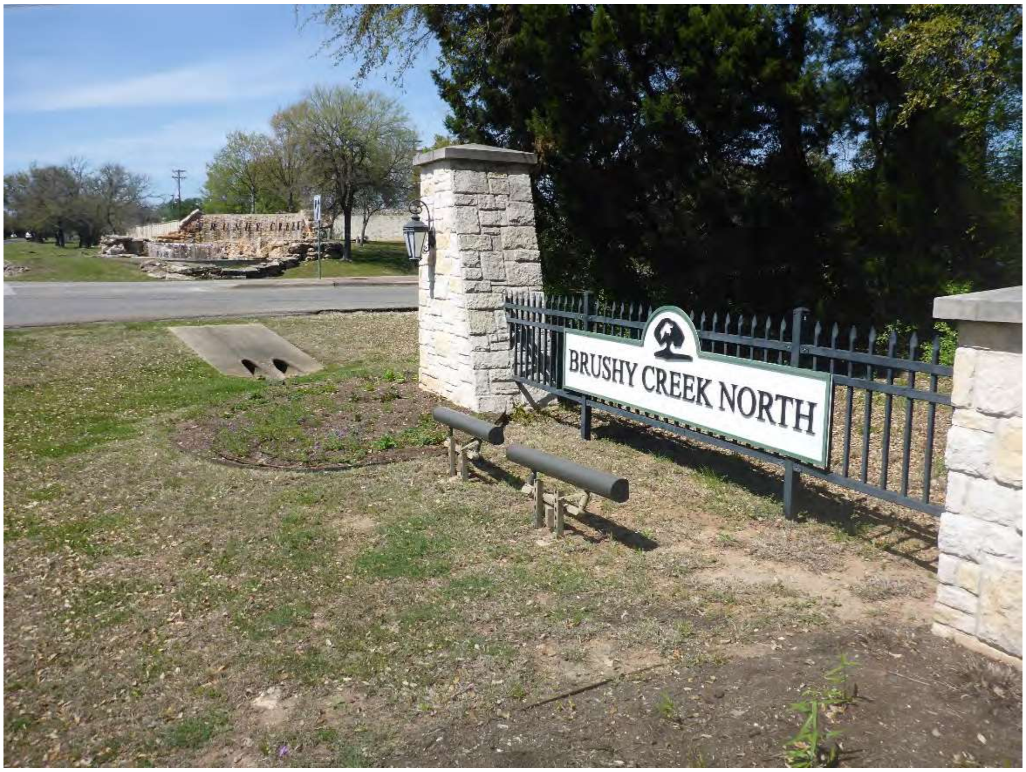

Figure 8: View of residential development along Sam Bass Road; facing west.

Figure 9: View of residential development north of Sam Bass Road; facing east.

Figure 10: View of buried utility lines in project area; facing northwest.

Figure 11: View of commercial, roadway, and residential development in project area; facing east.

Figure 12: View of water management feature near project area; facing south.

Figure 13: View of drainage crossing project area; facing northwest.

Figure 14: View of area of lower ground surface visibility; facing west.

Figure 15: View of area of higher ground surface visibility; facing west.

During CMEC's 2019 survey, 18 shovel tests were excavated within the project area; none of these shovel tests contained cultural material (see **Figure 4a–d**). Typical shovel test units within the project area contained rocky, friable, very dark grayish brown (10YR 3/2) clay loam from 0 to between 15 and 20 centimeters (roughly 0 to between 6 and 9 inches) below ground surface, underlain by degraded bedrock or by very dark gray (10YR 3/1), firm clay loam with clay content and density increasing with depth to between 40 and 65 centimeters (roughly 25 inches) below ground surface. Excavated shovel test units were terminated at bedrock or clay subsoil.

The site boundary for 41WM721, which is recorded as a Prehistoric-age lithic procurement site containing cores and primary, secondary, and tertiary flakes, is mapped adjacent to the eastern terminus of the project area. Although the site was determined to be ineligible for listing on the NRHP or as a SAL, CMEC archeologists examined the portion of the project area closest to the site's mapped location near the intersection of Sam Bass Road and Wyoming Springs Drive. No evidence of this site was observed, and the area containing this site has been severely disturbed by construction of the existing Sam Bass Road and Wyoming Springs Drive roadways and rights-of-way, as well as nearby residential development (see **Figures 5** and **9**). Any portion of the site that extended into the proposed project area has very likely been destroyed.

Recommendations

In March 2019, CMEC archeologists excavated a total of 18 shovel tests within areas of proposed new right-of-way of the overall 46.30-acre proposed project area for improvements to Sam Bass Road. Results of the survey indicate that disturbances are present within the project area and are mostly caused by roadway, residential, and utility development. Additionally, soils within the project area are generally thin and stony, and the project area is located on a variably-sloping area without access to any major drainages.

As the project is subject to the Antiquities Code of Texas, the project area was assessed only for direct impacts to archeological resources. No cultural material was encountered on the ground surface or in any of the excavated shovel test units, and no evidence of archeological features or sites was observed. No evidence was found of preserved deposits with a high degree of integrity, associations with distinctive architectural and material culture styles, rare materials and assemblages, the potential to yield data important to the study of preservation techniques and the past in general, or potential attractiveness to relic hunters (3 TAC 26.10).

Therefore, CMEC recommends that no further work is required within the proposed project area, and construction should be allowed to continue as planned. If any unanticipated discoveries of archeological materials, deposits, or features are made during construction, work should halt immediately, and both Williamson County and THC personnel should be notified.

No artifacts were collected during this survey, but field forms, photographs, and other project records will be curated at the Center for Archaeological Studies at Texas State University in San Marcos per 13 TAC 26.16 and 26.17.

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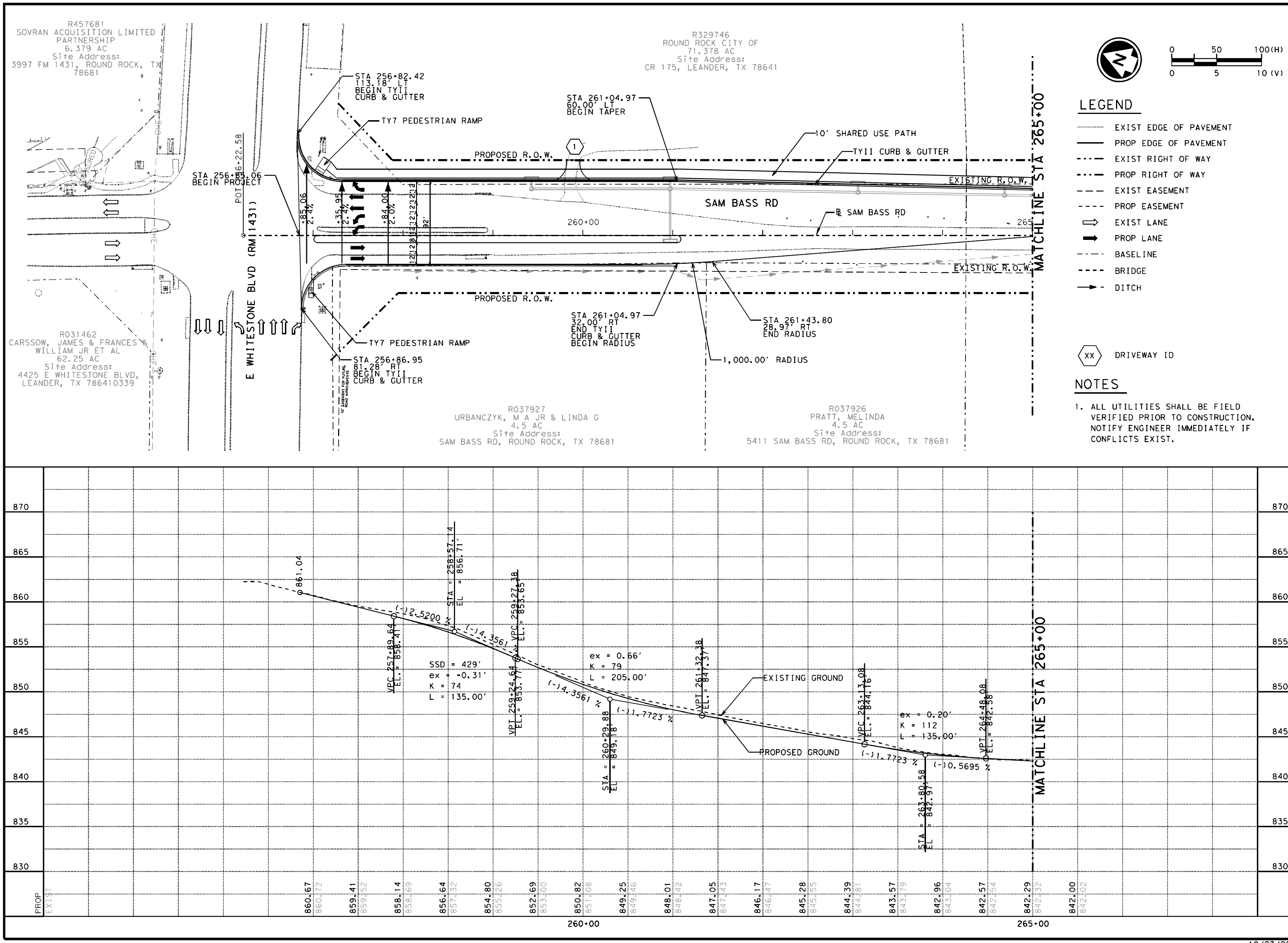
APPENDIX A: PROJECT DESIGN



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- PROP LANE
- BASELINE
- BRIDGE
- DITCH

(XX) DRIVEWAY ID

NOTES

1. ALL UTILITIES SHALL BE FIELD VERIFIED PRIOR TO CONSTRUCTION. NOTIFY ENGINEER IMMEDIATELY IF CONFLICTS EXIST.

REV. NO.	BY	DATE	REVISION DESCRIPTION

THESE DOCUMENTS ARE FOR INTERIM REVIEW AND NOT FOR CONSTRUCTION, BIDDING OR PERMIT PURPOSES.

RESPONSIBLE ENGINEER:
$ENGR$
TBPE NO. $ENGNO$
10/23/2020

K FRIESE + ASSOCIATES, INC.
1120 S. CAPITAL OF TEXAS HWY, II-100, AUSTIN, TX 78746

$CLIENT$
$PROJECT$
$SHTTITLE$
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K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING
(FIRM # 6535)

WILLIAMSON COUNTY 1848

$CLIENT$

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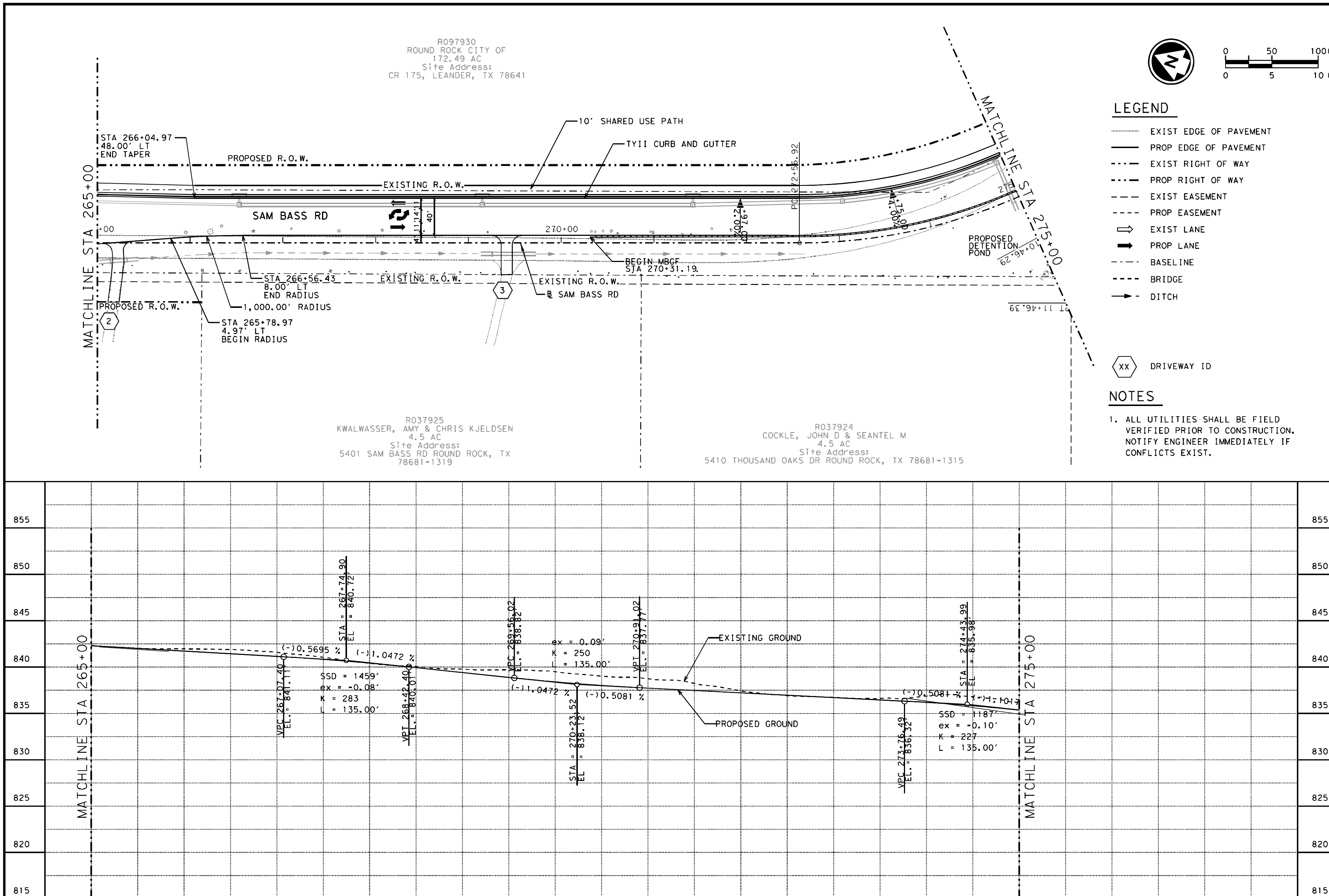

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EXIST	842.32	842.02	841.96	841.91	841.58	841.06	840.41	840.07	839.78	839.71	839.50	839.01	838.74	838.24	837.43	836.91	836.73	836.62	836.87	836.79	836.17

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PUBLIC PROJECT ENGINEERING (FIRM # 6535)

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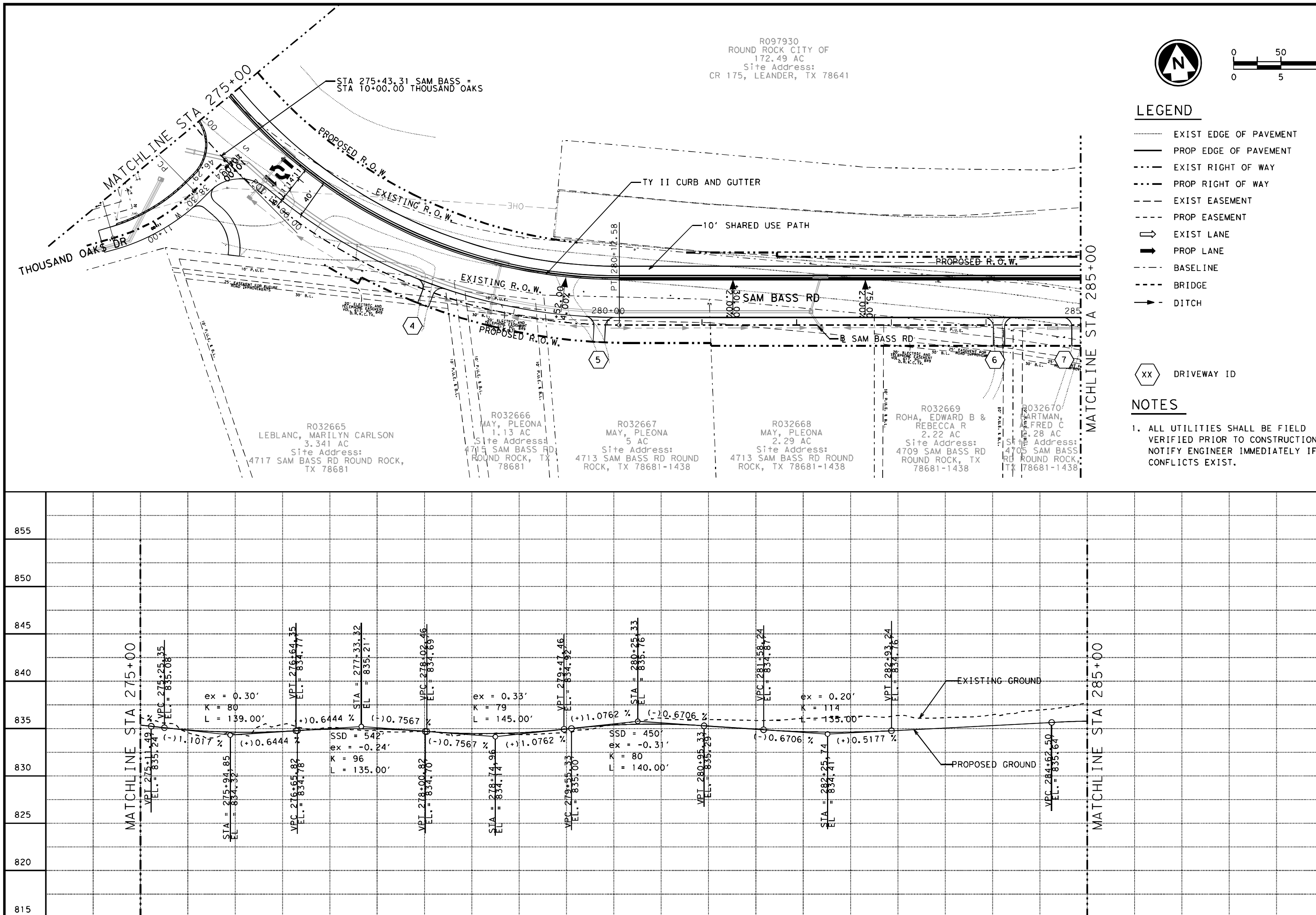

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EXIST	836.17	834.57	834.43	835.42	835.10	834.73	834.69	834.35	834.37	834.54	835.41	836.10	835.94	835.85	836.06	836.25	836.37	836.14	836.45	836.96	837.71

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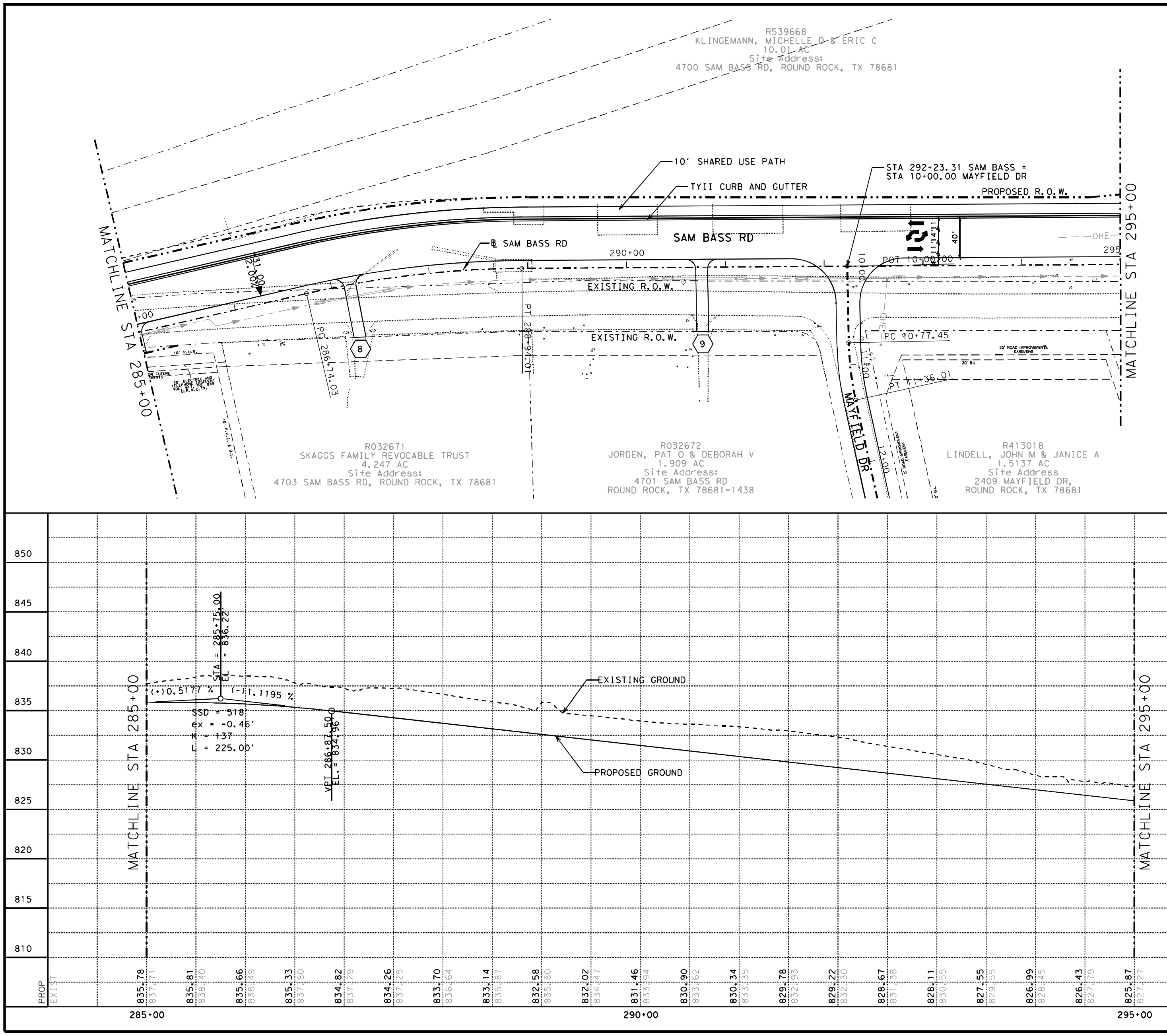

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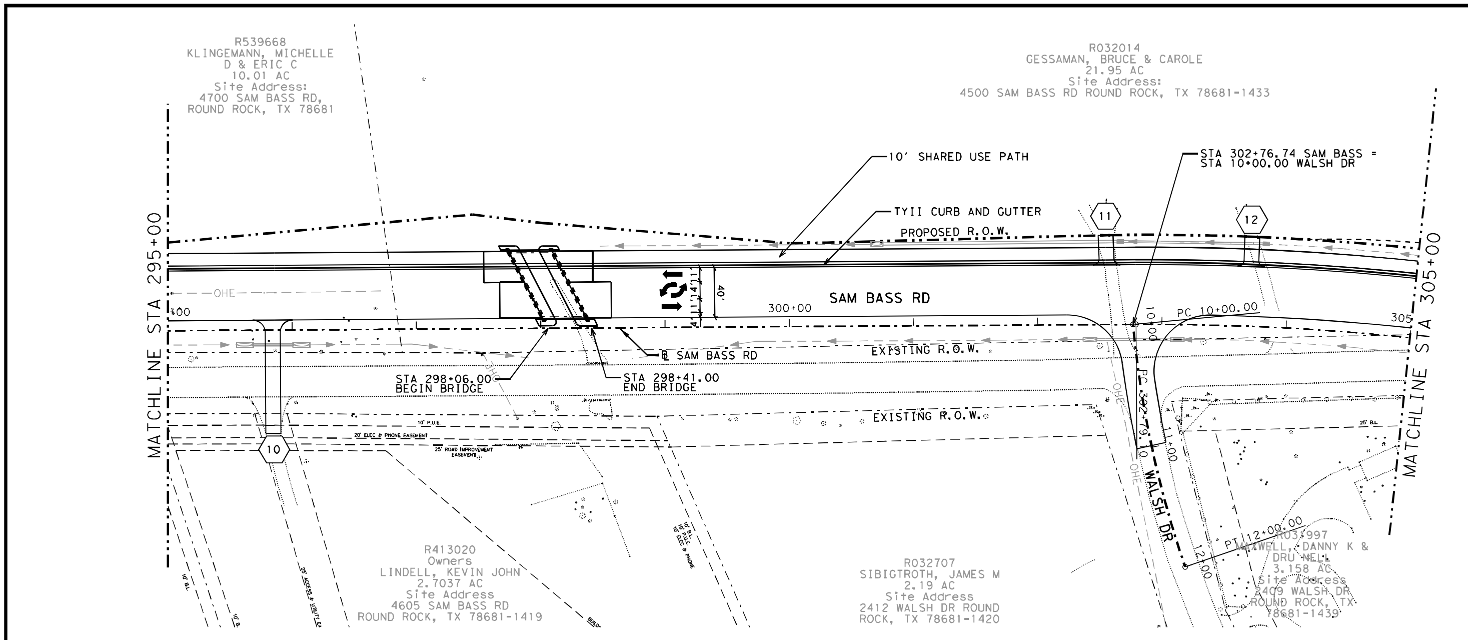

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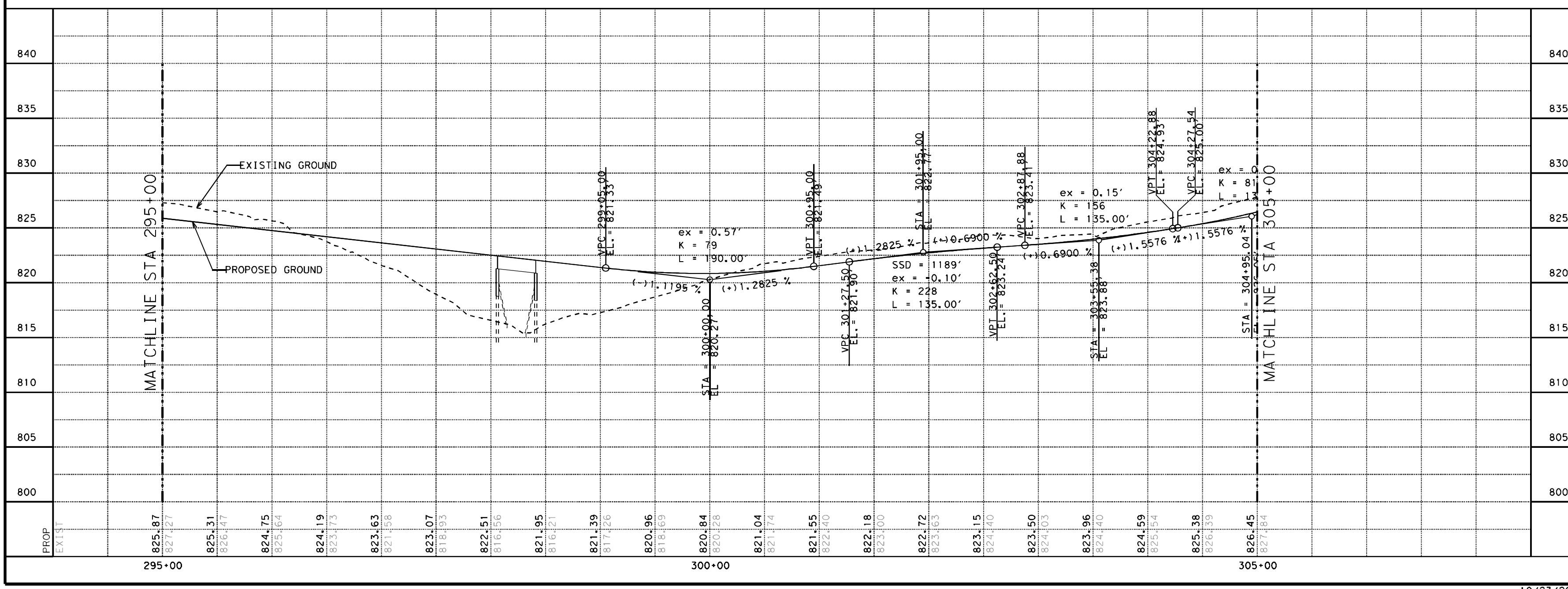

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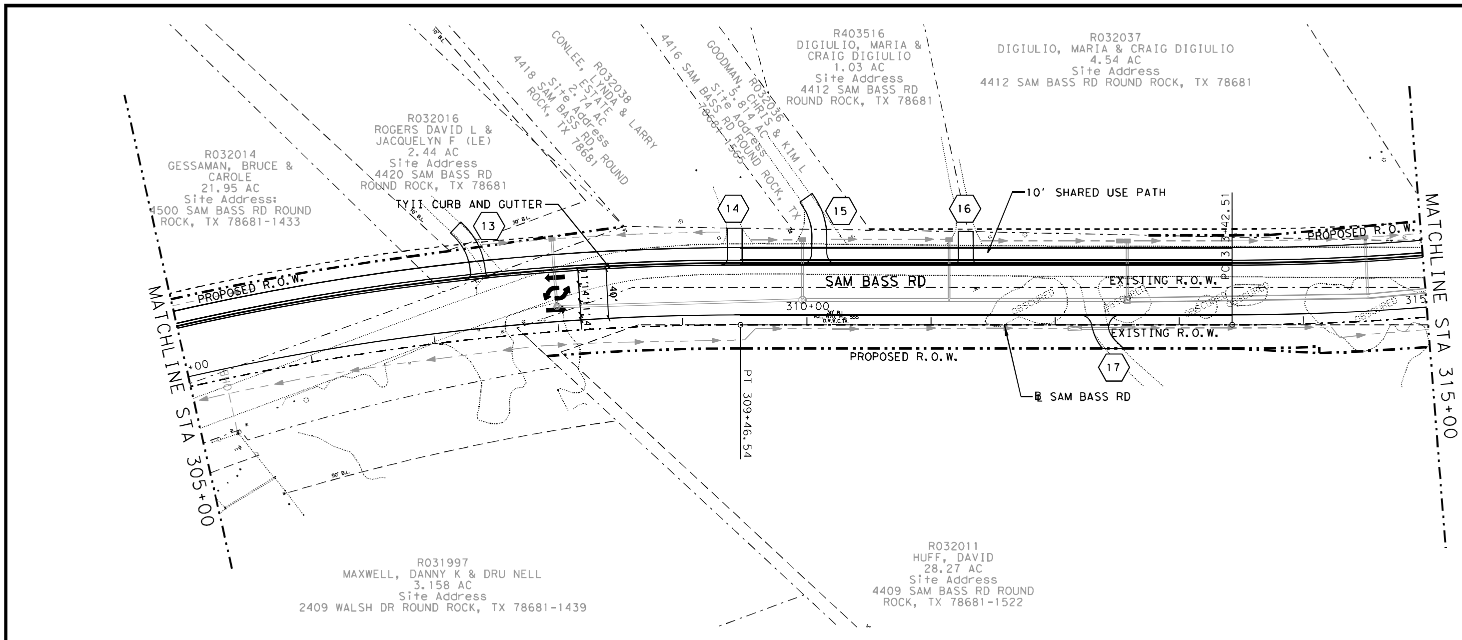

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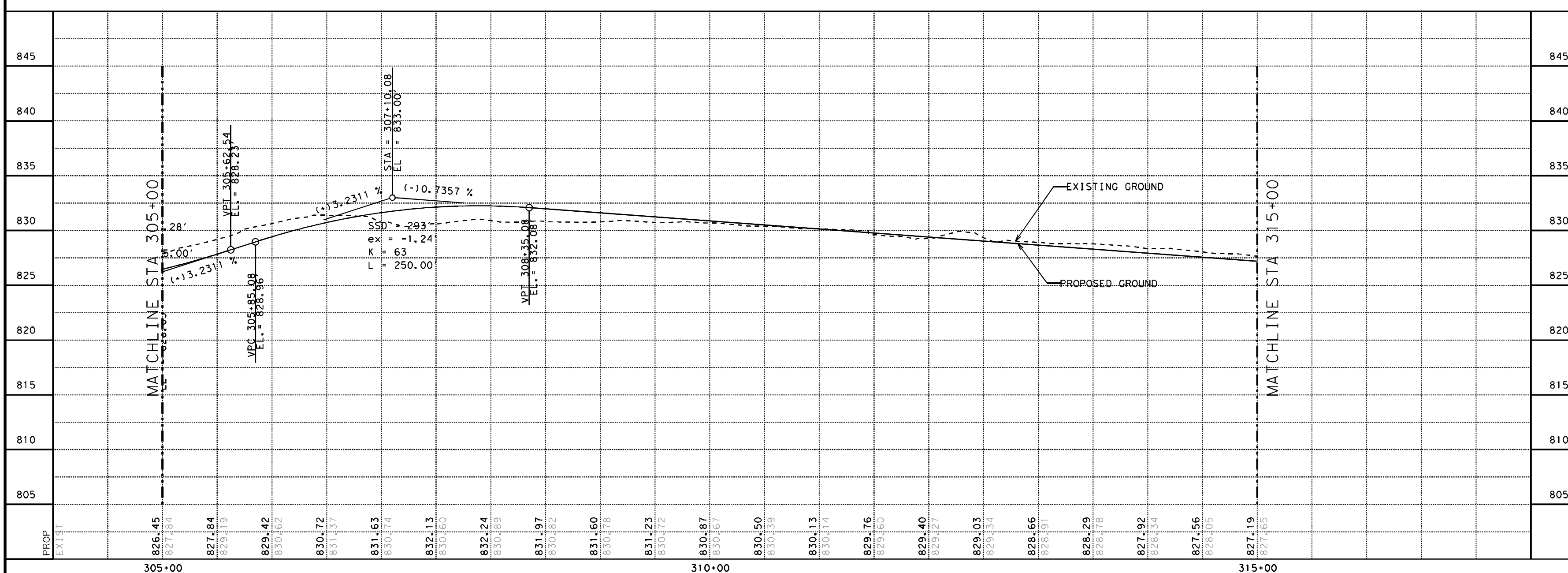

