

Alternatives Analysis

City of Shenandoah Drainage Relief Pond

USACE Project Number SWG-2017-00597



Prepared by:

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For:

City of Shenandoah
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KH No. 064517300

INTRODUCTION:

As proposed, the project consists of modifying, by excavating and enlarging, an existing pond and constructing a pump station which is designed to lower the permanent water surface levels, provide a path for positive drainage within the east region of the City of Shenandoah, and give the City more control over floodplain mitigation. The City also desires to retain, and improve, the existing natural aesthetics and recreation potential associated with the existing open water on the site for public access. To do this, the pond will need to be landscaped and constructed with a wet-bottom amenity.

Kimley-Horn performed an aquatic resources delineation on approximately 34.5 acres of undeveloped land currently owned by the City to aid in the development of the anticipated plan for the drainage relief pond. Based on the results of the delineation, Kimley-Horn identified three forested wetlands totaling approximately 9.8 acres in size, four emergent wetlands totaling approximately 4.8 acres in size, two shrub/scrub wetland totaling approximately 11 acres in size, and one open water feature (pond) measuring approximately 7.7 acres in size.

The proposed development of the drainage relief pond would occur on approximately 23 acres (of the 34.5-acre site) and would result in unavoidable impacts to 6.1 acres of forested wetlands, 4.3 acres of emergent wetlands, 3.8 acres of shrub/scrub wetlands, and 7.7 acres of open waters (pond). Please note that although the proposed project would impact a total of approximately 21.9 acres of waters of the U.S., approximately 11.4 acres of waters of the U.S. would be completely avoided, and approximately 15.5 acres of open water habitat would exist upon project completion.

Table 1: Proposed Impacts to waters of the U.S.

Waterbody ID¹	Latitude and Longitude (Decimal Degrees)	Resource Type	Acres in Project Area	Acres of Impact
W1	30.192, -95.449	Forested Wetland	3.9 acres	0.2 acre
W2	31.193, -95.446	Emergent Wetland	2.9 acres	2.4 acres
W3	30.193, -95.445	Emergent Wetland	0.3 acre	0.3 acre
W4	30.192, -95.449	Forested Wetland	4.9 acres	4.9 acres
W5	30.193, -95.449	Emergent Wetland	0.2 acre	0.2 acre
W6	30.193, -95.448	Forested Wetland	1.0 acre	1.0 acre
W7	30.193, -95.447	Emergent Wetland	1.4 acres	1.4 acres
W8	30.193, -95.445	Shrub/Scrub Wetland	0.2 acre	0.2 acre
W9	30.192, -95.445	Shrub/Scrub Wetland	10.8 acres	3.6 acres
OW1	30.193, -95.445	Impoundment	7.7 acres	7.7 acres
TOTAL			33.3 acres	21.9 acres

PURPOSE AND NEED:

There is a local need within the City of Shenandoah to remove large areas of permanent standing water and to provide positive drainage relief out of the City. Currently, there is a significant permanent drainage backup along Carter Slough Tributary One that extends west and upstream from the east city limit boundary (at the Union Pacific Railroad), across IH-45, and into the Vision Park Regional Detention Pond. This drainage backup is primarily due to the local topography and limited infrastructure that does not allow positive drainage towards the east across the Union Pacific Rail Road. There is also localized flooding that occurs with floodwaters frequently overtopping David Memorial Drive, Ed English Drive, and Shenandoah Park Drive causing road closures, and flooding of properties including the City wastewater treatment plant.

Under existing conditions, areas downstream of the existing pond experience peak flows in excess of 1,000-cfs. Flows of that volume do not drain out of the watershed and cause flooding. The need to detain flood flows and be able to release at a lower rate is the purpose of the project. That lower rate has been identified as 300-cfs.

The Applicant is proposing a drainage relief pond in the City of Shenandoah, Montgomery County, Texas just west of the eastern city limit boundary. The purpose of the pond is to hydraulically disconnect the ponding areas within the city limits from the ponding areas downstream of the city limits by excavating out a large pond and constructing a pump station. The pond is designed to lower the permanent water surface levels, provide a path for positive drainage, and give the City more control over widespread flooding in the area.

The Preferred Alternative for the proposed project consists of excavating a large pond and constructing a pump station. The purpose of the pond is to create floodwater storage while the pump releases water at a steady state downstream at an acceptable rate to not cause flooding while replacing the storage capacity of the pond. In other words, the pond will have the capacity to accept flood flows from upstream while quickly filling, then the pump will slowly release the stored water making room for the next flood event.

ALTERNATIVES CONSIDERED:

In accordance with the Clean Water Act Section 404(b)(1) guidelines, the Applicant has described alternatives relative to the overall project purpose to demonstrate that the proposed preferred alternative represents the least environmentally damaging practicable alternative.

The City of Shenandoah needs to develop the project near the drainage outfall located within the northeastern region of the City which drains a stormwater watershed within the City of Shenandoah boundaries in order to provide drainage relief for the citizens and visitors of the City. A map of the pond watershed is attached for reference. A search for other properties within this region of the City of Shenandoah was conducted before deciding on the Preferred Alternative. The City of Shenandoah searched for alternative properties to accommodate the purpose and need of the project that met the following siting criteria:

Owned by City or Available for Acquisition - The site had to be located on undeveloped land proximate to the drainage outfall and on property already owned by the City or on property which could be acquired by the City. Proximity is relevant to the physical requirements of drainage. The pond location and outfall path has to be fundamentally supported by gravity to drain to the watershed outfall.

Sufficient Parcel Size (at least 20 acres) (able to provide approximately 284 ac-ft storage volumes) - The site had to have sufficient area to be able to either provide approximately 284 ac-ft worth of storm water storage per the detailed drainage analysis performed by the City. This storage is on top of any existing

storage that the site may already be providing. Based on typical groundwater depths in the area and considering constructability of the pond, the pond site is required to be at least 20 acres in size. The groundwater is a size limiting factor. Groundwater is expressed at 10-ft of depth and requires additional separation from storage water with a clay liner. For each additional 10-ft of depth increase the size of the pond has to be doubled to reduce groundwater infiltration. This is explained in more detail in the relevant onsite analysis of pond depth. The 284 ac-ft volume storage calculation comes from discharge equations. The pond would need to discharge at a rate of 300-cfs to maintain an acceptable downstream acceptance volume. In other words, this rate would allow for a discharge following storm events from the pond that could be handled by gravity drainage to allow for storage volume to be restored in anticipation of the next storm event.