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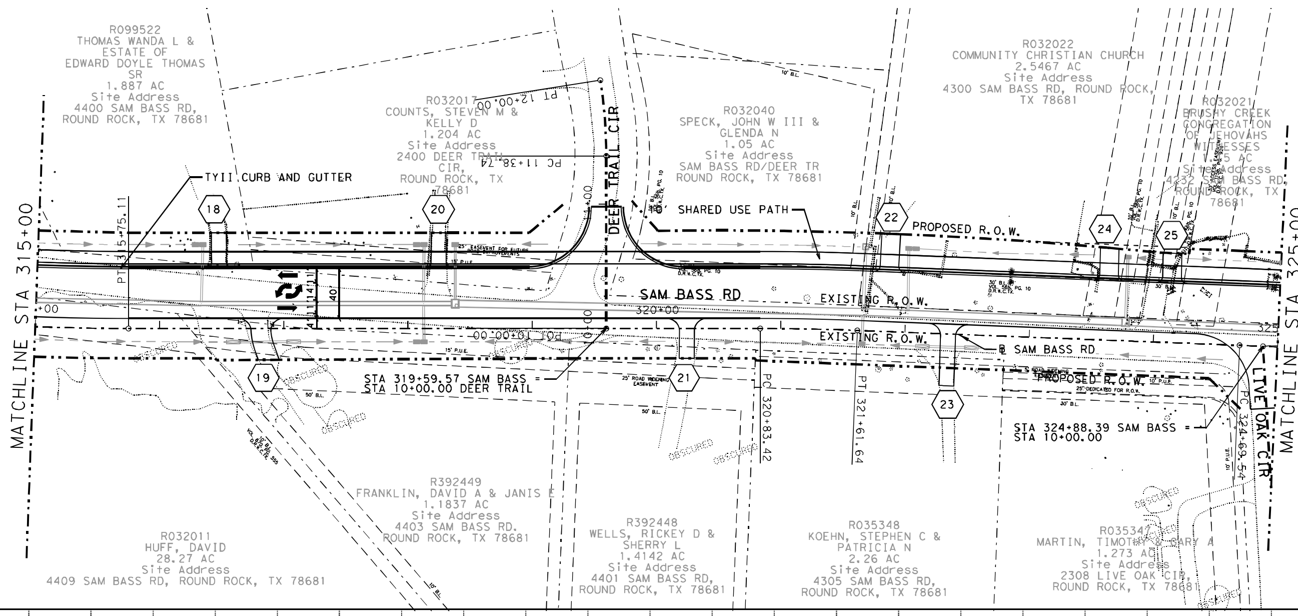

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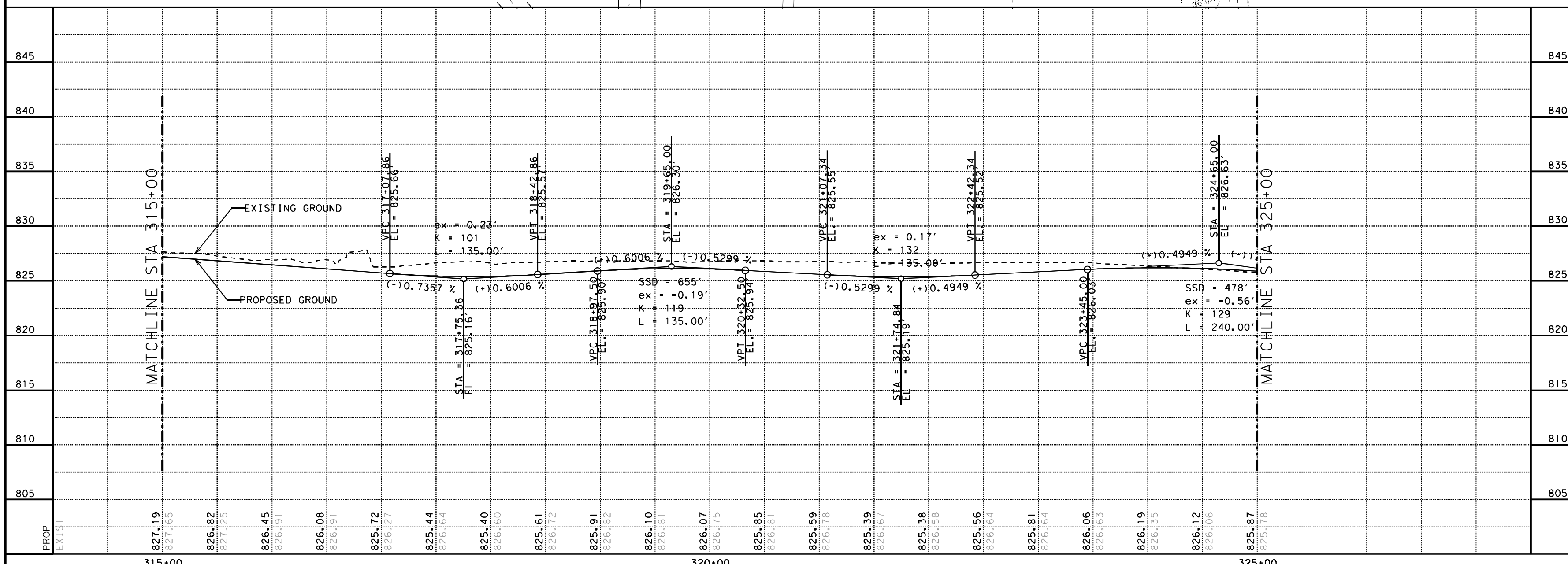

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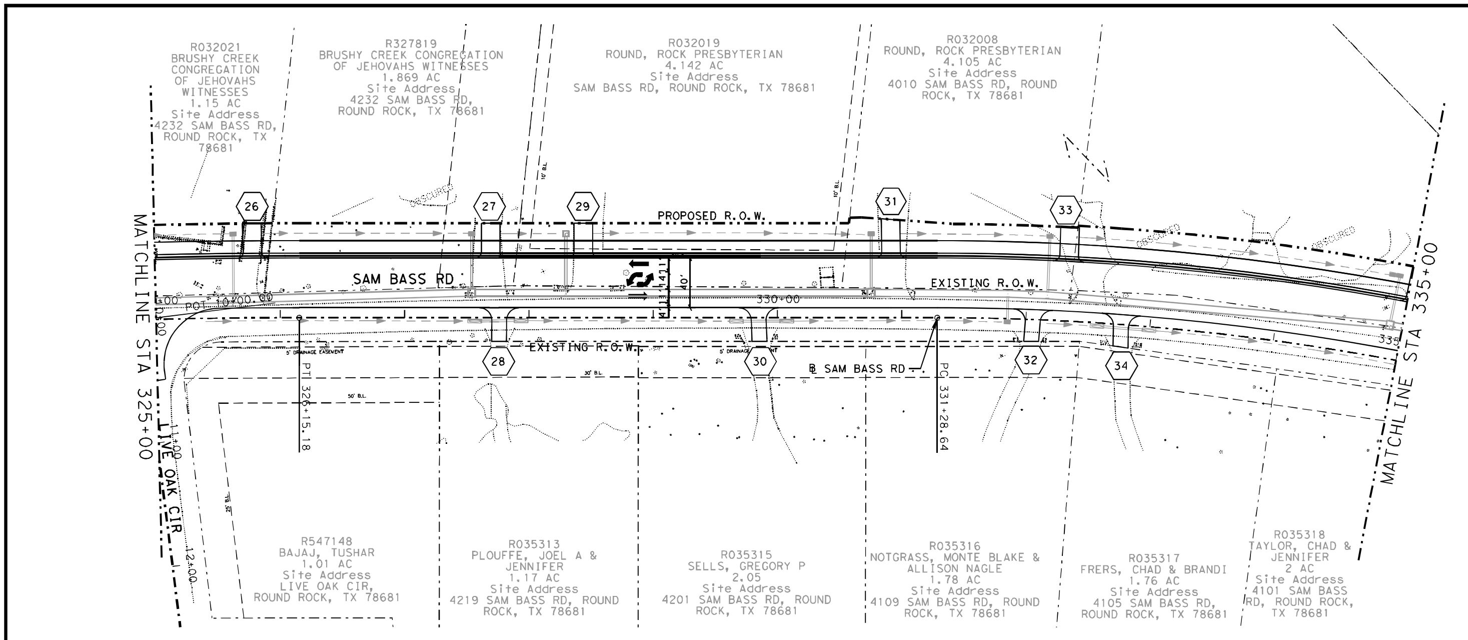

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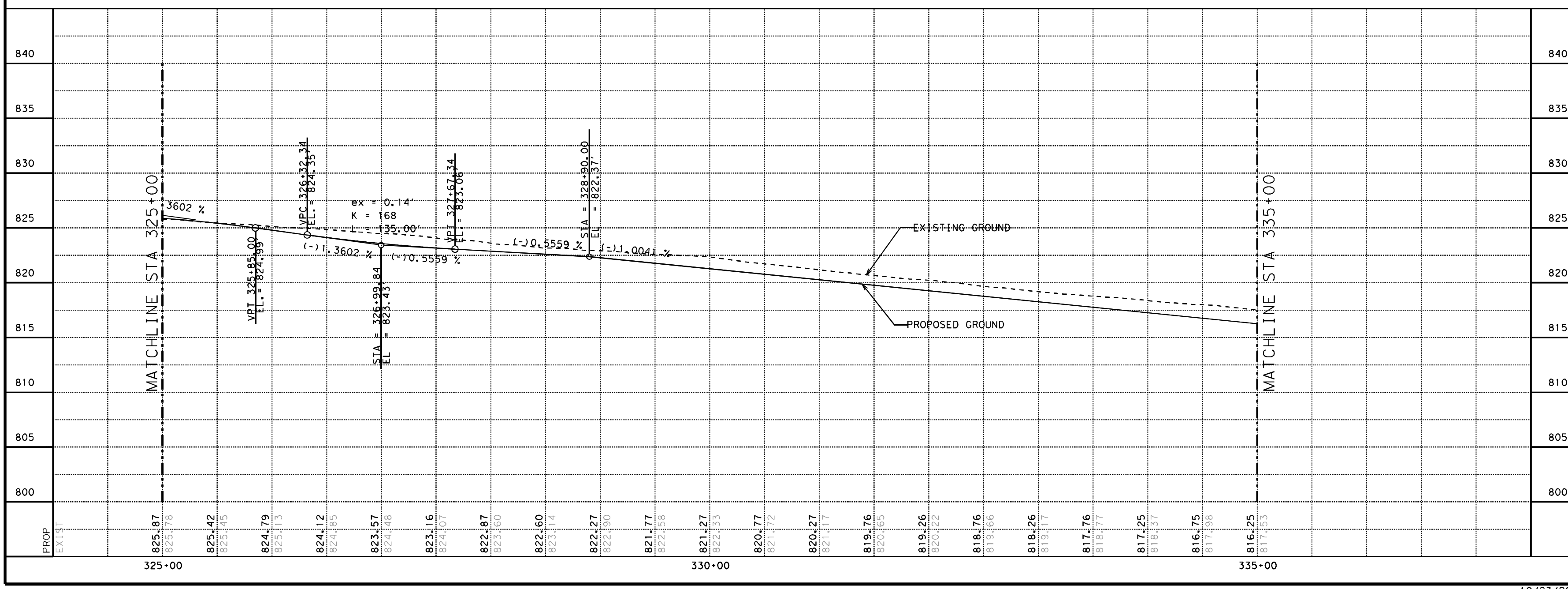

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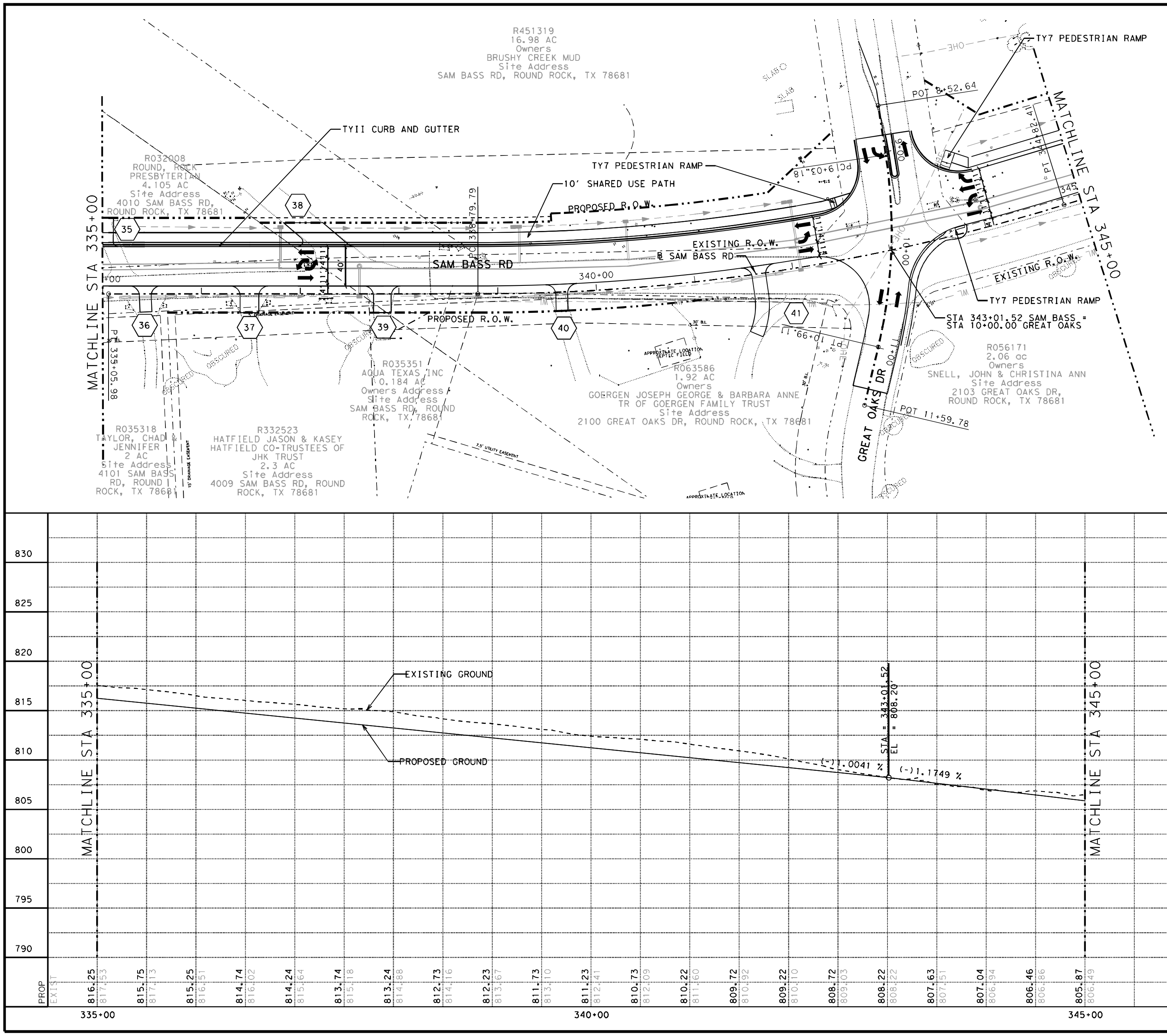

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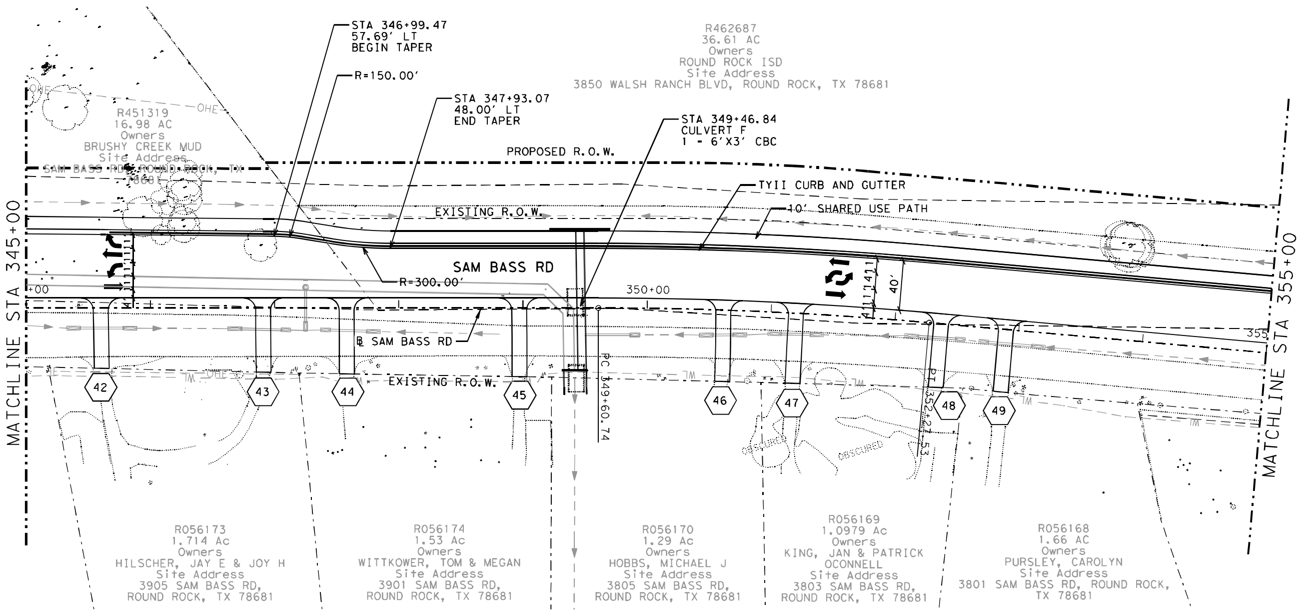

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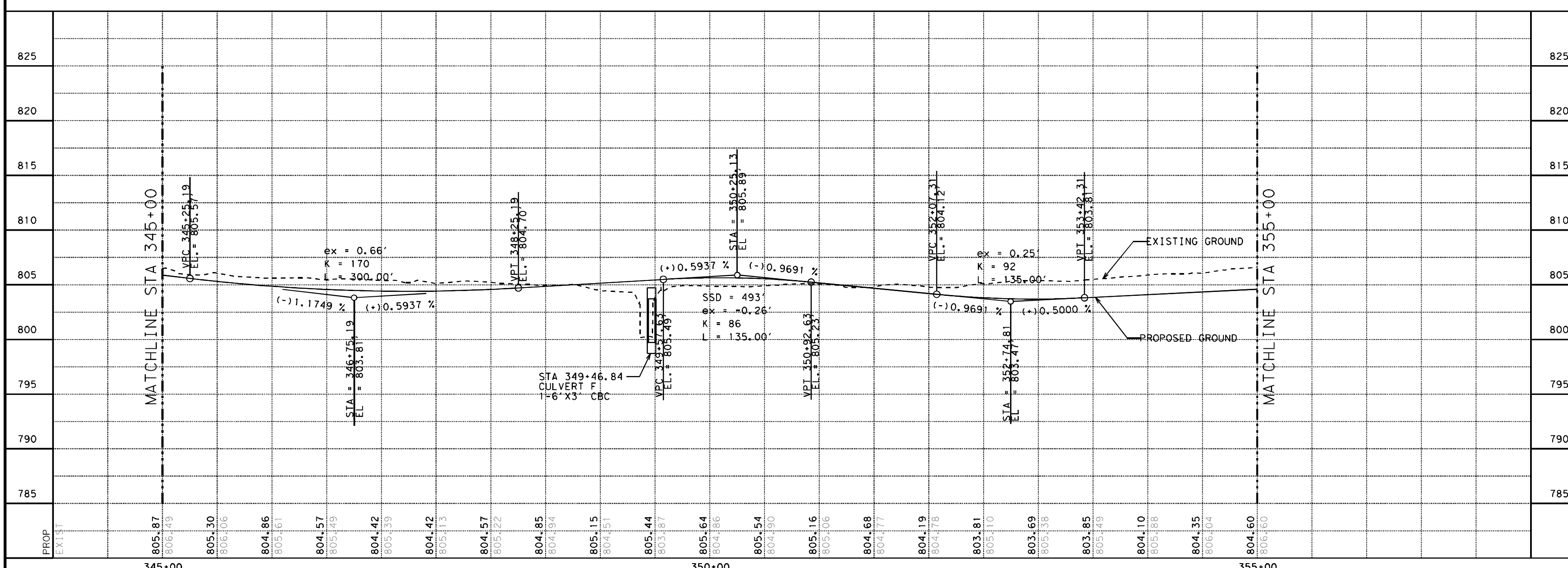

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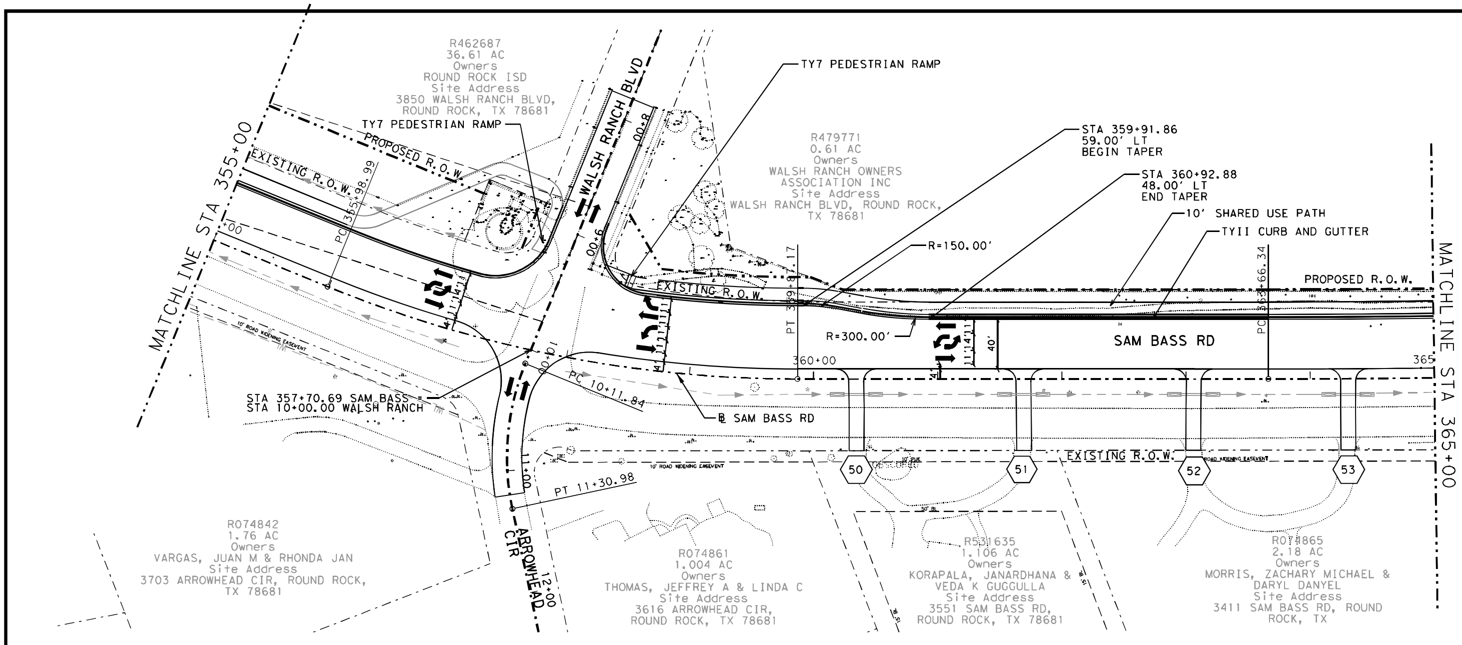

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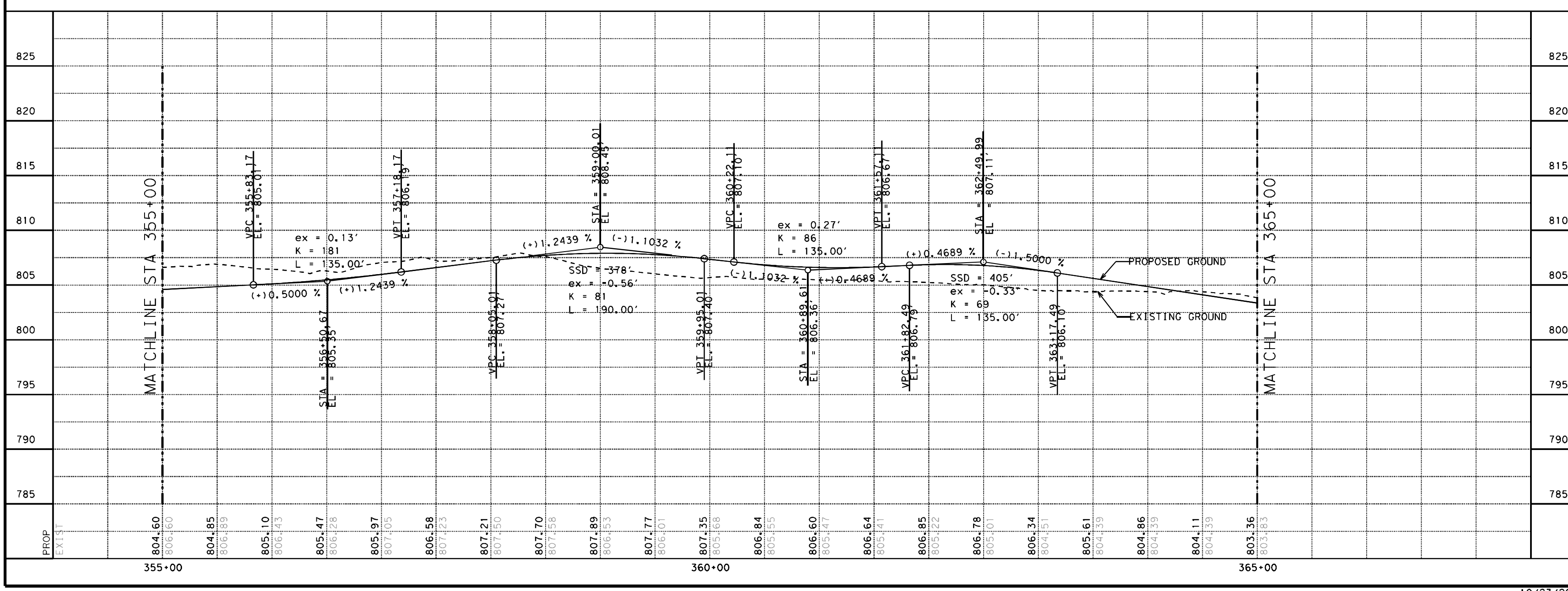

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TBPE NO. $ENGNO$
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K FRIESE + ASSOCIATES, INC.
1120 S. CAPITAL OF TEXAS HWY, II-100, AUSTIN, TX 78746

$CLIENT$
$PROJECT$
$SHTTITLE$
$SHTDESCRIP$

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING
(FIRM # 6535)

WILLIAMSON COUNTY 1848

$CLIENT$

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SCALE	$SCALE$
DATE	10/23/2020
SHEET NUMBER	$SN$$ST$

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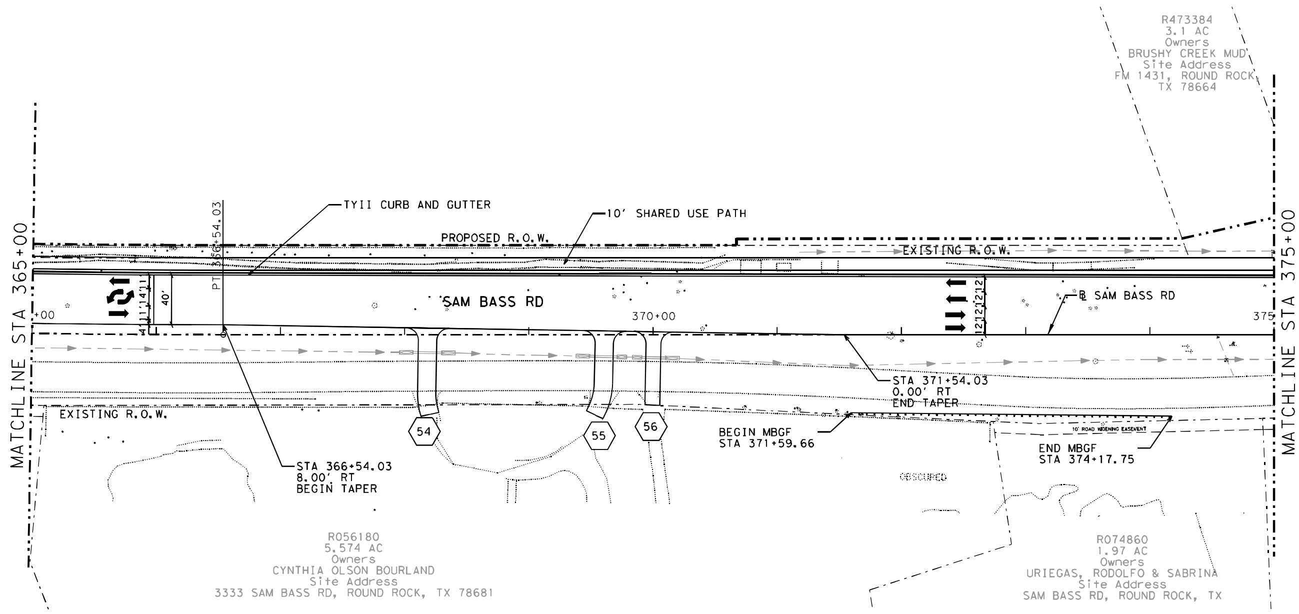

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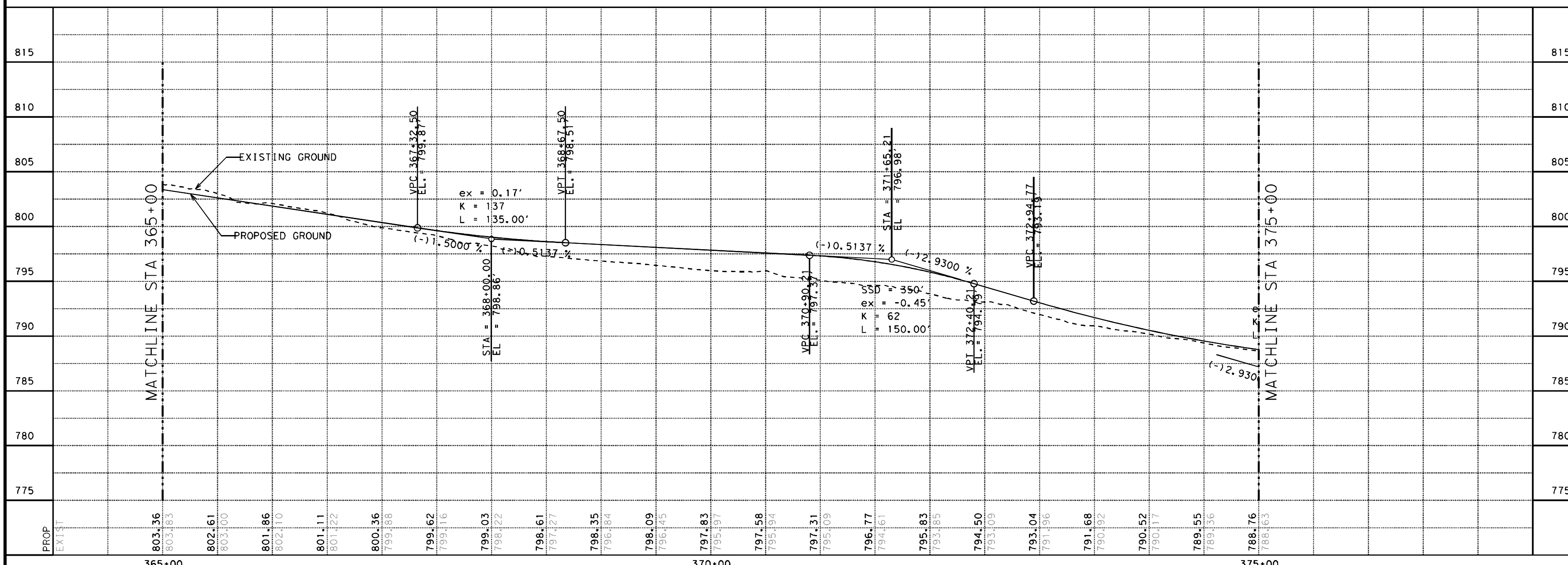
0 5 10

LEGEND

- EXIST EDGE OF PAVEMENT
- PROP EDGE OF PAVEMENT
- EXIST RIGHT OF WAY
- PROP RIGHT OF WAY
- EXIST EASEMENT
- PROP EASEMENT
- EXIST LANE
- PROP LANE
- BASELINE
- BRIDGE
- DITCH
- XX DRIVEWAY ID

NOTES

1. ALL UTILITIES SHALL BE FIELD VERIFIED PRIOR TO CONSTRUCTION. NOTIFY ENGINEER IMMEDIATELY IF CONFLICTS EXIST.



REV. NO.	BY	DATE	REVISION DESCRIPTION

THESE DOCUMENTS ARE FOR INTERIM REVIEW AND NOT FOR CONSTRUCTION, BIDDING OR PERMIT PURPOSES.

RESPONSIBLE ENGINEER: $ENGR$
TBPE NO. $ENGNO$
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1120 S. CAPITAL OF TEXAS HWY, II-100, AUSTIN, TX 78746

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$SHTTITLE$
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K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING
(FIRM # 6535)

WILLIAMSON COUNTY 1848

$CLIENT$

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SCALE	$SCALE$
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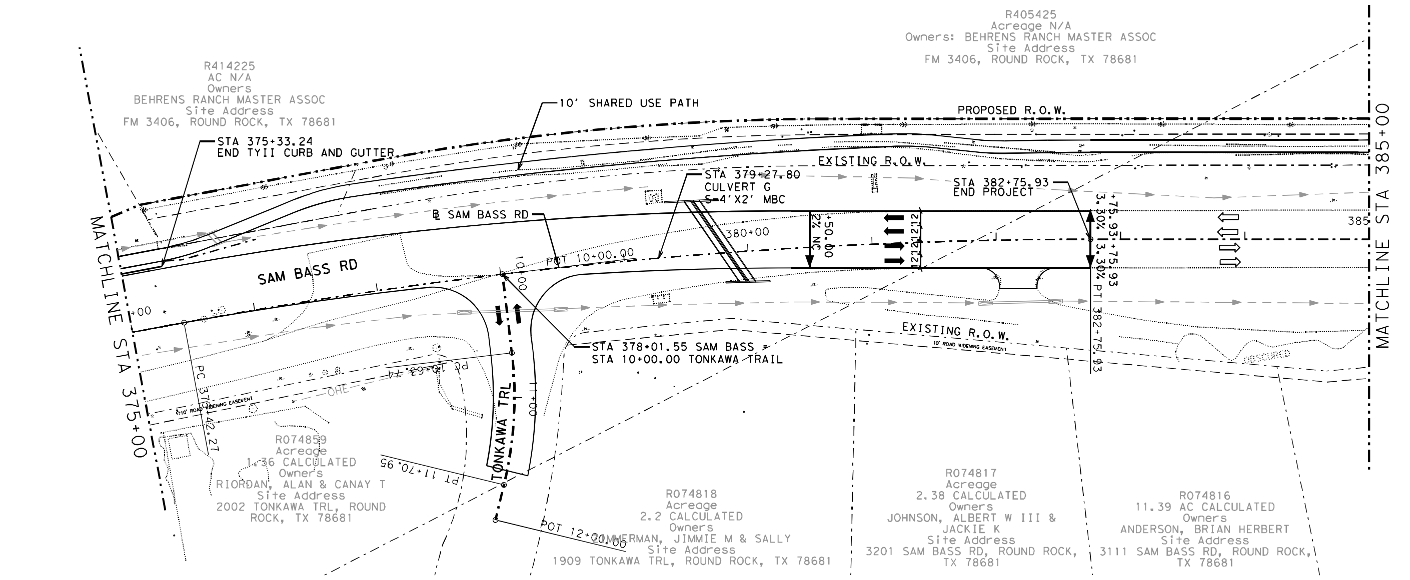

LEGEND

- EXIST EDGE OF PAVEMENT
- PROP EDGE OF PAVEMENT
- EXIST RIGHT OF WAY
- PROP RIGHT OF WAY
- EXIST EASEMENT
- PROP EASEMENT
- EXIST LANE
- PROP LANE
- BASELINE
- BRIDGE
- DITCH
- (XX) DRIVEWAY ID

NOTES

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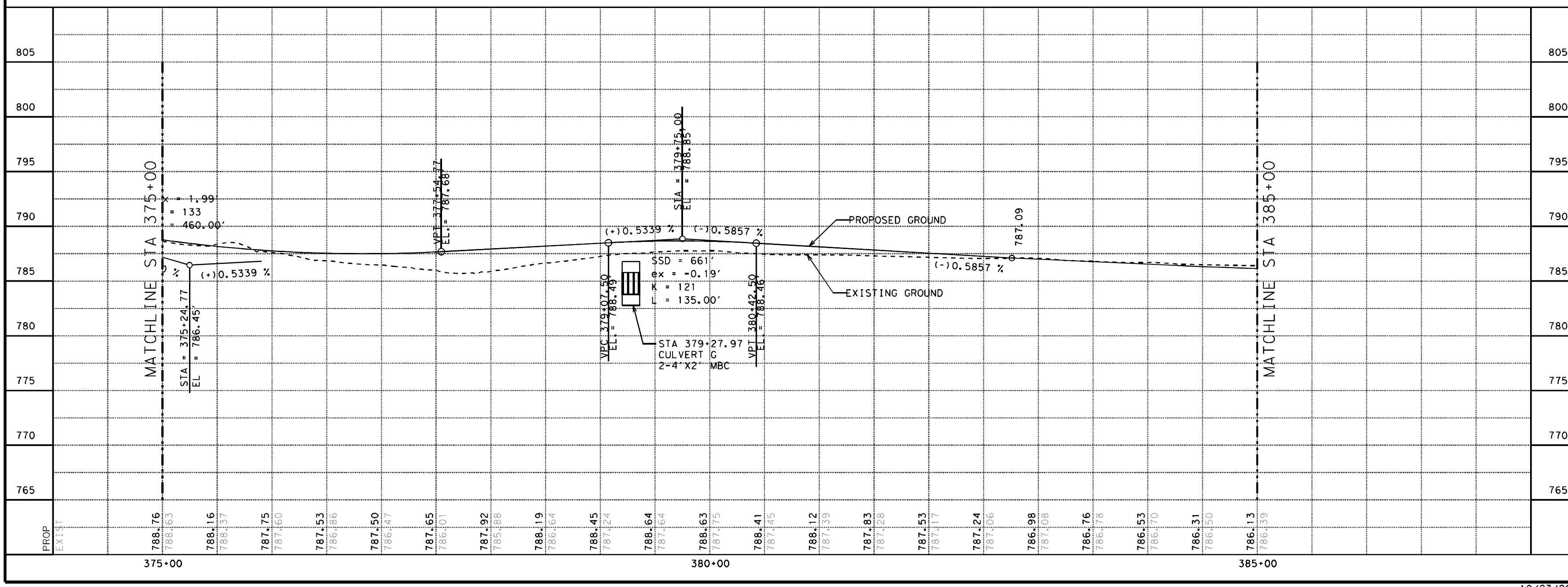

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RESPONSIBLE ENGINEER:
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1120 S. CAPITAL OF TEXAS HWY, II-100, AUSTIN, TX 78746

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(FIRM # 6535)

WILLIAMSON COUNTY 1848

$CLIENT$

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SHEET NUMBER	$SN$$ST$

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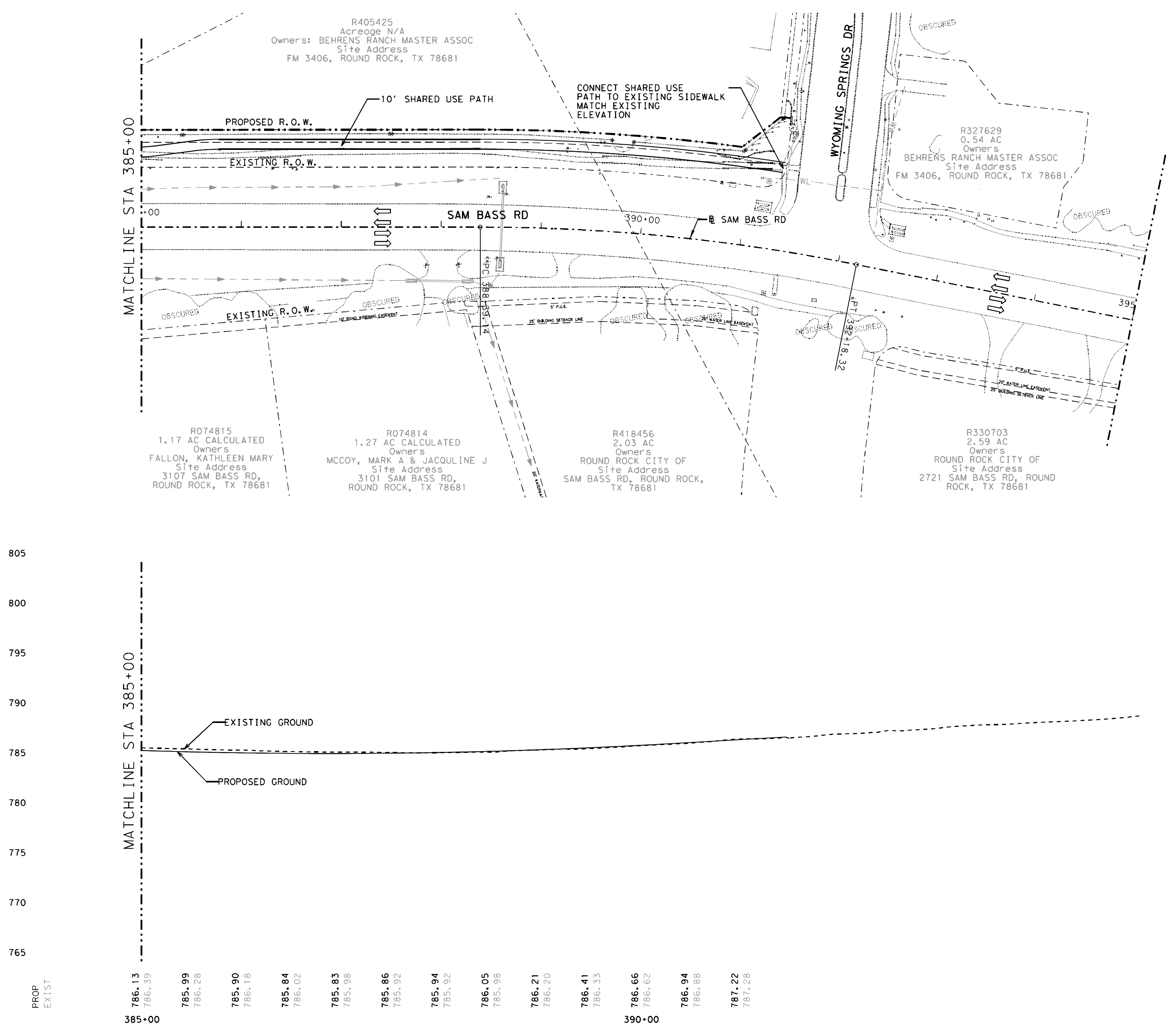

XX DRIVEWAY ID

NOTES

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$CLIENT$

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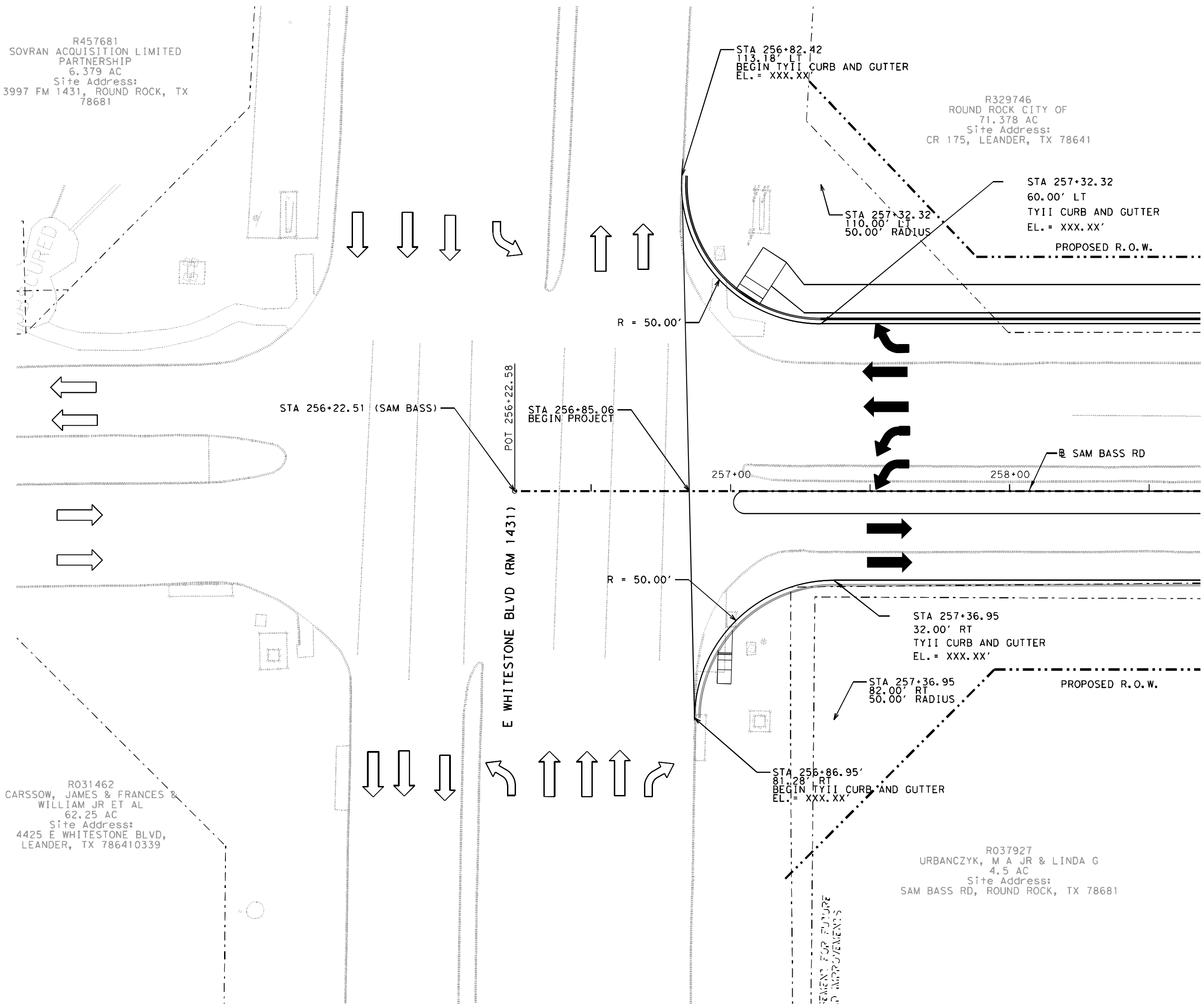

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LEGEND

- EXIST EDGE OF PAVEMENT
- PROP EDGE OF PAVEMENT
- EXIST RIGHT OF WAY
- PROP RIGHT OF WAY
- EXIST EASEMENT
- PROP EASEMENT
- EXIST LANE
- PROP LANE
- BASELINE
- BRIDGE
- DITCH

XX DRIVEWAY ID

NOTES

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WILLIAMSON COUNTY 1848

$CLIENT$

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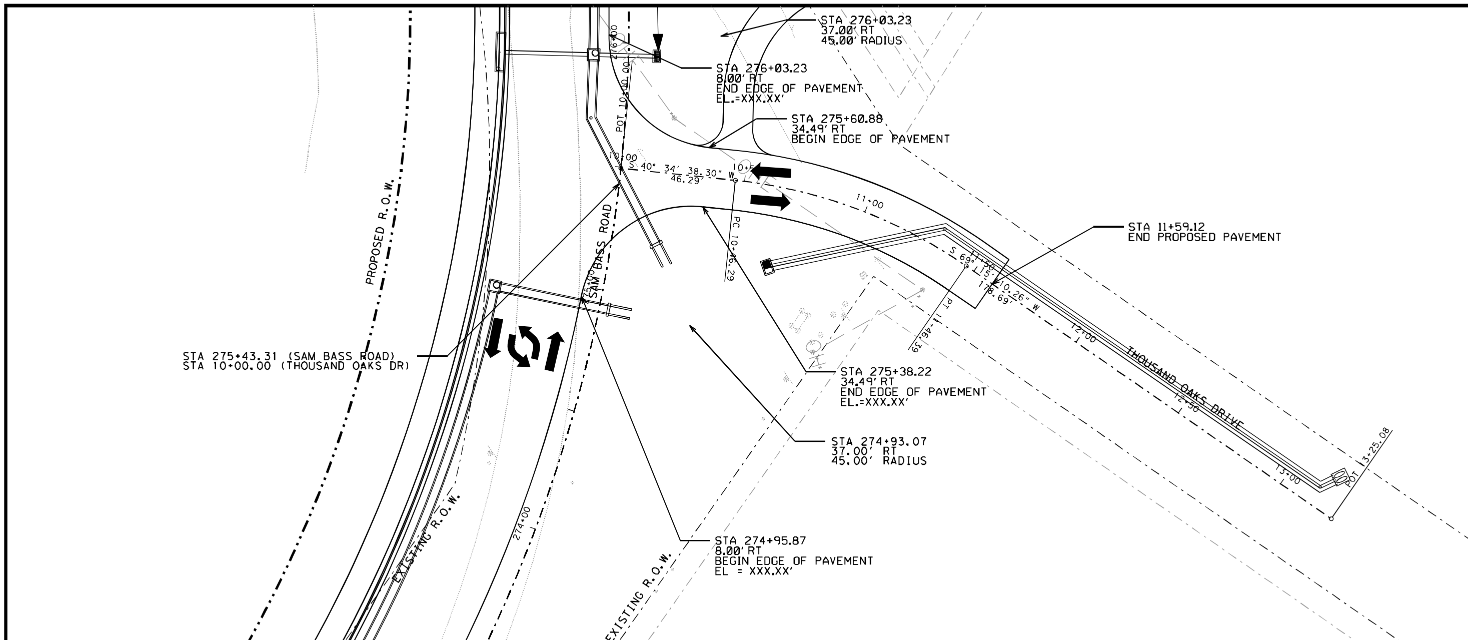

LEGEND

········	EXIST EDGE OF PAVEMENT
——	PROP EDGE OF PAVEMENT
- · · -	EXIST RIGHT OF WAY
- · · -	PROP RIGHT OF WAY
— —	EXIST EASEMENT
- - -	PROP EASEMENT
⇨	EXIST LANE
➡	PROP LANE
- · -	BASELINE
- - -	BRIDGE
-▸-	DITCH
(XX)	DRIVEWAY ID

Scale: 0 20 40 (H); 0 2 4 (V)

NOTES

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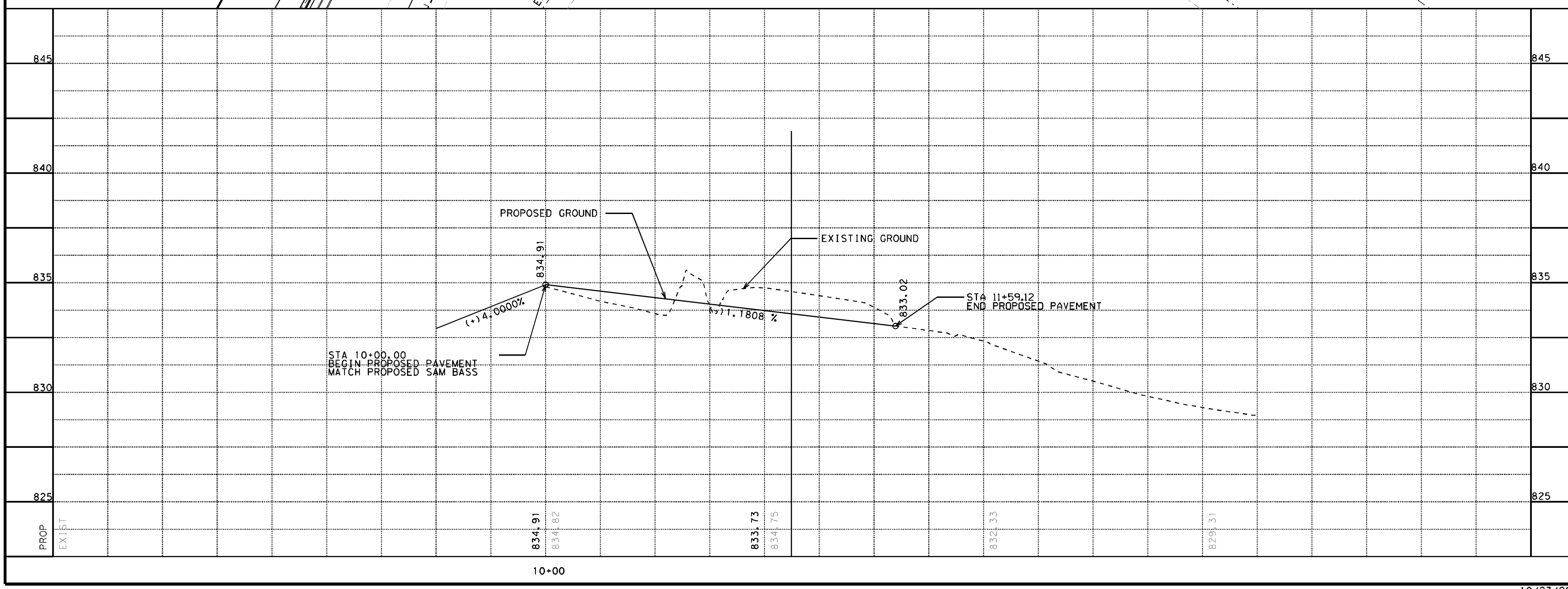

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1120 S. CAPITAL OF TEXAS HWY, II-100, AUSTIN, TX 78746

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$PROJECT$
$SHTTITLE$
$SHTDESCRIP$

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PUBLIC PROJECT ENGINEERING (FIRM # 6535)

WILLIAMSON COUNTY 1848

$CLIENT$

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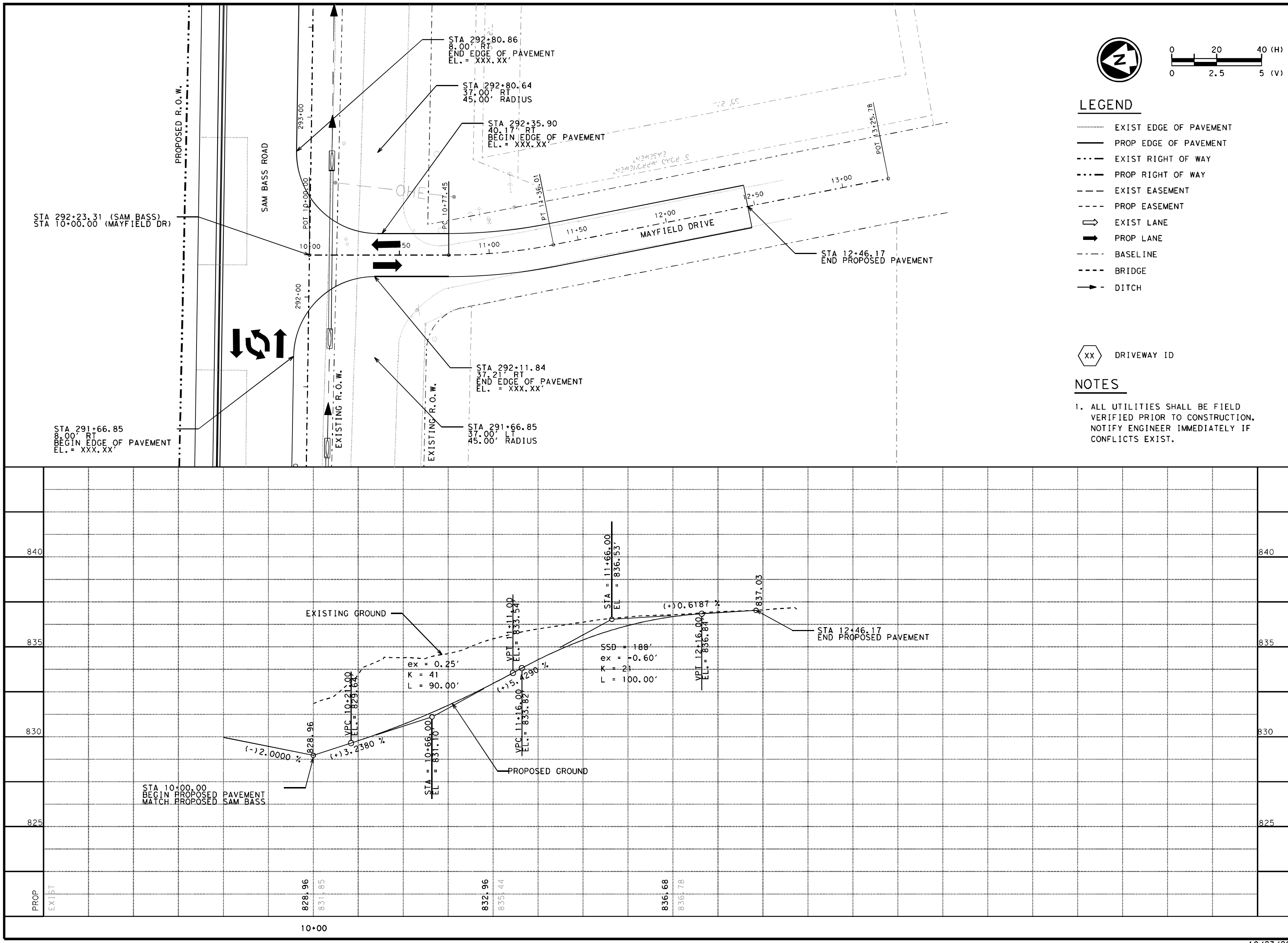

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K FRIESE + ASSOCIATES, INC.
1120 S. CAPITAL OF TEXAS HWY, II-100, AUSTIN, TX 78746

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WILLIAMSON COUNTY 1848

$CLIENT$

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SCALE	$SCALE$
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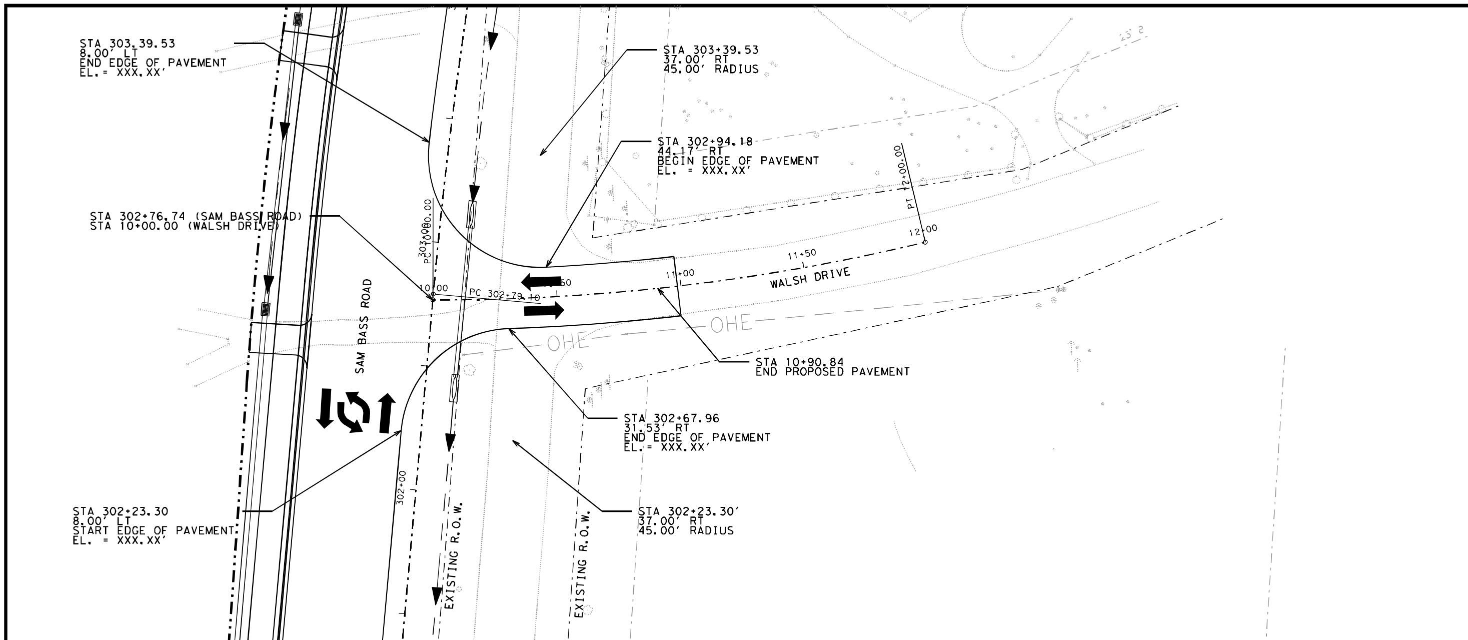

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LEGEND

- EXIST EDGE OF PAVEMENT
- PROP EDGE OF PAVEMENT
- EXIST RIGHT OF WAY
- PROP RIGHT OF WAY
- EXIST EASEMENT
- PROP EASEMENT
- EXIST LANE
- PROP LANE
- BASELINE
- BRIDGE
- DITCH

XX DRIVEWAY ID

NOTES

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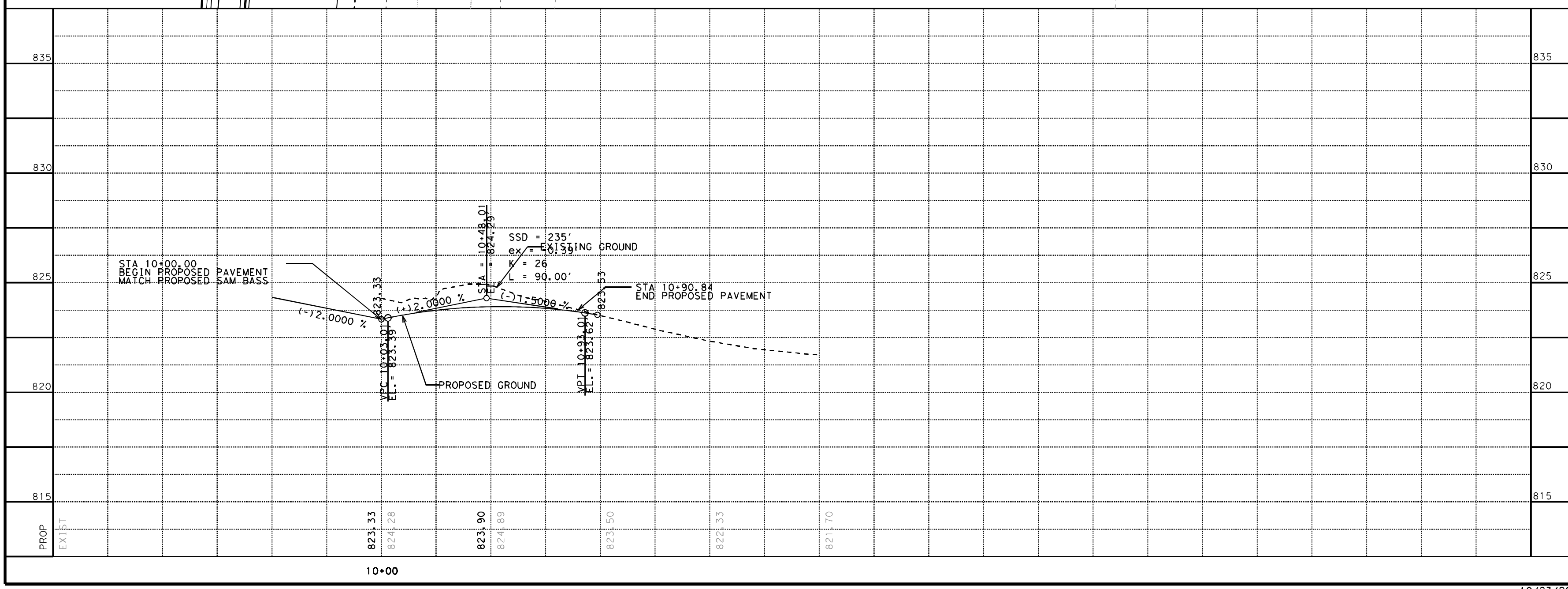

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WILLIAMSON COUNTY 1848

$CLIENT$

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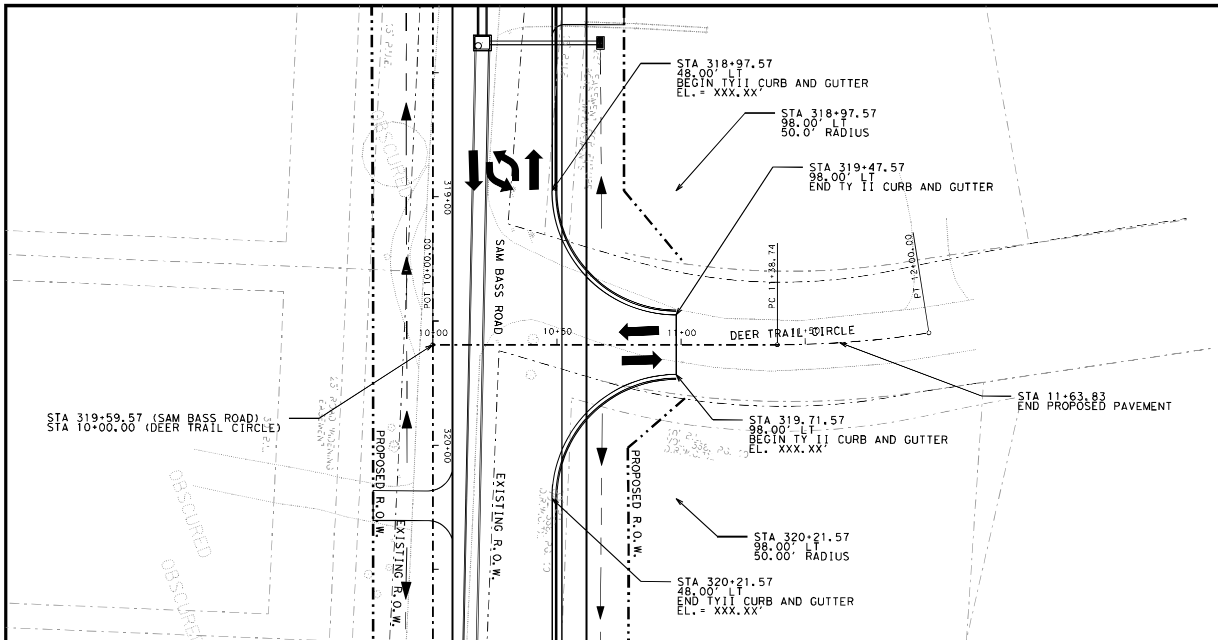