Provided a Path for Positive Drainage - The site had to adequately provide positive drainage inside the City limits that would eliminate permanent standing water by lowering the static water surface elevations in the area. The pond has to be located so that barriers to gravity flow do not exist.

Mitigate Increased Peak Flows - The site also needs to have access to an acceptable drainage outfall to be able to release drainage and storage from the site at an acceptable rate and within a reasonable timeframe. As described in 2, above, the 284 ac-ft requirement would allow for the acceptable 300-cfs discharge requirement.

Meets funding capabilities - Constructability of the site has to allow construction of the improvements at a cost consistent with the City's funding capabilities (\$22,981,500 with Texas Department of Emergency Management TDEM grant funding). The City owns this property and the grant is sufficient to construct the project.

Safe to Public and Wildlife - The Site and improvements must be safe to the public and also maintain a suitable habitat for local wildlife.

No Action Alternative

Though the no action alternative would avoid all impacts to waters of the U.S., it would not meet the need and purpose of the proposed project. As the undeveloped areas within the watershed continue to be developed, the inevitable increase in runoff volume will only increase the level of permanent standing water in the City. Neighboring developers and jurisdictions (Montgomery County and TxDOT) understand the issue with the lack of positive drainage to and through Carter Slough located north of the Preferred Alternative site. However, no assistance has been offered in fixing the issue. Therefore, the no action alternative is not practicable for the City.

During major rain events several roads within this area have been closed due to flooding. In addition, the City has repeatedly experienced damages at the City Wastewater Treatment Plant. Major frontage roads along I-45 are also flooded and closed in this area during major rain events which cuts off the public from residential areas, commercial areas and local hospitals. Reducing roads closures due to flooding during these events is vital to improve emergency access and public safety.

Offsite Alternatives

The City evaluated five offsite alternatives and they can be seen on the Offsite Alternatives Location Map (Sheet 1) attached to this document and in Figure 1, below.

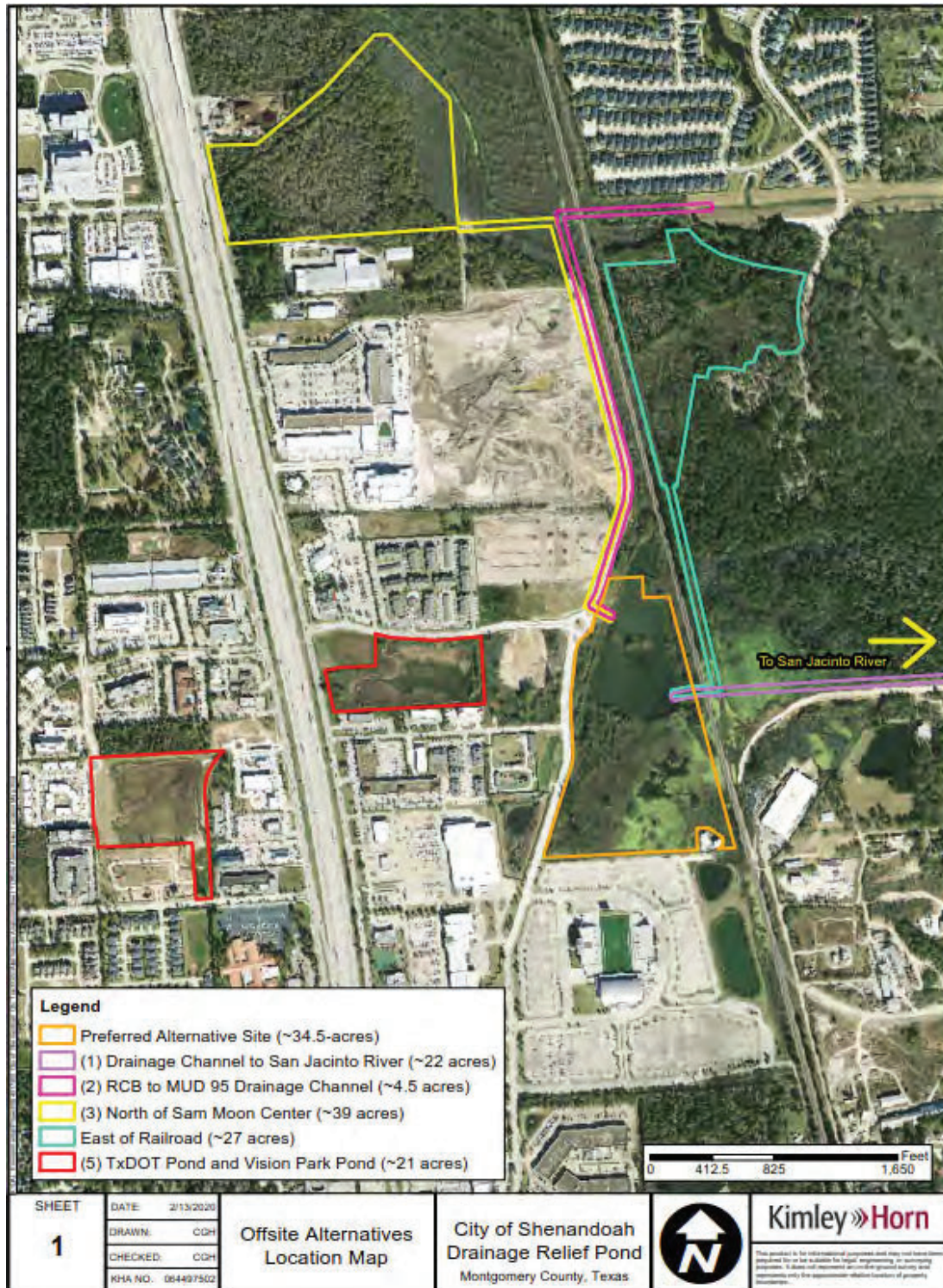


Figure 1. Offsite Alternative Locations.

Of the five offsite alternatives (Figure 1), only alternatives 2 and 3 are either owned by the City or available for acquisition. However, alternate 2 is not viable since the MUD 95 channel does not have any additional capacity and therefore the City cannot make an additional connection to this outfall thereby increasing the flows. This alternative would also exceed available funding and negatively impact the natural

characteristics of the existing pond. Alternative 3 is not viable since it is located across Carter Slough Tributary One and outside the City limits. The cost to convey the City's drainage to this location far exceeds the available funding. In addition, the property is outside of the City limits and ETJ limiting the City's ability to use the property. Lastly, this site also contains jurisdictional wetlands that would be impacted even beyond the impacts of the preferred alternative. Table 2, below, is a summary of the selection criteria used to selected the Preferred Alternative.

Table 2: Offsite Alternatives Comparison Matrix

Practicability Category	Factor	Preferred Alternative (Pumped Pond)	Offsite Alt. 1 (Channel to San Jac. River)	Offsite Alt. 2 (MUD 95 Channel)	Offsite Alt. 3 (North of Sam Moon Center)	Offsite Alt. 4 (East of Railroad)	Offsite Alt. 5 (TxDOT and Vision Park Ponds)
Available	1. Owned by City or Available for Acquisition	Yes	No	Yes	Yes	No	No
		City owns the parcel.	Land not for sale and outside of the City's Jurisdiction	Possible land acquisition opportunity available	Possible land acquisition opportunity available but outside of the City's Jurisdiction	Land reserved for wetlands mitigation and green space. outside of the City's Jurisdiction	Vision Park pond is owned by the City but reserved for existing detention needs. TxDOT pond is reserved for wetlands mitigation and detention.
	2. Sufficient Parcel Size (at least 20 acres) (able to provide approximately 284 ac-ft storage volumes)	Yes	N/A	N/A	Yes	Yes	No
		34.5 acres reserved	Alternative would exist as a drainage channel but would measure 22 acres in size	Alternative would exist as a RCB underground pipe and would measure ~4.5 acres in size	~39 acres	~27 acres	Total acreage between the two ponds is ~21 acres; however, the separated parcels and existing use do not allow for large enough ponds to provide the required storage.
Logistics	3. Provided a Path for Positive Drainage	Yes	Yes	Yes	Yes	Yes	No
		Pond would be pumped	San Jacinto River provides enough grade difference to provide positive drainage	MUD 95 channel provides enough grade difference to provide positive drainage	Additional drainage infrastructure will need to be constructed to route runoff to the pond	Additional drainage infrastructure will need to be constructed to route runoff to the pond	Too far upstream to eliminate all standing water

	4. Mitigate Increased Peak Flows	Yes	No	No	Yes	Yes	No
		Storage provided to reduce flow rate	Increased conveyance across railroad without storage increases peak flows downstream	MUD 95 cannot take additional flows	Storage provided to reduce flow rate	Storage provided to reduce flow rate	The separated parcels and existing use do not allow for large enough ponds to provide the required storage.
	5. Meets funding capabilities	Yes	Yes	No	No	No	Yes
		Project estimated to be within budget	Possible Improvements would likely be within budget	Cost of underground box culverts and downstream improvements exceeds budget	Additional cost of land and drainage infrastructure exceeds budget	Additional cost of land and drainage infrastructure exceeds budget	Possible Improvements would likely be within budget
	6. Safe to Public and Wildlife	Yes	No	No	No	No	Yes
		Public safety and wildlife considered in design and budget	City pond would be drained reducing habitat for wildlife and leaving an undesirable area that is difficult to maintain. Area would be hazardous to the public.	City pond would be drained reducing habitat for wildlife and leaving an undesirable area that is difficult to maintain. Area would be hazardous to the public.	In remote area with limited access. City pond would still need to be drained.	In remote area with limited access. City pond would still need to be drained.	Public safety and wildlife could be considered in design. Existing Pond would remain full.

Based on the information presented in Table 2 above, the preferred alternative is the Least Environmentally Damaging Practicable Alternative while still meeting the project purpose and need.

Notwithstanding the practicability analysis above, the City estimated the extent of aquatic resources at each of the Offsite Alternative sites. National Wetlands Inventory (NWI) data and aerial photographs were reviewed (Sheets 2-6 attached to this document) to identify suspect aquatic resources on each site. Table 3 below depicts the suspect aquatic resources on each offsite alternative site.

Table 3: Suspect Aquatic Resources on Offsite Alternative Sites

Site	Aquatic Resources Avoided	Aquatic Resources Impacted	Total Delineated Aquatic Resources Onsite	Practicable? (refer to Table 2 above)
Preferred Alternative	11.4 acres	21.9 acres	33.3 acres	Yes; all selection criteria are met
Site	NWI Features Onsite	Other Suspect Aquatic Resources Onsite	Total Suspect Aquatic Resources Onsite	Practicable? (refer to Table 1 above)
Offsite Alt. 1 (~22 acres)	5.3 acres	15.1 acres	20.4 acres	No; all selection criteria are not met.
Offsite Alt. 2 (~4.5 acres)	3.5 acres	0.1 acre	3.6 acres	No; all selection criteria are not met
Offsite Alt. 3 (~39 acres)	26.7 acres	4.1 acres	30.8 acres	No; all selection criteria are not met
Offsite Alt. 4 (~27 acres)	5.8 acres	21.2 acres	27 acres	No; all selection criteria are not met
Offsite Alt. 5 (~21 acres)	3.3 acres	14.2 acres	17.5 acres	No; all selection criteria are not met

Offsite alternatives 1 and 2 would not result in comparable storage capacity because they are not pond options; however, these alternatives are not practicable because of other reasons (refer to Table 2 above). While some of the offsite alternatives may result in fewer impacts to waters of the U.S., they would not allow for comparable avoidance and minimization of impacts to waters of the U.S. The Preferred Alternative proposes avoidance of 34% of waters of the U.S. onsite, while the other offsite alternatives with fewer aquatic resources would not avoid a substantial amount of waters of the U.S.