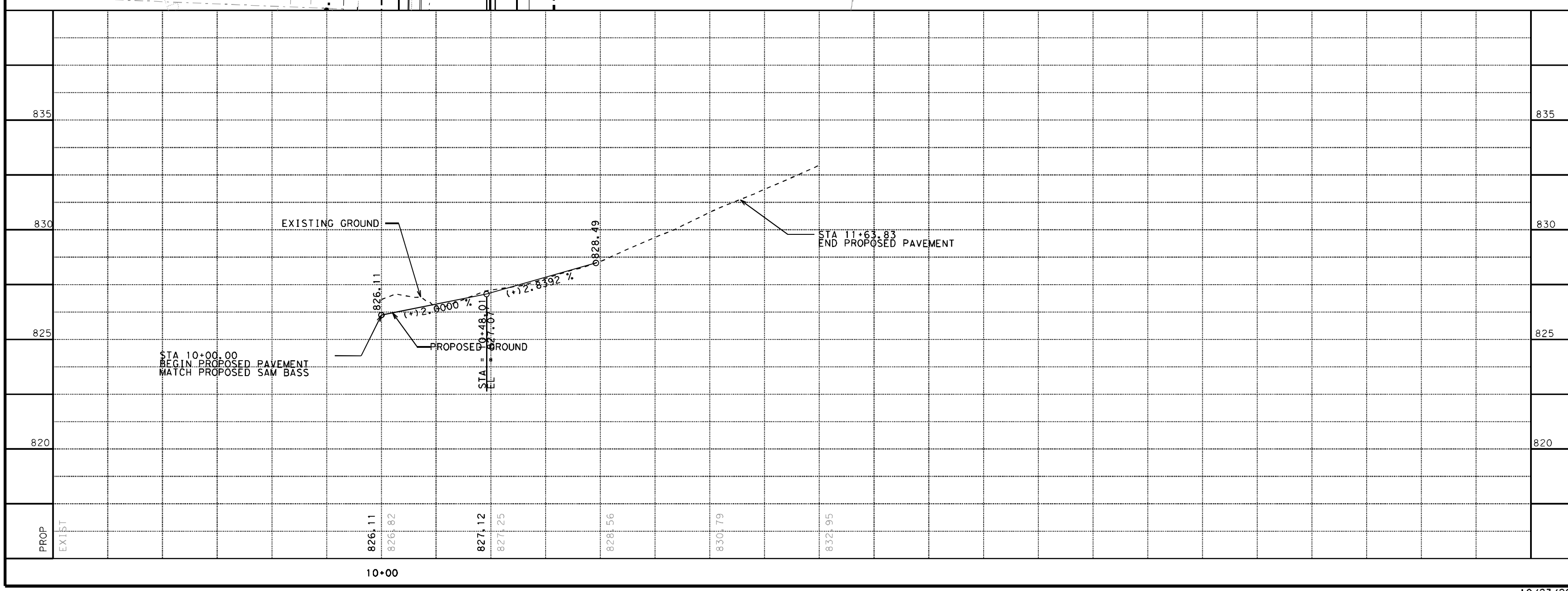

0 20 40 (H)
0 2.5 5 (V)

LEGEND

- EXIST EDGE OF PAVEMENT
- PROP EDGE OF PAVEMENT
- EXIST RIGHT OF WAY
- PROP RIGHT OF WAY
- EXIST EASEMENT
- PROP EASEMENT
- EXIST LANE
- PROP LANE
- BASELINE
- BRIDGE
- DITCH

XX DRIVEWAY ID

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$CLIENT$
$PROJECT$
$SHTTITLE$
$SHTDESCRIP$

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(FIRM # 6535)

WILLIAMSON COUNTY 1848

$CLIENT$

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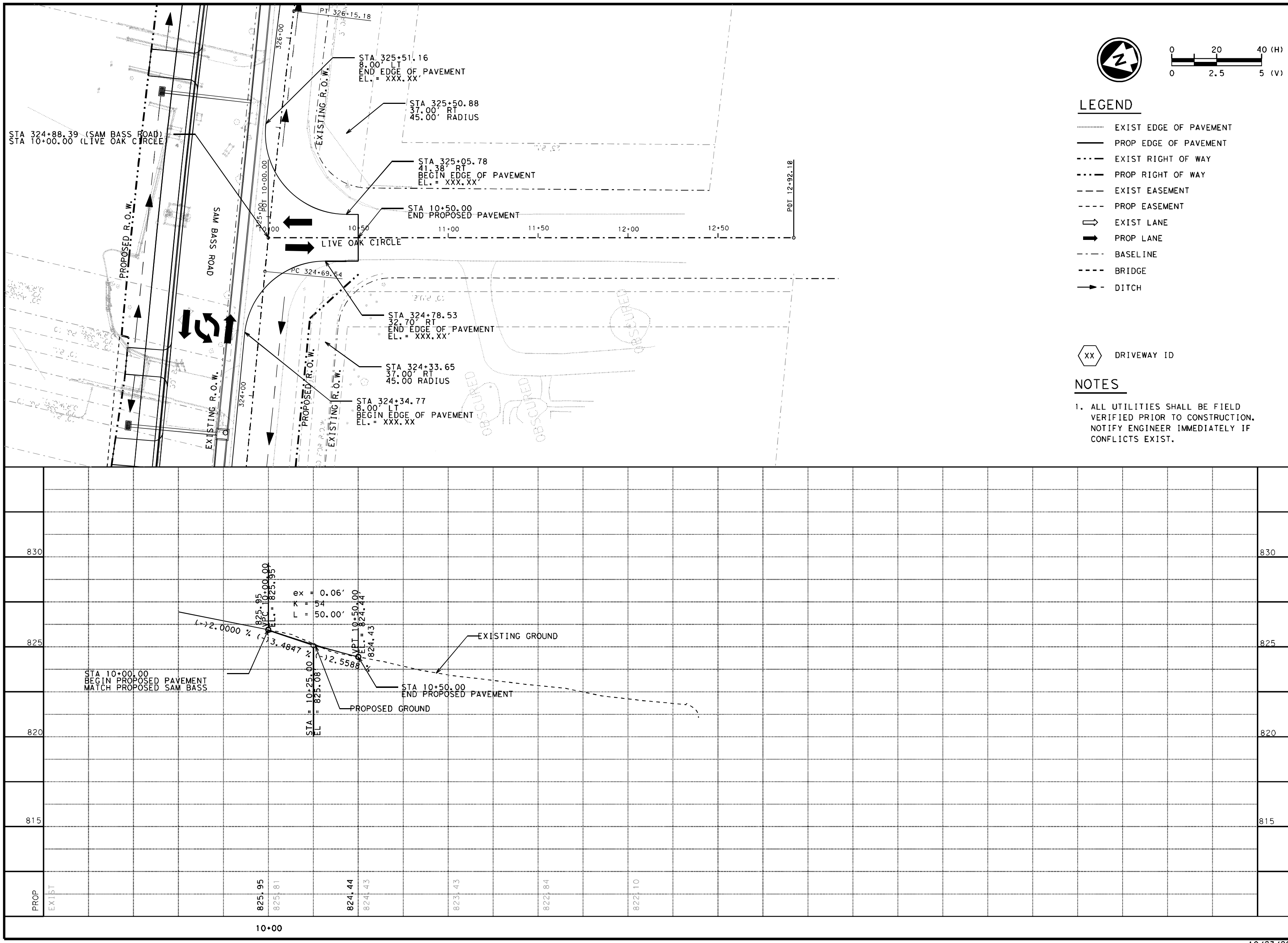

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$SHTDESCRIP$

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WILLIAMSON COUNTY 1848

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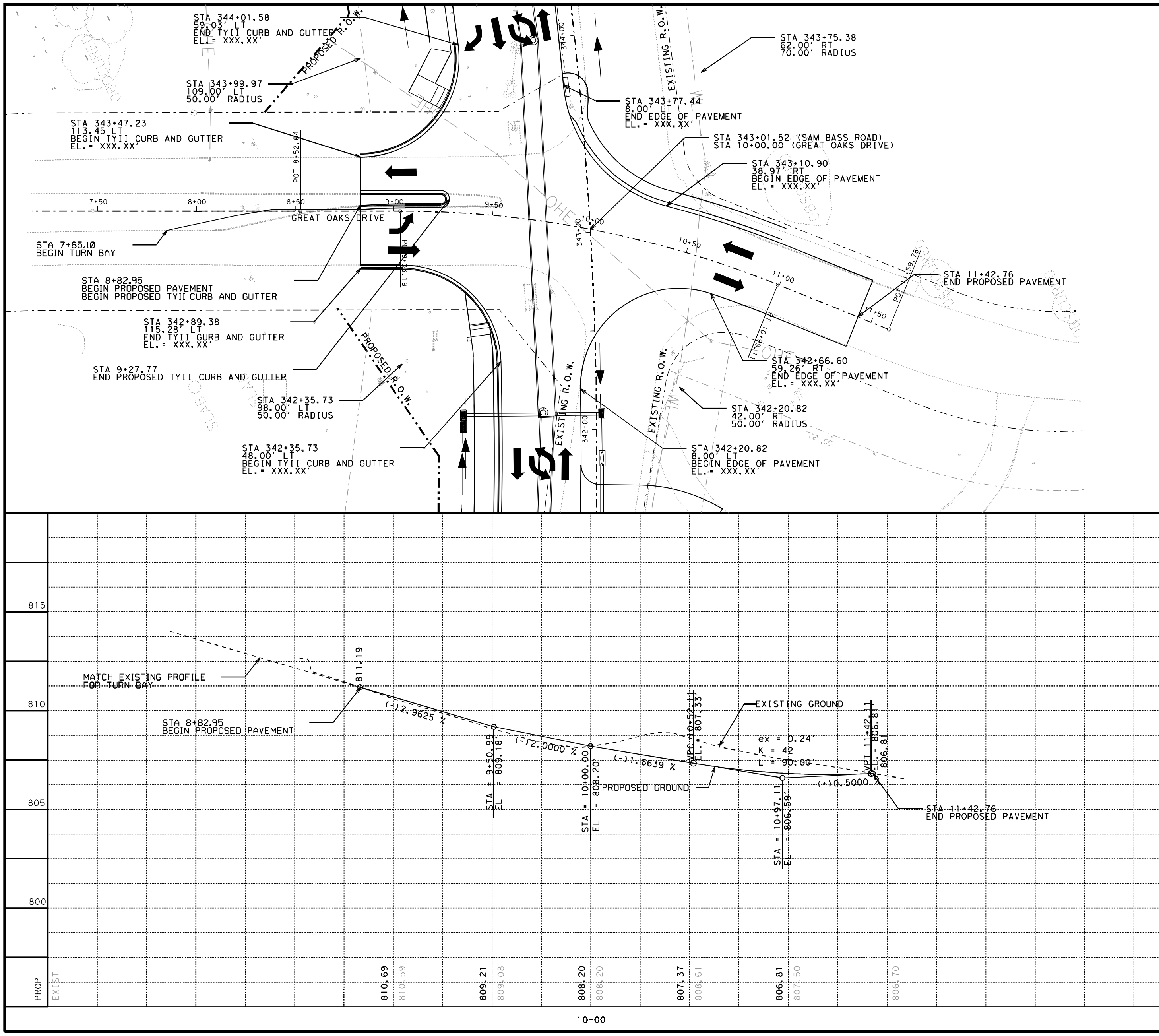

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0 2.5 5 (V)

LEGEND

- EXIST EDGE OF PAVEMENT
- PROP EDGE OF PAVEMENT
- EXIST RIGHT OF WAY
- PROP RIGHT OF WAY
- EXIST EASEMENT
- PROP EASEMENT
- EXIST LANE
- PROP LANE
- BASELINE
- BRIDGE
- DITCH

XX DRIVEWAY ID

NOTES

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$CLIENT$
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PUBLIC PROJECT ENGINEERING
(FIRM # 6535)

WILLIAMSON COUNTY 1848

$CLIENT$

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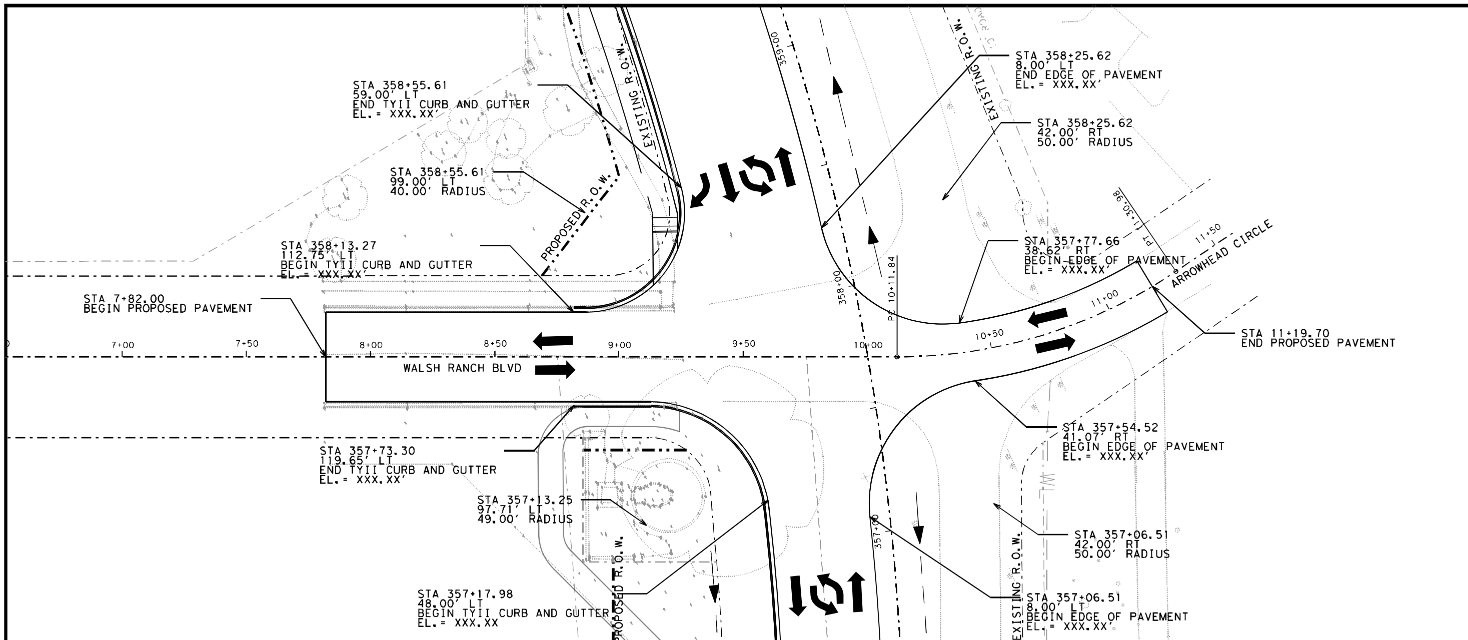

LEGEND

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- PROP EDGE OF PAVEMENT
- EXIST RIGHT OF WAY
- PROP RIGHT OF WAY
- EXIST EASEMENT
- PROP EASEMENT
- EXIST LANE
- PROP LANE
- BASELINE
- BRIDGE
- DITCH

0 20 40 (H)
0 2.5 5 (V)

XX DRIVEWAY ID

NOTES

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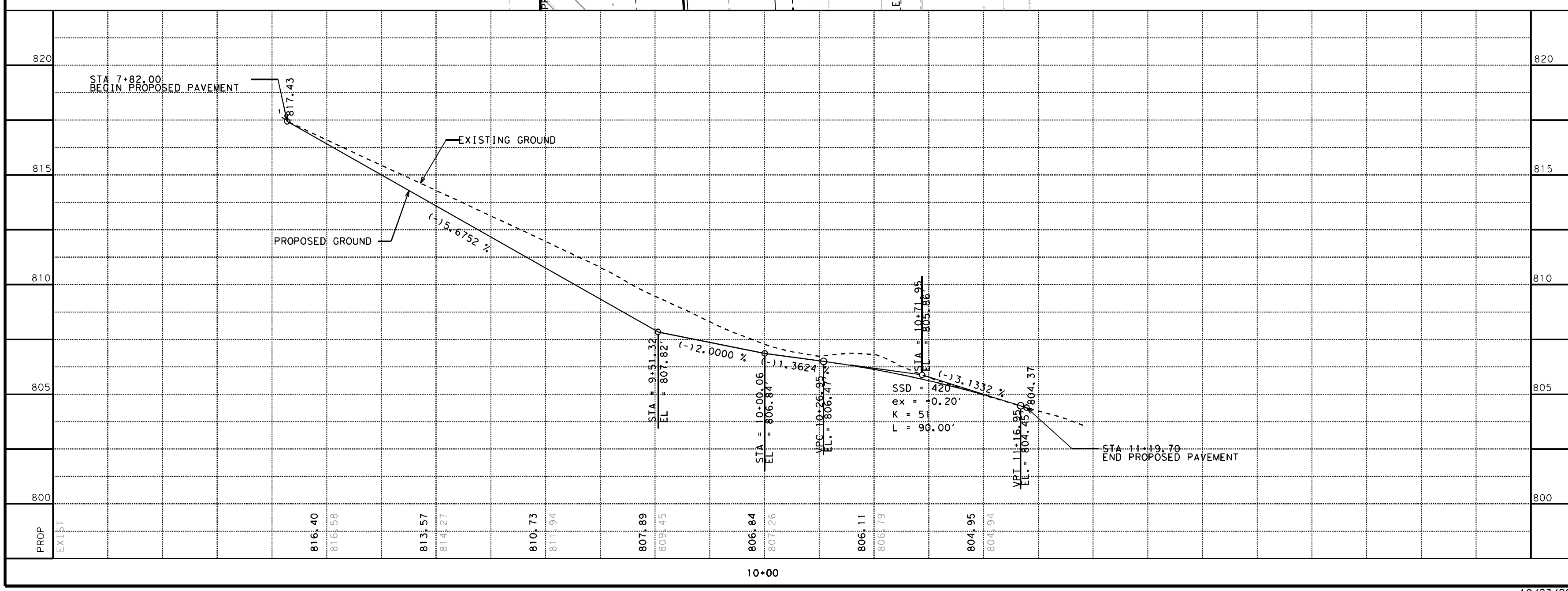

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PUBLIC PROJECT ENGINEERING
(FIRM # 6535)

WILLIAMSON COUNTY 1848

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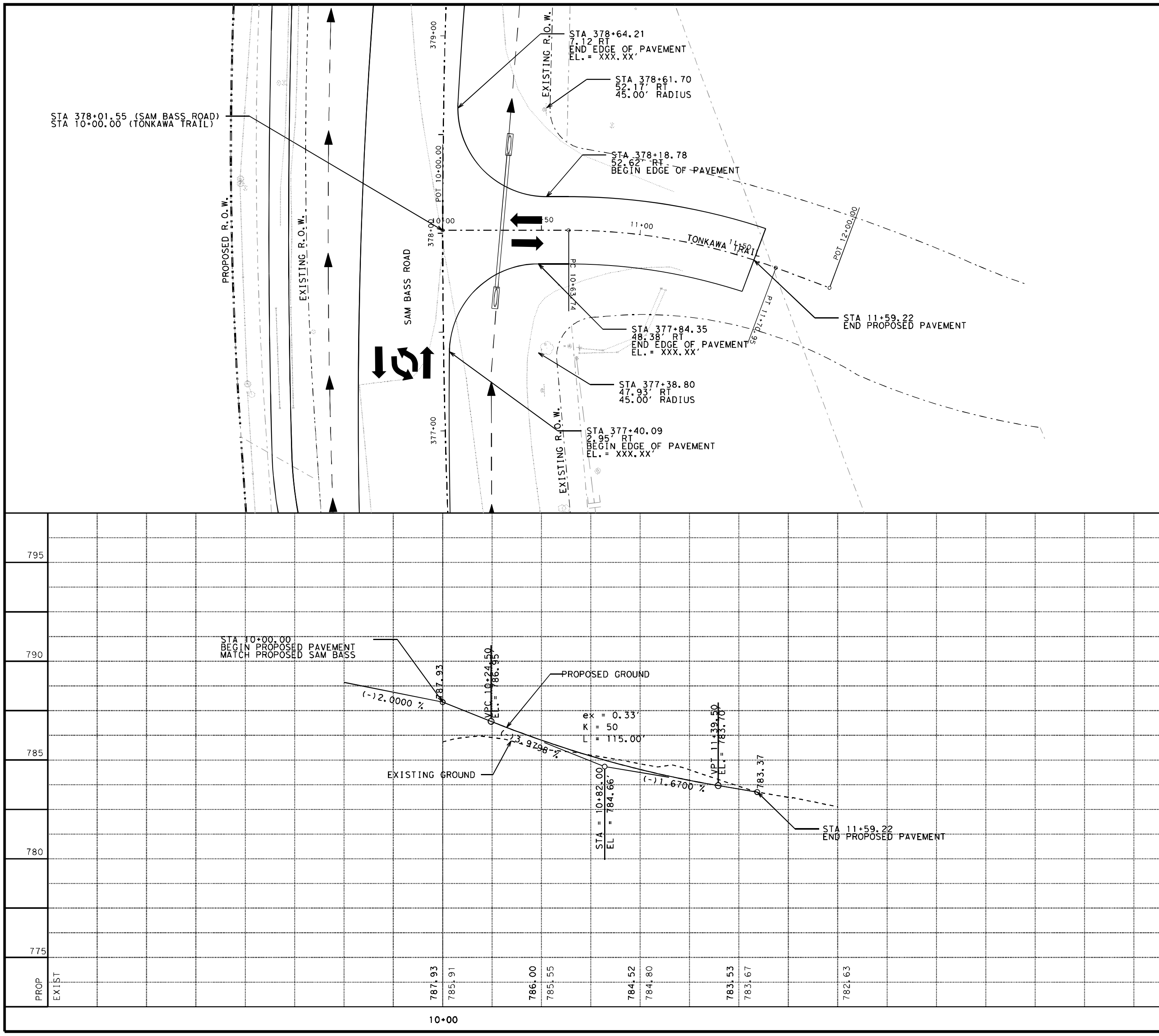

LEGEND

- EXIST EDGE OF PAVEMENT
- PROP EDGE OF PAVEMENT
- EXIST RIGHT OF WAY
- PROP RIGHT OF WAY
- EXIST EASEMENT
- PROP EASEMENT
- EXIST LANE
- PROP LANE
- BASELINE
- BRIDGE
- DITCH

0 25 50 (H)
0 2.5 25 (V)

XX DRIVEWAY ID

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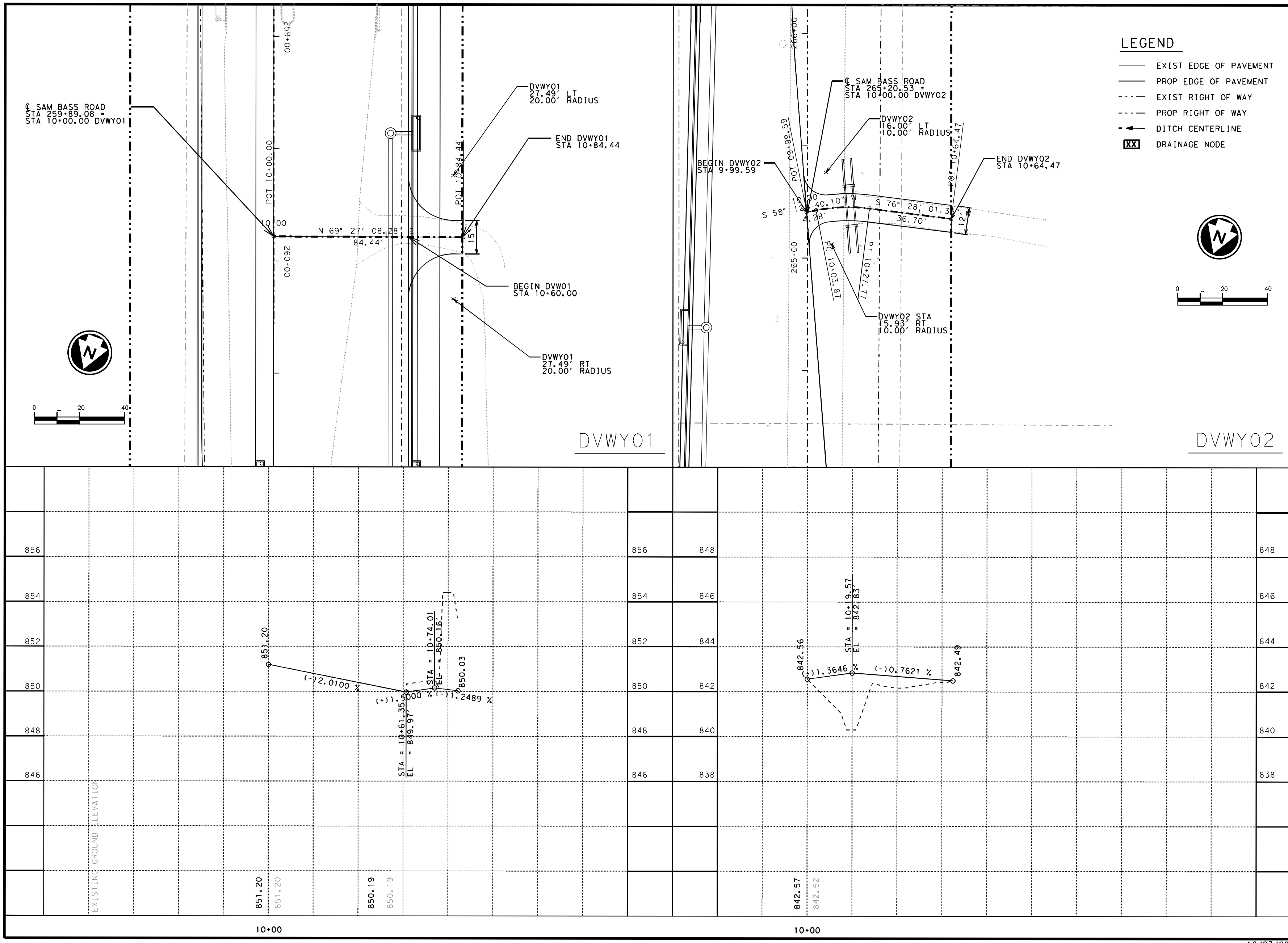

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WILLIAMSON COUNTY 1848

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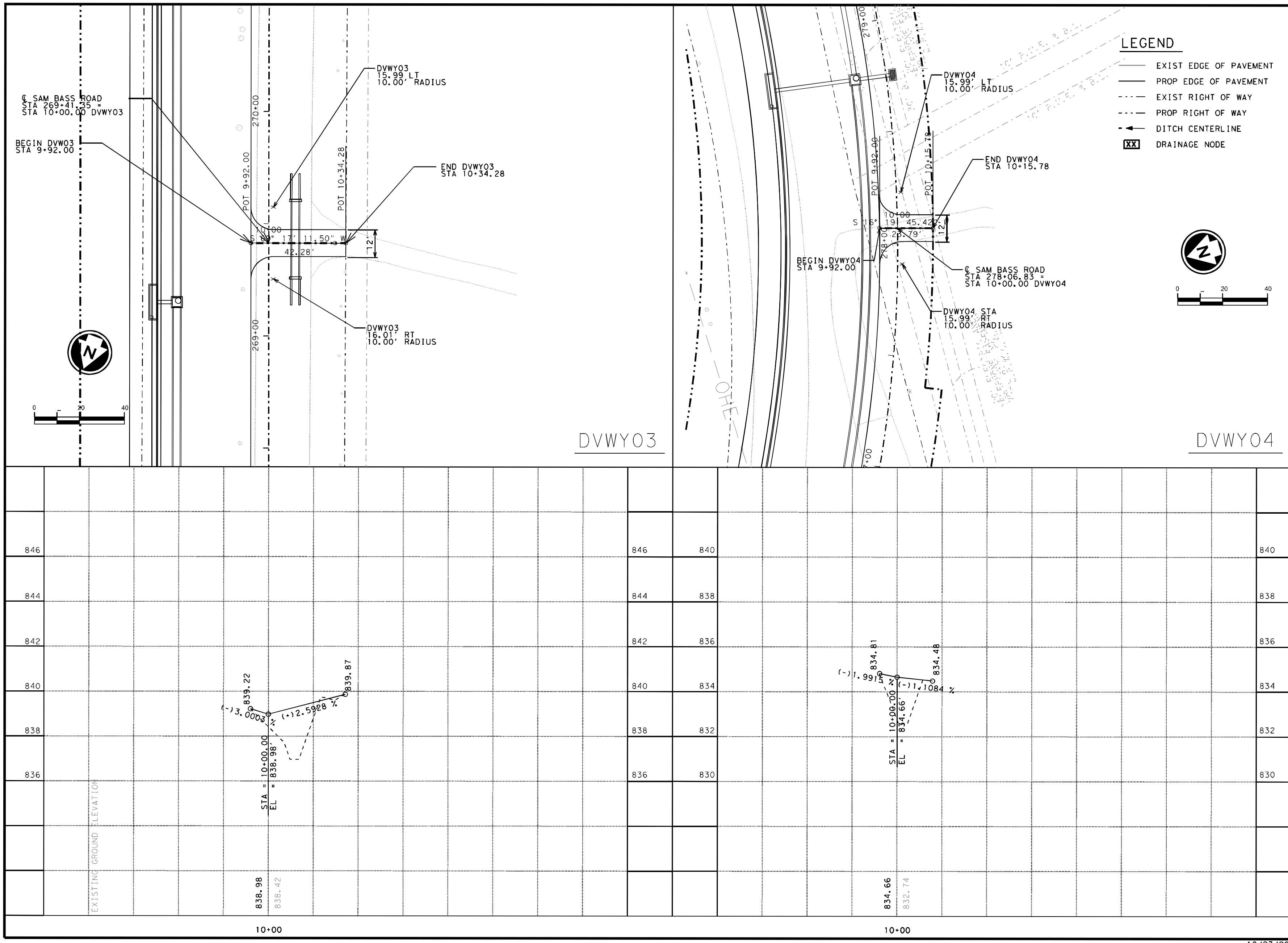

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WILLIAMSON COUNTY 1848

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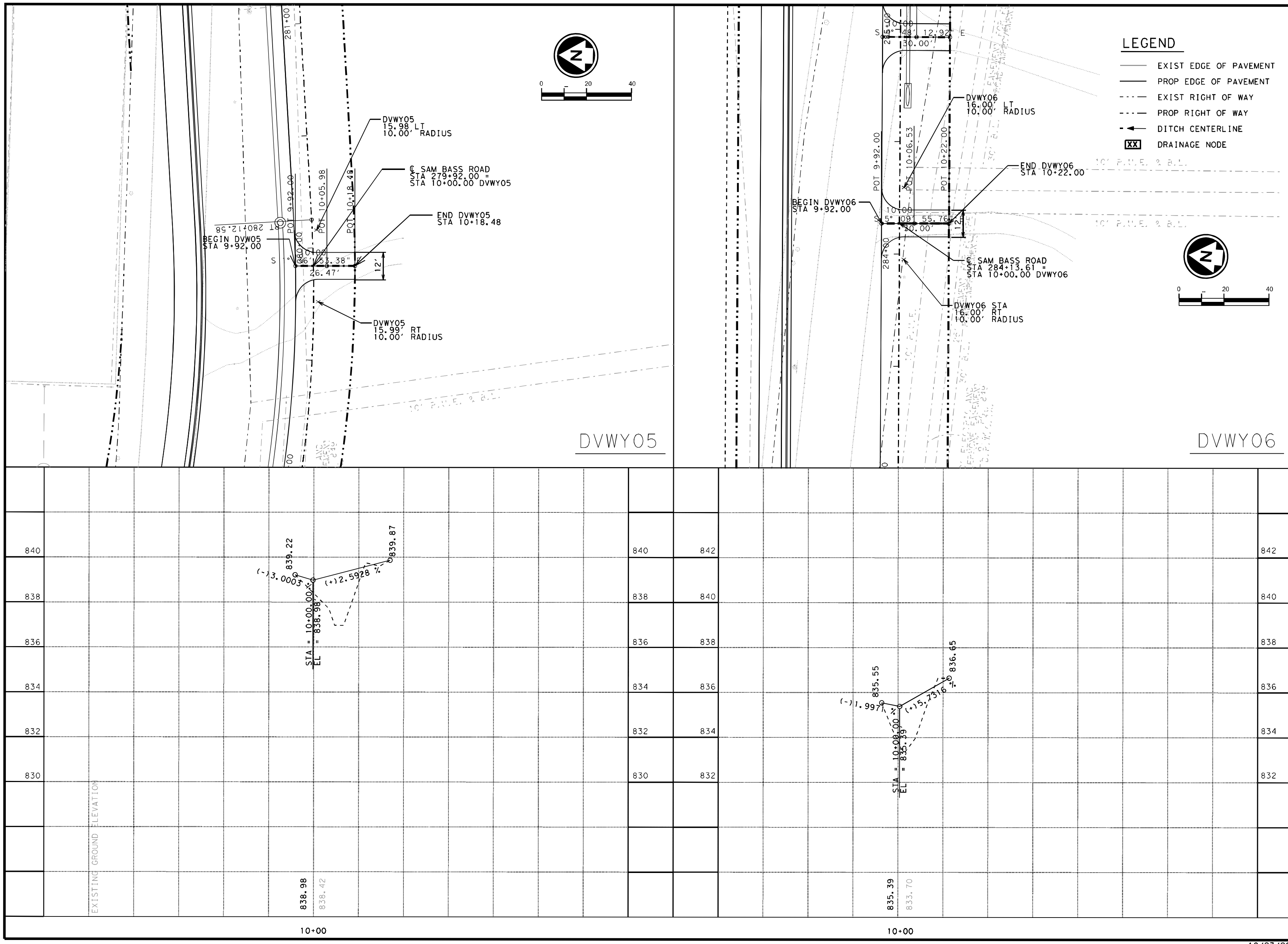

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WILLIAMSON COUNTY 1848

$CLIENT$

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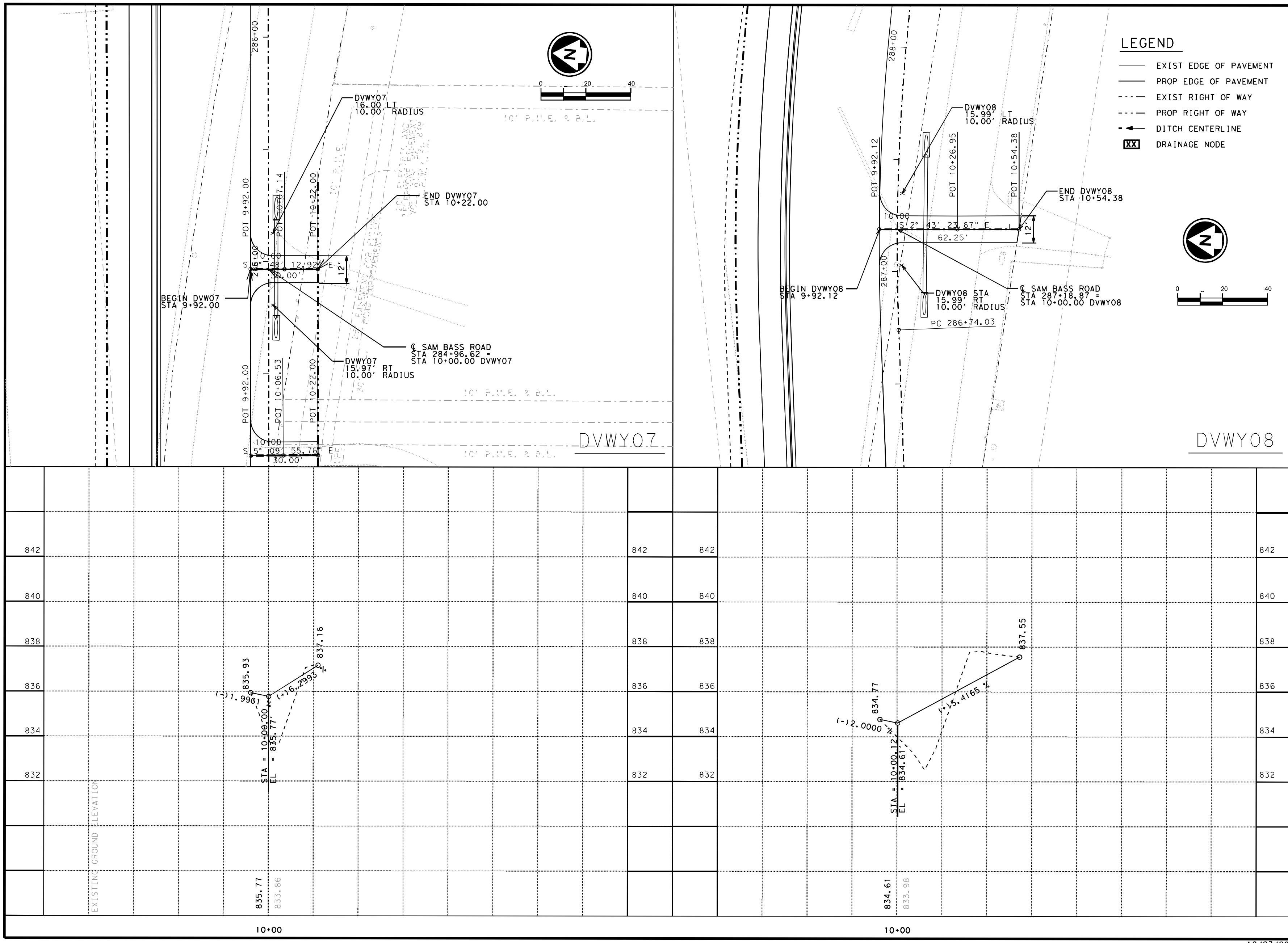

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RESPONSIBLE ENGINEER:
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TBPE NO. $ENGNO$
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1120 S. CAPITAL OF TEXAS HWY, II-100, AUSTIN, TX 78746

$CLIENT$
$PROJECT$
$SHTTITLE$
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PUBLIC PROJECT ENGINEERING
(FIRM # 6535)

WILLIAMSON COUNTY 1848

$CLIENT$

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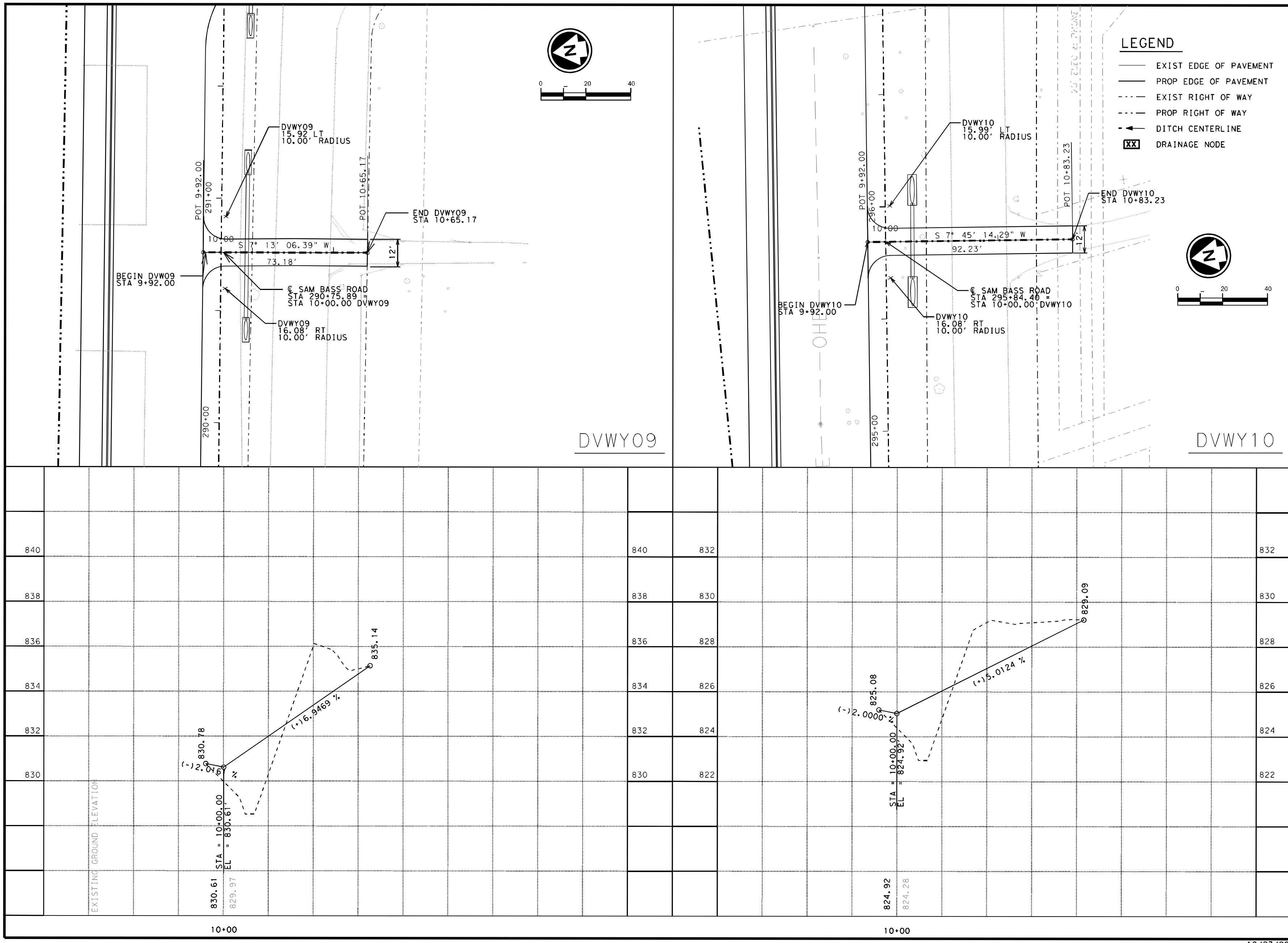

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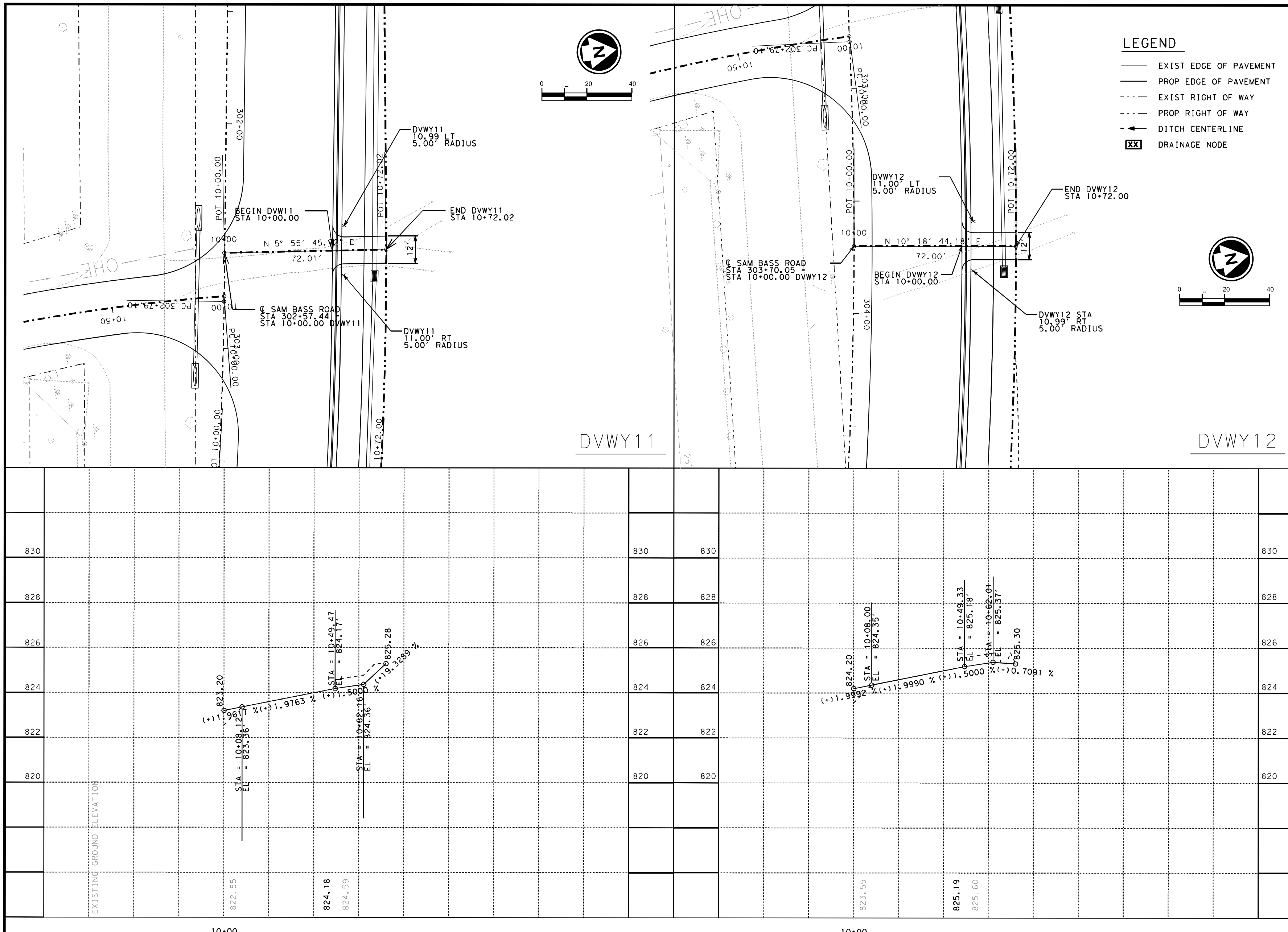

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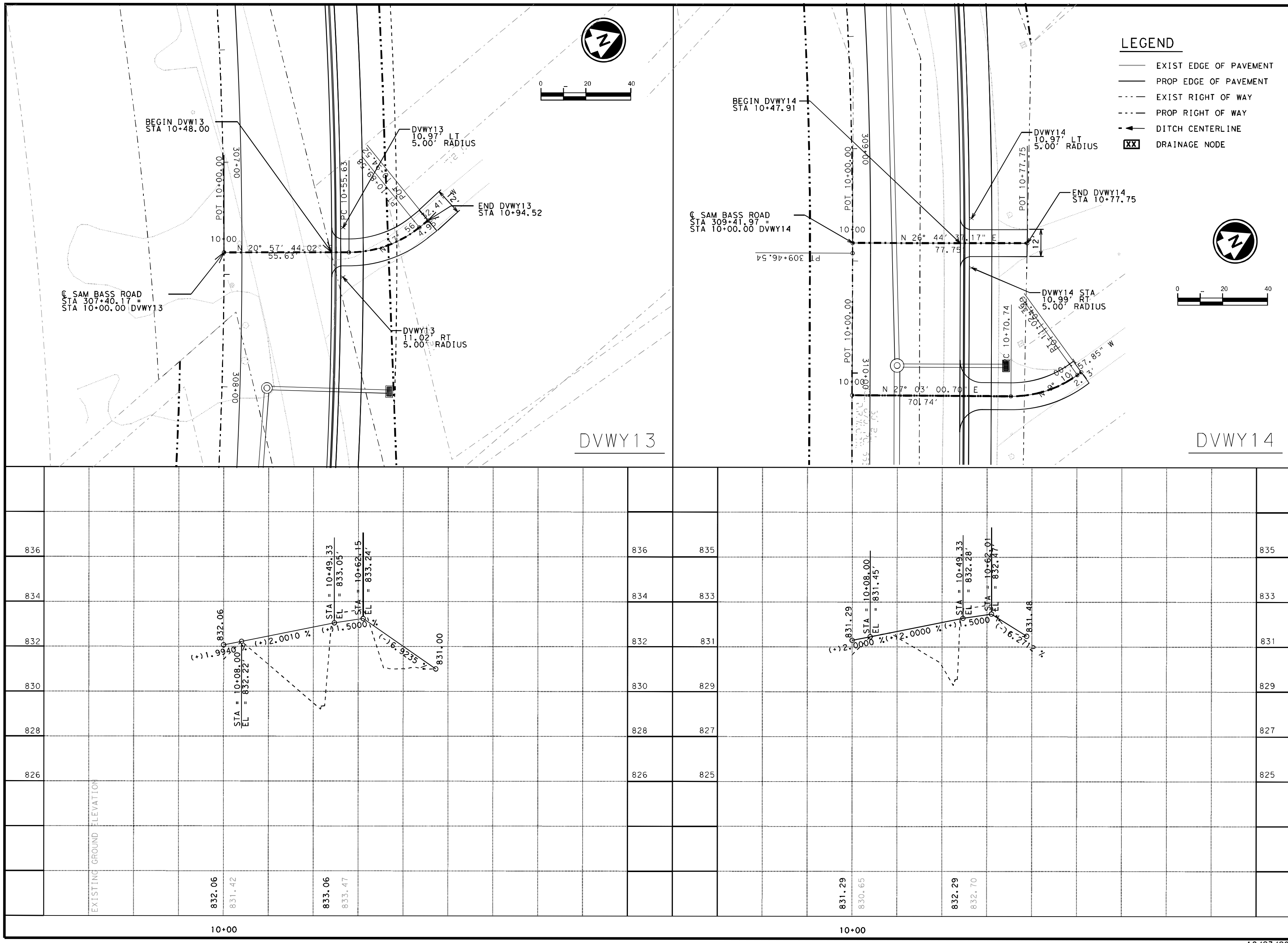

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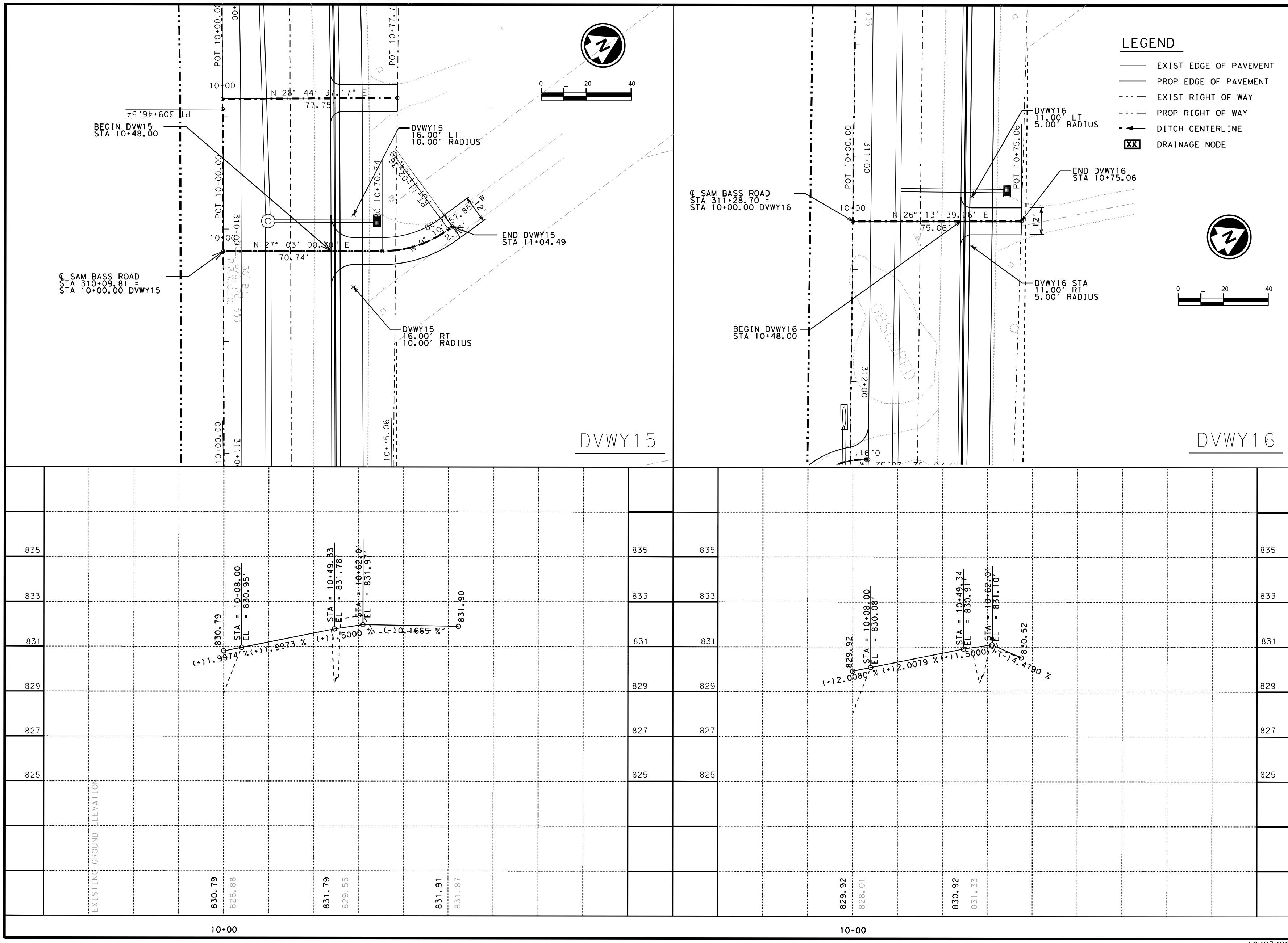

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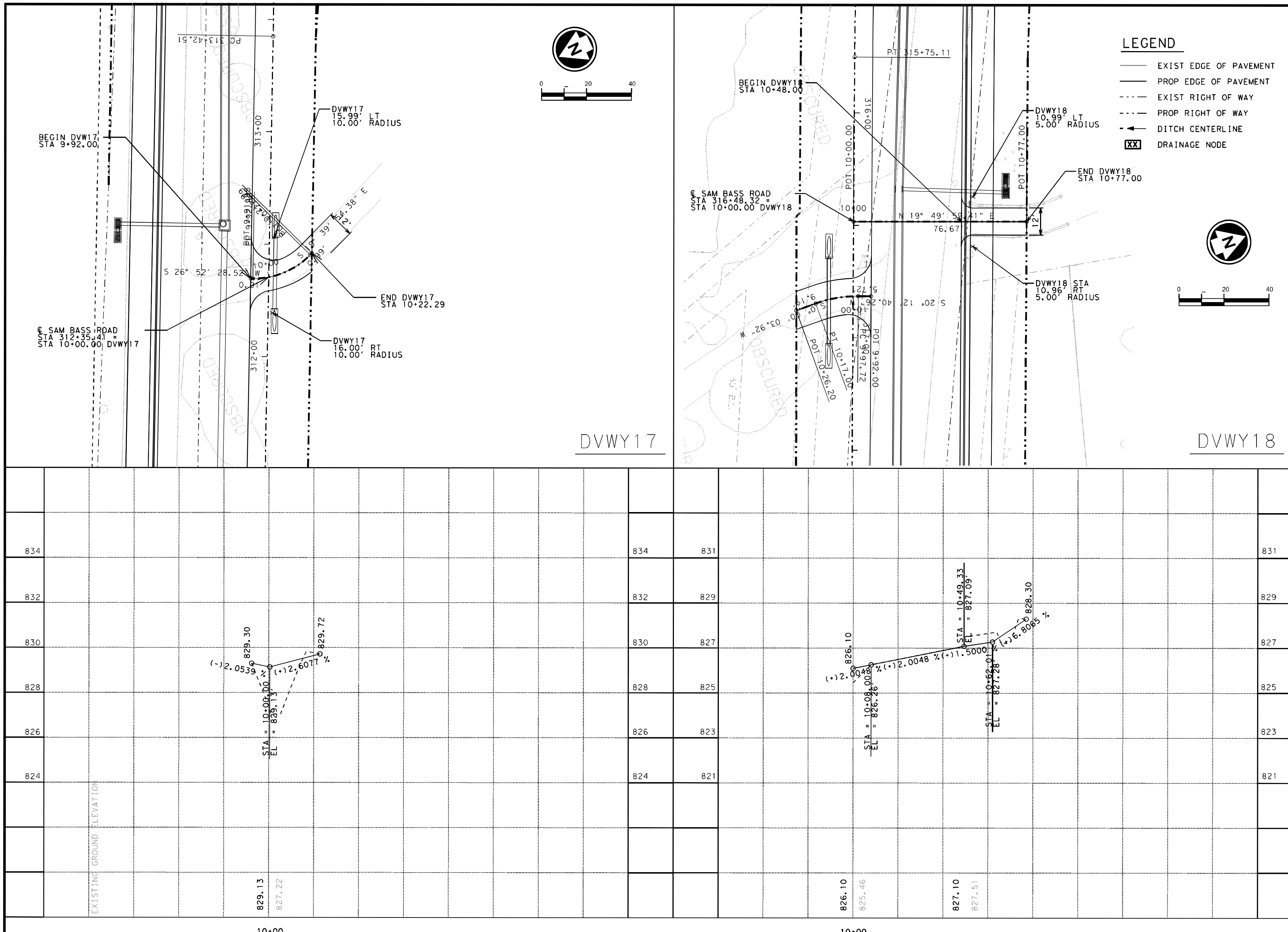

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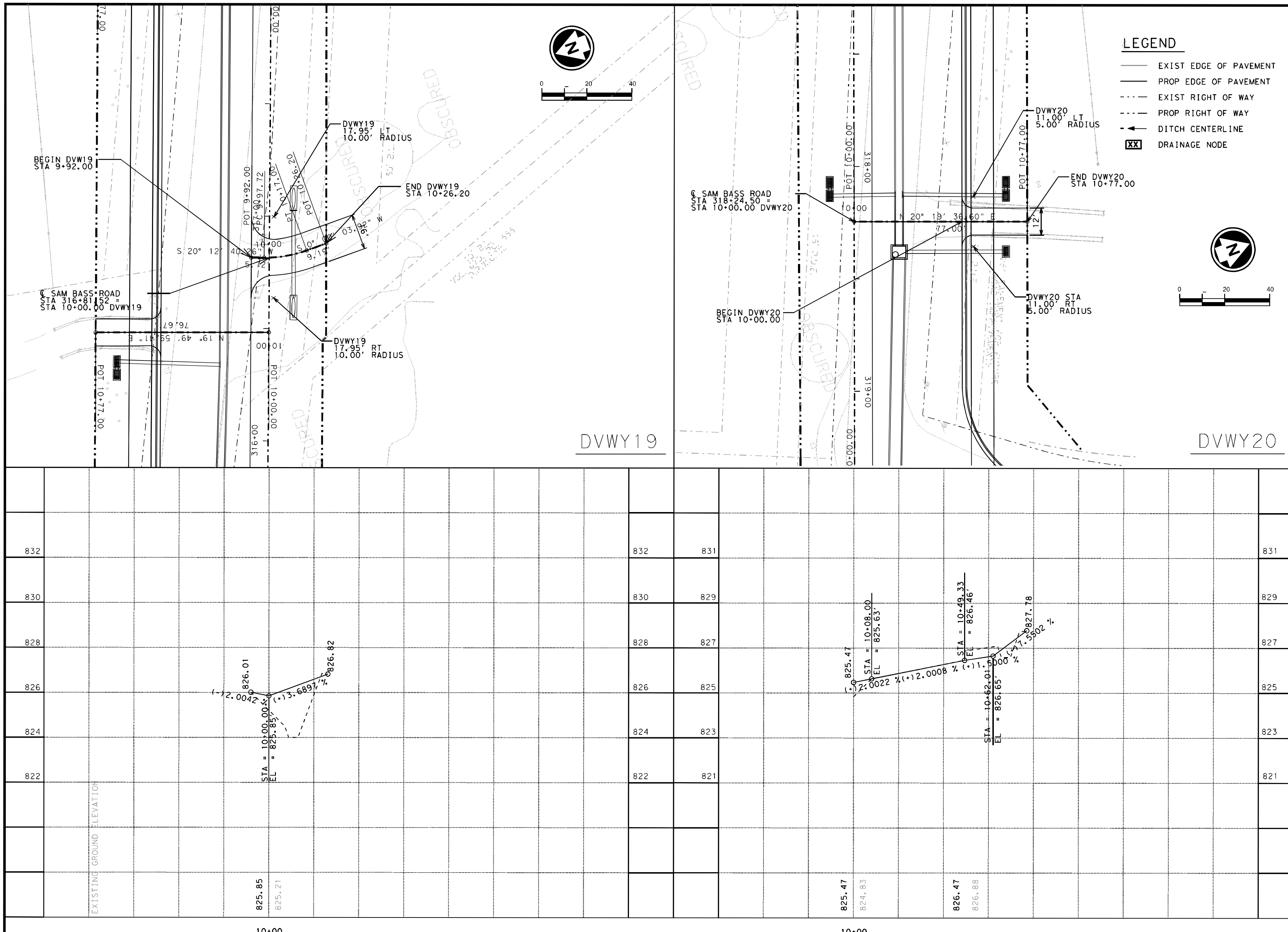

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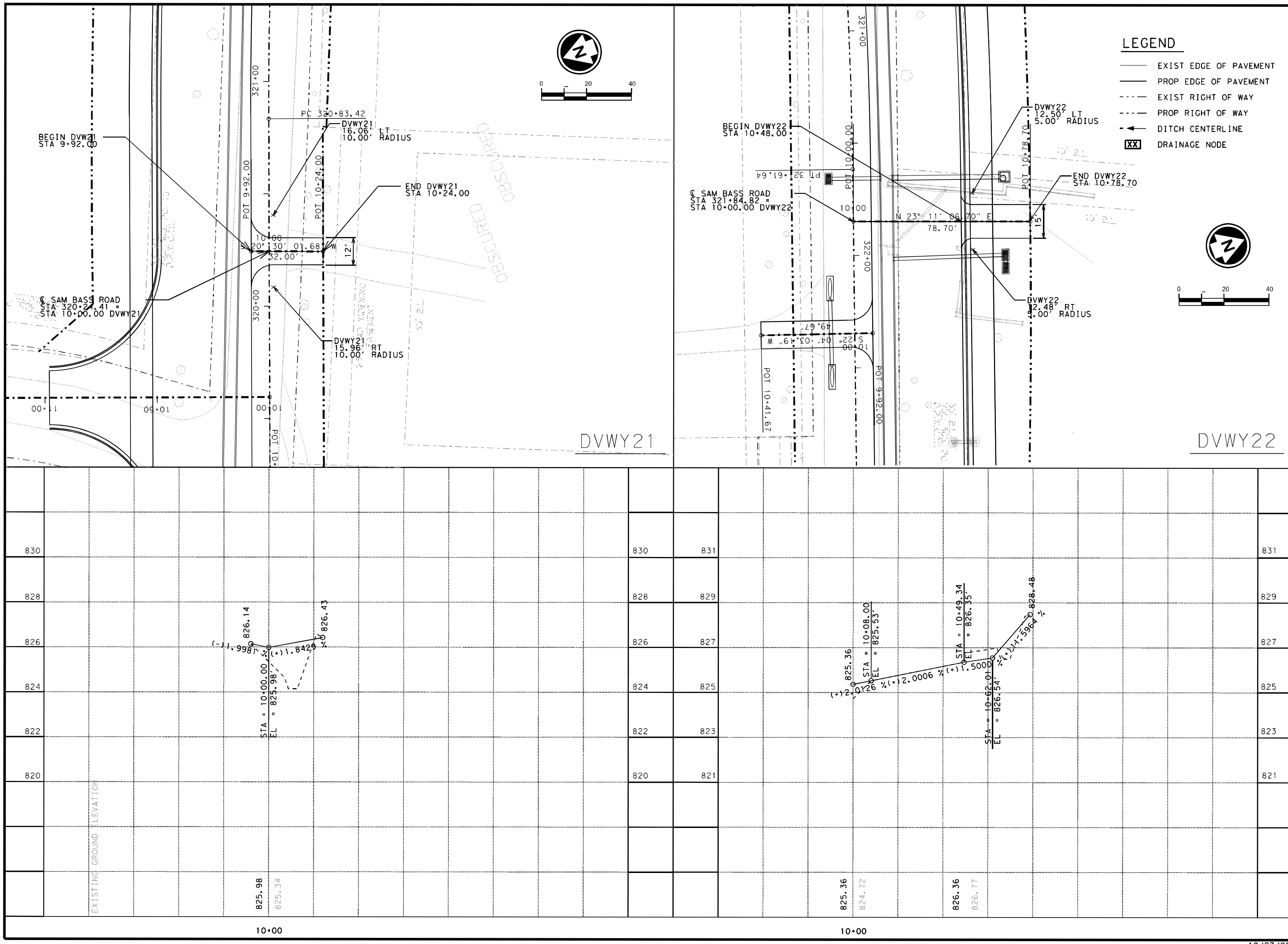

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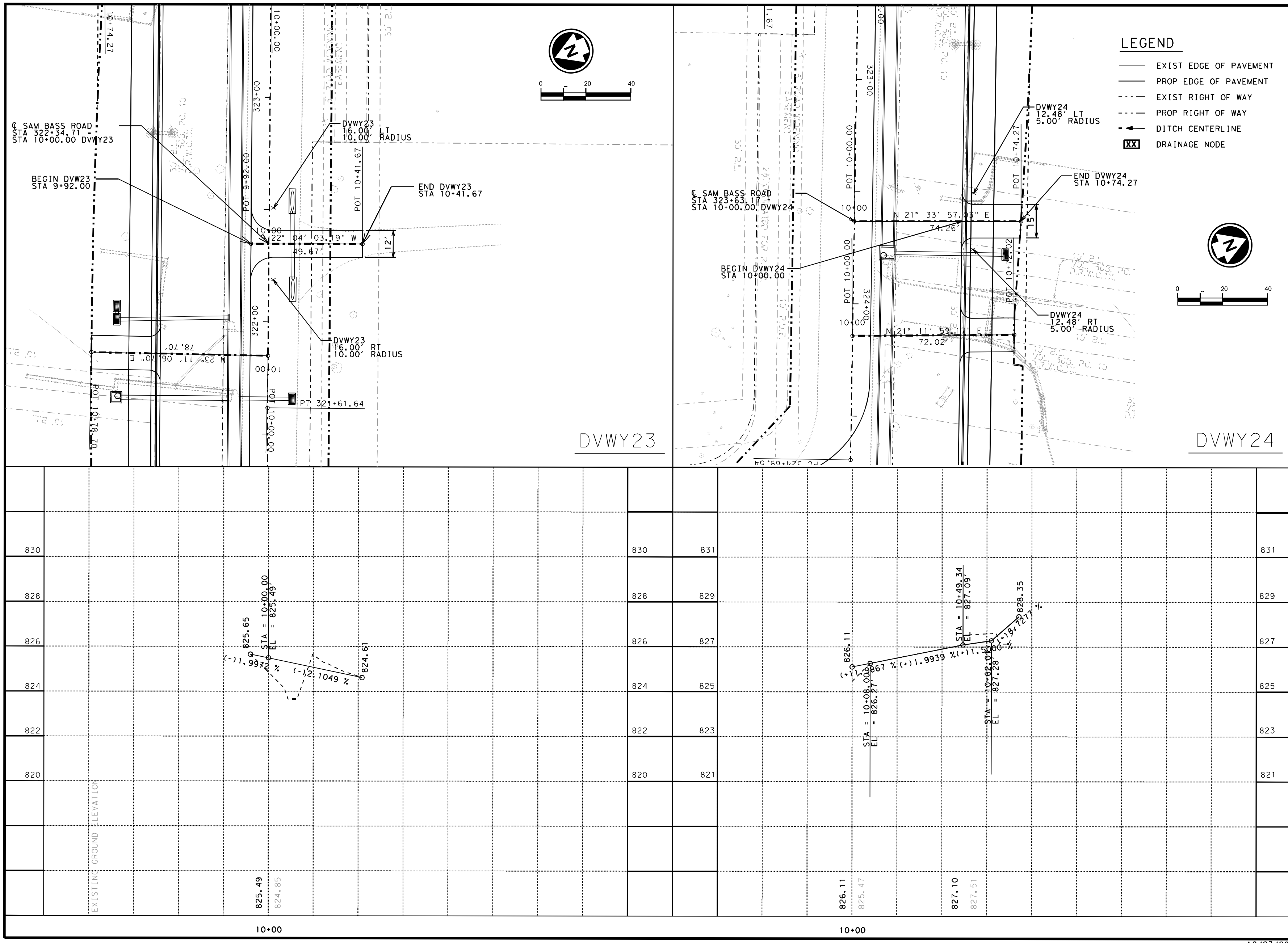