Onsite Alternatives

There are several critical items which led to the selection of the Preferred Alternative. The following is the justification for the Applicant's preferred design solution:

1. The design solution had to be located within property in close proximity to the City's major drainage outfall in the most easterly portion of the City near the Union Pacific Railroad and also within property that is available for acquisition. The location is largely a requirement of the need for gravity drainage from the pond outfall after being pumped out at an acceptable downstream rate of 300-cfs. The preferred site is already owned by the City in this downstream location and there would be no need to acquire any additional property.
2. For any pond design solution, the site had to have sufficient area to be able to provide approximately 284 ac-ft worth of storage on top of any existing storage that the site may already be providing. The preferred site, with at least 20-acres of available developable land, is sufficient size to provide a pond with a storage volume of 284 ac-ft. The size of the pond is largely a function of groundwater intrusion considerations. Groundwater is found at a depth of 10-ft. Additional groundwater requires additional clay liner to keep the groundwater out. For every additional 10-ft of depth, the size of the pond needs to double.
3. The design solution had to adequately provide positive drainage inside the city limits that would eliminate permanent standing water upstream from the most easterly portion of the City near the Union Pacific Railroad. The pond is located along the east city limit line and just west of the Union

Pacific Railroad. This location is sufficiently downstream to eliminate the standing water within the city limits.

4. The design solution had to adequately mitigate any increase in peak flow rates and lower flood levels to reduce flooding of existing roadways and the City's wastewater treatment plant. In addition, the design must be accepted by the governing jurisdictions of any downstream channel or river that is accepting the increased peak flows. Additional storage above the existing natural storage and pumps sized to adequately maintain downstream flow rates are being provided as mitigation to meet applicable standards. In other words, the pumps will maintain a steady downstream flow of 300-cfs which has been demonstrated as acceptable by the listed jurisdictions.
5. The City is limited on available funding for this project and also requires additional grant funding from the Texas Department of Emergency Management to complete this project. On site alternatives were considered but the design solution must be the most economically feasible solution to fit within the constraints of the funding that is available for the project.
6. As part of the preliminary engineering, budgeting and design process for this project, the City has been adamant that this project should maintain a habitat for local wildlife and meet stringent public safety standards.

In an effort to achieve the project's purpose and need while minimizing impacts to aquatic sites, the Applicant examined the following onsite design alternatives:

1. **Avoidance Alternative** – This alternative involves pumping the existing pond downstream with a smaller pump station and no expansion of the pond. This alternative does not provide sufficient storage volume to handle the expected inflows and therefore is not practicable and is eliminated from further analysis.
2. **Full Impact Alternative – Shallow pond to avoid groundwater intrusion.** – This alternative involves pumping a proposed shallow pond downstream with a pump station. Because of groundwater intrusion the pond could be limited to a depth of 10-ft. This would meet the purpose and need for the project but would impact all the aquatic resources on the project area. Because the impact to aquatic resources is larger, the alternative is eliminated from further analysis.

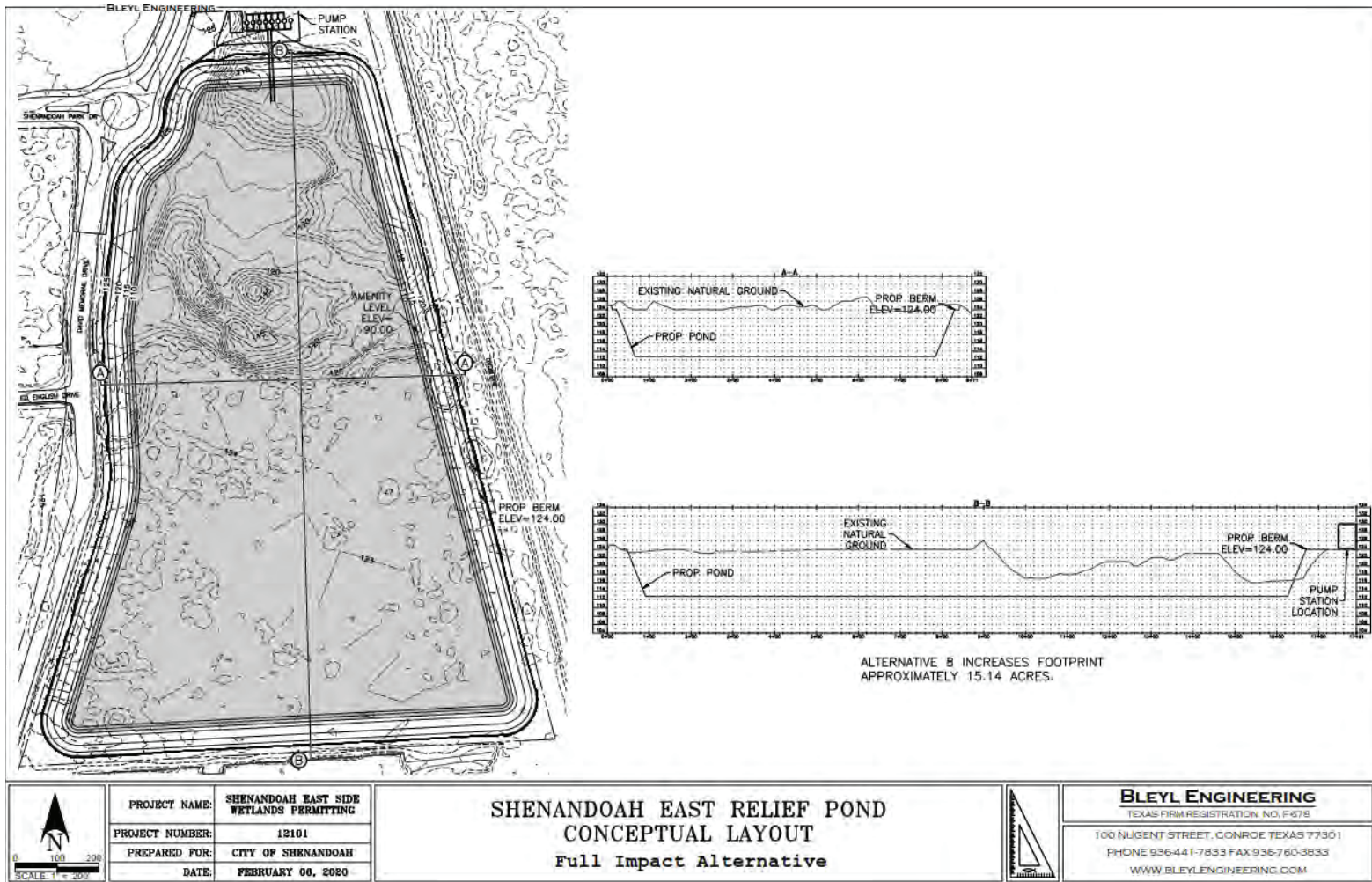


Figure 1. Conceptual View of Full Impact Alternative.