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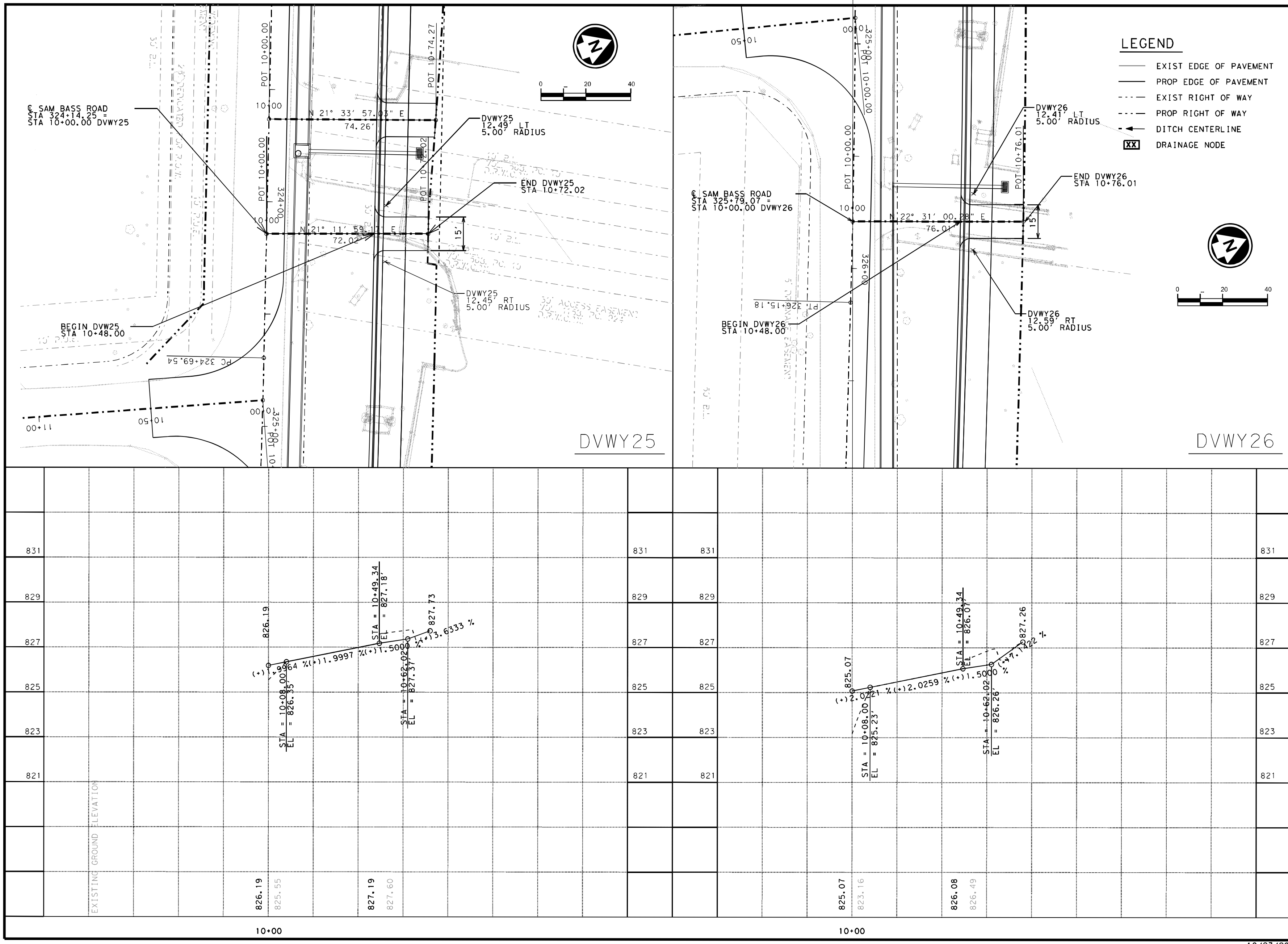

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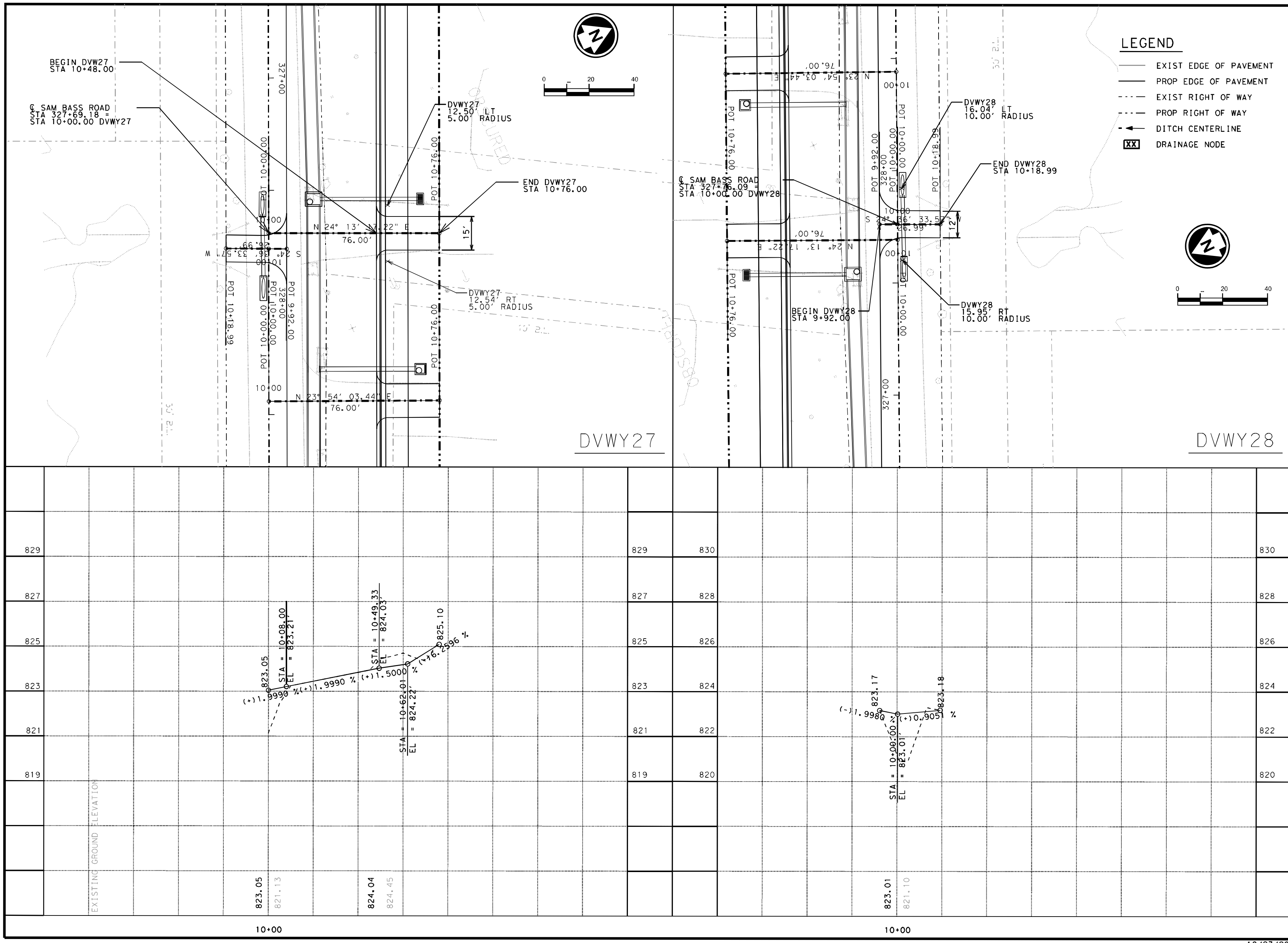

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WILLIAMSON COUNTY 1848

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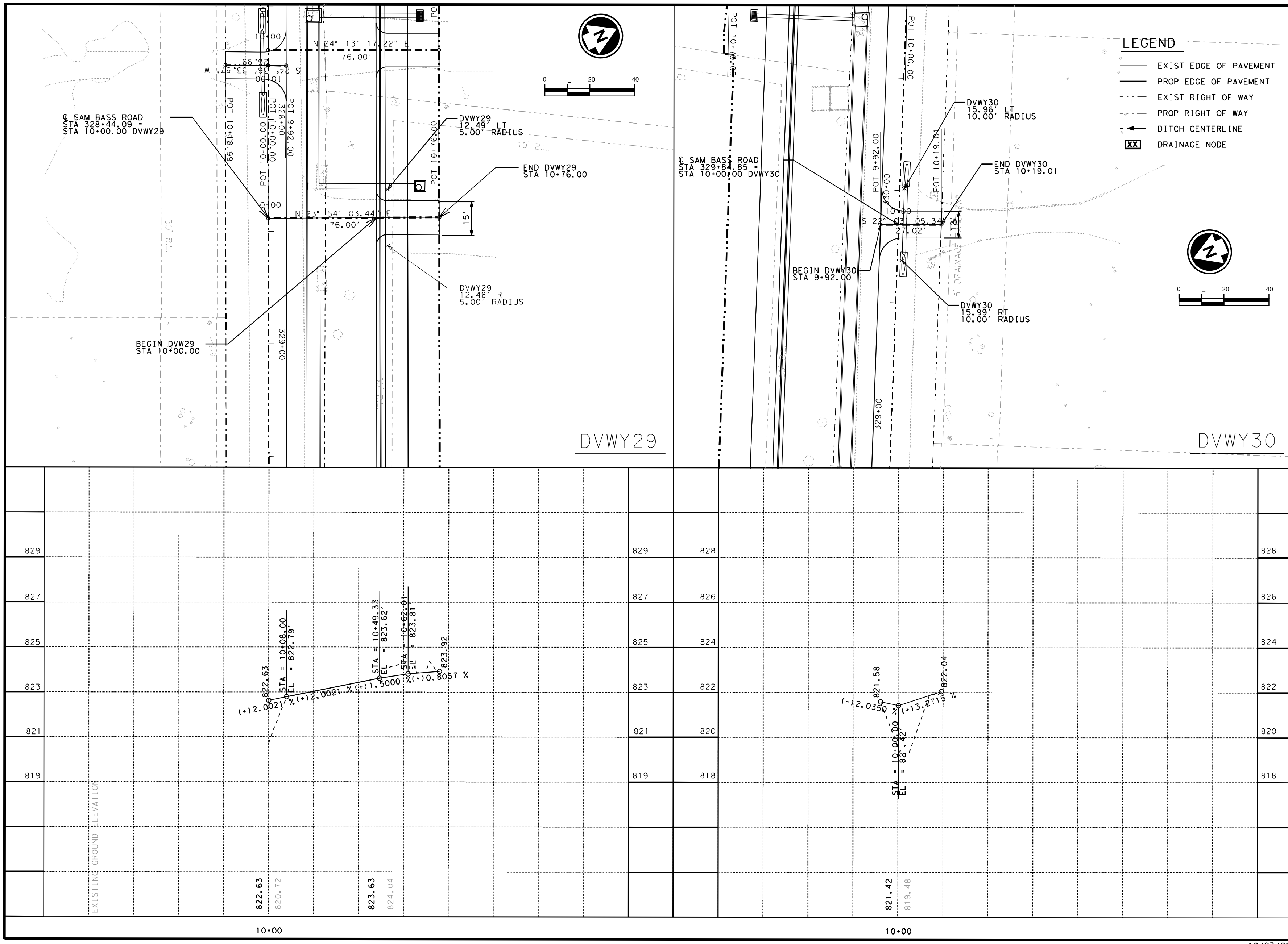

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PUBLIC PROJECT ENGINEERING (FIRM # 6535)

WILLIAMSON COUNTY 1848

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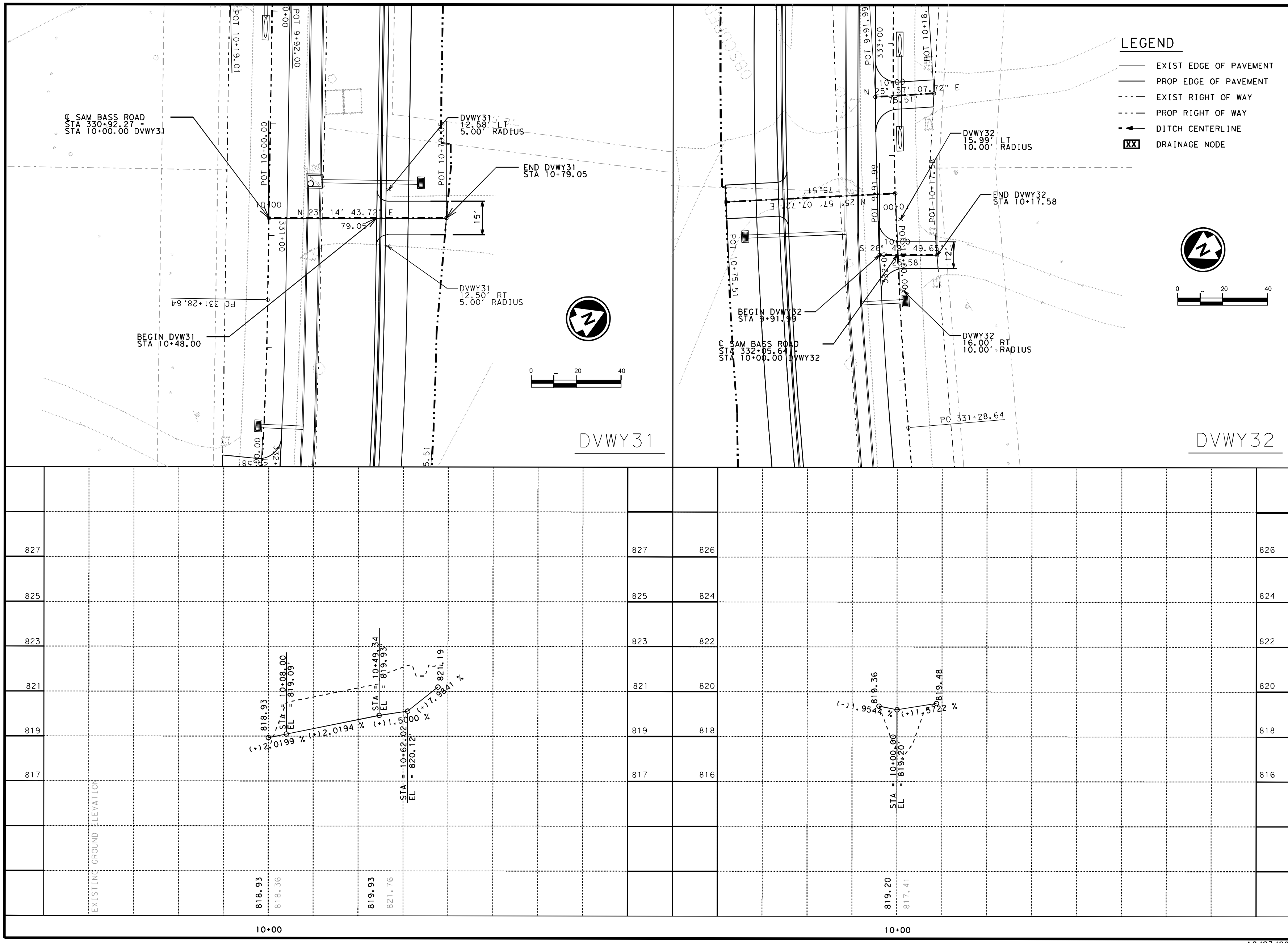

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WILLIAMSON COUNTY 1848

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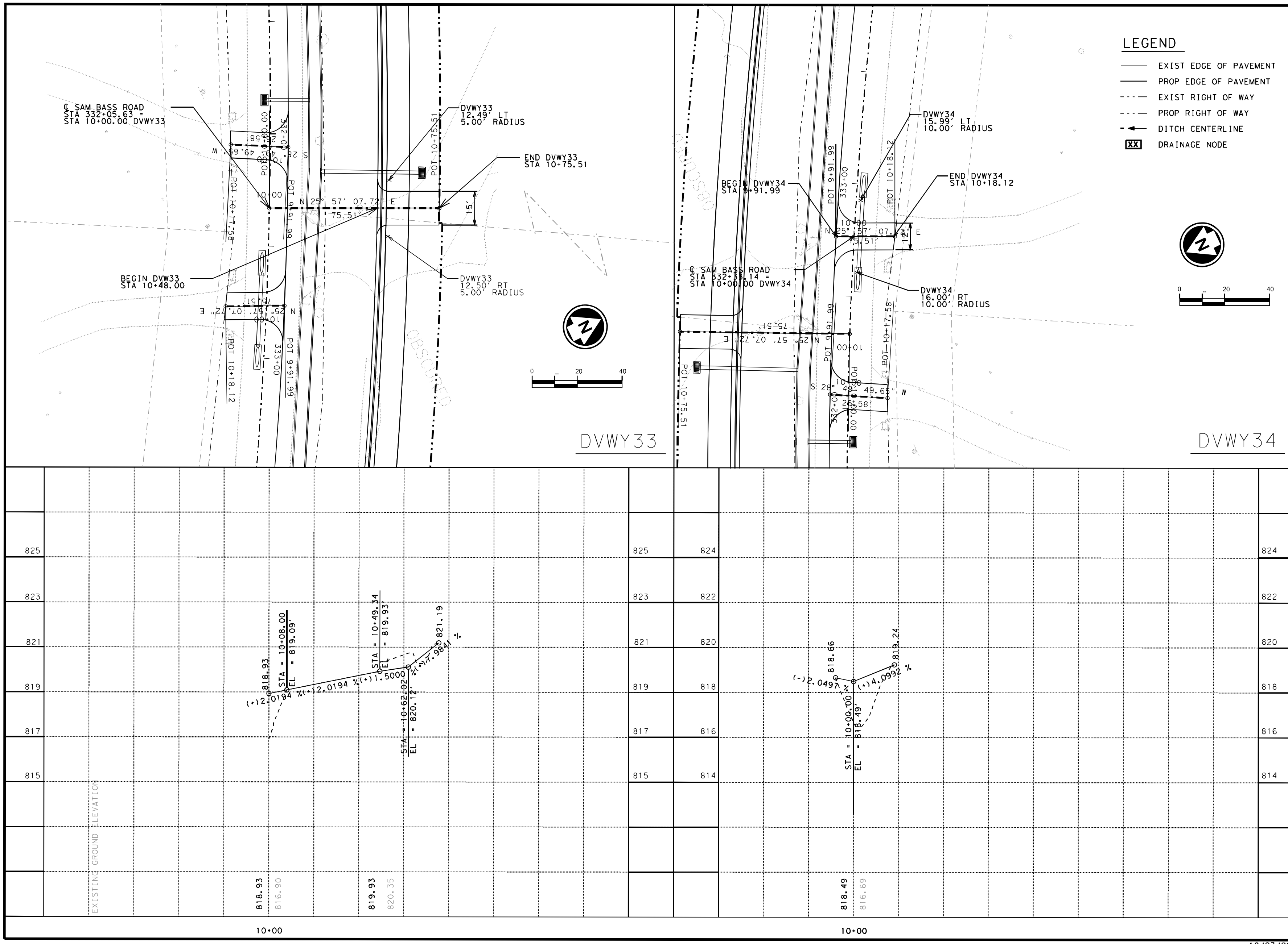

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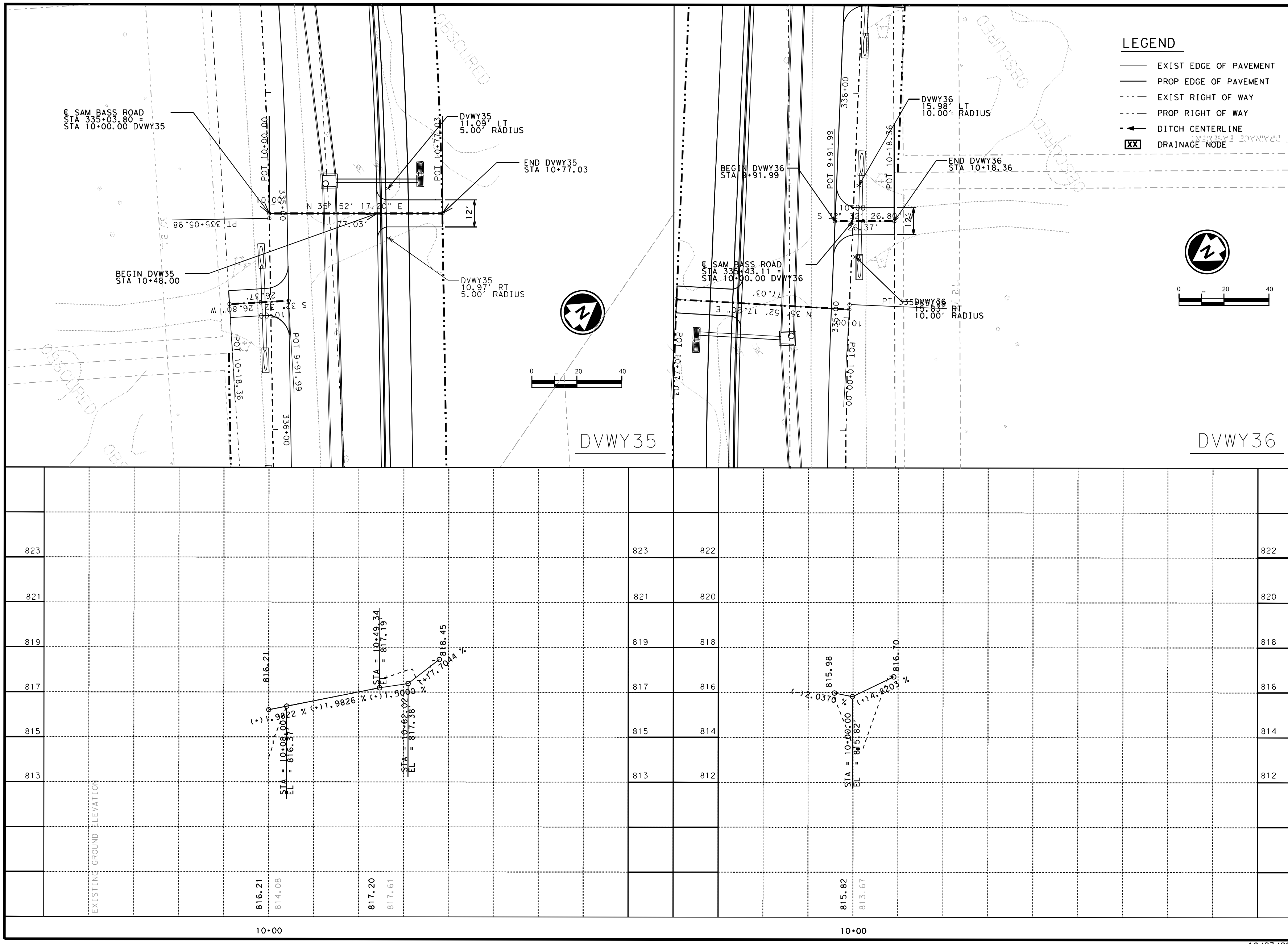

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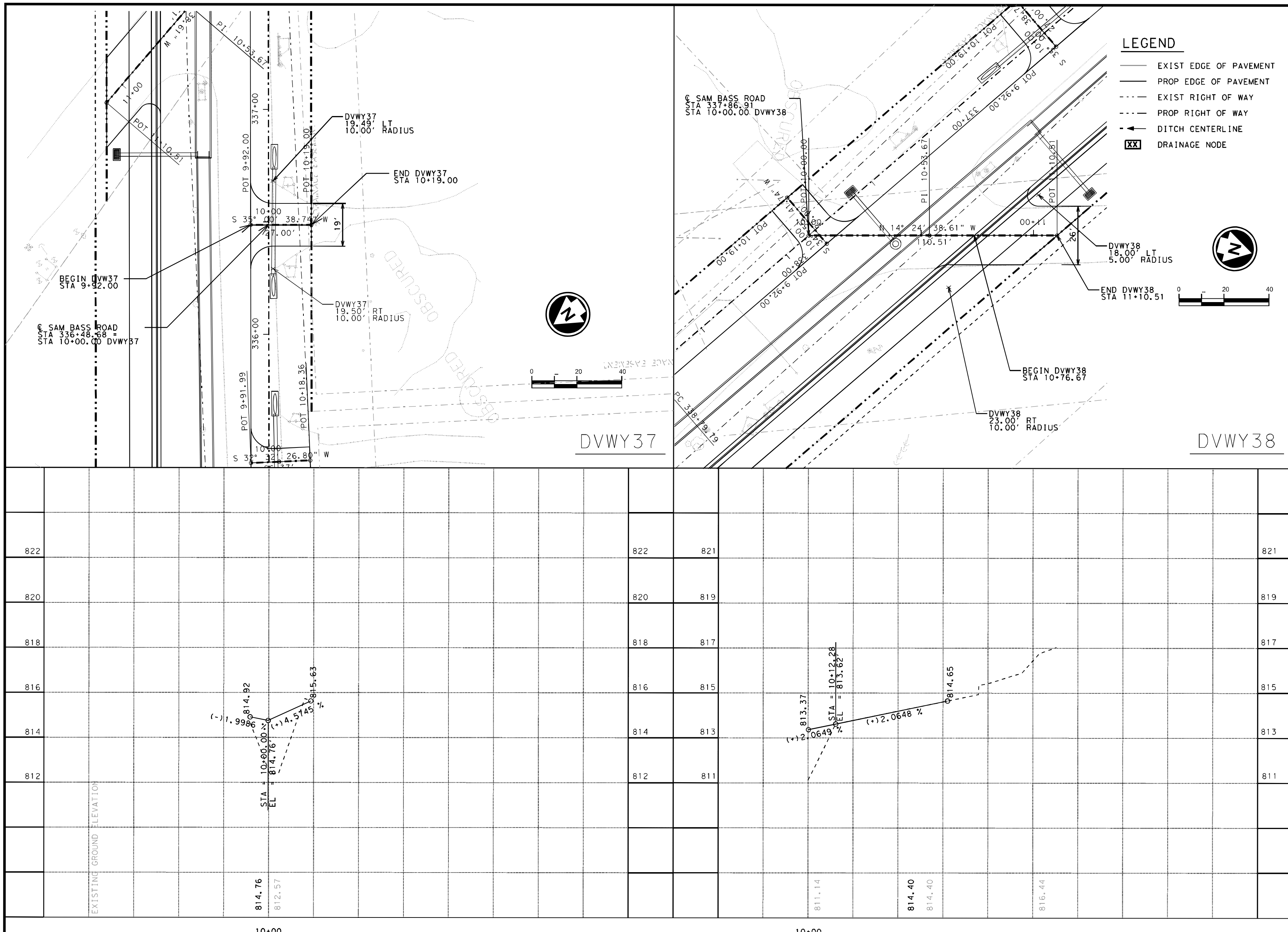

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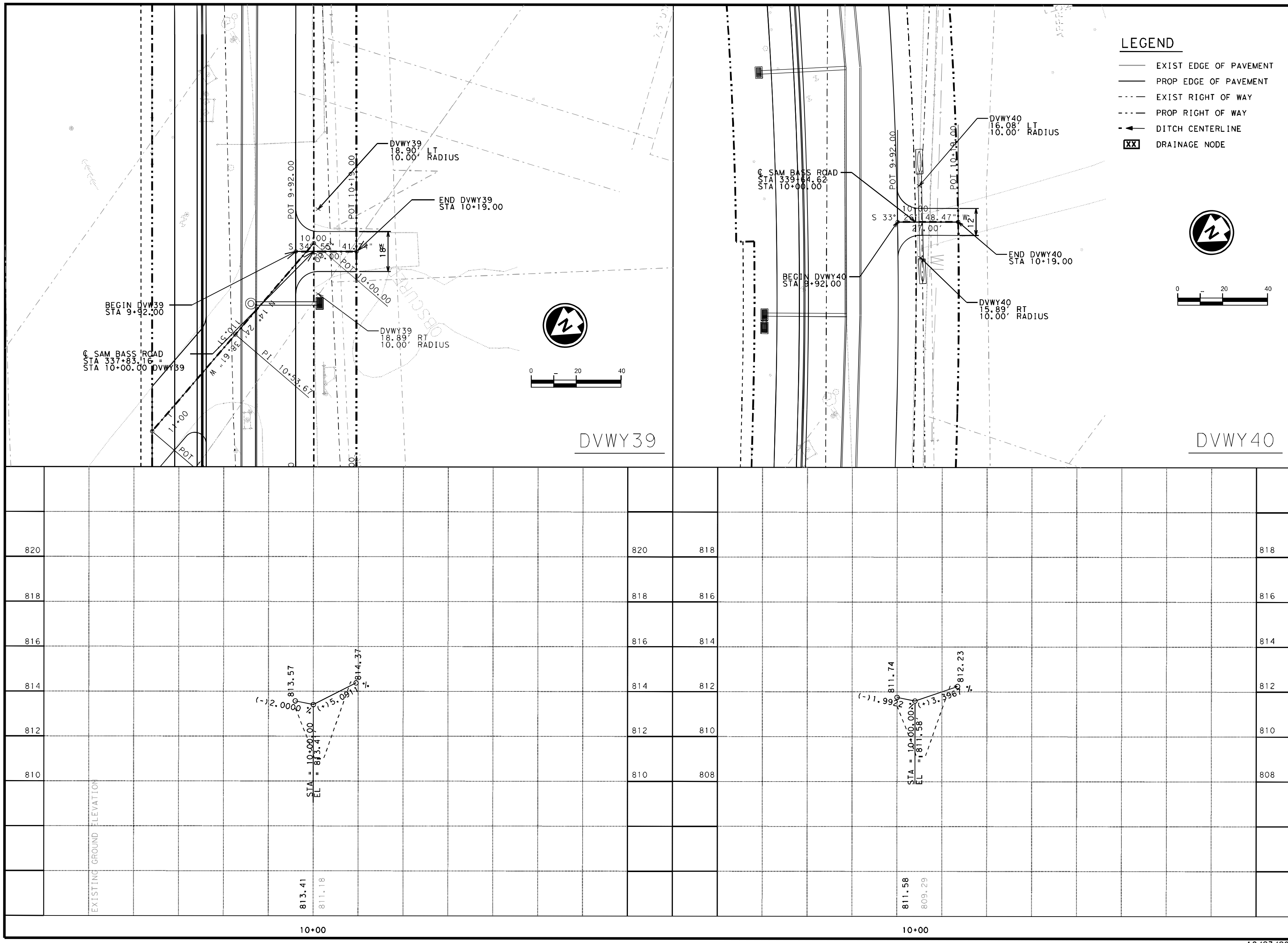

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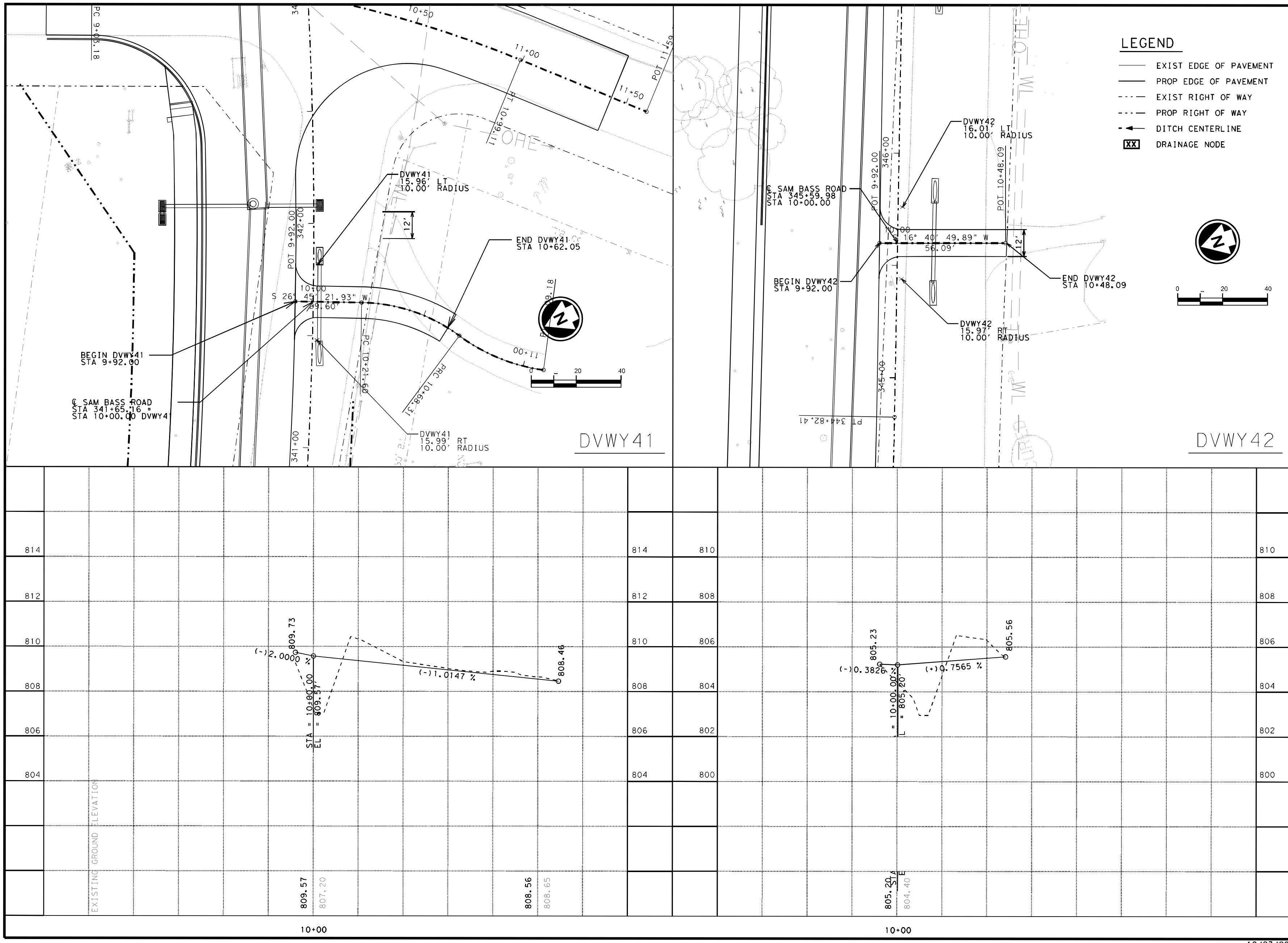

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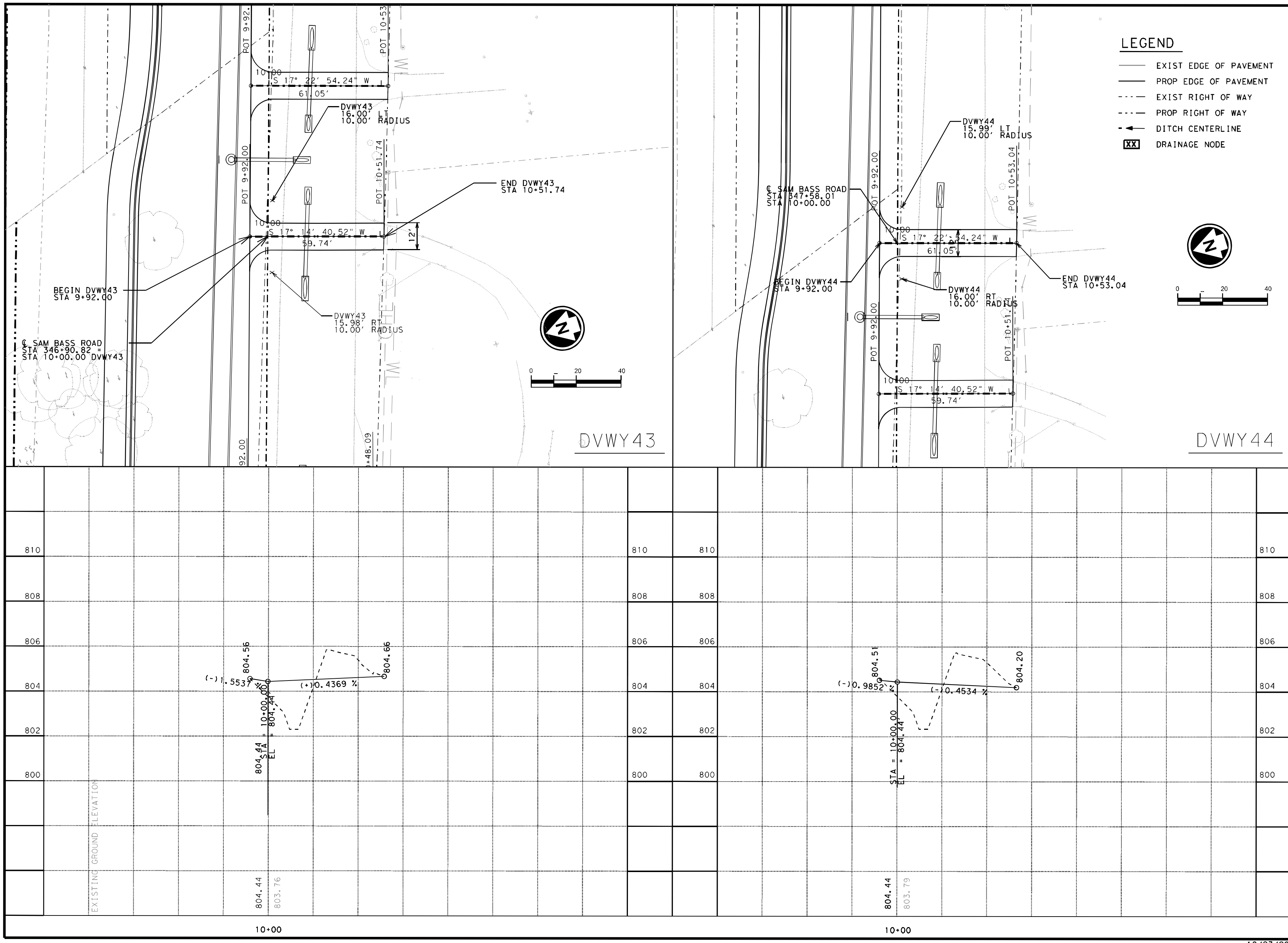

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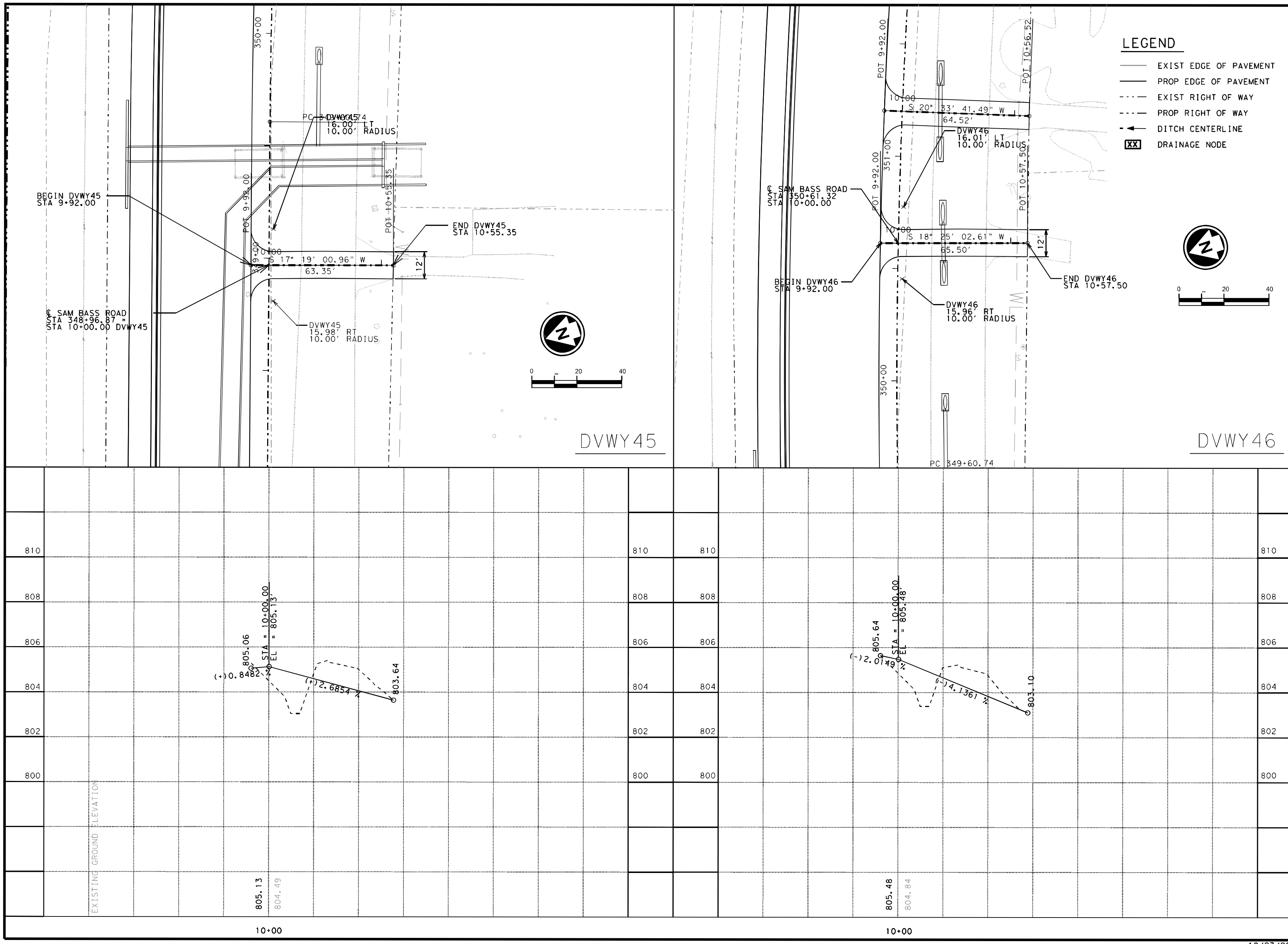

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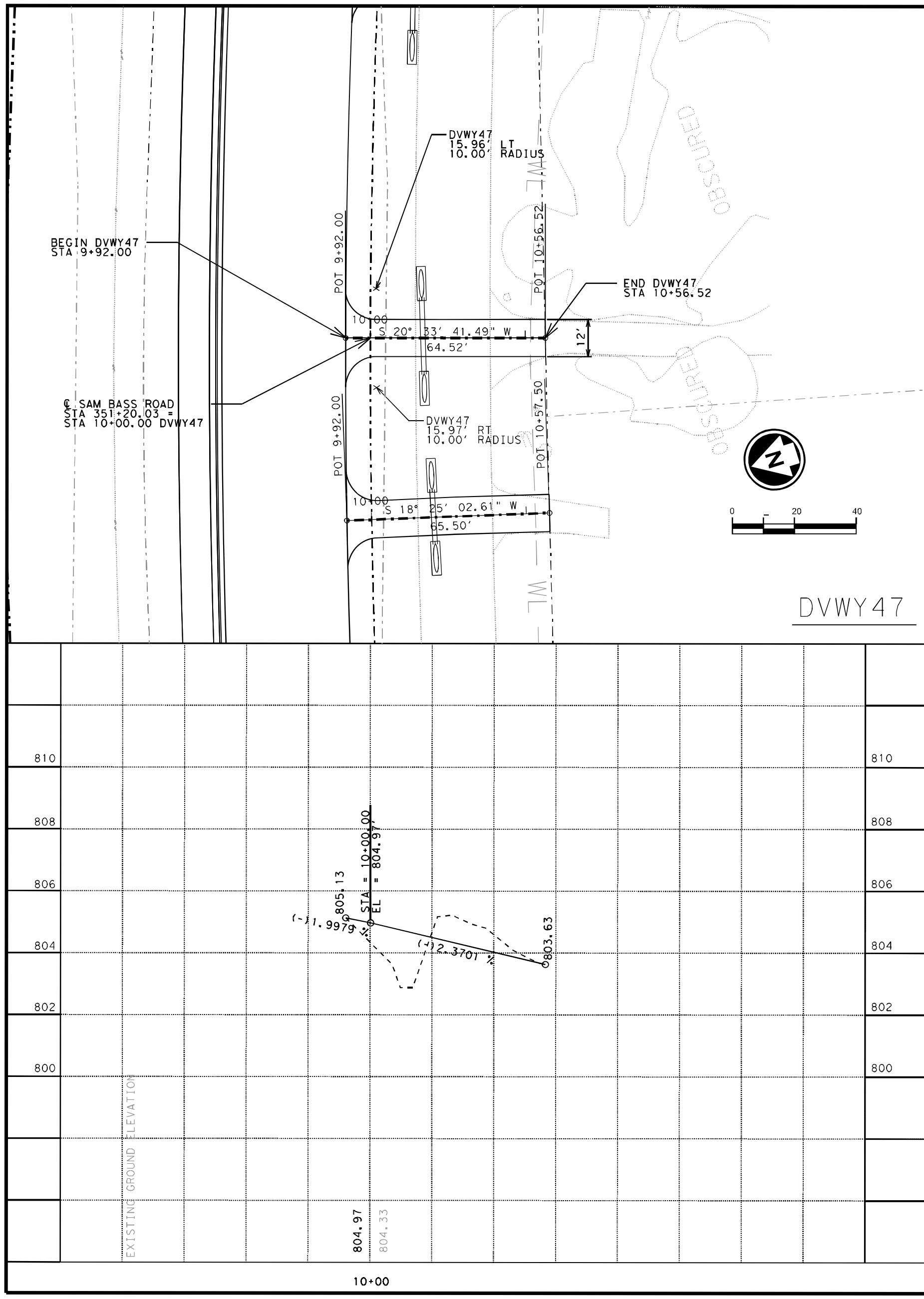

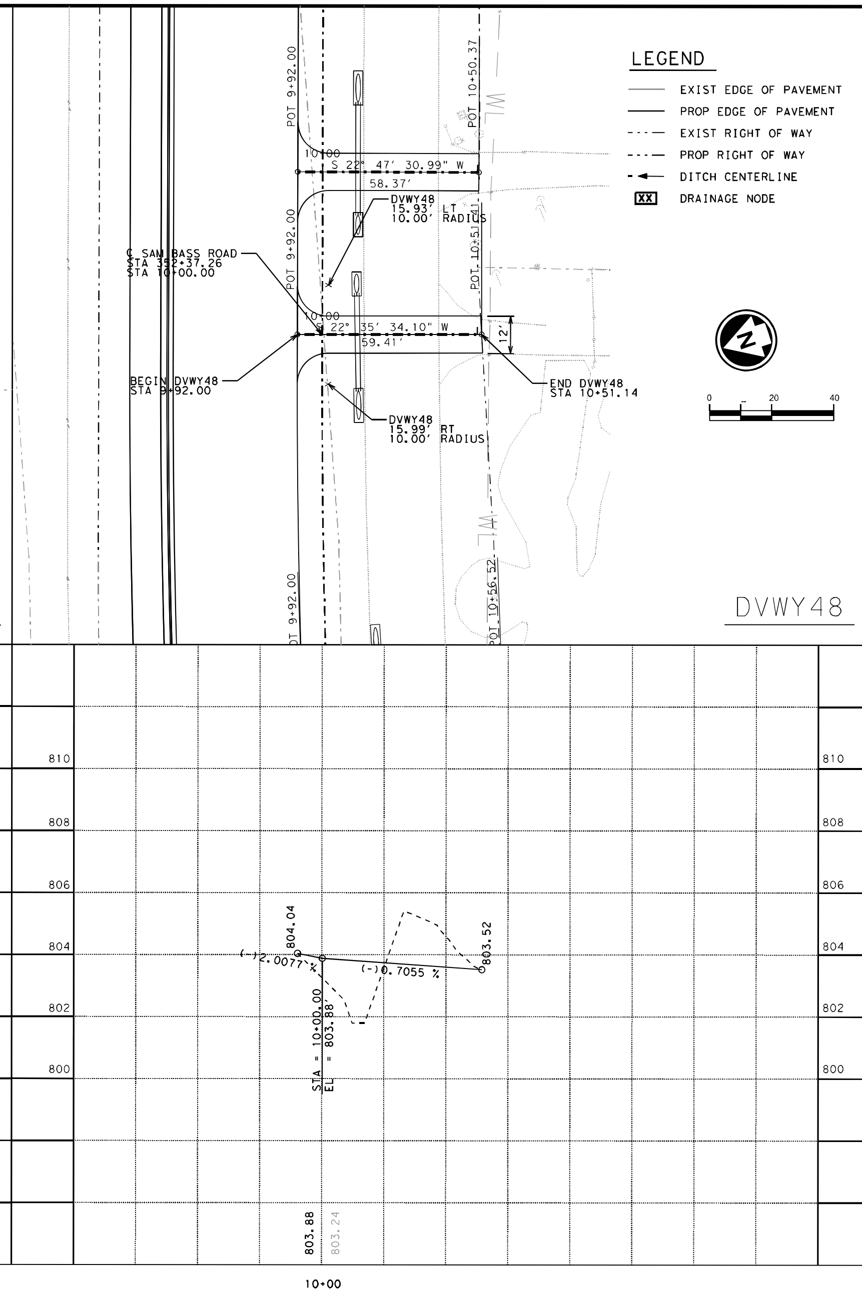

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$ENGR$
TBPE NO. $ENGNO$
10/23/2020

K FRIESE & ASSOCIATES, INC.
1120 S. CAPITAL OF TEXAS HWY, II-100, AUSTIN, TX 78746

$CLIENT$
$PROJECT$
$SHTTITLE$
$SHTDESCRIP$

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING
(FIRM # 6535)

WILLIAMSON COUNTY 1848

$CLIENT$

SHEET GNS OF GT

SCALE	$SCALE$
DATE	10/23/2020
SHEET NUMBER	$SN$$ST$

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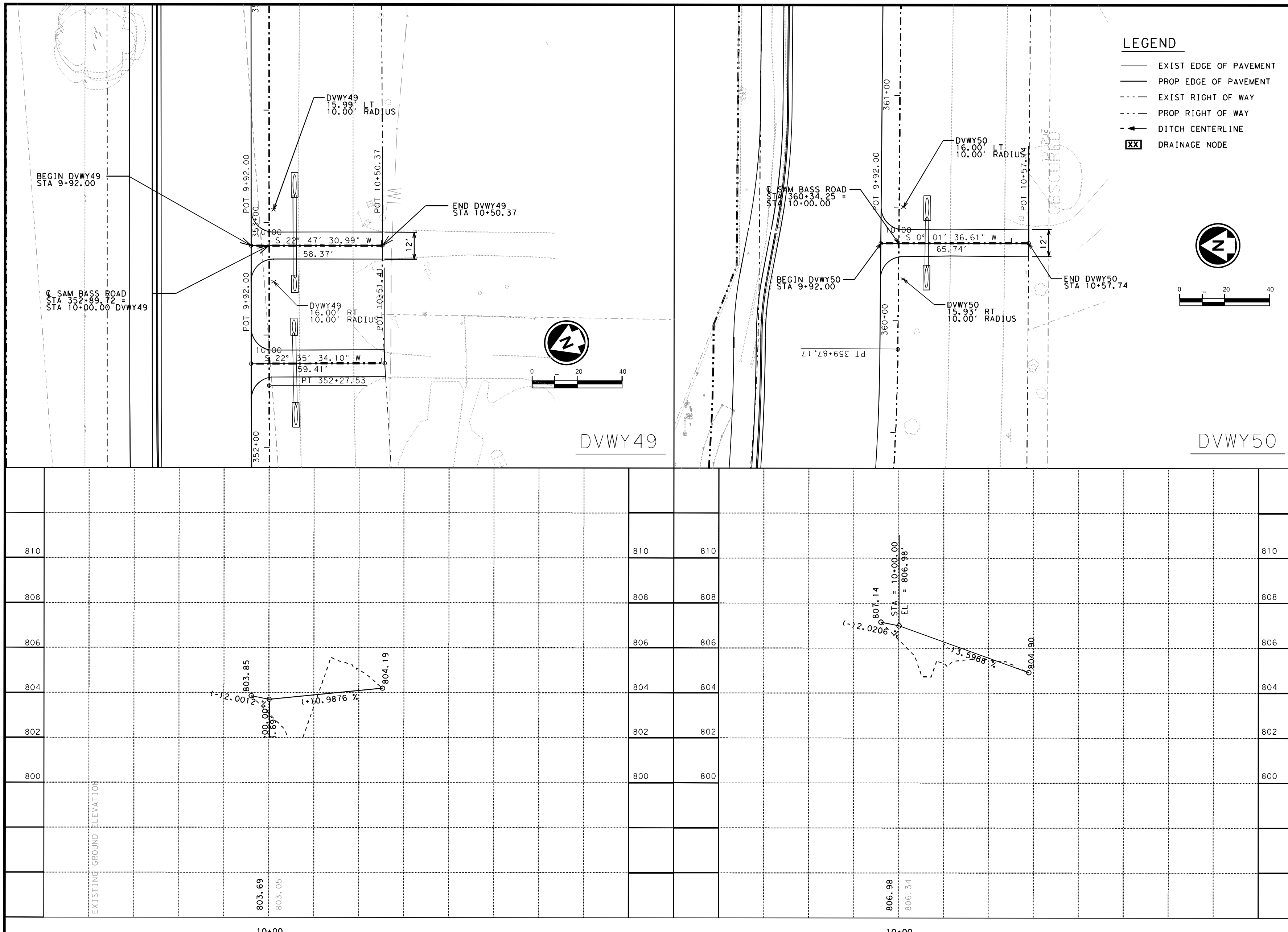

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WILLIAMSON COUNTY 1848

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SCALE	$SCALE$
DATE	10/23/2020
SHEET NUMBER	$SN$$ST$

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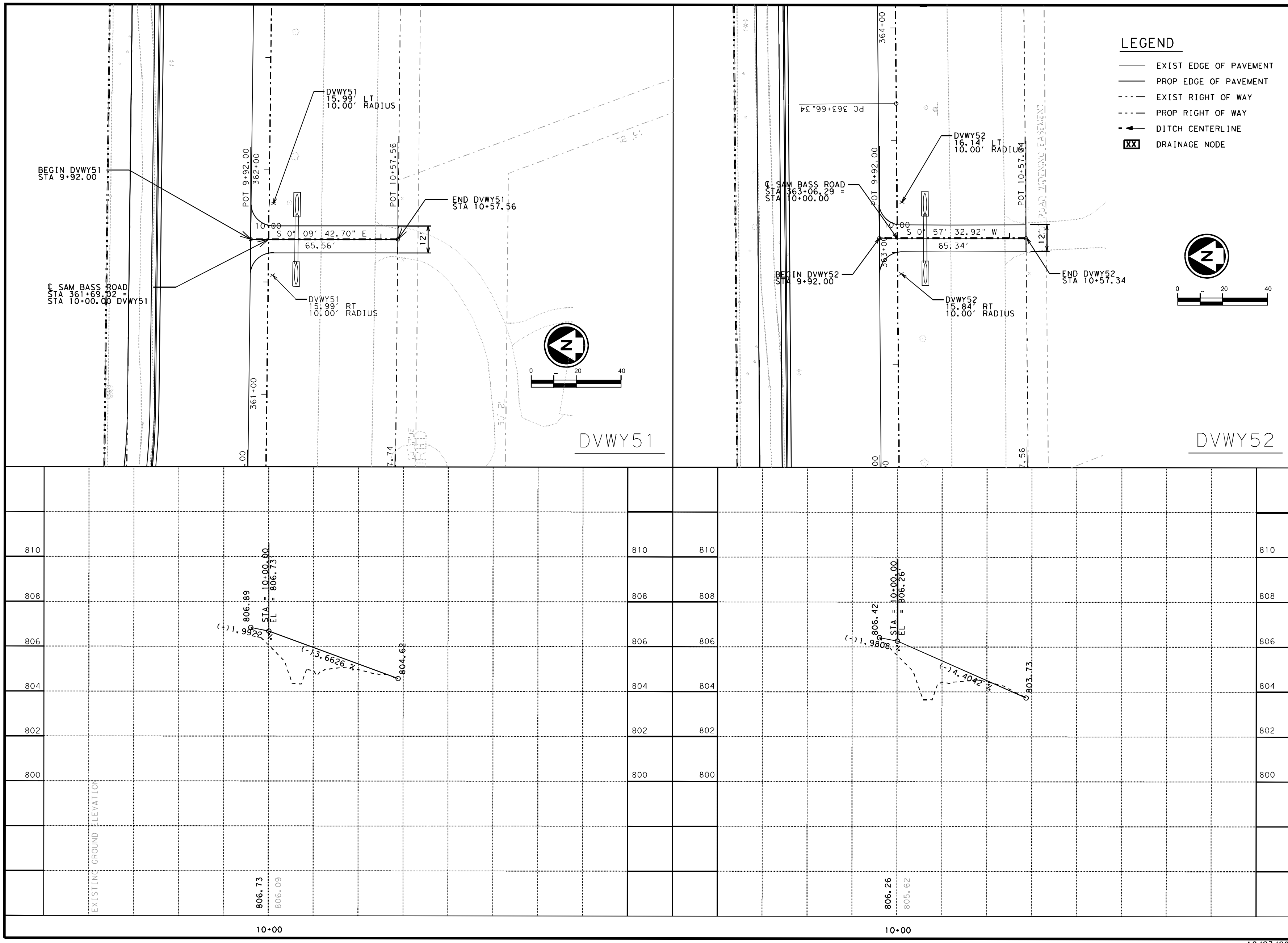

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TBPE NO. $ENGNO$
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PUBLIC PROJECT ENGINEERING
(FIRM # 6535)

WILLIAMSON COUNTY 1848

$CLIENT$

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SCALE	$SCALE$
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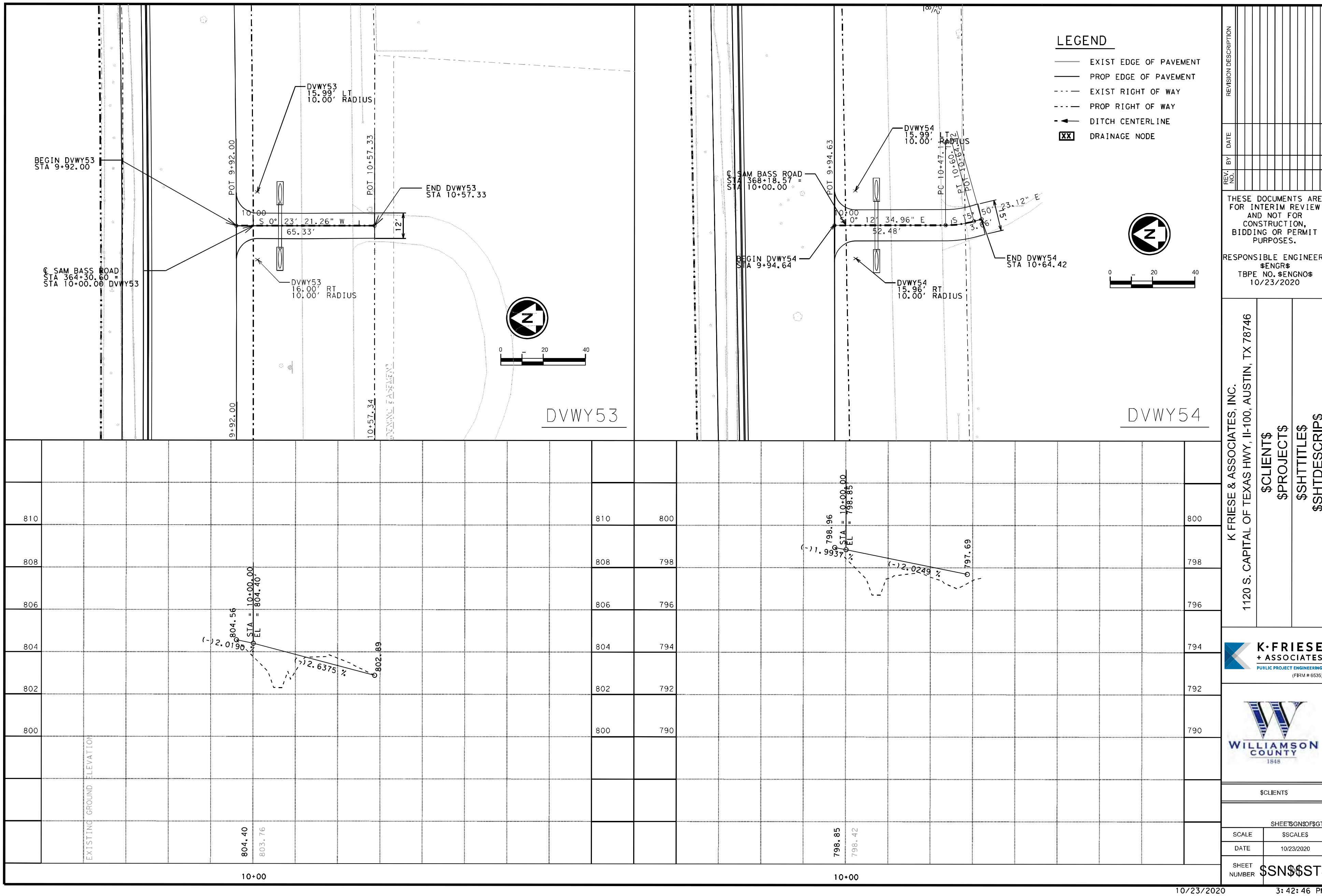

DVWY53
BEGIN DVWY53
STA 9+92.00
℄ SAM BASS ROAD
STA 364+30.60 =
STA 10+00.00 DVWY53
DVWY53
15.99' LT
10.00' RADIUS
DVWY53
16.00' RT
10.00' RADIUS
POT 9+92.00
POT 10+57.33
END DVWY53
STA 10+57.33
S 0° 23' 21.26" W
65.33'
12'
DVWY54
℄ SAM BASS ROAD
STA 368+18.57 =
STA 10+00.00
BEGIN DVWY54
STA 9+94.64
DVWY54
15.99' LT
10.00' RADIUS
DVWY54
15.96' RT
10.00' RADIUS
POT 9+94.63
PC 10+47.11
PT 10+60.1
POT 10+64.42
END DVWY54
STA 10+64.42
0° 12' 34.96" E
52.48'
50° 23.12" E
15'
3.86'
LEGEND
EXIST EDGE OF PAVEMENT
PROP EDGE OF PAVEMENT
EXIST RIGHT OF WAY
PROP RIGHT OF WAY
DITCH CENTERLINE
DRAINAGE NODE
STA = 10+00.00
EL = 804.40
804.56
(-)2.0190 %
(+)2.6375 %
802.89
STA = 10+00.00
EL = 798.85
798.96
(-)1.9937 %
(-)2.0249 %
797.69
EXISTING GROUND ELEVATION
804.40
803.76
798.85
798.42
10+00
810
808
806
804
802
800
798
796
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792
790
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RESPONSIBLE ENGINEER: $ENGR$
TBPE NO. $ENGNO$
10/23/2020
REV. NO.
BY
DATE
REVISION DESCRIPTION
K FRIESE & ASSOCIATES, INC.
1120 S. CAPITAL OF TEXAS HWY, II-100, AUSTIN, TX 78746
$CLIENT$
$PROJECT$
$SHTTITLE$
$SHTDESCRIP$
K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING
(FIRM # 6535)
WILLIAMSON COUNTY
1848
$CLIENT$
SCALE
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DATE
10/23/2020
SHEET NUMBER
$SN$$ST$
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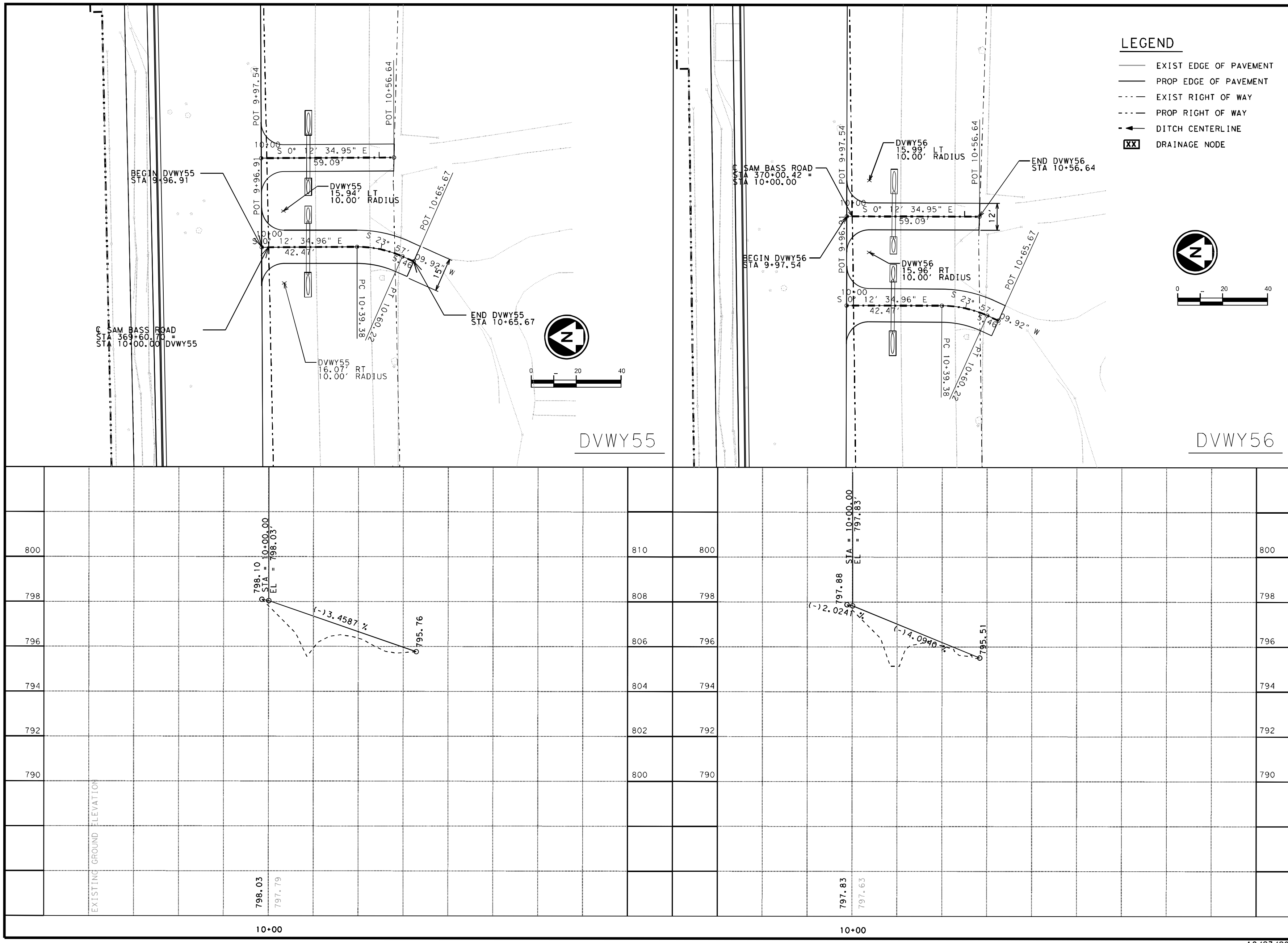