3. **Minimal Impact Alternative – Deeper pond.** This alternative involves increasing the depth of the pond by ten feet (ten feet deeper than the preferred alternative) to make the overall footprint of the pond approximately 3.47 acres smaller; therefore, this alternative would result in fewer impacts to waters of the U.S. Groundwater intrusion would not allow for enough storage and makes this alternative not practicable and is therefore eliminated from further analysis. The groundwater component also exceeds the grant budget.

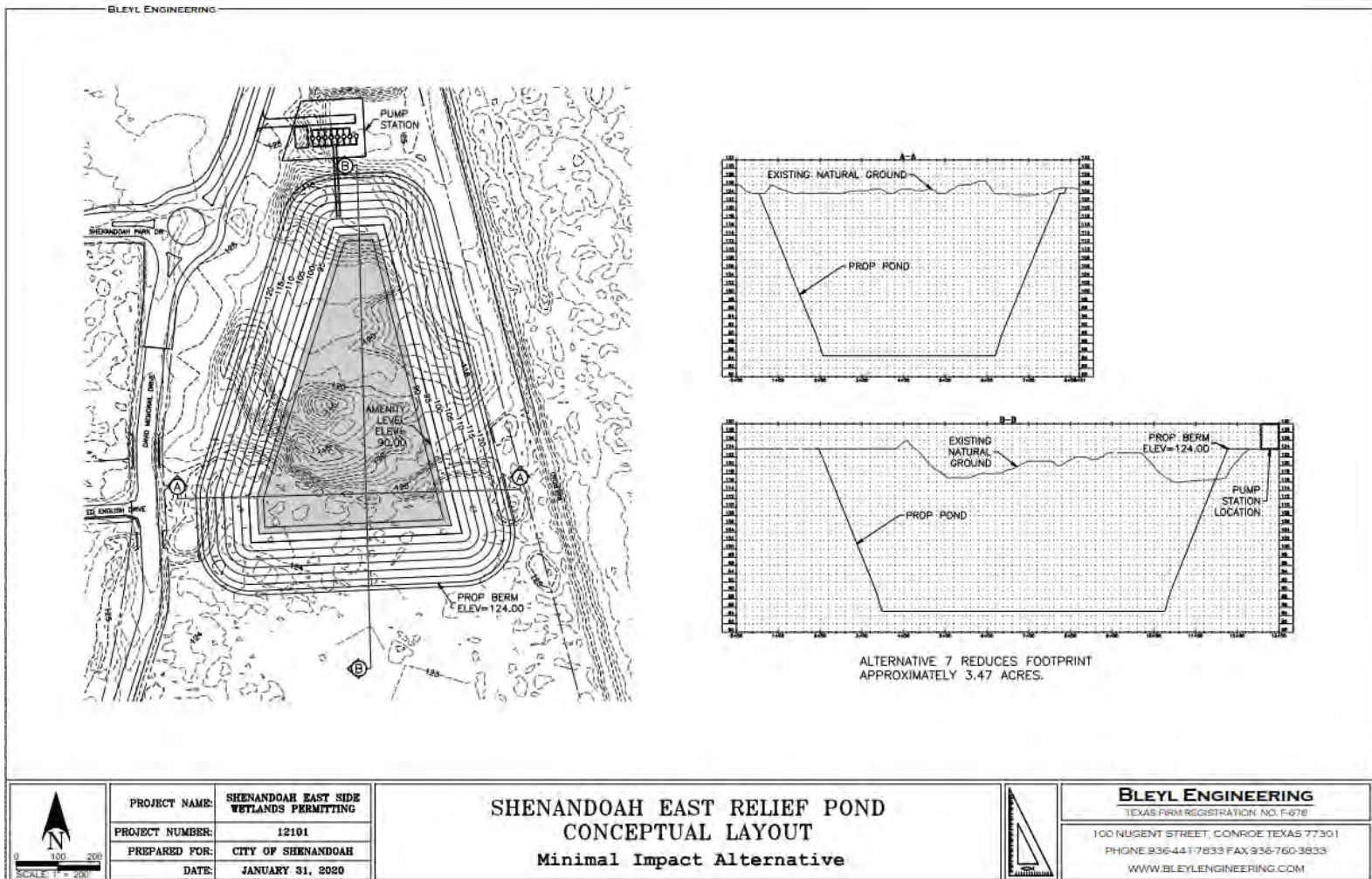


Figure 2. Minimal Impact Alternative – Deeper pond

Preferred Alternative

The preferred alternative will include the construction of drainage relief pond that doubles as a natural habitat for local wildlife and amenity for the City. The pond would include a water amenity level and landscaping to preserve and enhance the aesthetics and recreational potential of the site. The pond would also provide a viable habitat for local wildlife and give the City control for flood mitigation.

The construction of a small pump station, with a series of eight pumps, in concert with the proposed pond that will empty over the period of a week, at 300-cfs would be constructed. This alternative provides relief to drainage in the area by reducing standing water between rain events. Since the pond is being pumped, the pond will lower the standing water and control it as a wet-bottom amenity pond that can be maintained by the City. The site has proper access and has been designed to imitate the existing natural habitat and meet or exceed all applicable public safety guidelines.

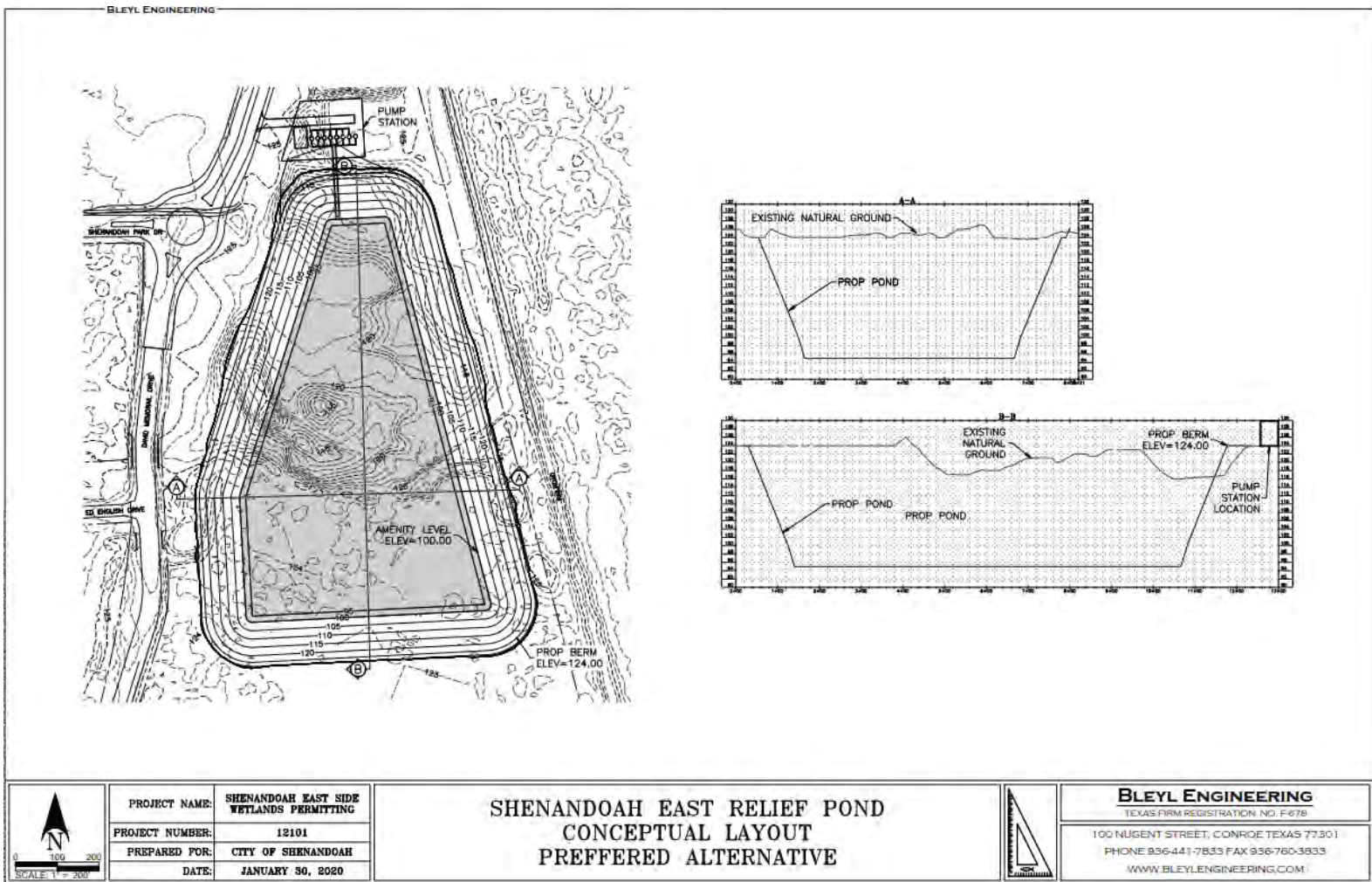
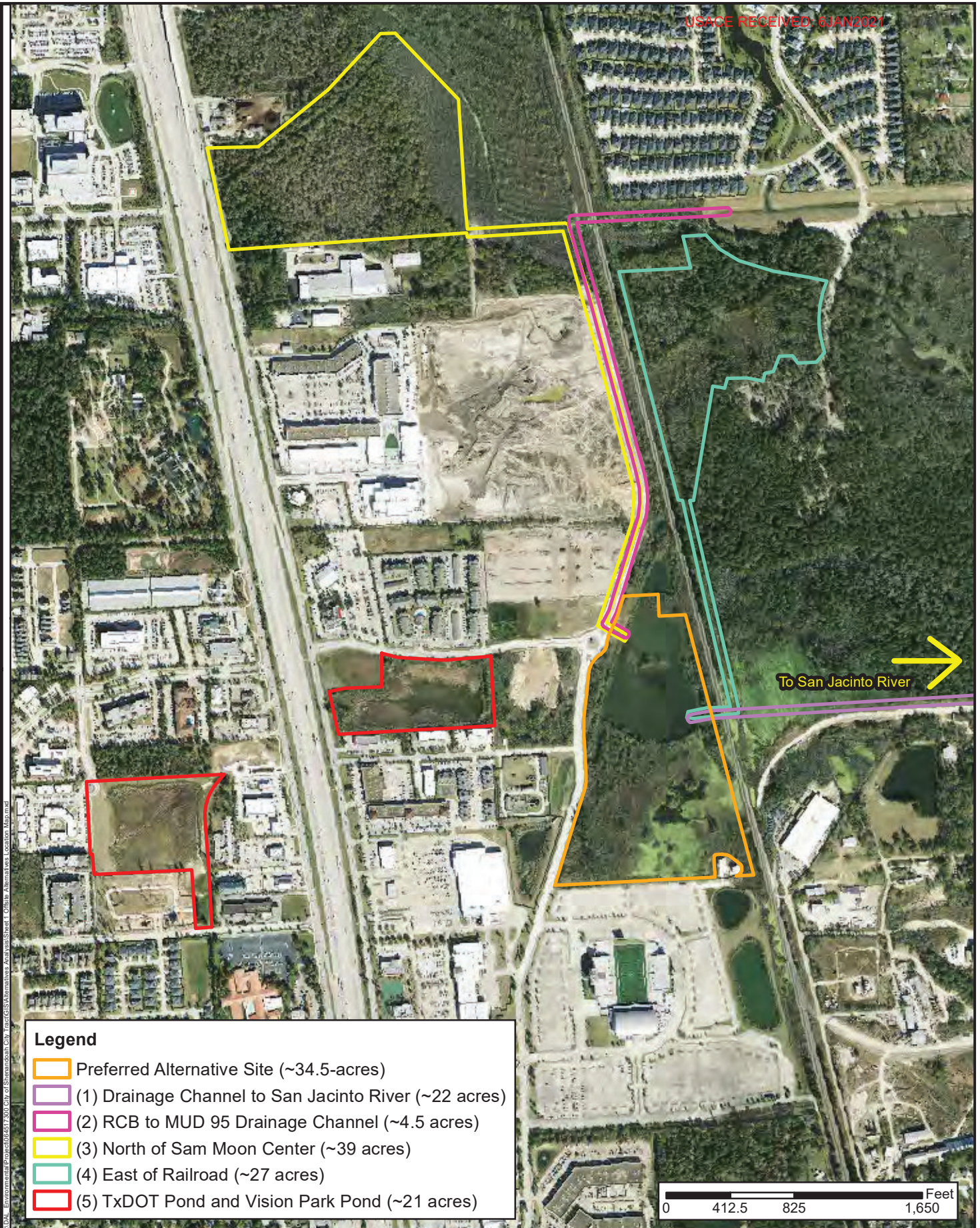


Figure 3. Preferred Alternative.

The preferred alternative is the least environmentally damaging practicable alternative because it meets the site criteria, the project purpose and need, and the practicability factors, while proposing the minimum necessary impacts to waters of the U.S. necessary to complete the project.



SHEET

1

DATE: 2/13/2020

DRAWN: CGH

CHECKED: CGH

KHA NO.: 064497502

Offsite Alternatives Location Map

City of Shenandoah
Drainage Relief Pond
Montgomery County, Texas



Kimley»Horn

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

San Jacinto
River**Legend**

(1) Drainage Channel to San Jacinto River (~22 acres)

NWI Wetland/Waterbody Type

- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Lake
- Riverine
- Apparent Aquatic Resource

Offsite Alternative 1

NWI Features within Site: ~5.3 acres
Apparent Aquatic Resources within Site: ~15.1 acres
Total: ~20.4 acres

0 1,400 2,800 5,600 Feet

SHEET

2

DATE: 2/13/2020

DRAWN: CGH

CHECKED: CGH

KHA NO.: 064497502

Offsite Alternative 1

**Aquatic Features
Within Site**

City of Shenandoah
Drainage Relief Pond
Montgomery County, Texas









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Legend

 (2) RCB to MUD 95 Drainage Channel (~4.5 acres)

NWI Wetland/Waterbody Type

-  Freshwater Emergent Wetland
-  Freshwater Forested/Shrub Wetland
-  Freshwater Pond
-  Lake
-  Riverine
-  Apparent Aquatic Resource

Offsite Alternative 2

NWI Features within Site: ~3.5 acres
Apparent Aquatic Resources within Site: ~0.1 acre
Total: ~3.6 acres

0 175 350 700 Feet

SHEET

3

DATE: 2/13/2020

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CHECKED: CGH

KHA NO.: 064497502

Offsite Alternative 2

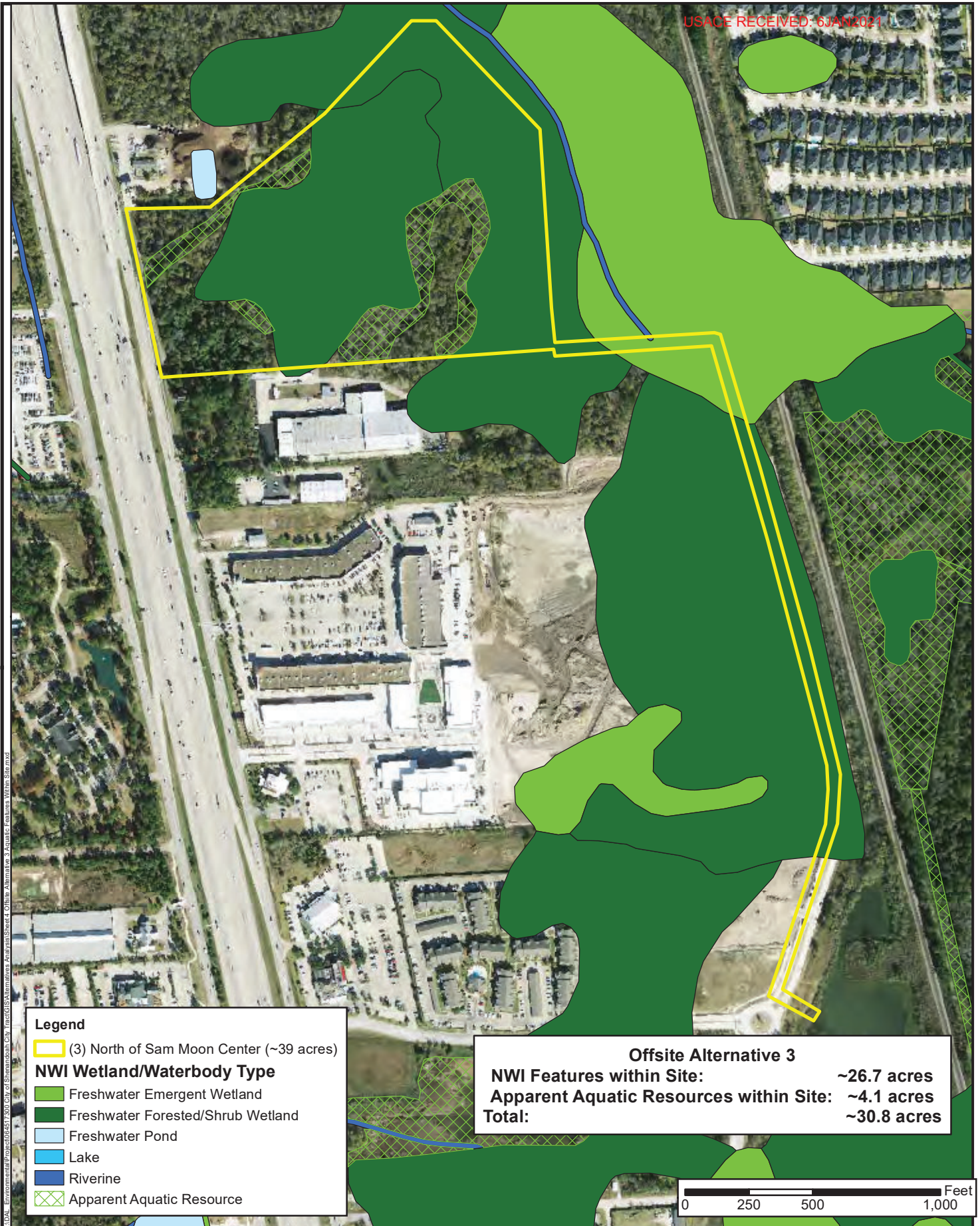
**Aquatic Features
Within Site**

City of Shenandoah
Drainage Relief Pond
Montgomery County, Texas



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Legend

 (3) North of Sam Moon Center (~39 acres)

NWI Wetland/Waterbody Type

- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Lake
- Riverine
- Apparent Aquatic Resource

Offsite Alternative 3

NWI Features within Site: ~26.7 acres
Apparent Aquatic Resources within Site: ~4.1 acres
Total: ~30.8 acres

SHEET

4

DATE: 2/13/2020

DRAWN: CGH

CHECKED: CGH

KHA NO.: 064497502

Offsite Alternative 3

**Aquatic Features
Within Site**








**City of Shenandoah
Drainage Relief Pond
Montgomery County, Texas**



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Legend

-  (4) East of Railroad (~27 acres)
- NWI Wetland/Waterbody Type**
-  Freshwater Emergent Wetland
 -  Freshwater Forested/Shrub Wetland
 -  Freshwater Pond
 -  Lake
 -  Riverine
 -  Apparent Aquatic Resource

Offsite Alternative 4

NWI Features within Site: ~5.8 acres

Apparent Aquatic Resources within Site: ~21.2 acres

Total: ~27 acres

0 200 400 800 Feet

SHEET

5

DATE: 2/13/2020

DRAWN: CGH

CHECKED: CGH

KHA NO.: 064497502

Offsite Alternative 4

**Aquatic Features
Within Site**

**City of Shenandoah
Drainage Relief Pond**
Montgomery County, Texas



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Legend

 (5) TxDOT Pond and Vision Park Pond (~21 acres)

NWI Wetland/Waterbody Type

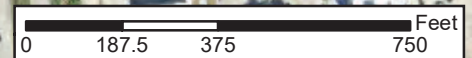
- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Lake
- Riverine
- Apparent Aquatic Resource

Offsite Alternative 5

NWI Features within Site: ~3.3 acres

Apparent Aquatic Resources within Site: ~14.2 acres

Total: ~17.5 acres



SHEET

6

DATE: 2/13/2020

DRAWN: CGH

CHECKED: CGH

KHA NO.: 064497502

Offsite Alternative 5

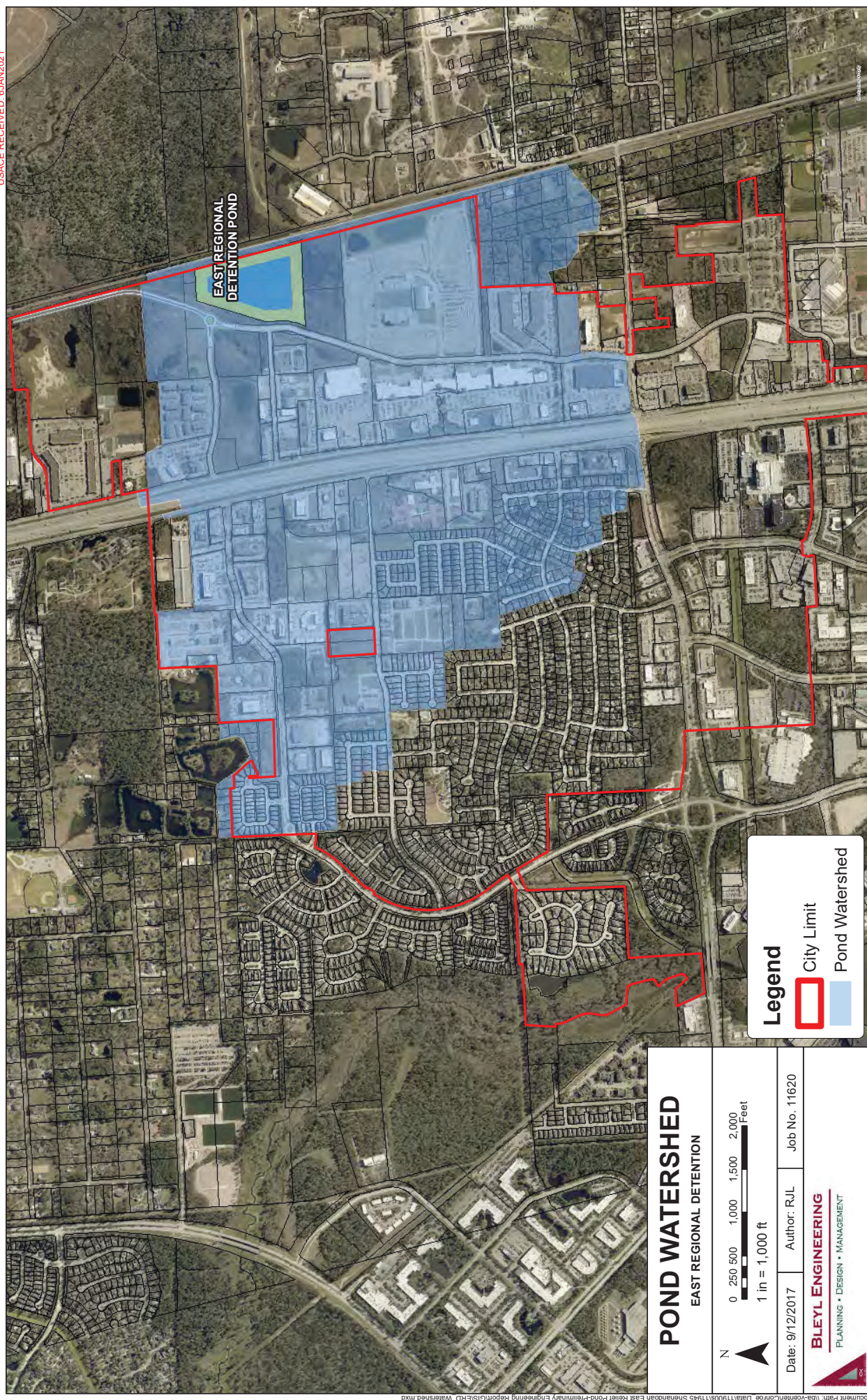
**Aquatic Features
Within Site**

City of Shenandoah
Drainage Relief Pond
Montgomery County, Texas



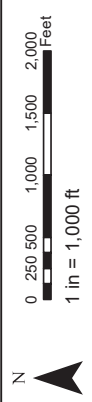
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POND WATERSHED

EAST REGIONAL DETENTION



Date: 9/12/2017 Author: RJL Job No. 11620

BLEYL ENGINEERING
PLANNING • DESIGN • MANAGEMENT

Legend



City Limit



Pond Watershed