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TBPE NO. $ENGNO$
10/23/2020

REV. NO.	BY	DATE	REVISION DESCRIPTION

K FRIESE & ASSOCIATES, INC.
1120 S. CAPITAL OF TEXAS HWY, II-100, AUSTIN, TX 78746

$CLIENT$
$PROJECT$
$SHTTITLE$
$SHTDESCRIP$

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING
(FIRM # 6535)

WILLIAMSON COUNTY 1848

$CLIENT$

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SCALE	$SCALE$
DATE	10/23/2020
SHEET NUMBER	$SN$$ST$

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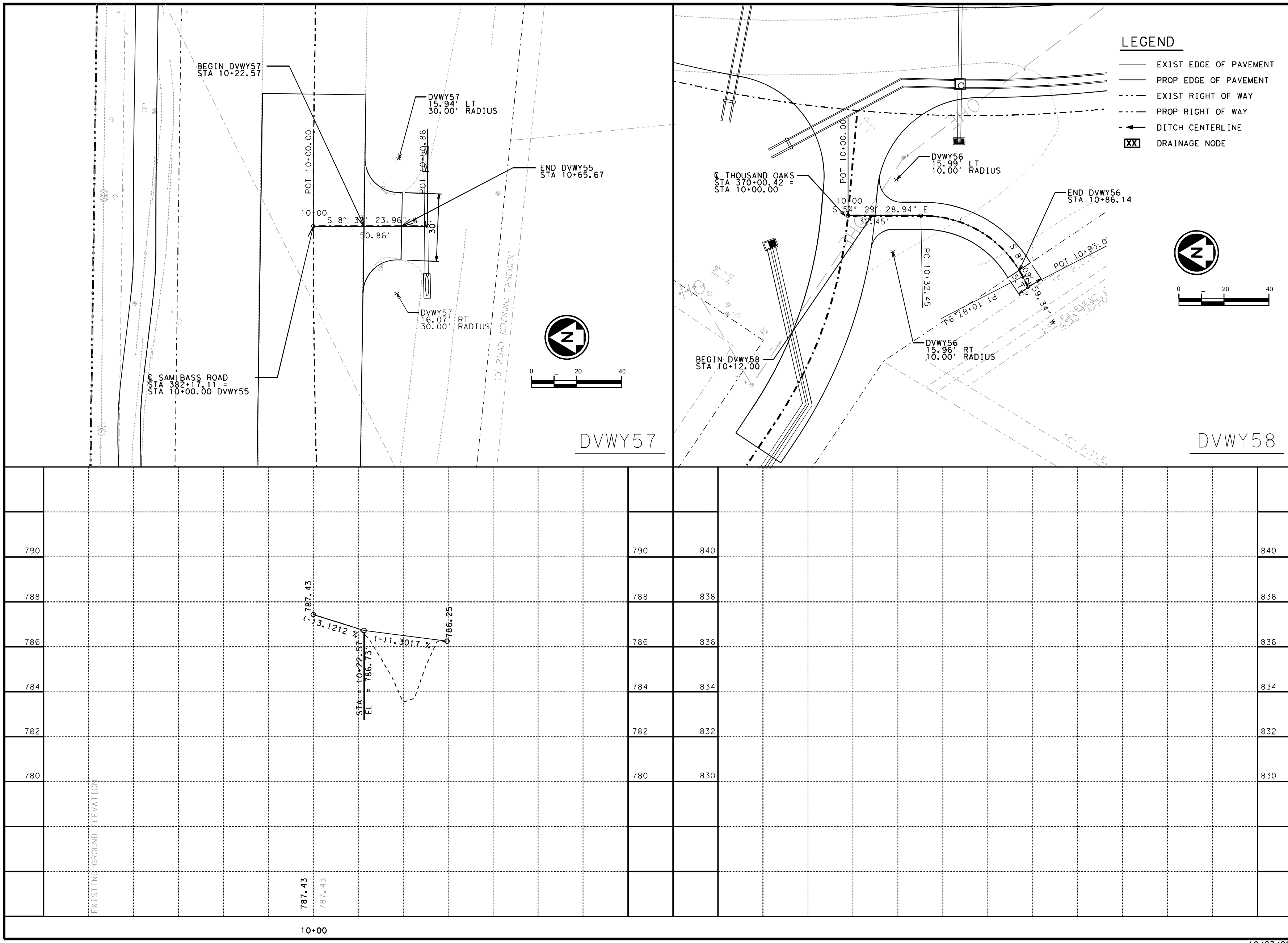

K FRIESE & ASSOCIATES, INC.
1120 S. CAPITAL OF TEXAS HWY, II-100, AUSTIN, TX 78746

$CLIENT$
$PROJECT$
$SHTTITLE$
$SHTDESCRIP$

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TBPE NO. $ENGNO$
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(FIRM # 6535)

WILLIAMSON COUNTY 1848

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SCALE	$SCALE$
DATE	10/23/2020
SHEET NUMBER	$SN$$ST$

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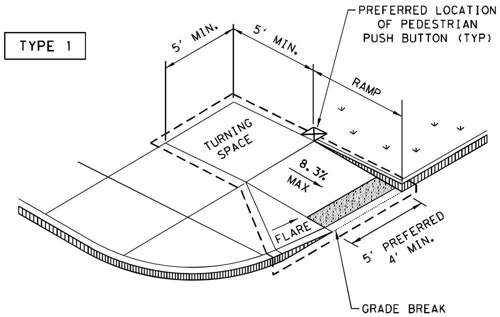
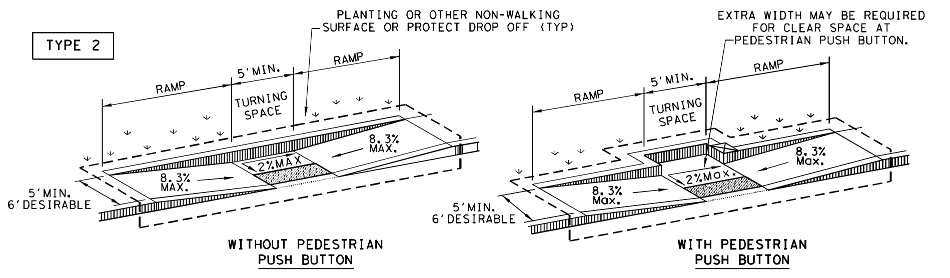
DATE:
FILE:

TYPE 1



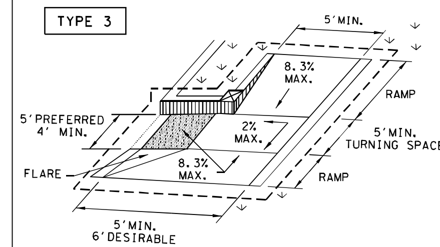
PERPENDICULAR CURB RAMP

TYPE 2

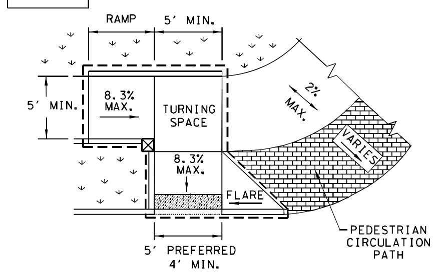


PARALLEL CURB RAMP

TYPE 3

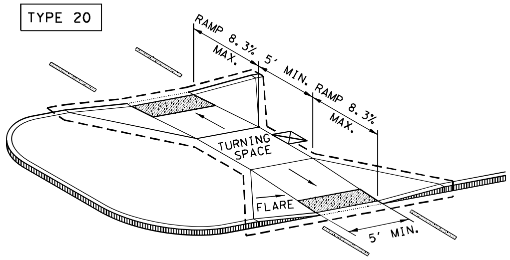


TYPE 6



COMBINATION CURB RAMPS

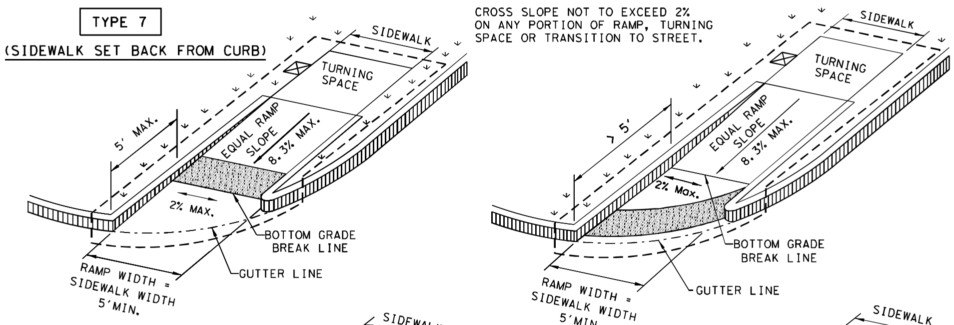
TYPE 20



CURB RAMPS AT MEDIAN ISLANDS

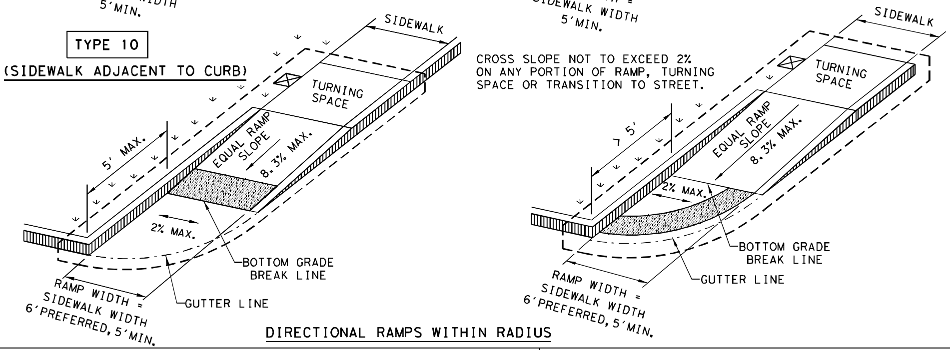
TYPE 7
(SIDEWALK SET BACK FROM CURB)

CROSS SLOPE NOT TO EXCEED 2% ON ANY PORTION OF RAMP, TURNING SPACE OR TRANSITION TO STREET.



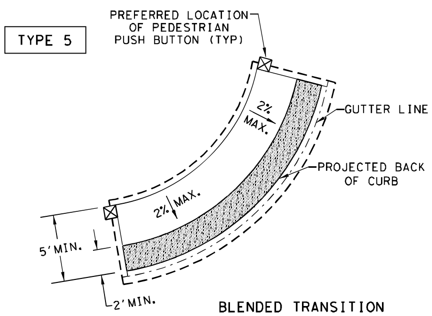
TYPE 10
(SIDEWALK ADJACENT TO CURB)

CROSS SLOPE NOT TO EXCEED 2% ON ANY PORTION OF RAMP, TURNING SPACE OR TRANSITION TO STREET.



DIRECTIONAL RAMPS WITHIN RADIUS

TYPE 5

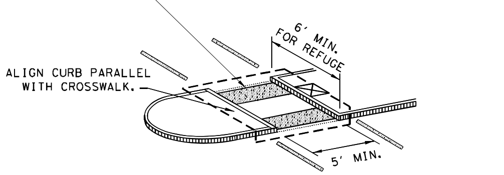


BLENDED TRANSITION
(FLUSH LANDING)

TYPE 21

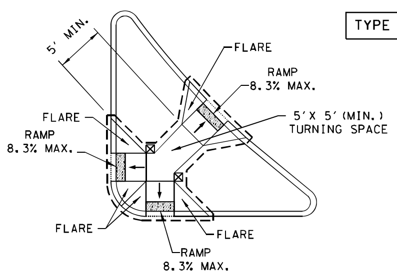
INSTALL DETECTABLE WARNING SURFACE AT EACH END OF THE CUT-THROUGH RAMP WITH A MINIMUM 2' USUAL SIDEWALK SURFACE BETWEEN. IF MEDIAN IS LESS THAN 6' WIDE, ELIMINATE DETECTABLE WARNING SURFACES.

ALIGN CURB PARALLEL WITH CROSSWALK.

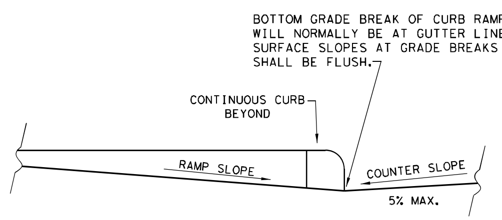


NOTE: CURB DETAILS ARE SHOWN ELSEWHERE IN THE PLANS.

TYPE 22



COMBINATION ISLAND RAMPS



TYPICAL SECTION OF PERPENDICULAR CURB RAMP AT CONNECTION TO ROADWAY

NOTES / LEGEND:

SEE GENERAL NOTES ON SHEET 2 OF 4 FOR MORE INFORMATION.

DENOTES PLANTING OR NON-WALKING SURFACE NOT PART OF PEDESTRIAN CIRCULATION PATH.	ѵ ѵ ѵ	GUTTER LINE	— · —
DETECTABLE WARNING SURFACE	▒	GRADE BREAK	········
DENOTES PREFERRED LOCATION OF PEDESTRIAN PUSH BUTTON IF APPLICABLE.	⊠	RAMP LIMITS OF PAYMENT	— — —

SHEET 1 OF 4

Texas Department of Transportation

Design Division Standard

PEDESTRIAN FACILITIES CURB RAMPS

PED-18

FILE: ped18	DN: TxDOT	DW: VP	CK: KM	CK: PK & JG
© TxDOT: MARCH, 2002	CONT	SECT	JOB	HIGHWAY
REVISIONS REVISED 08, 2005 REVISED 06, 2012 REVISED 01, 2018	DIST		COUNTY	SHEET NO.
				$SN1$

DATE:
FILE:

GENERAL NOTES

CURB RAMPS

1. Install a curb ramp or blended transition at each pedestrian street crossing.
2. All slopes shown are maximum allowable. Cross slopes of 1.5% and lesser running should be used. Adjust curb ramp length or grade of approach sidewalks as directed.
3. Maximum allowable cross slope on sidewalk and curb ramp surfaces is 2%.
4. The minimum sidewalk width is 5'. Where the sidewalk is adjacent to the back of curb, a 6' sidewalk width is desirable. Where a 5' sidewalk cannot be provided due to site constraints, sidewalk width may be reduced to 4' for short distances. 5'x 5' passing areas at intervals not to exceed 200' are required.
5. Turning Spaces shall be 5'x 5' minimum. Cross slope shall be maximum 2%.
6. Clear space at the bottom of curb ramps shall be a minimum of 4'x 4' wholly contained within the crosswalk and wholly outside the parallel vehicular travel path.
7. Provide flared sides where the pedestrian circulation path crosses the curb ramp. Flared sides shall be sloped at 10% maximum, measured parallel to the curb. Returned curbs may be used only where pedestrians would not normally walk across the ramp, either because the adjacent surface is planted, substantially obstructed, or otherwise protected.
8. Additional information on curb ramp location, design, light reflective value and texture may be found in the latest draft of the Proposed Guidelines for Pedestrian Facilities in the Public Right of Way (PROWAG) as published by the U.S. Architectural and Transportation Barriers Compliance Board (Access Board).
9. To serve as a pedestrian refuge area, the median should be a minimum of 6' wide, measured from back of curbs. Medians should be designed to provide accessible passage over or through them.
10. Small channelization islands, which do not provide a minimum 5'x 5' landing at the top of curb ramps, shall be cut through level with the surface of the street.
11. Crosswalk dimensions, crosswalk markings and stop bar locations shall be as shown elsewhere in the plans. At intersections where crosswalk markings are not required, curb ramps shall align with theoretical crosswalks unless otherwise directed.
12. Provide curb ramps to connect the pedestrian access route at each pedestrian street crossing. Handrails are not required on curb ramps.
13. Curb ramps and landings shall be constructed and paid for in accordance with Item 531 "Sidewalks".
14. Place concrete at a minimum depth of 5" for ramps, flares and landings, unless otherwise directed.
15. Furnish and install No. 3 reinforcing steel bars at 18" o.c. both ways, unless otherwise directed.
16. Provide a smooth transition where the curb ramps connect to the street.
17. Curbs shown on sheet 1 within the limits of payment are considered part of the curb ramp for payment, whether it is concrete curb, gutter, or combined curb and gutter.
18. Existing features that comply with applicable standards may remain in place unless otherwise shown on the plans.

DETECTABLE WARNING MATERIAL

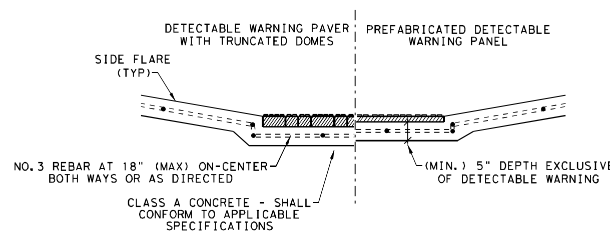
19. Curb ramps must contain a detectable warning surface that consists of raised truncated domes complying with PROWAG. The surface must contrast visually with adjoining surfaces, including side flares. Furnish and install an approved cast-in-place dark brown or dark red detectable warning surface material adjacent to uncolored concrete, unless specified elsewhere in the plans.
20. Detectable Warning Materials must meet TxDOT Departmental Materials Specification DMS 4350 and be listed on the Material Producer List. Install products in accordance with manufacturer's specifications.
21. Detectable warning surfaces must be firm, stable and slip resistant.
22. Detectable warning surfaces shall be a minimum of 24 inches in depth in the direction of pedestrian travel, and extend the full width of the curb ramp or landing where the pedestrian access route enters the street.
23. Detectable warning surfaces shall be located so that the edge nearest the curb line is at the back of curb and neither end of that edge is greater than 5 feet from the back of curb. Detectable warning surfaces may be curved along the corner radius.
24. Shaded areas on Sheet 1 of 4 indicate the approximate location for the detectable warning surface for each curb ramp type.

DETECTABLE WARNING PAVERS (IF USED)

25. Furnish detectable warning paver units meeting all requirements of ASTM C-936, C-33. Lay in a two by two unit basket weave pattern or as directed.
26. Lay full-size units first followed by closure units consisting of at least 25 percent (25%) of a full unit. Cut detectable warning paver units using a power saw.

SIDEWALKS

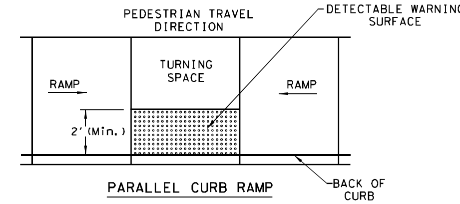
27. Provide clear ground space at operable parts, including pedestrian push buttons. Operable parts shall be placed within unobstructed reach range specified in PROWAG section R406.
28. Place traffic signal or illumination poles, ground boxes, controller boxes, signs, drainage facilities and other items so as not to obstruct the pedestrian access route or clear ground space.
29. Street grades and cross slopes shall be as shown elsewhere in the plans.
30. Changes in level greater than 1/4 inch are not permitted.
31. The least possible grade should be used to maximize accessibility. The running slope of sidewalks and crosswalks within the public right of way may follow the grade of the parallel roadway. Where a continuous grade greater than five percent (5%) must be provided, handrails may be desirable to improve accessibility. Handrails may also be needed to protect pedestrians from potentially hazardous conditions. If provided, handrails shall comply with PROWAG R409.
32. Handrail extensions shall not protrude into the usable landing area or into intersecting pedestrian routes.
33. Driveways and turnouts shall be constructed and paid for in accordance with Item "Intersections, Driveways and Turnouts". Sidewalks shall be constructed and paid for in accordance with Item, "Sidewalks".
34. Sidewalk details are shown elsewhere in the plans.



SECTION VIEW DETAIL

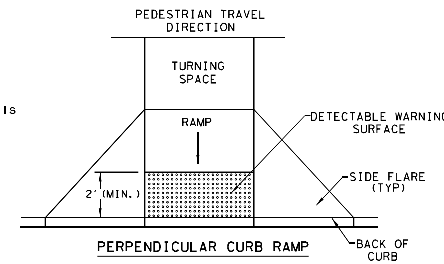
CURB RAMP AT DETECTIBLE WARNINGS

DETECTABLE WARNING SURFACE DETAILS



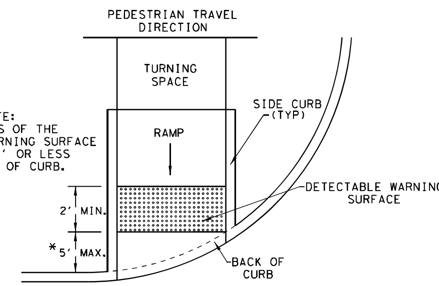
PARALLEL CURB RAMP

TYPICAL PLACEMENT OF DETECTABLE WARNING SURFACE ON LANDING AT STREET EDGE.



PERPENDICULAR CURB RAMP

TYPICAL PLACEMENT OF DETECTABLE WARNING SURFACE ON SLOPING RAMP RUN.



*NOTE:
BOTH ENDS OF THE DETECTABLE WARNING SURFACE SHALL BE 5' OR LESS FROM BACK OF CURB.

DIRECTIONAL CURB RAMP

TYPICAL PLACEMENT OF DETECTABLE WARNING SURFACE ON SLOPING RAMP RUN.

SHEET 2 OF 4

Texas Department of Transportation

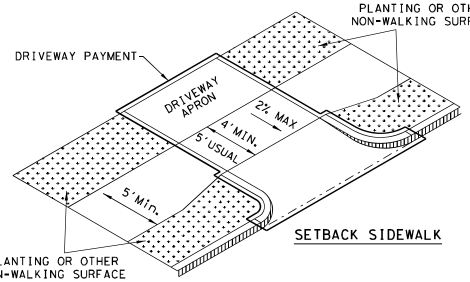
Design Division Standard

PEDESTRIAN FACILITIES CURB RAMPS

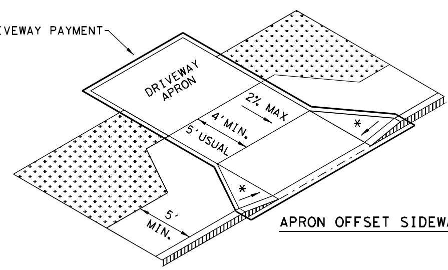
PED-18

FILE: ped18	DN: TxDOT	DW: VP	CK: KM	CK: PK & JG
© TxDOT: MARCH, 2002	CONT / SECT	JOB		HIGHWAY
REVISIONS: REVISED 08, 2005; REVISED 06, 2012; REVISED 01, 2018	DIST	COUNTY		SHEET NO. $SN2$

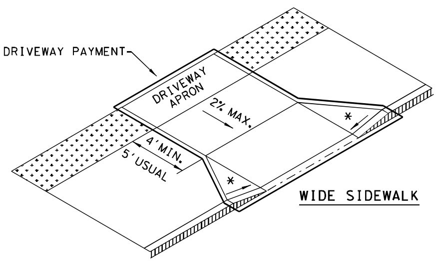
SIDEWALK TREATMENT AT DRIVEWAYS



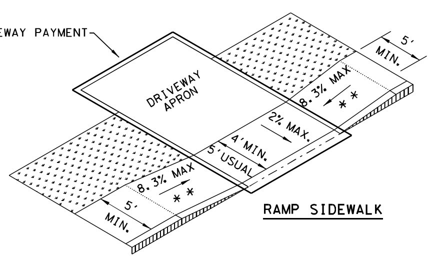
SETBACK SIDEWALK



APRON OFFSET SIDEWALK



WIDE SIDEWALK

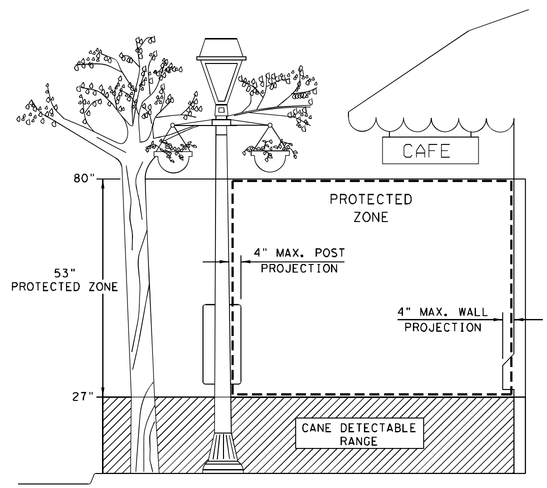


RAMP SIDEWALK

NOTES:

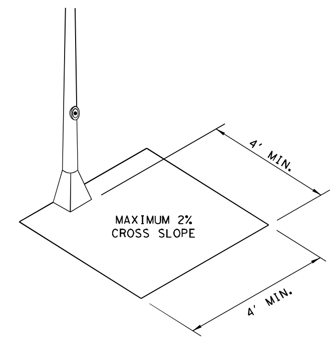
* WHERE DRIVEWAYS CROSS THE PEDESTRIAN ROUTE, SIDES SHALL BE FLARED AT 10% MAX SLOPE.

* * IF CURB HEIGHT IS GREATER THAN 6 INCHES, USE GRADE LESS THAN OR EQUAL TO 5%. HANDRAIL AND DETECTABLE WARNING ARE NOT REQUIRED.

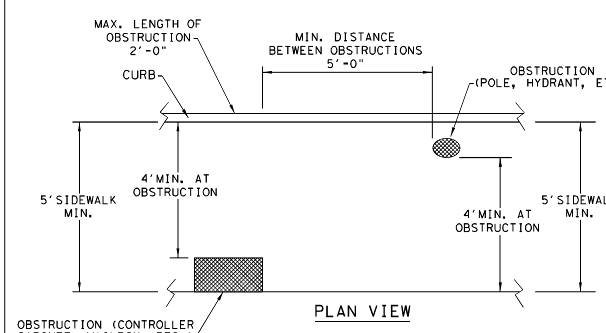


PROTECTED ZONE

NOTE: IN PEDESTRIAN CIRCULATION AREA, MAXIMUM 4" PROJECTION FOR POST OR WALL MOUNTED OBJECTS BETWEEN 27" AND 80" ABOVE THE SURFACE.



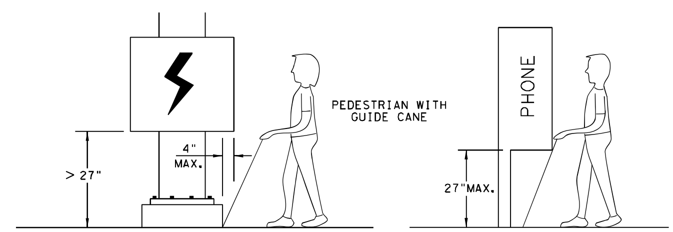
CLEAR SPACE ADJACENT TO PEDESTRIAN PUSH BUTTON



PLAN VIEW

PLACEMENT OF STREET FIXTURES

NOTE: ITEMS NOT INTENDED FOR PUBLIC USE. MINIMUM 4' X 4' CLEAR GROUND SPACE REQUIRED AT PUBLIC USE FIXTURES.



WHEN AN OBSTRUCTION OF A HEIGHT GREATER THAN 27" FROM THE SURFACE WOULD CREATE A PROTRUSION OF MORE THAN 4" INTO THE PEDESTRIAN CIRCULATION AREA, CONSTRUCT ADDITIONAL CURB OR FOUNDATION AT THE BOTTOM TO PROVIDE A MAXIMUM 4" OVERHANG.

PROTRUDING OBJECTS OF A HEIGHT ≤27" ARE DETECTABLE BY CANE AND DO NOT REQUIRE ADDITIONAL TREATMENT.

DETECTION BARRIER FOR VERTICAL CLEARANCE < 80"

Texas Department of Transportation | Design Division Standard

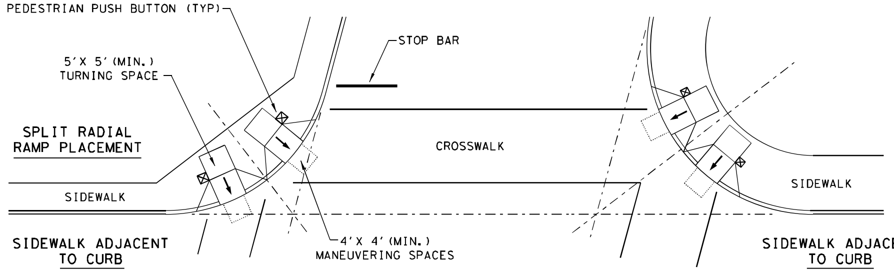
PEDESTRIAN FACILITIES CURB RAMPS

PED-18

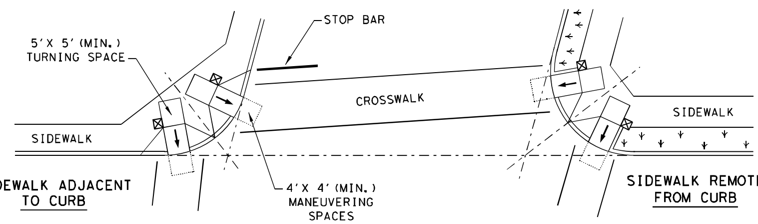
FILE: ped18	DN: TxDOT	DW: VP	CK: KM	CK: PK & JG
© TxDOT: MARCH, 2002	CONT	SECT	JOB	HIGHWAY
REVISIONS REVISED 08, 2005 REVISED 06, 2012 REVISED 01, 2018	DIST		COUNTY	SHEET NO. $SN3$

DATE:
FILE:

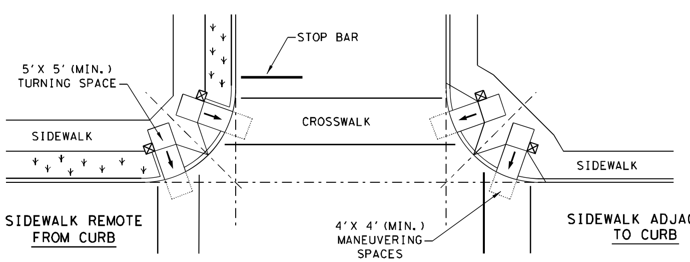
TYPICAL CROSSING LAYOUTS
SEE SHEET 1 OF 4 FOR DETAILS AND DIMENSIONS



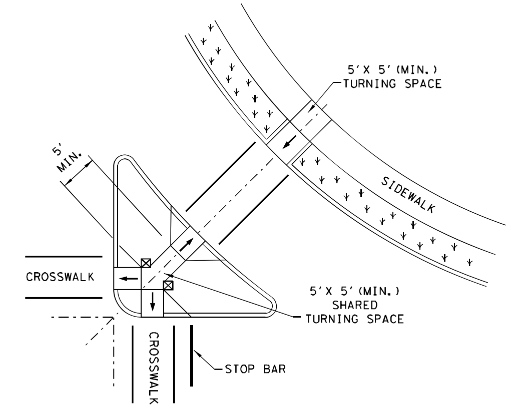
SKEWED INTERSECTION WITH "LARGE" RADIUS



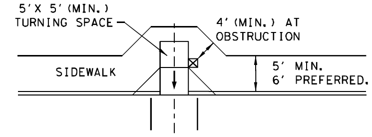
SKEWED INTERSECTION WITH "SMALL" RADIUS

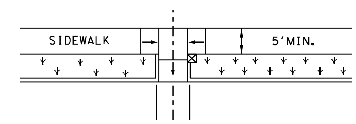


NORMAL INTERSECTION WITH "SMALL" RADIUS



AT INTERSECTION
W/FREE RIGHT TURN & ISLAND





MID-BLOCK PLACEMENT
PERPENDICULAR RAMPS

LEGEND:

SHOWS DOWNWARD SLOPE. →

DENOTES PREFERRED LOCATION OF PEDESTRIAN PUSH BUTTON (IF APPLICABLE). ⊠

DENOTES PLANTING OR NON-WALKING SURFACE NOT PART OF PEDESTRIAN CIRCULATION PATH.

SHEET 4 OF 4

Texas Department of Transportation | Design Division Standard

PEDESTRIAN FACILITIES
CURB RAMPS

PED-18

FILE: ped18	DN: TxDOT	DW: VP	CK: KM	CK: PK & JG
© TxDOT: MARCH, 2002	CONT	SECT	JOB	HIGHWAY
REVISIONS REVISED 08, 2005 REVISED 06, 2012 REVISED 01, 2018	DIST		COUNTY	SHEET NO. $SN4$

DATE:
FILE: