US Corps of Engineers
Galveston District

April 2022

Harris Reservoir Expansion Project
Draft Environmental Impact Statement

Prepared for Permit Application No. SWG–2016–01027

COVER SHEET

RESPONSIBLE AGENCY: The U.S. Army Corps of Engineers (the Corps) is the lead agency for the development of the environmental impact statement (EIS) for the Harris Reservoir Expansion Project (Project). The Corps will determine whether to issue, issue with conditions, or deny the Dow Chemical Company (Applicant) a Department of the Army (DA) permit, pursuant to the Section 404 of the Clean Water Act (CWA) and Section 10 of the 1899 Rivers and Harbors Act (RHA). The DA permit application evaluation would be performed in accordance with guidelines published by the U.S. Environmental Protection Agency pursuant to Section 404 (b)(1) and Section 401 of the CWA and in accordance with Title 30, Texas Administrative Code Section 279.1-13.

PROJECT TITLE: *Harris Reservoir Expansion Project Draft Environmental Impact Statement*

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DESIGNATION AND AUTHORITY: The decision to issue, issue with conditions, or deny the Applicant a DA permit, pursuant to Section 404 of the CWA and Section 10 of the RHA of 1899, is a major federal action that has the potential to significantly affect the quality of the human environment. The Corps is preparing this EIS to comprehensively assess the impacts from the Applicant's Proposed Action and evaluate reasonable alternatives to the Proposed Action.

PROJECT SUMMARY: The Basic Project purpose, as determined by the Corps is to improve the reliability of the water supply system that serves Dow Chemical Company's (Dow's) Texas Operations in Freeport, Texas, during extended drought conditions. The Overall Project purpose, as determined by the Corps, is to use Dow's existing run-of-river water rights from the Brazos River to improve reliability during extended drought conditions for the existing water supply system that serves Dow's Texas Operations in Freeport, as well as other industrial, community, and potable water users that rely on Dow's water supply. Based on modeling, Dow estimates that a total of 78,000 acre-feet (AF) of water storage capacity is necessary to provide the Texas Commission on Environmental Quality's recommended 180 days of drought resilience. Based on a 2020 survey, the current combined storage capacity in the existing Brazoria and Harris Reservoirs is approximately 27,343 AF (Doyle & Wachtstetter, Inc. 2020a, 2020b). Therefore, Dow needs to develop the proposed reservoir to provide an additional storage capacity of at least 50,658 AF to provide a reliable water supply during drought.

Dow is proposing construction and operation of an approximately 51,000-AF off-channel reservoir located adjacent to the existing Harris Reservoir (Proposed Action) that would have a surface area of 1,929 acres and a 2,533-acre Project site in Brazoria County, Texas. The proposed reservoir would include a new intake and pump station along the Brazos River adjacent to the west of the proposed reservoir site and an outfall into Oyster Creek adjacent to the east of the proposed reservoir Project site. The proposed reservoir would improve the reliability of water supply during drought for integrated chemical manufacturing facilities at Dow's Texas Operations, as well as improve the reliability of water supply for other industrial, community, and potable water users that rely on Dow's water supply. Water would be pumped from the Brazos River into the reservoir for storage and then discharged by baffle drop structure into Oyster Creek and would flow downstream to the Lake Jackson pump station for use at Dow's facility.

The proposed reservoir would be operated in conjunction with the existing Harris Reservoir located immediately to the south and the Brazoria Reservoir located 21 miles downstream. The proposed reservoir would be used mainly as additional storage to the existing two reservoirs but would become the primary reservoir during drought

conditions. The proposed reservoir would operate with the existing Harris and Brazoria Reservoirs in a manner similar to current operations and would increase total available water storage from 68 days of water to 180 days.

The proposed Project includes plans for the mitigating of impacts via restoration projects, all on Oyster Creek. These three projects (referred to as Mitigation Projects 1, 2, and 3) are intended to enhance the flood capacity and to provide restoration and enhancements of the plant habitats and communities along the river bank (riparian area). The proposed stream restoration includes creating flat or shallowly sloped areas above the bankfull height to slow high-velocity flows during storm events (bankfull benching), 100-foot buffer preservation, and buffer reestablishment up to 200 feet.

- Mitigation Project 1 would be located on a 3,600-linear-foot unnamed tributary to Oyster Creek and include floodplain enhancement and compensatory mitigation.
- Mitigation Project 2 would be located on a 12,860-linear-foot segment of Oyster Creek and include floodplain enhancement and compensatory mitigation.
- Mitigation Project 3 is a floodplain enhancement project that would be located on an 11,200-linear-foot segment of Oyster Creek, would serve as a receiving channel conveying overflows from Oyster Creek during high flows by providing additional hydraulic conveyance capacity in the floodplain. This project would also provide additional flood storage capacity by receiving backwater from Oyster Creek at the downstream end of Project 3 during flood events.

In addition to the No Action alternative, four other action alternatives are considered in this EIS. They include two alternative reservoir configurations located within the Proposed Action Project site (Alternative 2A and 2b), the West Bank Alternative (Alternative 3), and the Brackish Water Desalination Plant Alternative (Alternative 4). The No Action alternative assumes the Applicant would not receive authorization from the Corps under Section 404 of the CWA or Section 10 of the RHA of 1899 to fill jurisdictional waters of the United States, including wetlands.

Based on the verified wetland delineation, the Proposed Action would permanently impact 15.97 acres of wetlands and 31.89 acres of waterbodies on the Project site. Due to the larger footprint, Alternative 2A would permanently impact 20.87 acres of wetlands and 36.47 acres of waterbodies on the Project site. Alternative 2B has a slightly smaller footprint and would permanently impact 15.78 acres of wetlands and 31.72 acres of waterbodies on the Project site. Based on a desktop review, the Alternative 3 site contains 384.3 acres of National Wetland Inventory (NWI) wetlands, 15.12 acres of NWI waterbodies, and 4.21 miles of National Hydrography Dataset (NHD) waterbodies subject to permanent impacts. Based on a desktop review, the Alternative 4 site contains 199.15 acres of NWI wetlands, 22.61 acres of NWI waterbodies, and 0.97 mile of NHD waterbodies subject to permanent impacts.

Stream enhancements to Oyster Creek and off-site mitigation at Big Slough have been developed to serve as mitigation for unavoidable impacts to aquatic resources as part of the proposed reservoir and would be implemented as part of the Proposed Action, Alternative 2A, and Alternative 2B development. These enhancements would largely result in permanent alterations and effects to Oyster Creek and Big Slough, and the creation of a higher-functioning stable stream system with an established riparian corridor would be beneficial in the long term. Impacts to aquatic resources from Alternative 3 and Alternative 4 would require mitigation at an approved mitigation bank with a service area that covers the alternative Project sites.

COMMENT SOLICITATION: In response to the COVID-19 pandemic, on March 24, 2020, the Corps issued a memorandum: *Interim Army Procedures for National Environmental Policy Act (NEPA) in response to the coronavirus (COVID-19) pandemic*, which was relied upon for scoping. The Corps published a notice of intent and initiated the scoping process in the *Federal Register* to notify the public of the intent to prepare a draft EIS (DEIS) on April 9, 2020. A meeting invitation was emailed to federal and state agencies on April 28, 2020, and a virtual agency scoping meeting was held via WebEx Events on May 12, 2020. Notices to interested parties and local, state, and federal elected officials were sent via mail and email on May 27, 2020, providing information about the proposed Project, announcing the public meeting scheduled for June 17, 2020, and providing a link to the Project website. Additionally on May 27, 2020, an Affected Party Letter was mailed to 25 affected parties providing information about the proposed Project, the link to the Project website, and an invitation to the June 17, 2020, public meeting, which was held virtually via Cisco WebEx Events.

The notice of availability for the Harris Reservoir Expansion Project DEIS was published in the *Federal Register* on April 8, 2022, by the Corps. The public meeting for the Harris Reservoir Expansion Project will be held virtually on May 3, 2022, from 11:00 a.m. to 2:00 p.m. central time and from 4:00 p.m. to 7:00 p.m. central time. Access information, instructions, an opportunity to subscribe to project updates, and additional information regarding this proposed Project will be made available prior to the public hearings on the Project website at: https://doweisproject.com/.

The Corps solicited comments on the Project during the scoping period meetings from the public, federal, state, and local agencies and officials, Native American tribal groups, and other interested parties for the proposed permit activity.

EXECUTIVE SUMMARY

U.S. Army Corps of Engineers (Corps), Galveston District, Harris Reservoir Expansion Project (Project)

Environmental Impact Statement (EIS) for Department of the Army Permit Application Number SWG–2016–01027

AUTHORITY: The EIS for the Harris Reservoir Expansion Project has been prepared pursuant to Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act.

APPLICANT: Dow Chemical Company (Dow, the Applicant)

THIRD-PARTY CONTRACTOR: SWCA Environmental Consultants

Purpose and Need for the Proposed Action

The Texas Commission on Environmental Quality considers water supply systems with 180 days or fewer of available water supply at risk during drought. Based on modeling, Dow estimates that a total of 78,000 acre-feet (AF) of water storage capacity is necessary to provide drought resilience for Dow's Texas Operations and Brazosport Water Authority, who receives water through the Dow water supply system. Based on a 2020 survey, the current combined storage capacity in the existing Brazoria and Harris Reservoirs is approximately 27,343 AF (Doyle & Wachtstetter, Inc. 2020a, 2020b). Therefore, Dow needs to develop additional storage capacity of at least 50,658 AF to provide a reliable water supply during drought. The Proposed Action would increase Dow's storage capacity by approximately 51,000 AF, which, in conjunction with the existing two reservoirs, would provide 180 days of water storage when that reservoir comes online. The Corps has determined that the Overall Project Purpose is to use Dow's existing run-of-river water rights from the Brazos River to improve reliability during extended drought conditions for the existing water supply system that serves Dow's Texas Operations and other industrial, community, and potable water users that rely on Dow's water supply.

Controversial Areas

Some of the major concerns of agencies, stakeholders, and the public have included hydrologic and hydraulic alterations to the combined floodplains of the Brazos River and Oyster Creek and hydraulic alterations to the in-stream flows of the Brazos River, Oyster Creek, and Buffalo Camp Bayou, and their downstream estuaries. Specific concerns are about hydrological impacts, including watershed flow from major flood events, erosion, evaporative losses, water quality issues, habitat degradation, and loss of wetland functions and values. Impacts, including cumulative impacts, to riparian habitat and bottomland forested areas along the Brazos River and Oyster Creek and hydraulic alterations to stream systems and their estuaries are also concerns. To address impacts to water resources and aquatic habitats, the public recommended mitigation for lost function in stream and channelized areas; revisions to the mitigation plan; financial assurances and funding mechanisms; valley storage mitigation; and monitoring of mitigation sites.

To address these concerns, additional baseline information has been collected including an updated wetland delineation, ecological assessments (e.g., a Level I stream condition assessment and interim hydrogeomorphic functional assessment), aquatic assessment, site photographs, and other relevant baseline information. Additional hydrology and hydraulic modeling and analyses were also conducted. A mitigation plan with performance standards has been developed.

General concerns in the following categories have been identified: waters of the United States (WOUS), including wetlands; water quality; sedimentation and erosion; hydrology and flood hazards; water rights;

wildlife and aquatic species; migratory birds; threatened and endangered species; invasive species; air quality and climate change; socioeconomics; cultural resources; navigation and recreational resources; public health and safety; downstream and off-site impacts; and cumulative impacts.

Need for an Environmental Impact Statement

Dow proposes to discharge dredged and fill material into WOUS for the purpose of constructing the proposed Harris Reservoir Expansion Project (Project), including the construction of the off-channel impoundment reservoir, pumped intake station, gravity outfall, and new bypass channel. Based on a review of the Applicant's proposal, the Corps determined that the proposed Project constitutes a major federal action that has the potential to significantly affect the quality of the human environment and the preparation of an EIS is required.

In their Memorandum for the Record (MFR) issued on September 4, 2018 (USACE 2018a), the Corps indicates that the proposed reservoir is considered "major" (meaning it can hold more than 5,000 AF of water) and an EIS would be required for Department of the Army Permit SWG-2016-01027 because the proposed Project constitutes a major federal action when considering context and intensity. In the MFR, the Corps district engineer states that "the project may have a significant effect on public safety due to the unknown and controversial risk for flooding and changes to in-stream flows resulting from construction and operation of the proposed reservoir" and "the Corps considers alteration of floodplains and in-stream flows as an adverse effect to aquatic resource functions; although the Corps also acknowledges that some hydrologic modifications can benefit aquatic functions." In the MFR, the district engineer determined that the Project required the preparation of an EIS.

Public Scoping

The Corps issued a notice of intent (NOI) to inform agencies and the general public that an EIS is being prepared and invited comments on the scope and content of the document and participation at a public scoping meeting. The NOI was published in the *Federal Register* on April 7, 2020. The Corps then sent email notices to its EIS mailing list, and the NOI was posted on the Corps website. The NOI announced the development of a public involvement program allowing opportunities for public participation and involvement in the National Environmental Policy Act process.

An agency scoping meeting was held on May 12, 2020. Agencies that attended the meeting included the U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, Texas Commission on Environmental Quality, Texas Parks and Wildlife Department, and the Texas Historical Commission. Interagency coordination has assisted the Corps in determining the scope of this EIS; developing Project components and objectives; identifying the range of alternatives; identifying constraints; and defining potential environmental impacts, impact significance, and feasible mitigation measures. The Corps held a public scoping meeting on June 17, 2020, to solicit input from the community and public agencies regarding Project design, alternatives selection, and the scope and content of the EIS. The public comment period ended on July 2, 2020, as stated in the NOI. All scoping materials were posted on the Project website: https://doweisproject.com/.

Action Alternatives

The Corps regulations for alternatives analysis require that as part of the evaluation of permit applications to discharge dredged or fill material into WOUS, including wetlands, the Corps must analyze alternatives to the proposed Project that achieve its purpose. The Corps evaluated information obtained from scoping and from federal and state agencies and the public, as well as data collection and analysis of environmental, socioeconomic, and engineering factors as part of the development of alternatives to the proposed Project. The Corps prioritized minimization of impacts, both individually and cumulatively, to aquatic resources during both construction and operations in its development of alternatives. The Corps determined that the No Action alternative and four action alternatives be carried forward for detailed analysis in this EIS.

Alternative 1: Proposed Action Alternative

The Proposed Action would include the construction and operation of an approximately 51,000-AF off-channel reservoir located adjacent to the existing Harris Reservoir. The proposed reservoir along the Brazos River would be operated in conjunction with the existing Harris Reservoir located immediately to the south and the Brazoria Reservoir located 21 miles downstream. Total available storage would increase from 68 days of water to 180 days, with an estimated annual yield of approximately 80,000 AF. During periods of drought, the proposed reservoir would be exhausted first, followed by the existing Harris Reservoir, and then the existing Brazoria Reservoir. As with current operations, emergency releases would occur from severe weather, such as tropical storms and hurricanes with wind speeds that can overtop the embankments.

The 2,533-acre site for the Harris Reservoir expansion (Project site) is owned by Dow and located in rural Brazoria County south of Houston, approximately 8 miles northwest of the City of Angleton, and approximately 5 miles west of State Highway 288. The Project site is bordered by the Brazos River to the west, Oyster Creek to the east, and the existing Harris Reservoir to the south. The surrounding area is mostly agricultural fields and grazing pastures with scattered residences and the Texas Department of Criminal Justice prison to the north. The Project site is within the floodplain of the Brazos River and Oyster Creek.

The proposed reservoir would include a 1,929-acre impoundment with a storage capacity of 51,000 AF, an intake and pump station to divert water from the Brazos River, and an outlet and emergency spillway to Oyster Creek. The Project would also include temporary construction staging and laydown areas. After reservoir construction, the Project would include floodplain enhancements and stream restoration in Oyster Creek. Construction is scheduled to begin in May 2023 and would be complete after filling the reservoir in January 2026.

Alternative 2A: Alternate Embankment Configuration Alternative

Alternative 2A, the Alternate Embankment Configuration alternative, includes an alternate site layout located on the same site as the Proposed Action. The embankment would roughly parallel the Project site’s property boundary. This larger configuration would add approximately 56,760 AF of storage capacity. The reservoir embankment would have an approximate footprint of 2,195 acres within the Oyster Creek floodplain (266 acres larger than the Proposed Action). Other Project components would be the same as those described for the Proposed Action.

Alternative 2B: Alternate Layout Alternative

The footprint of the embankment under Alternative 2B would be slightly smaller than the Proposed Action embankment but located on the same site as the Proposed Action. The west side of the embankment would be set back 273 feet from the Brazos River oxbow, compared to 90 feet for the Proposed Action. This would improve safety in this area and reduce the embankment length. Storage capacity would be approximately 50,936 AF. The reservoir embankment would have a footprint of approximately 1,919 acres within the Oyster Creek floodplain (10 acres smaller than the Proposed Action). Other Project components would be the same as those described for the Proposed Action.

Alternative 3: West Bank Alternative

Alternative 3, or the West Bank alternative, provides an alternative location outside the floodplain. This alternative includes construction of a 51,080-AF off-channel reservoir, essentially the same design as the Proposed Action reservoir, that still allows Dow to use its existing Brazos River water rights. The reservoir under the West Bank alternative would not be located adjacent to Dow's existing Harris Reservoir infrastructure, therefore requiring an extensive water conveyance pipeline system and bridge crossing to move water across the Brazos River. The West Bank alternative site would be approximately 2,885 acres and allow a reservoir that could tie into the existing Harris Reservoir and discharge into Oyster Creek. The Alternative 3 site is not currently owned by Dow and is primarily agricultural land.

Alternative 4: Brackish Water Desalination Alternative

Alternative 4, or the Brackish Water Desalination alternative, would include building a brackish water desalination plant instead of a reservoir to provide water for Dow's Texas Operations. This alternative would include diversion of brackish surface water from the Brazos River using an intake facility, a reverse osmosis plant, an outfall to discharge brine concentrate, and water conveyance facilities. The desalination plant would produce 94 million gallons per day of desalinated water, which would require preliminary treatment (pretreatment) and solids handling and disposal. The desalination plant would also require an access road to the plant location, a power line corridor, and pipeline conveyance routes.

The brackish water desalination plant would be located along the Brazos River near the City of Lake Jackson. The site was selected to enable diversion of Dow's existing water rights and to leverage water quality with lower salinity than a diversion located farther downstream nearer to the Gulf of Mexico. The 733-acre site, which is just south of Dow's Brazoria Reservoir, is not currently owned by Dow and is primarily undeveloped land.

Major Conclusions

Soil Sedimentation and Erosion

Surface disturbance would be approximately, 2,016 acres for the Proposed Action, 2,282 acres for the Alternative 2B, 2,006 acres for Alternative 2B, 2,048 acres for Alternative 3, and 481 acres for Alternative 4, including temporary and permanent disturbance. Heavy equipment operations would cause soil compaction, which can lead to decreased infiltration rates and increased runoff rates. Removal of vegetation would expose soils and temporarily increase erosion. The Oyster Creek restoration area would improve bank stabilization along the creek, reduce erosion, and trap sediment over the long term.

Modeling of operations (Proposed Action, Alternative 2A, and Alternative 2B) determined the higher flows in conjunction with the low-sediment reservoir discharge into Oyster Creek is likely to result in erosion downstream. Because the proposed reservoir would not be continually releasing water, there would also be a wetting and drying cycle that could increase the bed and bank erosion when the sediment-deprived reservoir water is released. This could cause channel incision and widening, thus increasing the sediment load farther downstream, and could result in long-term moderate impacts in erosion and channel incision downstream during drought operations. The likelihood and magnitude of these potential impacts is unclear. The reservoir embankment would be regularly inspected as part of Dow's operations and maintenance (O&M) plan. Best management practices, as well as bank stability monitoring and proper remediation, would be implemented to avoid and minimize these impacts.

Water Quality

Sedimentation and erosion described above could impact the physical characteristics of water quality such as turbidity and temperature. The Project (Proposed Action, Alternative 2A, Alternative 2B, and Alternative 3) would change the land use from agriculture to water storage and associated facilities (e.g., access roadways, pump station etc.). The reduction of agriculture would reduce the amount of agricultural runoff into the Brazos River and Oyster Creek, which could provide minor improvements to water quality in the immediate vicinity of the Project site. Alternative 4 involves desalination of brackish water from the Brazos River using a process that results in a byproduct referred to as sludge that would be placed in treatment ponds. If sludge is discharged into the Brazos River, it could result in adverse effects to water quality.

System Flows

For all alternatives, system flows in the Brazos River would not be affected once the intake and associated bank stabilization are constructed. Long-term effects to Brazos River system flows would not be anticipated as Dow is not proposing to increase its water right withdrawal.

Under existing conditions, three interbasin flows are occurring between the Brazos River Basin and the Oyster Creek Basin during both the 50- and 100-year storm events within the location of the proposed Harris Reservoir. The removal of these flow paths (Proposed Action, Alternative 2A, and Alternative 2B) results in a shift of the interbasin flows downstream of the existing Harris Reservoir, resulting in an increase in the timing and magnitude of peak flows in Oyster Creek. Discharge from the proposed reservoir during drought conditions would increase average velocities, increase bank erosion, increase bed scour, and decrease water temperatures in Oyster Creek. Alternatives 3 and 4 are not within the Oyster Creek watershed.

Environmental Flows

Hydrologic and hydraulic modeling results for the Brazos River show negligible impacts on the flows and velocities during peak flows from placement of the intake for all action alternatives. There could be changes on Oyster Creek system flows due to Oyster Creek discharges from the proposed reservoir under the Proposed Action, Alternative 2A, or Alternative 2B depending on different reservoir discharge scenarios. An increase in flows increases the potential for erosion and hydromodification during larger storm events in the downstream reaches of Oyster Creek. There is potential for increases in the water surface elevations in Oyster Creek between the existing Harris Reservoir and Lake Jackson. Repeated wet/dry conditions can break down the soil structure and lead to minor to moderate erosion impacts in the creek. Regular inspections and an adaptive management approach are needed. Alternatives 3 and 4 are not within the Oyster Creek watershed.

Flood Hazards and Flood Hazard Values

The Project site for the Proposed Action, Alternative 2A, and Alterative 2B is located between the Brazos River and Oyster Creek in the 100-year floodplain for both river systems. The Project is estimated to result in a 1,028 AF (1%) loss of floodplain storage during a 100-year storm event. To address this floodplain storage loss, the reservoir could be operated to counter the effects. Full pool water surface elevation would be maintained at 68 feet, which would provide adequate capacity to capture up to 6 inches of rain. During hurricane season the pool elevation would be slowly lowered 1 foot from the maximum normal pool elevation. When hurricanes are expected, if the pool elevation is at target drawdown levels due to evaporation or water supply releases, no additional drawdown would occur. If the pool elevation is not at target drawdown, it would be lowered to reach 1.7 feet below the seasonal maximum pool elevations. Alternative 3 is not located within the floodplain. Alternative 4 is located entirely within the floodplain, and the proposed desalination facilities and the sludge ponds necessary for desalination waste product could result in displacement of some of the existing flood flows within the watershed.

Waters of the United States, Including Wetlands

The Proposed Action would permanently impact 15.97 acres of wetlands and 78,038.40 linear feet (31.89 acres) of the waterbodies. The Alternative 2A embankment is larger and therefore overlaps 5.10 more acres of the delineated wetlands and 9,187.20 linear feet (4.58 acres) more of the waterbodies compared to the Proposed Action. Alternative 2B would impact 1,372.80 linear feet (0.11 acre) less waterbodies (ephemeral and intermittent streams), but impacts to wetlands would be the same as the Proposed Action. Under the Proposed Action, Alternative 2A, and Alternative 2B, compensatory mitigation requirements for WOUS by the Corps would be determined based on the 2019 verified wetland delineation. Based on the desktop review, the Alternative 3 and Alternative 4 sites contain more wetlands but less waterbodies than the Proposed Action.

Groundwater

Excavation for the proposed reservoir may encounter groundwater; however, impacts to groundwater are not anticipated. All action alternatives would require a Texas Pollutant Discharge Elimination System stormwater general construction permit, which indicates that groundwater can be discharged with appropriate controls and filters if there is no known contamination.

Vegetation and Wildlife

Potential impacts to wildlife from construction include the loss, degradation, and fragmentation of breeding, feeding, and sheltering habitats. Vegetation removal depends on the alternative and would range from approximately 481 acres for Alternative 4, 2,006 acres for Alternative 2B, 2,016 acres for the Proposed Action, and 2,282 acres for Alternative 2A. Vegetation communities are primarily pasture/hay, cultivated crop, grassland/herbaceous with some forest, scrub-shrub, wetlands, and waterbodies. Alternative 3 contains similar vegetation as the Project site. Alternative 4 is within an area mapped as Columbia Bottomland Hardwood.

Water released into Oyster Creek during drought conditions would likely result in a decrease in water temperature and an increase in erosive velocities and scour downstream of the proposed outfall, which could impact aquatic species in Oyster Creek. Bank erosion and scour could impact vegetation along the banks while increased sediment and decreased temperature could cause some aquatic vegetation. Representative fish and macroinvertebrate species found in Oyster Creek are relatively tolerant of turbidity and low levels of dissolved oxygen. The Proposed Action, Alternative 2A, and Alternative 2B include enhancement of approximately 227 acres of habitat along Oyster Creek as part of the stream restoration that would offset impacts to floodplains and wetlands and could function as improved wildlife habitat.

Threatened and Endangered Species

The Corps is consulting with the U.S. Fish and Wildlife Service Coastal Ecological Services Field Office to determine whether the Proposed Action and all action alternatives would affect federally listed endangered, threatened, proposed, or candidate species. Impacts to federally listed species are detailed in the biological assessment. There would be no effect on the black rail (*Laterallus jamaicensis*). However, the Proposed Action an all action alternatives may affect, but are not likely to adversely affect, the whooping crane (*Grus americana*), Texas fawnsfoot (*Truncilla macrodon*), and monarch butterfly (*Danaus plexippus*).

State-Listed Wildlife

Most state-listed species have a low potential of occurring on the Proposed Action Project site and in the analysis area, which includes all the action alternatives. Bald eagle (*Haliaeetus leucocephalus*), wood stork (*Mycteria americana*), and white-faced ibis (*Plegadis chihi*) have a moderate potential of occurring on the Project site. The Project would remove forest and wetland habitats and cropland used by wildlife; however, suitable habitat is present in nearby wildlife refuges, management areas, parks, and preserves.

Essential Fish Habitat

The hydrologic and hydraulic modeling show that impacts to surface waters of the Brazos River and Oyster Creek would attenuate upstream and outside any areas designated areas of essential fish habitat (EFH). Therefore, no impacts are expected from the Proposed Action, Alternative 2A, Alternative 2B, or Alternative 3. The Alternative 4 site is not located in an area designated as EFH, but the proposed intake facility along the Brazos River is located 7.3 linear miles and 11.8 river miles north of designated EFH. Although unlikely, larval or juvenile fish could move upstream toward the proposed intake facility and become entrapped or entrained. Potential impacts would be minimized with implementation of best management practices for water diversions.

Land Use and Agriculture

The Project site for the Proposed Action, Alternative 2A, and Alternative 2B is owned by Dow and would be converted from farmland to a reservoir. The 522.6 acres of pasture/hay and 1,490.2 acres of cultivated crops and all farm amenities would be removed and replaced with the reservoir and associated infrastructure. The ConocoPhillips pipeline and CenterPoint Energy power line would be relocated but would remain in service. Alternative 3 would convert slightly less farmland to build the reservoir, but there are five residential properties within the site. Land at the western portion of the Alternative 4 site is undeveloped with 37.6 acres used for pasture/hay that would be permanently converted for the treatment plant and basins and the power line and substation. The water pipelines would be buried adjacent to a golf course, residential neighborhoods, a canal, office buildings, and Dow's Texas Operations but would not impact these land uses.

Housing and Employment

The construction labor force is estimated to average approximately 80 to 90 persons over the construction period, and peak staffing could be close to 130 persons. There is an available local construction workforce, and most workers are likely to commute from nearby cities. There may be a slight increase in the use of renter-occupied housing units and hotel rooms. Local businesses could experience moderate benefits due to the influx of the workforce population. Housing prices would not be expected to be affected. The post-construction workforce would 20 workers or less for operation and no noticeable impacts to population or housing would be anticipated for any alternative.

Environmental Justice

Minority populations would not be displaced under all action alternatives. There are no environmental or human health impacts that would specifically or disproportionately occur within low income or minority populations or areas with concentrations of children under all action alternatives.

Recreation and Navigation

Under all action alternatives, upland areas are privately held and there is no existing public recreation. Recreational activities in the Brazos River near the proposed intake structures would be prevented during construction for public safety. Through-navigation would be maintained along the Brazos River under the Proposed Action and all alternatives. The Alternative 3 bridge across the Brazos River would require a permit from the U.S. Coast Guard and conditions would be applied as dictated by them to avoid potential impacts associated with the bridge.

Visual and Aesthetic Resources

Visual effects during operation of the Proposed Action, Alternative 2A, Alternative 2B, and Alternative 3 would result from the visibility of the aboveground pumps station facilities and the introduction of a large body of water similar to the existing Harris Reservoir. Similarly, Alternative 4 would introduce new industrial facilities for the desalination cells and sludge ponds. Sensitive viewer groups include travelers, recreational users, and residents. The level of visual impacts would range from negligible to moderate depending on location and viewer group.

Climate and Air Quality

The level of emissions would be less than the General Conformity de minimis thresholds and the impacts would cease upon completion of construction and reclamation. During operations, the level of emissions from the three diesel engines needed for the proposed reservoir would be mitigated through compliance with federal New Source Performance and maximum achievable control technology standards. The units would comply with U.S. Environmental Protection Agency Tier 4 Standards, and levels of emissions from ongoing vehicle traffic associated with operation and maintenance activities would be negligible. Alternative 4 would require significantly more power than the other alternatives, which could result in increased criteria pollutant and hazardous air pollutant emissions within the analysis area; however, air quality impacts are anticipated to be minor.

Noise

The construction noise level at the nearest sensitive receptor to construction activity would range from approximately 66 A-weighted levels (dBA) for the Proposed Action, Alternative 2A, and Alternative 2B; approximately102 dBA for Alternative 3; and approximately 88 dBA for Alternative 4. During operations, noise from any alternative would be below noticeable noise levels.

Historic and Archaeological Resources

For the Proposed Action, Alternative 2A, and Alternative 2B, there is an avoidance and minimization plan to protect three historic sites within the Project site. One site cannot be avoided; however, mitigation measures are proposed to collect all significant data from the affected cultural resource. Alternatives 3 and 4 would require systematic cultural resources surveys to determine required mitigation for impacts to cultural and historical resources.

Hazardous Waste and Materials Management

During construction, there is potential for accidental spills or releases to the land, air, or water. Dow would be required to abide by all federal, state and local hazardous waste/hazardous material management regulations during operations of the Proposed Action and all action alternatives to include establishment of a Project- and site-specific spill prevention, control, and countermeasures plan, stormwater pollution prevention plan, and other waste and materials management guidelines, as applicable.

Safety

Dow would work with the contractors to determine the safety requirements to include in each construction work package. During operations, all facilities would be fenced and gated, and access would be limited to Dow's operational staff for all action alternatives. Dow's O&M plan for the Proposed Action, Alternative 2A, and Alternative 2B includes inspection and maintenance guidelines, its security policy, and emergency response plan.

Transportation

Construction would cause a temporary increase in large truck traffic and personal vehicle traffic generated by workers commuting to all action alternative construction sites. This can result in an increase in the possibility of accidents and increased rate of pavement deterioration. During operations, roadway traffic would return to current conditions with the exception of Alternative 3, which would require reroute of approximately 3 miles of County Road 25.

Utilities

For all alternatives, existing pipelines and would be relocated and well heads would be lowered if they interfere with construction. The Proposed Action, Alternative 2A and 2B require a reroute of the existing power line, which would be used to power the pump station and a new potable water well to supply water for the operations building. Alternative 4 would require a 2-mile-long power line and substation to feed the desalination plant.

Issues Resolved

Existing conditions and four operational scenarios were modeled to analyze floodplain gain or loss during 50-year and 100-year storm events for a total of eight scenarios. Modeling concluded that several operational measures result in floodplain storage gain and the floodplain storage loss resulting from the Proposed Action can be countered. Additional floodplain storage gains may also be used to counter the smaller magnitude peak flows resulting from loss of the three interbasin flows. Dow would implement emergency drawdown of the proposed reservoir in advance of a tropical storm (hurricane) landfall near the Project site and would also drawdown because of embankment instability. Emergency releases could also occur via the emergency spillway in a full reservoir condition.

Full pool water surface elevation would be maintained at 68 feet, which would provide adequate capacity to capture up to 6 inches of rain. Between May 15 and December 1, Dow would monitor weather events, and in the event of a hurricane making landfall, would drawdown the reservoir to allow 1.7 feet of capacity, which would capture up to 19 inches of rainfall. The reservoir would drawdown over a 6-hour period to bring water surface elevations in the reservoir down to between 66.3 and 65.3 feet, depending on the month as outlined in the O&M plan. Emergency releases could also occur via the emergency spillway in a full reservoir condition.

The Proposed Action and Alternatives 2A and 2B include plans for the mitigating of impacts via three restoration projects on-site at Oyster Creek. These three projects (referred to as Mitigation Projects 1, 2, and 3) are intended to enhance flood capacity; Mitigation Projects 1 and 2 would also provide restoration and enhancements of the plant habitats and communities along the riverbank (riparian area). The proposed stream restoration includes creating flat or shallowly sloped areas above the bankfull height to slow high-velocity flows during storm events (bankfull benching), 100-foot buffer preservation, and buffer reestablishment up to 200 feet. In addition, off-site mitigation would occur at the Big Slough site east of Lake Jackson. Key mitigation components of the Oyster Creek and Big Slough enhancement projects include riparian buffer restoration, bank stabilization, reestablishment, and preservation of riparian buffer habitats. These enhancements would largely result in permanent alterations and effects to Oyster Creek and Big Slough, and the creation of a higher-functioning stable stream system with an established riparian corridor would be beneficial in the long term. The restoration of forested riparian habitats along Oyster Creek would provide increases in function and value to wildlife habitats on-site.

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APPENDICES

FIGURES

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ABBREVIATIONS

°F	degrees Fahrenheit
AADT	annual average daily traffic
ACHP	Advisory Council on Historic Properties
ACT	Antiquities Code of Texas
AEP	Annual Exceedance Probability
AF	acre-feet
AJD	approved jurisdictional determination
Applicant	Dow Chemical Company
AQI	Air Quality Index
B.P.	before present
BCGCD	Brazoria County Groundwater Conservation District
BGEPA	Bald and Golden Eagle Protection Act
BMP	best management practice
BRA	Brazos River Authority
BWA	Brazosport Water Authority
CEA	cumulative effects analysis
Census	U.S. Census Bureau
CEQ	Council on Environmental Quality
CERCLA or Superfund	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
cfs	cubic feet per second
CMP	Texas Coastal Management Program
CO	carbon monoxide
CO_2	carbon dioxide
Corps or USACE	U.S. Army Corps of Engineers
COVID-19	Coronavirus Disease 2019
CR	County Road
CWA	Clean Water Act
Cy	cubic yards
DA	Department of the Army
dB	decibel
dBA	A-weighted decibel

dbh	diameter at breast height
DEIS	draft EIS
Dow	Dow Chemical Company
EDR	Environmental Data Resources, Inc.
EFH	essential fish habitat
EIS	environmental impact statement
EO	Executive Order
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FCI	functional capacity
FEIS	final environmental impact statement
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FINDS	Facility Indexing System
FIRM	Flood Insurance Rate Map
FM	Farm to Market Road
FMC	fishery management councils
FMP	fishery management plan
GHGs	greenhouse gases
gpm	gallons per minute
GWP	global warming potential
HAP	hazardous air pollutant
HEC-HMS	Hydrologic Engineering Center-Hydrologic Modeling System
HEC-RAS	Hydrologic Engineering Center-River Analysis System
HGAC	Houston-Galveston Area Council
HMG	hydrologic monitoring guidelines
HUC	hydrologic unit codes
HW/HM	hazardous waste/hazardous material
KOP	key observation point
Ksat	saturated hydraulic conductivity
L_{dn}	day-night average sound level
Listed Species	federally listed threatened and endangered plant and animal species
LNG	liquid natural gas
m	meter

MACT	maximum achievable control technology
MBTA	Migratory Bird Treaty Act
MCC	motor control center
MFR	Memorandum for the Record
mg/L	milligrams per liter
mgd	million gallons per day
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSL	mean sea level
MT	metric tons
NAAQS	National Ambient Air Quality Standards
NAVD88	North American Vertical Datum of 1988
NEPA	National Environmental Policy Act
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NFIP	National Flood Insurance Program
NHD	National Hydrography Dataset
NHPA	National Historic Preservation Act
NLCD	National Land Cover Database
NMFS	National Marine Fisheries Service
NNIPS	non-native invasive plant species
NNSR	Nonattainment New Source Review
NO_2	nitrogen dioxide
NOA	notice of availability
NOAA	National Oceanic and Atmospheric Administration
NOI	notice of intent
NO_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NRCS	National Resources Conservation Services
NRHP	National Register of Historic Places
NWI	National Wetland Inventory
O_3	ozone
OFD	One Federal Decision
O&M	operations and maintenance
PEM	palustrine emergent
PFO	palustrine forested

Phase I ESA	Phase I environmental site assessment
PM	particulate matter
PN	public notice
ppm	parts per million
PSD	prevention of significant deterioration
PSS	palustrine scrub-shrub
PUB	palustrine unconsolidated bottom
RCNM	Roadway Construction Noise Model
RCRA	Resource Conservation and Recovery Act
RECs	recognized environmental conditions
RHA	Rivers and Harbors Act
RO	reverse osmosis
ROD	record of decision
RRC	Railroad Commission of Texas
RUSLE	Revised Universal Soil Loss Equation
SB	Senate Bill
SF_6	sulfur hexafluoride
SH	state highway
SHPO	State Historic Preservation Officer
SO_2	sulfur dioxide
SOP	standard operating procedure
SPCC	spill prevention, control, and countermeasures plan
SWCA	SWCA Environmental Consultants
SWPPP	stormwater pollution prevention plan
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
TCEQ integrated report	*Texas Integrated Report for the Clean Water Act Sections 305(b) and 303(d)*
TDCJ	Texas Department of Criminal Justice
TDS	total dissolved solids
THC	Texas Historical Commission
TMDL	total maximum daily loads
TNC	The Nature Conservancy
TPDES	Texas Pollutant Discharge Elimination System
TPWD	Texas Parks and Wildlife Department

tpy	tons per year
TWDB	Texas Water Development Board
TxDOT	Texas Department of Transportation
TXNDD	Texas Natural Diversity Database
U.S.	United States
UF	ultrafiltration
USACE or Corps	U.S. Army Corps of Engineers
USC	United States Code
USCG	U.S. Coast Guard
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
USLE	Universal Soil Loss Equation
UST	underground storage tank
VOCs	volatile organic compounds
WAM	Water Availability Model
WOUS	waters of the United States
WSEL	water surface elevation

1 INTRODUCTION AND PURPOSE

1.1 Introduction

The project proponent (Applicant), Dow Chemical Company (Dow), submitted an application to the U.S. Army Corps of Engineers (USACE or the Corps) for a Department of the Army (DA) permit pursuant to Section 10 of the Rivers and Harbors Act of 1899 (RHA) (33 United States Code [USC] 403) and Section 404 of the Clean Water Act (CWA) (33 USC 1344) (Permit SWG–2016–01027). Dow proposes to discharge dredged and fill material into waters of the United States (WOUS) for the purpose of constructing the proposed Harris Reservoir Expansion Project (Project), including the construction of the off-channel impoundment reservoir, pumped intake station, gravity outfall, and new bypass channel. Based on a review of the Applicant's proposal, the Corps determined that the proposed Project constitutes a major federal action that has the potential to significantly affect the quality of the human environment and the preparation of an environmental impact statement (EIS) is required.

The Corps Galveston District Regulatory Division is the lead federal agency that prepared this EIS in compliance with the National Environmental Policy Act (NEPA) of 1969, as amended; the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of the NEPA (40 Code of Federal Regulations [CFR] 1500–1508); and the Corps' Procedures for Implementing NEPA (33 CFR 230). This EIS also addresses the requirements of U.S. Environmental Protection Agency (EPA) Section 404(b)(1) guidelines (40 CFR 230), the Corps' NEPA Implementation Procedures for the Regulatory Program (33 CFR 325 Appendix B), and the Public Interest Review (33 CFR 320.4). As specified at 33 CFR 320.1(a)(4), the Corps is neither a proponent nor opponent of any permit proposal. The instant action is not being funded by the Corps. The Corps has prepared this EIS through the assistance of a third-party contractor, as described at 40 CFR 1506.6(c) and clarified in 1983 guidance from the CEQ in 48 *Federal Register* 34263 (CEQ 1983), and would use the final EIS (FEIS) in rendering a final permit decision.

In the Memorandum for the Record (MFR) issued on September 4, 2018 (USACE 2018a), the Corps indicates that the proposed reservoir is considered "major" (meaning it can hold more than 5,000 acre-feet [AF] of water) and an EIS would be required for DA Permit SWG-2016-01027 because the proposed Project constitutes a major federal action when considering context and intensity. Appendix B of 33 CFR 325, NEPA Implementation Procedures for the Regulatory Program, establishes the procedures for implementing NEPA in processing DA permits. Paragraph 7 of Appendix B states "In those cases where it is obvious an EIS is required, an environmental assessment is not required. However, the district engineer should document reasons for requiring an EIS." In the MFR, the Corps district engineer states that "the project may have a significant effect on public safety due to the unknown and controversial risk for flooding and changes to in-stream flows resulting from construction and operation of the proposed reservoir" and "the Corps considers alteration of floodplains and in-stream flows as an adverse effect to aquatic resource functions; although the Corps also acknowledges that some hydrologic modifications can benefit aquatic functions." In the MFR, accordance with 33 CFR 325, Appendix B, Paragraph 7, the district engineer determined that the Project requires the preparation of an EIS (USACE 2018a).

The Corps has prepared this draft EIS (DEIS) to analyze the direct, indirect, and cumulative effects for the proposed Project, which is located in Brazoria County, Texas, between the Brazos River and Oyster Creek, approximately 8 miles northwest of the City of Angleton (Figure 1.1-1).

The proposed Project includes construction of an off-channel reservoir adjacent to the existing Harris Reservoir. The proposed reservoir would be operated in conjunction with the existing Harris Reservoir, which has its intake on the Brazos River at River Mile 46, and the Brazoria Reservoir 21 miles downstream at River Mile 25. Figure 1.1-2 illustrates the boundaries for the proposed reservoir and associated facilities, as well as the existing Harris Reservoir.

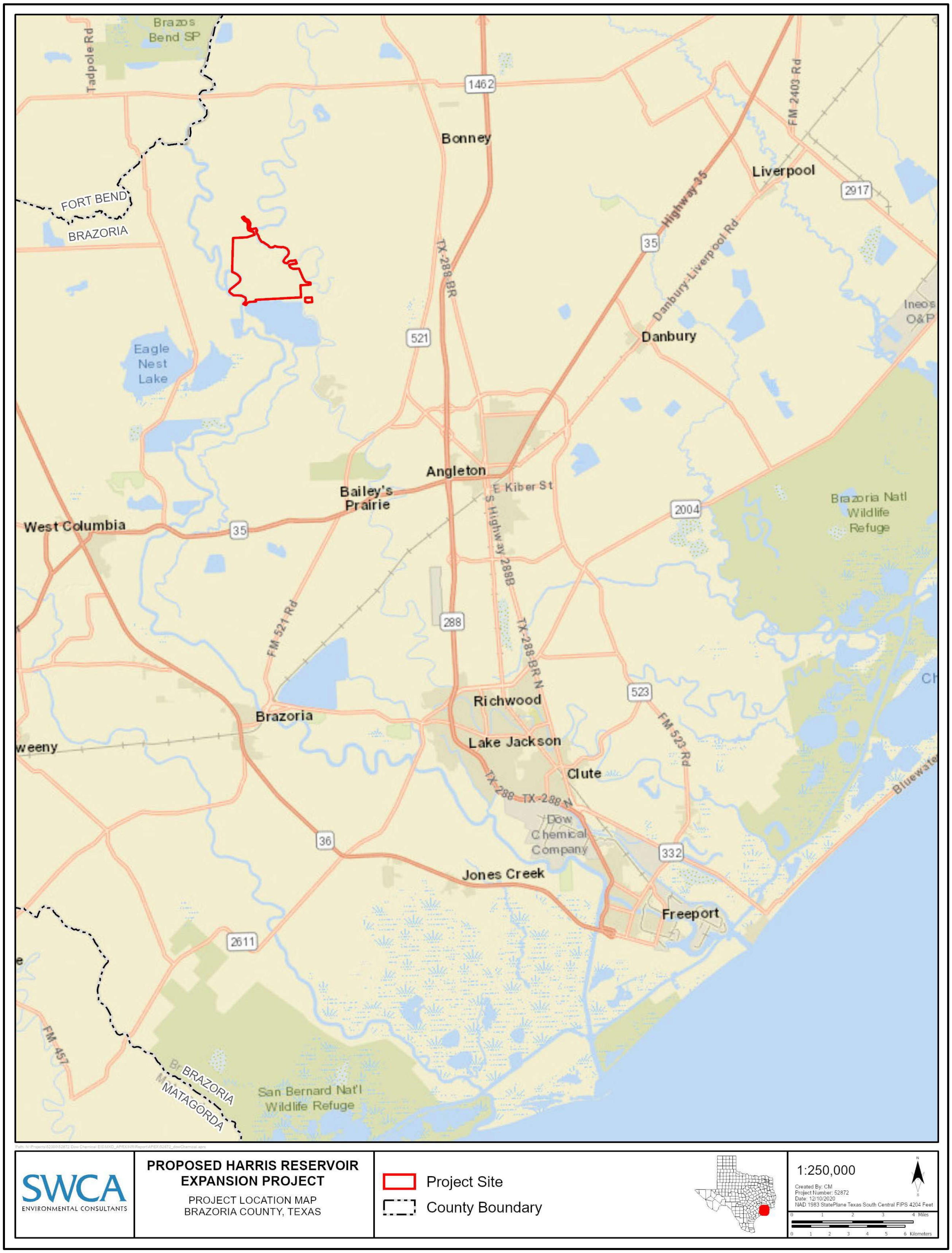

Figure 1.1-1. Project location.

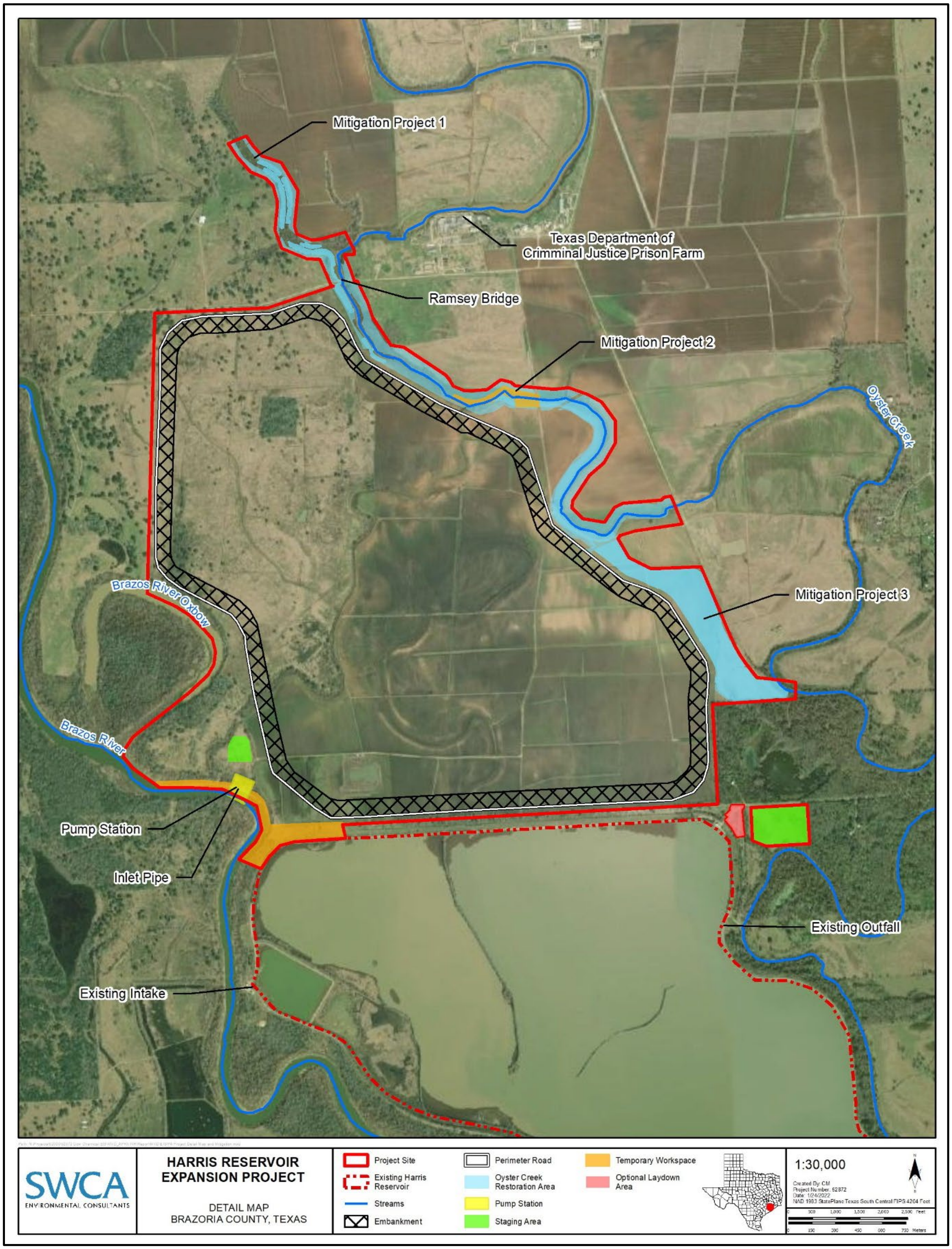

Figure 1.1-2. Proposed Harris Reservoir Expansion Project.

1.2 Purpose and Need

1.2.1 Applicant Stated Purpose and Need

The Applicant has identified a distinct need for its proposed action, the purpose of which is to expand Dow's water storage capacity at or near the existing Harris Reservoir to improve the long-term reliability of water supply during drought for facilities at Dow's Texas Operations (an integrated chemical manufacturing facility) in Freeport, Texas, as well as for other industrial, community, and potable water users that rely on Dow's water supply. The proposed Project is intended to allow more efficient use of Dow's existing Brazos River surface water rights. Dow currently manages the Brazoria and Harris Reservoirs for water supply and water quality (at the Dow intake for industrial water supply); together, the two reservoirs have a reported combined effective storage capacity of 27,343 AF. This provides approximately 68 days or less of stored water. The Texas Commission on Environmental Quality (TCEQ) recommendation for storage to meet drought preparedness and response standards is 180 days. This recommendation is based on 30 Texas Administrative Code (TAC) 290.41 (b)(1), which states that retail public utilities should report when they have less than 180 days of water supply storage and should develop a drought contingency plan. Based on a 2020 survey, the current combined storage capacity in the existing Brazoria and Harris Reservoirs is approximately 27,343 AF (Doyle & Wachtstetter, Inc. 2020a, 2020b). Therefore, Dow needs to develop the proposed reservoir to provide an additional storage capacity of at least 50,658 AF to provide a reliable water supply during drought. The Project would increase Dow's storage capacity by approximately 51,000 AF, which in conjunction with the existing two reservoirs would provide 180 days of water storage when the new reservoir comes online.

1.2.2 U.S. Army Corps of Engineers Purpose and Need

Defining purpose and need is discussed in Section 9(b)(4) of Appendix B to 33 CFR 325, as well as in CEQ's regulations at 40 CFR 1502.13. The Corps should use a reasonably and objectively formulated and stated project purpose, after taking into account the "purpose and need" provided by the applicant. The Corps should not allow the applicant to improperly limit the "purpose and need" of a project because a reasonably defined purpose and need is needed to conduct the alternatives analysis.

Defining the project purpose is critical to the evaluation of any project and in evaluating project compliance with the Section 404(b)(1) guidelines. Defining the basic project purpose enables the Corps to determine if the activity is special aquatic site–dependent (see 40 CFR 230.10(a)(3)). The overall project purpose is used to identify and evaluate practicable alternatives (see 40 CFR 230.10(a)(2)).

The Corps is responsible for defining the basic project purpose. The basic purpose of the project must be defined to determine if a given project requires access or proximity to, or siting within, a special aquatic site in order to fulfill its basic purpose. If a project does not require access or proximity to, or siting within, a special aquatic site in order to fulfill its basic purpose, alternatives that do not involve impacts to special aquatic sites are presumed to be available to the applicant, unless it is clearly demonstrated that such alternatives are not available. An activity that does not require access or proximity to, or siting within, a special aquatic site in order to fulfill its basic purpose may still be authorized, as long as the Section 404(b)(1) guidelines presumption against such discharges is successfully rebutted, the discharge meets the other criteria of the Section 404(b)(1) guidelines, the activity is not contrary to the public interest, and the activity satisfies all other statutory and regulatory requirements (see 40 CFR 230.10(a)(3)).

The overall project purpose is used to evaluate less environmentally damaging practicable alternatives. The Section 404(b)(1) guidelines state that an alternative is practicable if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes. This evaluation applies to all WOUS, not just special aquatic sites. Defining the overall project purpose is the Corps' responsibility. However, the Applicant's needs and the type of project being proposed should be considered. The overall project purpose should be specific enough to define the applicant's needs, but not so restrictive as to constrain the range of alternatives that must be considered under the Section 404(b)(1) guidelines (see 40 CFR 230.10(a)(2)). The following are considered when developing the overall purpose and need:

- **Basic project purpose, as determined by the Corps:** To improve the reliability of the water supply system that serves Dow's Texas Operations in Freeport during extended drought conditions.
- **Determination:** The proposed Project does not require access or proximity to, or siting within, a special aquatic site to fulfill its basic purpose. Alternatives that do not involve impacts to special aquatic sites are presumed to be available.
- **Overall project purpose, as determined by the Corps:** To use Dow's existing run-of-river water rights from the Brazos River to improve reliability during extended drought conditions for the existing water supply system that serves Dow's Texas Operations in Freeport, as well as other industrial, community, and potable water users that rely on Dow's water supply. Based on modeling, Dow estimates that a total of 78,000 AF of water storage capacity is necessary to provide TCEQ's recommended 180 days of drought resilience.

1.3 Background

1.3.1 Applicant

The Applicant, Dow, currently operates two reservoirs on the Brazos River, the existing Harris Reservoir located at River Mile 46 with an effective storage capacity of approximately 9,136 AF, and the Brazoria Reservoir located at River Mile 25, with an effective storage capacity of approximately 18,207 AF. These reservoirs provide potable water to the Dow chemical plant and other users. Dow has reported periodic but not regularly scheduled maintenance dredging on the existing reservoirs, which has resulted in loss of storage by approximately 15% of the original design volume. As stated above, Dow estimates the two-reservoir system would provide approximately 68 days or less of necessary water supplies during drought conditions (less than the 180 days recommended by TCEQ for a reservoir classified as a water storage facility), which according to TCEQ would classify it as a water storage facility at risk during droughts.

1.3.2 Location

The proposed Project site consists of 2,533[1] acres located south of Houston, Texas, approximately 8 miles northwest of Angleton (see Figure 1.1-1). The Project site is adjacent to the eastern bank of the Brazos River, and a portion of Oyster Creek runs through the eastern portion of the Project site. The Brazos River is a major river system within the state of Texas; its headwaters are located near Blackwater Draw, New Mexico, 19 miles north of the Project site, and its mouth is near Freeport, 25 miles south of the Project site. The Brazos River is highly managed through a series of dams and off-channel storage reservoirs. The primary water source for this system is rainfall, which results in a high variability of flows and a need to store water for dry season use and flood control. The proposed Project is located within River Segment 1202 of the Brazos River, which is tidally influenced. River Segment 1202 is located below the Navasota River from a point 100 meters (m) upstream of State Highway (SH) 332 in Brazoria County to the confluence of the Navasota River in Grimes County (TCEQ 2018).

[1] Includes 4-acre optional laydown area added after scoping.

1.3.3 Current Operations

Dow's existing surface water intakes for the Brazoria and Harris Reservoirs are located in River Segment 1202 of the Brazos River (TCEQ 2018). As stated in the *Preliminary Hydrology and Hydraulics Report* (Watearth 2020) Dow's existing water rights for industrial, municipal, and livestock uses consist of the following: 238,156 AF per year from the Brazos River, 60,000 AF per year from Oyster Creek, and 7,560 AF from Buffalo Camp Bayou. In the portion of the river between the U.S. Geological Survey (USGS) Rosharon gage (08116650) and the Gulf of Mexico, Dow has seniority amongst water rights holders (Texas Water Commission 1985). Dow's combined water rights allows a maximum diversion rate of 630 cubic feet per second (cfs) from the Brazos River (Watearth 2021a).

As stated in the *Brazos River Hydrology and Hydraulics Final Report* (Watearth 2021a), when flow conditions at the existing Brazos River pump station (located at River Mile 25) are reduced to approximately 1,730 cfs or lower, Dow is unable to divert water into the Brazoria Reservoir because of saltwater intrusion from the Gulf of Mexico and must rely on water delivered from the existing Harris Reservoir. The inshore extent of an estuarine system defines the edge of saltwater intrusion. This is locally referred to as the salt wedge. Because of the flat topography in the Project site, storm surges can cause inundation of brackish and saline water to reach farther upstream than they would under normal conditions. Based on sampling data, the salt wedge ranges from River Mile 15 to River Mile 43 and could reach River Mile 49. When river flows are sufficient at the existing Harris pump station intake on the Brazos River, river water is transferred through the reservoir to Oyster Creek by pumping water from the river into the reservoir and then discharging it to the creek through a siphon system. When flow conditions limit pumping to the existing Harris Reservoir, Dow and others' water supply needs are met by withdrawing water stored in the Harris and Brazoria Reservoirs.

The *Brazos River Hydrology and Hydraulics Final Report* (Watearth 2021a) examines recent drought conditions and its effects on river flows. In 2005, a multiyear drought began throughout Texas, with 2011 being the driest year on record (Dow 2018). By October 2011, 97% of the state was in extreme or exceptional drought conditions. During this drought period, flows in the river were significantly lower than during average conditions. In the event of continued severe drought conditions, Dow may have to reduce essential functions at its facility and curtail usage for the industries and municipal users that rely on its water supply system for a reliable source of water. Water Availability Model modeling provided by Dow indicate that Dow's run-of-river rights in the Brazos River (the rights diverted into existing reservoirs) may not be available for diversion during a repeat of the drought of record observed during the period of record for the Brazos River. Modeling indicates that when upstream junior water rights holders divert their full authorization, the availability for diversion would be decreased. Tree ring analyses and global climate models suggest that the Brazos River has been, and would be, subject to more frequent and longer droughts than those in recent years.

To combat these conditions, Dow has recently reduced its freshwater consumption from the Brazos River by more than 20,000 AF per year for production at its Texas Operations through on-site recycling and water efficiency practices. Dow also plans to implement additional water conservation/water use efficiency measures over time as technology and cost-effective approaches develop. Even with these demand reduction measures in place, the raw water use rate for Dow and its suppliers[2] is approximately 3,000 AF per week (approximately 430 AF per day, or 97,000 gallons per minute [gpm]) (Watearth 2021a). At this rate, and without any additional storage, the existing two reservoirs (when full) would provide a storage reserve of approximately 68 days or less, assuming all stored water could be accessed.

[2] In addition to meeting its own needs at the Texas Operations site in Freeport, Dow also has contractual agreements to supply water to other industrial customers located at the Texas Operations site and a pumping and storage agreement to divert and convey water rights owned by the Brazosport Water Authority (BWA). The BWA is a wholesale water provider that supplies municipal water to seven cities, as well as industries, in Brazoria and Fort Bend Counties.

This is 112 fewer days than the drought preparedness and response standards established by the state. The TCEQ considers water systems with 180 days or fewer of available water supply at risk during drought.

It is anticipated that these future water savings in combination with existing demand reduction measures would meet future water demands associated with operations and production growth during most climate conditions; however, these investments in water conservation do not provide the additional storage capacity required to sustain operations during extended drought per TCEQ's standard of 180 days. Modeling in the *Preliminary Hydrology and Hydraulics Report* (Watearth 2020) indicates that Dow needs a minimum of approximately 78,000 AF of water storage capacity to supply Dow's Texas Operations for 180 days during an extended drought using its existing water supplies and water rights. The current combined storage capacity in the existing Brazoria and Harris Reservoirs is approximately 27,343 AF. Therefore, Dow would need to develop additional storage capacity of at least 50,658 AF to provide a reliable water supply during drought. Additional storage capacity would provide similar drought resilience to the Brazosport Water Authority (BWA), which supplies approximately 16,000 AF per year to its customers through Dow water pumping and reservoir facilities.

Without additional storage capacity that would allow more efficient use of Dow's existing surface water rights from the Brazos River, petrochemical production at Dow's Texas Operations and reliable public water supplies for BWA[3] customers would be at risk during extended drought conditions.

Recent drought conditions demonstrate the urgency for implementation of a project to provide additional storage and increase the reliability of water supply during drought in an environmentally responsible and financially viable manner. Without additional water storage to increase Dow's resilience to drought, essential functions at Dow's Texas Operations site would be at risk during times of water shortage.

The proposed Project has been in the planning stages for many years and is included in both the 2011 and 2016 Texas Water Development Board (TWDB) Region H Regional Water Plans and the 2012 and 2017 Texas State Water Plans (Dow 2018). In addition, several studies have been conducted to study the floodplains and hydrology of the Project site. The Brazos River Authority (BRA) completed a study in 2019 to better understand the effects of large rain events and to provide comprehensive regional drainage criteria for the lower Brazos River watershed (BRA 2019a). The models in the study included assessing the impacts of the Memorial Day 2015, Tax Day 2016, and Hurricane Harvey 2017 flood events. The five counties affected by this study are Washington, Waller, Austin, Fort Bend, and Brazoria, where the proposed Project is located (BRA 2019a).

Dow submitted a report titled *Floodplain Studies for the Brazos River and Oyster Creek* as part of its permit application (Dow 2018). The hydraulic analysis in this report updated the effective Federal Emergency Management Agency (FEMA) modeling and verified that a no-rise condition exists for the Brazos River; however, the no-rise conditions on Oyster Creek were limited to the immediate area and are not being adopted by FEMA. This study was limited to the water surface elevation (WSEL) for the 100-year event and did not include impacts to in-stream flows, environmental flows, in-stream water quality, geomorphological changes to the river and creek, or freshwater inflows to the downstream bays and estuaries (Dow 2018; USACE 2018a).

1.3.4 Proposed Action

Dow proposes to construct an approximately 51,000-AF off-channel impoundment reservoir adjacent to and upstream of the existing Harris Reservoir, referred to in the permit application as the Harris Reservoir Expansion Project (proposed Project). The proposed impoundment is located directly upstream and

[3] The BWA owns Water Right 12-5366, which authorizes the diversion of 45,000 AF per year from the Brazos River for municipal use. BWA and Dow share storage and conveyance facilities as part of a combined system.

adjacent to the existing Harris Reservoir but would work independently. The proposed reservoir covers approximately 2,000 acres and includes a pumped intake station on the Brazos River and gravity outfall to Oyster Creek via a new bypass channel. The proposed Project also includes floodplain enhancements in Oyster Creek, stream restoration, and temporary construction staging and laydown areas. Dow proposes to operate the proposed new reservoir, existing Harris Reservoir, and Brazoria Reservoir together in a manner similar to current operations, with the proposed Project increasing available storage from 68 days of water to 180 days. During periods of drought, the proposed Project reservoir would be exhausted first, followed by the existing Harris Reservoir, and then the Brazoria Reservoir. The decision for emergency releases due to severe weather, such as tropical storms and hurricanes with wind speeds that can overtop the embankments, would remain unchanged. See Section 2.3.5.3 for details.

1.4 Decision to be Made

1.4.1 National Environmental Policy Act

As stated in Section 1.1, the Corps is preparing an EIS under NEPA because the Proposed Action is considered a major federal action that would result in adverse effects to the quality of the human and natural environment. An EIS is an informational document used by federal agencies in making decisions to provide full and open disclosure of environmental consequences prior to agency action, an interdisciplinary approach to project evaluation, objective consideration of all reasonable alternatives, application of measures to avoid or reduce adverse impacts, and an avenue for public and agency participation in decision-making (40 CFR 1502.1).

NEPA requires that a lead agency "include [in an EIS] appropriate mitigation measures not already included in the proposed action or [action] alternatives" (40 CFR 1502.14(f)). An EIS shall also include discussions of "means to mitigate adverse environmental impacts (if not fully covered under Section 1502.14(f))." In preparing a record of decision (ROD) under 40 CFR 1505.2, a lead federal agency is required to "[s]tate whether all practicable means to avoid or minimize environmental harm from the alternative selected have been adopted, and if not, why they were not. A monitoring and enforcement program shall be adopted and summarized where applicable for any mitigation."

1.4.2 Agency Roles and Responsibilities

The Proposed Action is being coordinated with a number of federal, state, regional, and local agencies, including the Corps (the lead agency), EPA, U.S. Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS), TCEQ, Texas General Land Office, and Texas Parks and Wildlife Department (TPWD). The EIS also may be used as an informational document by federal NEPA cooperating agencies that could have permitting or approval authority for Project components.

The Corps also requested that agencies with statutory authority over, or special expertise relative to, the proposed Project participate in the NEPA process as cooperating agencies (40 CFR 1501.6 and 40 CFR 1508.5). The EPA and USFWS are serving as cooperating agencies for this EIS. Under NEPA, a cooperating agency is any federal agency other than the lead agency that has jurisdiction by law or special expertise with respect to any environmental impact involved in an action requiring an EIS. Under NEPA, cooperating agencies are encouraged to actively participate in the NEPA process, review the NEPA documents of the lead agency, and use the documents when necessary if making decisions on a project.

1.4.2.1 U.S. ARMY CORPS OF ENGINEERS

The proposed Project represents a federal action because it would require a DA permit pursuant to Section 10 of RHA for structures and/or work in navigable waters and CWA Section 404 for discharges of dredge or fill material into WOUS and/or navigable waters. The Corps is preparing this EIS for the permit decision on the proposed DA Permit SWG-2016-01027 (Dow 2018) and ensuring that NEPA requirements have been met. The Corps' decision would be to issue, issue with modification, or deny DA permits for the Proposed Action.

Previous wetland delineations were completed and submitted to the Corps in 2012 and 2017. A new wetland delineation completed in September 2019 found an increase of 2.231 acres of wetlands, as well as an increase of 13.357 acres and 4,903 linear feet of 41 waterbodies that consist of 11 streams, five ditches, 22 agricultural ditches, and three ponds from the previous delineations (SWCA Environmental Consultants [SWCA] 2019a). In October 2019, the Corps verified the findings of the wetland delineation for a total of 21.38 acres of palustrine wetlands and 74.1 acres of the aforementioned 41 waterbodies (USACE 2019a).

This document has been prepared to comply with the requirements of NEPA, CEQ NEPA regulations, the Corps' NEPA implementing regulations, and Section 404(b)(1) guidelines. On September 4, 2018, the Corps determined that an EIS is required for the proposed Project because of the Project's potential to significantly affect the quality of the human and natural environment. Subpart H of the Section 404(b)(1) guidelines and associated implementing guidance further require that impacts be avoided and minimized; impacts that cannot be avoided or minimized are to be compensated. Avoidance and minimization actions that may be relevant to or influenced by the hydrologic modeling guidelines (HMGs) include operations of the Project involving diversions, storage, and/or releases. Subpart J, 40 CFR 230.93(b), 230.97(b), and 230.98(u)(4) of the Section 404(b)(1) guidelines (as well as the Corps compensatory mitigation regulations at 33 CFR 332) further this aspect of mitigation and require that specific water sources (including water rights) be secured to meet the objectives and functions of a mitigation plan.

The EIS would assess the potential social, economic, and environmental impacts of the construction and operation of the proposed reservoir and associated facilities and is intended to be sufficient in scope to address federal, state, and local requirements; environmental and socioeconomic issues concerning the proposed action; and permit reviews.

In 2018, the Corps' Fort Worth District released a final technical report titled *Hydrologic Modeling Guidelines for Regulatory Permit Actions* (USACE 2018c). The hydrologic monitoring guidelines (HMGs) were developed to assist in identifying hydrologic analysis and modeling needs and requirements associated with water supply and management permit applications, with a focus on the RiverWare modeling platform for cases that require hydrologic modeling. However, nothing in the HMGs is intended to replace the requirements of the referenced statutes and implementing regulations because the HMGs are applicable to a variety of permit evaluation scenarios associated with the Corps' Regulatory Program, and there are differing requirements associated with each of these statutes. As previously stated, the HMGs are not mandatory nor comprehensive to address all applicable regulatory requirements. Rather, they should be considered and applied to achieve more efficient permit reviews and to provide insight into the varying issues and circumstances that can occur with hydrologic modeling as it relates to aquatic resources analysis in the Corps' regulatory permit evaluation context (USACE 2018c).

1.4.2.2 U.S. ENVIRONMENTAL PROTECTION AGENCY

The EPA is a cooperating agency for this EIS on issues for which the agency has special expertise. The EPA's involvement is based on its special expertise with respect to the direct, indirect, and cumulative effects of the Project on the environment, aquatic resources, water quality, and environmental justice analysis. In the MFR (USACE 2018a), the EPA advised the Corps that the information provided by Dow in the DA permit application was insufficient to enable it to make a legally defensible permit decision in compliance with Section 230.10I of the Section 404(b)(1) guidelines. Section 230.10(c) requires that no discharge of dredged of fill material shall be permitted that would cause or contribute to significant deterioration of the WOUS. The EPA also recommended further assessment of on-site aquatic resources and analysis of potential downstream impacts to Oyster Creek habitat as a result of increased flows and potential impacts to the Brazos River system from water withdrawals, such as upstream saltwater migration, to assure compliance with the guidelines.

1.4.2.3 U.S. FISH AND WILDLIFE SERVICE

A cooperating agency may also be identified because it has jurisdiction by law or special expertise with respect to any environmental issue involved in a proposed action (or a reasonable alternative). In this case, the USFWS is a federal agency within the U.S. Department of the Interior charged with the responsibility of administering the Endangered Species Act (ESA) and providing for the conservation of federally listed aquatic and terrestrial species and their habitat. The USFWS is responsible for consulting with the federal action agency (in this case the Corps) under Section 7 of the ESA to address effects to federally listed aquatic and terrestrial species and their designated critical habitat. Because the Proposed Action may affect federally listed species, the Corps requested the USFWS's participation as a cooperating agency.

1.5 Public Participation

1.5.1 Public Notice for Department of the Army Permit Application

As part of Dow's DA permit application process, a public notice (PN) was issued on March 29, 2018, and comments were accepted until June 2, 2018.

During the PN period, comments were received from the general public; nongovernmental organizations; and local, state, and federal government agencies. Although most of the commenters requested a detailed analysis on the impacts to aquatic resources over a large geographic area, many of the commenters also noted that the Project site is located in the Columbia Bottomland, an ecologically important region to bird species. State and federal agencies, nonprofit environmental organizations, and several public citizens requested that impacts to migratory or nesting bird species be further studied. For more information on public comments on the PN, see Section 1.6.

In response to public concerns on potential impacts to floodplains and hydrology raised during the 2018 PN scoping period, Dow prepared the following studies:

- A geomorphic assessment of Oyster Creek that applied Rosgen Stream Classification Levels I, II, and III (Jacobs 2019a). The assessment was used to develop the proposed Oyster Creek enhancement prescriptions.
- Hydrology and hydraulic modeling reports using HEC-HMS, RiverWare, and HEC-RAS models (Watearth 2020, 2021a, 2021b). HEC-HMS provides hydrologic modeling. RiverWare provides reservoir operational modeling, and HEC-RAS provides hydraulic modeling. The modeling and analysis focused on drought conditions during the life of the proposed Project. Reports are provided in Appendix A and Appendix B.
- Planning-level floodplain analysis and modeling for areas downstream of the proposed Project to confirm the floodplain storage changes that would occur if the Project is implemented (Watearth 2021b) (Appendix C).

- A Level I and II stream condition assessment to determine the functions and values for wetlands and WOUS that would be affected as a result of reservoir and associated facility placement (SWCA 2019b) (Appendix D).
- An updated interim hydrogeomorphic functional assessment to determine the functional capacities of wetlands and WOUS within the Project site (SWCA 2021a) (Appendix E).
- Other planning studies, including a Phase I environmental site assessment (Jacobs 2019b).

As discussed in Section 1.4.2.1., subsequent to the public notice, additional wetland delineation work was conducted in September 2019 (Appendix F) that included preparation of a functional assessment and stream assessment. The Corps verified the wetland delineation on October 10, 2019. The conceptual mitigation plan submitted with the DA permit application in 2018 has been revised to address compensation of unavoidable impacts to WOUS based on the updated delineation and new studies (USACE 2019a). The revised mitigation plan is provided in Appendix G.

Additional hydrology and hydraulic modeling and analyses were also conducted subsequent to the public notice. In January 2020, two preliminary reports were prepared *Preliminary Hydrology and Hydraulics Report DCC Harris Reservoir Expansion EIS* (Watearth 2020a) and the *Oyster Creek Downstream Hydrologic and Hydraulic Impacts Draft Technical Memorandum DCC Harris Reservoir Expansion EIS* (Watearth 2020b). In October 2021, updated hydrology and hydraulic reports were prepared to address proposed Project changes and outstanding questions related to floodplain storage loss, erosion potential on Oyster Creek, and reservoir operational effects: *Brazos River Hydrology and Hydraulics Final Report* (Watearth 2021a); *Oyster Creek Downstream Hydrologic and Hydraulic Impacts Final Report DCC Harris Reservoir Expansion EIS* (Watearth 2021b); and the *Harris Reservoir Expansion Environmental Impact Statement Oyster Creek Aquatic Assessment* (SWCA 2021b) (Appendix H).

1.5.2 Scoping Process for Environmental Impact Statement

On March 24, 2020, the Corps issued a memorandum titled *Interim Army Procedures for National Environmental Policy Act (NEPA)* in response to the Coronavirus Disease 2019 (COVID-19) pandemic (USACE 2020a). The memorandum establishes interim DA NEPA procedures in consideration of the COVID-19 public health emergency. These interim NEPA procedures apply to all DA NEPA proponents responsible for NEPA compliance. The procedures include developing alternative means of public engagement, including virtual meetings.

The Corps issued an NOI to inform agencies and the general public that an EIS is being prepared and invited comments on the scope and content of the document and participation at a public scoping meeting. The NOI announced the development of a public involvement program allowing opportunities for public participation and involvement in the NEPA process. The NOI also provided information on the date and time of the public scoping meeting. The NOI was published in the *Federal Register* on April 7, 2020 (USACE 2020b), the Corps sent email notices to its EIS mailing list, and the NOI was posted on the Corps website. The public comment period ended on July 2, 2020, as stated in the NOI.

An agency scoping meeting was held via Cisco WebEx Events on May 12, 2020. Agencies that attended the meeting included the EPA, USFWS, TCEQ, TPWD, and the Texas Historical Commission (THC). Interagency coordination has assisted the Corps in determining the scope of this EIS; developing Project components and objectives; identifying the range of alternatives; identifying constraints; and defining potential environmental impacts, impact significance, and feasible mitigation measures.

The Corps held a public scoping meeting to solicit input from the community and public agencies regarding Project design, alternatives selection, and the scope and content of the EIS. The meeting was held via Cisco WebEx Events on June 17, 2020. All comment letters received during scoping are presented in Appendix I.

In addition to scoping activities, other public outreach activities included a website, https://doweisproject.com/, that provides overview information about the proposed Project. Documents are posted to the website as they become available, including the *EIS Scoping Report* and *EIS Agency Meeting Scoping Report* (see Appendix I).

1.5.3 Public Participation in Environmental Review Process

The notice of availability (NOA) for this DEIS is being distributed to all cooperating agencies and other potentially interested agencies, stakeholder organizations, nongovernmental organizations, Native American Tribes, and individuals. This distribution ensures that interested parties have an opportunity to provide comments on the DEIS and to ensure that information pertinent to permissions, permits, authorizations, and approvals is provided to decision-makers for the Corps and the EPA.

The DEIS is available for review online on the Corps' website, https://www.swg.usace.army.mil/Missions/Regulatory/Special-Projects-Environmental-Impact-Statements/, and the Project website, https://doweisproject.com/. The DEIS is being distributed for a 45-day review period that will end on May 23, 2022. Written comments on the DEIS must be postmarked no later May 23, 2022.

If comments are provided by email, please include the Project title in the subject line, attach comments in Microsoft Word format, include the commenter's mailing address, and email them to SWG201601027@usace.army.mil.

If comments are provided by mail, please send them to the following address:

Mr. Jayson Hudson
USACE, Galveston District, Regulatory Branch
P.O. Box 1229
Galveston, Texas 77553-1229

The Corps will hold a virtual public meeting on the DEIS on May 3, 2022, from 11:00 a.m. to 2:00 p.m. central time and from 4:00 p.m. to 7:00 p.m. central time. Comments on the DEIS will be accepted during the meeting and will be recorded at the public comment table. Written comments may also be submitted throughout the comment period as described above. Once all comments have been assembled and reviewed, responses will be prepared to address substantive environmental issues raised in the comments. The responses will be included in an FEIS. All comments received by the Corps are public records, subject to disclosure under the Freedom of Information Act or the Public Records Act.

The FEIS will be prepared and circulated in accordance with NEPA requirements and will include responses to all comments. The FEIS will constitute a reprint of the entire DEIS, as required by the Corps. When the FEIS is complete, the Corps will publish the document and the NOA will be printed in the *Federal Register*, which will mark the start of a 30-day public review period before the Corps can issue a ROD describing its decision whether or not to approve a DA permit and provide permission under Section 10 for the proposed Project.

1.5.4 Consultation and Coordination

Certain regulations require issuance of permits before Project implementation; other regulations require agency consultation but may not require issuance of any authorization, permits, or entitlements before Project implementation. Full compliance would be achieved prior to, or at the time of, issuance of the ROD under NEPA. The receipt of federal approvals and/or a signed ROD are required for the Project to demonstrate full compliance of many federal laws, regulations, and policies, and to receive federal authorizations and permits.

1.5.4.1 ENDANGERED SPECIES ACT OF 1973

Pursuant to the ESA, as amended (16 USC 1531 et seq.), the USFWS and NMFS have regulatory authority over federally listed species. Under the ESA, an incidental take statement is required for any federal action that may harm an individual of that species. *Take* is defined under ESA Section 9 as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." Under federal regulation, *take* is further defined to include habitat modification or degradation where it would be expected to result in death or injury to listed wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. ESA Section 7 outlines procedures for federal interagency cooperation to conserve federally listed species and designated critical habitat. Section 7(a)(2) requires federal agencies to consult with the USFWS and NMFS to ensure that they are not undertaking, funding, permitting, or authorizing actions likely to jeopardize the continued existence of listed species or result in destruction or adverse modification of designated critical habitat.

On May 29, 2020, the NMFS stated in an email correspondence with the Corps that they would not be commenting on the permit application because the Proposed Action does not include tidally influenced areas. USFWS consultation was initiated concurrent with publishing of the DEIS.

1.5.4.2 NATIONAL HISTORIC PRESERVATION ACT OF 1966

Section 106 of the National Historic Preservation Act (NHPA), as amended (54 USC 306108), and its implementing regulations (36 CFR 800, as amended in 2004) require federal agencies to consider the potential effects of their proposed undertakings on historic properties. Historic properties are cultural resources that are listed on, or are eligible for, the National Register of Historic Places (NRHP) (36 CFR 800.16[l]). Undertakings include activities directly carried out, funded, or permitted by federal agencies. Federal agencies must also allow the Advisory Council on Historic Properties (ACHP) to comment on the proposed undertaking and its potential effects on historic properties.

1.5.4.3 CLEAN WATER ACT SECTION 401 WATER QUALITY CERTIFICATION

Section 401 of the CWA requires that any applicant for an individual DA permit provide proof of water quality certification to the Corps prior to permit issuance. TCEQ is the lead state agency responsible for conducting Section 401 certification reviews of the Corps' DA permit for the discharge of dredged or fill material into WOUS, including wetlands. For projects involving oil and gas exploration, the Railroad Commission of Texas (RRC) is responsible for administering the Section 401 certification program in Texas. The purpose of these certification reviews is to determine whether a proposed discharge will comply with state water quality standards.

1.5.4.4 COASTAL ZONE MANAGEMENT ACT OF 1972

The Coastal Zone Management Act of 1972 requires that federal actions within and outside the coastal zone that have reasonably foreseeable effects on any coastal use or natural resource of the coastal zone be consistent with the enforceable policies of a state's federally approved coastal management program. The

Texas Coastal Management Program (CMP), approved by the National Oceanic and Atmospheric Administration (NOAA) in 1996, is administered by the Texas General Land Office in conjunction with the Coastal Coordination Advisory Committee. The Coastal Coordination Act is the primary authority for the Texas CMP.

1.6 Areas of Known Controversy

As discussed in Section 1.5.1, the public; federal, state, and local agencies; and nongovernmental organizations raised major concerns during the PN period in 2018. Commenters overwhelmingly requested the preparation of an EIS, citing that the proposed Project constituted a major federal action with significant impacts, and that the Corps hold a public meeting for public input. Commenters requested a clearly defined purpose and need, a more robust alternatives analysis, and information on several alternatives that were not included or fully analyzed in the PN for the CWA 404 permit application.

Commenters requested that the Corps conduct more detailed studies and collect additional baseline information so that the appropriateness of the proposed mitigation can be accurately assessed. Examples of these studies and baseline information include a hydrological and hydraulic study, a wetland delineation, ecological assessments (e.g., a Level I Stream Condition Assessment and interim hydrogeomorphic functional assessment), site photographs, performance standards, and other relevant baseline information on the condition of wetlands and streams on the Project site. Since the PN, the Corps has conducted more studies and collected additional baseline information in response to these comments, as stated in Section 1.5.1. PN commenters also noted that the Corps did not conduct a site visit because the Project site consists of agricultural land that is used by the Ramsey Unit of the Texas State Prison system and is not easily accessible. In response, the Corps has conducted several site visits that included verification of the wetland delineation (USACE 2019a).

As referenced above, some of the major concerns include hydrologic and hydraulic alterations to the combined floodplains of the Brazos River and Oyster Creek and hydraulic alterations to the in-stream flows of the Brazos River, Oyster Creek, and Buffalo Camp Bayou, and their downstream estuaries. Commenters are particularly concerned about hydrological impacts, including watershed flow from major flood events, erosion, evaporative losses, water quality issues, habitat degradation, and loss of wetland functions and values. Commenters requested considerable analysis of the direct, indirect, and cumulative impacts to riparian habitat and bottomland forested areas along the Brazos River and Oyster Creek resulting from the construction of the new reservoir, including the required floodplain enhancements, and hydraulic alterations to several stream systems and their estuaries.

Commenters also expressed concerns about biological resources and requested surveys for specific threatened and endangered species, including baseline surveys and assessments and presence-absence surveys. Many commenters had concerns about mitigation, specifically mitigation banking and on-site mitigation projects; recommendations for in-kind mitigation; mitigation for impacts to streams and mitigation for lost function in stream and channelized areas; revisions to the mitigation plan; financial assurances and funding mechanisms; valley storage mitigation; and monitoring of mitigation sites for 15 years. In response to these comments, a conceptual mitigation plan was submitted as part of the DA permit application.

General concerns in the following categories have been identified to date from comments on the DA permit: WOUS, including wetlands; water quality; sedimentation and erosion; hydrology and flood hazards; water rights; wildlife and aquatic species; migratory birds; threatened and endangered species; invasive species; air quality and climate change; socioeconomics; cultural resources; navigation and recreational resources; public health and safety; downstream and off-site impacts; and cumulative impacts. Commenters also requested the inclusion of the following topics: recreational and navigational access to these streams; oil/gas and other mineral rights on the property and how that may interfere with mitigation;

the impact of removing materials from borrow areas; conducting Special Interest Factor analysis; and implementing a monitoring plan for the use of herbicide and prevention of nonnative invasive plant species. All parties who express interest will be given an opportunity to participate in the NEPA process.

1.7 Document Organization

The content and format of this EIS is designed to meet the requirements of NEPA, the NEPA regulations issued by the CEQ, and the Corps' NEPA regulations. This EIS is organized into the following key sections so that the reader can easily obtain information about the Project, Project alternatives, and specific environmental issues related to those alternatives.

- The Executive Summary presents an overview of the Proposed Action and alternatives under consideration; lists environmental impacts, cumulative impacts, and mitigation measures; and identifies the next steps in the NEPA process.
- Chapter 1, Introduction and Purpose, describes the Project's purpose and need, background, the Applicant, and the Proposed Action; explains the NEPA process; discusses the lead, cooperating, and responsible agencies that may have discretionary authority over the Project; identifies consultation and coordination with other federal agencies; provides information on public scoping and participation; presents known areas of controversy and issues to be resolved; and outlines EIS organization.
- Chapter 2, Proposed Action and Alternatives, presents detailed descriptions of the actions that would be taken under each alternative under consideration. This chapter also contains alternative analysis evaluation criteria, the Proposed Action, and alternatives descriptions, including the Project location, characteristics, and components. This chapter also describes the alternatives eliminated from further consideration and provides an alternatives comparison.
- Chapter 3, Affected Environment, is divided by resource area and describes the baseline, or existing conditions, for each resource analyzed in this EIS.
- Chapter 4, Environmental Consequences, provides an analysis of impacts at an equal level of detail for all alternatives. A comparison of the impacts is presented at the beginning of each impact analysis discussion.
- Chapter 5, Cumulative Impacts, introduces the analysis of cumulative impacts and includes the cumulative impact methodology, cumulative context, and geographic scope; a list and brief summary of past, present, and reasonably foreseeable future projects; and the cumulative impact analysis for each resource area.
- Chapter 6, Mitigation, provides a summary of wetland and floodplain mitigation and monitoring which are detailed in the Project mitigation plan.
- Chapter 7, Consultation and Coordination, provides a summary of previous scoping activities; consultation and coordination with other federal, state, regional, and local agencies with jurisdiction over the Project or components of the Project; public scoping; and public meeting(s).
- Chapter 8, Preparers and Reviewers, lists individuals who were involved in oversight or preparation of sections of this EIS.
- Chapter 9, Literature Review, provides a list of sources cited in this EIS.
- Appendices A through L provide typical drawings, technical reports, operations and maintenance (O&M) plan, and scoping documentation.

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2 PROPOSED ACTION AND ALTERNATIVES

2.1 Introduction

As discussed in Section 1.4.2.1, the Corps regulations for alternatives analysis require that as part of the evaluation of permit applications to discharge dredged or fill material into WOUS, including wetlands, the Corps must analyze alternatives to the proposed Project that achieve its purpose. The Corps conducts this analysis pursuant to three requirements – the Section 404(b)(1) guidelines found in 40 CFR 230, NEPA found in 33 CFR Part 325 Appendix B and 40 CFR. The Corps also considers alternatives as part of its public interest review evaluation found in 33 CFR 320.4(a)(2)(ii).

The overall Project purpose is used to evaluate less environmentally damaging practicable alternatives. The Section 404(b)(1) guidelines state that an alternative is practicable if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall Project purposes. This evaluation applies to all WOUS, not just special aquatic sites such as wetlands and seagrasses.

The Corps evaluated information obtained from scoping and with federal and state agencies and the public, as well as data collection and analysis of environmental, socioeconomic, and engineering factors as part of the development of alternatives to the proposed Project. The Corps prioritized minimization of impacts, both individually and cumulatively, to aquatic resources during both construction and operations in its development of alternatives. Using these concepts and considering avoidance and minimization to reduce impacts, the following seven Project alternatives were identified. Dow developed one additional alternative that would be built within the Proposed Action Project site and envelope but would move the reservoir embankment to the east, farther away from the Brazos River oxbow.

1. **No Action alternative:** Under the No Action alternative, no additional water storage would be constructed and the proposed activity would not take place. Dow would continue to operate its water supply system as is currently done. The No Action alternative would include Dow's current water conservation and water reclamation projects.
2. **Harris Reservoir Expansion Project alternative (Proposed Action):** This alternative includes construction of an off-channel reservoir located on approximately 2,000 acres directly north of the existing Harris Reservoir to add approximately 51,000 AF of additional storage capacity and estimated annual yield of approximately 80,000 AF. This location is in the floodplain for the Brazos River and Oyster Creek and is adjacent to Dow's existing infrastructure.
3. **Alternate Embankment Configuration alternative:** This alternative includes an alternate site layout for the construction of an off-channel reservoir located on approximately 2,000 acres directly north of the existing Harris Reservoir. It would add approximately 56,000 AF of additional storage capacity and estimated annual yield of approximately 80,000 AF. Alternative site layouts, or on-site alternatives, may reduce impacts to the Brazos River and Oyster Creek.
4. **Alternative Reservoir Layout alternative.** This alternative includes an alternate site layout for the construction of an off-channel reservoir located on approximately 2,000 acres directly north of the existing Harris Reservoir. It would add approximately 51,000 AF of additional storage capacity and an estimated annual yield of approximately 80,000 AF. Alternative site layouts, or on-site alternatives, may reduce impacts to the Brazos River and Oyster Creek.
5. **West Bank alternative:** This alternative would be located on the west bank of the Brazos River. This alternative would include consideration of an area outside the Oyster Creek and Brazos River floodplains to construct a 50,000-AF reservoir and would allow Dow to use its existing Brazos River water rights but is not adjacent to Dow's existing infrastructure.

6. **Allens Creek Reservoir alternative:** This alternative is a proposed water supply storage reservoir planned for construction near the City of Wallis in Austin County. The off-channel reservoir is near the Brazos River on Allens Creek, a tributary of the Brazos River. The reservoir would be composed of diversions from the mainstem of the Brazos River, which would be pumped to the impoundment formed by a dam on Allens Creek. The reservoir would have a storage capacity of up to 145,533 AF and an approximate annual yield of 99,650 AF. The maximum permitted diversion rate is 2,200 cfs or approximately 1,400 million gallons per day (mgd). The water rights for Allens Creek Reservoir are owned by the BRA and the City of Houston.
7. **Seawater Desalination alternative:** This alternative would include diversion of seawater using an intake facility, a reverse osmosis plant, an outfall to discharge brine concentrate, and water conveyance facilities.
8. **Brackish Water Desalination alternative:** This alternative would include diversion of brackish water from the Brazos River using an intake facility, a reverse osmosis plant, an outfall to discharge brine concentrate, and water conveyance facilities.

The Corps conducted a multistep process to screen the range of alternatives to determine which alternatives are reasonable, practicable, and meet the Project purpose. The Project alternatives were analyzed using the following screening criteria to identify a range of reasonable alternatives: satisfaction of the overall Project purpose; practicability based on Clean Water Act Section 404(b)(1) guidelines (i.e., technology, logistics, and cost); and consideration of potential aquatic resources impacts. The alternatives screening analysis is summarized in Table 2.1-1.

Table 2.1-1. Comparison of Alternatives Summary

Alternative	Carried Forward (yes/no)				
	Purpose and Need	Practicability – Technology	Practicability – Logistics	Practicability – Cost*	Costs†
No Action	No	Yes	Yes	Yes	N/A
Harris Reservoir Expansion Project (Proposed Action)	Yes	Yes	Yes	Yes	$440 million (2022 dollars)
Alternate Embankment Configuration	Yes	Yes	Yes	Yes	$440 million (2022 dollars)
Alternative Reservoir Layout	Yes	Yes	Yes	Yes	$440 million (2022 dollars)
West Bank	Yes	Yes	Yes	Yes	$520 million (2020 dollars)
Allens Creek Reservoir	No	Yes	No	Yes	N/A
Seawater Desalination	No	Yes	Yes	No	N/A
Brackish Water Desalination	Yes	Yes	Yes	Yes	$1.9 billion (2020 dollars)

*It is not a particular applicant's financial standing that is the primary consideration for determining practicability in regard to cost, but rather characteristics of the Project and what constitutes a reasonable expense for these projects that are most relevant to practicability determinations.

† Estimated costs are provided only for alternatives that meet the purpose and need.

Based on this analysis, the Corps determined that the No Action alternative and four action alternatives be carried forward for detailed analysis in this EIS. The Seawater Desalination alternative and Allens Creek Reservoir alternative were eliminated because they do not allow Dow to use its existing run-of-river water rights from the Brazos River. In addition, the Allens Creek Reservoir site is owned by the BRA and the City of Houston and is not reasonably available to Dow.

2.2 No Action Alternative

Under the No Action alternative, no additional water storage would be constructed and the Project would not take place. Dow would continue to operate their water supply system as is currently done. The No Action alternative would include Dow's current water conservation and water reclamation projects.

2.3 Alternative 1: Proposed Action Alternative

2.3.1 Background

Alternative 1, hereafter referred to as the Proposed Action, would include the construction and operation of an approximately 51,000-AF off-channel reservoir located adjacent to the existing Harris Reservoir. The proposed reservoir would improve the reliability of water supply during drought for integrated chemical manufacturing facilities at Dow's Texas Operations in Freeport, Texas, as well as improve the reliability of water supply for other industrial, community, and potable water users that rely on Dow's water supply.

The TCEQ recommendation for storage to meet drought preparedness and response standards is 180 days of storage. This recommendation is based on the 30 TAC 290.41, which under (b)(1) states that retail public utilities should report when they have less than 180 days of water supply storage and should develop a drought contingency plan.

Currently, when flow conditions at the existing Brazos River pump station at the Brazoria Reservoir are reduced to approximately 1,730 cfs or lower, Dow is unable to divert water into the Brazoria Reservoir because of saltwater intrusion from the Gulf of Mexico and must rely on water delivered from the existing Harris Reservoir upstream. When river flows are sufficient at the existing Harris Reservoir pump station intake on the Brazos River, river water is transferred through the reservoir to Oyster Creek by pumping from the river into the reservoir and then discharging to the creek through a siphon system. When flow conditions limit pumping to the existing Harris Reservoir, water supply needs of Dow and others are met by withdrawing water stored in Harris and Brazoria Reservoirs.

The proposed reservoir along the Brazos River would be operated in conjunction with the existing Harris Reservoir located immediately to the south and the Brazoria Reservoir located 21 miles downstream. The proposed reservoir would operate with the existing Harris and Brazoria Reservoirs in a manner similar to current operations (see Section 1.3.3) to increase total available storage from 68 days of water to 180 days. During periods of drought, the proposed reservoir would be exhausted first, followed by the existing Harris Reservoir, and then the Brazoria Reservoir. As with current operations, emergency releases would occur from severe weather, such as tropical storms and hurricanes with wind speeds that can overtop the embankments.

The proposed reservoir would be part of the existing water supply system (Figure 2.3-1). The existing Harris Reservoir has a surface area of approximately 1,600 acres, an average depth of 5.5 feet, and a water storage capacity of approximately 9,136 AF. Water is pumped from the Brazos River into the reservoir for storage and discharged by siphons into Oyster Creek. Water flows down the creek to the Lake Jackson pump station in about 30 to 34 hours. The existing Harris Reservoir is used as the primary water supply when the river flows decrease and the chlorides at the Brazoria Reservoir pump station reach 300 parts per million (ppm).

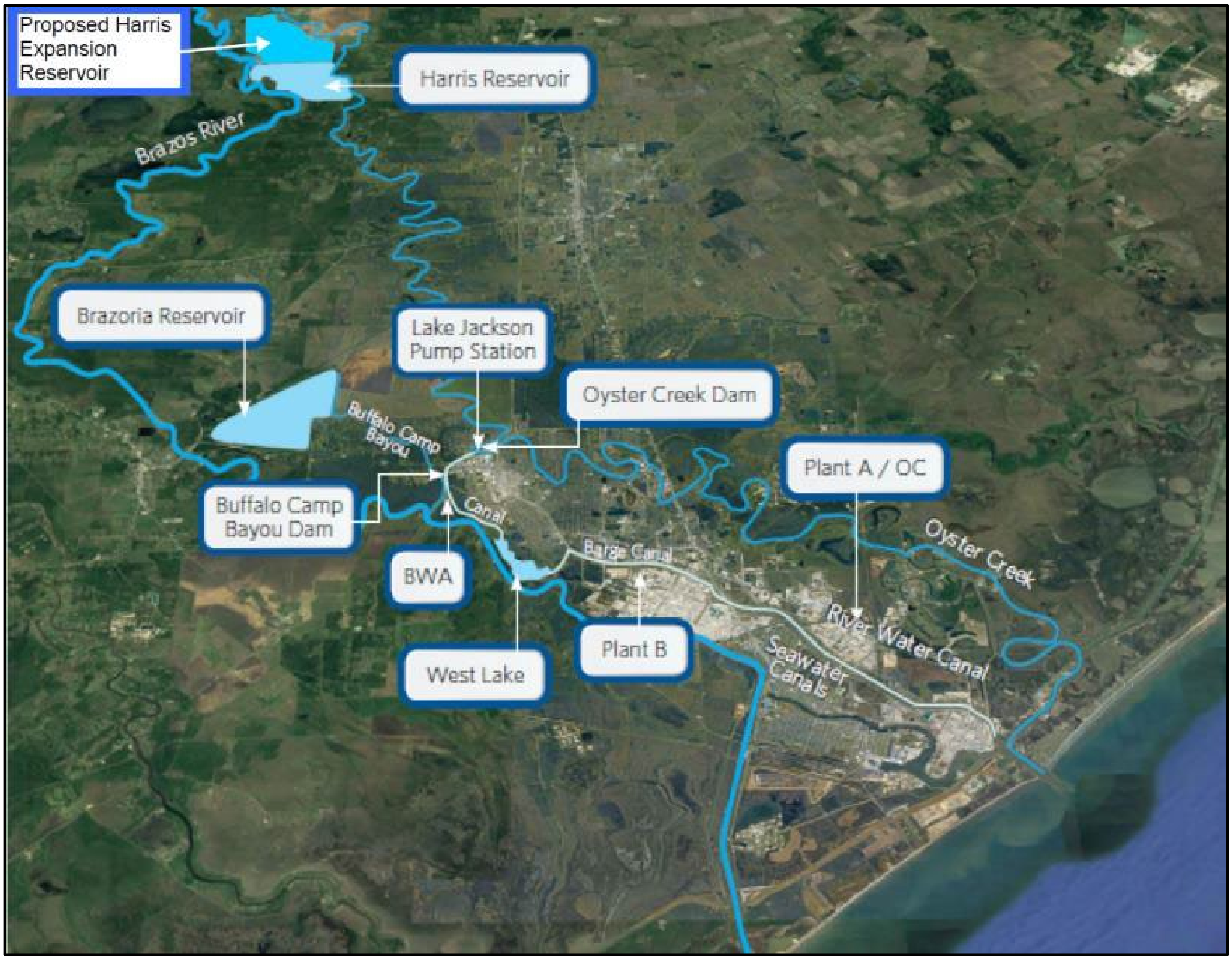


Figure 2.3-1. Dow water supply system.

The proposed reservoir would have a surface area of 1,929 acres and a nominal capacity of 51,000 AF. Water would be pumped from the Brazos River into the reservoir for storage and then discharged by baffle drop structure into Oyster Creek. Water would flow downstream in Oyster Creek to the Lake Jackson pump station in approximately 30 to 35 hours. The proposed reservoir would be used mainly as additional storage to the existing two reservoirs but would become the primary reservoir during drought conditions.

The Lake Jackson pump station is located at the intersection of Oyster Creek and Farm to Market Road (FM) 2004 in the city of Lake Jackson. The pump station has five pumps that can be run in combination to deliver a maximum of 150,000 gpm with varying flows to Dow Plants A and B (see Figure 2.3-1). Discharge flows from the existing Harris Reservoir must be slightly over the Lake Jackson pump station intake to ensure water flow over the dam in Oyster Creek. This would also be the case for the proposed reservoir. It takes approximately 1 hour for water to reach the canal at the Buffalo Camp Bayou diversion works from the Lake Jackson pump station.

The Brazoria Reservoir is approximately 5 miles west of Lake Jackson on SH 332. The Brazoria Reservoir has a surface area of 1,865 acres, an average depth of 9.5 feet, and a storage capacity of approximately 18,207 AF. The Brazoria Reservoir pump station pumps water from the Brazos River into the Brazoria Reservoir for storage and then discharges by siphons into Buffalo Camp Bayou where the water is diverted at the diversion works at the Buffalo Camp Bayou Dam into the freshwater canal. It takes approximately 2 to 4 hours for water to reach the diversion works when released from the reservoir.

The diversion works consist of three gates that can be adjusted to flow water from Buffalo Camp Bayou to the freshwater canal. It takes approximately 4 hours for water to reach Plant B from the diversion works. The freshwater canal is a 15.5-mile-long, 40-foot, human-made canal, which runs parallel to the Brazos River from Oyster Creek to Plant B, and runs parallel to Barge Canal and ends at Plant A.

West Lake, west of Plant B, has a survey area of approximately 235 acres and holds approximately 2,300 AF of water. There is a gated inlet structure on the north side of West End Lake and a gated outlet structure on the south side of the lake. The outlet gates are operated remotely. The purpose of the gates is to supply the raw river water users with water via the in-plant canal system. The gate operates to maintain canal level and flow to the downstream users and monitors the levels in West End Lake to maintain target elevations.

2.3.2 Project Site

The 2,533-acre site for the Harris Reservoir expansion (Project site) is located in rural Brazoria County south of Houston, approximately 8 miles northwest of the City of Angleton, and approximately 5 miles west of SH 288 (see Figure 1.1-1). The Project site is bordered by the Brazos River to the west, Oyster Creek to the east, the existing Harris Reservoir to the south, and Texas Department of Criminal Justice (TDCJ) Ramsey Prison Facility land to the north (see Figure 1.1-2). The southern boundary of the Project site abuts Harris Reservoir Road (County Road [CR] 34). The northern portion of the Project site can be accessed from a dirt road on the prison property to Ramsey Bridge. The site is currently leased to the TDCJ Ramsey Unit for agricultural farming and cattle grazing. The surrounding area is mostly agricultural fields and grazing pastures with scattered residences and the TDCJ prison to the north. The Project site is within the floodplain of the Brazos River and Oyster Creek. The Project site contains 21.38 acres of delineated wetlands and 109,338 linear feet (74.10 acres) of waterbodies.

2.3.3 Project Components

The proposed reservoir would include a 1,929-acre impoundment with a storage capacity of 51,000 AF, an intake and pump station to divert water from the Brazos River, and an outlet and emergency spillway to Oyster Creek. The Project would also include floodplain enhancements in Oyster Creek, stream restoration, temporary workspace and construction staging areas, and an optional temporary laydown area. Figure 2.3-2 provides a conceptual layout of the reservoir and associated Project components.

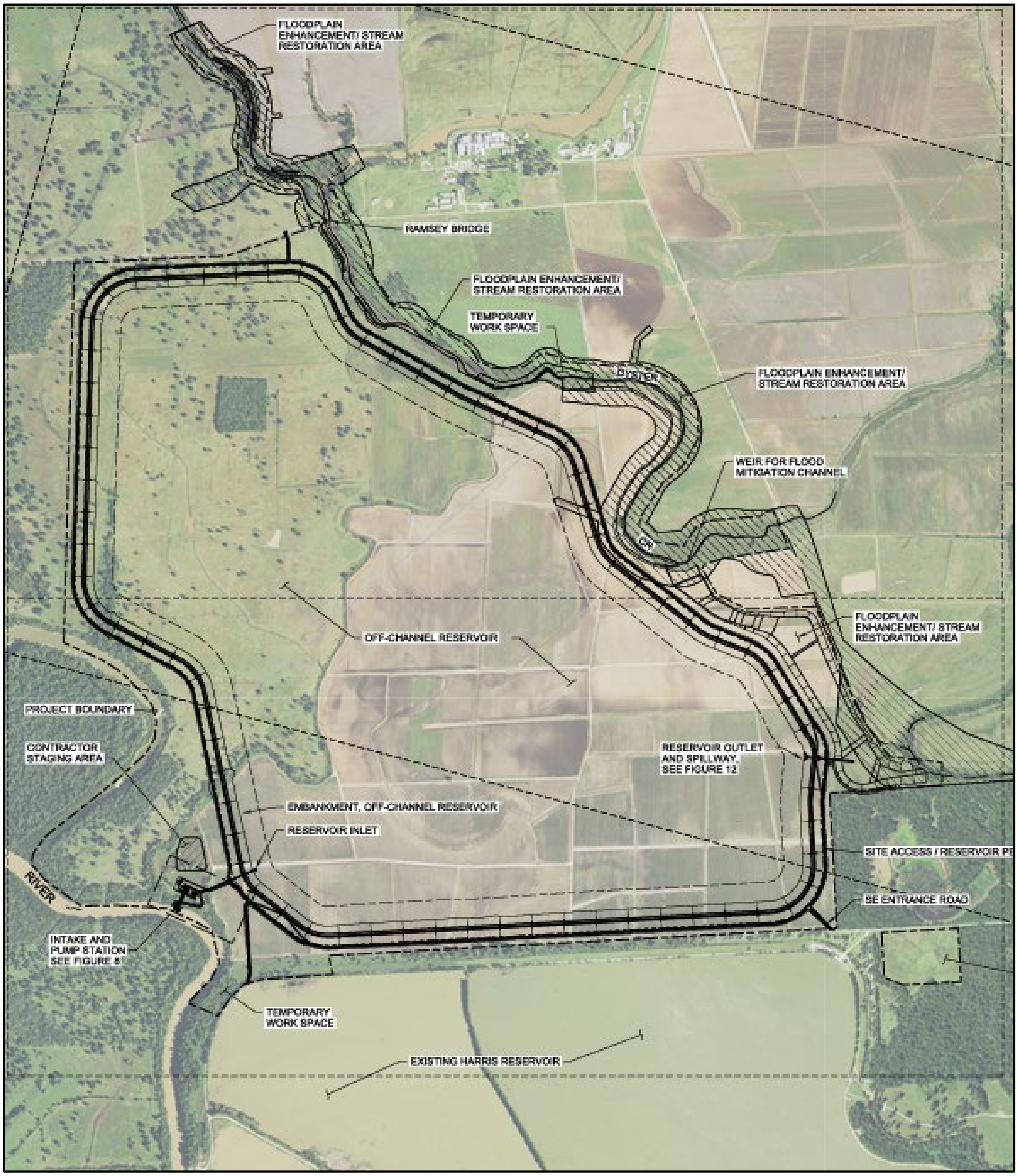


Figure 2.3-2. Project components.

Within the 2,533-acre Project site, approximately 77% of land would be permanently developed, 3% would be temporarily disturbed during construction, 11% would remain undeveloped, and 9% would be improved as part of mitigation (Table 2.3-1). This includes the following:

- 1,929 acres for the reservoir including the embankment.
- The 10 acres needed for construction of the river intake and pump station, including the intake pipeline. The permanent pump station (fenced area after construction) would be 2 acres.
- The reservoir outlet/spillway structure would be mostly within the reservoir and embankment, except for 400 feet of 10-foot-wide conduit between the embankment and Oyster Creek totaling 0.1 acre.
- 7-mile-long gravel perimeter road that would range from 12 to 20 feet wide (11 acres) plus a 4-foot shoulder (7 acres).
- 227-acre Oyster Creek floodplain enhancement/stream restoration area planting area, including the 66 acres that would be graded.

Table 2.3-1. Temporary and Permanent Disturbance Under the Proposed Action

Project Component	Temporary Acres	Permanent Acres	Total Acres
Reservoir	0.0	1,929.0	1,929.0
River intake and pump station	7.1	3.1	10.2
Spillway/outlet	0.0	0.1	0.1
Perimeter road	0.0	17.9	17.9
Temporary staging and work areas*	63.0	0.0	63.0
Total disturbance	**70.1**	**1,950.1**	**2,020.2**
Total floodplain enhancement	**0.0**	**227.0**	**227.0**
Total undisturbed land			**285.8**
Total Project site			**2,533.0**

*Includes 4-acre optional laydown area.

2.3.3.1 OFF-CHANNEL IMPOUNDMENT

An approximately 40-foot-high × 36,200-foot-long earthen embankment would be constructed to form the reservoir impoundment. The embankment would be constructed of compacted soils obtained from borrow areas within the reservoir interior. The results of the geotechnical investigations of the site in 2013 (Fugro 2013a, 2013b, 2013c) and 2018 (Jacobs 2018a) suggest soils from borrow areas in the reservoir interior primarily consist of cohesive or silty soils and therefore the preliminary slope design for this embankment section is based on designs for similar soil conditions. To gather information regarding construction methods, Dow constructed a small prototypical compacted earth embankment within the proposed reservoir footprint using soils from the proposed borrow area. Data gathered from the test embankment were used to design the proposed embankment.

The components of the embankment would include a stabilizing berm, soil-cement armoring, wave wall, main embankment, chimney and blanket filters and drains, perimeter toe ditch, seepage barrier wall, and a perimeter road embankment (Appendix K). The proposed embankment section has side slope ratios of 3:1 (horizontal to vertical) on the interior slope and 3.5:1 (horizontal to vertical) on the exterior slope. The 3.5 horizontal to 1 vertical ratio of the exterior slope is intended to reduce the probability of shallow slumps occurring on the slope. Such slumps are common on embankments with 3:1 (horizontal to vertical) side slopes constructed with clayey soils on the Gulf Coast because of weathering of the compacted clay that occurs because of alternating wetting and drying cycles. A stabilizing berm with a 6:1 (horizontal to vertical) slope is shown against the lower portion of the interior slope. The berm would be constructed of soils stripped from the embankment footprint and borrow areas and would mainly serve two purposes: 1) to stabilize the slope under a rapid drawdown loading condition during releases in drought conditions, and 2) to decrease the portion of the slope requiring armoring against erosion. Approximately 900,000 tons of sand and cement would be imported to the site for construction of internal filter/drains and soil-cement armoring. The exterior slope of the embankment would be seeded with native vegetation and maintained by mowing.

2.3.3.2 RIVER INTAKE AND PUMP STATION

The Brazos River in-channel intake structure (Figure 2.3-3) would include a sheet pile structure with a concrete head wall in the Brazos River, mechanically cleaned T-screens, and two 72-inch buried pipelines from the screens to the pump station building. The pump station would be partially underground with reinforced concrete walls and would be enclosed on three sides aboveground and have a roof. The aboveground portion would have exterior cladding and roofing of prefinished metal wall and roof panels. The design allows for removal of equipment through a roof opening. The pump station would contain two pumps capable of pumping 75,000 gpm each from the river to the reservoir. An electrical power line would be constructed to convey power from the nearby CenterPoint Energy transmission line to the pump station. Water would be conveyed to the reservoir via approximately 1,200 linear feet of steel discharge pipeline. Streambank stabilization measures would be installed in the immediate vicinity of the intake structure, approximately 200 feet upstream and 100 feet downstream. Measures anticipated to stabilize the riverbank would include sheet piling, native backfill, and riprap (4,245 cubic yards [cy] within a 32,008 square foot area) designed to reinforce the toe and a portion of the slope of the riverbank, preventing lateral migration of the Brazos River.

Other facilities associated with the pump station would include the operations building, electrical motor control center (MCC) building, and transformer area. The operations building would be an approximately 2,000-square-foot pre-engineered metal building supported by a concrete foundation and would include restrooms and a meeting space. The MCC building would be a pre-engineered/prefabricated structure, which may have to be elevated above the ground surface depending on the design flood elevation. Power would be brought into the MCC and pump station area and routed within the Project site to electrical components as needed. The transformer would be supported on a concrete foundation pad with a containment area.

For the intake and streambed stabilization, 420 cy of dredge and 8,075 cy of fill volume are proposed below the ordinary high water mark of the Brazos River (Table 2.3-2). Floodplain enhancement mitigation on Oyster Creek is described in Section 2.2.3.7.

Table 2.3-2. Brazos River Dredge and Fill Volumes Below Ordinary High Water Mark

Feature Name	Dredge Volume	Fill Volume
Intake	420 cy	3,830 cy
Streambank stabilization measures	0 cy	4,245 cy
Total	**420 cy**	**8,075 cy**

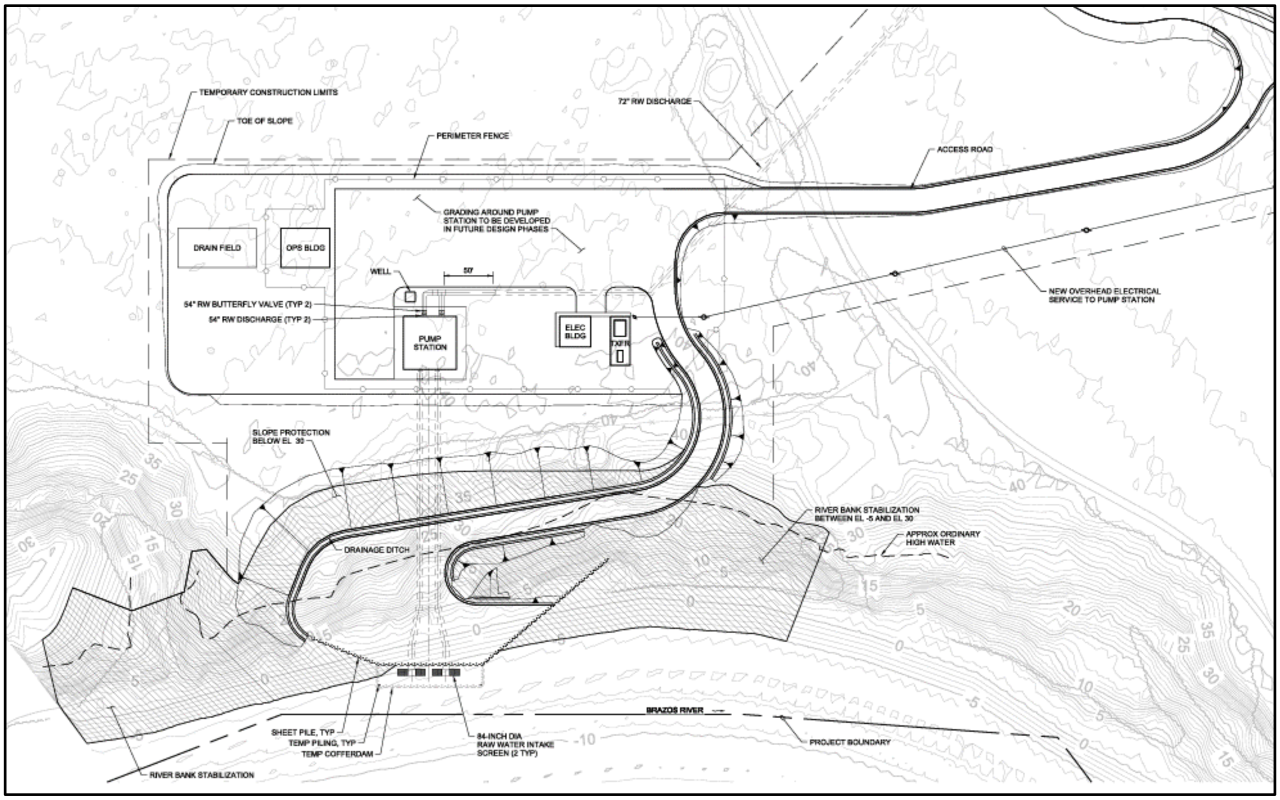


Figure 2.3-3. River intake and pump station.

2.3.3.3 DISCHARGE PIPELINE AND RESERVOIR INLET

Two 72-inch welded steel discharge pipelines from the pumps would run above grade to where they exit the pump station and combine into a common header and would remain above grade to immediately downstream of the flowmeter. Then, the discharge pipeline would be buried with minimum cover to where it meets the reservoir. The discharge pipeline would be exposed up the face of the reservoir embankment and through the top portion of the embankment into the reservoir, with the invert at or above the high-water level in the reservoir to ensure no reverse flow out of the reservoir.

The reservoir inlet structure would be located inside the reservoir and would serve to transition the pump discharge from the pipe into the reservoir. When the reservoir is at or near empty, the structure would provide energy dissipation from the high velocity of water flowing by gravity from the top of the embankment to the bottom of the reservoir. Therefore, a Corps-type (USACE 1963) stilling well at the end of the pipe is proposed to provide a structure to meet these requirements. The stilling well would be approximately 15 feet in diameter and in depth.

2.3.3.4 RESERVOIR OUTLET AND EMERGENCY SPILLWAY

The reservoir outlet and emergency spillway make up a concrete structure on the interior toe of the reservoir embankment. This structure would provide an uncontrolled spillway with a fixed crest to protect the reservoir embankment from overtopping without operations input (Figure 2.3-4). A sluice gate outlet would be used for controlled releases during normal operations and in emergency release conditions.

Water stored in the reservoir would be released into the proposed Oyster Creek flood bypass channel through the outlet works. The outlet works would be a baffle drop structure, which consists of a spillway crest with a weir crest that controls flow entering the drop shaft. Water cascades down the drop shaft through the horizontal baffle to the outlet conduit. The outlet conduit is a box culvert 5 feet high × 10 feet wide that conveys water from the bottom of the drop shaft to the stilling basin. The outlet conduit would convey the flows through the embankment and to the stilling basin, which is near the flood mitigation channel for Oyster Creek.

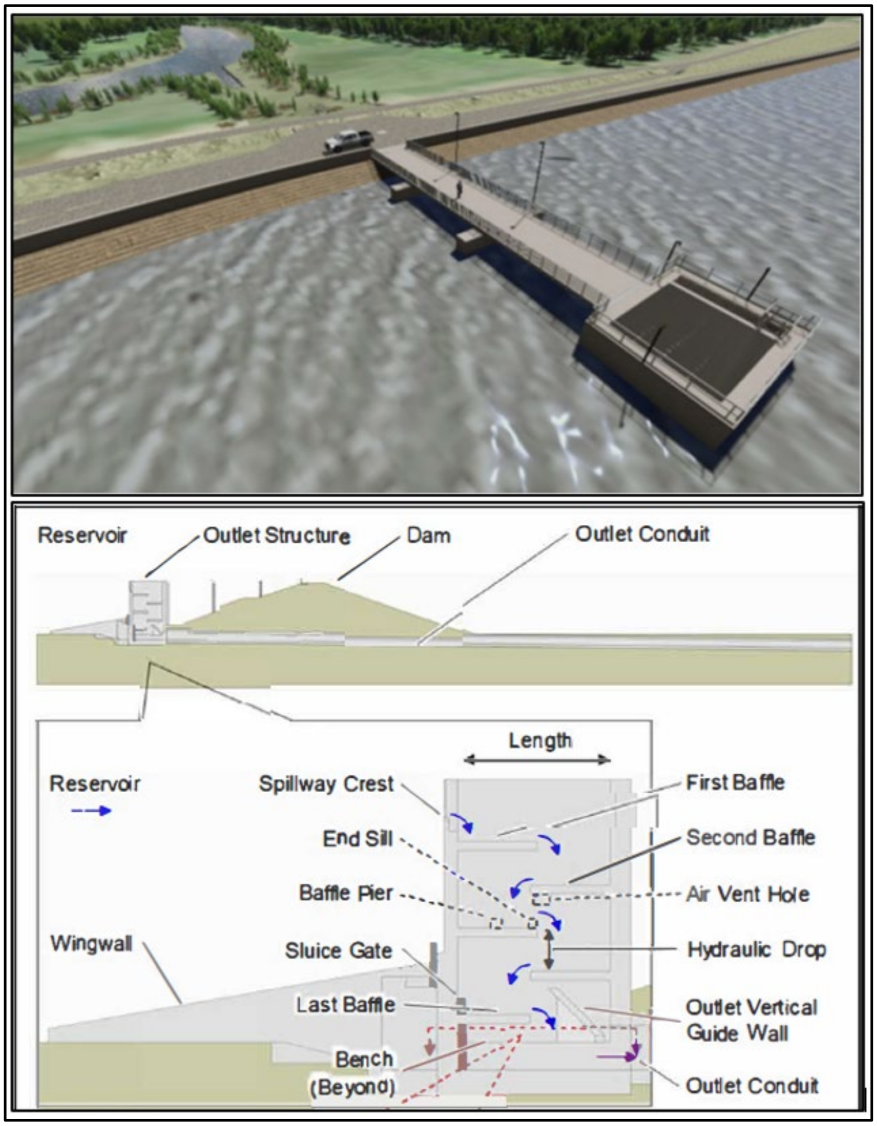


Figure 2.3-4. Reservoir outlet and emergency spillway.

2.3.3.5 CONVEYANCE

Water would be released from the reservoir into Oyster Creek via the outlet described above and would supplement releases from the existing Harris Reservoir discharge facilities (see Figure 2.3-1). Downstream, the existing pump stations and industrial canals at Lake Jackson and Freeport would convey the water to Dow's Texas Operations facility for use. No new canals are proposed as part of the Project.

2.3.3.6 ROADS

Access to the embankment for maintenance and inspection would be provided by a new 8-foot-wide gravel road on the embankment crest and another 12-foot-wide gravel road around the perimeter of the embankment.

2.3.3.7 OYSTER CREEK FLOODPLAIN ENHANCEMENT

Base flood information is available in Corps-approved HEC-HMS and HEC-RAS models (USACE 2018d, 2018e). The area between the Brazos River and Oyster Creek is a shared 1% annual exceedance probability floodplain (i.e., 100-year floodplain) as shown through modeling and Flood Insurance Rate Map (FIRM) 48039C0245K. Historic meanders are visible throughout the Project site and vicinity as well, which further demonstrates natural channel movement through the broad floodplain. The reservoir embankment would be above existing ground elevation with an approximate footprint of 1,929 acres within the Oyster Creek floodplain. The intake/pumping facility would be within the Brazos River floodplain.

Because of impacts within the floodplain, the Project would include three on-site floodplain enhancement projects along Oyster Creek, Oyster Creek Projects 1, 2, and 3. Projects 1 and 2 are detailed in the mitigation plan (SWCA 2022) (see Appendix G) because these two areas include compensatory mitigation required for unavoidable impacts to wetlands and waterbodies. The key mitigation components of these projects include riparian buffer restoration, bank stabilization, re-establishment, and preservation of riparian buffer habitats. Native vegetation plantings would occur within the on-site restoration, enhancement, and reestablishment projects. Invasive plant species would be selectively removed and controlled using herbicides selected based on the type of application procedure and would be in accordance with federal regulations. The invasive plant removal and follow-up herbicide application would be conducted by experienced contracted personnel. The restoration of forested riparian habitats along Oyster Creek would provide increases in function and value to wildlife habitats on-site. The monitoring plan would measure and document the progress, successes, and failures (if any) of the main strategies of the proposed mitigation.

Oyster Creek Project 1 would widen the unnamed tributary to Oyster Creek immediately north of the confluence of Oyster Creek and the unnamed tributary north of FM 655. This project would include riparian buffer and riparian vegetation improvements. The project includes widening the channel at key locations and providing a floodplain bench to help convey water, and would preserve and enhance the riverine habitat.

Oyster Creek Project 2 would widen the main Oyster Creek channel starting just downstream of Project 1 to a point approximately 12,000 feet downstream. Widening of the Oyster Creek channel through this section would be predominantly on the west side of Oyster Creek and would include the development of a floodplain bench and bank slopeback where required. Through this reach, farming activities have encroached on the Oyster Creek channel, reducing the capacity of the channel. The project would restore the natural function of the channel through rehabilitation and enhancement by planting riparian vegetation and providing a riparian buffer in addition to the channel widening.

Oyster Creek Project 3 is a floodplain enhancement project that includes a new flood conveyance channel to improve the capacity and flow characteristics of the Oyster Creek channel (Figure 2.3-5). The flood conveyance channel would be constructed from the end of Project 2 and flowing 4,300 feet south, rejoining Oyster Creek 12,000 feet upstream of Harris Reservoir Road (CR 34). This channel would not flow with water until the Oyster Creek main channel exceeds the 25-year water surface elevation for

Oyster Creek and spills higher flows into the relief channel. Project 3 would establish new riparian functionality and provide additional channel capacity for Oyster Creek during high-flow events.

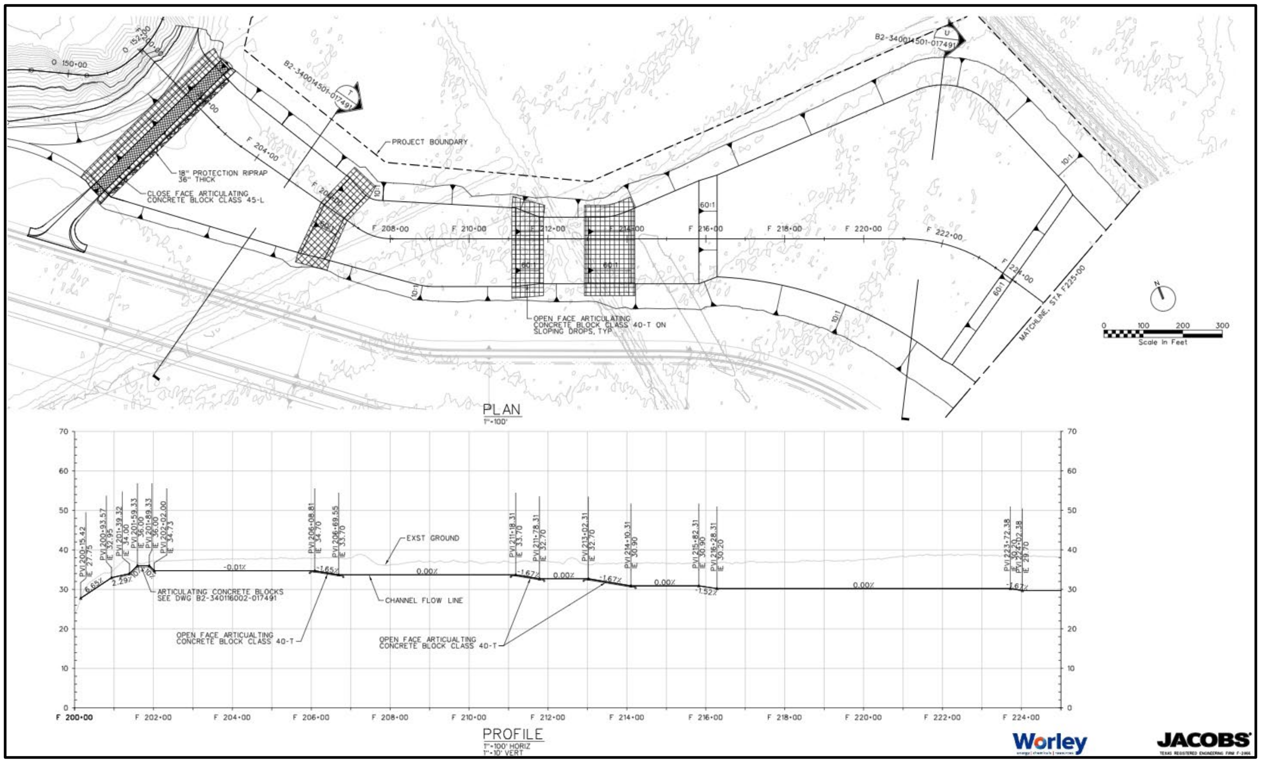


Figure 2.3-5. Oyster Creek Project 3.

2.3.4 Construction

Construction is described in Dow's preliminary construction management plan for the proposed Project (Jacobs 2018b). Construction would be broken into three primary elements: embankment construction, pump station construction, and Oyster Creek improvements. In addition, construction would include utility relocation, early site works (site grading and installing construction trailers, restrooms, temporary power, and fencing), and off-site road maintenance.

2.3.4.1 TEMPORARY STAGING AREAS AND WORKSPACE

An approximately 22-acre staging area southeast of the proposed reservoir would be used for construction offices, equipment and material storage, and work force parking (see Figure 1.1-2). A second 5-acre staging area on the southwest side of the proposed reservoir near the proposed pump station would be used during construction of the intake and pump station (see Figure 1.2-2). An optional temporary 4-acre laydown area may be required for staging on the southwest side of the Project site (note that this area was added after scoping). These staging and laydown areas would be sited to avoid impacts to surface waters and wetlands. A 32-acre temporary workspace near the southwest corner of the embankment would be used during construction of the intake from the Brazos River and the bank stabilization. The upland portion of the temporary workspace would be sited to avoid surface water and wetlands; however, some construction would occur in the Brazos River during construction of the intake facility and bank stabilization (see Section 2.3.3.2).

2.3.4.2 SAFETY

Prior to commencing work, construction contractors would submit to Dow for review and approval a comprehensive health and safety plan for the Project. The contractors would be responsible for complying with the health and safety plan as approved by Dow.

The Project site would be fenced, and access would be controlled and monitored for the duration of the construction. All personnel entering the site would complete comprehensive safety training and a site orientation. Prior to any contractor beginning work, a start work assessment and kick-off meeting would be required to ensure that everyone is up to date on safety requirements. In addition, safe work permits would be issued for regular construction activities and regular safety audits would be completed to ensure compliance.

Dow would rely on its extensive and well-established safety policies and procedures, which provide a firm foundation for implementing safety for the Project. The proposed Project is primarily a large earthmoving project, and the Dow team has health and safety (HSE) plans for their existing reservoirs that meet industry and regulatory standards, including meeting department of Homeland Security requirements which render contents confidential. The proposed reservoir would be added to the existing HSE plans and would include the right combination of industry standard safety protocols for this type of construction and the often more extensive safety standards required by current Dow policies and procedures to ensure the safe and most effective execution of the proposed Project.

2.3.4.3 UTILITIES

Three ConocoPhillips pipelines cross the Project site in a single corridor (Figure 2.3-6). The pipelines would be relocated in a 100-foot-wide easement along the toe of the perimeter access road at the western and northern sides of the reservoir. ConocoPhillips would demolish and remove the pipelines from the Project site and install new pipelines with conventional open-cut construction methods. The new pipelines would be installed at a depth of approximately 6 feet below grade, matching the design of the existing pipelines.

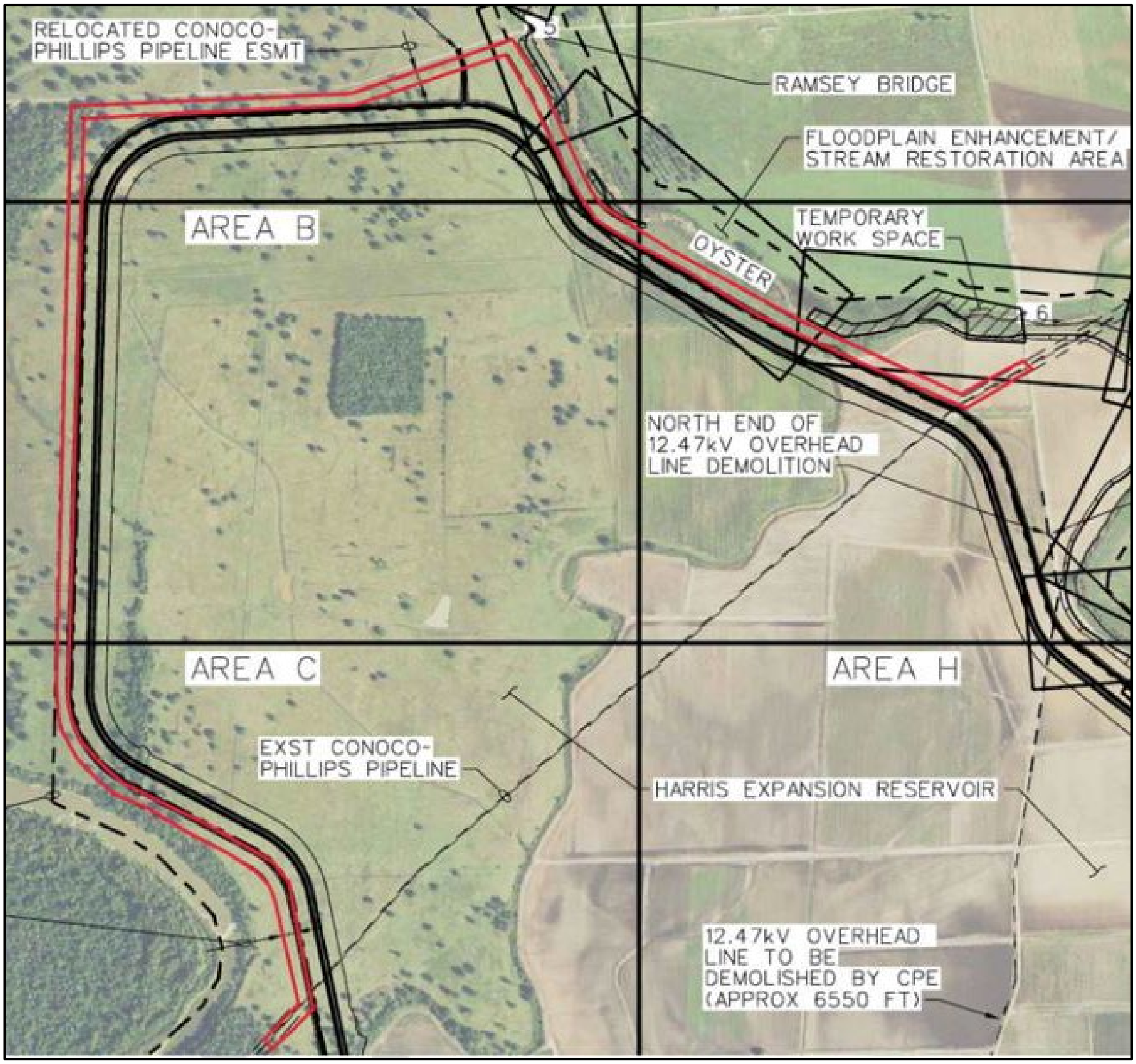


Figure 2.3-6. Existing ConocoPhillips pipeline and proposed route (Jacobs 2018b).

The existing CenterPoint Energy power line would be relocated to the eastern perimeter of the Project site, and power would be distributed as needed throughout the site (Figure 2.3-7). CenterPoint Energy would be responsible for relocating the power line. This work would happen in two phases. The first phase would be the demolition and re-route of the 12.47-kilovolt line that currently runs through the Project site. This re-route would tie into the existing line running along CR 34 at the northeast corner of the existing Harris Reservoir and head north just outside the proposed reservoir toe road tying back into the existing line along the northeast side of the proposed reservoir. The second phase would be the installation of two new power lines, one on the southwest corner of the site heading north to the new pump station and the second extending from the previously installed rerouted line on the east side of the reservoir over to the new reservoir outlet structure.

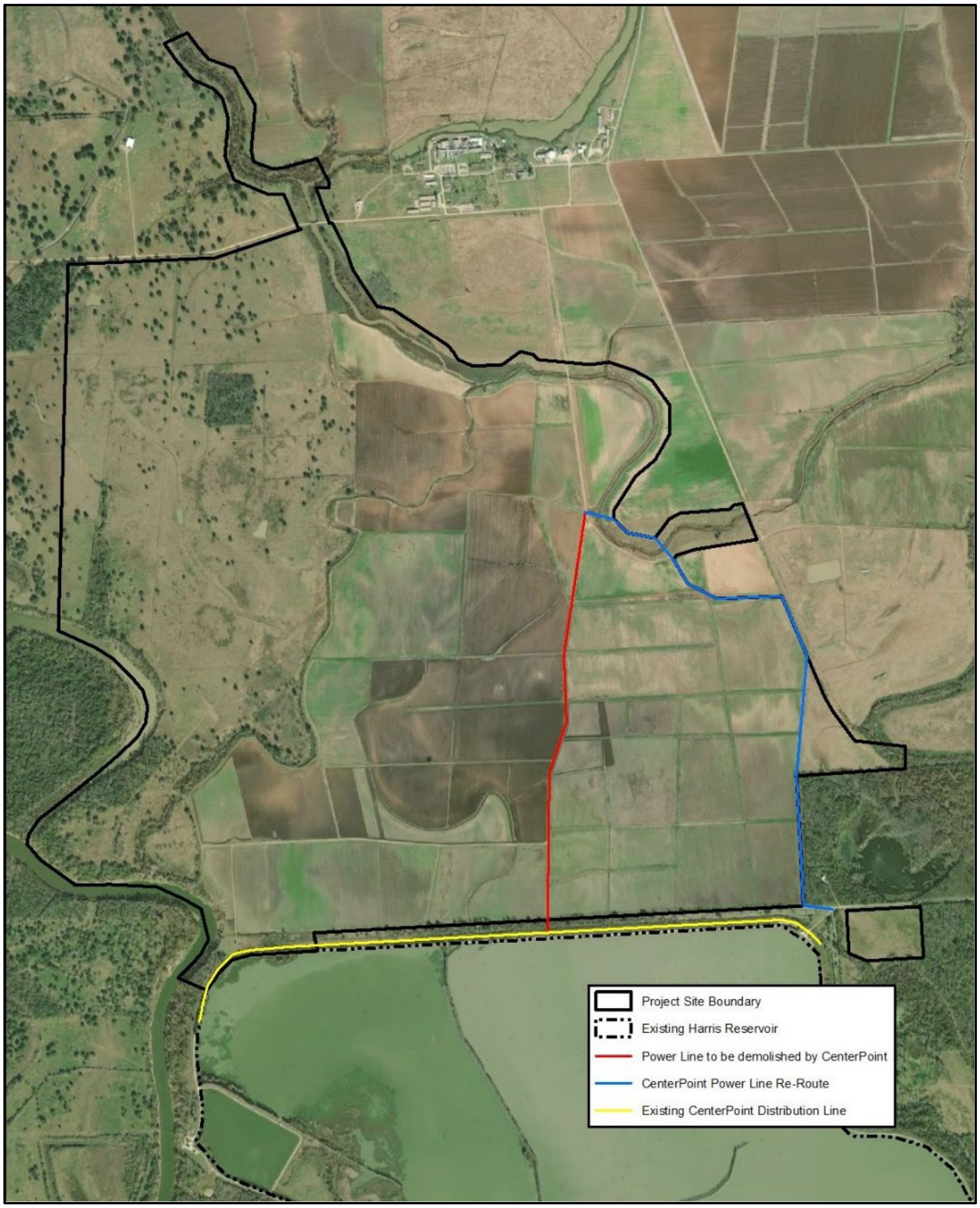


Figure 2.3-7. Existing CenterPoint Energy power line and proposed route.

There are also 11 abandoned and plugged oil and gas wells on the Project site, which have been closed in accordance with Texas Railroad Commission regulations (Figure 2.3-8). Closure would be validated, and appropriate steps would be taken so proper closure occurs during construction if required. Protocols would be established for lowering well heads interfering with the reservoir construction.

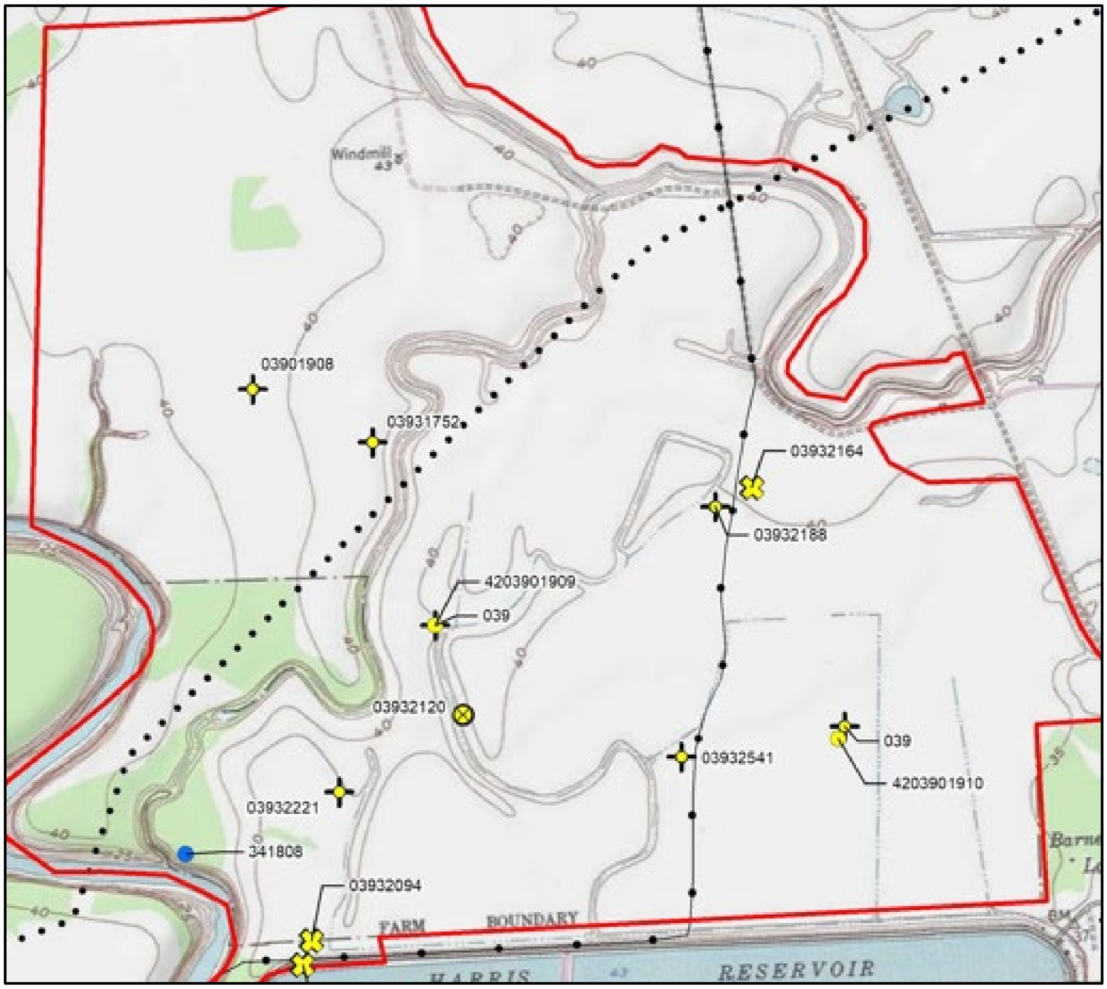


Figure 2.3-8. Approximate location of abandoned and plugged oil and gas wells.

A potable water well would be provided to supply water for the operations building, restrooms, eyewash, vacuum pump seal water, utility hose water, water pump seal flushing and bearing cooling, and gear reducer oil cooling if needed.

2.3.4.4 EQUIPMENT

The excavation would require the removal and placement of more than 12 million cy of material, in addition to the installation of several large pipelines, concrete structures, sheet piling, and a pumping station. Major equipment that may require mobilization by the contractors would include excavators, scrapers, loaders, dozers, blades, compactors, water trucks, bobcats, tractors, backhoes, electrical trenchers, lifts, and cranes. The quantity required for each phase (reservoir, pump station, and Oyster Creek Improvement) is listed in the construction management plan (Jacobs 2018b). An on-site concrete batch plant would be used for construction of the inlet, pump station, and outlet.

2.3.4.5 CONSTRUCTION ACCESS AND TRAFFIC

The southern access to the Project site would be from CR 34. The northern access would be from a dirt road on the prison property to Ramsey Bridge. The dirt road is not a public road and Ramsey Bridge is old and has weight restrictions; contractors would not be allowed to access the Project site from Ramsey

Bridge. This prohibition includes deliveries of materials, mobilization and demobilization of construction equipment, and workers' passenger cars and pickup trucks. All access would be from the southern entrance on CR 34. The Project site would be fenced, and access would be controlled and monitored for the duration of the construction.

Wheeled vehicular traffic becomes very difficult after rainfall because of slippery conditions from the presence of clay soils, especially along the western portions of the Project site. In coordination with the contractor and county, access plans would be developed for constructing and maintaining haul roads that can accommodate wet conditions and be operational soon after rain events. In addition, Dow recognizes that CR 34 may need maintenance and repairs during Project construction and would work with the county to manage the need.

CR 34 is currently lightly traveled, but during peak Project construction, the work force of approximately 100 people would travel CR 34 individually. Delivery of materials and equipment, primarily deliveries of aggregate and concrete, would be a source of traffic. Assuming a double-axle dump truck with a 30-ton capacity, a total of 30,000 truckloads would be needed. During the 44-month construction period, deliveries would average 70 truckloads per day for 300 days. During the peak of construction, deliveries would be more than 100 truckloads per day for 90 days.

2.3.4.6 LABOR FORCE

Ten full-time and five part-time on-site construction management staff (e.g., project managers, engineers) are anticipated. The construction labor force is estimated to average approximately 80 to 90 persons over the construction period of approximately 2.5 years. Peak staffing could be close to 130 persons depending on the contractor's schedule. Construction crews would likely work 10-hour days from 7 a.m. to 5 p.m., Monday through Friday. Total estimated construction manpower is summarized in Figure 2.3-9. Most of the construction workers would come from local communities.

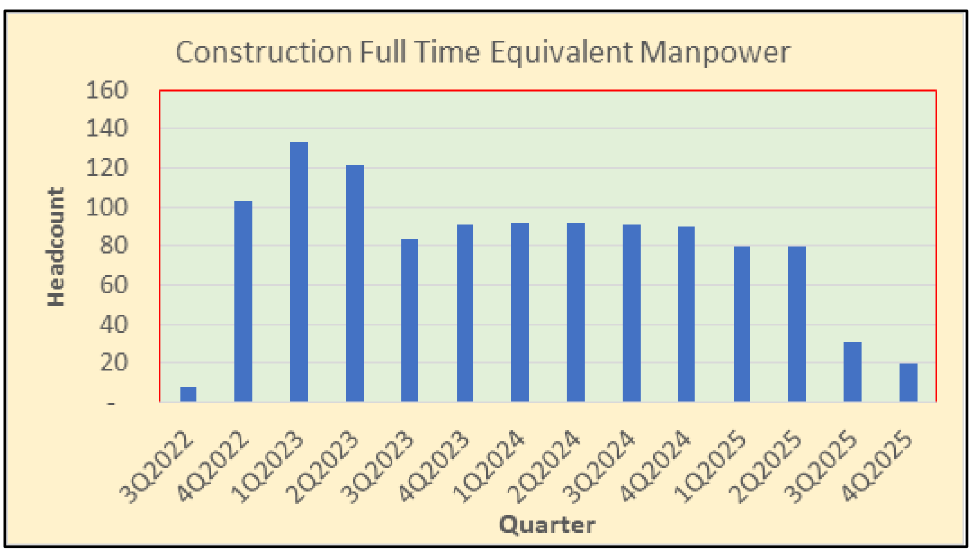


Figure 2.3-9. Construction labor force.

2.3.4.7 CONSTRUCTION SCHEDULE

Dow's proposed construction schedule is shown in Table 2.3-3.

Table 2.3-3. Dow's Proposed Construction Schedule

Key Construction Milestones	Start Date	Completion Date
Oyster Creek flood mitigation and stream restoration construction	May 2023	April 2024
Reservoir embankment construction	May 2023	March 2026
Pump station and Brazos River intake construction	May 2024	September 2025
Reservoir filling	June 2026	October 2026

2.3.5 Operations

Dow's Operation and Maintenance Plan (Dow 2022) (Appendix L) defines responsibilities and prescribes guideline procedures for inspection, maintenance, repairs, and operation of the reservoir.

Operation of the existing and proposed reservoirs can generally be categorized into the following: 1) normal operations, 2) drought conditions, and 3) emergency release conditions.

2.3.5.1 EXISTING OPERATIONS

During normal non-drought conditions, Dow's river water supply would continue to be operated in generally the same fashion as it has been for the past 60 years with the Harris and Brazoria Reservoirs. The additional proposed reservoir would result in minor changes to existing operations. The proposed reservoir would normally be maintained at a full level until releases are required for maintenance, seasonal adjustments to operating pool level, or a drawdown in advance of a tropical storm or hurricane landfall near the site. During normal operations, the proposed river intake and pump station would only operate as necessary to fill the reservoir and maintain it in a full condition.

2.3.5.2 PROPOSED OPERATIONS

Minimal flow would be released from the Project to maintain the proposed reservoir and Oyster Creek water quality. During drought conditions with low stream flows on the Brazos River, Oyster Creek, and Buffalo Camp Bayou, the average daily demand of water for Dow's Texas Operations cannot be met by pumping from the Brazos River alone. Water is released from Dow's water storage reservoirs in a manner that maximizes the benefit of the storage and yields the highest probability to refill storage during a sustained drought. Water storage releases during drought would be conducted as follows:

- Water releases would first be made from the proposed reservoir. Water would be released exclusively from this source or used to augment flows from the existing Harris Reservoir.
- Once the proposed reservoir water supply is exhausted, releases would then be made from the existing Harris Reservoir.
- Finally, releases from the Brazoria Reservoir would be made. The release rates would first be set to augment the diminishing flow from the existing Harris Reservoir as it empties and then at the full demand rate after both Harris reservoirs are depleted. Releases from the Brazoria Reservoir would be reduced to some minimum rate, identified as required to meet critical demands.

The use of Dow's existing water rights and storage facilities, existing pumping and conveyance system through Oyster Creek and Buffalo Camp Bayou, and existing industrial plant canal system supplemented with expanded storage at the proposed reservoir site provides a viable means of meeting the storage requirements and increasing drought resilience at Dow's Texas Operations, industries, and the BWA (Watearth 2020a).

Operating action items for the proposed reservoir include the following:

- A minimal flow would be maintained from Harris Reservoir and/or the proposed reservoir and blended with the water from Brazoria Reservoir. Minimal flow from Harris Reservoir and/or the proposed reservoir needs to be approximately 10,000 gpm to match the capacity of the smallest pump at the Lake Jackson pump station. Any flow released from Harris Reservoir and the proposed reservoir would be picked up at Lake Jackson pump station and sent to Dow's Texas Operations.
- One of the two pumps, P1 or P2, would be pumping out of the river and into the reservoir.
- The proposed reservoir would be maintained seasonally as depicted in Table B of the O&M plan (see Appendix L). Water surface elevations would be maintained at a range between 67.0 and 68.0 feet depending on season. These levels would be maintained as river flows allow.
- A reservoir technician would increase or decrease the flow of water at the baffle drop structure as water is needed by the plant demand. Water would take approximately 40 hours to reach Plant B from the proposed reservoir outlet, and quick adjustments to plant demands from the proposed reservoir are not practical.
- A reservoir technician would turn on pumps as flow reaches the intake for the Lake Jackson pump station. The Lake Jackson pump station has limited variability for flow adjustments. A reservoir technician would balance the flow from the proposed reservoir to match the pump capacities at the Lake Jackson pump station.
- Plant demand would be determined by coordinating with the board operator. This would be done by telephone on all normally scheduled workdays. If plant demand changes drastically during off hours, board operators would call the reservoir technician to make necessary adjustments at the reservoir outlet to either cut flow back or increase flow.
- A reservoir technician would also make necessary adjustments to flow at the West End Lake outlet structure as necessary. West End Lake has an operational target of 9.5 feet, and the plant canal level has an operational target level of 8.5 feet.

2.3.5.3 EMERGENCY OPERATIONS

During non-hurricane season, the pool level would be operated to stay close to the maximum normal pool elevation. During hurricane season, the pool elevation would be slowly lowered 1 foot from the maximum normal pool elevation. When hurricanes or other extreme weather events are expected, if the pool elevation is at target drawdown levels due to evaporation or water supply releases, no additional drawdown would occur. If the pool elevation is not at target drawdown, it would be lowered to reach 1.7 feet below the seasonal maximum pool elevations. Between May 15 and December 1, Dow would monitor weather events, and in the event of a hurricane making landfall, would drawdown the reservoir to allow 1.7 feet of capacity, which would capture up to 19 inches of rainfall. The reservoir would drawdown over a 6-hour period to bring water surface elevations in the reservoir down to between 66.3 and 65.3 feet, depending on the month (see Table B of the O&M plan [Appendix L]). Emergency releases could also occur via the emergency spillway in a full reservoir condition.

2.3.6 Maintenance

As described in Dow's operation and maintenance plan (Dow 2022), the reservoir would be inspected weekly for basin structure integrity. Brush-clearing activities along the basin would be conducted prior to the inspections. The reservoir technician would use the inspection checklist to look for and record evidence of potential problems such as slumping, sloughing, or slides on the basin or abutment; cloudy or dirty seepage; seepage with an increase in flow; cracks, settlement, misalignment, or sinkholes; erosion; animal burrows; tree and brush growth; leakage into the intake; and undermining of the spillway. The area upstream and downstream of the basin would also be inspected. Dow would ensure that necessary maintenance, repairs, alterations, or modifications are initiated and completed in a timely manner following an inspection.

Maintenance would be conducted at the frequency listed in the operation and maintenance plan, or as needed based on the inspections, and tracked on the Master Task List. Regular maintenance would include the following:

- Earthwork maintenance to repair damage from erosion, woody vegetation, or rodent burrow
- Cleaning the trashrack
- Repair of concrete or riprap
- Clearing unwanted vegetation such as brush or trees, mowing the embankment
- Electrical maintenance
- Evaluating changes in storage capacity, sediment dredging

2.3.7 Off-site Mitigation

In addition to the on-site mitigation on Oyster Creek described in Section 2.3.3.7, off-site compensatory mitigation would occur along Big Slough for unavoidable impacts to wetlands and waterbodies. Big Slough is within the Brazos River watershed. The Big Slough mitigation site is an approximately 1,100-acre area located on Dow property 7 miles east of Lake Jackson near the Brazoria National Wildlife Refuge. The mitigation site consists of herbaceous/shrub wetland, forested wetland, tidal wetland, and upland rangeland and forest associated with the riparian areas (Cardno 2021). The site has been historically used for agriculture. The existing wetland habitats contain invasive species and lack water retention capabilities.

Approximately 6.4 miles of Big Slough and adjacent riparian areas (1,113 acres) would be restored to increase stream function. The key mitigation components include riparian buffer restoration, bank stabilization, re-establishment, and preservation of riparian buffer habitats.

2.4 Alternative 2A: Alternate Embankment Configuration Alternative

Alternative 2A, the Alternate Embankment Configuration alternative, includes an alternate site layout located on the same site as the Proposed Action. This alternative would include an off-channel reservoir located on the same 2,533-acre Project site directly north of the existing Harris Reservoir that would be the same in almost all respects as the Proposed Action; it would meet the needed 50,000 AF of additional storage capacity and estimated annual yield of approximately 80,000 AF. Alternative site layouts, or on-site alternatives, may reduce impacts to the Brazos River and Oyster Creek.

The embankment under the Alternate Embankment Configuration Alternative 2A would roughly parallel the Project site’s property boundary so the reservoir footprint for this alternative would be slightly larger than the Proposed Action, but located within the same 2,180-acre site (Figure 2.4-1). This larger configuration would add approximately 56,760 AF of storage capacity. Other Project components would be the same as those described for the Proposed Action. The outlet/spillway structure would be the same as the Proposed Action with water flowing through the embankment and to the stilling basin, which is near the flood mitigation channel for Oyster Creek.

The reservoir embankment would be above existing ground elevation with an approximate footprint of 2,195 acres within the Oyster Creek floodplain (266 acres larger than the Proposed Action). All other temporary and permanent disturbance would be the same as the Proposed Action (see Table 2.3-1). Within the 2,533-acre Project site, approximately 88% of land would be permanently developed, 3% would be temporarily disturbed during construction, 1% would remain undeveloped, and 8% would be improved as part of Oyster Creek mitigation. It should be noted that under Alternative 2A, the portion of the Oyster Creek stream restoration adjacent to the existing oxbow would need to be relocated to the east or the eastern portion of the embankment would need to be pulled back. Off-site mitigation at Big Slough would occur as described for the Proposed Action.

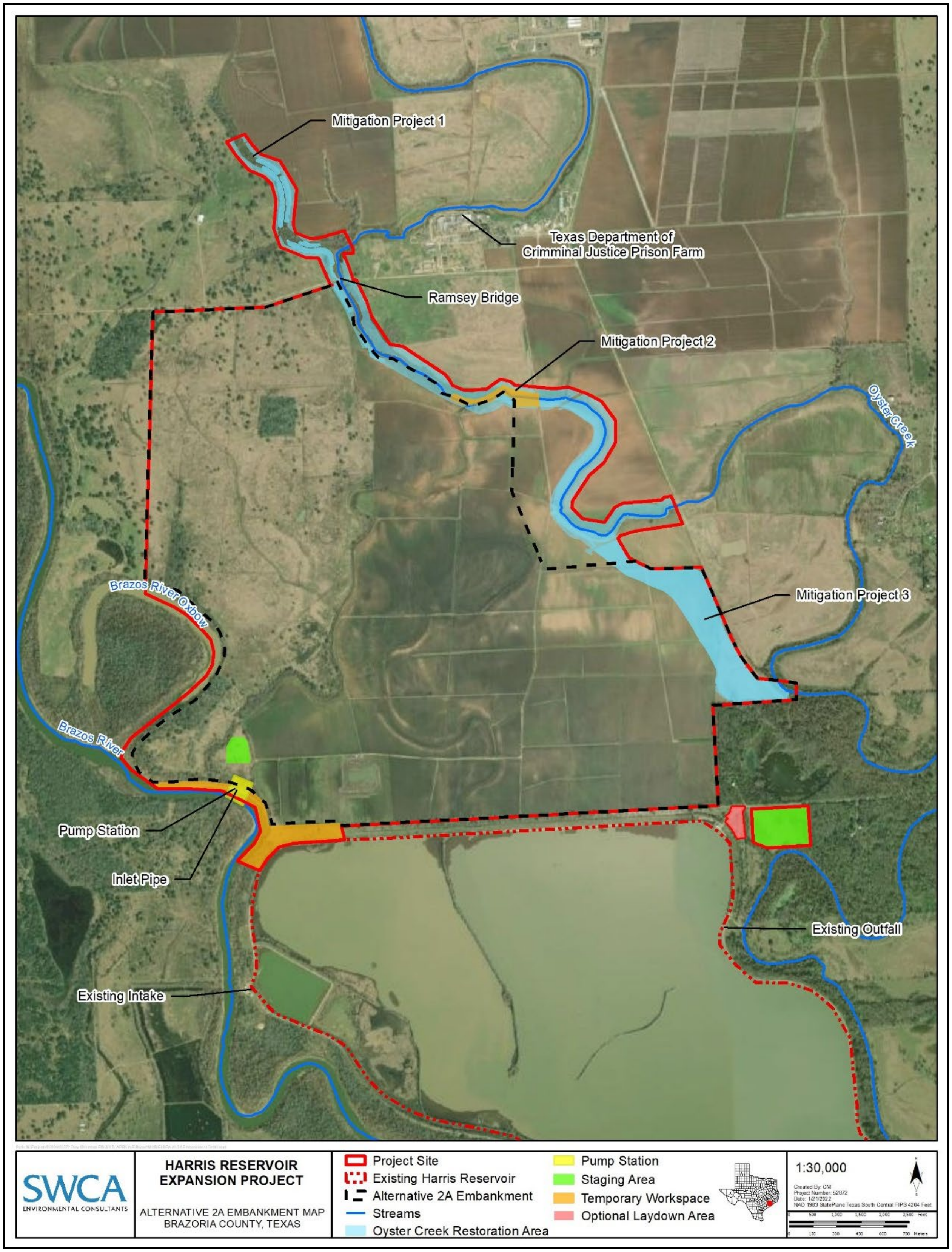


Figure 2.4-1. Conceptual layout of Alternative 2A.

2.5 Alternative 2B: Alternate Reservoir Layout

The footprint of the embankment under Alternative 2B would be slightly smaller than the Proposed Action embankment but located within the same 2,180-acre site (Figure 2.5-1). The west side of the embankment under this alternative would be set back 273 feet from the Brazos River oxbow, compared to 90 feet for the Proposed Action. This would improve safety in this area and would reduce the embankment length. Storage capacity would be approximately 50,936 AF, which exceeds the required storage by 278 AF. In addition, the upstream berm slope would be 4:1 with a 50-foot-wide berm at the upstream slope, rather than a constant 5:1 slope. The berm would be used as a working platform to accommodate the hauling trucks and equipment during construction. There would be a seepage barrier wall in the foundation of the embankment to reduce risks of erosion and/or blowout near the Brazos River and Oyster Creek.

Other Project components would be the same as those described for the Proposed Action. The outlet/spillway structure would be the same as the Proposed Action with water flowing through the embankment and to the stilling basin, which is near the flood mitigation channel for Oyster Creek.

The reservoir embankment would be above existing ground elevation with an approximate footprint of 1,919 acres within the Oyster Creek floodplain (10 acres smaller than the Proposed Action). All other temporary and permanent disturbance would be the same as the Proposed Action (see Table 2.3-1). Within the 2,533-acre Project site, approximately 76% of land would be permanently developed, 3% would be temporarily disturbed during construction, 12% would remain undeveloped, and 9% would be improved as part of mitigation. Off-site mitigation at Big Slough would occur as described for the Proposed Action.

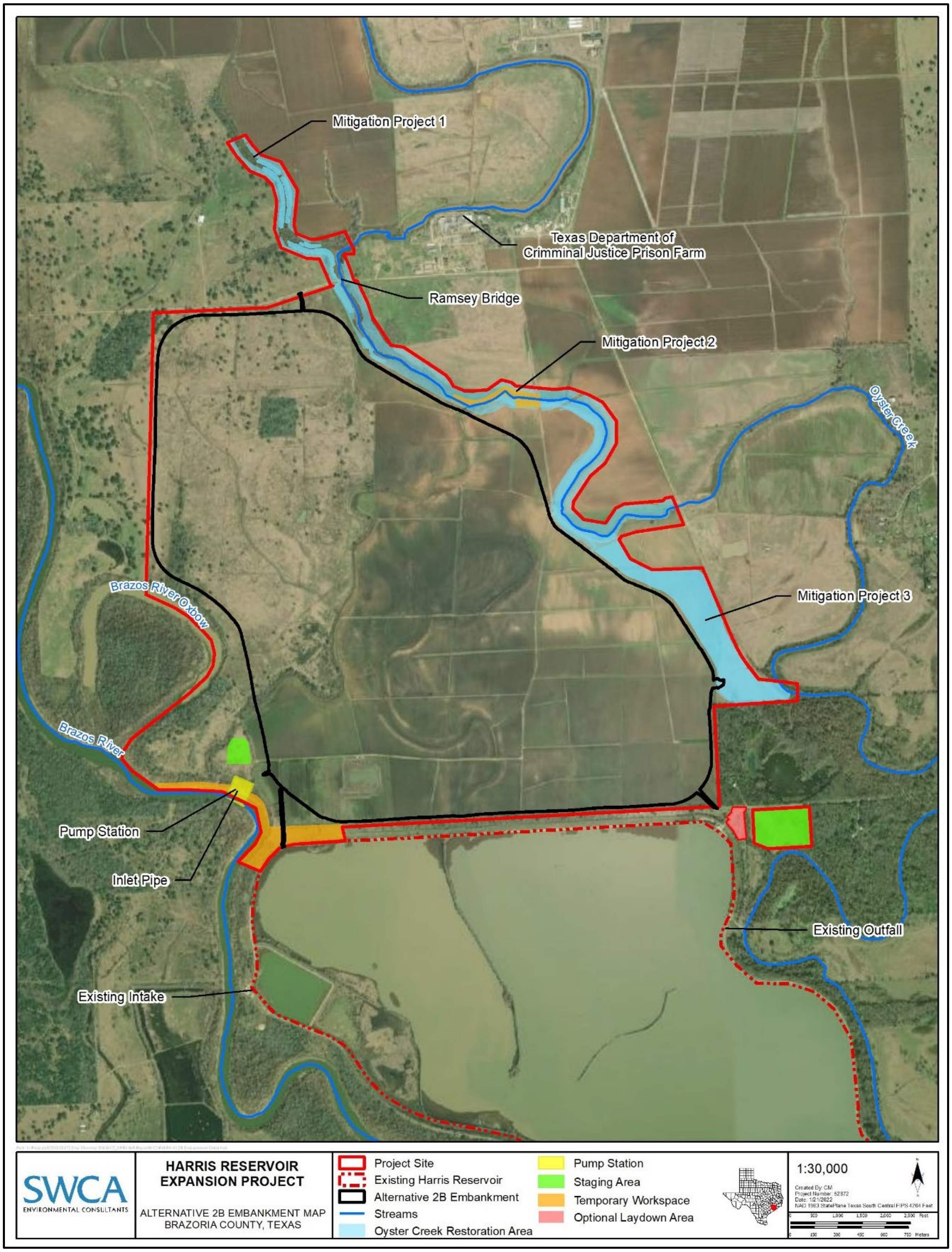


Figure 2.5-1. Conceptual layout of Alternative 2B.

2.6 Alternative 3: West Bank Alternative

2.6.1 Background

As part of the scoping process, interested parties were encouraged to provide the Corps with feedback related to their issues and concerns. Concern was raised that the Proposed Action, which is located within the floodplain, could remove flood storage capacity and alter flows during flood events. Alternative 3, hereafter referred to as the West Bank alternative, was developed to provide an alternative location that would be outside the floodplain. This alternative includes construction of a 51,080-AF off-channel reservoir, essentially the same design as the Proposed Action reservoir, that still allows Dow to use its existing Brazos River water rights to support Dow's purpose and need. Unlike the proposed reservoir under the Proposed Action, the proposed reservoir under the West Bank alternative would not be located adjacent to Dow's existing Harris Reservoir infrastructure. For this reason, this alternative would require an extensive water conveyance pipeline system and bridge crossing.

2.6.2 Project Site

The West Bank alternative site would be approximately 2 miles west of the existing Harris Reservoir along CR 25 (Figure 2.6-1). The reservoir would be on the west side of the Brazos River outside the floodplain and was sited to meet basic engineering standards for a 50,000-AF reservoir that could tie into the existing Harris Reservoir and discharge into Oyster Creek. Siting also attempted to minimize impacts on current land use, existing civil infrastructure, and environmentally sensitive areas (e.g., Nash Prairie Preserve). The West Bank alternative site would be approximately 2,885 acres.

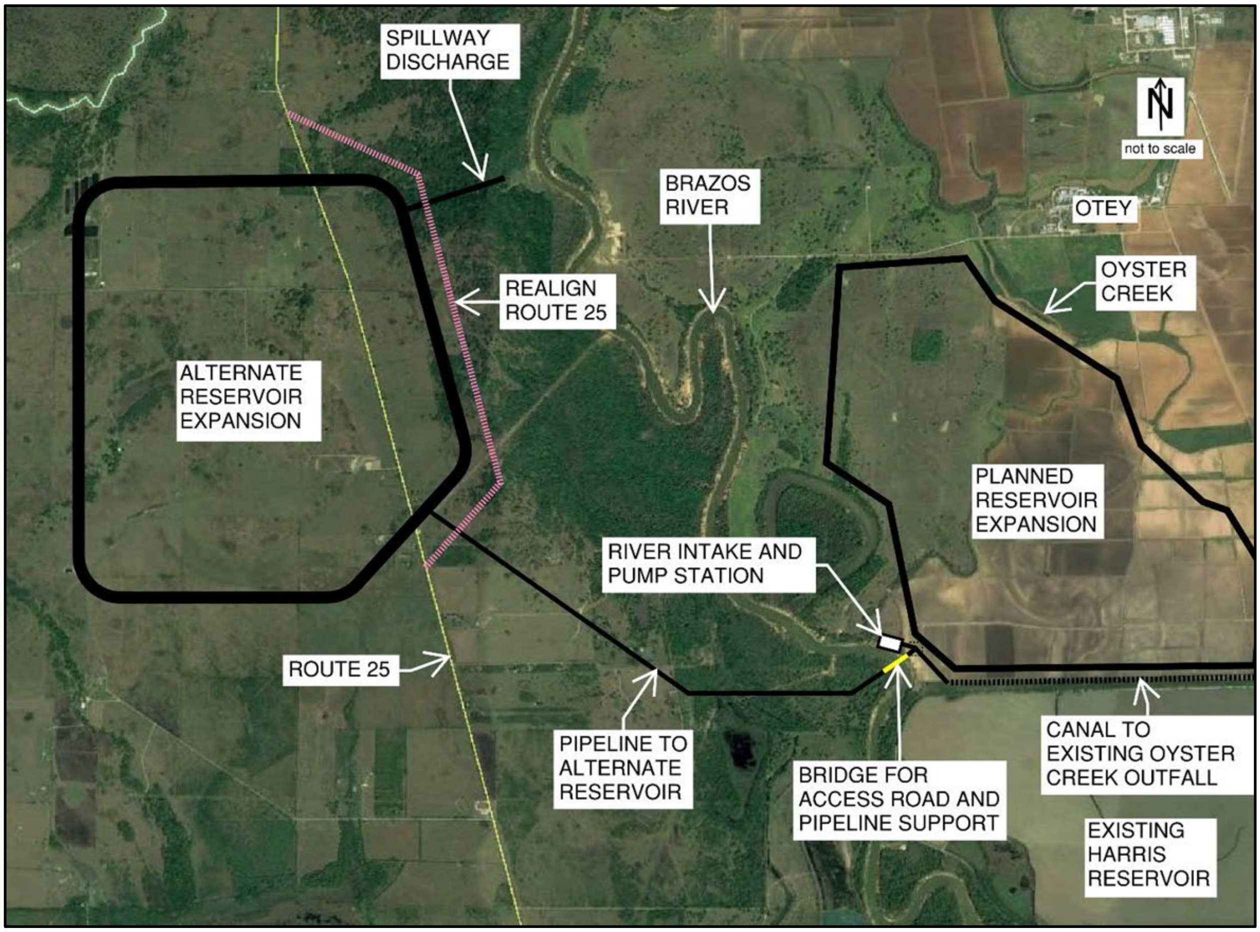


Figure 2.6-1. Conceptual layout of West Bank alternative reservoir.

2.6.3 Project Components

The proposed reservoir under this alternative would have a design similar to the proposed reservoir under the Proposed Action. However, the water conveyance system between the proposed reservoir on the west side of the Brazos River and farther west of Oyster Creek would be approximately 5 miles (Figure 2.6-2). Access to the West Bank alternative site under this alternative would require construction of a new bridge over the Brazos River. The bridge is also needed to support the pipeline to Oyster Creek, which is needed so that the water can be diverted at the Lake Jackson pump station. The new intake for this alternative would be located on the east bank of the Brazos River, in the same location as the Proposed Action's Project site.

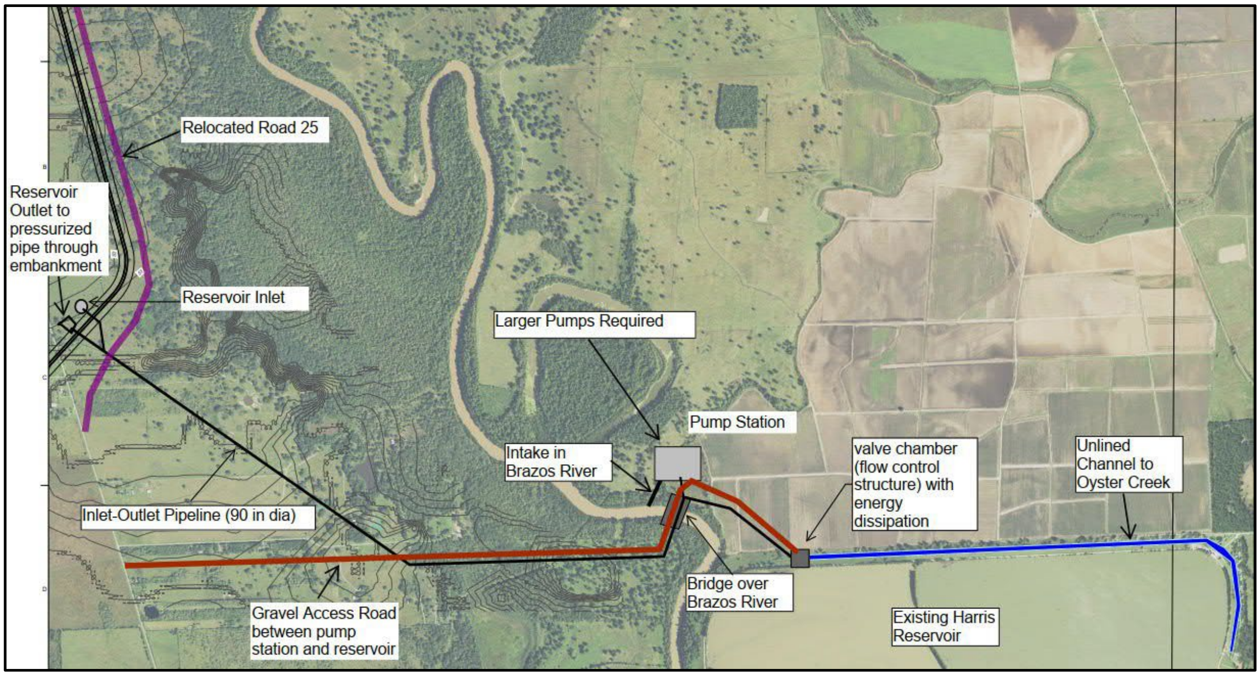


Figure 2.6-2. West Bank alternative components.

The West Bank alternative site under this alternative would be approximately 2,885 acres. Prior to construction, Dow would need to acquire land for the Project components on the west side of the river. The components on the east side of the river (i.e., pump station and outlet channel) are on land currently owned by Dow. Within the 2,885-acre Project site, approximately 66.5% of land would be permanently developed and 4.5% would be temporarily disturbed during construction (Table 2.6-1), including the components below. The remaining 29% of the site would remain undisturbed.

- 1,864 acres for the 51,080-AF off-channel reservoir.
- 1.8 acres for the 1,500 linear feet of spillway to the Brazos River that would be 52-feet-wide.
- 31.4 acres for 16,300 linear feet of Route 25 realignment within an 84-foot-wide ROW (40 feet temporary and 44 feet permanent).
- 26.2 acres for the 2.7-mile-long, 80-foot-wide inlet/outlet pipeline ROW (40-foot temporary, 40-foot permanent) and bridge to the pump station.
- 24.6 acres for the outlet channel that would be 90 feet wide (40 feet wide for temporary disturbance, 50 feet wide for permanent disturbance) and 2.3 miles long. The valve chamber would be within the ROW.
- 5.2 acres for the 2.7-mile-long gravel access road. A portion of this would overlap the pipeline ROW and bridge.

Table 2.6-1. Temporary and Permanent Disturbance Under the West Bank Alternative

Project Component	Temporary Acres	Permanent Acres	Total Acres
Reservoir	0.0	1,864.0	1,864.0
Spillway	0.0	1.8	1.8
Route 25 realignment	15.0	16.5	31.5

Project Component	Temporary Acres	Permanent Acres	Total Acres
Inlet/outlet pipeline ROW	13.1	13.1	26.2
Bridge	0.0	0.5	0.5
River intake and pump station	7.1	3.1	10.2
Outlet channel	11.0	13.6	24.6
Gravel access road	0.0	5.2	5.2
Temporary staging area	84.0	0.0	84.0
Total disturbance	**130.2**	**1,917.8**	**2,048.0**
Total undisturbed land			**837.4**
Total West Bank alternative site			2,885.4

2.6.3.1 OFF-CHANNEL IMPOUNDMENT

The proposed reservoir under the West Bank alternative would be 1,864 acres and would have a normal pool storage volume of 51,080 AF. The embankment design would be the same as described in the Proposed Action, but the conceptual shape allows for a slight reduction in the reservoir's height and volume. Since the crest elevation and reservoir elevation would be 12.8 feet higher than the Proposed Action reservoir, it would require larger pumps to convey water from the pump station.

As with the Proposed Action, the embankment fill would be borrowed from the interior of the reservoir, and a perimeter access road would be constructed around the toe of the embankment. Subsurface conditions at the West Bank alternative site are comparable to those under the Proposed Action, consisting of intermixed and layered deposits of clay, silt, sand, and gravel within the depth of influence for foundation seepage. A seepage cutoff barrier beneath the east half of the reservoir embankment would reduce risks associated with backward erosion piping initiating at a free exit at the Brazos River.

2.6.3.2 RIVER INTAKE AND PUMP STATION

The river intake and pump station under the West Bank alternative would be the same as under the Proposed Action. The river intake and pump station would be on the east bank of the Brazos River just upstream of the existing Harris Reservoir intake. Long-term observations and bathymetry studies determined that this location is stable with relatively low susceptibility to scouring and bank movement compared to other nearby reaches of the Brazos River. Under this alternative, the pump station design would be modified to accommodate a different pipeline configuration if necessary. In addition, the West Bank alternative would require larger pumps (3,500 horsepower) for the higher normal maximum pool elevation.

2.6.3.3 CONVEYANCE PIPELINE AND OUTLET

A single 90-inch-diameter pipeline would run between the pump station and reservoir. A junction at the east end of the pipeline would direct water either from the pump station to the reservoir or from the reservoir to the pump station for delivery to Oyster Creek. Conveyance from the pump station junction to Oyster Creek would consist of an initial segment of buried 90-inch-diameter welded steel pipeline that would transition to an open canal running along the north and east perimeters of the existing Harris Reservoir. The existing open channel would be enlarged to form a trapezoidal channel that has a bottom width of 20 feet and a water depth of 4 feet when flowing at full capacity (Figure 2.6-3). The existing Harris Reservoir outlet into Oyster Creek, located at the east perimeter of Harris Reservoir, would be modified to receive increased discharge.

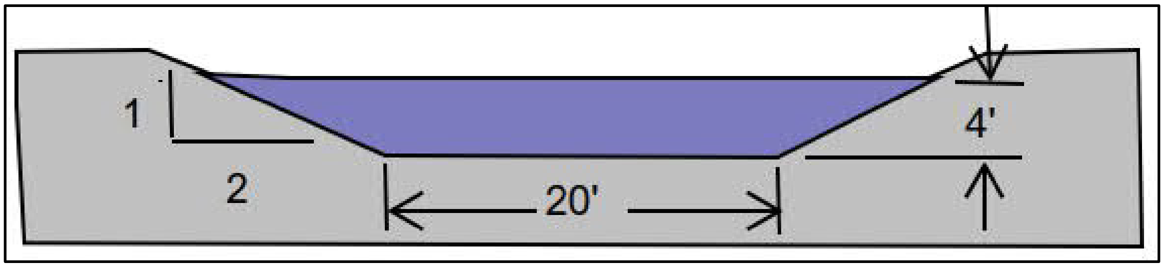


Figure 2.6-3. West Bank alternative trapezoidal channel.

2.6.3.4 PIPELINE BRIDGE

The West Bank alternative would require a bridge over the Brazos River to support the pipeline and provide vehicle access for maintenance and operation activities. The addition of a single-lane road would provide a direct route between the pump station and the reservoir inlet/outlet structures for maintenance and daily inspections. The one-lane vehicle bridge would provide additional connectivity between the new reservoir, the new pump station, and the existing Harris Reservoir during emergencies, and egress from a dam safety perspective. The bridge would be located southeast of the intake structure and pump station (see Figure 2.6-2).

The bridge would be approximately 700 feet in length, with a continuous steel plate girder deck, with three separate spans of 200 feet, 300 feet, and 200 feet, respectively, from east to west. The 300-foot-long center span would be supported by foundations and piers within the riverbank slope protection areas. The bridge would be approximately 30 feet wide, including a 14-foot-wide traffic lane bounded by vehicle barriers, deck support for the pipeline, and pedestrian (foot) access for pipeline inspection, and would be protected by pedestrian railing (Figure 2.6-4).

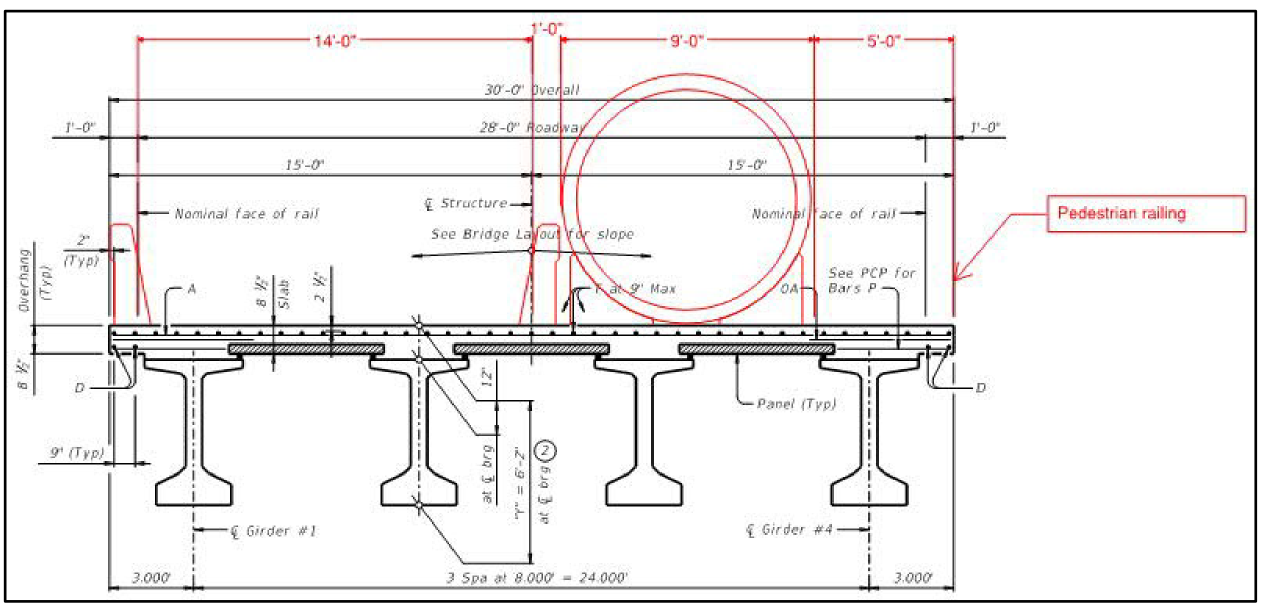


Figure 2.6-4. Conceptual bridge over the Brazos River.

According to FEMA (2020), the 100-year flood elevation at the bridge location is approximately 41.4 feet. Therefore, the bottom of the bridge deck would be 45 feet to provide clearance for river debris during a storm event.

The foundation and columns would be cast in place while the superstructure would be largely precast. The deck panels would be 4 inches with a 4.5-inch wide cast-in-place portion placed on top. The deck overhang and railings are typically cast in place; however, the contractor would be given the option to use precast if needed. The bridge deck would be supported by substructure consisting of two abutments and two bents. Each bent would be supported by 4-foot diameter pier founded on a 4-foot diameter drilled shaft. There would be three drilled shafts at each of the abutments for a total of 24 drilled shafts. Surface protection material (riprap) would extend from 5- to 40-foot elevations and extend 150 feet upstream and 150 feet downstream of the bridge.

Slope protection would be installed on both banks of the river to support the piers and the bridge crossing. Surface protection material would be installed up to the crest of the slope and would extend 150 feet upstream and downstream of the bridge structure. Additional continuous slope protection would be installed between the intake structure and the bridge on the east bank. Sheet piles would be installed at the perimeter of the slope protection, and a single row of tieback anchors would be required for sheet piles at the toe of the slope. These anchors would stabilize exposed wall heights up to approximately 25 feet and reduce passive resistance that could occur as a result of potential scour.

2.6.3.5 EMERGENCY SPILLWAY

The combined spillway and drawdown concept would be generally the same as the Proposed Action. A baffle drop structure near the interior toe of the embankment would discharge water via a gravity-fed pipeline embedded in the embankment and foundation. The outlet would consist of a reinforced concrete structure in the reservoir that acts as a combined gated outlet works and spillway structure. Similar to the Proposed Action, the rectangular reinforced concrete outlet conduit would convey either flow releases from the gated outlet works or flows from the spillway through the embankment for 700 feet, transitioning from the rectangular conduit to an open channel. The 1,500-foot-long channel would terminate in an energy dissipation structure at the existing oxbow feature on the Brazos River. The trapezoidal channel would be 20 feet wide at the bottom, 52 feet wide at the top, and an estimated 8 feet deep. The energy dissipation structure would be similar to the energy dissipation structure for the Proposed Action but would be 10 feet longer due to the grade change in this location.

2.6.4 Construction

Construction methods would be generally the same as described for the Proposed Action. However, the West Bank alternative would require construction of approximately 5 miles of conveyance system between the reservoir and Oyster Creek, which would include a new bridge over the Brazos River. The permanent ROW width for the 90-inch-diameter conveyance pipeline would be 40 feet, and the construction ROW would be 80 feet. The open trench excavation for the pipeline would be 15 feet deep with construction side slopes of 1.5:1 (H:V) so that the top of the excavated trench would be approximately 50 feet wide. Stockpile material would be on one side, and access would be on other side, requiring a temporary work area of approximately 20 feet wide on both sides of the trench.

The section of CR 25 intersecting the reservoir would need to be relocated to the east side of the reservoir. The estimated length of the CR 25 relocation is 16,300 linear feet (3.1 miles). The temporary construction ROW would be 64 feet, and the permanent ROW would be 44 feet (Figure 2.6-5).

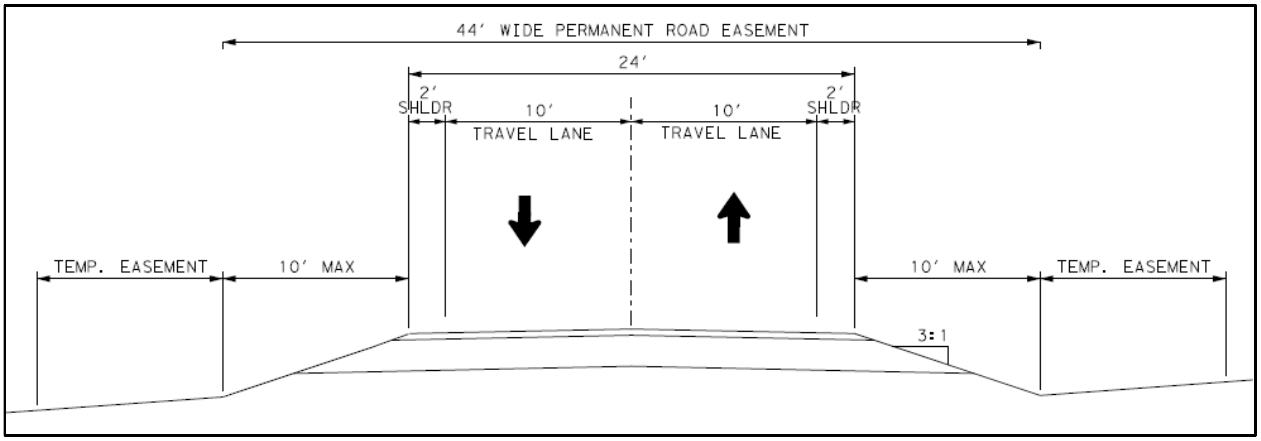


Figure 2.6-5. Road typical.

This alternative would also require relocation of two oil and natural gas pipelines, which currently run through the West Bank site (Figure 2.6-6). The pipelines would be relocated to run along the outside of the reservoir embankment to the west and north. Approximately 1.4 miles of the natural gas pipeline operated by Energy Transfer is in the reservoir footprint, and 2.0 miles would need to be relocated. Approximately 2.3 miles of the highly volatile liquid pipeline operated by Enterprise Products Partners L.P. is in the reservoir footprint, and 3.6 miles would need to be relocated. The total temporary impacts for the pipeline relocations would be 2,125 acres; the total permanent impacted area would be 2,110 acres.

Construction traffic ingress and egress for facilities east of the Brazos River would be from CR 34 and west of the Brazos River from CR 25.

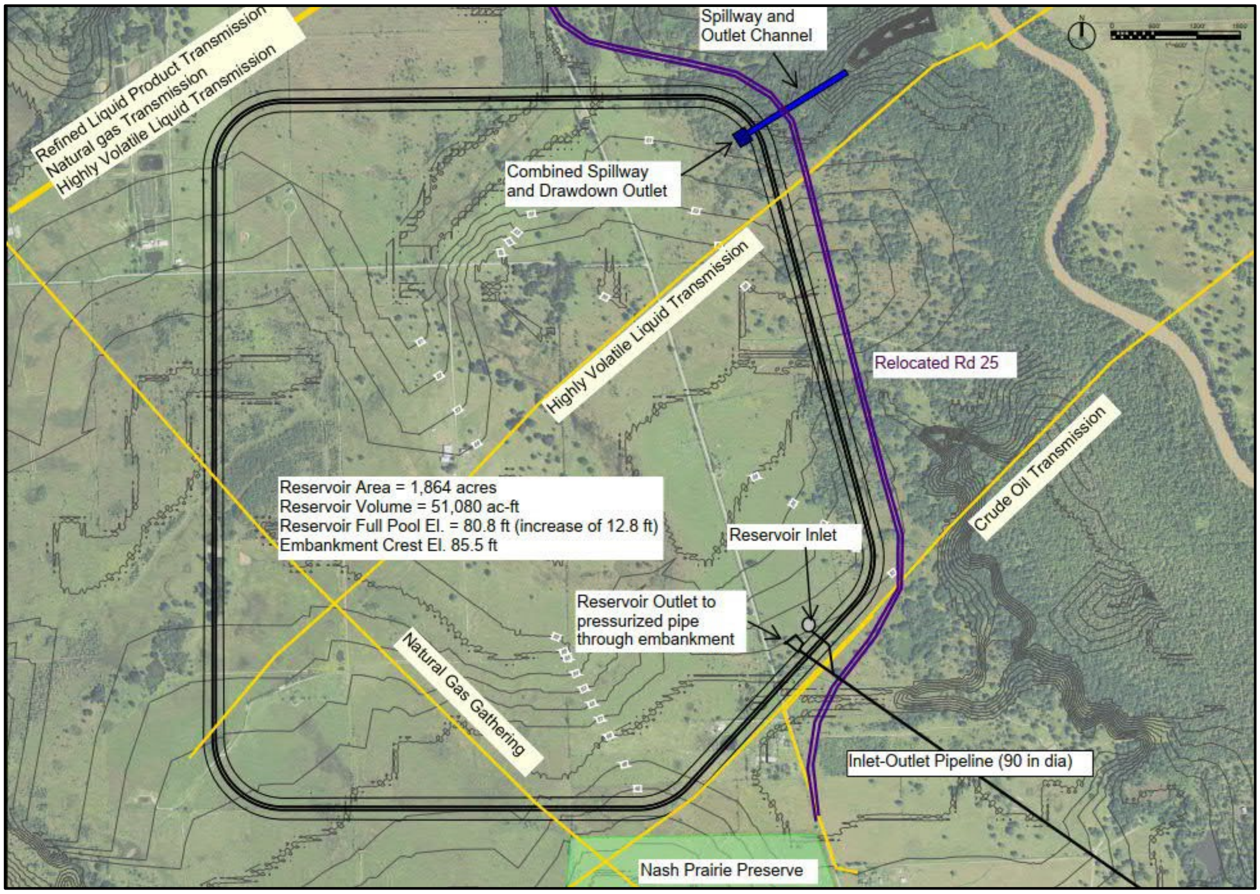


Figure 2.6-6. Relocation of County Road 25 and several pipelines.

2.6.5 Operations and Maintenance

Operations and maintenance would be the same as the Proposed Action. The conveyance pipeline, bridge, and canal would require additional maintenance. Since the access road would not be open to the public, inspections meeting federal guidelines would not be required. An inspection schedule modeled after the federal inspection program would be implemented once the bridge has been in service for several years to identify maintenance issues.

The O&M of riprap slopes would not be needed as part of regular maintenance since the entire perimeter of the riprap (i.e., toe of slope and upstream of downstream extents) would be protected from undermining by sheet piles. However, maintenance of the perimeter may be required for rare, extreme events.

2.7 Alternative 4: Brackish Water Desalination Alternative

2.7.1 Background

Alternative 4, hereafter referred to as the Brackish Water Desalination alternative, was also developed through the scoping process and would include building a brackish water desalination plant instead of a reservoir to provide water for Dow's Texas Operations. This alternative would also include diversion of brackish surface water from the Brazos River using an intake facility, a reverse osmosis plant, an outfall to discharge brine concentrate, and water conveyance facilities. The brackish water desalination plant would be located along the Brazos River near the City of Lake Jackson. The site was selected to enable diversion of Dow's existing water rights and to leverage water quality with lower salinity than a diversion located farther downstream nearer to the Gulf of Mexico.

Under drought conditions, the Brazos River is influenced by seawater from tidal action and variations in the Brazos River flowrate. As a result, the intake salinity level to the desalination plant would vary from 1,000 milligrams per liter (mg/L) to approximately 33,000 mg/L. To facilitate Dow's plant operation with the maximum anticipated river salinity (33,000 mg/L total dissolved solids [TDS]), a two-pass reverse osmosis (RO) process would be required to reduce chloride levels to Dow's process water quality requirement (less than 100 mg/L). Under lower river salinity conditions (approximately15,000 mg/L TDS), portions of the second pass could be bypassed, and desalinated water would be produced predominantly by the first pass. Under brackish water salinities (1,000–15,000 mg/L), desalination could be achieved through a varying combination of first- and second-pass systems operating in parallel rather than series.

The desalination plant would produce 94 mgd of desalinated water, which would require preliminary treatment (pretreatment) and solids handling and disposal. The desalination plant would also require an access road to the plant location, a power line corridor, and pipeline conveyance routes.

2.7.2 Project Site

The Brackish Water Desalination alternative site would be in the City of Lake Jackson approximately 8 miles northwest of Dow's Texas Operations and along the Brazos River (Figure 2.7-1). The Brackish Water Desalination alternative site would be south of the Brazoria Reservoir and north of the Brazos River. The Brackish Water Desalination alternative site would require 500 acres for the treatment plant and 100 acres of temporary construction areas for trailers and equipment laydown. A new access road from Brazoria Road would be required, as well as a power line and substation.

A 72-inch-diameter pipeline would convey desalinated water to Dow's Texas Operations, specifically the process area at Plant B (see Figure 2.3-1). In the same trench, a 96-inch-diameter pipeline would convey the RO concentrate to Dow's Texas Operations for discharge into Dow's seawater discharge canal (Figure 2.7-2). The route would be approximately 8.8 miles and would follow existing roads and ditches on the west side of Lake Jackson, including This Way Street, Medical Drive, and Sycamore Street.

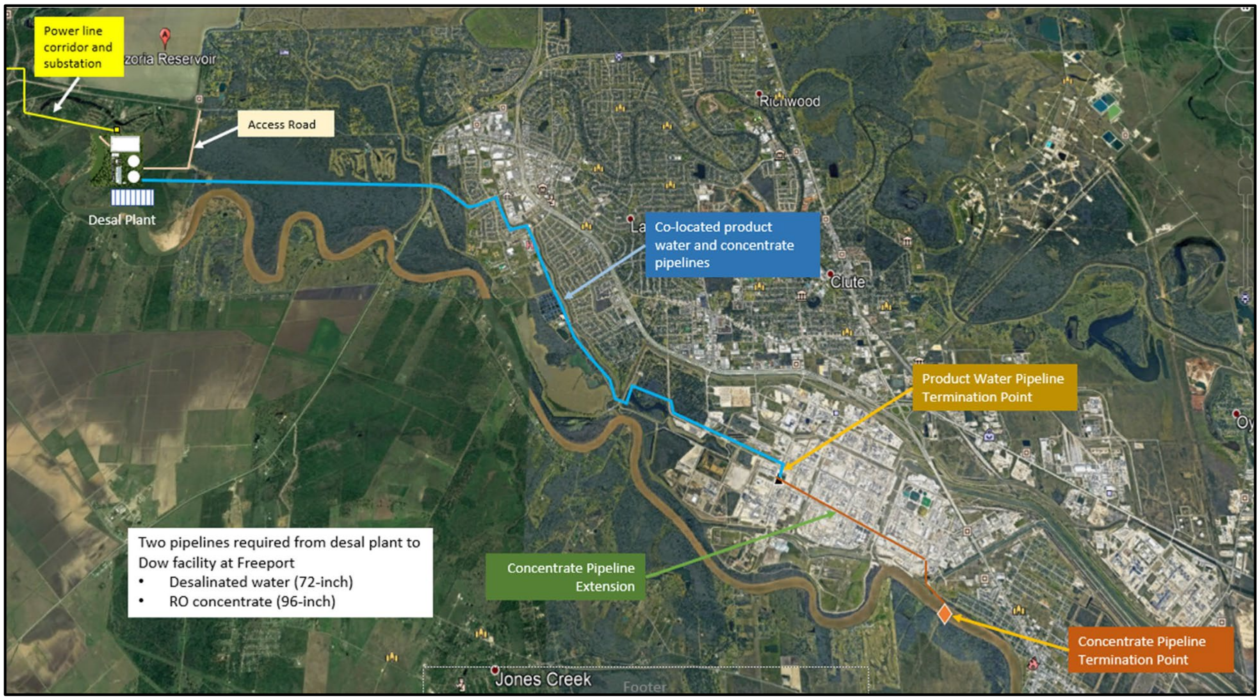


Figure 2.7-1. Desalination plant site in Lake Jackson.

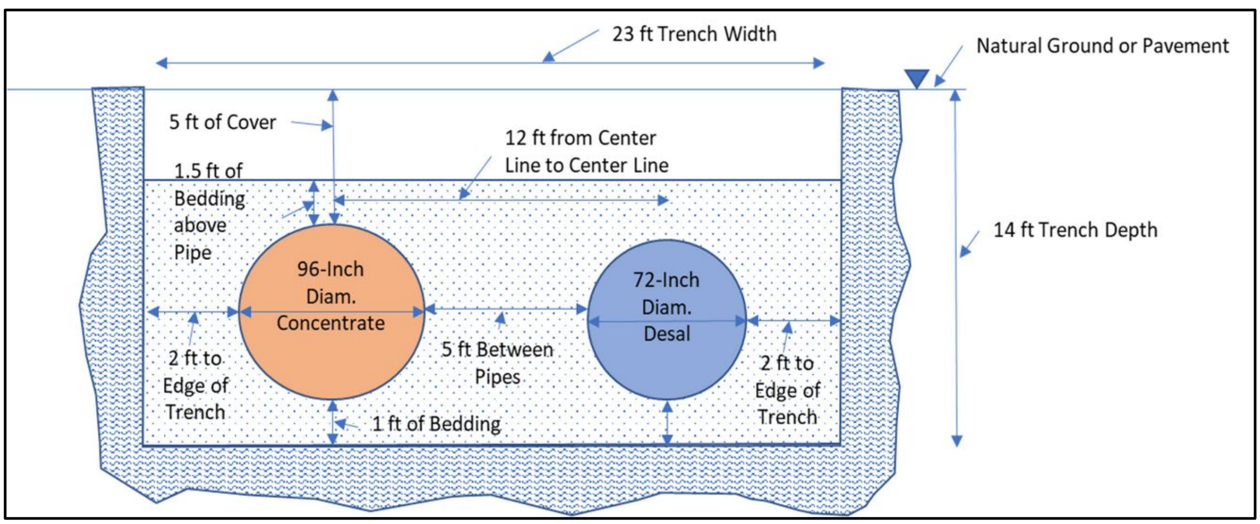


Figure 2.7-2. Conveyance pipe trench cross section.

2.7.3 Project Components

The intake pump station for the desalination plant would be on the east bank of the Brazos River. The treatment plant site would include a 46-acre pre-sedimentation basin to the north and 20 sludge drying beds (108 acres total) to the south (Figure 2.7-3). Other treatment process equipment would be located between these structures, including two 650-foot-diameter tanks to store desalinated water. The product water and concentrate pipelines would be sited beneath the proposed facility access road.

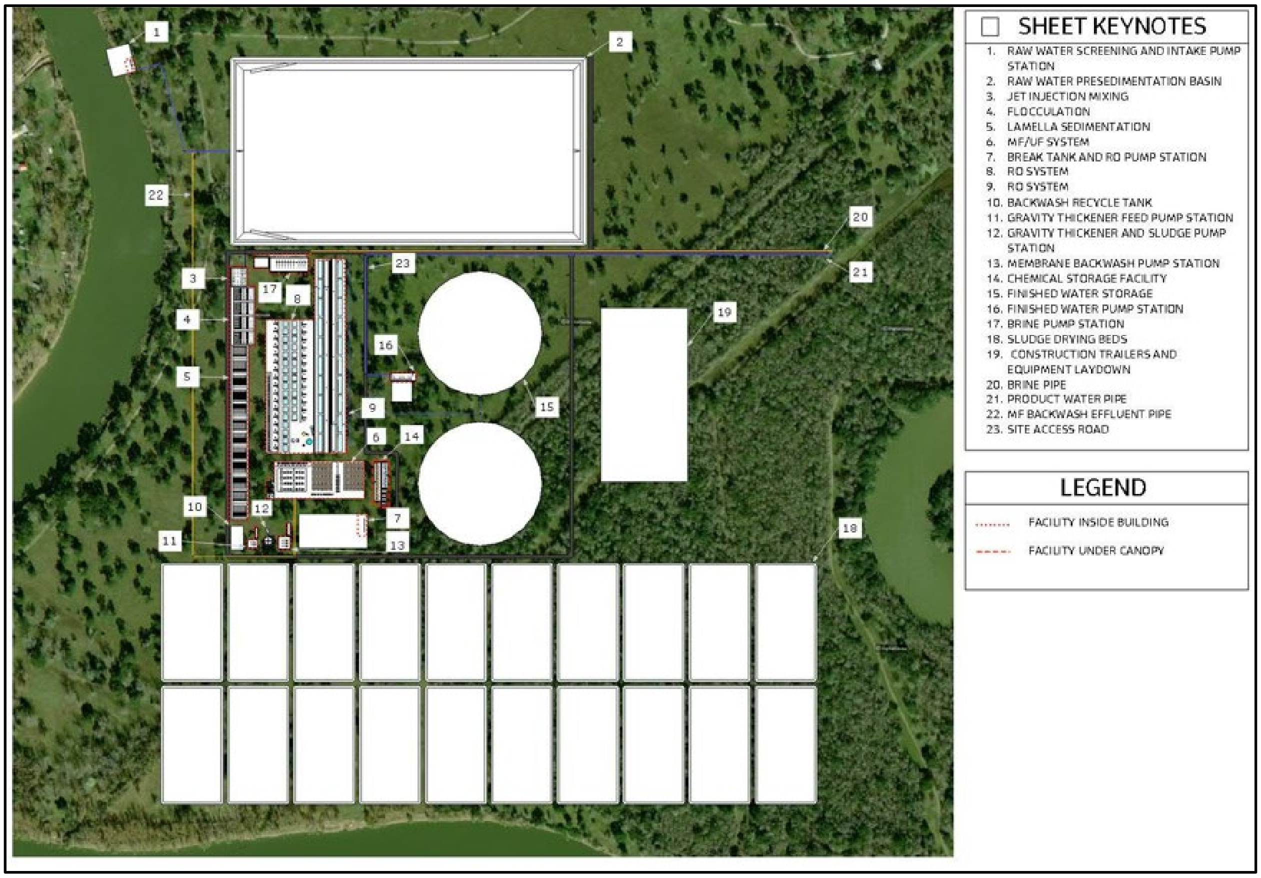


Figure 2.7-3. Desalination plant layout.

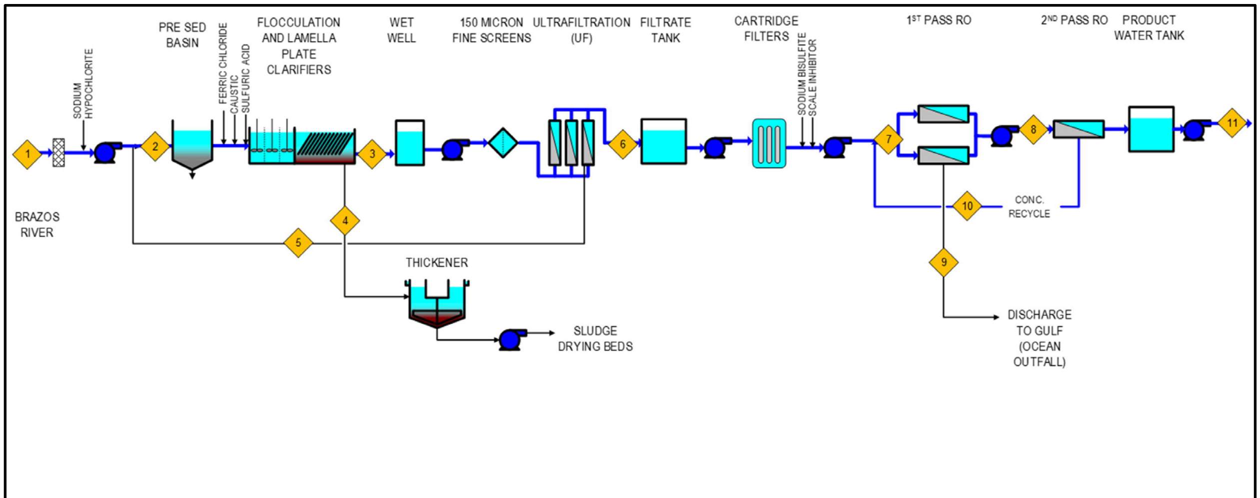
Brazos River water would be diverted through two intake pipes equipped with screens to prevent entrainment of aquatic life and debris. River water would flow by gravity through the intake pipes into a below-grade pump station, which would convey the water to the pre-sedimentation basin for removal of higher-density solids present in the river water (silts and sands) by gravity. The intake pipes would be periodically shock-chlorinated to inhibit biological growth. Subsequent coagulation, flocculation, and high-rate (lamella plate) clarification, using ferric chloride and pH adjustment, would remove colloidal particulate and precipitable organic matter. The clarified water would then be filtered using ultrafiltration (UF). UF removes undissolved solids to the level required for RO pretreatment. Solids from the plate clarifiers would be sent to a gravity thickener and then pumped to sludge drying beds. Solids accumulating in the pre-sedimentation basin would be manually removed on an infrequent basis and transported to the sludge drying beds. UF backwash water would be flow-equalized and pumped back to the pre-sedimentation basin. See flow diagram in Figure 2.7-4.

RO feed water would be dosed with sodium bisulfite (to quench any chlorine present from shock chlorination or UF cleaning) to prevent RO membrane oxidation and with anti-scalant to prevent precipitation of calcium carbonate in the first-pass RO elements. First-pass concentrate would be discharged to a dedicated pump station and then pumped to a discharge location at Dow’s Texas Operations for eventual discharge to the Gulf of Mexico. Second-pass RO concentrate would be recycled by blending with first-pass feed when the RO system is operating in a two-pass (series) configuration. Second-pass concentrate would be blended with first-pass concentrate during parallel-pass operation.

RO permeate (from both passes) would be collected in two on-site storage tanks having a total capacity of 94 million gallons (equivalent to 1 day of storage), and then pumped to Dow’s Texas Operations.

During treatment of maximum salinity water (up to 33,000 mg/L TDS), product water recovery (percentage of desalinated water divided by process feed water) would be approximately 42%. At this recovery rate, it would be necessary to divert 227 mgd of Brazos River surface water to produce 94 mgd of desalinated water. The recovery rate increases as feed-water salinity decreases; however, pre-treatment equipment must be sized for the minimum recovery of 42%.

The desalination plant, including pump stations for product water and brine disposal, is estimated to have a 60-megawatt electrical load. The Project would require a new power substation and aboveground power line.



Stream #	1	2	3	4	5	6	7	8	9	10	11
Flow, MGD	227	244	238	6.0	18	221	231	104	127	10.4	93.6

Figure 2.7-4. Desalination plant process flow diagram.

2.7.4 Construction

The Brackish Water Desalination alternative site would be 733 acres; approximately 51% of this area would be permanently developed, 14% would be temporarily disturbed during construction, and 35% would not be disturbed (Table 2.7-1). Prior to construction, Dow would need to acquire the following land for the following Project components:

- Approximately 500 acres along the Brazos River for the treatment plant (76 acres), sludge basins (108 acres), and pre-sedimentation basin (46 acres), plus 100 acres needed temporarily during construction (10 acres for trailers and equipment laydown and 90 acres around the perimeter of the treatment plant). The remaining land within the property would not be developed.
- 11 acres for the new 20-foot-wide access road to the desalination plant. The 1.4-mile road to the desalination plant would require a 64-foot-wide ROW during construction; the permanent ROW would be 44 feet wide. A typical of the road is shown in Figure 2.6-5.
- 0.6 acre for a 0.3-mile-long, 16-foot-wide gravel road to the intake pump station.
- 107 acres for conveyance pipelines (8.8 miles long in the 100-foot-wide corridor). The 100-foot conveyance pipeline corridor would require permanent maintenance (e.g., mowing of surface vegetation). In addition, approximately 2.1 miles are within the developed Dow facility.
- 30 acres for the power line ROW (10,000 feet long × 130 feet wide). The power line would tie into the double pole on the west side of CR 674 and the single pole on the east side of CR 674 (Figure 2.7-5). The power provider would design, construct, and perform maintenance on these lines as a separate project.

- 2 acres for the new power substation to feed the desalination plant (land for new power corridor is assumed to be acquired by the power company). The substation would be a fenced road base pad with electrical facilities and setbacks.

Table 2.7-1. Temporary and Permanent Disturbance Under the Brackish Water Desalination Alternative

Project Component	Temporary Acres	Permanent Acres	Total Acres
Treatment plant and basins	100.0	230.0	330.0
Access road, maintenance	3.5	7.5	11.0
Access road, gravel	0.0	0.6	0.6
Conveyance pipelines	0.0	107	107.0
Power substation	0.0	2.0	2.0
Power line ROW	0.0	30.0	30.0
Total disturbance	**103.5**	**377.1**	**480.6**
Total undisturbed land			**252.2**
Total Brackish Water Desalination alternative site			732.8

Figure 2.7-5. Example of proposed power lines (Google Maps 2021).

2.7.5 Operations and Maintenance

The desalination plant would require energy, chemicals, sludge disposal, maintenance, and labor for operations. The desalination plant, including pump stations for product water and brine disposal, is estimated to have a 60-megawatt electrical load.

The anticipated total suspended solids in the feed water would be 20 to 30 mg/L. At an average of 200 mgd of feed water, the sludge generated would be approximately 50,000 pounds/day (dry weight basis). This translates to approximately 66,100 cy per year of wet sludge, which would require that the 108 acres of sludge drying beds be emptied approximately every 4 years (1.5-foot sludge depth).

Annual estimated chemical usage in dry tons (dt) would be 500 dt sodium hypochlorite, 1,200 dt sodium hydroxide, 1,500 dt citric acid, 20 dt sodium bisulfite, 8,000 dt sulfuric acid, 4,000 dt ferric chloride, 400 dt polymer, 2,000 dt scale inhibitor, and 600 dt trisodium phosphate. Disposal would occur at a landfill such as the Seabreeze Environmental Landfill in nearby Angleton.

The substation would be operated and maintained by the power company.

2.8 Standard Best Management Practices and Applicant-Committed Measures

Temporary erosion and runoff best management control measures would be implemented during construction to minimize stormwater pollution resulting from erosion and sediment migration from the construction, borrow, and staging areas. Temporary control measures including sediment control fences, vertical tracking, rock or timber construction exits, diversion dikes, and erosion control logs would be installed. Dust control measures would be applied to roads and work areas on a systematic basis. After construction is complete, the temporary staging areas and temporary construction offices/facilities would be demobilized and restored to pre-Project conditions. Site restoration activities for areas disturbed by construction activities may include regrading, reseeding, constructing permanent diversion ditches, using straw wattles and bales, and applying straw mulch and other measures deemed appropriate.

Other best management practices (BMPs) and applicant-committed measures that would be implemented for all action alternatives are listed below by resource. Standard BMPs would be implemented for terrestrial work. Standard BMPs are typically included in the “issued for construction” plans and specifications.

2.8.1 Geology and Soils

2.8.1.1 TOPOGRAPHY

- Effects to and influences of topography and bathymetry have been and would continue to be incorporated into design considerations to minimize potential Project effects to topography. Local effects to topography would be minimized to the extent possible using site-specific data collection and analyses incorporated into the final design.
- Vertical tracking would be used on slopes to temporarily stabilize soil. Tracks would be a minimum of 12 inches long by 2 to 4 inches wide by 0.5 to 2 inches deep and would be installed no more than 12 inches apart, oriented perpendicular to the slope or direction of water flow.
- After construction is complete, the temporary staging areas and temporary construction offices/facilities would be demobilized and contours restored to pre-Project conditions. Site

restoration activities for areas disturbed by construction activities may include regrading, reseeding, constructing permanent diversion ditches, using straw wattles and bales, and applying straw mulch and other measures deemed appropriate.

2.8.1.2 SOILS

- Sand imported to the site would be free of contaminants and hazardous materials.
- Coordination with the Natural Resources Conservation Service (NRCS) would be conducted to avoid and minimize impacts to farmland soils.
- The design and construction of all Project elements would be based on the results of detailed geotechnical engineering studies and would meet or exceed applicable USACE, TCEQ, and Brazoria County Groundwater Conservation District design standards for static and dynamic stability, liquefaction, subsidence, and seepage.
- Other potential erosion control BMPs include the use of mulch, sod, berms, silt fences, temporary vegetation, and blankets and matting.

2.8.1.3 SEDIMENTATION AND EROSION

- Erosion and stormwater pollution control measures would be consistent with the National Pollutant Discharge Elimination System (NPDES) and Texas Pollutant Discharge Elimination System (TPDES) general permit and would be included in a stormwater pollution prevention plan (SWPPP). Proposed BMPs would be implemented as approved by TCEQ and inspected at installation and throughout the construction period in compliance with the general permit.
- Temporary erosion and runoff best management control measures would be implemented during construction to minimize stormwater pollution resulting from erosion and sediment migration from the construction, borrow, and staging areas. Temporary control measures including sediment control fences, vertical tracking, rock or timber construction exits, diversion dikes, and erosion control logs would be installed.
- All sediment barriers would be installed along the contour, perpendicular to runoff flow, with each end curving gently upslope enough to capture and pool the design volume of runoff during a storm event.
- Sediment control fences would be inspected and maintained after each rainstorm.
- All stockpiles would be covered or seeded.
- Dikes may be used to intercept runoff and divert it to stabilized areas or erosion control devices. Soil used for dike construction would be machine compacted. Dikes in place for more than 14 calendar days would be stabilized to prevent sediment runoff. Sediment and debris would be removed from dikes after rain and whenever accumulation affects device performance.
- Gravel or riprap areas or pads would be installed at points where vehicles enter and leave the construction site. This BMP provides a buffer area where vehicles can drop their mud and sediment to avoid transporting it onto public roads, to control erosion from surface runoff, and to help control dust.
- The outer face of the proposed reservoir embankment and the slopes to either side of the embankment maintenance road would be mulched and/or hydroseeded and maintained by mowing.
- Because the discharge from the proposed reservoir would only occur during drought conditions, the potential for and extent for erosion on Oyster Creek to occur is unclear and requires an

adaptive management approach. Erosion that may result downstream of the proposed reservoir on Oyster Creek shall be addressed in the mitigation, monitoring and adaptive management plan. When Dow operates the proposed reservoir in response to drought conditions, monitoring will be conducted on the portion of Oyster Creek downstream of the proposed reservoir discharge to its confluence with the existing Harris Reservoir outfall. Monitoring shall be conducted by a qualified aquatic ecologist and include identification of any areas where erosion is occurring per standard practices. If erosion is identified, Dow will take immediate action to remediate the erosion. These steps may include curtailing of operations to prevent further erosion, installation of bioengineered bank stabilization, revegetation of riparian areas, among others.

2.8.2 Water Resources

2.8.2.1 SURFACE WATER

In addition to the BMPs listed in Section 2.8.2.1, the following BMPs would be implemented:

- Staging areas and temporary workspaces have been sited to avoid impacts to surface waters and wetlands to the extent possible.
- The Applicant would comply with the requirements of the Section 401 Water Quality Certification issued by TCEQ.
- Blankets and matting (i.e., sheets or rolls of porous erosion control material) would be installed and anchored at the soil surface in channels and swales and on diversion dikes, steep slopes, and stream and tidal banks.
- A protected, lined area for concrete truck washouts would be clearly identified and located away from streams, storm drains, or ditches.
- A spill prevention, control, and countermeasures plan would be prepared that would minimize potential impacts to water quality during construction.
- Spill kits will be kept on-site to clean up any spills or leaks immediately, including spills on pavement or earthen surfaces.

2.8.2.2 GROUNDWATER

- A potable water well would be provided to supply water for the operations building, restrooms, eyewash, vacuum pump seal water, utility hose water, water pump seal flushing and bearing cooling, and gear reducer oil cooling, if needed. The well would be constructed and managed in accordance with TCEQ Rules and Regulations for Public Water Systems (30 TAC 290(D)) and the Brazoria County Groundwater Conservation District rules and regulations.
- A supplemental site investigation and additional earthwork methods evaluations (test borrow pits and test embankments) would be conducted during detailed design to determine the effects of borrow source excavations on groundwater.
- Borrow pits would be excavated to a maximum depth of 10 feet in areas with a high water table.

2.8.2.3 HYDROLOGY

- In-river and Oyster Creek BMPs would be selected based on site-specific conditions and may include but are not necessarily limited to cofferdams.

2.8.2.4 FLOOD HAZARDS AND FLOOD HAZARD VALUES

- Follow seasonal and emergency flood operation protocols in the O&M plan (see Appendix L).

2.8.2.5 WATERS OF THE UNITED STATES, INCLUDING WETLANDS

- Streams, riparian zones, and wetlands would not be used as staging or refueling areas. Equipment will be stored, serviced, and fueled a minimum of 150 feet from aquatic habitats and other sensitive areas.
- Wetlands and other WOUS that are not within the Project footprint will be protected by a 150-foot buffer. The avoidance area will be clearly marked with flagging or fencing.
- Streambank stabilization measures, including sheet piling, native backfill, and riprap, would be installed along the Brazos River approximately 200 feet upstream and 100 feet downstream of the proposed intake structure to reinforce the toe and a portion of the slope of the riverbank, preventing lateral migration of the Brazos River.
- Wetland and stream restoration areas would be monitored in accordance with the mitigation plan (SWCA 2022) (see Appendix G).

2.8.3 Vegetation

- A monitoring plan would be developed and implemented to prevent and manage nonnative invasive plant species.
- A remediation plan would be developed to address revegetation for any temporarily disturbed areas. Revegetation would include only native species and would be monitored for meeting success criteria.
- Only native shrubs, trees, and seed mixes from local ecotypes will be included in the reclamation and restoration of disturbed sites.
- Invasive plant species would be selectively removed and controlled using herbicides selected based on the type of application procedure and would be in accordance with federal regulations. The evaluation of herbicide, pesticide, and fertilizer use shall include the accuracy of applications, effects on target and non-target species, and the potential impacts to aquatic and terrestrial ecosystems. The invasive plant removal and follow-up herbicide application would be conducted by experienced contracted personnel.
- Aquatic nonnative invasive species would be monitored and managed in accordance with the monitoring plan described above.

2.8.4 Wildlife

2.8.4.1 TERRESTRIAL

- Barbed-wire fencing would include features that would minimize the potential for injury to wildlife.
- Reduce vehicular traffic speeds (25 mph or less) at dusk and dawn to minimize and avoid vehicular collisions with wildlife.
- Trenches left open for more than two daylight hours should be inspected for the presence of trapped wildlife prior to backfilling. If trenches/excavation areas cannot be backfilled the day of initial excavation, then escape ramps should be installed at least every 90 meters (approximately 295 feet). Escape ramps can be short lateral trenches or wooden planks sloping to the surface at an angle less than 45 degrees (1:1).

- A biological monitor should be present during construction to assist in detecting protected species in the Project site, especially in areas of suitable habitat including riparian woodlands, bottomland forest, and upland forest.
- Use no-till drilling, hydromulching, and/or hydroseeding rather than erosion control blankets or mats due to a reduced risk to wildlife. If erosion control blankets or mats will be used, the product should contain no netting or contain loosely woven, natural fiber netting in which the mesh design allows the threads to move, therefore allowing expansion of the mesh openings. Plastic mesh matting should be avoided.

2.8.4.2 AQUATIC

- The BMPs to minimize impacts to surface water would also minimize impacts to the aquatic fauna.
- Impacts to the water quality, including the temperature, dissolved oxygen, and total suspended solids, will monitored and mitigated during drawdown and addressed through adaptive management in Dow's mitigation plan and O&M plan.
- Prior to construction, the Project site would be surveyed to determine the potential of the site to support listed mussel species or their habitat in order to adequately plan to avoid or minimize impacts to listed mussel species.

2.8.4.3 MIGRATORY BIRDS

- Vegetation clearing would be scheduled outside the general bird nesting season of March 15 to September 15; however, if clearing must occur during nesting season, nest surveys would be conducted prior to clearing. Nest surveys would take place within 5 days of scheduled clearing in order to maximize the detection of active nests. If nests are observed during surveys, a vegetation buffer area of no less than 150 feet in diameter would remain around the nest until all young have fledged.

2.8.5 Threatened and Endangered Species/Essential Fish Habitat

- An environmental awareness training program will be presented to all construction personnel to brief them on the status of the special-status species and the required avoidance measures.
- Install screens with 2-mm wedge wire using a configuration that creates turbulence to reduce entrainment.
- Design, adjust, or adaptively manage intakes with minimal flows to prevent entrainment.
- Diversions of marine seawater should not exceed flow-through velocities of 0.5 feet per second (fps), nor be co-located such that combined impacts in the surrounding approach area exceeds 0.5 fps.
- Implement a site-specific study of conditions at the proposed intake location to identify marine organisms at risk from intake operations and to inform the design planning process.
- Employ a stop-work order when a whooping crane is observed within 1,000 feet of construction activities and resume work after the bird has left the area. At night, lower all vehicles and equipment taller than 15 feet to minimize risk of collision during migration.
- To aid in the scientific knowledge of a species' status and current range, encounters of protected and rare species will be reported to the Texas Natural Diversity Database (TXNDD) according to

the data submittal instructions found at the TPWD Texas Natural Diversity Database: Submit Data webpage.

- Revegetation would include use of milkweeds and/or other nectar producing plants to reduce, avoid and mitigate for potential impacts to foraging habitat for the monarch butterfly.

2.8.6 Land Use

- Farmland areas within the Project site are anticipated to remain in production until immediately prior to construction.

2.8.7 Social and Economic Resources

- To the extent possible during construction, the Applicant would seek to hire the work force from within the state and extended analysis area to limit population increase.

2.8.7.1 NAVIGATION AND RECREATION

- Through navigation would be maintained along the Brazos River during construction and operations.
- Small-boat traffic would be routed away from intake facilities using appropriate signage.

2.8.7.2 VISUAL AND AESTHETIC RESOURCES

- Materials and surface treatments to reduce visual impacts include the following:
    - Using materials and surface treatments that repeat the form, line, color, and texture of the surrounding landscape
    - Using non-reflective materials, coatings, and/or paint
    - Color-treating grouped structures using the same color
    - Maintaining painted, stained, or coated surfaces properly
- Lights would be properly directed to eliminate light spill and trespass
- Lighting usage would be minimized during construction and operations
- The Project site and associated disturbance would be minimized to avoid unnecessary disturbance
- Construction activities and facilities would be confined to pre-defined areas

2.8.8 Climate and Air Quality

- Dust control measures would be applied to roads and work areas on a systematic basis.
- Open storage piles and disturbed areas would be stabilized by covering and/or applying water or chemical/organic dust palliative where appropriate at active and inactive sites.
- To the extent practicable, construction vehicles and equipment would be new and would meet the most stringent federal or state emissions standards with the best available emissions control technology (e.g., Tier 4 engines).
- All construction equipment would be inventoried prior to construction to identify the suitability of add-on emission controls for each piece of equipment.
- All construction equipment would be maintained in proper working condition, and all required preventative maintenance would be performed incompliance with all manufacturer's

recommendations, including proper upkeep and replacement of filters and mufflers and maintenance of all engine and emissions systems in proper operating condition. Maintenance schedules would be detailed in an air quality control plan prior to commencement of construction and implemented during construction.

- Speeds of construction vehicles would be limited to 15 miles per hour. Speeds of earth-moving equipment would be limited to 10 miles per hour. Vehicle idling would be limited to 5 minutes at a time.
- Maintain all construction equipment in proper working condition and perform all preventative maintenance. Required maintenance includes compliance with all manufacturer's recommendations, proper upkeep and replacement of filters and mufflers, and maintenance of all engine and emissions systems in proper operating condition. Maintenance schedules will be detailed in an air quality control plan prior to commencement of construction and implemented during construction.
- Equip gas insulated switchgear and circuit breakers containing sulfur hexafluoride (SF_6) with leak detection system.

2.8.9 Noise

- The Project would comply with local noise ordinances during construction, operation, and maintenance.
- Operation of equipment, machinery, and large vehicles would be restricted to daylight hours, between the hours of 8:00 a.m. and 5:00 p.m. unless otherwise specified in writing within the construction contract.
- Mufflers on equipment used for construction and during operations and maintenance would be properly maintained on a regular basis.

2.8.10 Historic and Archaeological Resources

- Potentially adverse effects to cultural resources shall be minimized through cultural resource reviews, surveys, and compliance with Section 106 of the NHPA. All sites discovered in the future shall be treated as eligible for the NRHP until listed or formally evaluated as ineligible in consultation with the State Historic Preservation Officer (SHPO).
- A 150-foot buffer would be established around the cemetery east of Oyster Creek.

2.8.11 Hazardous Waste and Materials Management

- A Project-specific construction debris recycling and diversion program would be developed to achieve a documented 50% diversion of construction waste.
- Hazardous waste would be properly disposed of at a hazardous waste drop-off and collection facility.
- As stated in Section 2.8.11, a spill prevention, control, and countermeasures plan would be developed and implemented to prevent spillage when hauling material and operating non-earthmoving equipment.

2.8.12 Infrastructure

2.8.12.1 PUBLIC SAFETY

- Prior to commencing work, construction contractors would submit to Dow for review and approval a comprehensive health and safety plan for the Project. The contractors would be responsible for complying with the health and safety plan as approved by Dow.
- No construction access, including material deliveries, mobilization of construction equipment, or workers' passenger vehicles, would be permitted via Ramsey Bridge due to weight restrictions and safety concerns. All access would occur via the southern entrance on Harris Reservoir Road.
- The Project site would be fenced, and access would be controlled and monitored for the duration of the construction. Existing fences would be protected along the Project boundary to the extent possible. Damaged fencing would be replaced with barbed-wire fencing where appropriate and as indicated by the engineer or property owner.

2.8.12.2 TRANSPORTATION

- A construction traffic and parking management plan would be developed to maintain traffic flow and minimize vehicle trips.
- Deliveries of materials and equipment to the site would be limited to off-peak traffic congestion hours and would be spaced out sufficiently during each workday to minimize congestion at any given time.
- CR 34 would be properly maintained. Care would be taken to keep CR 34 and other roads free of mud and debris and to control speeds and congestion during construction.
- Erosion control logs would be avoided at curb inlets where the resulting flooding would impede traffic.

2.8.12.3 UTILITIES

- Closure of the 11 oil and gas wells on-site would be validated with the Texas Railroad Commission and TCEQ, as appropriate, and protocols would be established for lowering the existing well heads, if necessary.
- ConocoPhillips and CenterPoint Energy would be responsible for maintaining utility service during relocation of the pipelines and electric power line.

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3 AFFECTED ENVIRONMENT

3.1 Introduction

This section describes the affected environment relevant to the Proposed Action and alternatives. Alternative 2A and Alternative 2B are located within the same Project site for the Proposed Action. The Alternative 3 site is 2 miles west of the Project site, on the west side of the Brazos River. The Alternative 4 site is also located along the Brazos River, but approximately 13 miles south of the other alternatives near Lake Jackson.

The affected environment includes a description of existing conditions for each resource in and around the action alternatives, mainly within the Lower Brazos River area. The analysis area for each of the relevant resources may not be the same and is tied closely to the potential effects associated with implementation of the Proposed Action or alternatives. A description of the analysis area associated with each resource and by alternative as appropriate is provided.

3.2 Geology and Soils

The analysis area for geology and soils is the Project site (see Figure 1.1-2).

3.2.1 Topography

3.2.1.1 PROPOSED ACTION, ALTERNATIVE 2A, ALTERNATIVE 2B, ALTERNATIVE 3, AND ALTERNATIVE 4

Brazoria County is part of the Gulf Coastal Plain physiographic province (Bureau of Economic Geology 1996). A further subdivision of the Gulf Coastal Plain places the Project site in the Coastal Prairies sub-province (Figure 3.2-1). Specifically, the Coastal Prairies sub-province has a maximum elevation of 300 feet and a minimum elevation of 0 feet at mean sea level (MSL) (Bureau of Economic Geology 1996). Most of the terrain features in this sub-province are nearly flat grasslands with imperceptible slopes to the southeastern portion of the Coastal Prairies. The elevation range in Brazoria County varies from 144 feet MSL at Damon Mound in the northwest portion of the county to 0 feet MSL along the Gulf of Mexico (USGS 2013).

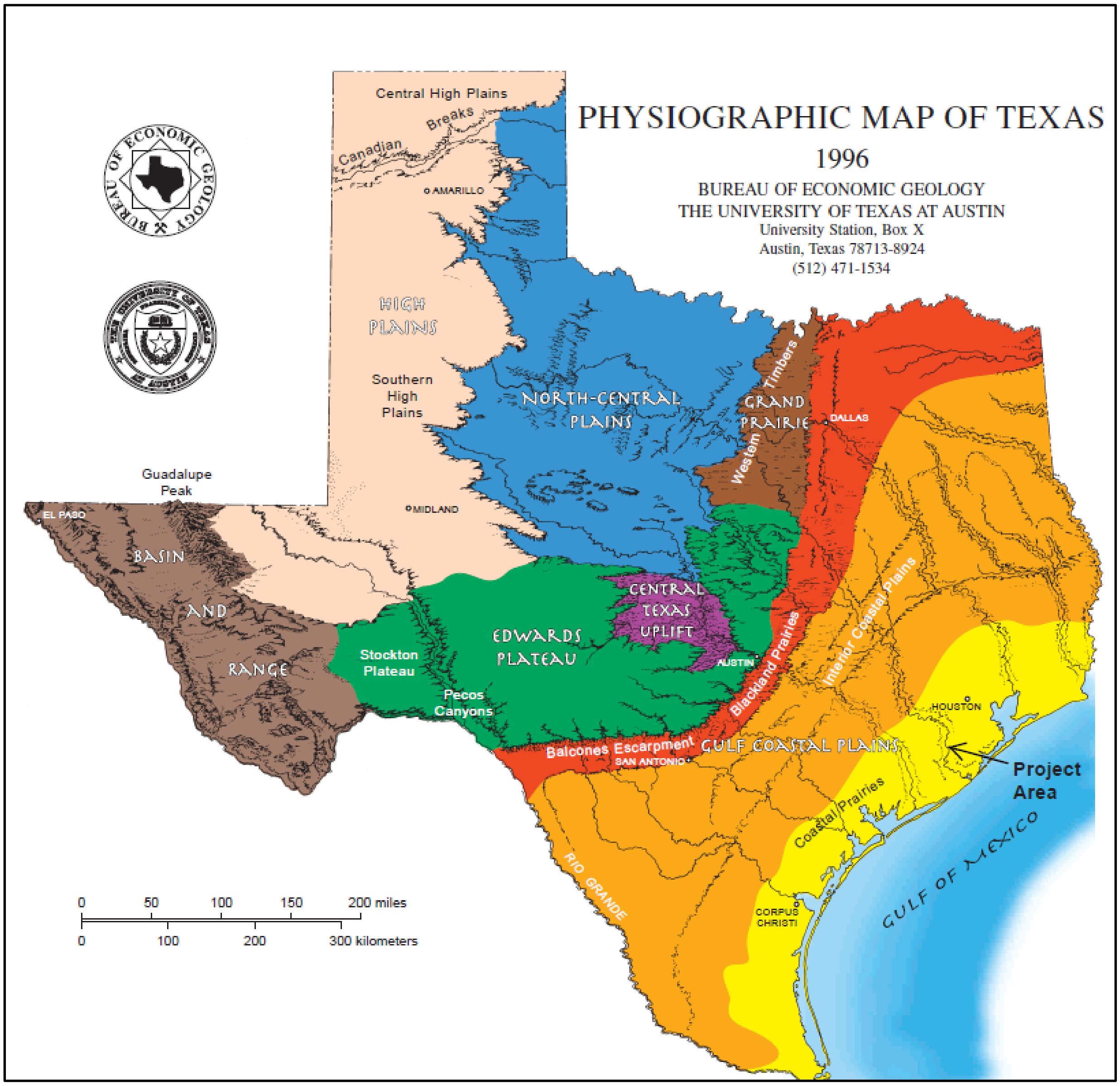

Figure 3.2-1. Physiographic map of Texas (Bureau of Economic Geology 1996).

Over geologic time, the Brazos River, Oyster Creek, and their associated tributaries have created broad, gently sloping channels rimmed by nearly flat plains. The lowest elevation in the Project site is 2 feet MSL at the Brazos River near the proposed pump station, and the highest elevation is 45 feet MSL along the existing Harris Reservoir's northern embankment.

3.2.1 Geology

3.2.1.1 PROPOSED ACTION, ALTERNATIVE 2A, ALTERNATIVE 2B

The Project site is underlain by the Beaumont Formation (Qb), which is overlain by Quaternary alluvium (Qal) deposits (Barnes 1982). The Beaumont Formation consists of barrier island and beach deposits composed of mostly clay, silts, and sands. The Beaumont Formation includes mainly stream channel, point bar, natural levee, and backswamp deposits, and to a lesser extent it contains coastal marsh and mud flat deposits. Concretions of calcium carbonate, iron oxide, and iron-manganese oxides are present in zone of weathering. The Beaumont Formation surface area, which is less than 30 feet in thickness, is almost featureless and characterized by relict river channels shown by meander patterns and pimple mounds on meander-belt ridges and is separated by areas of low, relatively smooth featureless backswamp deposits. Quaternary alluvium, which overlays the Beaumont Formation, is composed of point bars, natural levees, stream channels, backswamps, and narrow beach deposits that are composed of clay, silt, sand, and organic matter (Barnes 1982). There are no faults mapped in or near the Project site.

Oil and gas activity is present in Brazoria County. The Blue Lake Oil Field is immediately south-southeast of the existing Harris Reservoir (Barnes 1982). There are three underground ConocoPhillips pipelines within one corridor that cross the Project site (RRC 2021). Eleven oil and gas wells identified in the Project site limits have been plugged (Figure 3.2-2 and Table 3.2-1). Well site location #32120, is shown on Figure 3.2-2 as within the Project site, but according to the RRC, the permit was canceled and the well was never drilled. Additional dry holes have been drilled within the Project site. Field surveys have not found any indication that this well exists within the Project site.

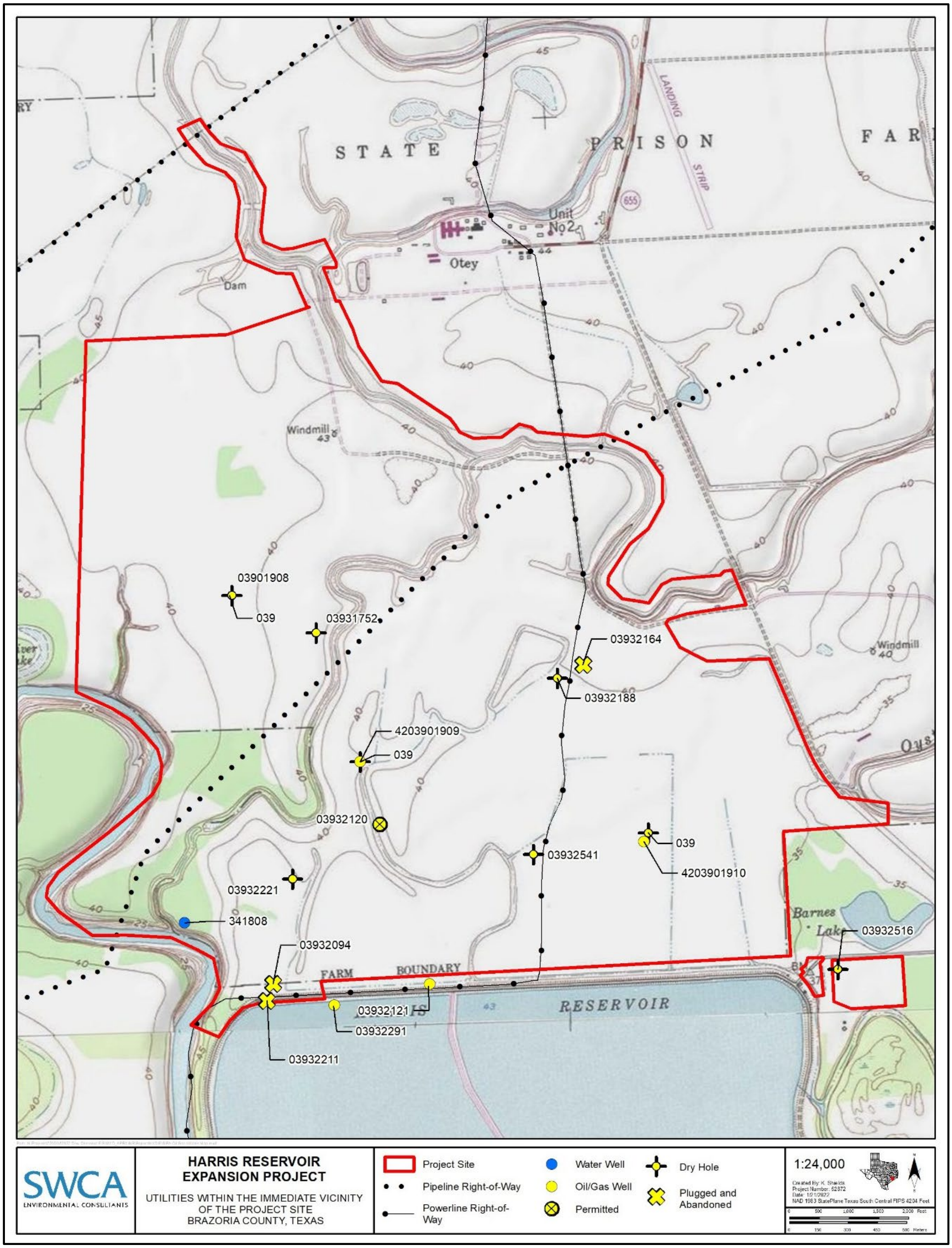

Figure 3.2-2. Oil and gas wells and pipelines in and near the Project site.

Table 3.2-1. Oil and Gas Wells within the Project Site

Well Number	Year Drilled	Well Depth	Type	Plug Date
API 03932094	1995	9,982	Oil	11-20-95
API 03932121	1986	9,900	Gas	7-12-91
API 03932211	1987	10,052	Gas	9-18-96
API 03932221	1987	10,179	Dry	10-1-87
API 03932291	1988	9,993	Gas	6-1-92
API 03932541	1995	10,228	Dry	5-16-95
API 39331752	1981	10,244	Dry	1-12-82
API 03932188	1987	10,200	Dry	5-21-87
API 039-1-1955	1955	10,200	Dry	6-8-55
API 039-1-1961	1961	9,876	Dry	1-19-62
API 039-1A-1962	1962	4,540	Dry	8-6-62

Source: RRC (2020)

3.2.1.2 ALTERNATIVE 3

The Alternative 3 site is underlain by the Beaumont Formation (Qb), which is the same formation as the Proposed Action Project site described above (Barnes 1982). There are no faults mapped in or near the Alternative 3 site limits.

There are two highly volatile liquid transmission lines, one natural gas gathering line, and one crude oil transmission line that cross Alternative 3 (RRC 2021). The current operators and status of the pipelines crossing the Alternative 3 site are summarized in Table 3.2-2 and displayed on Figure 3.2-3.

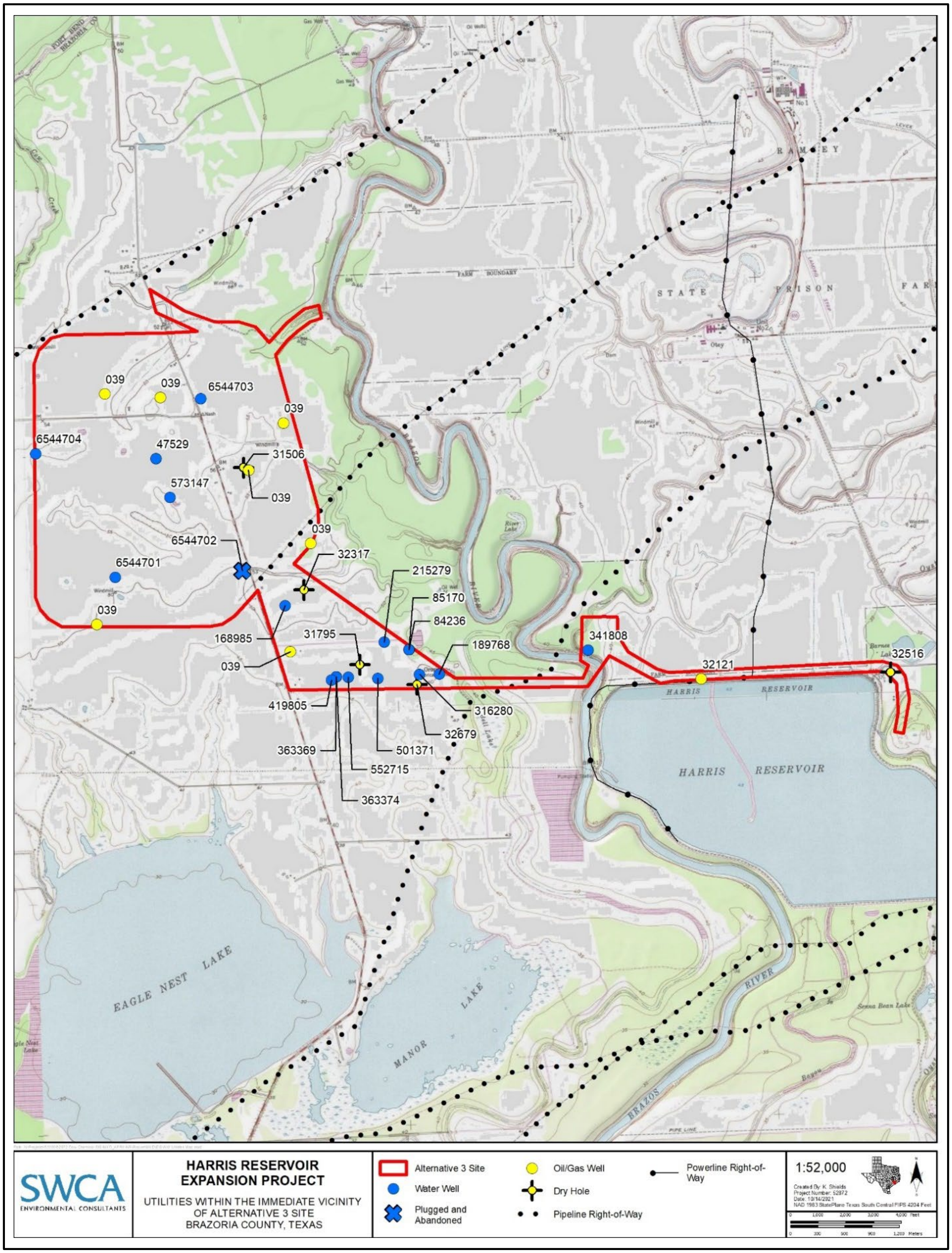

Figure 3.2-3. Oil and gas wells and pipelines in and near the Alternative 3 site.

Table 3.2-2. Oil and Gas Pipelines within Alternative 3

Type of Pipeline	Operator	Current Status
Highly Volatile Liquid Transmission Line	Phillips 66 Pipeline LLC	In service
Crude Oil Transmission Line	Enterprise Crude Pipeline LLC	In service
Natural Gas Gathering Line	Energy Transfer Company	In service
Highly Volatile Liquid Transmission Line	Enterprise Products Operating LLC	In service

Source: RRC (2021).

Ten oil and gas wells were identified in the Alternative 3 site (Table 3.2-3; see Figure 3.2-3). Of the 10 identified oil and gas wells, six do not have well plugging report illustrating the well depths or well plugging dates. The four dry holes identified with plugging depths and/or completed depths are summarized in Table 3.2-3.

Table 3.2-3. Oil and Gas Wells within Alternative 3

Well Number	Year Drilled	Well Depth	Type	Plug Date
API 03932679	Unknown	10,516	Dry	10-17-1999
API 03931795	Unknown	Unknown	Dry	03-17-1982
API 03932317	Unknown	9,912	Dry	11-12-1988
API 03931506	Unknown	Unknown	Dry	01-09-1980

Source: RRC (2021).

3.2.1.3 ALTERNATIVE 4

The Alternative 4 site is underlain by the Beaumont Formation (Qb), which is overlain by Quaternary alluvium (Qal) deposits (Barnes 1982). Descriptions of the Beaumont Formation (Qb) and Quaternary alluvium (Qal) deposits are provided under the Project Action and Alternative 2 section. There are no faults mapped in or near the Alternative 4 site.

A portion of the Alternative 4 site crosses through the Dow Chemical plant (Figure 3.2-4). Numerous highly volatile liquid transmission lines, refined liquid product transmission lines, natural gas transmission lines, and other gas transmission lines traverse through the Dow Chemical plant property and through the proposed Alternative 4 corridor (RRC 2021). The current operators and status of the pipelines crossing the Alternative 4 corridor are summarized in Table 3.2-4. The one oil and gas well within the Alternative 4 site (API 42039) is a dry hole (RRC 2021).

Figure 3.2-4. Oil and gas wells and pipelines in and near the Alternative 4 site.

Table 3.2-4. Oil and Gas Pipelines within Alternative 4

Type of Pipeline	Operator	Current Status
Refined Liquid Product Transmission Line	Equistar Chemicals, LP	In service
Highly Volatile Liquid Transmission Line	Phillips 66 Pipeline LLC	In service
Highly Volatile Liquid Transmission Line	Phillips 66 Pipeline LLC	In service
Highly Volatile Liquid Transmission Line	Chevron Pipeline Company	In service
Highly Volatile Liquid Transmission Line	Chevron Pipeline Company	In service
Crude Oil Transmission Line	Enterprise Crude Pipeline LLC	In service
Crude Oil Transmission Line	Texas Colt LLC	In service
Air Liquide Large Indust U.S. LP	Oxy Choc-Freeport-Phillips	In service
Highly Volatile Liquid Transmission Line	Phillips 66 Pipeline LLC	In service
Refined Liquid Product Transmission Line	Phillips 66 Pipeline LLC	In service
Natural Gas Transmission Line	Dow Pipeline Company	In service
Natural Gas Transmission Line	Dow Pipeline Company	In service
Natural Gas Transmission Line	Dow Pipeline Company	In service
Highly Volatile Liquid Transmission Line	Dow Pipeline Company	In service
Air Liquide Large Indust U.S. LP	South Texas Syngas System	In service
Refined Liquid Product Transmission Line	Dow Chemical Company	In service
Highly Volatile Liquid Transmission Line	Dow Chemical Company	In service
Other Gas Transmission Line	Dow Chemical Company	Abandoned
Highly Volatile Liquid Transmission Line	Dow Chemical Company	In service
Other Gas Transmission Line	Dow Chemical Company	In service
Highly Volatile Liquid Transmission Line	Dow Chemical Company	In service
Natural Gas Transmission Line	Energy Transfer Company	In service
Other Gas Transmission Line	Dow Chemical Company	In service
Highly Volatile Liquid Transmission Line	OQ Chemicals Corporation	In service
Highly Volatile Liquid Transmission Line	Enterprise Products Operating LLC	In service
Highly Volatile Liquid Transmission Line	Chevron Pipeline Company	In service
Highly Volatile Liquid Transmission Line	Equistar Chemicals, LP	In service

Source: RRC (2021).

3.2.2 Soils

3.2.2.1 PROPOSED ACTION, ALTERNATIVE 2A, AND ALTERNATIVE 2B

Soil descriptions for the Project site were obtained from the NRCS (NRCS 2019). The NRCS soil resource report references nine soil map units present in the Project site (Table 3.2-5, Figure 3.2-5).

Table 3.2-5. Summary of Soil Map Units in the Project Site

Soil Map Unit (map unit code)	Hydric Map Unit (yes or no)	Hydrologic Group	K-factor	T-factor	Prime Farmland (yes/no)	Acreage within Project Site*	Percentage of Project Site
Asa silty clay loam, 0% to 1% slopes, rarely flooded (3)	No	B	.28	5	Yes	15.1	0.6%
Brazoria clay, 0% to 1% slopes, rarely flooded (10)	No	D	.15	5	Yes	1,028.7	40.5%
Brazoria clay, 1% to 3% slopes, rarely flooded (11)	No	D	.17	5	Yes	70.2	2.8%
Clemville silty clay loam, 0% to 1% slopes, occasionally flooded (12)	No	C	.37	5	No	138.7	5.5%
Norwood loam, 0% to 1% slopes, rarely flooded (33)	No	B	.49	5	Yes	183.1	7.2%
Norwood silty loam 1% to 5% slopes, rarely flooded (34)	No	B	.49	5	Yes	115.4	4.6%
Norwood-Asa complex, 1% to 8% slopes, rarely flooded (35)	No	B	.37	5	No	132.3	5.2%
Pledger clay, 0% to 1% slopes, rarely flooded (36)	No	D	.17	5	Yes	776.5	30.7%
Churnabog clay, 0% to 1% slopes, frequently flooded, occasionally ponded (38)	Yes, hydric criteria 2, 3[†]	D	.15	5	No	12.8	0.5%
Total						**2,472.8**	**97.6% (remainder is water)**

Source: NRCS (2019a).

Notes: K- and T-factors = erosion factors, see Section 3.2.3.2.1

* Acreages were calculated using Esri ArcMap in July 2019 and rounded to the nearest 0.1 acre.

Hydric criteria 2 = somewhat poorly to very poorly drained soils that have a shallow water table (i.e., at a depth of less than 1 foot) during the growing season; 3 = soils that are frequently ponded for a long or very long duration during the growing season.

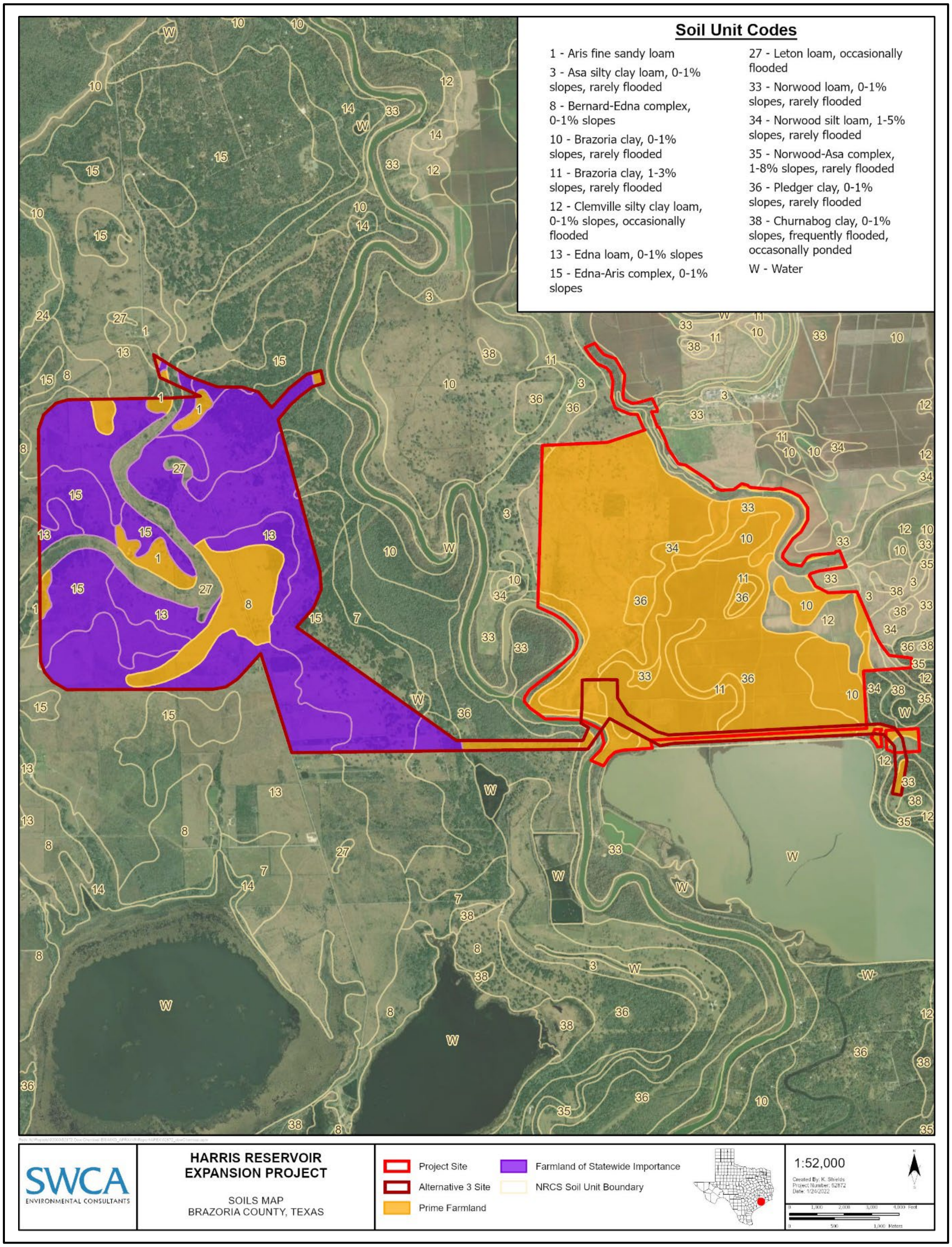

Figure 3.2-5. Soil units in and near the Project site and Alternative 3 site.

Soil texture is determined by the proportions of different-sized particles—sand, silt, and clay—found in a soil sample (NRCS 2020a). The soils in the Project site include clays and various loam combinations. The two predominant soil units are the Brazoria Clay (43.3%) and the Pledger Clay (30.7%) (see Table 3.2-5). These soils are moderately well drained, have very slow permeability, and feature clayey soils. These soils are rarely flooded, but because the largest component is clay, there is very high shrink-swell potential.

The soils in the Big Slough mitigation site are primarily (78.1%) Asa silt loam, 0% to 1% slopes, rarely flooded. These soils are well drained, have moderate permeability, and negligible runoff. These soils are on flats on flat coastal plains with slopes ranging from 0 to 1 percent and are rarely flooded. This soil series does not have a hydric soil rating.

3.2.2.2 ALTERNATIVE 3

The NRCS soil resource report references 11 soil map units present in Alternative 3 (NRCS 2019) (Table 3.2-6; see Figure 3.2-5).

Table 3.2-6. Summary of Soil Map Units in Alternative 3

Soil Map Unit (map unit code)	Hydric Map Unit (yes or no)	Hydrologic Group	K-factor	T-factor	Prime Farmland (yes/no)	Acreage within Alternative 3*	Percentage of Alternative 3
Aris fine sandy loam, 0% to 1% slopes (1)	No	C	.37	5	Yes (if drained)	99.5	3.4%
Bernard-Edna complex, 0% to 1% slopes (8)	No	D	.32	5	Yes	242.1	8.3%
Brazoria clay, 0% to 1% slopes, rarely flooded (10)	No	D	.15	5	Yes	32.6	1.1%
Clemville silty clay loam, 0% to 1% slopes, occasionally flooded (12)	No	C	.37	5	No	5.8	0.2%
Edna loam, 0% to 1% slopes (13)	No	D	.43	5	Yes	1,068.8	37%
Edna-Aris complex, 0% to 1% slopes (15)	No	D	.43	5	Yes	1,040.2	36%
Leton loam, occasionally flooded (27)	Yes	C/D	.43	5	No	235.4	0.8%
Norwood loam, 0% to 1% slopes, rarely flooded (33)	No	B	.49	5	Yes	22.9	0.7%
Norwood silty loam 1% to 5% slopes, rarely flooded (34)	No	B	.49	5	Yes	2.4	0.0%

Soil Map Unit (map unit code)	Hydric Map Unit (yes or no)	Hydrologic Group	K-factor	T-factor	Prime Farmland (yes/no)	Acreage within Alternative 3*	Percentage of Alternative 3
Norwood-Asa complex, 1% to 8% slopes, rarely flooded (35)	No	B	.37	5	No	3.2	0.1%
Pledger clay, 0% to 1% slopes, rarely flooded (36)	No	D	.17	5	Yes	124.9	4.3%
Total						**2,878.5**	**99.7% (remainder is water)**

Source: NRCS (2019a).

K- and T-factors = erosion factors, see Section 3.2.3.2.1

* Acreages were calculated using Esri ArcMap on July 2019 and rounded to the nearest 0.1 acre.

The soils in Alternative 3 include clays and various loam combinations. The two predominant soil units are the Edna loam (37%) and the Edna-Aris complex (36%) (see Table 3.2-6). These soils have a perched water table above a depth of 2 feet during most winter months. Under unusual weather conditions, some areas are flooded, which can cause a high shrink-swell potential.

3.2.2.3 ALTERNATIVE 4

The NRCS soil resource report references nine soil map units present in the Alternative 4 site (NRCS 2019) (Figure 3.2-6, Table 3.2-7).

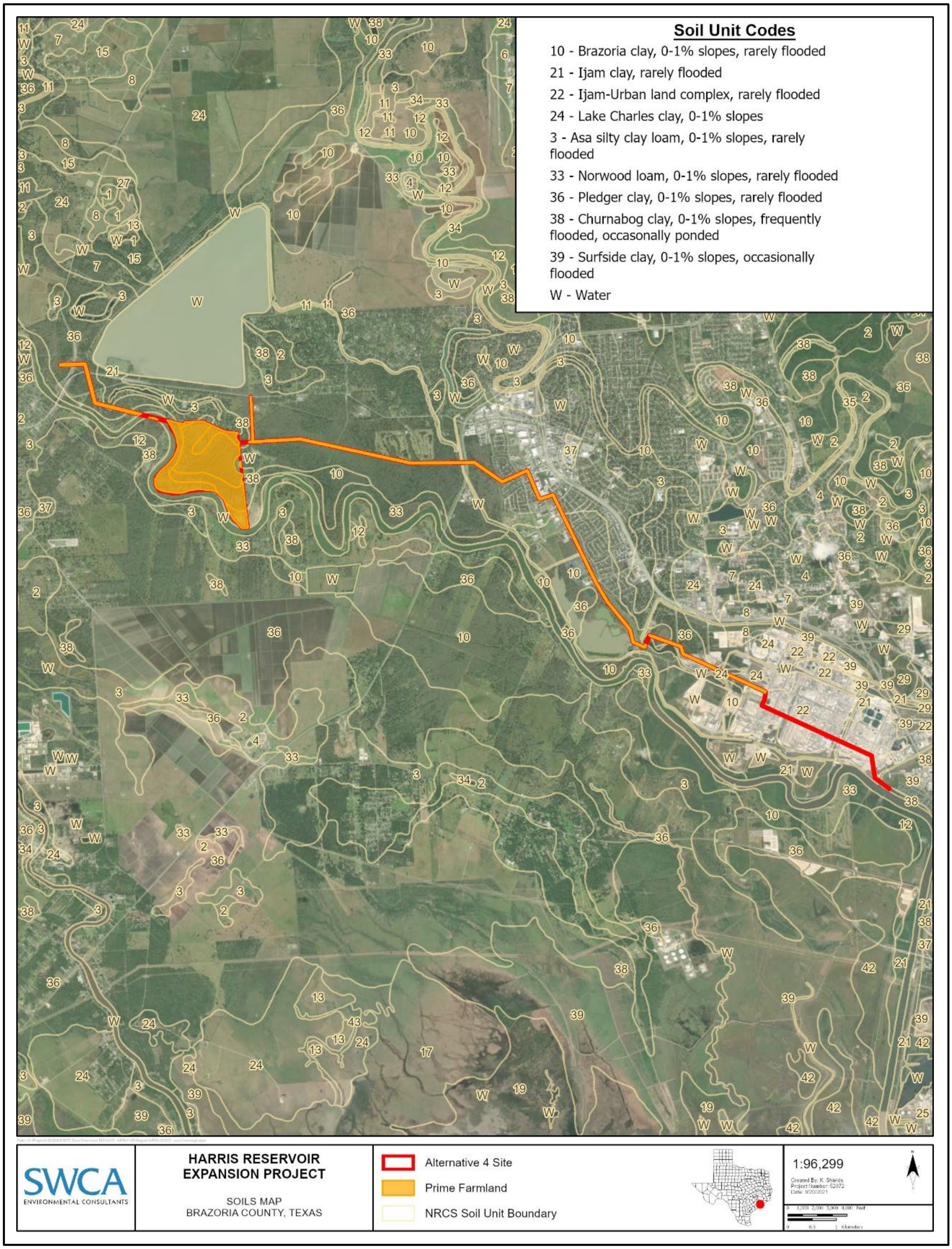

Figure 3.2-6. Soil units in and near the Alternative 4 site.

Table 3.2-7. Summary of Soil Map Units in Alternative 4

Soil Map Unit (map unit code)	Hydric Map Unit (yes or no)	Hydrologic Group	K-factor	T-factor	Prime Farmland (yes/no)	Acreage within Alternative 4*	Percentage of Alternative 4
Asa silty clay loam, 0% to 1% slopes, rarely flooded (3)	No	B	.28	5	Yes	51.8	7.3%
Brazoria clay, 0% to 1% slopes, rarely flooded (10)	No	D	.32	5	Yes	135.8	19.1%
Sievers-Ijam complex, 0% to 3% slopes, occasionally flooded, tidal (21)	No	C/D	.32	5	No	5.9	0.8%
Ijam-Urban land complex, rarely flooded (22)	Yes	D	.32	5	No	19.1	2.7%
Lake Charles clay, 0% to 1% slopes (24)	No	D	.32	5	Yes	7.4	1.0%
Norwood loam, 0% to 1% slopes, rarely flooded (33)	No	B	.43	5	Yes	134.0	18.9%
Pledger clay, 0% to 1% slopes, rarely flooded (36)	No	D	.32	5	Yes	348.4	49.2%
Churnabog clay, 0% to 1% slopes, frequently flooded, occasionally ponded (38)	Yes	C/D	.32	5	No	4.1	0.5%
Surfside clay, 0% to 1% slopes, occasionally flooded (39)	Yes	D	.32	5	No	0.5	0.0%
Total						**707.3**	**99.5% (remainder is water)**

Source: NRCS (2019a).

K- and T-factors = erosion factors, see Section 3.2.3.2.1

* Acreages were calculated using Esri ArcMap on July 2019 and rounded to the nearest 0.1 acre.

The soils in Alternative 4 include clays and various loam combinations. The predominant soil unit is the Pledger Clay (49.2%) (see Table 3.2-7). These soils are moderately well drained, have very slow permeability, and feature clayey soils. These soils are rarely flooded, but because the largest component is clay, there is very high shrink-swell potential.

3.2.2.1 HYDRIC SOILS

3.2.2.1.1 Proposed Action, Alternative 2A, and Alternative 2B

Hydric soils are formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper horizons (NRCS 2020b). The Churnabog component is classified as hydric (NRCS 2020b). The Churnabog clay 0% to 1% slopes, frequently flooded, occasionally ponded soil unit covers 12.8 acres (0.5%) of the Project site (see Table 3.2-5).

3.2.2.1.2 Alternative 3

One of the 11 map units identified in Alternative 3 is classified as hydric (NRCS 2020b) (see Table 3.2-6). The Leton loam, occasionally flooded soil unit covers 235.4 acres (0.8%) of Alternative 3.

3.2.2.1.3 Alternative 4

Three of the nine map units identified in Alternative 4 are classified as hydric (NRCS 2020b) (see Table 3.2-7). The Churnabog clay 0% to 1% slopes, frequently flooded, occasionally ponded soil unit covers 4.1 acres (0.5%), Ijam-Urban land complex, rarely flooded soil unit covers 19.1 acres (2.7%), and Surfside clay, 0% to 1% slopes, occasionally flooded soil unit covers 0.5 acre (0%) of Alternative 4.

3.2.2.2 PRIME FARMLAND SOILS

3.2.2.2.1 Proposed Action, Alternative 2A, and Alternative 2B

Prime Farmland is defined by the U.S. Department of Agriculture (USDA) in Title 430 – National Soil Survey Handbook Part 622.3 as "land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops that is available for these uses" (NRCS 2017).

Important characteristics of Prime Farmland include the right combinations of soil quality, growing season, and moisture supply. The soils should be permeable to both air and water and should not be excessively erodible or saturated with water for a long period of time. The soils should have favorable temperature, acceptable acidity or alkalinity, acceptable salt and sodium content, and few or no rocks (NRCS 2020c).

Of the nine soil map units present in the Project site, six are listed as Prime Farmland (NRCS 2019). Soils designated as Prime Farmland comprise 2,185.1 acres, which makes up 86.4% of the Project site (see Table 3.2-5). Approximately 80.6% of soils in the Big Slough mitigation site are also Prime Farmland.

Conversion of designated farmland to nonagricultural use may be regulated subject to the Farmland Protection Policy Act, enacted in 1994, to address conversion of farmland to nonagricultural uses by federally funded projects (NRCS 2020d). The program is administered by the NRCS through USDA regulations. Proposed federal actions that affect designated Prime Farmland or Unique Farmland could be subject to the Farmland Protection Policy Act.

3.2.2.2.2 Alternative 3

Of the 11 soil map units present in Alternative 3, eight are listed as Prime Farmland (NRCS 2019). Soils designated as Prime Farmland comprise 2,633.4 acres, which makes up 91.2% of Alternative 3 (see Table 3.2-6). As shown on Figure 3.2-5, some of these soils are categorized as Farmland of Statewide Importance. In Texas, all Farmland of Statewide Importance is considered Prime Farmland.

3.2.2.2.3 Alternative 4

Of the nine soil map units present in Alternative 4, five are listed as Prime Farmland (NRCS 2019). Soils designated as Prime Farmland comprise of 92.4% of Alternative 4 (see Table 3.2-7).

3.2.2.3 LAND SUBSIDENCE

3.2.2.3.1 Proposed Action, Alternative 2A, Alternative 2B, Alternative 3, and Alternative 4

Land subsidence is defined as the gradual settling or sudden sinking of the Earth's surface owing to subsurface movement of earth materials (USGS 2020a). Large-scale subsidence has occurred in Brazoria County since the 1900s. The extent of land-surface subsidence in Brazoria County was between 0.5 and 1.5 feet between 1943 and 1964 (Sandeen and Wesselman 1973). The Brazoria County Groundwater Conservation District (BCGCD) controls and prevents subsidence. The BCGCD has a map of projected subsidence through 2050 (BCGCD 2013). Subsidence in the Project site and alternative sites is estimated to be up to 1 foot by 2050, according to the BCGCD.

3.2.3 Sedimentation and Erosion

Sedimentation occurs when particles suspended in fluid settle out of the fluid and come to rest. Sedimentation is often the terminal end of the process of erosion and sediment transport. Settling is the falling of suspended particles through the liquid, whereas sedimentation is the termination of the settling process. In most environments, settling can be influenced by the presence or absence of vegetation or other controls to encourage settling of suspended particles and/or even final sedimentation.

Erosion is the process of soil particles being dislodged by natural forces such as wind or flowing water and being transported away from their original location to a new location, normally downwind or downslope. The potential for erosion and the rate in which soils may erode vary according to the soil types present, the existing topography and ground slopes, the presence of vegetation, ground substrates, and/or structures, and even human and/or wildlife influences.

Sedimentation by soil erosion has been an important factor that affects the morphological changes of riverbeds and water quality in river systems. The suspended sediments resulting from erosion can change the riverbed morphologically through the transport and settlement within the river system. The sediments, which accumulate on the riverbed or on the bottom of reservoirs, cause the inundation of a water system (river, stream, reservoir) by decreasing the cross-section area of river stream and the reduction of storage capacity of reservoirs. The sediments resulting from erosion are one of the leading sources of nonpoint source pollution. In particular, the deposition of fine silt and sands from nearby lands into river systems, including reservoirs, degrade the water quality by decreasing the depth of streams, increasing the turbidity, and increasing nutrient pollution. Although wind can be a factor in influencing erosion, it is the action of stormwater flows that has the greater impact on the effects of erosion.

3.2.3.1 REGULATORY SETTING

Section 402 of the CWA regulates the discharge of pollutants, including sediment, into WOUS through the National Pollutant Discharge Elimination System (NPDES) permit program, which was established in 1972. In 1998, TCEQ was authorized to administer the NPDES program at the state level through the Texas Pollutant Discharge Elimination System (TPDES) program. The TPDES program holds federal regulatory authority over discharges of pollutants to surface waters of the state of Texas except for oil and gas exploration and development. Under the TPDES program, TCEQ has issued requirements for minimizing stormwater pollution through issuance of general permits. Construction activities that disturb more than 1 acre of land are regulated under the TPDES Construction General Permit TXR150000 and are required to comply with the permit terms and conditions, including preparing a stormwater pollution prevention plan (SWPPP) to ensure that Project activities do not result in erosion issues or an exceedance of pollutant discharges. Projects that disturb 5 or more acres, such as the proposed Project, are considered large construction projects and require an implemented Project SWPPP, submittal of an NOI to TCEQ and any impacted municipal separate storm sewer system (MS4) operators, and a construction site notice to be posted on the construction site.

3.2.3.2 EROSION AND SEDIMENTATION POTENTIAL

3.2.3.2.1 Proposed Action, Alternative 2A, and Alternative 2B

The soil types present within the Project site are listed in Table 3.2-5. The characteristics of soil composition (clay, silt, sand, etc.) generally influence how the soils may be susceptible to erosion. In general, soils that contain high amounts of fine sand or silt can be easily eroded especially when ground slopes are increased (i.e., steepened), whereas clayey soils are generally less susceptible to erosion and hold together while wind or water passes over. Clayey soils make up nearly three-quarters of the Project site, whereas sand and silt soils make up the rest. To be more specific, three clayey soils, generally less susceptible to erosion, encompass approximately 74% of the Project site: Brazoria clay, 0% to 1% slopes (10), rarely flooded (40.5% of the area), Brazoria clay, 1% to 3% slopes (11), rarely flooded (2.8% of the area), and Pledger clay, 0% to 1% slopes, rarely flooded (36) (30.7%).

These three clayey soils are moderately well drained and exhibit a higher runoff potential when thoroughly wet (hydrologic soil group Class D). Hydrologic groups in the Project site, classified by the soil's runoff-producing characteristics, range from B to D (see Table 3.2-5). The erodibility value (K-factor) indicates the susceptibility of a soil to sheet and rill erosion by water. A soil's K-factor is one of six factors used in the Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and saturated hydraulic conductivity (Ksat). Values of K range from 0.02 to 0.69 (Streile et al. 1996). Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water. Brazoria clay has a K-factor of 0.15 and Pledger clay has K-factor of 0.17, indicating a low potential for soil erosion to occur with both soil types (see Table 3.2-5).

The T-factor is an estimate of the maximum average annual rate of soil erosion by wind and/or water that can occur without affecting crop productivity over a sustained period. Soils in the Project site have a T-factor of 5, indicating 5 tons per acre per year is lost to wind and/or water erosion (see Table 3.2-5). For reference, 5 tons a year would be roughly equivalent to a 5 × 5–foot container filled 43 inches deep with soil.

The hydrologic groups of the Project site soils range from B to D. Hydrologic groups are classified by a soil's runoff-producing characteristics. The two predominant soil units in the Project site are classified as D (i.e., clay soils and soils with high water table). Although these soils do not allow for efficient infiltration and do have runoff potential, they are not highly erodible with K-factors under 0.20.

Human-influenced sources of erosion and sedimentation in the Project site are associated with the primary land use, which is agriculture. Cover crops can control soil erosion off fields because root systems hold the soil from water erosion and the established vegetation cover reduces soil loss from wind.

3.2.3.2.2 Alternative 3

The soil types present within the Alternative 3 site are listed in Table 3.2-6. Loam soils make up nearly three-quarters of the Alternative 3 site, whereas sand and clay soils make up the rest. To be more specific, two loamy soils make up approximately 73% of the Alternative 3 site: Edna loam, 0% to 1% slopes (13) (37% of the area) and Edna-Aris complex, 0% to 1% slopes (15) (36%).

Both Edna loam and Edna-Aris has K-factor of 0.43, indicating a moderate to high potential for soil erosion to occur due to the high rate of runoff. Soils in the Alternative 3 site have a T-factor of 5, indicating 5 tons per acre per year is lost to wind and/or water erosion (see Table 3.2-6).

3.2.3.2.3 Alternative 4

The soil types present within the Alternative 4 site are listed in Table 3.2-7. Clay soils make up nearly three-quarters of the Alternative 4 site, whereas sand and loam soils make up the rest. To be more specific, two clay soils make up approximately 68% of the Alternative 4 site: Brazoria clay, 0 to 1 percent slopes, rarely flooded (10) (19.1% of the area) and Pledger clay, 0 to 1 percent slopes, rarely flooded (36) (49.2%).

Both Brazoria clay and Pledger clay have a K-factor of 0.32, indicating a moderate potential for soil erosion to occur with both soil types. Soils in the Alternative 4 site have a T-factor of 5, indicating 5 tons per acre per year is lost to wind and/or water erosion (see Table 3.2-7)

3.2.3.3 BRAZOS RIVER

3.2.3.3.1 Proposed Action, Alternative 2A, Alternative 2B, and Alternative 3

The reach of the Brazos River adjacent to the Project site and the Alternative 3 site is a “C” type stream (Rosgen 1996). “C” stream types are typically found in narrow to wide valleys and are constructed from alluvial deposition (Rosgen 1996). “C” type channels have a well-developed floodplain and are relatively sinuous with a channel slope of 2% or less and a bedform morphology indicative of a riffle/pool configuration. The primary morphological features of a “C” stream type are the sinuous, low-relief channel; the well-developed floodplains built by the river; and characteristic “point bars” within the active channel.

A review of aerial imagery indicates possible erosion along the bank of the Brazos River in the southwest corner of the Project site as shown in Figure 3.2-7. This outer bend is just north of the existing Harris Reservoir (see Figure 3.2-7). In the aerial image, there appears to be the formation of a point bar and cut bank. A site visit was not conducted to confirm the suspected erosion at this specific location on the Brazos River. Multiple factors can contribute to this type of potential erosion: storms, upstream flooding, land use, lack of stream management, and over clearing of streambank vegetation.

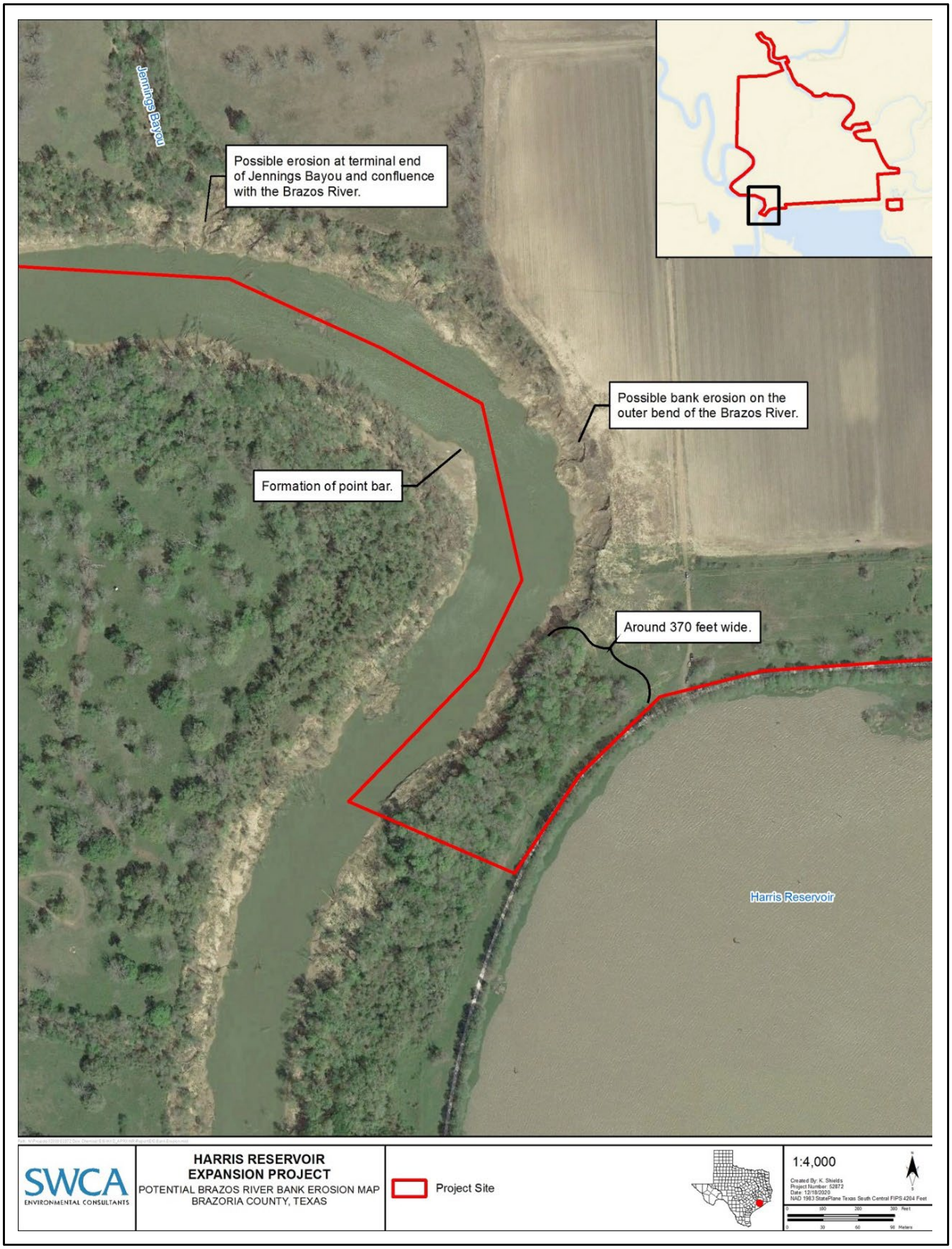

Figure 3.2-7. Potential Brazos River bank erosion.

The formation of a point bar indicates that the river is meandering. A point bar is a depositional feature that accumulates on the inside bend of streams and rivers. Point bar establishment typically occurs and is associated with a cut bank, the outside bank of a stream or river. Cut banks are usually vertical, unstable, and lack vegetation. Cut banks are found in abundance along mature or meandering streams. They are located on the *outside* of a stream bend, known as a meander, opposite the slip-off slope on the inside of the bend. They are shaped much like a small cliff and are formed by the erosion of soil as the stream collides with the riverbank. As opposed to a point bar, which is an area of deposition, a cut bank is an area of erosion.

3.2.3.3.2 Alternative 4

This alternative is similar to the Proposed Action as the Alternative 4 site is located adjacent to the Brazos River, but approximately 13 miles (23 river miles) south of the Proposed Action Project site. A review of aerial imagery indicates the vegetated banks with possible erosion are present at the Alternative 4 site along the western bank of the Brazos River.

3.2.3.4 OYSTER CREEK

3.2.3.4.1 Proposed Action, Alternative 2A, and Alternative 2B

The reach of Oyster Creek in the Project site is located within a Balley Type X, which are areas with slight elevation that are constructed from alluvial materials (Rosgen 1996). Based on *Geomorphic Assessment of Oyster Creek* (Jacobs 2019a), Oyster Creek is a “B” (northern section) and “C” stream type. “B” type streams are moderately entrenched and have low channel sinuosity (Rosgen 1996). The bedform morphology can produce scour pools and rapids. “C” stream types are typically found in very wide valleys and “C” type channels have a well-developed floodplain and are relatively sinuous with a channel slope of 2% or less and a bedform morphology indicative of a riffle/pool configuration. The primary morphological features of a “C” stream type are the sinuous, low-relief channel; the well-developed floodplains built by the river; and characteristic “point bars” within the active channel.

3.2.3.4.2 Alternative 3 and Alternative 4

For Alternative 3, water would be piped south for the proposed reservoir and across the Brazos River (affixed to a bridge deck) to an existing open channel along the north and east sides of the existing Harris Reservoir. The existing channel would be modified by increasing the width to 20 feet and depth to 4 feet to accommodate the increased flows. The outlet from the existing Harris Reservoir into Oyster Creek would be modified for the increased discharge. Alternative 4 would use a 72-inch diameter pipeline to convey desalinated water from the desalination plant to Dow’s Freeport facility and would not convey water into Oyster Creek.

3.3 Water Resources

The Project site and alternatives are located within the San Jacinto-Brazos Coastal Basin and abuts the Brazos River Basin along its western perimeter (TPWD 2013; TWDB 2020a) (Figure 3.3-1). The San Jacinto-Brazos Coastal Basin is named according to major river basins that bound it (i.e., the San Jacinto River Basin and the Brazos River Basin). The San Jacinto River Basin is a small river basin that supplies surface waters and groundwater to the Houston metropolitan area (TWDB 2019). The Brazos River, which flows along the western border of the Project site, is associated with the Brazos River Basin, which is the second largest river basin in Texas. Surface water demands are increasing in the upper portion of the basin with decreasing availability of groundwater resources (TWDB 2019). The Project site and alternatives are located within two 8-digit hydrologic unit codes (HUCs) which are the Austin-Oyster Creek (12040205) and Lower Brazos (12070104) (USGS and NRCS 2013). The Project site is bordered by Harris Reservoir to the south and Oyster Creek to the northeast. Oyster Creek receives water from the Brazos River via a diversion dam at Flat Bank Creek and Harris Reservoir and from overland sheet flow, seepage around dams, and treated wastewater effluent (Linam and Kleinsasser 1987).

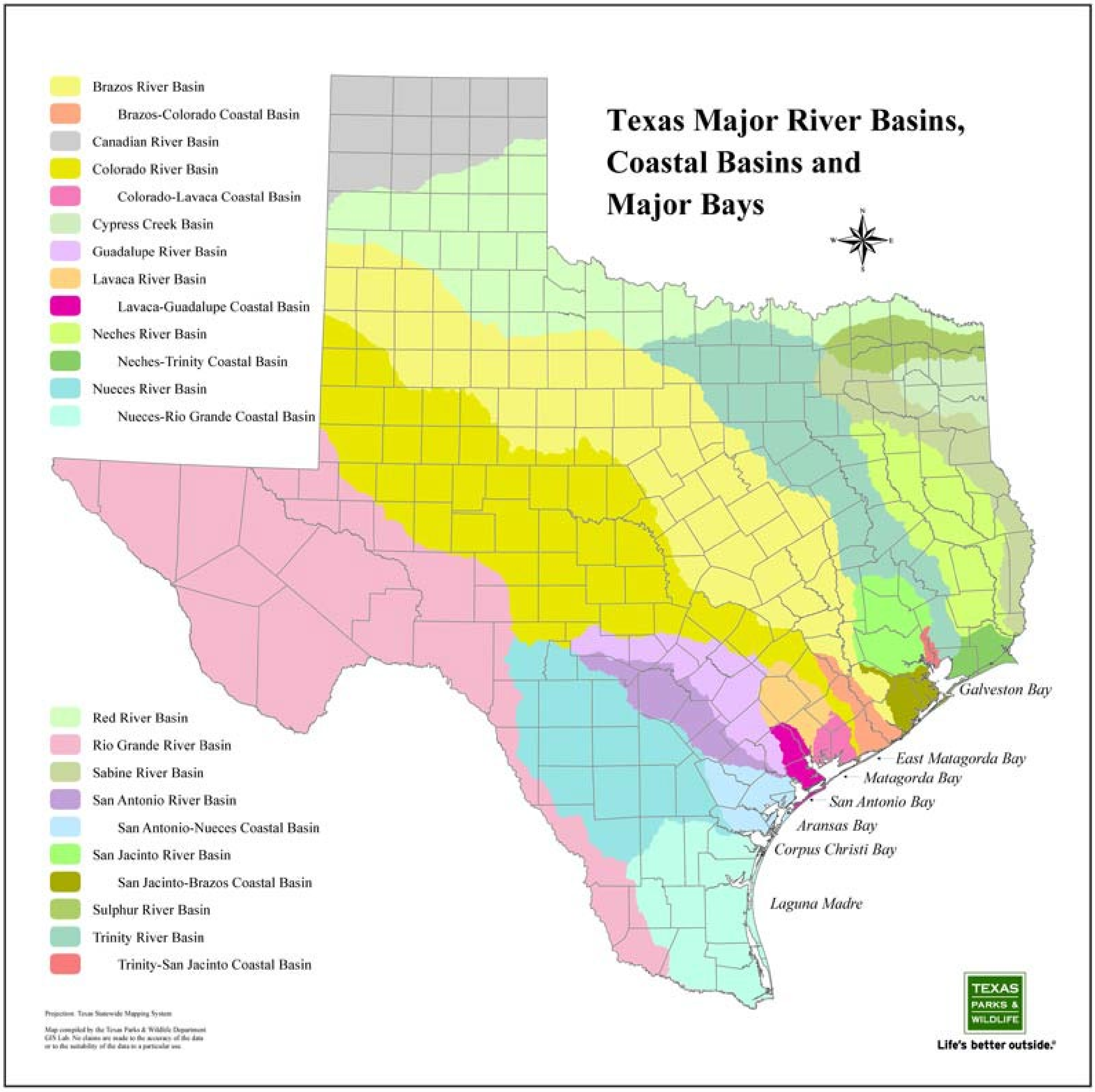

Figure 3.3-1. Texas major river basins, coastal basins, and major bays (TPWD 2013).

3.3.1 Surface Water

The Project site is between the Brazos River to the west, Oyster Creek to the east, and the existing Harris Reservoir to the south (Figure 3.3-2). The Brazos River and Oyster Creek both flow from north to south and outfall to the Texas Gulf Coast; the Oyster Creek outfall is east of Freeport, and the Brazos River is west of Freeport, Texas (see Figure 3.3-2). The existing Harris Reservoir draws water pumped from the Brazos River then releases that water at the outfall on the southeast corner of the reservoir by gravity flow to Oyster Creek (Texas State Historical Association 2010). See Section 1.3.3 for a description of current reservoir operations.

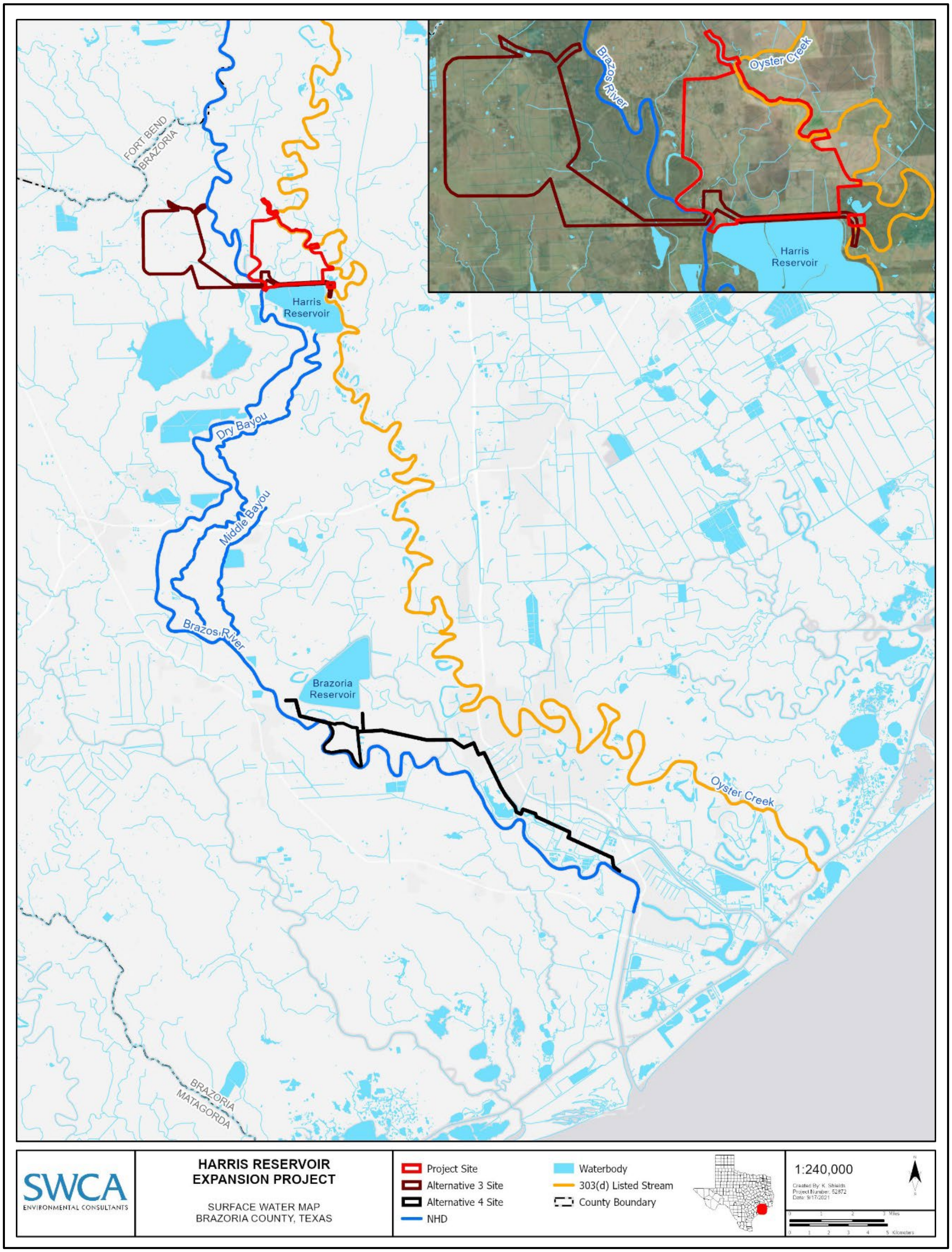

Figure 3.3-2. Surface water features in and near the Project site and alternatives.

3.3.1.1 REGULATORY SETTING

Federal, state, and local entities regulate surface waters within the Project site. At the federal level, FEMA regulates the flows in rivers and streams to the extent that they impact development in the associated floodplains, as discussed in Section 3.3.2. The Corps regulates activities that affect the course, location, and condition of WOUS (discussed in Section 3.3.4). At the state level, TCEQ protects surface water quality through regulating discharges of pollutants into regulated waters (discussed in Section 3.3.1). At the local level, Brazoria County requires hydraulic modeling to show that downstream properties will not be impacted (Brazoria County 2020; Forister 2017). Attaining a No-Rise Certification is one way to confirm that properties located downstream of proposed development will not be impacted (Brazoria County 2020). Brazoria County also requires demonstration that properties upstream will not be impacted by flooding as a result of proposed development. A proposed development must address potential for creating erosion (termed hydromodification) downstream of the proposed development project. This often occurs when there are increases in peak flows (similar to the crest of flood event) or in total flows when the peak flow is unaffected.

3.3.1.2 WATERSHED CHARACTERISTICS AND CLIMATE

3.3.1.2.1 Proposed Action, Alternative 2A, Alternative 2B, Alternative 3, and Alternative 4

Brazoria County is in the Gulf Coastal Plain area of Texas, which covers east Texas gradually rising from the Gulf of Mexico inland to elevations of 600 to 700 feet. The Gulf Coastal Plain area is covered with marshes, flat flood-prone areas, farmland, prairies, estuaries and bayous, and sandy beaches. The Project site is along the Brazos River, the second largest watershed (river basin) by area in Texas (TWDB 2020a). The Brazos River watershed starts 50 miles west of the Texas-New Mexico border and runs approximately 1,050 miles to the Gulf of Mexico (see Figure 3.3-1). The Brazos River watershed generally runs northwest to southeast with the headwaters in New Mexico and discharges to the Gulf of Mexico near Freeport, Texas (Figure 3.3-3).

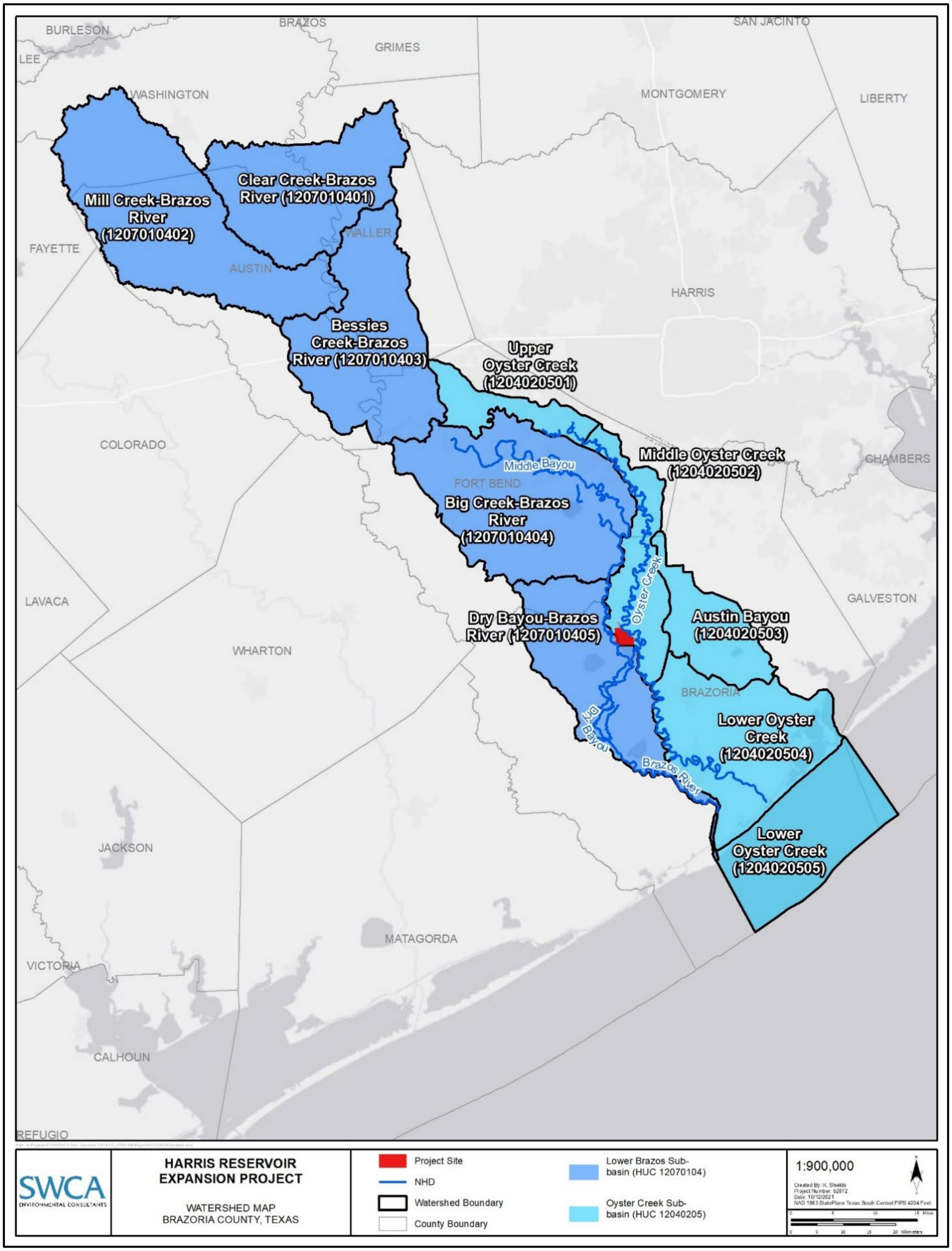

Figure 3.3-3. Brazos River and Oyster Creek watersheds.

The Brazos River has the largest average annual flow of any river in Texas. The Brazos River flow is primarily supplied through precipitation, with many creeks and streams along the mainstem of the river. The upper basin was historically underused for withdrawals for irrigation, livestock water, and other agricultural purposes until recently with the decline in groundwater supplies in the region, in particular the overuse of the Ogallala Aquifer (TWDB 2020a). This decline led to decreasing supplies farther downstream in the more populated areas of the basin, especially during low rainfall and drought years. The Brazos River is a highly managed and regulated river system with three BRA reservoirs, eight Corps flood-control dams, and numerous other large to small impoundments. There are more than 1,200 adjudicated water rights in the Lower Brazos River. Dow is a potable water supplier for industries and municipal users near their facility in Freeport, Texas.

The climate in the Brazos River watershed is characterized by hot humid summers and mild winters. The area receives approximately 50 inches of rainfall and little to no snow but is susceptible to tropical storms and hurricanes from the Gulf of Mexico. Coastal plain streams are subject to flooding from both storm systems coming over land from the western United States and from tropical storms and hurricanes coming from the Atlantic Ocean and entering the Gulf of Mexico from the east. The storms coming from the western United States use the Gulf of Mexico moisture source to generate precipitation events or rainfall, which can be large at times. The tropical storms and hurricanes use the same Gulf of Mexico moisture source when the water is at its seasonal warmest as well to produce large rainfall and storm surges from the high winds pushing seawater onto the shore that accompany these storms.

The Corps has developed Climate Hydrology and Watershed Vulnerability models to understand changes in rainfall and temperature, among other climate predictors. The Corps Region 12 (Texas-Gulf Region), which covers current climate and hydrology literature for the Project site, predicts that seasonal precipitation is expected to decrease slightly with warmer annual temperatures, although intense rainfall events may increase in frequency (Figure 3.3-4). This means that mean annual rainfall may decrease while the variance from increases year to year.

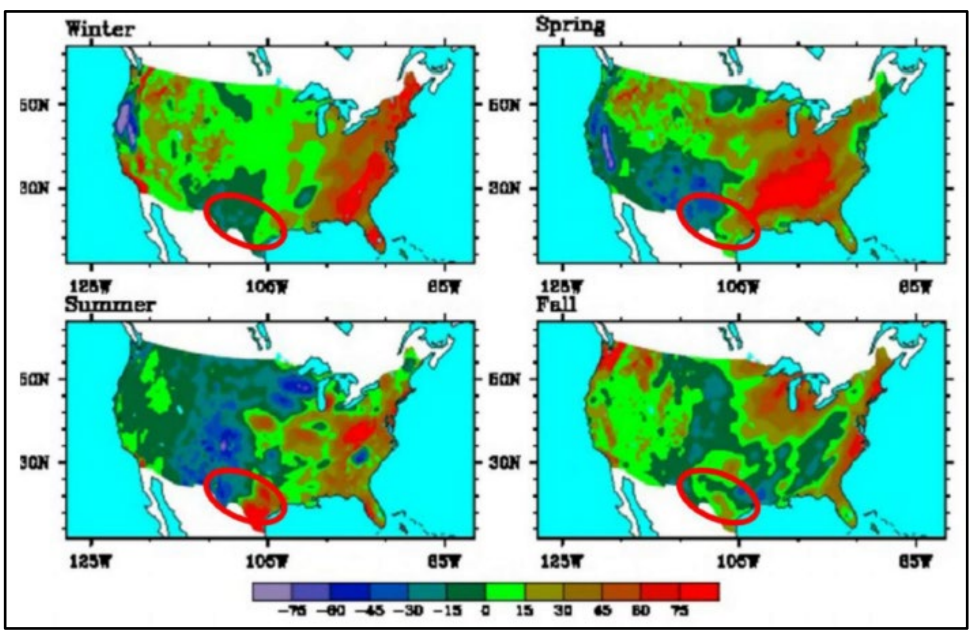

Figure 3.3-4. Projected changes in seasonal precipitation, 2,085 vs. 1,985 millimeters (USACE 2015). Texas region circled with red oval.

Although a slight decrease in precipitation is predicted in southern Texas, projections of future precipitation change are especially uncertain in this region because it is located in a transition zone between projected drier conditions to the south and projected wetter conditions to the north, which could have mixed effects on river flows at the Project site. Because of these uncertainties, the assumption that future precipitation in the region will be roughly similar to past precipitation appears to be accurate.

3.3.1.3 WATER QUALITY

3.3.1.3.1 Proposed Action, Alternative 2A, Alternative 2B, Alternative 3, and Alternative 4

Water quality describes the chemical and physical composition of water as affected by natural conditions and human activities. Water resource regulations focus on the right to use water and protection of water quality. The principal federal law enforced by the EPA to protect water quality is the CWA. The CWA provides protection of surface water quality through regulating discharges of pollutants into regulated waters. Regulation of wetlands and WOUS is discussed in Section 3.3.4.

Some provisions of the CWA are delegated to the state level and regulated through TCEQ and include Section 401 and Section 402. Section 401 Water Quality Certification is used to verify and/or waive compliance with water quality requirements. CWA Section 402, the NPDES program, regulates point (industrial) and nonpoint (stormwater) sources of pollutants. Because the NPDES is delegated to the state level for regulation and overseeing compliance, construction and operation activities are permitted under the delegated state program, the TPDES.

CWA Section 303(d) and CWA Section 305(b) require states to identify and develop a list of surface waters (rivers, streams, creeks, reservoirs, lakes, etc.) within the state that exceed current water quality standards. In compliance with these two sections of the CWA, TCEQ issues the *Texas Integrated Report of Surface Water Quality for the Clean Water Act Sections 305(b) and 303(d)* (TCEQ integrated surface water quality report) (TCEQ 2020a) every 2 years, which evaluates historical and current surface water quality data to identify impaired surface waters and their associated pollutants that exceed the current water quality standards. Depending on the impairment and the assigned category,[4] some pollutants may require a plan for total maximum daily loads (TMDL) to assist with restoring a degraded surface water to the regulated water quality standards.

The BRA manages and protects the water resources within the Brazos River Basin (BRA 2019b). The Houston-Galveston Area Council (HGAC) is working toward a bacteria reduction project in partnership with community organizations and local governments located within the San Jacinto-Brazos Coastal Basin (HGAC 2019a). Currently, these authorities do not have an established water protection plan for any of the identified waterbodies within the Project site (BRA 2019b; HGAC 2019a).

To establish the existing conditions for analysis of water quality for the Project, the water quality analysis area is defined as the area north of the existing Harris Reservoir and area north of the proposed reservoir, the adjacent Brazos River and Oyster Creek and their downstream reaches to Lake Jackson (see Figure 3.3-2). Dry Bayou, located immediately south of the Project site and Middle Bayou, located south of Griffith Reservoir, were also included in the analysis. The water quality analysis area is influenced by upstream activities that affect existing water quality within the Brazos River and Oyster Creek (Texas State Historical Association 2010). Water quality within the analysis area is affected by multiple factors

[4] Category 4: water quality standard does not require development of a TMDL. Category 5a: TMDL standards are underway, scheduled, or will be schedule for one or more parameters. Category 5b: Review of parameter standards will be conducted before management strategy is selected or water quality standards are revised. Category 5c: Additional data required before a management strategy is selected.

such as agricultural runoff and return flows, natural runoff, grazing, ground-disturbing activities (e.g., construction, agricultural, recreational), urbanization and population growth, flooding, groundwater withdrawals, and operations of flow-regulating facilities (i.e., the Sienna Plantation stormwater reservoir regulates flow because it removes 63% of the Oyster Creek flows and moves them to Brazos River).

Review of the 2020 TCEQ integrated surface water quality report (TCEQ 2020a) and the TCEQ surface water quality viewer (TCEQ 2020b) identified the following monitored waterbody segments bordering the Project site:

- Brazos River below Navasota River (Segment ID 1202): A freshwater stream located within the Brazos River Basin from a point approximately 328 feet upstream of SH 332 in Brazoria County to the confluence of the Navasota River in Grimes County. This segment was previously listed as an impaired waterway for bacteria, Category 5c, in 2018 303(d) list (TCEQ 2019a) but is no longer listed in the 2020 303(d) list (TCEQ 2020a).
- Brazos River Tidal (Segment ID 1201): A tidal stream located within the Brazos River Basin from the confluence of the Gulf of Mexico in Brazoria County to a point 330 feet upstream of SH 332 in Brazoria County. This segment is not listed as an impaired waterway on the 2020 303(d) list (TCEQ 2020a).
- Oyster Creek above tidal (Segment ID 1110): A freshwater stream located within the San Jancinto-Brazos Coastal Basin from a point approximately 328 feet upstream of FM 2004 in Brazoria County to a point approximately 2.7 miles upstream of Scanlan Road in Fort Bend County (see Figure 3.3-2). This segment has been listed as an impaired waterway for bacteria, Category 5a, since 2006 and for depressed dissolved oxygen2, Category 5c, since 1996 (TCEQ 2020a). Currently TMDLs have not been adopted for this segment (TCEQ 2020a). However, Assessment Unit ID 1110_02 (which occurs within the Proposed Action and Alternative 2) is not classified as impaired waterway on the 2020 303(d) list (TCEQ 2020a). This segment classification may be due to the release of water from the existing Harris Reservoir. This segment is found from Styles Bayou upstream to an unnamed tributary 1.8 miles downstream of FM 1462.

The existing Harris Reservoir, Dry Bayou, and Middle Bayou are not currently monitored by TCEQ and do not have an identified impairment in the TCEQ integrated report (TCEQ 2020a).

3.3.1.4 SYSTEM FLOWS

3.3.1.4.1 Proposed Action, Alternative 2A, Alternative 2B, Alternative 3, and Alternative 4

Hydrology is the movement of water through the water cycle, and hydraulics refers to how water moves through a specific location such as a river, stream, or channel. Floodplains are hydrologically and hydraulically connected to adjacent channels. The floodplain provides many beneficial functions, including water storage and dissipation of water velocities during flood events. Development within these areas can result in loss of life or property when flooding occurs.

Brazos River discharges are dominated by upstream riverine processes such as erosion, sedimentation transport, and deposition rather than precipitation-induced discharges locally in the coastal plain. This is typical of systems with large drainage areas such as the Brazos River that increase the travel time of flows. As discussed above, the upper basin of the Texas panhandle was historically underused as a water supply until recently. The recent increasing demand on surface water resources in the upper basin has occurred concurrently with decreases in groundwater supplies, particularly in the Ogallala Aquifer, which historically supplied most of the water in that region (TWDB 2020a).

Increase water supply demand in the region has resulted in a decrease in available water supply downstream in the more populated areas of the basin, especially during low rainfall and drought years. Localized heavy rainfall most typically occurs as a major storm event, e.g., the recent Memorial Day Flood (2015), Tax Day Flood (2016), and Hurricane Harvey (2017). In comparison, a multi-year drought began throughout Texas in 2005, with 2011 being the driest year on record in Texas. By October 2011, 97% of the state was in extreme or exceptional drought conditions. During this drought period, flows in the river were significantly lower than during average conditions.

Most of Brazos River flows originate farther up in the watershed near its headwaters close to the New Mexico border; this results in delayed peak flows and flood crests of days to even weeks in relation to the precipitation-causing event (BRA 2021a; Nelson 2015). The Gulf Coastal Plain is a low-lying and flat terrain with a common 0.5-foot drop in elevation per river mile. A USGS gage on the Brazos River upstream of the Project site (USGS 08116650 [Brazos River near Rosharon, Texas]) shows the flow time series fluctuates significantly in a relatively short period of time (Figure 3.3-5). Historical records show that daily flows within 1 month can go from 800 cfs to more than 100,000 cfs and back again within the next month.

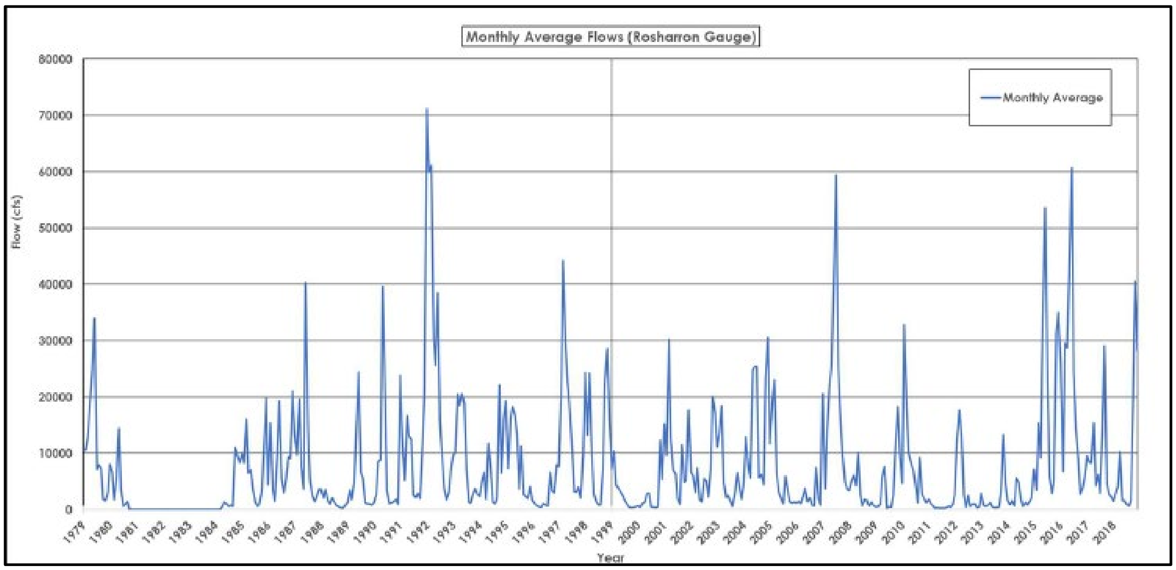

Figure 3.3-5. Monthly average flows, USGS 08116650 (Brazos River near Rosharon, Texas) (USGS 2020b).

The comparison of these data shows that over the entire period of record, the monthly mean peak discharge attenuates downstream (Figure 3.3-6). This results in a decrease in flow velocity as the channel and floodplain expand downstream of USGS 08116650. This is demonstrated by the maximum monthly mean discharge drops from 14,200 to 12,400 cfs in May (USGS 2020b). Attenuation is expected in the lower sections of the Brazos River as the high flows enter the wide floodplain where they are temporarily stored. The peak discharges are then released back into the river over longer periods of time instead of immediately if the floodplain storage was unavailable. Lower flows that occur during November, December, January, February, March, April, June, July, and September increase in the downstream reach (USGS 2020b). June has the highest monthly average discharge on the Brazos River (USGS 2020b).

Historic sediment loads for the Brazos River have decreased for particles larger than sand (e.g., gravel and cobble) and have increased overall for sand and smaller particles (Fields 1988). The decrease in larger particles is the result of the upper reaches of the Brazos River watershed being highly controlled by Corps facilities. Larger particles settle out in the reservoirs and reduce large flood flows with high velocities that can transport larger particles. The reduced sediment load can increase the amount of sediment picked up and carried downstream with a corresponding reduction in the amount of sedimentation, which results in steep-sided channels (incised), loss of sinuosity (bends in the creek or river), and undercut banks.

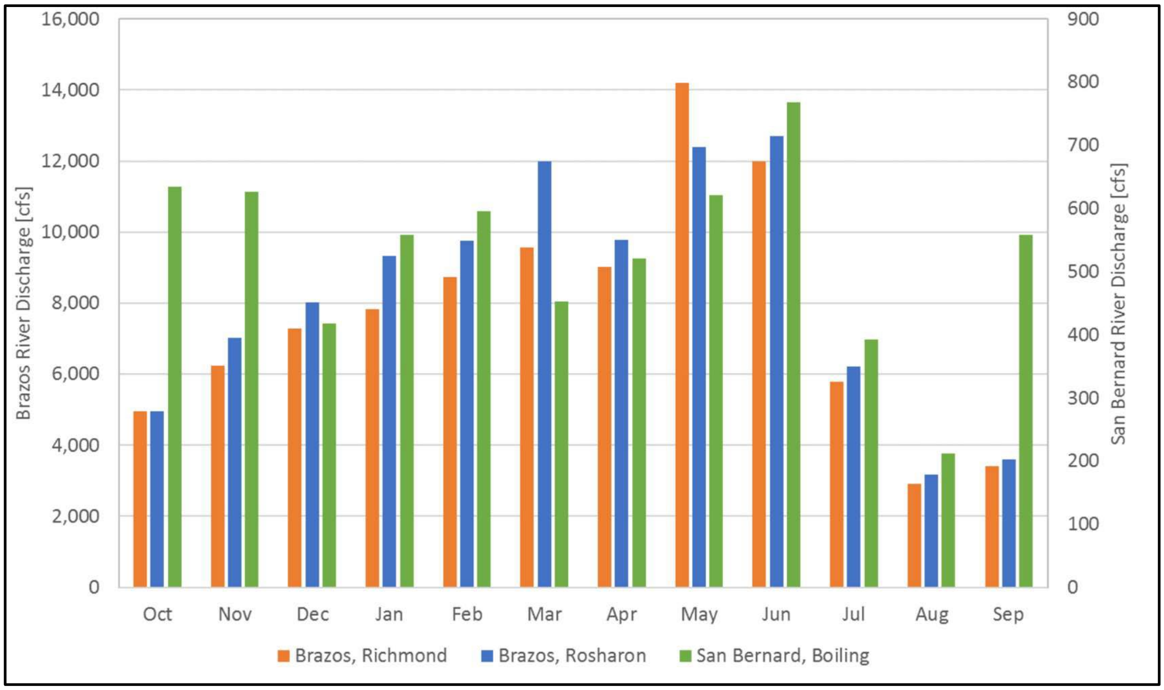

Figure 3.3-6. Long-term monthly mean streamflow discharge at three USGS gages: Brazos River near Richmond (upstream in blue), Brazos River near Rosharon (downstream in red), and San Bernard River near Boling. Data are shown in water year from October 1 to September 30.

The estuary and associated brackish water, referred to locally as the salt wedge, comprises salinity levels of 500 mg/L or higher of chloride. The estuary typically runs from River Mile 15 to River Mile 43, with the potential to reach River Mile 49 upstream of the Project site (Watearth 2020). Sea level rise anticipated over the next 50 years is likely to push the leading edge of the salt wedge farther upstream and maintain that position farther upstream. The fluctuations in location of the salt wedge require operational changes for management of the existing reservoirs to minimize drawing high salt content water into the reservoirs.

3.3.1.4.2 Brazos River Near Project Site

Proposed Action, Alternative 2A, Alternative 2B, Alternative 3, and Alternative 4

Brazos River flows at the Project site are the result of precipitation that occurs in the upper watershed. Because the Brazos River watershed covers a large portion of the region, climate precipitation predictions and resulting peak flows near the Project site are anticipated to be similar to those at the regional level.

Dow's currently diverts approximately 162,000 AF of water per from the 42,865 square mile Brazos River watershed which has an average runoff volume of 6,074,000 AF per year (TWDB 2020a). The Lower Brazos River subwatershed, which includes the Project site, is approximately 9,766 square miles. Although there are no major structures that control the river flow in the Lower Brazos River, the river system is highly managed for water rights and flood control through the use of off-channel reservoirs, weirs, and other diversions (Figure 3.3-7).

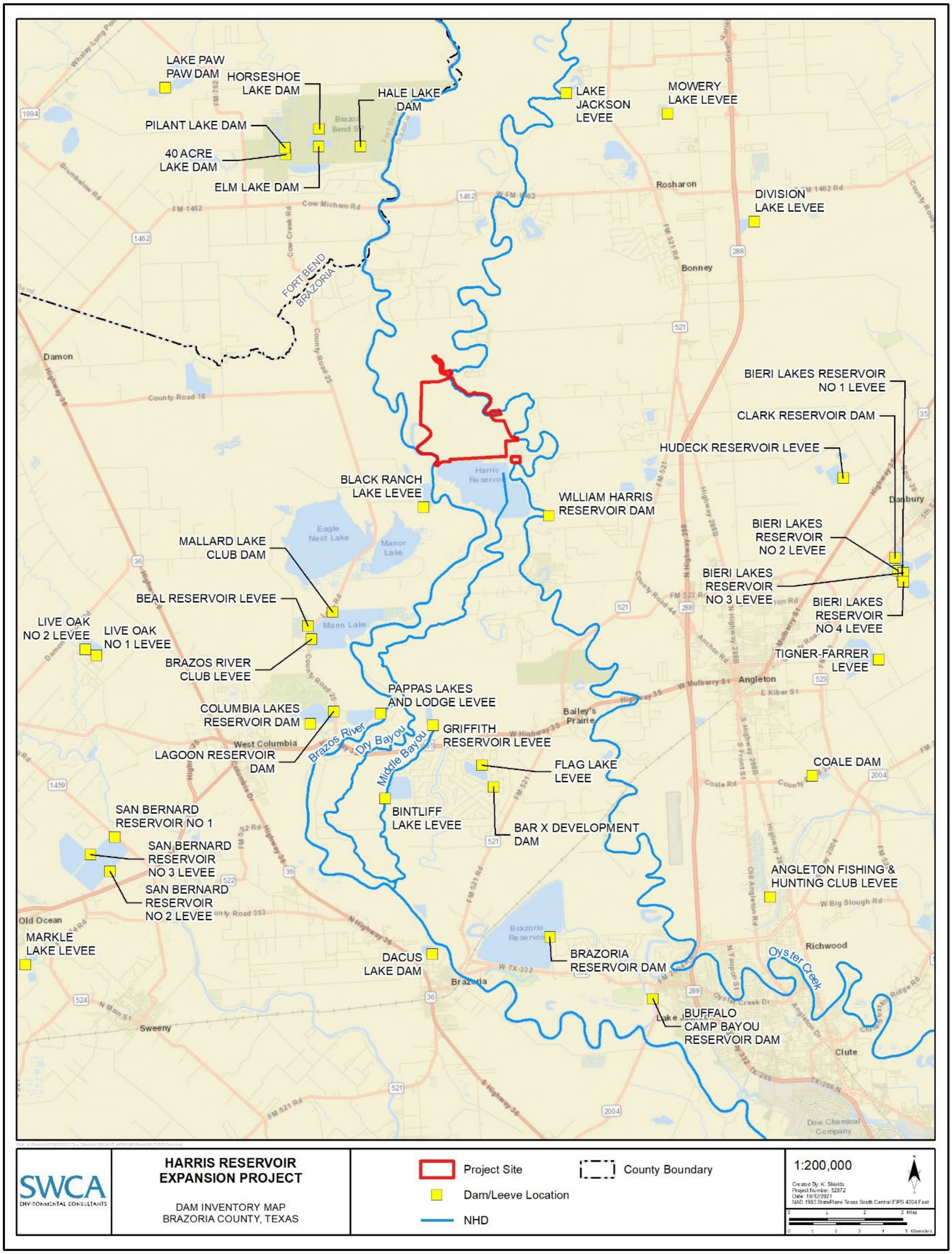

Figure 3.3-7. Dam inventory for the Lower Brazos River (Segment 1201).

The Lower Brazos River crosses the southern Texas counties of Falls, Limestone, Robertson, Milam, Lee, Burleson, Grimes, Washington, Waller, Austin, Fort Bend, and Brazoria. The greater Houston-Harris County and surrounding counties, including the area approximately 10 miles north of the Project site, has one of the fastest population growth rates in the country. The most recent U.S. Census Bureau (Census) data (2019a) show a population growth rate of 15% since 2010, which exceeds many other major metropolitan areas (Census 2020a) and results in development pressures in the Brazos River floodplain.

3.3.1.4.3 Oyster Creek Near Project Site

Proposed Action, Alternative 2A, Alternative 2B, Alternative 3, and Alternative 4

Oyster Creek shares many similarities with the Brazos River but is located within a much smaller watershed. The Oyster Creek watershed is approximately 108 square miles (see Figure 3.3-3) and has a runoff volume of approximately 27,655 AF per year (Jacobs 2018).

Oyster Creek has been subject to drought and extreme flooding in the region. Oyster Creek and the Brazos River share the 1% Annual Exceedance Probability (AEP) floodplain near the Project site. The AEP floodplain is commonly referred to as the 100-year floodplain, which is land adjacent to a stream or river that has a 1 in 100 chance of flooding during a storm event each year. The two stream systems are also hydrologically connected near the Sienna Plantation development located to the north that includes a large stormwater detention basin that diverts approximately 63% of the Oyster Creek flows and discharges them to the Brazos River (Watearth 2021a).

South of the Sienna Plantation, the primary land use in the floodplain and areas surrounding Oyster Creek is agriculture, which over time has contributed to an incised stream channel and steep eroding banks. Oyster Creek is disconnected from the surrounding floodplain in this area except for during large events such as the extreme flooding experienced most recently during Hurricane Harvey in 2017.

3.3.1.5 ENVIRONMENTAL FLOWS

3.3.1.5.1 Proposed Action, Alternative 2A, Alternative 2B, Alternative 3, and Alternative 4

The term *environmental flows* is used to describe the flow of water (both quantity and timing of flow) needed to maintain ecologically healthy streams and rivers, as well as the bays and estuaries that they feed (TWDB 2020b). The Texas Senate Bill (SB) 2 was enacted by the 77th Texas Legislature in 2001 to establish the Texas Instream Flow Program with the mission of performing studies to identify flow conditions necessary to support the ongoing ecological functions of streams throughout Texas. The 80th Texas Legislature then passed SB 3 to provide guidance in the processed by which environmental flows are defined. These studies are multi-disciplinary biology, hydrology, water quality, geomorphology, and connectivity assessments that serve to identify the necessary flows. These studies are carried out to enumerate subsistence,[5] base,[6] high pulse,[7] and overbank flow[8] conditions that are required for each major watershed. These studies are carried out to reflect seasonal and yearly fluctuations that adequately provide these data.

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[5] Subsistence flows: “Infrequent, seasonal periods of low flow. Primary objective is to maintain water quality criteria. Secondary objectives to provide important low flow life cycle cues or refugia habitat” (Texas Instream Flow Program 2018).

[6] Base flows: “Normal flow conditions between storm events. Ensure adequate habitat conditions, including variability, to support the natural biological community” (Texas Instream Flow Program 2018).

7 High pulse flows: “Short duration, within channel, high flow events following storm events. Maintain important physical habitat features. Provide longitudinal connectivity along the river channel” (Texas Instream Flow Program 2018).

[8] Overbank flows: “Infrequent, high flow events that exceed the normal channel. Maintain riparian areas. Provide lateral connectivity between the river channel and active floodplain” (Texas Instream Flow Program 2018).

As of 2015, the TWDB had executed studies on seven of the 11 major watersheds of Texas comprising the Sabine-Neches River; Trinity-San Jacinto River; Brazos River; Colorado-Lavaca River; Guadalupe, San Antonio, Mission, and Aransas River; Nueces River; and Rio Grande watershed basins and their associated estuaries (TWDB 2020b). Although this covers much of Texas' watersheds, significant gaps in environmental flow standards remain including for Oyster Creek.

Numerous studies have been completed for the neighboring Brazos River, including TWDB's *Instream Flow Study of the Middle and Lower Brazos River* (Texas Instream Flow Program 2018), *Instream Flows Research and Validation Methodology Framework and Brazos Estuary Characterization* (Bonner et al. 2015), and *Instream Flows Research and Validation Methodology Framework 2016-2017* (Bonner et al. 2017). These studies provide examples of the data required to elucidate environmental flow requirements for Oyster Creek. A full evaluation on Oyster Creek similar to that on the Brazos River would require collection of multi-year, seasonal water quality, fisheries, and flow studies. Additionally, fisheries and water chemistry data could not be collected because of width, depth, velocity, and safety issues (e.g., presence of alligators) and because the portion of Oyster Creek adjacent to the Project site was determined to be non-wadable with viable access location for sampling from boats. Existing stream gages such as USGS 08079010 (Oyster Creek at FM 2004 near Lake Jackson, Texas), USGS 08079000 (Oyster Creek Near Angleton, Texas), and Oyster Creek at Sims Road (University of Houston at Clear Lake gage), provide information regarding physical flow data for Oyster Creek, although these data are limited by the short time frame of available data (USGS 2021a; University of Houston at Clear Lake 2021).

Analyses of USGS historical peak flow data were used to illustrate hydrological (flow) conditions and variability of flow at the nearest USGS stream gage (USGS 08079000 [Oyster Creek Near Angleton, Texas]). USGS 08079000 is located approximately 19 miles downstream of the Project site, and thus discharge is likely higher than what would occur closer to the Project site. Data at this gage are only available for water years[9] 1945 to 1980, and the peak flow data from this gage shows that the largest annual peak flow on record is 10,600 cfs during the May 1957 floods (USGS 2020c). Table 3.3-1 summarizes the largest annual peak flows recorded in water years 1945 to 1980.

Table 3.3-1. Largest Annual Peak Flows Recorded at USGS 08079000 (Oyster Creek Near Angleton, Texas) during Water Years 1945 to 1980

Rank	Date	Flow (cfs)
1	5/10/1957	10,600*
2	9/21/1979	4,580 [*,†]
3	9/07/1973	4,070[*,‡]
4	5/30/1965	3,260[*,‡]
5	6/26/1968	3,080[*,‡]
6	9/13/1961	2,600[*]
7	10/12/1949	2,320[*]

[9] USGS water year: "The 12-month period from October 1, for any given year through September 30, of the following year. The water year is designated by the calendar year in which it ends, and which includes 9 of the 12 months. Thus, the year ending September 30, 1999, is called the "1999 water year" (USGS 2020d).

Rank	Date	Flow (cfs)
8	11/07/1946	2,230[*]
9	11/21/1953	1,900[*]
10	6/01/1970	1,740[*,‡]

Source: USGS (2020c).

[*] All or part of the record affected by urbanization, mining, agricultural changes, channelization, or other.

† Discharge affected by regulation or diversion.

‡ Discharge affected to unknown degree by regulation or diversion.

Based on average annual discharge data, hydrological flow averages 184 cfs annually, with averages ranging between 63 and 468 cfs per year (USGS 2020d). Monthly discharge data, as shown in Table 3.3-2, indicate that late spring and early summer months experience highest flow, allowing for a higher capacity to move sediments and nutrients during this time of year (USGS 2020e).

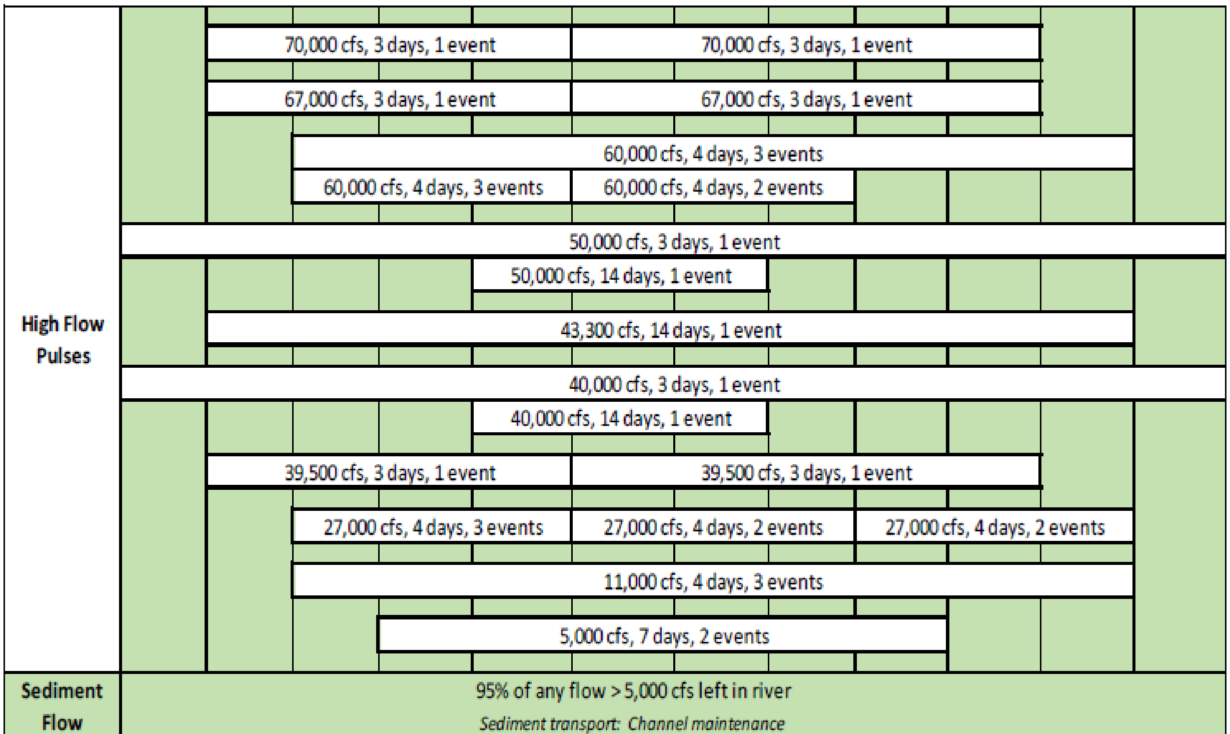
Table 3.3-2. Monthly Average Discharge Data for USGS 08079000 (Oyster Creek near Angleton, Texas) during Water Years 1945 to 1980 (cfs)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
183	178	145	161	295	225	162	131	223	168	168	171

Source: USGS (2020e).

Data for the Brazos River reach nearest the Project site is unavailable; however, some insights into environmental flows for the Brazos River can be determined based on TWDB's *Instream Flow Study of the Middle and Lower Brazos River* (Texas Instream Flow Program 2018) and recordings from nearby existing stream gages (e.g., USGS 08116650 [Brazos River near Rosharon, Texas]). Historical discharge records for the Middle and Lower Brazos River indicate that the highest flows generally occur during winter and spring, although large magnitude events generating high flow pulses and overbank flows can occur during any time of year. Hydrology throughout the Middle and Lower Brazos River Basins are impacted by numerous reservoirs. However, downstream of the city of Waco, several tributaries, unregulated areas, and water supply operations add to the river's flow, which reduce the effects of these reservoirs. Water flows thus continue to vary in response to seasons and precipitation patterns within sub-basins (Texas Instream Flow Program 2018).

The nearest study site to the Project site in TWDB's Instream Flow Study is at Allens Creek, which is located at Allens Creek near the Austin/Fort Bend/Harris County border, located between 29.648706° N 96.022969° W and 29.633708° N, 95.990539° W (Texas Instream Flow Program 2018). This Allens Creek Study site is located approximately 75 miles upstream from the Project site and Harris Reservoir, and recommended flows are likely lower than they would be closer to the Project site. Figure 3.3-8 provides a summary of instream flow recommendations by the TWDB for the Allens Creek study site (Texas Instream Flow Program 2018).



BASE FLOWS (cfs) - Aquatic Habitat protection (intra- and interannual variability)									Key Indicators: Aquatic Habitat, Water Quality			
Base Wet	2,739	3,027	3,881	3,358	5,297	5,074	1943*	1943*	1943*	1,312	1,622	1,766
Base Average	1,587	1,754	2,249	1,946	3,069	2,940	1,115	946*	946*	760	940	1,023
Base Dry	563	622	798	691	1,089	1,043	626*	626*	626*	517**	517**	517**
SUBSISTENCE FLOWS (cfs) - Water quality protection and maintainence of limited aquatic habitat									Key Indicators: Aquatic Habitat, Water Quality			
Subsistence	517	517	517	517	626*	626*	626*	626*	626*	517	517	517
MONTH	January	February	March	April	May	June	July	August	September	October	November	December

Note: This study site is located approximately 75 miles upstream from the Project site, and thus recommended flows are lower than what would likely be recommended closer to the Project site if a study was conducted in this reach.

* Mussel thermal tolerance flows.

** Subsistence overlay on base.

Figure 3.3-8. Instream flow recommendations for the Brazos River Allens Creek Study Site (Texas Instream Flow Program 2018).

To supplement recommendations by TWDB at the Allens Creek Study site (Texas Instream Flow Program 2018), an analysis of USGS historical peak flow data was used to illustrate hydrological (flow) conditions and variability of flow at the nearest USGS stream gage, USGS 08116650 (Brazos River near Rosharon, Texas). This gage is approximately 10 miles upstream of the Project site, and discharge data are likely lower than what would occur closer to the Project site. A review of peak flow data at USGS 08116650 shows that the largest annual peak flow on record is 133,000 cfs during the August 2017 floods associated with Hurricane Harvey. Table 3.3-3 summarizes the largest annual peak flows recorded in water years 1914 and 1967 to 2018.

Table 3.3-3. Largest Annual Peak Flows Recorded at USGS 08116650 (Brazos River near Rosharon, Texas) during Water Years 1914 and 1967 to 2018

Rank	Date	Flow (cfs)
1	8/29/2017	133,000[*,†]
2	6/04/2016	112,000[*]
3	10/22/1994	84,400[*]
4	1/03/1992	82,700[*]
5	5/14/1968	79,900[*]
6	6/15/1973	79,300[*]
7	6/09/1979	76,500[*]
8	11/17/1998	76,400[*]
9	4/23/1977	73,000[*]
10	11/29/2004	71,100[*]

Source: USGS (2020f).
[*] Discharge affected by regulation or diversion.
[†] Discharge due to Hurricane Harvey.

A summary of Brazos River discharge statistics based on flow data obtained at the USGS 08116650 (Brazos River near Rosharon, Texas) for the 50-year period of record for water years 1967 through 2018 is provided in Table 3.3-4, and monthly mean discharge statistics are provided in Table 3.3-5 (USGS 2020f). The annual river flow pattern and variation shown by these data illustrate that there is a relatively dry season from July or August through October or November of each year and wetter conditions from January to June. The Lower Brazos River area is therefore located within a humid subtropical climate, and the patterns of flow in the watershed are dictated by climate (precipitation, early summer thunderstorms, and the hurricane season). Increased flow during spring and early summer months illustrates a higher capacity for moving sediments and nutrients during this time of year.

Table 3.3-4. Discharge Summary Statistics for USGS 08116650 (Brazos River near Rosharon, Texas) during Water Years 1967 to 2018

Item	Amount	Water Year
Average annual mean	8,335 cfs	N/A
Highest annual mean	29,050 cfs	1992
Lowest annual mean	852.6 cfs	2013
Highest daily mean	121,000 cfs	August 29, 2017
Lowest daily mean	27.0 cfs	July 21, 2000
Annual 7-day minimum	44.3 cfs	April 04, 1967
Maximum peak flow	133,000 cfs [*,†]	August 29, 2017
Maximum peak stage	52.65 cfs	August 29, 2017
Average annual runoff	0.179 cfs	N/A
Average annual runoff	2.43 inches	N/A

Item	Amount	Water Year
Average 10% exceeds	21,800 cfs	N/A
Average 50% exceeds	3,120 cfs	N/A
Average 90% exceeds	558.0 cfs	N/A

Source: USGS (2018).
* Discharge affected by regulation or diversion
† Discharge due to Hurricane Harvey

Table 3.3-5. Monthly Discharge Summary Statistics for USGS 08116650 (Brazos River near Rosharon, Texas) during Water Years 1967 to 2018

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Mean (cfs)	4,893	6,865	7,846	9,185	9,598	11,720	9,775	11,990	12,310	6,038	3,393	4,067
Max (cfs)	24,240	33,580	36,060	70,560	60,529	60,170	32,050	42,910	59,819	59,930	24,250	25,850
Max water year	1974	1975	2016	1992	1992	1992	1977	2016	2016	2007	2007	2017
Min (cfs)	342	290	501	542	436	498	278	312	228	246	279	347
Min water year	2000	1989	2013	2009	2000	1971	2011	1978	2011	1971	2011	2000

Source: USGS (2018).

3.3.2 Flood Hazards and Flood Hazard Values

3.3.2.1 REGULATORY SETTING

The National Flood Insurance Program (NFIP) was established by the National Flood Insurance Act of 1968 (42 USC 4001 et seq.). The general purpose of the NFIP is both to offer primary flood insurance to properties with significant flood risk and to reduce flood risk through the adoption of floodplain management standards. Communities volunteer to participate in the NFIP to have access to federal flood insurance, and in return are required to adopt minimum standards. The NFIP is managed by FEMA, which produces Flood Insurance Rate Maps (FIRMs). Depicted on FIRMs are Special Flood Hazard Areas, which are the same as 100-year floodplains. Participating communities such as Brazoria County adopt a flood map and enact minimum floodplain standards to regulate development in Special Flood Hazard Areas (FEMA 2019). The existing Harris Reservoir and Project site can be found on FIRMs 48039 C0410H, 48039 C0235H, 48039 C0240H, and 48039 C0405H, all effective as of June 5, 1989 (FEMA 2020).

Brazoria County is required to manage the county's floodplain to minimize potential impacts to other properties through floodplain development regulations. Non-compliance with FEMA regulations related to floodplain development and management affects other flood insurance holders and the county's flood insurance rate. Dam and reservoir safety requirements are under TCEQ jurisdiction. These requirements apply to all reservoirs greater than 500 AF, and compliance with operation and maintenance standards applies to all reservoirs regardless of size (TCEQ 2020c). Operation and maintenance plans are intended to maximize the functional life of an infrastructure project such as a reservoir. These plans include items such as inspection schedules and information on how to safely operate the structure such as water release rates depending on different conditions ranging from normal to emergency.

Brazoria County also requires submission of drainage plans for developments within the county's floodplain that are not in a drainage district (Brazoria County 2020; Forister 2017). The drainage plans are reviewed by the County Engineer and the Local Floodplain Administrator. The 2003 *Brazoria County Drainage Criteria Manual*, adopted by the County Commissioners Court, has several methodologies for a proposed development in the floodplain to demonstrate that the development would not impact adjacent and downstream properties. These methodologies include demonstrating that no WSEL rises would occur downstream of a project (Brazoria County 2003; Turner 2018), which is referred to as a No-Rise Certification. In addition to providing a No-Rise Certification, Brazoria County drainage criteria require mitigation for loss of floodplain storage that can either shorten the time flood waters arrive at a downstream location or affect the amount of water at a downstream location. Either condition can result in new occurrences of flooding to downstream properties and/or result in hydromodification downstream. *Hydromodification* is defined as a change in the natural hydrologic processes and runoff characteristics (i.e., interception, infiltration, overland flow, interflow, and groundwater flow) that is caused by urbanization or other land use changes that result in increased stream flows and changes in sediment transport.

3.3.2.2 BRAZOS RIVER AND OYSTER CREEK FLOODPLAIN

3.3.2.2.1 Proposed Action, Alternative 2A, and Alternative 2B

The Project site is located between the Brazos River and Oyster Creek and is in the 100-year floodplain for both river systems, as shown through modeling and observation. Historic oxbows of former channels that are no longer connected to either the Brazos River or Oyster Creek are visible near the Project site, which demonstrates natural channel movement through the broad floodplain. Because the Project site is within the floodplain and sits at low elevations (ranging from 1 to 54 feet above sea level), it can be assumed that the entire site would have been inundated in the recent Memorial Day Flood, April Tax Day Flood, and Hurricane Harvey flooding described below.

As discussed in Section 3.3.1.2.1, the Corps' Climate Hydrology and Watershed Vulnerability models were used to screen the vulnerability of the Project site to flooding under future conditions (USACE 2019b). For the Brazos River watershed (HUC 12070104), the projected future risk is expected to be low for the dry scenario and moderate for the wet scenario. These scenarios are based on different climate patterns and reflect the difficulty in predicting future climate in the South-Central Texas coastal area because this region is located in a transition zone between dryer conditions to the south and wetter conditions to the north. The South-Central Texas coastal area is susceptible to extreme weather such as tropical storms and hurricanes from the Gulf of Mexico, as well as prolonged droughts. There have been several hydrologically significant events in recent years that have affected the hydraulics of the Brazos River and Oyster Creek.

A multi-year drought began throughout Texas in 2005, with 2011 being the driest year on record in Texas. October 2010 represented very dry conditions, when most of Texas experienced a relatively dry fall and winter. The record dry period in March 2011 brought widespread extreme drought conditions to the state. A record dry March through May 2011 was followed by a record dry June through August 2011, and the 12-month rainfall total for October 2010 through September 2011 was 11.18 inches, far below the previous low record that was set in 1956. Average temperatures for June through August 2011 exceeded 22 degrees Fahrenheit (°F) above the previous Texas record and were close to the warmest statewide summer temperatures ever recorded in the United States (Nielson-Gammon 2011). The 2011 drought resulted in $7.62 billion in agricultural losses throughout the state of Texas (Fannin 2012).

In May 2015, there was an event commonly referred to as the Memorial Day Flood, causing the Brazos River in Brazoria County to rise to 50.73 feet in elevation, which was the highest level recorded since October 1995 (Figure 3.3-9). This event resulted in a depth of water in the floodplain of more than 7 feet (flood stage is 43 feet in elevation). Continued rains in the area during the remainder of 2015 and in early 2016 inundated the Brazos River watershed and continued to fill the upstream lakes and reservoirs. Following heavy rains in March 2016 and several record-level local rainfalls during the April Tax Day Flood, the Brazos River experienced crests of approximately 47.41 feet and 50.98 feet, respectively, almost the same high levels experienced during the Memorial Day Flood in May 2015. On June 4, 2016, Brazoria County experienced a catastrophic flood event that resulted in the Brazos River flooding over its banks. At the time, this was a historic event with the river cresting at its second highest level ever (52.51 feet), which was only exceeded by the flood of 1913. According to the Brazoria County Emergency Management Department, more than 1,500 homes sustained flood damages throughout the county, resulting in $32 million of disaster recovery need (Brazoria County 2018).

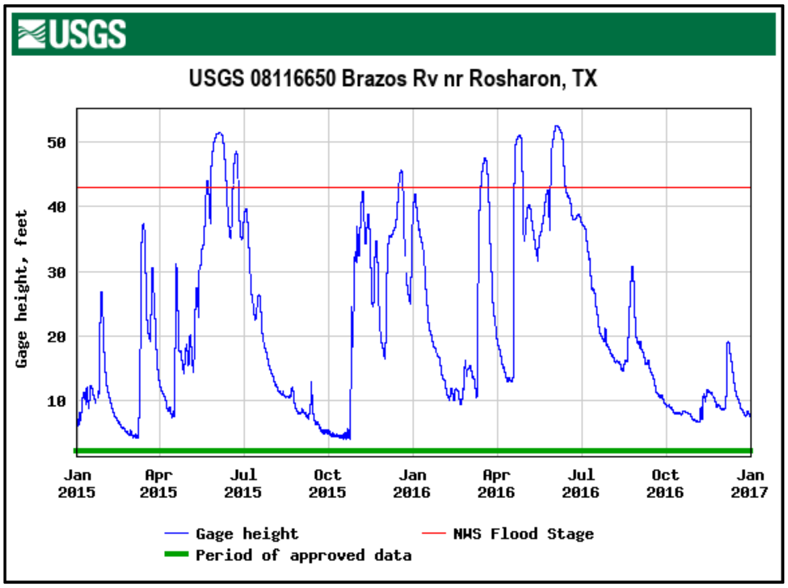


Figure 3.3-9. Gage height for USGS 08116650 (Brazos River near Rosharon, Texas) 2015 and 2016 (USGS 2020f).

Approximately 1 year later in August 2017, Hurricane Harvey made landfall in Texas. In Brazoria County, the Brazos River experienced record water levels (crest elevation of 52.54 feet [USGS 2020f]), which caused widespread floods across the county. The hardest hit communities were in Baileys Prairie, Richard, and West Columbia. Widespread major flooding on the Brazos River and Oyster Creek led to numerous roads and homes flooding in Columbia Lakes, Mallard Lakes, Great Lakes, Riverside Estates, and the Bar X Ranch subdivisions, as well as homes on CR 39. Flooding damaged the bridge over Cow Creek at CR 25, making it impassable. High flows from the Brazos River caused navigation problems for several weeks. More than 9,000 homes experienced flood damage from the storm (NOAA 2018).

3.3.2.2.2 Alternative 3

The Alternative 3 site is approximately 2 miles west of the Proposed Action Project site and largely located outside the 100-year floodplain for both Oyster Creek and the Brazos River. All structures to the east of Station 8+00 of the pipeline to the proposed reservoir are within the Brazos River 100-year floodplain.

As discussed for the Proposed Action, the Corps' Climate Hydrology and Watershed Vulnerability models were used to screen the vulnerability of the site to flooding under future conditions (USACE 2019b). Like the Proposed Action, the Alternative 3 site is also in the Lower Brazos River watershed (HUC 12070104). Similarly, the projected future risk is expected to be low for the dry scenario and moderate for the wet scenario. As previously stated, the South-Central Texas coastal area experiences extreme weather, such as tropical storms and hurricanes from the Gulf of Mexico, as well as prolonged droughts. There have been several hydrologically significant events in recent years that have affected the hydraulics of the Brazos River.

3.3.2.2.3 Alternative 4

The Alternative 4 site is located approximately 14 miles south of the Project site, just south of the Brazoria Reservoir. Most of the Alternative 4 site is located within the 100-year floodplain at very low elevations ranging from 22 feet above sea level on the northwestern portion of the Alternative 4 site to 3 feet above sea level in the southeastern portion, with the exception of the locations of the 96" RO concentrate pipeline and power line corridor that would cross the Brazos River over FM 2004 to its exit at the BASF Chemicals Division. The Alternative 4 site is located at a much lower elevation than all other sites because of its proximity to the Gulf of Mexico, which is approximately 19 miles downstream.

As discussed for the Proposed Action, the Corps' Climate Hydrology and Watershed Vulnerability models were used to screen the vulnerability of the Alternative 4 site to flooding under future conditions (USACE 2019b). Like the Proposed Action, the Alternative 4 site is also in the Lower Brazos River watershed (HUC 12070104). Similarly, the projected future risk is expected to be low for the dry scenario and moderate for the wet scenario. As previously stated, the South-Central Texas coastal area experiences extreme weather, such as tropical storms and hurricanes from the Gulf of Mexico, as well as prolonged droughts. There have been several hydrologically significant events in recent years that have affected the hydraulics of the Brazos River.

Because the Alternative 4 site sits at very low elevations (from 3 to 22 feet above sea level), it can be assumed that the entire site would have been inundated in all floods discussed above.

3.3.3 Water Rights

The Brazos River is a major river system within the state of Texas with its headwaters[10] located near Blackwater Draw, New Mexico, and its mouth near Freeport, Texas. The river is highly managed through a series of dams and off-channel reservoirs throughout its length to store water for municipal, industrial and dry season use and to provide flood control. The reservoirs are necessary because of the high variability of flows as the primary water source is rainfall in the upper reaches.

Basin hydrology is an important factor when determining the availability of water within a basin to fulfill water rights. The general climate for the Project site includes high potential for rainfall events from tropical storms and hurricanes with long periods of drought. As discussed in Section 3.3.1.2, rainfall is predicted to trend toward lower rainfall levels, and higher temperatures are anticipated in future. Sea level is expected to rise by 1 to 2 feet in the next 50 years, which may push the salt wedge and storm surges farther upstream than under current conditions. In recent years, water availability in the Ogallala Aquifer has declined, which has placed an increasing demand on surface waters in the upper reaches of the Brazos River Basin (Brazos Basin Expert Science Team 2012). This may be impacting water availability in the lower reaches.

[10] *Headwaters* are the start or tributary stream to a river. *Water rights* are the legal right to make use of the water from a stream, lake, or irrigation canal. *Impoundments* are confined with an enclosure such as a reservoir to store water. *Recycling* is the process of recovering or reprocessing water. *Water efficiency* practices are the changing of processes to reduce the volume of water used.

3.3.3.1 REGULATORY SETTING

On the Brazos River, there are three BRA reservoirs (Possum Kingdom Lake, Lake Granbury, and Lake Limestone), eight Corps flood control dams (Lakes Proctor, Whitney, Aquilla, Belton, Stillhouse Hollow, Georgetown, Granger, and Somerville), and numerous other various-sized impoundments (Figure 3.3-10) (BRA 2021b). The Brazos River flow is primarily supplied through precipitation with many creeks and streams along the main stem (Watearth 2021a). The TCEQ Brazos Watermaster Program administers water rights in the Brazos River Basin, including more than 1,200 water rights in the Lower Brazos River (TCEQ 2013). Included in the 1,200 are Dow's water rights for use at its plant in Freeport, Texas, and those they hold as a potable water supplier for industries and municipal users in the region (Dow 2018).

Figure 3.3-10. Brazos River impoundments (BRA 2021b).

The TCEQ Water Availability Model (WAM) is a computer-based simulation predicting the amount of water that would be in a river or stream under a specified set of conditions (TCEQ 2020d). The WAM is also used to evaluate water right applications to help determine if water would be available for new any water right or amendment to an existing water right and if an amendment might affect other water rights. The WAM is used by Dow and TCEQ in predicting available flows for water rights in the Brazos River.

3.3.3.2 DOW'S WATER NEED AND WATER RIGHTS

3.3.3.2.1 Proposed Action, Alternative 2A, Alternative 2B, Alternative 3, and Alternative 4

The Brazos River is managed by TCEQ through an adjudication process that confirmed seniority of the water rights and requires reporting to the state of actual use (Texas Water Commission 1985).

Dow holds the following water rights (TCEQ 2013):

- Certificate of Adjudication # 12-5328, granted January 14, 1988, for the Brazos River, Oyster Creek, and Buffalo Camp Bayou
- Certificate of Adjudication # 12-5328A, granted February 27, 1991, Oyster Creek Adjustment to # 12-5328
- Certificate of Adjudication # 12-5328B, granted December 4, 1991, Oyster Creek Adjustment to # 12-5328

Dow's primary water right is on the Brazos River for 238,156 AF per year for industrial, municipal, domestic, and livestock uses (Figure 3.3-11). In addition, Dow has an Oyster Creek water right for 60,000 AF per year and a 7,650-AF Buffalo Camp Bayou water right, both for industrial and municipal uses (Dow 2018). Combined, Dow has a total water right of approximately 284,000 AF. Dow currently uses 162,222 AF (Dow 2018). The maximum diversion rate for Dow's water right is 630 cfs, which is 175,000 gpm. Dow currently withdraws 100,000 gpm, or 222.2 cfs (TCEQ 2013; Texas Water Comission 1985).

Dow operations require 430 AF per day of water supply to meet their daily water supply obligations including to BWA, which supplies approximately 16,000 AF per year to their customers through the Dow water pumping and reservoir facilities (Dow 2018). The agreement to supply BWA results in Dow potentially being classified as a water purveyor.

Dow's Oyster Creek and Buffalo Camp Bayou water rights are not available most of the time because of drought (Dow 2018). Water rights become available when there are localized rain events when short-duration flows in the Project vicinity allow temporary availability of this water by Dow. In addition to flows being dependent on local rainfall, the upper 63% of the Oyster Creek drainage area has been diverted by a canal at the Sienna Plantation, which is upstream of the proposed reservoir.

Dow currently operates two reservoirs that store water for Dow's Texas Operations and BWA from the Brazos River to provide access to their water right during low-flow and drought conditions (Dow 2018). The Harris Reservoir is located at River Mile 46 and has effective storage capacity of 7,000 AF, and the Brazoria Reservoir is located at River Mile 25 and has effective storage capacity of 21,000 AF. Dow reports an effective total storage of 27,343 AF, which is maintained through the water rights described above. Dow has reported periodic but not regularly scheduled maintenance dredging on the existing reservoirs, which has resulted in loss of storage by up to half of the original design volume. The most recent survey of the existing reservoirs was conducted in 1990 (Dow 2018). According to the Dow purpose statement in the Section 404 permit application, during drought conditions, Dow estimates the two-reservoir system provides 68 days or less of necessary water supplies. TCEQ identified that facilities with less than 180 days of water storage are at risk during droughts (Texas Administrative Code 290.41).

During recent years, Dow has successfully reduced its freshwater consumption from the Brazos River by more than 20,000 AF per year for production at their Texas Operations through on-site recycling and water efficiency practices (Dow 2019). This reduction represents a 10% reduction in water at the site (in accordance with Dow's 10-year goal in their TCEQ-required water conservation plan). Additional water conservation and water use efficiency measures are planned for implementation over time as technology and cost-effective approaches develop, such as additional improvements in water use efficiency for industrial processes and water recycling. This may include equipment upgrades such as control equipment, tanks, nozzles, valves, or pumps or increased efficiency from improving the flow rates, pressure, temperature, chemistry, filtration, or timing of processes (TWDB 2004). However, these investments in water conservation do not provide the additional storage capacity required to sustain operations during extended drought based on current and planned operational water requirements.

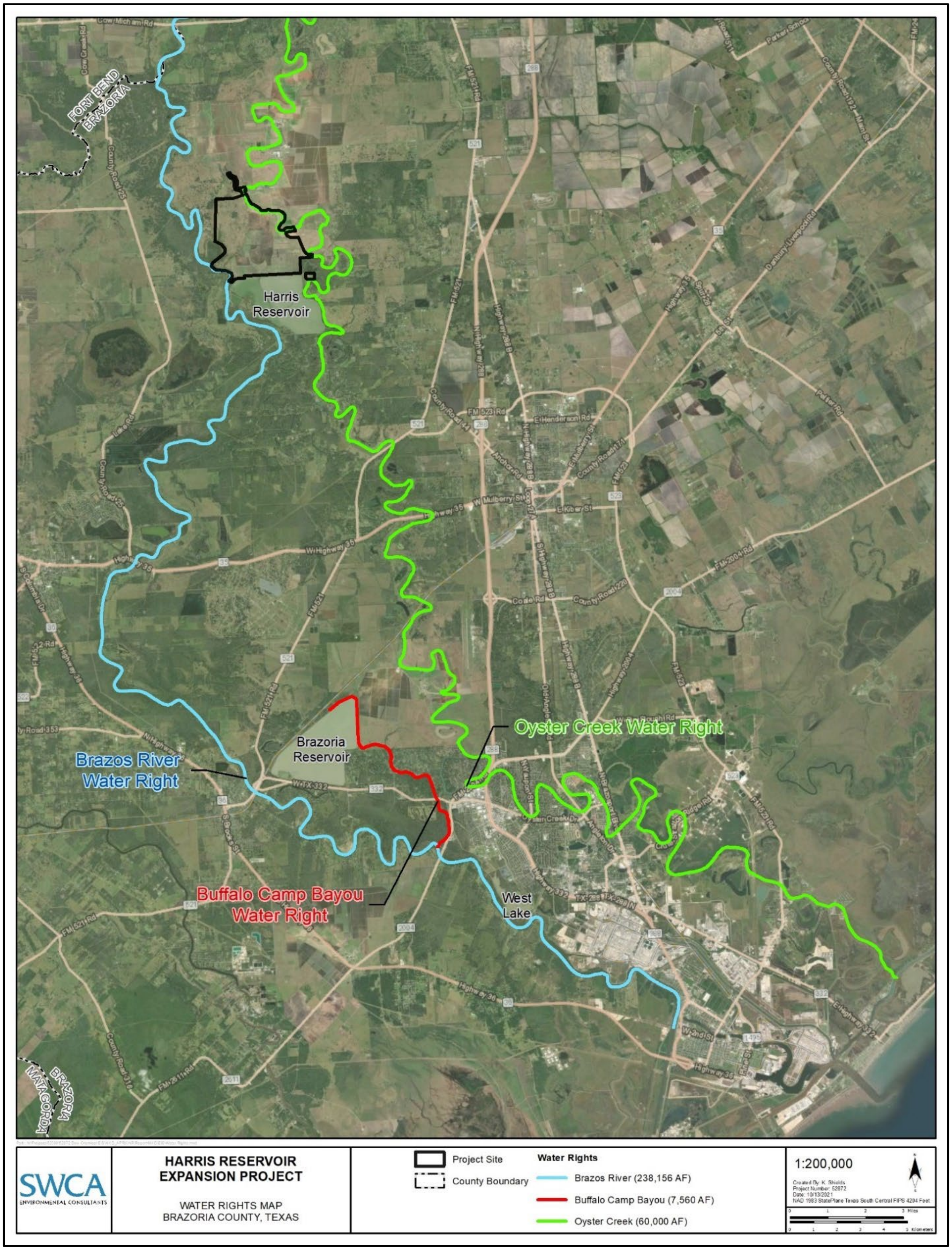


Figure 3.3-11. Dow's water rights.

3.3.4 Waters of the United States, Including Wetlands

Section 404 of the CWA and 33 CFR 323 require authorization from the Corps to discharge dredged or fill material into WOUS and jurisdictional wetlands. Section 10 of the Rivers and Harbors Act regulates those acts that affect the course, location, or condition of a navigable water. DA permits related to both regulations are issued by the Corps.

On August 30, 2021, the U.S. District Court for the District of Arizona issued an order vacating and remanding the Navigable Waters Protection Rule in the case of *Pascua Yaqui Tribe v. U.S. Environmental Protection Agency*. The USACE has been directed to cease issuance of approved jurisdictional determinations (AJDs) using the Navigable Waters Protection Rule and to immediately begin issuing AJDs under the 1986 Waters of the U.S. definitions with applicable Solid Waste Agency of Northern Cook County and Rapanos guidance, also referred to as the pre-2015 Regulatory regime (EPA 2021a). Under this definition, WOUS are defined to include the following:

9. All waters which are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide;
10. All interstate waters including interstate wetlands;
11. All other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation or destruction of which could affect interstate or foreign commerce including any such waters:
    a. Which are or could be used by interstate or foreign travelers for recreational or other purposes; or
    b. From which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or
    c. Which are used or could be used for industrial purposes by industries in interstate commerce;
12. All impoundments of waters otherwise defined as waters of the United States under this definition;
13. Tributaries of waters identified in paragraphs (s)(1) through (4) of this section;
14. The territorial sea;
15. Wetlands adjacent to waters (other than waters that are themselves wetlands) identified in paragraphs (s)(1) through (6) of this section; waste treatment systems, including treatment ponds or lagoons designed to meet the requirements of CWA (other than cooling ponds as defined in 40 CFR 423.11(m) which also meet the criteria of this definition) are not waters of the United States.

WOUS do not include prior converted cropland.

The Brazos River is a navigable water regulated under Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act. A wetland delineation of the Project site was conducted during June and July 2019 (SWCA 2019a). On June 24 and 26, 2019, the Corps conducted a site visit, and a verification of the 2019 wetland delineation was issued by the Corps on October 22, 2019 (USACE 2019a). As part of Dow's application for the proposed Harris Reservoir, they requested the Corps issue an AJD. However, Dow withdrew their AJD request on May 23, 2019. Therefore, at this time, an AJD has not been completed. For the purpose of Dow's permit application, the Corps assumes that all wetlands and waterbodies that have been delineated are WOUS. Dow may request an approved jurisdictional determination during any part of the permitting process and if they did so, the total quantity of WOUS as described in Sections 3.3.4.1 and 3.3.4.2 would remain as described therein or could possibly be reduced.

3.3.4.1 WATERBODIES

3.3.4.1.1 Proposed Action, Alternative 2A, and Alternative 2B

The Corps regulates all perennial and intermittent streams, ephemeral streams exhibiting an ordinary high water mark, natural lakes and ponds with surface connections to navigable water or other ties to interstate commerce, all impounded lakes or ponds created from jurisdictional waters described above, and their adjacent wetlands. These features are defined as the following:

- Ephemeral streams only flow for short durations after precipitation. Ephemeral beds are located above the water table year-round, with runoff from rainfall being the primary source of flow, and aquatic life being extremely scarce or typically absent.
- Intermittent streams are those that exhibit temporary connection to the water table and flow during certain parts of the year, typically seasonally, when groundwater provides water for stream flow. During dry periods, intermittent streams may not have flowing water and rainfall is a supplemental source of flow. The biological constituents for intermittent streams are adapted to wet and dry fluctuations.
- Perennial streams flow year-round during a typical year. The water table is located above the stream bed for most of the year, and groundwater is a primary source for stream flow. A perennial stream is typically capable of supporting aquatic life.
- An ordinary high water mark is a line on the shore established by the fluctuations of water during ordinary high water flows and indicated by physical characteristics such as “a clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas” (33 CFR 328.3[e]).

Based on the definitions above, the 2019 wetland and WOUS survey (SWCA 2019a) identified 41 waterbodies consisting of 11 streams or rivers, five ditches, 22 agricultural ditches, and three ponds within the Project site (Table 3.3-6, Figure 3.3-12). These waterbodies, which total 74.10 acres (109,338 linear feet), were verified in the field by the Corps in 2019 (USACE 2019a).

Named streams include two segments of the Brazos River (perennial) that are approximately 300 feet wide and total 8,838 linear feet (24.97 acres). Two segments of Oyster Creek (perennial) in the Project site are 15 to 30 feet wide and total 17,411 linear feet (21.52 acres). In addition, Jennings Bayou runs diagonally through the Project site between the Brazos River and Oyster Creek for a length of 13,497 linear feet (11.34 acres).

Table 3.3-6. Waterbodies in the Project Site

Type	USGS Name*	Length in Project Site (feet)	Project Site (acres)†
Ephemeral agricultural ditches (22)	N/A	39,337	6.91
Ephemeral ditches (4)	N/A	13,178	2.15
Ephemeral stream	UT of Brazos River	2,589	0.18
Ephemeral stream	N/A	678	0.06
Ephemeral stream	UT of Jennings Bayou	116	0.00
Ephemeral stream	UT of Jennings Bayou	73	0.00
Ephemeral stream	UT of Oyster Creek	201	0.04
Subtotal of ephemeral waterbodies		***56,172***	***9.35***
Intermittent stream	Jennings Bayou	13,497	11.34
Intermittent ditch	UT of Jennings Bayou	6,129	1.41
Intermittent stream	N/A	7,290	2.68
Subtotal of intermittent waterbodies		***26,916***	***15.43***
Perennial stream	Oyster Creek	16,888	21.34
Perennial river	Brazos River	4,309	15.96
Perennial river	Brazos River	4,530	9.01
Perennial stream	Oyster Creek	523	0.18
Perennial ponds (3)	N/A	N/A	2.84
Subtotal of perennial waterbodies		***26,250***	***49.32***
		109,338	**74.10**

* N/A = not applicable; UT = unnamed tributary.
† Acreages were rounded to the nearest 0.01 acre.

Following the wetlands and WOUS survey, a qualitative Level I and II stream condition assessment was prepared (SWCA 2019b). The stream assessment found that most of the ephemeral and intermittent streams, including Jennings Bayou, in the Project site are agricultural ditches manipulated into depressional areas within upland areas, and evidence of artificial widening is present. Most of the channels exhibit evidence of past alteration through channelization and impacts by culverts and hoof shear, with some exhibiting stream stability and recovery from these impacts. Riparian buffers, which are important for retaining nutrients along ephemeral streams, were rated as severe (area is dominated by impervious surfaces, mine spoil lands, denuded surfaces, conventional tillage row crops, active feed lots, or comparable conditions) to low (native woody community species represent between 30%–60% coverage with no wetlands present; no maintenance or grazing activities) in the Project site. Most of the riparian buffers consist of a mixed land use between herbaceous land maintained by grazing and conventional row crops. However, a few areas dominated by woody vegetation parallel some assessed channels. The presence of native woody community species varies throughout the Project site. Forested riparian areas occur more often along the southwestern portions of the Project site. Overall, the reach condition index (RCI) scores averaged 2.23 for assessed streams, indicating poor or relatively poor quality.

The proposed 1,113-acre Big Slough mitigation site includes approximately 33,990 linear feet, the total length of Big Slough. Analysis of geologic maps and light detection and ranging (LiDAR) data indicates that Big Slough is a paleo-channel (slough) of the Brazos River that was left behind due to avulsion of the main channel; therefore, it used to experience much higher flow rates from a larger drainage area in the past (Cardno 2020). Development pressures in and around Richmond, Texas, led to conversion of open areas to impervious surfaces, and increased stormwater outfalls often directed north toward Big Slough (Cardno 2020). The upper end of Big Slough was excavated and stormwater conveyance culverts were installed to convey water toward both Oyster Creek and Big Slough. It appears that the Oyster Creek outfall may have silted in, causing the majority of stormwater to flow into Big Slough (Cardno 2020). Stagnant flows are present in Big Slough that have been caused by multiple embankment crossings with undersized culverts, which have increased fine sediment deposition, reduced flows, and reduced hydraulic connectivity (Cardno 2020). Fine organic sediments have accumulated for over 100 years, creating an anoxic channel bottom with low biological diversity and poor water quality. Cattle have likely contributed to eutrophication of the Big Slough stream system, in which nutrients accumulate due to poor flow conveyance (Cardno 2020).

3.3.4.1.2 Alternative 3

A desktop review of USFWS National Wetland Inventory (NWI) (USFWS 2021a), USGS National Hydrography Dataset data (NHD) (USGS 2021b), historic USGS topographic maps (USGS 2021c), and the most recently available FEMA FIRM data (FEMA 2021a) were reviewed to identify potential wetlands and water resources for Alternative 3. According to this data, the Alternative 3 site contains 18 NHD waterbodies, totaling approximately 22,228 linear feet (4.21 miles), and 25 NWI waterbodies, totaling approximately 15.12 acres (Table 3.3-7). This includes approximately 808.6 linear feet of the Brazos River and approximately 739.5 linear feet of Oyster Creek. The USGS NHD data categorizes these portions of the Brazos River as ephemeral and Oyster Creek as intermittent. Field reconnaissance for the Proposed Action has determined both features to be perennial.

Table 3.3-7. NWI and NDH Waterbodies within the Alternative 3 Site

Waterbody Type	Number of Features within Alternative 3 Site	Acreage/Feet
NHD Data*		
Ephemeral Stream	7	9,120 feet
Intermittent Stream	11	13,108 feet
NHD Subtotal	***18***	***22,228 feet***
NWI Data		
Freshwater Pond	14	3.37 acres
Riverine	11	11.75 acres
NWI Subtotal	***25***	***15.12 acres***

Source: USFWS (2021a), USGS (2021a)

Note: *USGS NHD data categorizes these portions of the Brazos River as ephemeral and Oyster Creek as intermittent. Field reconnaissance for the Proposed Action has determined both features to be perennial.

If Alternative 3 is pursued, a wetland delineation would be required to confirm the locations of waterbodies. Additional waterbodies could be present within the Alternative 3 site.

3.3.4.1.3 Alternative 4

A desktop review of USFWS NWI (USFWS 2021a), USGS NHD data (USGS 2021b), historic USGS topographic maps (USGS 2021c), and the most recently available FEMA FIRM data (FEMA 2021a) were reviewed to identify potential wetlands and water resources for Alternative 4. According to this data, the Alternative 4 site contains 17 NHD waterbodies, totaling approximately 5,110 linear feet (0.97 mile), and 19 NWI waterbodies, totaling approximately 22.61 acres (Table 3.3-8). This includes approximately

540.9 linear feet (0.10 mile) of the Brazos River and approximately 102.6 linear feet (0.02 mile) of Buffalo Camp Bayou, which are both classified as perennial streams.

Table 3.3-8. NWI and NDH Waterbodies within the Alternative 4 Site

Waterbody Type	Number of Features within Alternative 4 Site	Acreage/Feet
NHD Data		
Ephemeral Stream	15	4,466 feet
Perennial Stream	2	644 feet
NHD Subtotal	***17***	***5,110 feet***
NWI Data		
Freshwater Pond	10	10.66 acres
Lake	2	0.23 acre
Riverine	7	11.72 acres
NWI Subtotal	***19***	***22.61 acres***

Sources: USFWS (2021a), USGS (2021a).

If Alternative 4 is pursued, a wetland delineation would be required to confirm the locations of waterbodies. Additional waterbodies could be present within the Alternative 4 site.

3.3.4.2 WETLANDS

3.3.4.2.1 Proposed Action, Alternative 2A, and Alternative 2B

Wetlands are typically the most common special aquatic resources present and are defined by the Corps as “areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions” (EPA 2021b). Wetland functions serve to protect and improve water quality, provide fish and wildlife habitats, store floodwaters, and maintain surface water flow during dry periods. These valuable functions are the result of the unique natural characteristics of wetlands. For an area to be considered a wetland it must possess the following parameters under normal circumstances: 1) a predominance of vegetation adapted to live in water or saturated soils (i.e., hydrophytic vegetation), 2) soil characteristics of frequent saturation (i.e., hydric soils), and 3) the presence of hydrology showing evidence of regular flooding or ponding (i.e., wetland hydrology).

Prior to wetlands and WOUS surveys conducted in 2019 (SWCA 2019a), the USFWS NWI, USGS NHD data, historical USGS topographic quadrangles, and the most recently available FEMA FIRM data were reviewed to identify potential wetlands and water resources. The NWI depicts the presence of palustrine emergent (PEM) wetlands, palustrine scrub-shrub (PSS) wetlands, palustrine forested (PFO) wetlands, and palustrine unconsolidated bottom (PUB) wetlands within the Project site (USFWS 2021a).

According to Houston Wilderness (2019), the Project site is outside the current limits of the Columbia Bottomlands ecological area; however, the ecological area is not well defined, and the Project site has historically been mapped as bottomlands. Therefore, the 2019 wetland survey evaluated if any of the forested communities in the Project site are consistent with the descriptions of the historical Columbia Bottomlands. The survey concluded that Columbia bottomlands are not present in the Project site (SWCA 2019a).

A total of 23 wetlands totaling 21.38 acres were identified within the Project site, consisting of 16 PEM, three PSS, and four PFO wetlands (SWCA 2019a), all of which were verified by the Corps in 2019 (USACE 2019a) (Appendix F). The remaining areas were herbaceous, scrub-shrub, and forested uplands that did not meet the wetland criteria (see Figure 3.3-12).

The delineated wetlands were assessed to determine their functional capacities (FCIs) using the interim hydrogeomorphic functional assessment method (SWCA 2021a). FCIs quantify temporary storage of surface water, maintenance of plant and animal communities, and removal and sequestration of elements and compounds for each wetland to determine physical, biological, and chemical functions, respectively. FCIs are determined based on 10 variables and given a value between 0 and 1.

PEM wetland: PEM wetland communities consist of a prevalence of hydrophytic non-woody vegetation less than 3 feet in height. Dominant herbaceous species within the 9.624 acres of PEM wetlands (9.624 acres total) in the Project site include jungle-rice (*Echinochloa colona*), sand spike-rush (*Eleocharis montevidensis*), tall scouring-rush (*Equisetum hyemale*), common rush (*Juncus effusus*), golden crown grass (*Paspalum dilatatum*), mild water-pepper (*Persicaria hydropiper*), and swamp smartweed (*P. hydropiperoides*). These communities range from approximately 0.1 to 2.1 acres and may provide some minimal functional capacity for physical, chemical, and biological processes based on their FCIs that average between 0.5 and 0.6.

PSS wetland: PSS wetland communities consist of a prevalence of hydrophytic woody species less than 20 feet in height and 3 inches or greater in diameter at breast height (dbh). The three PSS wetlands (4.933 acres total) within the Project site are dominated by black willow (*Salix nigra*), poison-bean (*Sesbania drummondii*), and Chinese tallow (*Triadica sebifera*). Golden crown grass is the prevalent herbaceous species within these wetland communities. These wetland communities generally range from 0.1 to 0.3 acre with one exception of a wetland of 4.5 acres in the northwestern portion of the Project site. These PSS wetland communities may also provide some functional capacity for physical, chemical, and biological processes based on their FCIs, which average 0.6 (SWCA 2021a).

PFO wetland: PFO wetland communities consist of a prevalence of hydrophytic woody species greater than 20 feet in height and 3 inches in dbh. The 6.823 acres of PFO wetlands located on the Project site are dominated by tree and shrub species of pecan (*Carya illinoinensis*), sugarberry (*Celtis laevigata*), green ash (*Fraxinus pennsylvanica*), and American elm (*Ulmus americana*). The tree species found within these communities are typical of forested areas in the coastal plains; however, they do not appear to be consistent with remnants of the historical Columbia Bottomlands. These PFO wetland communities range between 1.6 and 3.1 acres with the exception of one that is less than 0.1 acre. They offer moderate functional capacity for physical, chemical, and biological processes based on the presence of small but dense patches of mast-producing mature trees that result in FCIs that average 0.7.

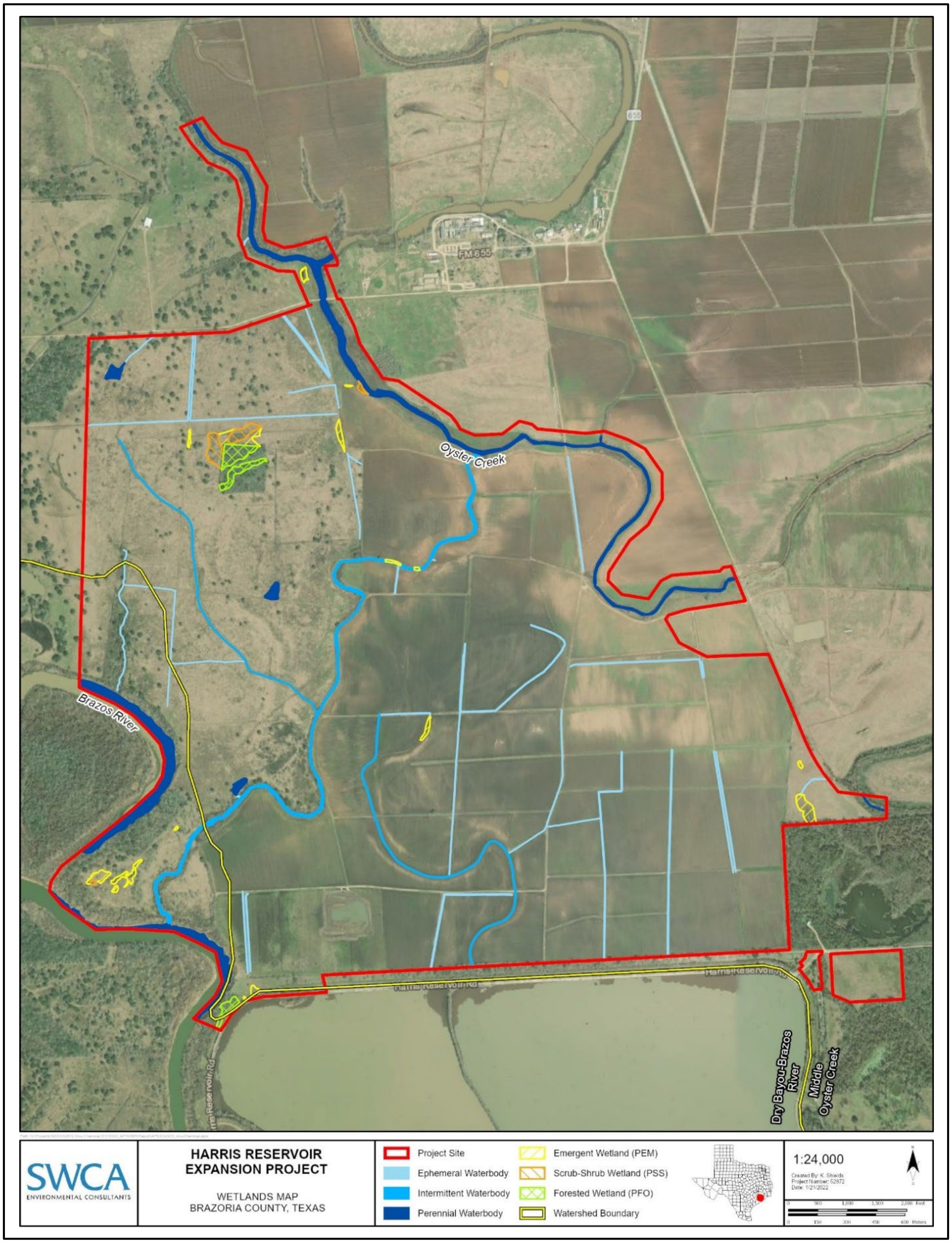


Figure 3.3-12. Wetlands and waterbodies delineated within the Project site.

3.3.4.2.2 Alternative 3

A desktop review of USFWS NWI (USFWS 2021a), USGS NHD data (USGS 2021b), historical USGS topographic maps (USGS 2021c), and the most recently available FEMA FIRM data (FEMA 2021a) were reviewed to identify potential wetlands and water resources for the Alternative 3 site (Figure 3.3-13). According to these data, the Alternative 3 site contains 144 NWI wetlands, totaling approximately 384.25 acres (Table 3.3-9).

Table 3.3-9. NWI Wetlands within the Alternative 3 Site

NWI Wetland Type	Number of Features within Alternative 3 Site	Acreage
Freshwater Emergent Wetland	121	350.70
Freshwater Shrub Wetland	1	0.43
Freshwater Forested Wetland	10	17.42
Palustrine Farmed*	12	15.70
Total	***144***	***384.25***

Source: USFWS (2021a).

Note: *Palustrine Farmed are defined as freshwater wetlands that occur where the soil surface has been mechanically or physically altered for production of crops, but where hydrophytes would become reestablished if the farming were discontinued. Farmed wetlands should be classified as Palustrine-Farmed.

If Alternative 3 is pursued, a wetland delineation would be required to confirm the locations and size of wetlands. Additional wetlands could be present within Alternative 3 site.

3.3.4.2.3 Alternative 4

A desktop review of USFWS NWI (USFWS 2021a), USGS NHD data (USGS 2021b), historical USGS topographic maps (USGS 2021c), and the most recently available FEMA FIRM data (FEMA 2021a) were reviewed to identify potential wetlands and water resources for the Alternative 4 site (Figure 3.3-14). According to these data, the Alternative 4 site contains 25 NWI wetlands, totaling approximately 199.15 acres (Table 3.3-10).

Table 3.3-10. NWI Wetlands within the Alternative 4 Site

NWI Wetland Type	Number of Features within Alternative 4 Site	Acreage
Freshwater Emergent Wetland	9	7.67
Freshwater Shrub Wetland	1	0.57
Freshwater Forested Wetland	15	190.91
Total	***25***	***199.15***

Source: USFWS (2021a).

If Alternative 4 is pursued, a wetland delineation would be required to confirm the locations and size of wetlands. Additional wetlands could be present within the Alternative 4 site.

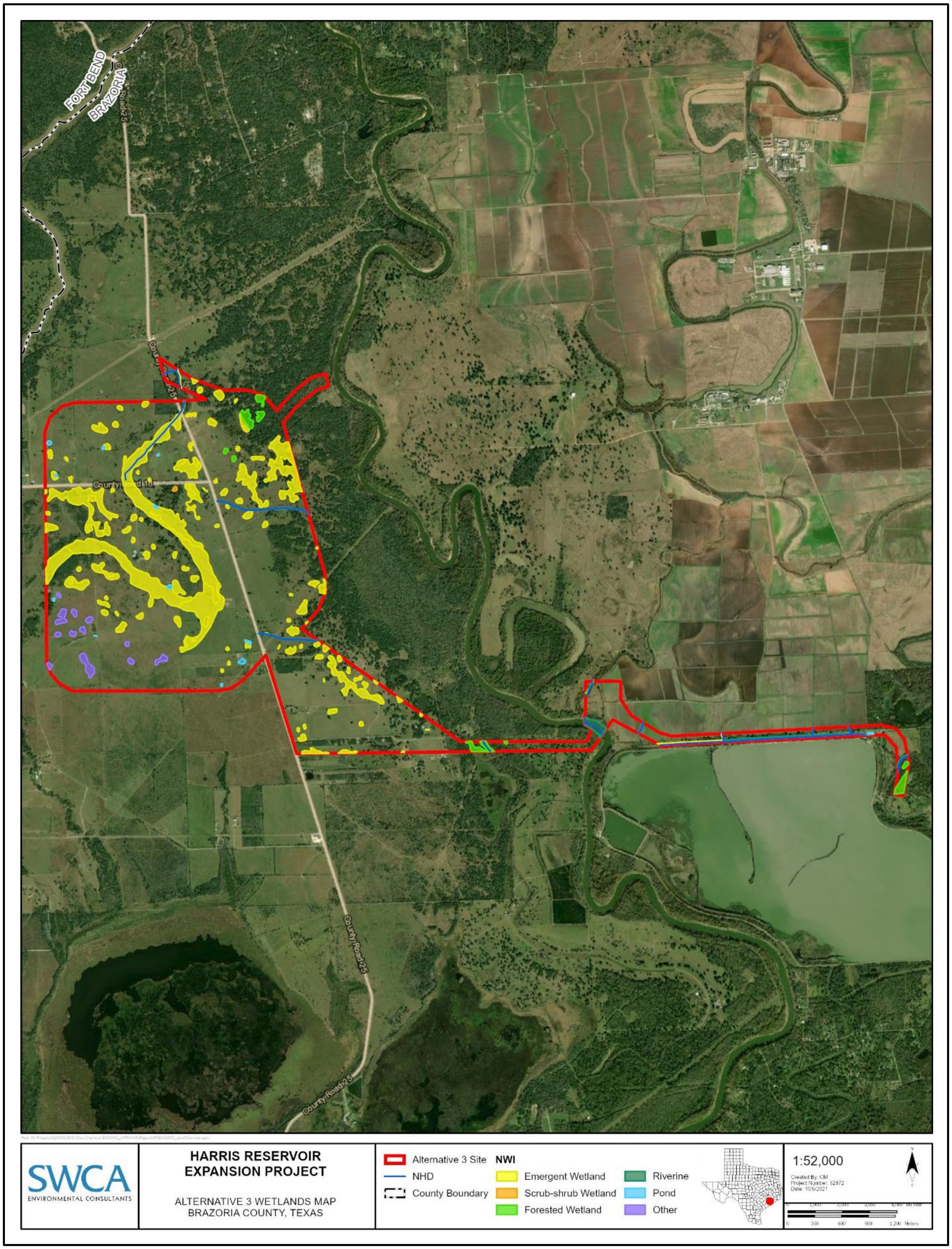


Figure 3.3-13. Potential wetlands and waterbodies within the Alternative 3 site.

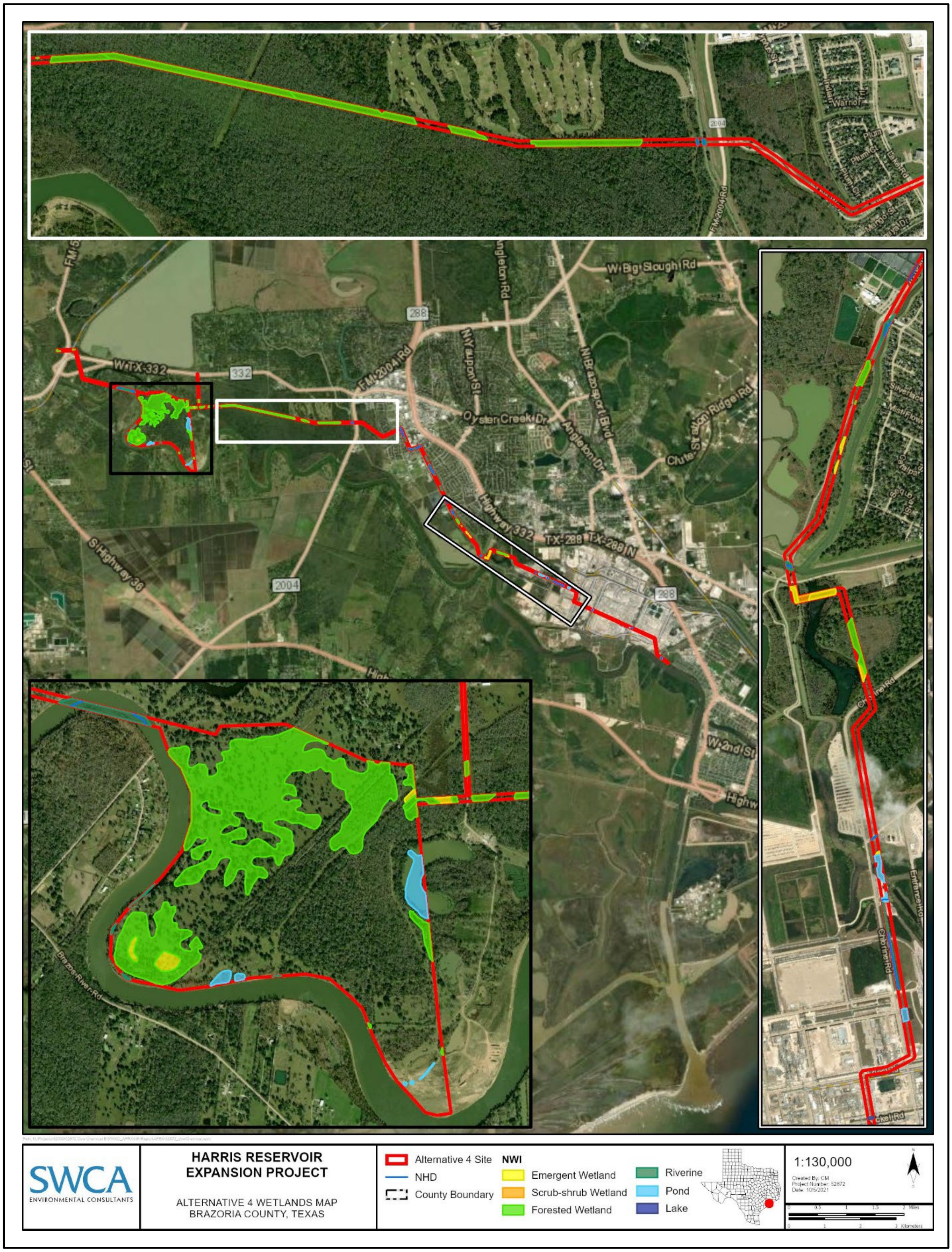


Figure 3.3-14. Potential wetlands and waterbodies within the Alternative 4 site.

3.3.5 Groundwater

3.3.5.1 PROPOSED ACTION, ALTERNATIVE 2A, AND ALTERNATIVE 2B

The Project site is above the central portion of the Gulf Coast Aquifer, which is one of nine major aquifers within the state of Texas (TWDB 2020c). The Gulf Coast Aquifer parallels the Texas Gulf Coastline from Louisiana to Mexico and consists of several discontinuous aquifer layers comprising sand, silt, clay, and gravel beds. The uppermost layer comprises the Chicot Aquifer, underlined by the Evangeline Aquifer and the Jasper Aquifer, with depths of freshwater to 1,000 feet deep (TWDB 2020c). The recharge zone and outcrop area for the Gulf Coast Aquifer are approximately 93 miles northwest of the Project site. Overall aquifer depth ranges from 1,300 feet deep in the northern limits to approximately 700 feet deep further south as it gets closer to Mexico (TWDB 2020c, 2020d). The general water quality of the aquifer within the central reach is considered good with TDS levels generally ranging less than 500 mg/L (TWDB 2020c). Primary uses of water from the Gulf Coast Aquifer include municipal, industrial, and irrigation.

The Gulf Coast Aquifer is both a confined and unconfined aquifer. It comprises three minor aquifers: Chicot Aquifer, Evangeline Aquifer, and the Jasper Aquifer. Based on the cross-section data for the Gulf Coast Aquifer (TWDB 2020d), the Chicot Aquifer, which lies under the Project site, is an unconfined aquifer with depths of up to approximately 600 feet. Immediately below the Chicot Aquifer lies the Evangeline Aquifer, which is also an unconfined aquifer with depths between 600 and 2,900 feet. Below the Evangeline Aquifer lies the Burkeville confining unit, which is approximately 700 feet thick below the Project site (with depths between 2,900 and 3,600 feet). Under the Burkeville confining unit lies the Jasper Aquifer (3,600–4,700 feet in depth), which is considered a confined aquifer and is sandwiched between the Burkeville confining unit and the Catahoula confining unit described below. The cross-section data presented for the Gulf Coast Aquifer (TWDB 2020d) show the Catahoula confining unit extending down from 4,700 to 7,600 feet; however, the cross-section map limits the depth of data presented at 7,600 feet, and it is likely that within the Project site, the Catahoula confining unit extends farther down to depths of 9,000 feet or more (Figure 3.3-15). Beneath the Catahoula confining unit lies pre-Miocene rocks in which hydrocarbon (oil/gas) pockets can be found in Pre-Miocene source beds.

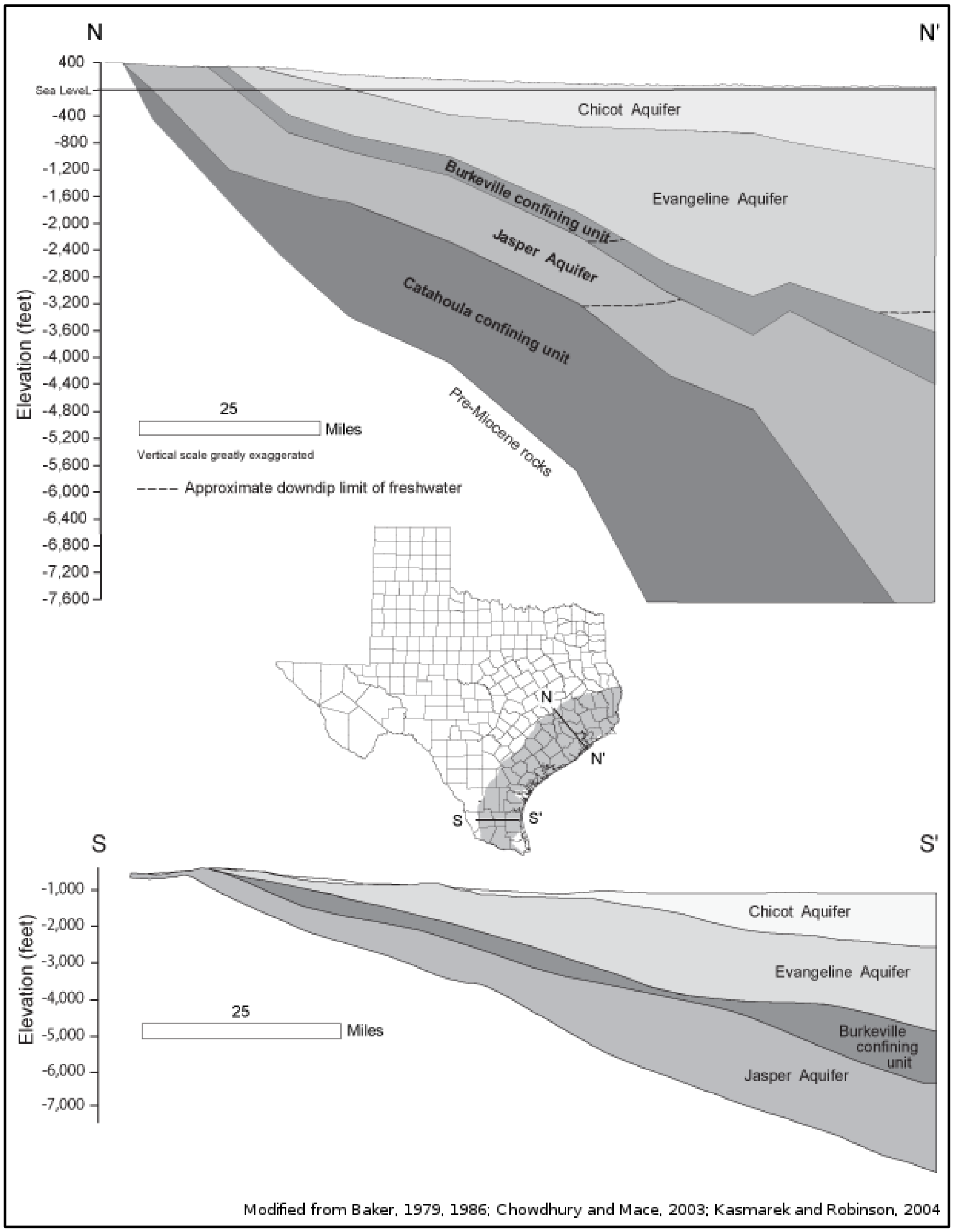


Figure 3.3-15. Cross-section data for the Gulf Coast Aquifer (TWDB 2020d).

Groundwater depths under the Project site depend on various conditions including rainfall, irrigation, flowing surface waters (i.e., streams, rivers), surface water storage (i.e., ponds, lakes, reservoirs), and surface water runoff. Geotechnical borings conducted for the proposed reservoir encountered groundwater at depths ranging from 8 to 38 feet (Fugro 2013a, 2013b, 2013c). Shallow groundwater depths between 8 and 14 feet were encountered in the central to southern-central portion of the proposed reservoir with groundwater depths increasing from 16 to 38 feet along the western and northern Project site limits and within the eastern Project site limits as shown in Figure 3.3-16 (Fugro 2013a, 2013b, 2013c).

The TCEQ Groundwater Contamination Viewer does not show any active groundwater contamination cases for the Project site (reporting years 2015–2017) (TCEQ 2020e). Nearest reported groundwater contamination sites are 2 miles south of the Project site and 4.3 miles northeast of the Project site (both reported in 2015; TCEQ 2020e) and also 5.5 miles west of the Project site (reported in 2015 and 2017) (TCEQ 2020e). Within the Project site there is one groundwater monitoring well (#341808) that was drilled in by Dow in 2013. The purpose of the well was to determine static groundwater elevations; no sampling was ever performed on the well, and as of May 2020, the well had not been plugged.

Eleven oil and gas wells on the Project site have been plugged (see Table 3.2-1). The oil and gas well depths far exceed the aquifer depth for drawing freshwater and all of them have been plugged. The wells identified for the Project site exceed down to depths of more than 9,800 feet, indicating that these wells are deeper than the confining layer depths of both the Burkeville and Catahoula confining layers.

There are also 25 water wells identified within 1 mile of the Project site (see Figure 3.3-16); 15 of these are for domestic use, two are for public supply use, two are for irrigation use, three are for stock tank use, one is for energy rig supply use, and the two remaining have been plugged or destroyed (TCEQ 2019b). The existing groundwater resources serve as a suitable drinking water supply for residents and livestock surrounding the Project site, with 80% of the wells within 1 mile of the Project site used for public supply, domestic, and stock tank uses.

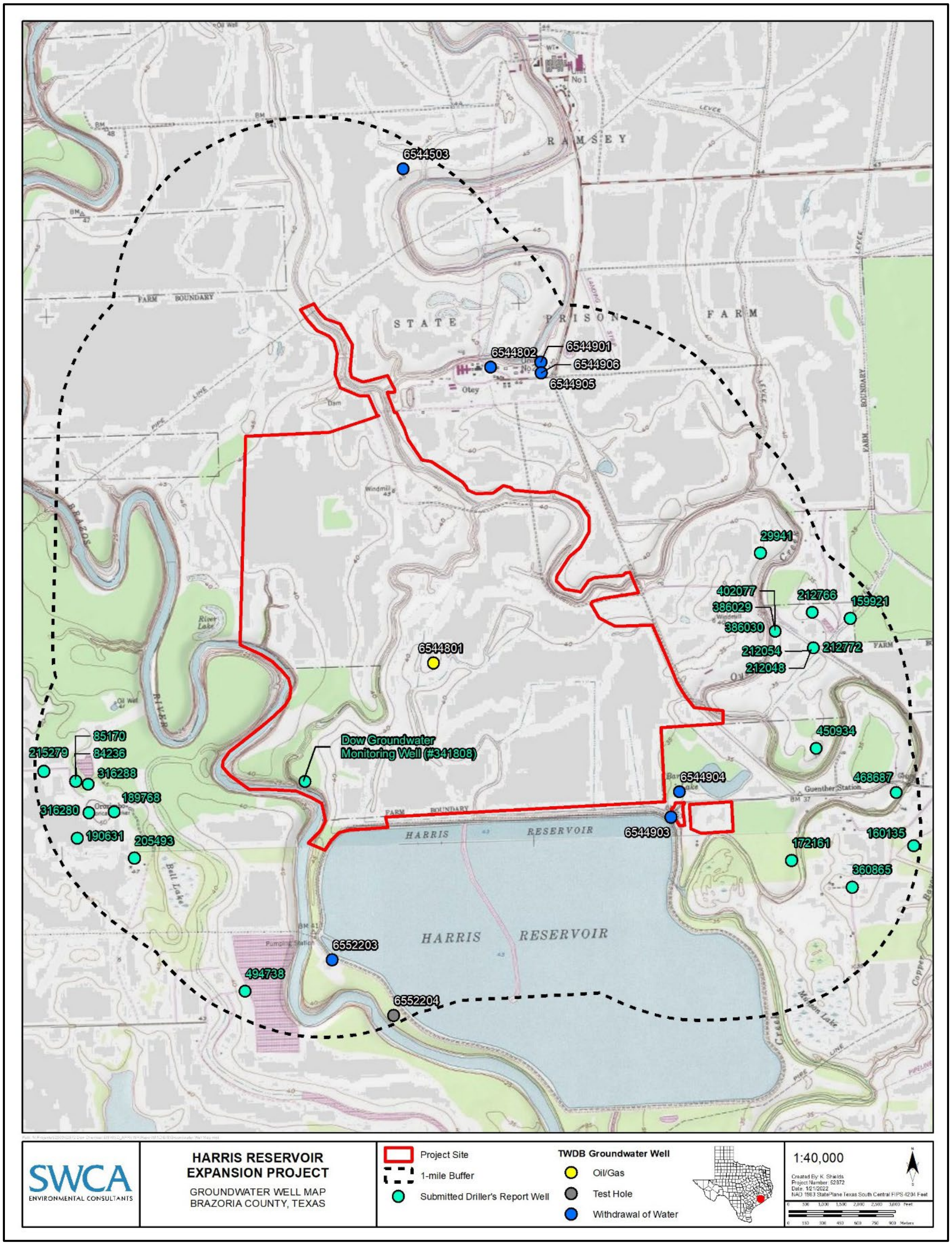


Figure 3.3-16. Water wells in and within 1 mile of the Project site.

3.3.5.2 ALTERNATIVE 3

The Alternative 3 site is 2 miles west of the Project site on the west side of the Brazos River and is also above the central portion of the Gulf Coast Aquifer.

The TCEQ Groundwater Contamination Viewer does not show any active groundwater contamination cases for the site (reporting years 2015–2017) (TCEQ 2020e). Nearest reported groundwater contamination sites are 2 miles west of the Alternative 3 site and 4.3 miles northeast of the site (both reported in 2015) (TCEQ 2020e) and also 5.5 miles west of the site (reported in 2015 and 2017; TCEQ 2020e). Within the Alternative 3 site there is one groundwater monitoring well (#341808) that was drilled in by Dow in 2013.

Ten oil and gas wells on the Alternative 3 site have been plugged (see Table 3.2-3). Six of the wells do not have records for well depths and the others are dry wells. The dry wells identified for the Alternative 3 site exceed down to depths of more than 9,800 feet deep, indicating that these wells are deeper than the confining layer depths of both the Burkeville and Catahoula confining layers.

There are also 37 water wells identified within 1 mile of the Alternative 3 site (Figure 3.3-17); 24 of these are for domestic use, two are for irrigation use, seven are for stock tank use, one is for energy rig supply use, one is for industrial use, one is listed as other, and the one remaining is a monitoring well (TWDB 2021). The existing groundwater resources serve as a suitable drinking water supply for residents and livestock surrounding the site, with 84% of the wells within 1 mile of the site used for domestic and stock tank uses.

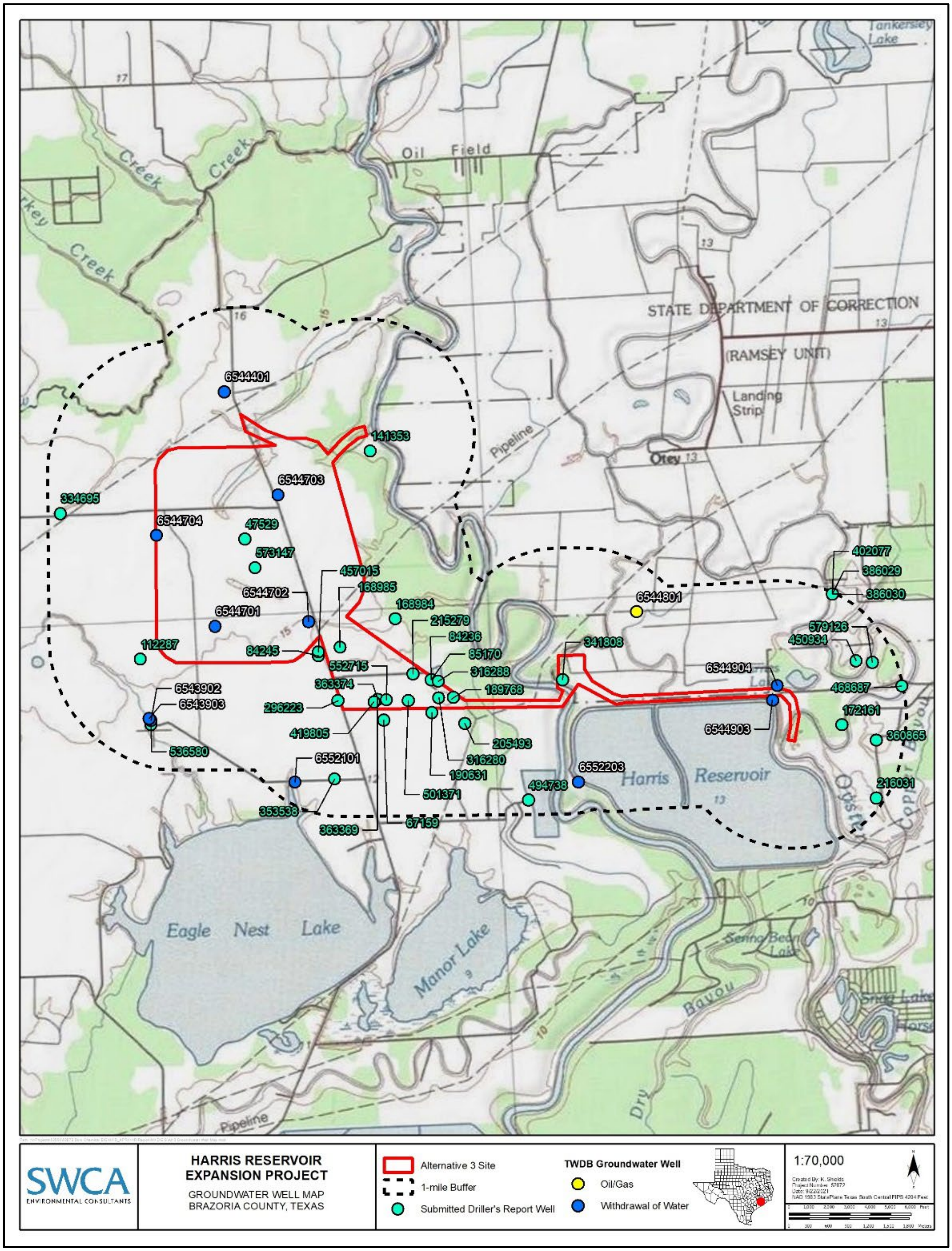


Figure 3.3-17. Water wells in and within 1 mile of the Alternative 3 site.

3.3.5.3 ALTERNATIVE 4

The Alternative 4 site is 13 miles south of the Project site on the east side of the Brazos River and is also above the central portion of the Gulf Coast Aquifer.

The TCEQ Groundwater Contamination Viewer does not show any active groundwater contamination cases for the Alternative 4 site (reporting years 2015–2017) (TCEQ 2020e). Nearest reported groundwater contamination sites are approximately 4.5 miles east of the plant site and 4.3 miles northeast of the site (both reported in 2014; TCEQ 2020e) and also approximately 7.0 miles southeast of the plant site (reported in 20145 and 2017; TCEQ 2020e). There are no groundwater monitoring wells within the Alternative 4 site.

There are also 261 water wells identified within 1 mile of the Alternative 4 site (Figure 3.3-18); 157 of these are for domestic use, 44 are monitoring wells, nine are for public supply use, 10 are for irrigation use, four are for stock tank use, three are industrial, and 34 are other uses (TWDB 2021). The existing groundwater resources serve as a suitable drinking water supply for residents and livestock surrounding the Alternative 4 site, with 65% of the wells within 1 mile of the site used for public supply, domestic, and stock tank uses. Domestic wells average 401 feet in depth.

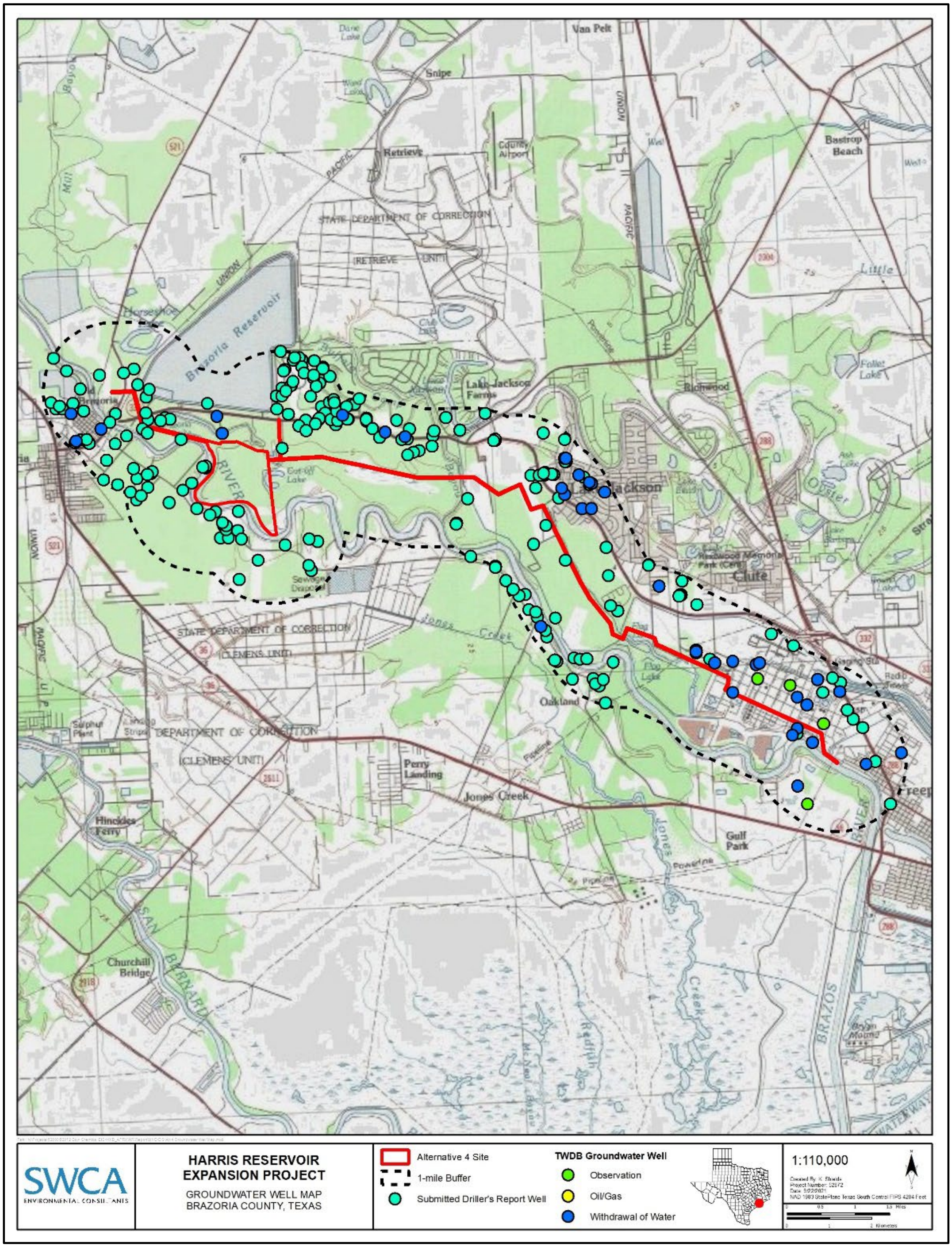


Figure 3.3-18. Water wells in and within 1 mile of the Alternative 4 site.

3.4 Vegetation

The analysis area for Sections 3.4 through 3.8 was developed using the analysis area in the Water Quality Section 3.3.1.3, as well as ecoregions discussed in Section 3.4.1.1. The analysis area comprises the Brazos River from the Rosharon USGS stream gage to the Buffalo Camp Bayou Dam and portions of Oyster Creek to the dam/pump station at Lake Jackson, as well as the Big Slough mitigation site (Figure 3.4-1).

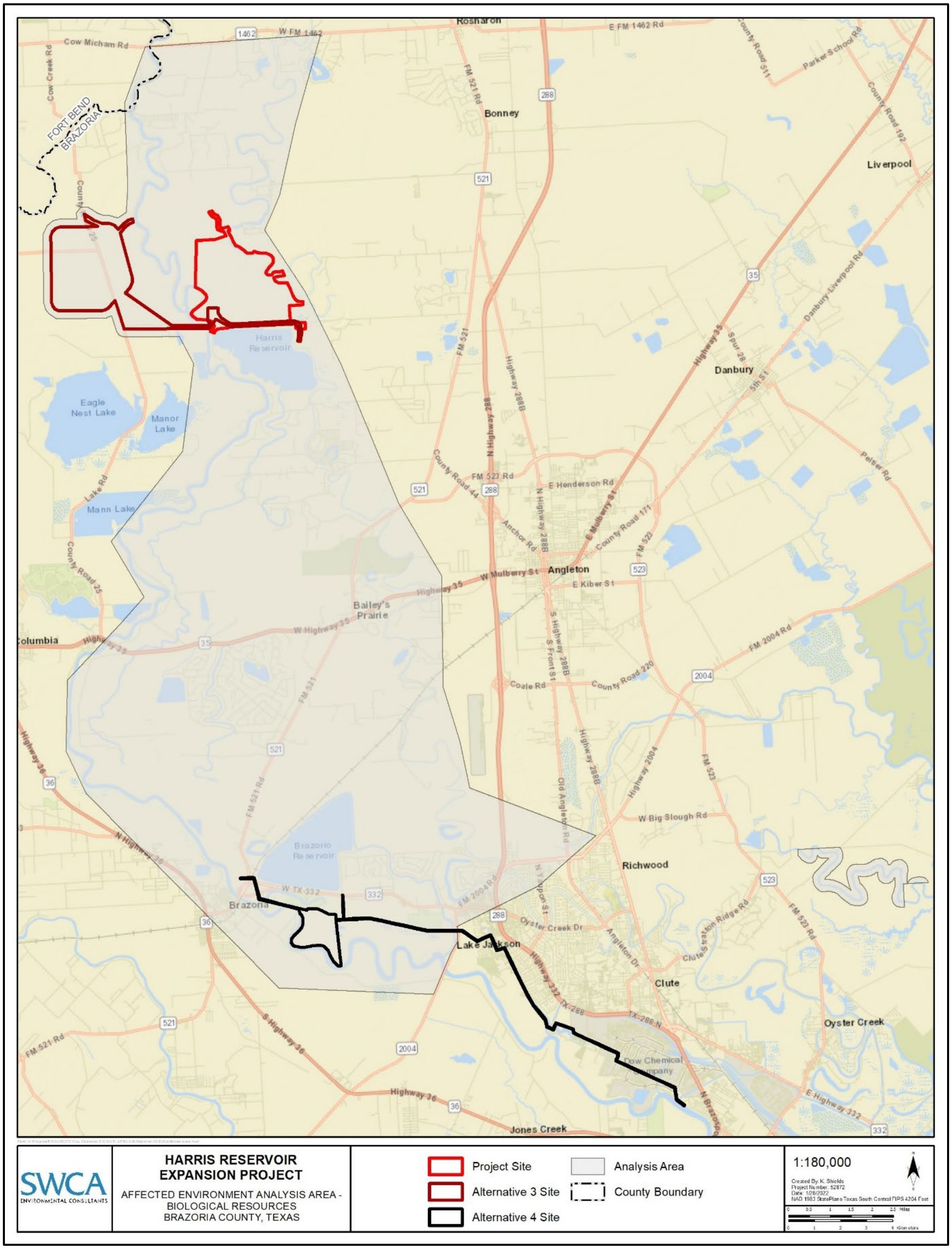


Figure 3.4-1. Biological resources analysis area.

3.4.1 Terrestrial

3.4.1.1 PROPOSED ACTION, ALTERNATIVE 2A, AND ALTERNATIVE 2B

The Project site is located within the Texan Biotic Province, a subhumid (aridity increases from east to west) mosaic of forest and grassland with very little excess rain and one in which the soils and waters heavily influence the spatial distribution of vegetation communities (Blair 1950). According to a more recent classification of ecoregions (Griffith et al 2007), the Project site is located within the Floodplains and Low Terraces (Level IV) ecoregion of the Western Gulf Coastal Plain (Level III), characterized by little topography (Figure 3.4-2). Mixed forest and savannah vegetation communities are found toward inland areas and grassland communities are found toward the coast. The forest vegetation communities are predominantly bottomland forests (Griffith et al. 2007; McMahan et al. 1984) with some gradual changes in tree species composition in terraced areas and along larger streams. Within the Floodplains and Low Terraces ecoregion are floodplains and bottomland hardwood forest vegetation communities along rivers (including the Brazos) and adjacent streams and creeks (including Oyster Creek) that make up the Columbia Bottomlands ecosystem (Rosen et al. 2008; TPWD 2019a). Columbia Bottomlands are ecologically important for migratory neotropical birds, wintering waterfowl, and bald eagles (*Haliaeetus leucocephalus*), and it is designated as an Aquatic Resource of National Importance (Rosen et al. 2008; TPWD 2019a; USACE 2021). Under Regional Condition 15c, Columbia Bottomlands are designated as a WOUS and are thus protected from unauthorized discharges (USACE 2017a). Uplands located in the Columbia Bottomlands are not subject to federal regulations associated with Section 404 of the CWA. Surveys confirmed the Project site is not located within the Columbia Bottomlands (see Figure 3.4-2) (USACE 2017b; SWCA 2019a); however, they may occur downstream.

The low relief and soil types in the Floodplains and Low Terraces ecoregion make it well suited for agriculture and floodplain forest. Much of the ecoregion, including most of the Project site, has been converted to cropland and pasture (Table 3.4-1). Dominant crops are rice (*Oryza sativa*), grain, soybean (*Glycine max*), sorghum (*Sorghum bicolor*), and cotton (*Gossypium hirsutum*) (Griffith et al. 2007). The 2016 NLCD shows that 79.6% of the Project site consists of agricultural land covers (i.e., pasture/hay or cultivated crop); grassland/herbaceous land cover makes up 13.4%; and forest, scrub-shrub, wetlands, and waterbodies make up the remaining 6.9% (Yang et al. 2018) (see Figure 3.4-2 and Table 3.4-1).

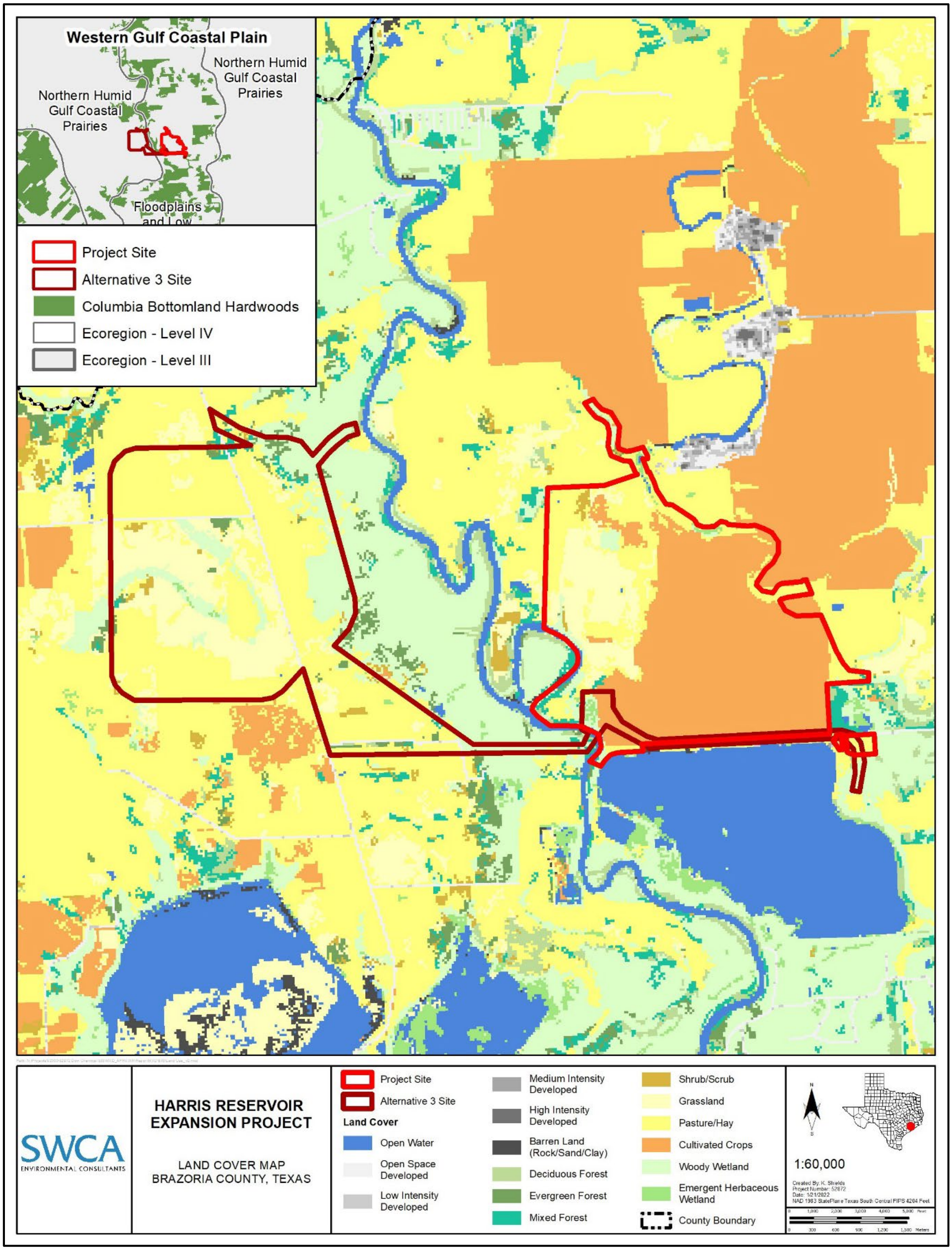


Figure 3.4-2. Ecoregions and land cover in and near the Project site and Alternative 3 site.

Table 3.4-1. Land Cover Types Within the Project Site

NLCD (2016) Land Cover Type	Project Site (acres)	Project Site (%)	Alternative 3 Site (acres)	Alternative 3 Site (%)	Alternative 4 Site (acres)	Alternative 4 Site (%)
Deciduous forest	8.2	0.3%	5.1	0.2%	26.0	3.5%
Evergreen forest	3.1	0.1%	57.7	2.0%	115.8	15.8%
Mixed forest	20.4	0.8%	30.2	1.0%	9.6	1.3%
Shrub/scrub	14.0	0.6%	29.5	1.0%	12.5	1.7%
Grassland/herbaceous	339.9	13.4%	620.3	21.5%	7.8	1.1%
Emergent herbaceous wetlands	82.4	3.3%	16.3	0.6%	7.6	1.0%
Woody wetlands	21.8	0.9%	433.0	15.0%	394.7	53.9%
Open water	27.2	1.1%	4.8	0.2%	13.6	1.9%
Pasture/hay	523.9	20.7%	1,552.5	53.8%	37.6	5.1%
Cultivated crops	1,490.2	58.9%	73.1	2.5%	5.9	0.8%
Barren land (rock/sand/clay)	0.2	0.01%	0.0	0.0%	7.0	1.0%
Developed, open space	1.7	0.01%	62.9	2.2%	94.8	12.9%
Total	**2,533.0**	**100%**	**2,885.4**	**100.0%**	**732.8**	**100.0%**
Total Aggregate Land Covers						
Forest (deciduous, mixed, evergreen)	31.8	1.2%	93.0	3.2%	151.4	20.7%
Wetlands and Waterbodies * (emergent herbaceous wetlands, woody wetlands, open water)	131.3	5.2%	454.1	15.7%	415.9	56.7%
Agricultural (pasture/hay, cultivated crops)	2,014.0	79.6%	1,625.6	56.3%	43.5	5.9%
Developed (low intensity, medium intensity, high intensity, developed open space)	1.7	0.01%	62.9	2.2%	94.8	12.9%

Source: Yang et al. (2018).

* Acreage based on land cover in Yang et al. (2018). Field delineated WOUS acreage differs and is quantified in Section 3.3.4.

Three upland vegetation communities—herbaceous upland, scrub-shrub upland, and forested uplands—were documented during the 2019 wetland delineation for the proposed Project (SWCA 2019a). Herbaceous upland communities consist of non-wetland areas dominated by non-woody vegetation. Dominant herbaceous species documented in the Project site (Table 3.4-2) include those commonly associated with pasturelands (Ragsdale and Welch 2000). Scrub-shrub upland communities consist of woody vegetation less than 20 feet in height and 3 inches or greater in dbh.

Forested uplands consist of a prevalence of non-wetland woody species greater than 3 inches in dbh. Forested uplands in the Project site are consistent with the Coastal Plains but do not bear the hallmarks of the Columbia Bottomlands, which contain old-growth wetland forest species such as green ash, cedar elm (*Ulmus crassifolia*), Carolina laurel cherry (*Prunus caroliniana*), water hickory (*Carya aquatica*), water oak (*Quercus nigra*), and an understory dominated by swamp-privet (*Forestiera acuminata*) and buttonbush (*Cephalanthus occidentalis*) (Rosen et al. 2008; SWCA 2019a). Historical Columbia Bottomlands communities have a high diversity of native plant species (Rosen et al. 2008), whereas the forested uplands communities in the Project site contain a low diversity and exotic species such as Bermuda grass (*Cynodon dactylon*) and golden crown grass (Ragsdale and Welch 2000; SWCA 2019a).

The agriculture crops in the Project site provide economic value, and some of the other plant species, such as great ragweed (*Ambrosia trifida*), tumble windmill grass (*Chloris verticillata*), poison-bean, and mast-producing tree species (i.e., produces seeds, nuts, fruits), native to Texas, provide economic and ecological values because they are moderate to well-suited for grazing of livestock and/or wildlife (Ragsdale and Welch 2000). However, several plant species in the Project site are listed as invasive, noxious, and/or exotic (e.g., Bermuda grass, golden crown grass, Johnsongrass [*Sorghum halepense*], and Chinese tallow) and have been introduced to Texas for agriculture, ranching, or commercial purposes (Texas Department of Agriculture 2019; TexasInvasives.org 2021).

No federally listed or state-listed plant species; plant species listed as a Species of Greatest Conservation Need; or rare, unique, and imperiled vegetation communities (TPWD 2011, 2019b, 2019c) were observed during 2019 Project site field surveys.

Table 3.4-2. Dominant Upland Plant Species in the Project Site

Upland Vegetation Community	Common Name	Scientific Name
Herbaceous	Careless weed	*Amaranthus palmeri*
	Great ragweed	*Ambrosia trifida*
	Tumble windmill grass	*Chloris verticillate*
	Bermuda grass*	*Cynodon dactylon*
	Jungle-rice	*Echinochloa colona*
	Sand spike-rush	*Eleocharis montevidensis*
	Petticoat-climber	*Eragrostis spectabilis*
	Annual marsh-elder	*Iva annua*
	Long-leaf basket grass	*Oplismenus hirtellus*
	Santa maria feverfew	*Parthenium hysterophorus*
	Golden crown grass*	*Paspalum dilatatum*
	Poison-bean	*Sesbania drummondii*
	Johnsongrass*	*Sorghum halepense*
	St. Augustine grass	*Stenotaphrum secundatum*
	Soybean	*Glycine max*
	Cotton	*Gossypium hirsutum*
	Corn	*Zea mays*
Shrub	Poison-bean	*Sesbania drummondii*
Tree	Pecan	*Carya illinoensis*
	Sugarberry	*Celtis laevigata*
	American elm	*Ulmus americana*
	Southern live oak	*Quercus virginiana*

Source: SWCA (2019a).
* Invasive, noxious, and/or exotic.

Land cover in the off-site Big Slough mitigation site is 36.7% wetland and waterbodies, 31.1% forest, 19.3% shrub/scrub, 11.4% grassland/herbaceous, and 1.5% developed (Yang et al. 2018). Herbaceous wetlands are the most predominant wetland community and are dominated by woodrush flatsedge (*Cyperus entrerianus*), green flatsedge (*Cyperus virens*), common spikerush (*Eleocharis palustris*), alligatorweed (*Alternanthera philoxeroides*), *Sagittaria* sp., and southern cutgrass (*Leersia hexandra*) (Cardno 2021). Tidal wetlands are dominated by gulf cordgrass (*Spartina spartinae*), saltmeadow cordgrass (*Spartina patens*), annual marsh elder (*Iva annua*), Virginia glasswort (*Salicornia virginica*), and turtleweed (*Batis maritima*). Uplands are dominated by southern live oak (*Quercus virginiana*), common hackberry (*Celtis occidentalis*), yaupon (*Ilex vomitoria*), Macartney rose (*Rosa bracteata*), and St. Augustine grass (*Stenotaphrum secundatum*). Chinese tallow (*Triadica sebifera*) is an invasive species with a substantial presence throughout the site.

3.4.1.2 ALTERNATIVE 3

Ecoregions and regional landcover in the Alternative 3 site are similar to the Proposed Action (see Figure 3.4-2). Land cover in the Alternative 3 site is predominately pasture/hay (53.8%), grassland/herbaceous (21.5%), and woody wetlands (15.0%) (see Table 3.4-1). No field surveys have occurred; however, due to the location, dominant vegetation in these communities is expected to be similar to the Proposed Action Project site (see Table 3.4-2). Like the Proposed Action Project site, the Alternative 3 site is mostly agricultural, but with more pasture/hay than crops. No federally listed or state-listed plant species; plant species listed as a Species of Greatest Conservation Need; or rare, unique, and imperiled vegetation communities are known to occur there. The 400-acre Nash Prairie Preserve is 500 feet to the south and protects untouched native prairie with potentially sensitive plants. Although the Alternative 3 site appears to be altered prairie based on aerial imagery, biological surveys have not been completed and native prairie habitat could be present.

3.4.1.3 ALTERNATIVE 4

Ecoregions and regional landcover in the Alternative 4 site differ slightly from the Proposed Action. Land cover in the Alternative 4 site is predominately categorized as woody wetland (53.9%) and evergreen forest (15.8%) (Figure 3.4-3; see Table 3.4-1). This alternative is located in an area mapped as Columbia Bottomlands (see Figure 3.4-3). Columbia bottomland hardwoods are designated as an Aquatic Resource of National Importance (Rosen et al. 2008; TPWD 2019a; USACE 2021). As stated for the Proposed Action and Alternative 2, Columbia Bottomlands are designated as a WOUS under Regional Condition 15c and are thus protected from unauthorized discharges (USACE 2017a). Uplands located in the Columbia Bottomlands are not subject to federal regulations associated with Section 404 of the CWA.

No field surveys have occurred; however, due to the location, the herbaceous vegetation communities are expected to be similar to the Proposed Action Project site (see Table 3.4-2). Unlike the Proposed Action Project site, the Alternative 4 site and surrounding area contains more forested and woody vegetation than agricultural cover. No federally listed or state-listed plant species; plant species listed as a Species of Greatest Conservation Need; but Columbia Bottomlands are expected to occur in the Alternative 4 site and vicinity.

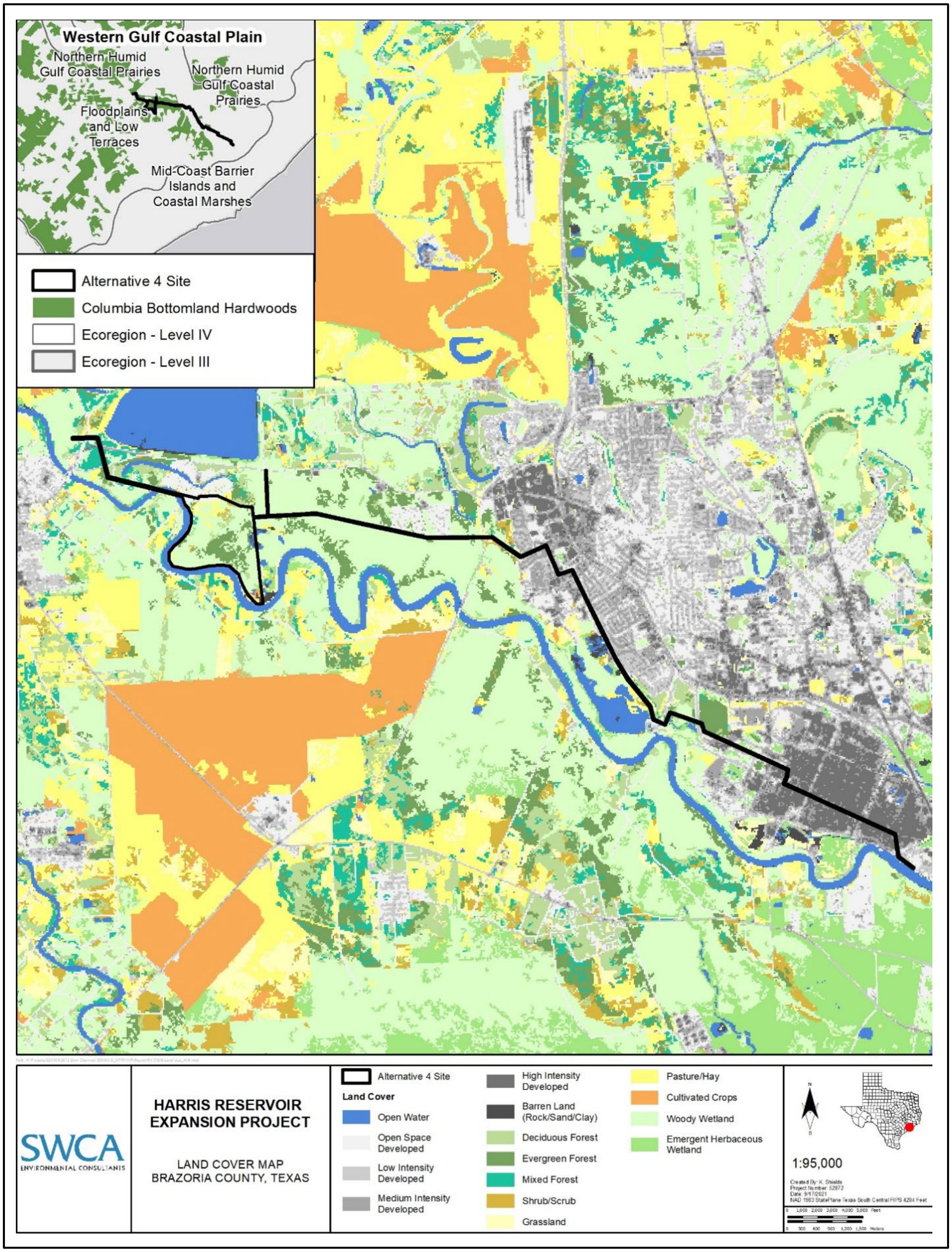


Figure 3.4-3. Ecoregions and land cover in and near the Alternative 4 site.

3.4.2 Aquatic

3.4.2.1 PROPOSED ACTION, ALTERNATIVE 2A, AND ALTERNATIVE 2B

Wetlands are described in Section 3.3.4. Delineated PEM wetlands on the Project site consist of a prevalence of hydrophytic non-woody vegetation less than 3 feet in height. The dominant herbaceous species in the Project site's PEM wetlands include jungle-rice, sand spike-rush, tall scouring-rush, common rush, golden crown grass, mild water-pepper, and swamp smartweed (SWCA 2019a, 2019b). PSS wetland communities consist of a prevalence of hydrophytic woody species less than 20 feet in height and 3 inches or greater in dbh. The dominant woody species in the Project site's PSS wetlands include black willow, poison-bean, and Chinese tallow, whereas golden crown grass dominates the herbaceous stratum. PFO wetland communities consist of a prevalence of hydrophytic woody species greater than 20 feet in height and 3 inches in dbh. The dominant tree and shrub species in the Project site's PFO wetlands include pecan, sugarberry, green ash, and American elm. These species are typical of forested areas in the Coastal Plains but do not appear to be consistent with remnants of the historical Columbia Bottomlands. Tree density in the Project site's PFO wetlands is 100 to 200 trees per acre.

3.4.2.2 ALTERNATIVE 3

As described in Section 3.3.4, NWI wetlands on the Alternative 3 site consist of Freshwater Emergent Wetland, Freshwater Shrub Wetland, and Freshwater Forested Wetland habitats totaling 384.3 acres. No field surveys have occurred, but the plant species found in the wetlands are expected to be similar to those described for the Proposed Action.

3.4.2.3 ALTERNATIVE 4

As described in Section 3.3.4, NWI wetlands in the Alternative 4 site consist of Freshwater Emergent Wetland, Freshwater Shrub Wetland, and Freshwater Forested Wetland habitats totaling 199.2 acres. No field surveys have occurred, but the plant species found in the wetlands are expected to be similar to those described for the Proposed Action.

3.5 Wildlife

3.5.1 Terrestrial

3.5.1.1 PROPOSED ACTION, ALTERNATIVE 2A, AND ALTERNATIVE 2B

As discussed in Section 3.4.1.1, the Project site is located within the Floodplains and Low Terraces (Level IV) ecoregion of the Western Gulf Coastal Plain (Level III) (see Figure 3.4-2) (Griffith et al. 2007). The Western Gulf Coastal Plains historically contained wildlife associated with tallgrass prairie and savannah ecosystems, including bison (*Bison bison*), pronghorn (*Antilocapra americana*), white-tailed deer (*Odocoileus virginianus*), bobcat (*Lynx rufus*), mountain lion (*Puma concolor*), various species of rodents, rabbits, nine-banded armadillo (*Dasypus novemcinctus*), and game birds such as the Attwater's prairie chicken (*Tympanuchus cupido attwateri*) (Griffith et al. 2007). Bottomland forests within the ecoregion historically contained a variety of herpetofauna (i.e., amphibians and reptiles) represented more so by snakes, turtles, frogs, and salamanders (and less so by lizards); waterfowl; and red wolf (*Canis rufus*) (Blair 1950; Griffith et al. 2007). Jaguar (*Panthera onca*) and ocelot (*Leopardus pardalis*) were also present historically toward the southern subtropical portions of the coastal prairie (Blair 1950).
The faunal diversity in the Western Gulf Coastal Plains ecosystem (see Section 3.4.1.1) has shifted toward species adapted to landscapes converted for agriculture, ranching, and urban development

(Griffith et al. 2007). Because of agriculture and grazing in the Project site, none of the habitats are likely to serve as specialized resources to wildlife. Of the 52 mammal species known to occur in Brazoria County (TPWD 2019b; USFWS 2019a), 26 species may occur in or around the Project site (Table 3.5-1). These species tend to have broad distributions and secure populations.

Although herpetofaunal diversity of Brazoria County may exceed 100 species (TPWD 2019b; USFWS 2019a), few herpetofauna are expected to be present in the Project site because of the dominance of agriculture and pasturelands. Most herpetofaunal species that may occur (see Table 3.5-1) are associated with forest, riparian, and pasture habitats. Avifauna is discussed in Section 3.5.3 (Migratory Birds), Section 3.6.2.3 (Threatened and Endangered Species, Birds), and Section 3.8.2 (State-Listed Wildlife, Birds).

Table 3.5-1. Wildlife Species that May Occur within the Project Site

Taxonomic Group	Common Name	Scientific Name
Mammals	Southern short-tailed shrew	*Blarina carolinensis*
	Coyote	*Canis latrans*
	Hispid pocket mouse	*Chaetodipus hispidus*
	Nine-banded armadillo	*Dasypus novemcinctus*
	Virginia opossum	*Didelphis virginiana*
	Southern flying squirrel	*Glaucomys volans*
	Hoary bat	*Lasiurus cinereus*
	Striped skunk	*Mephitis*
	Nutria†	*Myocastor coypus*
	Eastern woodrat	*Neotoma floridana*
	White-tailed deer*	*Odocoileus virginianus*
	Marsh rice rat	*Orzyomys palustris*
	Deer mouse	*Peromyscus maniculatus*
	Eastern pipestrelle	*Pipistrellus subflavus*
	Northern raccoon	*Procyon lotor*
	Roof rat	*Rattus fattus*
	Fulvous harvest mouse	*Reithrodontomys fulvescens*
	Eastern harvest mouse	*Reithrodontomys humulis*
	Eastern mole	*Scalopus aquaticus*
	Eastern gray squirrel	*Sciurus carolinensis*
	Eastern fox squirrel	*Sciurus niger*
	Hispid cotton rat	*Sigmodon hispidus*
	Feral hog†	*Sus scrofa*
	Swamp rabbit	*Sylvilagus aquaticus*
	Eastern cottontail	*Sylvilagus floridanus*
	Brazilian free-tailed bat	*Tadarida brasiliensis*

Taxonomic Group	Common Name	Scientific Name
Amphibians	Blanchard's cricket frog	*Acris blanchardi*
	Cope's gray tree frog	*Hyla chrysoscelis*
	Green tree frog	*Hyla cinereal*
	Gulf coast toad	*Incilius nebulifer*
	American bullfrog	*Lithobates catesbeiana*
	Spring peeper	*Pseudacris crucifer*
Reptiles	Northern cottonmouth*	*Agkistrodon piscivorus*
	American alligator*	*Alligator mississippiensis*
	Green anole	*Anolis carolinensis*
	Brown anole	*Anolis sagrei*
	Pallid spiny softshell	*Apalone spinifera pallida*
	Rough earth snake	*Haldea striatula*
	Eastern hog-nosed snake	*Heterodon platirhinos*
	Western coachwhip	*Masticophis flagellum*
	Broad-banded watersnake*	*Nerodia fasciata*
	Texas ratsnake	*Pantherophis obsoletus*
	Ground skink	*Scincella lateralis*
	Western ribbon snake*	*Thamnophis proximus*
	Red-eared slider*	*Trachemys scripta elegans*

Sources: TPWD (2019b); USFWS (2019a).
* Observed on-site in 2019 (SWCA 2019b)
† Evidence observed on-site in 2019 (SWCA 2019b).

Field surveys conducted on the Project site in 2019 included observations of white-tailed deer, watersnake (*Nerodia fasciata*), western ribbon snake (*Thamnophis proximus*), northern cottonmouth (*Agkistrodon piscivorus*), red-eared slider (*Trachemys scripta elegans*), and several American alligators (*Alligator mississippiensis*) (SWCA 2019b). Evidence of presence of feral hog (*Sus scrofa*) and nutria (*Myocastor coypus*) was noted. Terrestrial species at the Big Slough mitigation site are likely similar to those that may occur in the Project site.

3.5.1.2 ALTERNATIVE 3

The Alternative 3 site is 2 miles west of the Proposed Action Project site on the west side of the Brazos River. Since the habitat is similar, the terrestrial wildlife that may occur in the Alternative 3 site are the same as described for the Proposed Action. The 400-acre Nash Prairie Preserve is 500 feet to the south and protects untouched native prairie containing a variety of prairie bird species and other wildlife.

3.5.1.3 ALTERNATIVE 4

The Alternative 4 site is 13 miles south of the Project site along the Brazos River. Unlike the other sites, which are dominated by crops and pasture, the Alternative 4 site is predominately woody wetlands and evergreen forest, including Columbia Bottomland habitat. The terrestrial wildlife that may occur in the Alternative 4 site is the same as described for the Proposed Action, but it would likely have greater species richness and diversity. More species associated with forested and bottomland habitats, such as herpetofauna, are likely to occur compared to the Proposed Action Project site. The pipelines that cross through urban/developed lands indicate wildlife would be limited to species commonly found in residential areas.

3.5.2 Aquatic

3.5.2.1 PROPOSED ACTION, ALTERNATIVE 2A, AND ALTERNATIVE 2B

A robust and detailed discussion on the aquatic environment in and around the Project site is in Section 3.3. As described in Section 3.3, there are 11 streams in the Project site including the Brazos River, Oyster Creek, and Jennings Bayou (SWCA 2019a). There are also 22 agricultural ditches, five ditches, and three ponds. The Level I and Level II stream condition assessments conducted for 31 ephemeral channels and three intermittent channels, respectively, included assessments of biotic integrity based on assemblages of fishes and macroinvertebrates sampled (SWCA 2019b). All of the streams were assessed as either ephemeral or intermittent and thus unable to support aquatic life year-round. Most had low condition assessment scores associated with limited riparian buffer, channel erosion and alteration, and generally low biotic integrity indices (SWCA 2019b). Table 3.5-2 lists 24 fish species and 19 aquatic macroinvertebrate taxa identified during the assessments and includes an additional 15 species that could occur in the Project site and surrounding waterbodies based on data from a 1987 fisheries use assessment of Oyster Creek (Linam and Kleinsasser 1987) and NatureServe Explorer (2019a). Commercial or game fish species are further discussed in Section 3.5.4. Aquatic species at the Big Slough mitigation site are likely similar to those that may occur in the Project site.

None of the aquatic species listed in Table 3.5-2 have habitat requirements specific to the Project site. Many are ubiquitous species tolerant of poor physiochemical conditions, high turbidity, pulse flow events, and harsh environmental conditions (e.g., low dissolved oxygen, pollutants) (Linam and Kleinsasser 1987; Winemiller et al. 2010). For example, surveys conducted on the Project site in 2019 (SWCA 2019b) noted the dominance of the western mosquitofish (*Gambusia affinis*), a species tolerant of poor water quality (Linam and Kleinsasser 1987). The surveys were conducted on September 17, 20, 23, 24, and 25, 2019, during tropical storm Imelda, which may have influenced the presence of larger fish species such as alligator gar (*Atractosteus spatula*), largemouth bass (*Micropterus salmoides*), and suckermouth and channel catfishes (*Hypostomus plecostomus* and *Ictalurus punctatus*) (SWCA 2019b).

Table 3.5-2. Aquatic Species that Occur or May Occur within the Project Site

Taxonomic Group	Common Name (Order, Family)	Scientific Name
Documented Species		
Fish	Yellow bullhead	*Ameiurus natalis*
	Pirate perch	*Aphredoderus sayanus*
	Alligator gar	*Atractosteus spatula*
	River carpsucker	*Carpiodes carpio*
	Red shiner	*Cyprinella lutrensis*
	Common carp	*Cyprinus carpio*
	Gizzard shad	*Dorosoma cepedianum*
	Threadfin shad	*Dorosoma petenense*
	Western mosquitofish	*Gambusia affinis*
	Mississippi silvery minnow	*Hygobognauthus nuchalis*
	Suckermouth catfish	*Hypostomus plecostomus*
	Channel catfish	*Ictalurus punctatus*
	Brook silverside	*Labidesthes sicculus*
	Green sunfish	*Lepomis cyanellus*
	Warmouth	*Lepomis gulosus*
	Orangespotted sunfish	*Lepomis humilis*
	Bluegill	*Lepomis macrochirus*
	Longear sunfish	*Lepomis megalotis*
	Redear sunfish	*Lepomis microlophus*
	Largemouth bass	*Micropterus salmoides*
	Striped mullet	*Mugil cephalus*
	Blue tilapia	*Oreochromis aureus*
	Sailfin molly	*Poecilia latipinna*
	White crappie	*Pomoxis annularis*

Taxonomic Group	Common Name (Order, Family)	Scientific Name
Macroinvertebrates	Asian clam	*Corbicula fluminea*
	Crayfish species (Cambaridae)	–
	Damselfly species (Zygoptera)	–
	Diving beetle species (Coleoptera)	–
	Dragonfly species (Anisoptera)	–
	Gilled snail species (Caenogatropoda)	–
	Grass shrimp species (Decapoda)	–
	Horse fly (Diptera)	–
	Leech species (Hirudinea)	–
	Lunged snail (Heterbranchia)	–
	Mayfly species (Ephemeroptera)	–
	Midge fly species (Chironomidae)	–
	Mussel species (Heterodonta)	–
	Riffle beetle species (Elmidae)	–
	Scud (Amphipoda)	–
	Sow bug species (Isopoda)	–
	Toebiter (Hemiptera)	–
	Water boatman species (Heteroptera)	–
	Watersnipe fly (Athericidae)	–
	Whirligig beetle (Gyrinidae)	–
Potentially occurring species	Goldfish	*Carassius auratus*
	Blacktail shiner	*Cyprinella venusta*
	Threadfin shad	*Dorosoma petenense*
	Slough darter	*Etheostoma gracile*
	Golden topminnow	*Fundulus chrysotus*
	Blackstripe topminnow	*Fundulus notatus*
	Blue catfish	*Ictalurus furcatus*
	Smallmouth buffalo	*Ictiobus bubalus*
	Spotted gar	*Lepisosteus oculatus*
	Tidewater silverside	*Menidia peninsulae*
	Golden shiner	*Notemigonus crysoleucas*
	Silverband shiner	*Notropis shumardi*
	Tadpole madtom	*Noturus gyrinus*
	Pugnose minnow	*Opsopoeodus emiliae*
	Bullhead minnow	*Pimephales vigilax*

Sources: Linam and Kleinsasser (1987); NatureServe Explorer (2019a); SWCA (2019b).

Of the 53 species of mussel native to Texas, seven species have been documented in the San Jacinto-Brazos Coastal Basin and 33 species have been documented in the Brazos River Basin (Winemiller et al. 2010). The Texas fawnsfoot (*Truncilla macrodon*) is a candidate for federal listing and is state-listed as threatened (TPWD 2019b; USFWS 2019b, 2021d). This species has been documented in the Brazos

River Basin but was not observed during the 2019 stream assessment; it is further discussed in Section 3.6.2.5 (Threatened and Endangered Species, Mollusks). The smooth pimpleback (formerly considered *Cyclonaias houstonensis*) is now the Texas pimpleback (*Cyclonaias pustulosa*) (Johnson et al. 2018); this change resulted in the removal of this species from the federal list of threatened and endangered species (USFWS 2019d). However, the Texas pimpleback is still listed as a distinct species with a state-listed status as threatened (TPWD 2019b). The Texas pimpleback has also been documented in the Brazos River Basin but was not observed during the 2019 stream assessment; it is further discussed in Section 3.8.4 (State-Listed Wildlife, Mollusks).

During the 2019 stream assessment (see Table 3.5-2), the invasive Asian clam (*Corbicula fluminea*) was observed in Jennings Bayou, and an unidentified mussel species (Heterodonta) was documented in an unnamed tributary of Jennings Bayou (SWCA 2019b).

Surveys for freshwater mussels along a 500-foot segment of the Brazos River were conducted in October 2012 (HDR Engineering, Inc. [HDR] 2012) approximately 560 feet downstream of the existing Harris Reservoir water intake structure. The surveys were conducted in water depths of 4 feet or less, within 5 to 7 feet from the water's edge. No evidence of live mussel, shell, or shell fragments was observed (HDR 2012). The survey report concluded that the absence of fine substrates appeared to be the primary limiting factor affecting the presence of mussels within this section of the river. In addition, shallow shoreline areas were composed of very dense, hard-packed clay, which may be unsuitable for mussel colonization (HDR 2012). Additional mussel surveys are scheduled for the Brazos River near the Project site.

3.5.2.2 ALTERNATIVE 3

The Alternative 3 site is 2 miles west of the Project site on the west side of the Brazos River. Since the habitat is similar, the aquatic wildlife that may occur in the Alternative 3 site is the same as described for the Proposed Action.

3.5.2.3 ALTERNATIVE 4

The Alternative 4 site is 13 miles south of the Project site along the Brazos River. Since the river habitat is similar, the aquatic wildlife that may occur at the Alternative 4 site is expected to be similar to that described for the Proposed Action. There are two lakes on the Alternative 4 site, a small lake and the 22-acre Cut Off Lake that provide habitat for fish and other aquatic wildlife.

3.5.3 Migratory Birds

3.5.3.1 PROPOSED ACTION, ALTERNATIVE 2A, AND ALTERNATIVE 2B

The Migratory Bird Treaty Act (MBTA) provides protection for all avian species native to the United States and its territories (16 USC 703–712). The USFWS is responsible for enforcing the MBTA:

> The MBTA provides that it is unlawful at any time, by any means or in any manner, to pursue, hunt, take, capture, kill, attempt to take, capture or kill, possess, offer for sale, sell, offer to purchase, purchase, deliver for shipment, ship, cause to be shipped, deliver for transportation, transport, cause to be transported, carry, or cause to be carried by any means whatsoever, receive for shipment, transportation or carriage, or export, at any time, or in any manner, any migratory bird, included in the terms of this Convention . . . for the protection of migratory birds . . . or any part, nest, or egg of any such bird. (16 USC 703)

The MBTA was enacted in response to four international conventions addressing observed declines of migratory birds due to commercial trade of feathers, un-regulated hunting practices, and other factors. Almost all native birds in the United States are protected by the MBTA, including many non-migratory, year-round residents.

The USFWS published a new rule on January 7, 2021, which became effective on March 8, 2021, stating, "that the MBTA's prohibitions on pursuing, hunting, taking, capturing, killing, or attempting to do the same, apply only to actions directed at migratory birds, their nests, or their eggs" (USFWS 2021b:49875–49880). However, on October 4, 2021, the USFWS (USFWS 2021b:54642) announced a final rule revoking the rule published on January 7, 2021, and removing the regulations that codified the interpretations of the of the MBTA set forth in the January 7, 2021, rule (50 CFR 10.14). The current interpretation by the USFWS per the revocation of the January 7, 2021, rule is the prohibition of the unintentional killing or taking of migratory birds, subject to applicable court precedent.

Birds protected by the MBTA occur in every habitat type, and nests may be found in trees and on forest floors, in grassland or shrubland, and in uplands and wetlands. The avian diversity within the Project site is expected to be low because of the extent of pasture and agriculture land cover. Birds that generally inhabit crops and rangeland include icterids like the red-winged blackbird (*Agelaius phoeniceus*) and brown-headed cowbird (*Molothrus ater*), and other common species like the cattle egret (*Bubulcus ibis*). Reservoirs, such as the Harris Reservoir, attract many wading birds (e.g., heron, ibis, egret) that may or may not use the surrounding agricultural crop fields and reservoir edges for nesting and foraging. Other shorebirds (e.g., sandpipers, stilts) and waterfowl (e.g., ducks, geese) may use Harris Reservoir at various times of the year. Sandhill cranes (*Grus canadensis*) may occur in large numbers in crop fields, like those present in the Project site, during the winter months. In the spring and fall there may be a higher concentration of migrating songbirds (e.g., warblers, flycatchers, vireos) in the area, with concentrations higher during spring migration (USFWS 2013). During the fall season in Brazoria County, there is an increased number of raptors (e.g., hawks, kites) like the northern harrier (*Circus hudsonius*), red-tailed hawk (*Buteo jamaicensis*), broad-winged hawk (*Buteo platypterus*), merlin (*Falco columbarius*), and white-tailed hawk (*Buteo albicaudatus*) (USFWS 2013). Bald eagles use habitat (wooded tree lines near waterbodies) within Brazoria County year-round. During the fall 2019 field surveys, several species of birds with broad ranges and ubiquitous distributions were observed (Table 3.5-3) (SWCA 2019a, 2019b). Bald eagle and wood stork (*Mycteria americana*) are further discussed in Section 3.8.2 (State-Listed Wildlife, Birds).

Table 3.5-3. List of Bird Species Documented within the Project Site in Fall 2019

Common Name	*Scientific Name*
Great egret	*Ardea alba*
Great blue heron	*Ardea herodias*
Cattle egret	*Bubulcus Ibis*
Red-tailed hawk	*Buteo jamaicensis*
Red-shouldered hawk	*Buteo lineatus*
Northern crested caracara	*Caracara cheriway*
Northern cardinal	*Cardinalis*
Turkey vulture	*Cathartes aura*
Black vulture	*Coragyps atratus*
Blue jay	*Cyanocitta cristata*
Bald eagle	*Haliaeetus leucocephalus*

Common Name	*Scientific Name*
Northern mockingbird	*Mimus polyglottos*
Wood stork	*Mycteria americana*
House sparrow*	*Passer domesticus*
Roseate spoonbill	*Platalea ajaja*
Common grackle	*Quiscalus quiscula*
Bank swallow	*Riparia*
Eastern phoebe	*Sayornis phoebe*
Eastern meadowlark	*Sturnella magna*
European starling*	*Sturnus vulgaris*
Carolina wren	*Thryothorus ludovicianus*
Mourning dove	*Zenaida macroura*

Sources: SWCA (2019a, 2019b), USFWS (2020a:21262).
*Species not protected under the MBTA

3.5.3.2 ALTERNATIVE 3

The Alternative 3 site is 2 miles west of the Project site on the west side of the Brazos River and contains habitat similar to the Project site. Therefore, the migratory bird species that may occur on the Alternative 3 site are the same as described for the Proposed Action.

3.5.3.3 ALTERNATIVE 4

The Alternative 4 site is 13 miles south of the Project site along the Brazos River. Because habitats on the Project site and the Alternative 4 site are similar, many of the same migratory bird species described for the Proposed Action may be present. However, the Alternative 4 site has less pasture and cropland and contains more forested habitat including mapped Columbia Bottomlands. In addition, there are two small lakes on this site. These habitat differences could result in presence of migratory bird species that are associated with the forested habitats or Columbia Bottomlands.

3.5.4 Commercial Game Animals

3.5.4.1 PROPOSED ACTION, ALTERNATIVE 2A, AND ALTERNATIVE 2B

In Texas, game animals, including game and nongame fish, are regulated and protected by both the USFWS in accordance with the Fish and Wildlife Conservation Act (16 USC 2901-2911) and the Fish and Wildlife Coordination Act (16 USC 661-666c), and by the TPWD in accordance with TPWD Code Section 12.0011 – Resource Protection. A valid hunting license is required for any person who hunts “any animal, bird, frog or turtle” (TPWD 2019d) within the state of Texas, with some exceptions made for certain nuisance or widely common wildlife species. The TPWD issues all hunting licenses and associated stamps or permits (TPWD 2019e). Open hunting season and permit requirements for game animals vary by species (see TPWD 2019e for exact dates). For migratory birds, legal shooting hours (e.g., sunrise/sunset hours) apply. The period from one-half hour before sunrise to one-half hour after sunset are the legal hours for hunting migratory birds (TPWD 2019e).

There are no public hunting grounds or fishing grounds in or near the Project site (TPWD 2019f); however, several commercial game species were documented during 2019 surveys, including American alligator, feral hog, eastern cottontail (*Sylvilagus floridanus*), squirrels, white-tailed deer, and mourning dove (*Zenaida macroura*) (SWCA 2019b). There are two public hunting grounds in Brazoria County near the Gulf Coast: Nannie M. Stringfellow Wildlife Management Area near Cedar Lane, Texas, and Justin Hurst Wildlife Management Area near Freeport, Texas (TPWD 2019d).

The Brazos River, Harris Reservoir, and Oyster Creek may be used for recreational fishing. Commercial game fish species (TPWD 2019g) documented in the Project site include blue catfish (*Ictalurus furcatus*), channel catfish, largemouth bass, and white crappie (*Pomoxis annularis*) (see Table 3.5-2) (Linam and Kleinsasser 1987; SWCA 2019b).

3.5.4.2 ALTERNATIVE 3

The Alternative 3 site is 2 miles west of the Project site on the west side of the Brazos River and has habitat similar to the Project site. Therefore, game species that may occur on the Alternative 3 site are the same as those described for the Proposed Action. Hunting may occur on private ranches within and around the site.

3.5.4.3 ALTERNATIVE 4

The Alternative 4 site is 13 miles south of the Project site on private land along the Brazos River. Commercial upland game species and game fish species that may occur there are expected to be similar to those described for the Proposed Action. Catch and release fishing occurs on the adjacent church property according to their website (https://cornerstonecotn.org/amenities/fishing).

3.5.5 Invasive Wildlife

3.5.5.1 PROPOSED ACTION, ALTERNATIVE 2A, ALTERNATIVE 2B, ALTERNATIVE 3, AND ALTERNATIVE 4

EO 13112 defines invasive species as “alien species whose introduction does or is likely to cause economic or environmental harm to human health,” and an alien species as any species that is “not native to that ecosystem.” Invasive species compete with native animals for resources and habitat, which can result in the loss or reduction of biodiversity. Invasive species can also affect industries such as agriculture, ranching, fishing, mariculture, and more, which can negatively affect the economy (Union of Concerned Scientists 2002). In Texas, there are 10 invasive mammals, seven invasive freshwater fishes, four invasive bird species, 11 invasive insect species, and 11 invasive mollusks and crustacean species (Union of Concerned Scientists 2002), as well as other invasive amphibian, reptile, and invertebrate species. Table 3.5-4 lists the invasive wildlife species that are known to occur in Brazoria County and provides the likelihood of their occurrence in or near the Project site and Alternative sites.

Table 3.5-4. Invasive Animal Species Known to Occur in Brazoria County, Texas

Common Name ***Scientific Name***	**General Ecology**	**Threats**	**Potential to Occur**
Mammals			
Brown rat/Norway rat *Rattus norvegicus*	Human-made structures; marshy open fields with tall vegetation.	Outcompetes native species; carries various diseases.	May occur in Project site and Alternative sites
Feral hog/wild boar *Sus scrofa*	Sizeable, free-ranging populations occur in the Rio Grande and Coastal Plains, and in wooded areas of eastern Texas.	Destroys native vegetation and soils, which can cause a shift in plant succession.	Documented in Project site; may occur in Alternative sites
House mouse *Mus musculus*	Lives near humans.	In the wild, may cause destruction to native habitat.	May occur in Project site and Alternative sites
Nutria *Myocastor coypus*	Semi-aquatic mammal that looks similar to the North American beaver (*Castor canadensis*).	Damages over a million dollars' worth of sugarcane and rice annually. Has been used as a tool in Texas for aquatic vegetation control; however, it can overpopulate an area destroy native habitats.	Documented in Project site; may occur in Alternative sites
Birds (not protected under MBTA)			
House sparrow/common sparrow *Passer domesticus*	Lives near humans and in human-made environments.	Evicts native bird species from their nests and from nearby areas.	Documented in Project site; may occur in Alternative sites
European starling *Sturnus vulgaris*	Lives near humans and in human-made environments.	Outcompetes native cavity nesting birds, evicting them from their nests; contaminates crops; can cause aircraft strikes; and transmits diseases to humans and livestock (e.g., avian salmonellosis) (Linz et al. 2007).	Documented in Project site; may occur in Alternative sites
Eurasian collared-dove *Streptopelia decaocto*	Open agricultural, suburban, or coastal areas. Avoids heavily forested habitats and urbanized cities.	Aggressive competitor to native doves and other dove species. Can spread parasites to native doves or to larger birds of prey that hunt them.	May occur in Project site and Alternative sites
Rock dove *Columba livia*	Occurs in human-made environments and agriculture (Lowther and Johnston 2014).	Nuisance pest in metropolitan areas, may carry parasites.	May occur in Project site and Alternative sites

Common Name ***Scientific Name***	**General Ecology**	**Threats**	**Potential to Occur**
Reptiles			
Brown anole *Anolis sagrei*	Commonly pet that may escape into the wild and expand upon native lizard habitat.	Displaces and reduces native green anole (*Anolis carolinensis*) populations, may transmit invasive parasites or disease to native lizards.	May occur in Project site and Alternative sites
Mediterranean house gecko *Hemidactylus turcicus*	Commonly pet that may escape into the wild and expand upon native lizard habitat.	Highly resistant to pesticides and able to establish significant populations, consuming native lizards' resources.	May occur in Project site and Alternative sites
Fish			
Armored catfish *Hypostomus plecostomus* and *Pterygoplichthys anisitsi*	Freshwater and some brackish water habitats and can withstand a wide range of ecological conditions.	Can survive salinities up to 10 parts per trillion, allowing them to invade brackish habitats. Forage on algae and invertebrate species, out-compete native fauna.	Documented in Project site; may occur in Alternative sites
Asian carp *Cyprinidae* spp.	Various cyrprinid fishes from the Asian continent have been introduced into native waters in Texas. Highly adaptable and can live in waters with fluctuating turbidity, temperature, pH, and dissolved oxygen levels.	Consumes a substantial amount of food, outcompeting native fish for resources; can alter aquatic vegetation and water flow.	May occur in Project site and Alternative sites
Blue tilapia *Oreochromis aureus*	Freshwater and some brackish water habitats and can withstand a wide range of ecological conditions. Broad tolerances for pH, oxygen, and warm temperatures.	Outcompetes native sunfishes, shiners, minnow, and topminnows for food and spawning areas.	Documented in Project site; may occur in Alternative sites
Mollusks			
Apple snail *Pomacea maculata*	Large mollusk that lives in slow-moving streams and can reproduce quickly.	Feeds on rice seedlings, which causes great economic damage to Texas rice crops. Carries parasites, which could infect humans and cause fatal damage if eaten.	May occur in Project site and Alternative sites
Asian clam *Corbicula fluminea*	Small freshwater bivalve mussel that is found in most streams of Texas. Can withstand extreme water conditions, making it a successful invasive species of streams, rivers, lakes, and reservoirs (Howells 2014).	Larvae in water enter power plants where they become full-grown clams clogging tubes, pipes, and other equipment; cause economic damage to energy industry.	Documented in Project site; may occur in Alternative sites
Insects			
Africanized honeybee *Apis mellifera scutellate*	A hybrid of the European honeybee (*Apis mellifera*) and the Africa honeybee (*Apis mellifera scutellata*). Found in native bee habitats.	Displaces native bees by forcing them from their hives; economic threat to honey industry. Aggressive, reproduces year-round, and resistant to pesticides, making it a successful invader.	May occur in Project site and Alternative sites
Invasive aphids Aphididae spp.	Aphid species are generally associated with a specific host plant.	Causes loss of millions of dollars within agricultural industry by feeding on the host plant or transmitting exotic parasites to host plants.	May occur in Project site and Alternative sites
Cactus moth *Cactoblastis cactorum*	Use native *Opuntia* cactus species; develop within cactus pads and feed on the internal tissue (Galveston Bay Invasives 2019).	Causes eradication of cactus detrimental to native moths and butterflies.	May occur in Project site and Alternative sites

Common Name ***Scientific Name***	**General Ecology**	**Threats**	**Potential to Occur**
Red imported fire ant *Solenopsis invicta*	Rain forests, disturbed areas, deserts, grasslands, alongside roads and buildings, and in electrical equipment.	Destroys landscaping and native range. Displace native ants. Attack small ground-nesting birds, mammals, lizards, amphibians, and insects.	Documented in Project site; may occur in Alternative sites
Tawny crazy ant/raspberry crazy ant *Nylanderia fulva*	Landscaping and electrical equipment. Currently limited to coastal counties.	Destroys landscaping, harms small wildlife such as native ground-nesting birds by taking over the native environment. Damage electrical equipment.	May occur in Project site and Alternative sites

Source: TexasInvasives.org (2021)

3.6 Federally Listed Species

3.6.1 Bald and Golden Eagle Protection Act

The bald eagle is protected by the federal Bald and Golden Eagle Protection Act (BGEPA). The BGEPA prohibits the taking, possessing, or transporting of bald and golden eagles (or their parts, nests, or eggs) without authorization from the USFWS. Under the BGEPA, *take* is defined as actions that pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest, or disturb bald or golden eagles (16 USC 668–668c; 50 CFR 22.3). A permit, issued by USFWS on behalf of the Secretary of the Interior, is required for any activities that may result in the taking of bald and golden eagles. The bald eagle is also state-listed and is further discussed in Section 3.8 (State-Listed Wildlife Species).

3.6.2 Threatened and Endangered Species

3.6.2.1 PROPOSED ACTION, ALTERNATIVE 2A, ALTERNATIVE 2B, ALTERNATIVE 3, AND ALTERNATIVE 4

The ESA prohibits *take* of federally listed threatened and endangered plant and animal species (hereafter referred to as *Listed Species*) and protects the critical habitats designated to those Listed Species from federal actions or any actions with a federal nexus. 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 USC 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). Listed plants are not protected from take, although it is illegal to collect or maliciously harm them on federal land. Protection from commercial trade and the effects of federal actions do apply to listed plants.

If a Listed Species may be affected by a federal action, even if entirely beneficial, consultation (either formal or informal) with the USFWS is necessary as required by Section 7(a) of the ESA. If an action is not likely to adversely affect a Listed Species or designated critical habitat, informal consultation may be conducted and then a USFWS concurrence letter can be issued. If an action is likely to adversely affect a Listed Species or designated critical habitat, formal Section 7 consultation must be initiated with the USFWS. If a single Listed Species or designated critical habitat triggers formal Section 7 consultation, all Listed Species and designated critical habitats are considered during the formal process. Further, the USFWS must ensure that actions are not likely to jeopardize the continued existence of any Listed Species or result in the destruction or adverse modification of designated critical habitats.

The USFWS and the NMFS are responsible for administering the ESA and implementing the ESA Section 7 consultation process. The USFWS consults on terrestrial and freshwater aquatic plants and animals, whereas the NMFS consults on marine aquatic animals and anadromous fish.

For Listed Species that may be affected by a federal action, the affected environment area under evaluation is often larger than a project site and may encompass the geographic extent of existing conditions and potential changes to those exiting conditions associated with direct and indirect effects from activities that are part of a project's proposed activities. All action alternatives involve either the Brazos or Oyster Creek or both. Consequently, the analysis area for Listed Species includes portions of Oyster Creek and portions of the Brazos River (Figure 3.6-1), as well as areas adjacent to proposed activities for all alternatives. Specifically, the analysis area comprises the Brazos River from the Rosharon USGS stream gage to the Buffalo Camp Bayou Dam and portions of Oyster Creek to the dam/pump station at Lake Jackson. In addition, the analysis includes looking downstream at potential hydromodification in Oyster Creek for the Proposed Action, Alternative 2A, and Alternative 2B.

The USFWS Information for Planning and Consultation (IPaC) online database was used to develop a list of federally Listed Species that are known or have potential to occur in Brazoria County (USFWS 2019b, 2021d). The list includes 11 federally Listed Species, one candidate, and one proposed threatened species (see Table 3.6-1).

Based on review of the Texas Natural Diversity Database (TXNDD), no ESA Listed Species have been observed in the Project site or analysis area (see Figure 3.6-1) or the Big Slough mitigation site. However, potentially suitable habitat for whooping crane, monarch butterfly, and Texas fawnsfoot are present within the Project site and analysis area. There is no designated critical habitat within the analysis area or the Big Slough mitigation site.

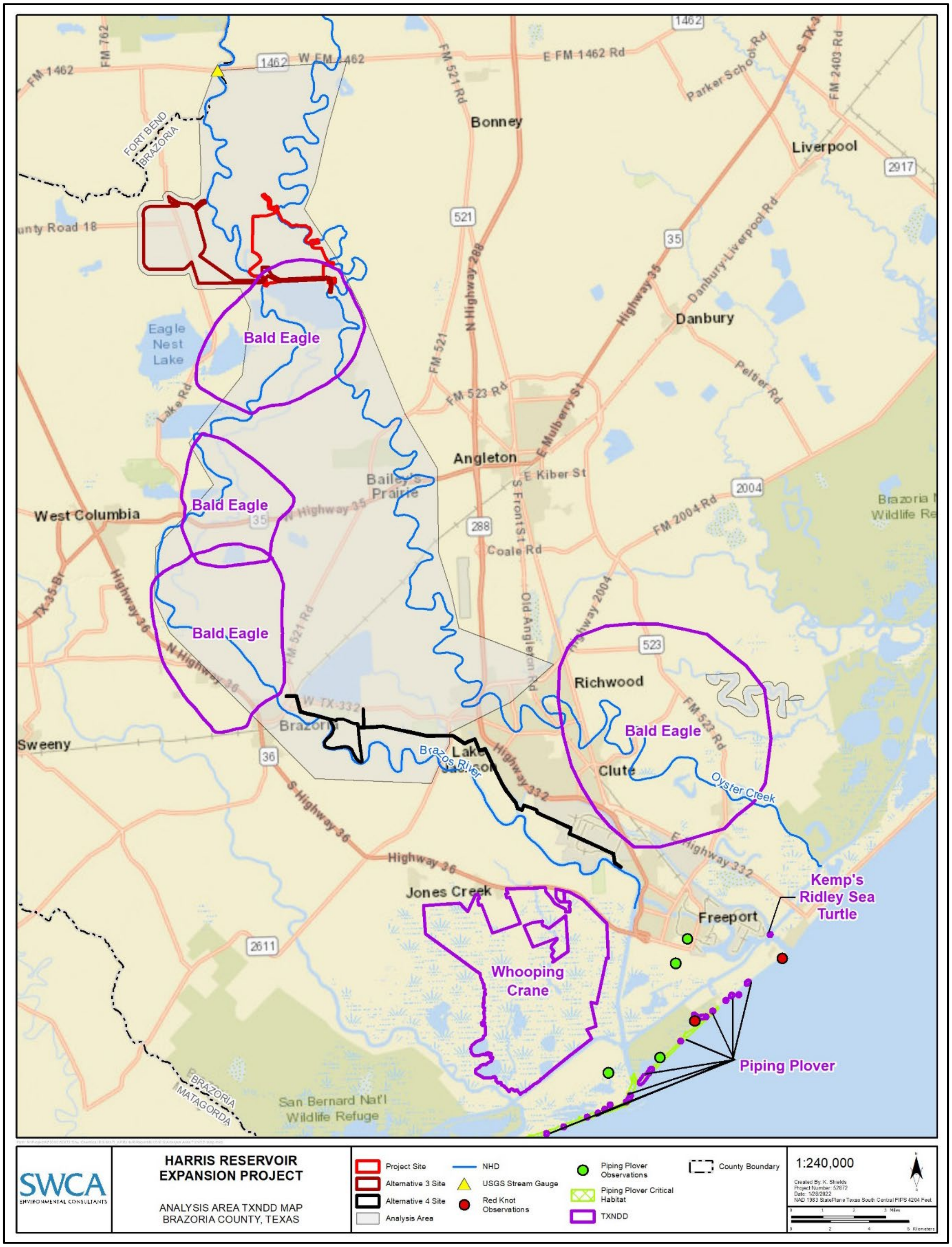


Figure 3.6-1. TXNDD occurrences.

Table 3.6-1. Federally Listed Species and their Potential to Occur

Common Name ***Scientific Name***	**Federal Status**	**Designated Critical Habitat (yes or no)**	**Habitat Description**	**Habitat Present in Project Site (yes or no)**	**Habitat Present in Analysis Area (yes or no)**	**Potential to Occur within the Analysis Area**
Mammals						
West Indian manatee *Trichechus manatus*	Threatened	Yes	Aquatic; occurs in marine and estuarine habitats with coastal waters. Texas is the extreme western edge of this species' distribution (USFWS 2003). Occurrences in Texas are occasional to rare.	No	No	None
Birds						
Black Rail (Eastern) *Laterallus jamaicensis* ssp. *jamaicensis*	Threatened	No	Occurs in a variety of wetland habitats, including, salt, brackish, and freshwater marshes, pond borders, wet meadows, and grassy swamps (TPWD 2019c). Suitable habitat typically contains moist soils with dense overhead cover of emergent vegetation. Breeding habitat usually contains fined-stemmed emergent plants, such as grasses, reeds, or cordgrass. This species uses similar habitats year-round for breeding, migration, and overwintering (Eddelman et al. 2020). Occurs as a breeding resident and as a migrant/winter resident in Brazoria County (Lockwood and Freeman 2014).	No	Yes	Low
Piping plover *Charadrius melodus*	Threatened	Yes	Non-breeding resident; prefers bare or sparsely vegetated tidal areas periodically covered with water with limited human disturbance; may include algal flats, beaches, sand flats, and spoil islands.	No	No	None
Red knot *Calidris canutus rufa*	Threatened	No	Coastal migrant; habitat includes large areas of exposed intertidal sediments (e.g., mudflats) associated with marine and estuarine areas on the shoreline of coasts and bays.	No	No	None
Whooping crane *Grus americana*	Threatened	Yes	Coastal winter resident and Texas migrant. Overwinters in estuarine marshes, shallow bays, and tidal flats along the Texas Gulf Coast in and immediately adjacent to Aransas National Wildlife Refuge. Stopover roosting habitat during migration in fall and winter includes palustrine or riverine wetland systems adjacent to crops or grasslands throughout the state.	Yes	Yes	Low

Common Name *Scientific Name*	Federal Status	Designated Critical Habitat (yes or no)	Habitat Description	Habitat Present in Project Site (yes or no)	Habitat Present in Analysis Area (yes or no)	Potential to Occur within the Analysis Area
Insects						
Monarch butterfly *Danaus plexippus*	Candidate	No	Migrant and breeder throughout Texas, including Brazoria County. The species requires milkweed as an obligate host plant (primarily *Asclepias* spp.), which is an essential component of habitat required for reproduction and survival of the species (USFWS 2020b).	Yes	Yes	Moderate
Reptiles						
Green sea turtle *Chelonia mydas*	Threatened	No	Aquatic; occurs only in marine coastal waters. Comes ashore only to nest on sandy shorelines.	No	No	None
Hawksbill sea turtle *Eretmochelys imbricata*	Endangered	Yes	Aquatic; occurs only in marine coastal waters. Does not nest in Texas.	No	No	None
Kemp's Ridley sea turtle *Lepidochelys kempii*	Endangered	Proposed critical habitat	Aquatic; occurs only in marine coastal waters. Comes ashore only to nest on sandy shorelines.	No	No	None
Leatherback sea turtle *Dermochelys coriacea*	Endangered	Yes	Aquatic; occurs only in marine coastal waters. Comes ashore only to nest on sandy shorelines.	No	No	None
Loggerhead sea turtle *Caretta*	Threatened	Yes	Aquatic; occurs only in marine coastal waters. Comes ashore only to nest on sandy shorelines.	No	No	None
Mollusks						
Texas fawnsfoot *Truncilla macrodon*	Proposed Threatened	No	Endemic to Colorado and Brazos River drainages associated with run edge, pool edge, and backwater habitats with clay, silt, and sand substrates.	Yes	Yes	Low
Flowering Plants						
Texas prairie dawn-flower *Hymenoxys texana*	Endangered	No	Found only in the open grasslands of the northern part of the Gulf Prairie region of Harris and Fort Bend Counties, Texas. Found in poorly drained, slightly saline soils with sparsely vegetated areas ("slick spots") at the bases of small mounds (mima or pimple mounds) in open grassland or in almost barren areas (Roth 1996).	No	No	None

Sources: Campbell (2003); USFWS (2003, 2019b, 2021d).

3.6.2.2 MAMMALS

Marine aquatic mammals, such as **West Indian manatee** (*Trichechus manatus*), are restricted to marine and coastal waters and would not occur within the Project site or analysis area.

3.6.2.3 BIRDS

The **black rail** (*Laterallus jamaicensis*) is a federally and state-listed threatened species that occurs in coastal marshes and in freshwater grassy marshes and wet meadows at inland locations. The species occurs in areas containing dense wetland vegetation such as spartina (*Spartina* sp.), rushes, sedges, and other grasses, typically with shallow waters (Eddleman et al. 2020). Historically, the species occurred at both inland and coastal locations in Texas during the breeding season (USFWS 2019c). Recently in Texas, black rails are only known to breed on the upper and central Gulf Coast in Brazoria and Galveston Counties (USFWS 2019c), where the species is a rare to locally uncommon resident (Lockwood and Freeman 2014). The species is also a rare migrant across the eastern third of the state, including Brazoria County, with coastal populations augmented during the winter by migratory birds that nest out of state. Typical spring migration occurs from April through early May, with fall migration typically occurring from August through early October (Lockwood and Freeman 2014). In Texas, black rails primarily breed in saltmarsh habitat and typically occur in wetlands dominated by *Spartina* and *Scirpus* species (Butler et al. 2015; Oberholser 1974). Although, the black rail has low potential to occur in the analysis area, it has no potential to occur in the Project Site or alternative sites.

The **piping plover** (*Charadrius melodus*) and **red knot** (*Calidris canutus rufa*) are restricted to habitats along the Texas Gulf Coast. These birds have not been documented near the Project site or within the analysis area, nor is potentially suitable habitat for either present (iNaturalist 2021a, 2021b).

Whooping cranes currently exist in the wild at three locations and in captivity at 12 sites (Canadian Wildlife Service and USFWS 2007). There is only one self-sustaining wild population of whooping crane, the Aransas-Wood Buffalo National Park population. This population nests in Wood Buffalo National Park and adjacent areas in the Northwest Territories and Alberta provinces of Canada, and winters mainly in and adjacent to Aransas National Wildlife Refuge along the central Texas coast in Aransas, Calhoun, and Refugio Counties. The cranes migrate in the spring and fall through an approximately 200-mile-wide corridor between the Aransas National Wildlife Refuge and Wood Buffalo National Park through the Great Plains (Canadian Wildlife Service and USFWS 2007). Spring migration generally begins in late March, with some birds remaining on the wintering grounds into early May. Whooping cranes use a variety of habitats during migration, including croplands for feeding and wetlands for roosting (Howe 1987, 1989; Lingle 1987; Lingle et al. 1991). Whooping cranes roost predominantly in palustrine or riverine wetland systems, with these types of wetlands accounting for 91.5% of roost sites (Austin and Richert 2001). They have also been recorded in upland cropfields, including row crop stubble, small grain stubble, and green crops such as winter wheat (*Triticum aestivum*) and alfalfa (*Medicago sativa*), and in palustrine wetlands, seasonally flooded habitats, permanent water, pastures, and meadows (Austin and Richert 2001).

The Project site and analysis area occur at the edge (95th percentile) of the whooping crane migration corridor, and there have been three sightings of whooping cranes within 12 miles of the Project site (Figure 3.6-2) (USFWS 2009). These three sightings occurred in 1999, 2003, and 2010, with the closest sighting (2010) approximately 2.6 miles from the Project site in pastureland near Eagle Nest Lake (USFWS 2015). The closest documented occurrences reported to eBird (2021) are approximately 7 miles northwest of the Project site near Brazos Bend State Park in 1999, and the most recent documented occurrences within the last 5 years are in Brazoria National Wildlife Refuge approximately 16 miles southeast of the Project site. The Project site and analysis area provide potentially suitable habitat for the whooping crane, though no whooping cranes have been documented since 2010.

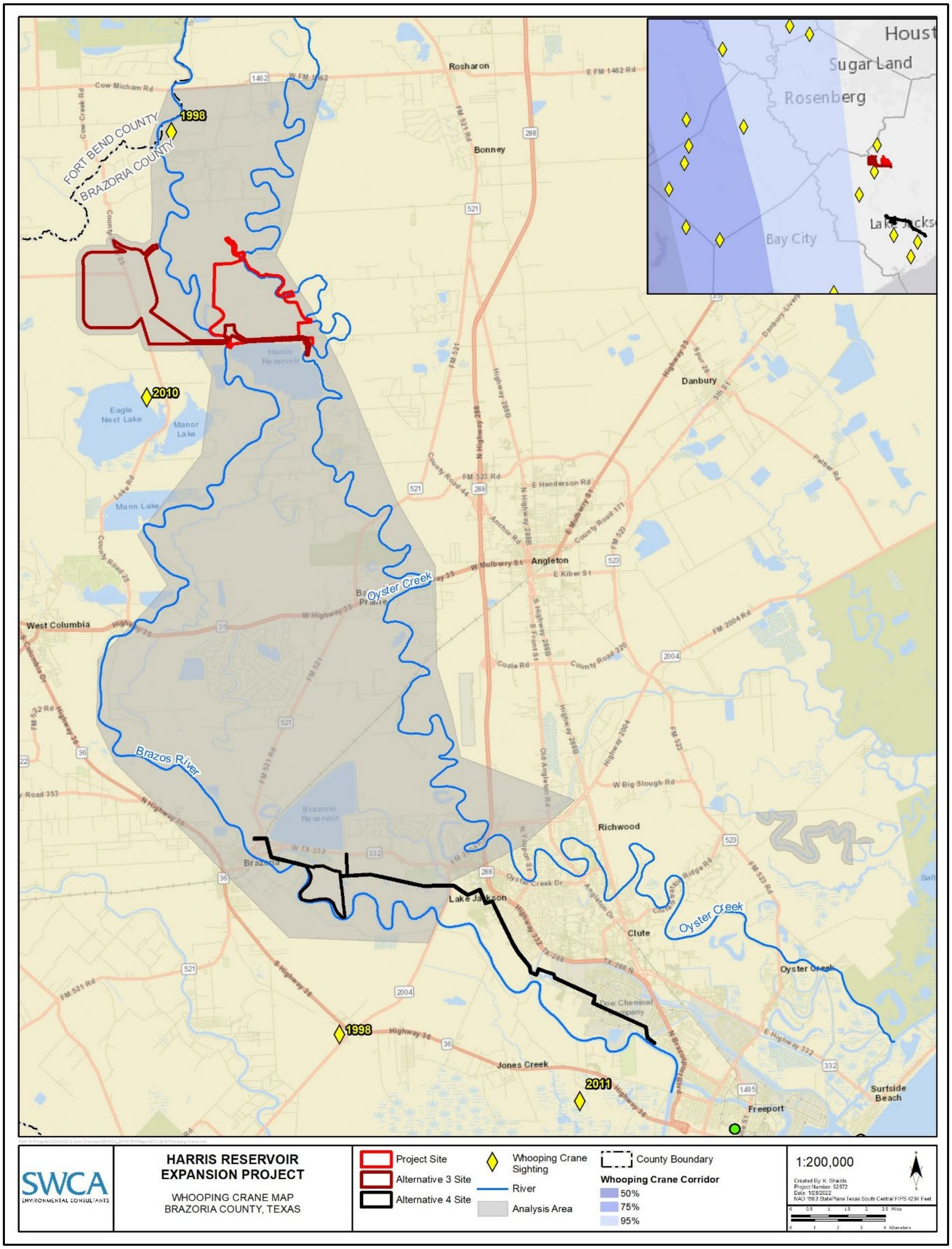


Figure 3.6-2. Whooping crane sightings and migration corridor.

3.6.2.4 INSECTS

The **monarch butterfly** is a currently identified as a candidate for listing under the ESA whose range covers the United States, northern Mexico, and southern Canada for migration and breeding. Monarchs overwinter in California and Mexico, travel northwards for spring migration, breed in the southeastern United States during the spring and northern and western United States during the summer, then travel back south during fall migration; a non-migratory population exists in southern Florida (USFWS 2019f). Habitat for the monarch butterfly includes grassland or shrubland habitats with native grasses and shrubs with milkweed (*Asclepias* spp.) and other flowering plants (USFWS 2020b).

The Project site and analysis area are within the species' fall and spring migration corridors, as well as their spring breeding area (USFWS 2019e). No monarchs have been observed at the Project site. The closest documented occurrence of monarchs occur approximately 2 miles south of the Project site south of the Brazos River and 2 miles west at the Nash Prairie Preserve where several monarchs have been documented (all adult monarchs) (iNaturalist 2021c). The closest documented occurrence of a monarch caterpillar (fifth instar) is from Angleton, Texas, approximately 9 miles southeast of the Project site (iNaturalist 2021c). Several tagged adult monarchs have been observed in Katy, Texas, and Houston, Texas, north of the Project site during the 2017–2020 Monarch Watch field seasons (Monarch Watch 2017, 2018, 2019, 2020). Milkweeds (the sole food source for monarch larvae) have been observed on the Project site in 2019 and 2021; additionally, several milkweeds have been documented at the Nash Prairie Preserve east of the Project site (iNaturalist 2021c).

3.6.2.5 MOLLUSKS

The **Texas fawnsfoot** is a freshwater mussel that is proposed for federal listing as threatened. This mussel occurs in the Colorado River and Brazos River Basins within moderate to large rivers and streams with moderate flow and fine or coarse sediments such as mud, sand, or gravel substrate (Howells 2014; Randklev et al. 2017). Texas fawnsfoot adults are commonly detected in bank habitats and occasionally in backwater, riffle, and point bar habitats with low to moderate water velocities and fine or coarse sediments (Randklev et al. 2017). Additional information on the biology and life history of the species is limited (Howells 2014; Randklev et al. 2017).

Randklev et al. (2017) surveyed 59 sites in the Brazos River drainage in areas with recent or historical occurrences of this species and found live individuals at two sites on the Little River. Additionally, there are two records of the Texas fawnsfoot in the TXNDD for potential sightings in the Brazos River in 2013 and 2012; these are approximately 11.8 miles and 35.5 miles, respectively, north of the Project site and outside of the analysis area in Fort Bend County (TXNDD 2018).

The Project site and alternative sites include the Brazos River. Intermittent streams within the Project site are likely to contain high flow velocities during high rainfall events and little habitat where the Texas fawnsfoot may seek refuge during high flow events. No live or dead shells of Texas fawnsfoot were found within a portion of the Brazos River approximately 1 mile downstream of the Project site near the existing reservoir in 2012 (HDR 2012). There is potential for the Texas fawnsfoot to occur in reaches of the Brazos River near the Project site and in the analysis area, though occurrences are rare to unlikely (Randklev et al. 2017). Additional mussel surveys planned for 2022 will include species presence/absence in the Brazos River and Oyster Creek at the Project site and assessment of the amount of suitable habitat, if present.

3.6.2.6 FLOWERING PLANTS

The **Texas prairie dawn-flower** (*Hymenoxys texana*) inhabits areas with fine, sandy, compacted saline soils not found on the Project site. Presence/absence surveys were not conducted; however, no Texas prairie dawn-flowers were detected during the 2019 wetland delineations (SWCA 2019a), and there are no documented occurrences of this species in or within 5 miles of the analysis area.

3.7 Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) was enacted in April 1976 to conserve and manage coastal and anadromous fisheries resources in U.S. federal waters (16 USC 1801 et seq). Under the MSA, fishery management councils (FMCs) were established to develop fishery management plans (FMPs) that comply with the purpose and management requirement under the MSA. The NMFS issued additional provisions to the MSA in 1996 (NOAA 1997:19723–19732) that require FMPs to define and describe essential fish habitat (EFH). The FMPs must also discuss measures to minimize adverse effects on EFH and identify other actions to conserve and enhance EFH. The coordination and consultation provisions would specify procedures for adequate consultation with the NMFS on activities that may adversely affect EFH.

Gulf of Mexico FMC manages the fishery resources in U.S. federal waters of the Gulf of Mexico. This management council has FMPs for specific marine species including reef fishes, coastal migratory pelagic fishes, shrimp species, spiny lobster (*Panulirus argus*), corals, sharks, and red drum (*Sciaenops ocellatus*) (NOAA 2021). The Gulf of Mexico FMC also has management plan for EFH and aquaculture (Gulf of Mexico FMC 2021a). NMFS develops regulations for the fisheries of the Gulf of Mexico, based on guidance from this management council and their FMPs. NMFS also reviews and consults on projects that have potential environmental impacts to these fisheries. The management plan for the EFH describes the habitats that are essential for each life history stage of 26 representative species found in the Gulf of Mexico. The plan also describes the distribution of these habitats, threats to these habitats, predator-prey relationships, factors resulting in the losses of EFH, conservation and enhancement measures for EFH, and recommendations to minimize impacts from non-fishing threats (Gulf of Mexico FMC 2021b). The Gulf of Mexico FMC provides a web-based mapping tool for each species it manages (Gulf of Mexico FMC 2021b). This tool was used to determine the presence of EFH and/or habitats in the vicinity of the Proposed Action and the alternatives.

3.7.1 Proposed Action, Alternative 2A, Alternative 2B, and Alternative 3

The Project site and Alternative 3 site are located in inland areas and not in the vicinity of any areas designated as EFH (Figure 3.7-1) (Gulf of Mexico FMC 2021b). Though the surface waters (i.e., Brazos River and Oyster Creek) associated with the Project site and Alternative 3 site may be brackish and tidally influenced (see Section 3.3.1 for details on surface water) these surface waters do not contain habitats, as identified by Gulf of Mexico FMC (2021b) that would support the marine species identified in the FMPs for the Gulf of Mexico (see Figure 3.7-1).

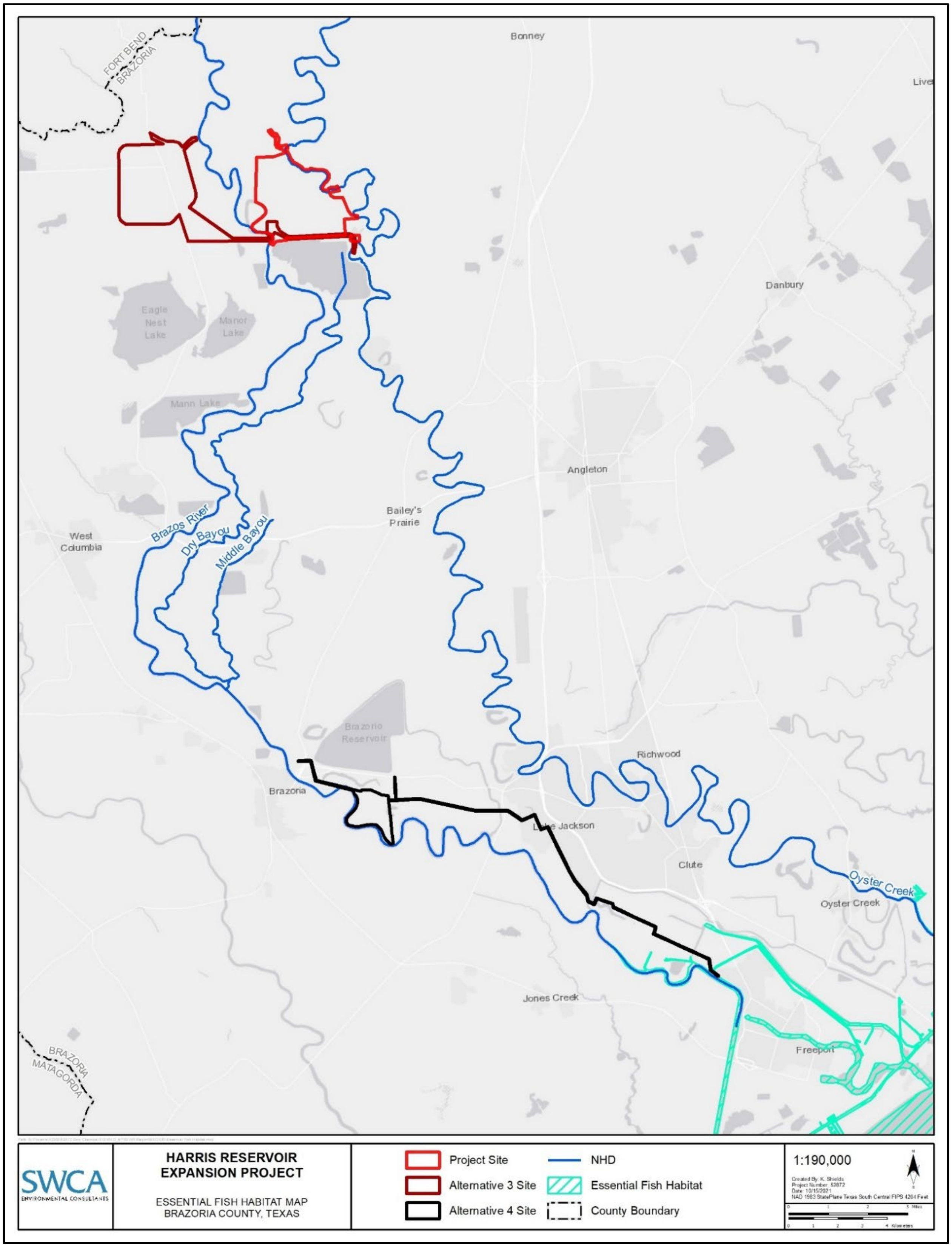


Figure 3.7-1. Locations of Project site and Alternative 3 site relative to mapped essential fish habitat.

3.7.2 Alternative 4

The Alternative 4 site is also inland and outside of areas designated as EFH (Figure 3.7-2). However, the proposed intake facility along the Brazos River is located in the vicinity of EFH, specifically 11.8 linear miles and 7.4 river miles north of designated EFH. The pipeline that would convey RO concentrate from the treatment plant to Dow's Texas Operations would be collocated with existing roads and canals and not within any areas designated as EFH (see Figure 3.7-2).

The EFH mapped for this area pertains to EFH for the red drum, reef fishes, coastal migratory pelagic fishes, shrimp species, blacktip shark (*Carcharhinus limbatus*), and finetooth shark (*C. isodon*) (Gulf of Mexico FMC 2021b).

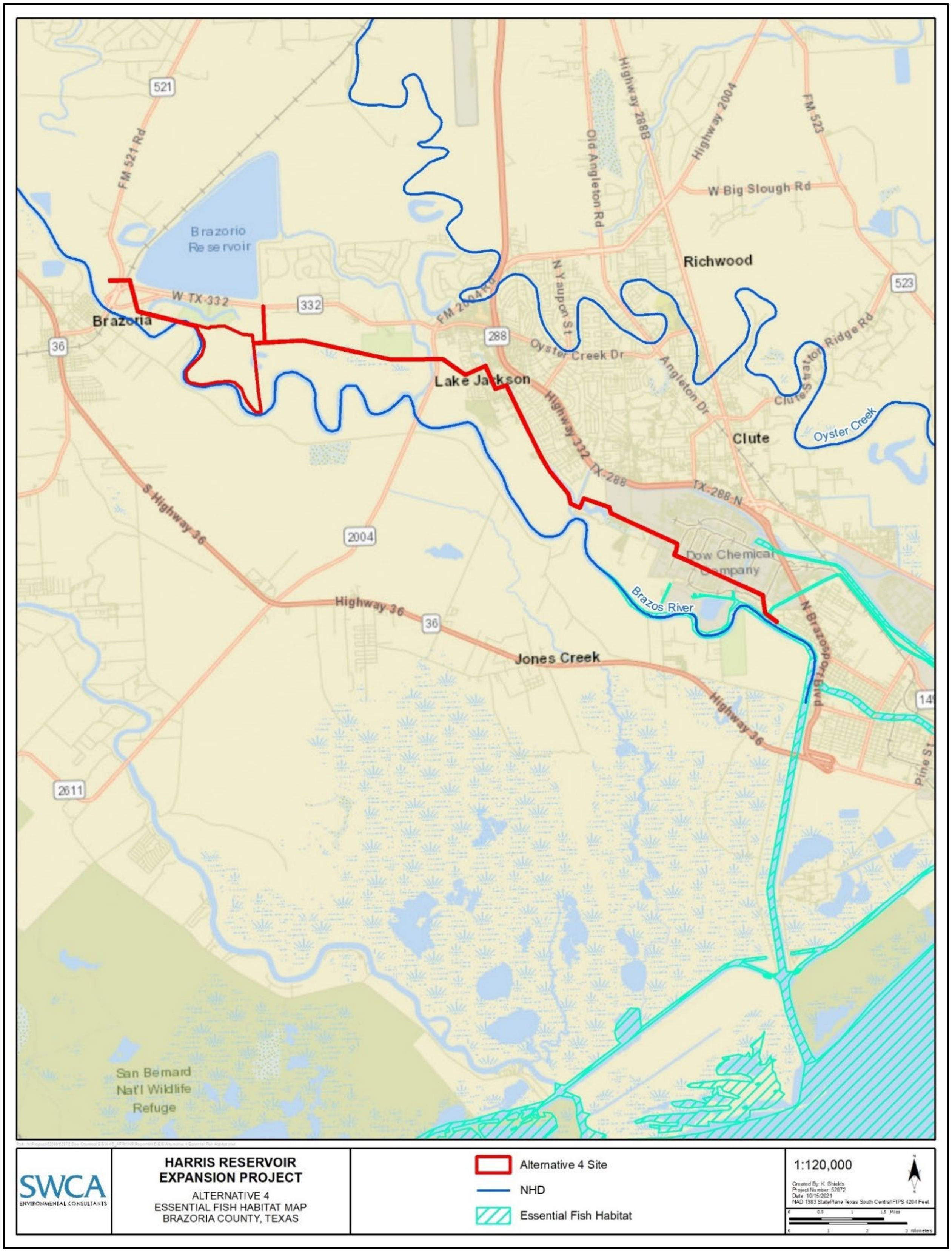


Figure 3.7-2. Location of Alternative 4 site relative to mapped essential fish habitat.

3.8 State-Listed Wildlife Species

According to Chapters 67 and 68 of the TPWD Code and Sections 65.171–65.176 of Title 31 of the Texas Administrative Code (TAC), it is unlawful to take (incidental or otherwise) state-listed threatened and endangered species. State-listed species may only be handled by persons possessing a Scientific Collecting Permit or a Letter of Authorization issued to relocate a species. Listed bird species are also protected by the federal MBTA (see Section 3.5.3, Migratory Birds) as regulated and implemented by the USFWS.

The analysis area is the same as the analysis area for federally listed species and general wildlife (see Figure 3.4-1). The Project site and alternatives sites are all within the analysis area. There are 23 state-listed threatened and endangered species with potential to occur in Brazoria County, Texas that were reviewed to determine if they would potentially occur in the analysis area (Table 3.8-1). State-listed species with the likelihood to occur in the Project site and the analysis area are discussed following Table 3.8-1. State-listed species likely to occur in the Big Slough mitigation site include bald eagle, reddish egret (*Egretta rufescens*), white-faced ibis, wood stork, and alligator snapping turtle (*Macrochelys temminckii*) (Cardno 2021).

Table 3.8-1. State-Listed Species and their Potential to Occur

Common Name ***Scientific Name***	**State Status**	**Habitat Description**	**Habitat Present in Project Site (yes or no)**	**Habitat Present in Analysis Area (yes or no)**	**Potential to Occur in Analysis Area**
Mammals					
Humpback whale *Megaptera novaeangliae*	Endangered	Aquatic; occurs in open ocean and coastal waters including inshore bays.	No	No	None
Rafinesque's big-eared bat *Corynorhinus rafinesquii*	Threatened	Hardwood forests with cavity trees for roosting; may also roost in concrete culverts and abandoned human-made structures.	No	Yes	None
Birds					
Bald eagle *Haliaeetus leucocephalus*	Threatened	Resident; nests in tall trees or cliffs near open water (e.g., rivers and large lakes) for foraging.	Yes	Yes	Moderate (foraging) Low (nesting)
Piping plover *Charadrius melodus*	Threatened	Non-breeding resident; prefers bare or sparsely vegetated tidal areas periodically covered with water with limited human disturbance; may include algal flats, beaches, sand flats, and spoil islands.	No	No	None
Reddish egret *Egretta rufescens*	Threatened	Coastal resident; nests in estuarine environments on the ground, trees, or bushes; occurs in brushy thickets of yucca and prickly pear on dry coastal islands.	No	No	None
Swallow-tailed kite *Elanoides forficatus*	Threatened	Resident; nests in tall trees near wooded edges or in clearings; occurs mainly in lowland forested areas, in swampy areas, and open woodlands near waterbodies (e.g., rivers, lakes, ponds).	Yes	Yes	Low
White-faced ibis *Plegadis chihi*	Threatened	Resident; occurs in near-coastal rookeries in hog-wallow prairies; nests on low trees, in bulrushes or reeds, or on floating mats, over shallow water. Rare and localized breeder in inland locations with preference to freshwater marshes, irrigated or flooded crop fields, and herbaceous wetlands.	Yes	Yes	Moderate
White-tailed hawk *Buteo albicaudatus*	Threatened	Resident; occurs in and nests within prairies farther inland from the coast that are associated with mesquite and oak trees.	Yes	Yes	Low
Whooping crane *Grus americana*	Endangered	Coastal winter resident and Texas migrant. Overwinters in estuarine marshes, shallow bays, and tidal flats along the Texas Gulf Coast in and immediately adjacent to Aransas National Wildlife Refuge. Stopover roosting habitat during migration in fall and winter includes palustrine or riverine wetland systems adjacent to crops or grasslands throughout the state.	Yes	Yes	Low

Common Name ***Scientific Name***	**State Status**	**Habitat Description**	**Habitat Present in Project Site (yes or no)**	**Habitat Present in Analysis Area (yes or no)**	**Potential to Occur in Analysis Area**
Wood stork *Mycteria americana*	Threatened	Non-breeding resident; occurs in mud flats and other wetland habitats associated with nearby forested areas; forages in areas with shallow standing water including ponds, flooded pastures or crop fields, and ditches.	Yes	Yes	Moderate
Fish					
Blackside darter *Percina maculata*	Threatened	Aquatic; commonly occurs in streams that drain 10 to 20 km with gravel or other rocky substrates within the Red, Sulfur, and Cypress River basins. Prefers a riffle-pool complex system with either quiet or slight current in pools and swift riffles.	No	No	None
Blue sucker *Cycleptus elongatus*	Threatened	Occurs in large channels and flowing pools with moderate current within most major streams in Texas. Intolerant of channels with high turbidity; may occur in deep pools near large streams or rivers; prefers benthic habitat with exposed bedrock and sand, clay, or gravel. Documented occurrence in the Sabine, Neches, Red, and Colorado river basins (TWDB 2015).	No	Yes	Low
Opossum pipefish *Microphis brachyurus*	Threatened	Adults lay eggs in fresh or low salinity waters. Young then move into or are carried into more saline waters near southern coastal areas. Found only in the lowermost reaches of the Rio Grande (Patrick 2003).	No	No	None
Western creek chubsucker *Erimyzon claviformis*	Threatened	Prefers pools of headwaters with bottoms of silt, sand, and gravel near vegetation. May occur in creeks, small rivers, occasionally in lakes, and seldom in springs or impoundments.	No	No	None
Mollusks					
Texas pimpleback (syn. smooth pimpleback *Cyclonaias houstonensis syn. Cyclonaias pustulosa*	Threatened	Present in small to moderate streams and rivers within the Colorado and Brazos River basins. Prefers habitat with low to moderate water depths, low to moderate water velocities, and with mixed mud, sand and fine gravel substrates.	Yes	Yes	Low
Texas fawnsfoot *Truncilla macrodon*	Threatened	Endemic to Colorado and Brazos River drainages associated with run edge, pool edge, and backwater habitats with clay, silt, and sand substrates.	Yes	Yes	Low

Common Name *Scientific Name*	State Status	Habitat Description	Habitat Present in Project Site (yes or no)	Habitat Present in Analysis Area (yes or no)	Potential to Occur in Analysis Area
Reptiles					
Alligator snapping turtle *Macrochelys temminckii*	Threatened	Aquatic; occurs in deep perennial water bodies (e.g., rivers, lakes, canals, swaps, bayous, and ponds near deep running water). Prefer habitats with mud bottoms and ample aquatic vegetation.	Yes	Yes	Low
Green sea turtle *Chelonia mydas*	Threatened	Aquatic; occurs only in marine coastal waters. Comes ashore only to nest on sandy shorelines.	No	No	None
Kemp's Ridley sea turtle *Lepidochelys kempii*	Endangered	Aquatic; occurs only in marine coastal waters. Comes ashore only to nest on sandy shorelines.	No	No	None
Leatherback sea turtle *Dermochelys coriacea*	Endangered	Aquatic; occurs only in marine coastal waters. Comes ashore only to nest on sandy shorelines.	No	No	None
Loggerhead sea turtle *Caretta*	Threatened	Aquatic; occurs only in marine coastal waters. Comes ashore only to nest on sandy shorelines.	No	No	None
Texas horned lizard *Phrynosoma cornutum*	Threatened	Habitat includes open, arid, and semi-arid regions with sparse vegetation (e.g., grass, cactus, scattered brush, and trees) below 6,000 feet above mean sea level. Burrows into sandy to rocky soils or hides under rocks when inactive.	No	No	None
Timber (canebrake) rattlesnake *Crotalus horridus*	Threatened	Associated with densely vegetated riparian waterways and floodplains, upland wooded areas, and limestone bluffs; prefers dense ground cover (e.g., grapevine, palmetto).	Yes	Yes	Low

3.8.1 Mammals

3.8.1.1 PROPOSED ACTION, ALTERNATIVE 2A, ALTERNATIVE 2B, ALTERNATIVE 3, AND ALTERNATIVE 4

The **Rafinesque's big-eared bat** (*Corynorhinus rafinesquii*) is state-listed as threatened. This species may be found in older growth bottomland hardwood forests with mature hollow trees used for roosting, which are not present in the Project site or Alternative 3 site but may occur on the Alternative 4 site. This species may also use abandoned human-made structures and concrete culverts. Although mature bottomland hardwood forest and other potentially suitable habitat may be present in the analysis area, the distribution and records of the species are scattered and limited to the Pineywoods ecoregions of eastern Texas (NatureServe Explorer 2020a; Schmidly and Bradley 2016). There are no records of this species in any of the alternative sites.

3.8.2 Birds

3.8.2.1 PROPOSED ACTION, ALTERNATIVE 2A, ALTERNATIVE 2B, ALTERNATIVE 3, AND ALTERNATIVE 4

The **bald eagle** is state-listed as threatened. Within 10 miles of the Project site, there are several lakes (e.g., Eagle Nest Lake, Manor Lake, Mann Lake) and reservoirs (i.e., Harris Reservoir) with surrounding tree lines that may serve as potential suitable foraging habitat for the bald eagle. Bald eagles have been spotted near the Project site as recent as January 2020 (eBird 2021). There are also several records in the TXNDD with potential sightings of bald eagle within the analysis area along the Brazos River (Figure 3.8-1). A few large, tall trees present in the Project site could be suitable for nesting, though no nests were observed during the September 2019 surveys (SWCA 2019a, 2019b). A bald eagle was observed flying overhead during the September 2019 surveys. The recent sightings and presence of suitable foraging habitat indicate a moderate likelihood that bald eagles use the Project site for foraging. Because there are only a few large trees, there is a low likelihood for bald eagles to nest on the Project site or alternative sites. There is a TXNDD record of bald eagle at the Big Slough mitigation site (TXNDD 2018).

The **swallow-tailed kite** (*Elanoides forficatus*) is a "rare to uncommon migrant through the Coastal Prairies and eastern third of the state" (Lockwood and Freeman 2014) and a possible summer resident of Brazoria County. This species may occur near the Project site in open wooded areas near large waterbodies (e.g., lakes, ponds, reservoirs). Nearby sightings of the swallow-tailed kite have been recorded at Eagle Nest Lake in 2009 and Manor Lake in 1987 (eBird 2021). Another bird of prey, the **white-tailed hawk**, is an "uncommon to locally common resident" (Lockwood and Freeman 2014) within its range, which includes Brazoria County. This species has been recorded near Eagle Nest Lake and Manor Lake as recently as 2017, and downstream of the Project site, this hawk has been documented along the Brazos River in 2012; other nearby sightings have occurred in farmland to the east and west of the Project site within a 3-mile radius of the site boundary (eBird 2021). There is a low likelihood for these species to occur on the Project site or alternative sites.

Wading birds with the potential to occur in or near the Project site and analysis area include the **white-faced ibis** (*Plegadis chihi*) and the **wood stork**. In 2016, three white-faced ibis individuals were documented in and adjacent to the Project site by three separate observers (eBird 2021). Although concentrated along the Texas Gulf Coast, the white-faced ibis could occur throughout the State of Texas (Lockwood and Freeman 2014). The wood stork arrives at the Texas Gulf Coast after breeding and may occur inland to the eastern third of the state (Lockwood and Freeman 2014). There is a moderate likelihood ibis occurs and wood stork are known to occur on the Project site or alternative sites. Three wood storks were documented on the western portion of the Project site in 2019 (eBird 2021; SWCA 2019b).

For information on the **whooping crane,** see Section 3.6.2.3.

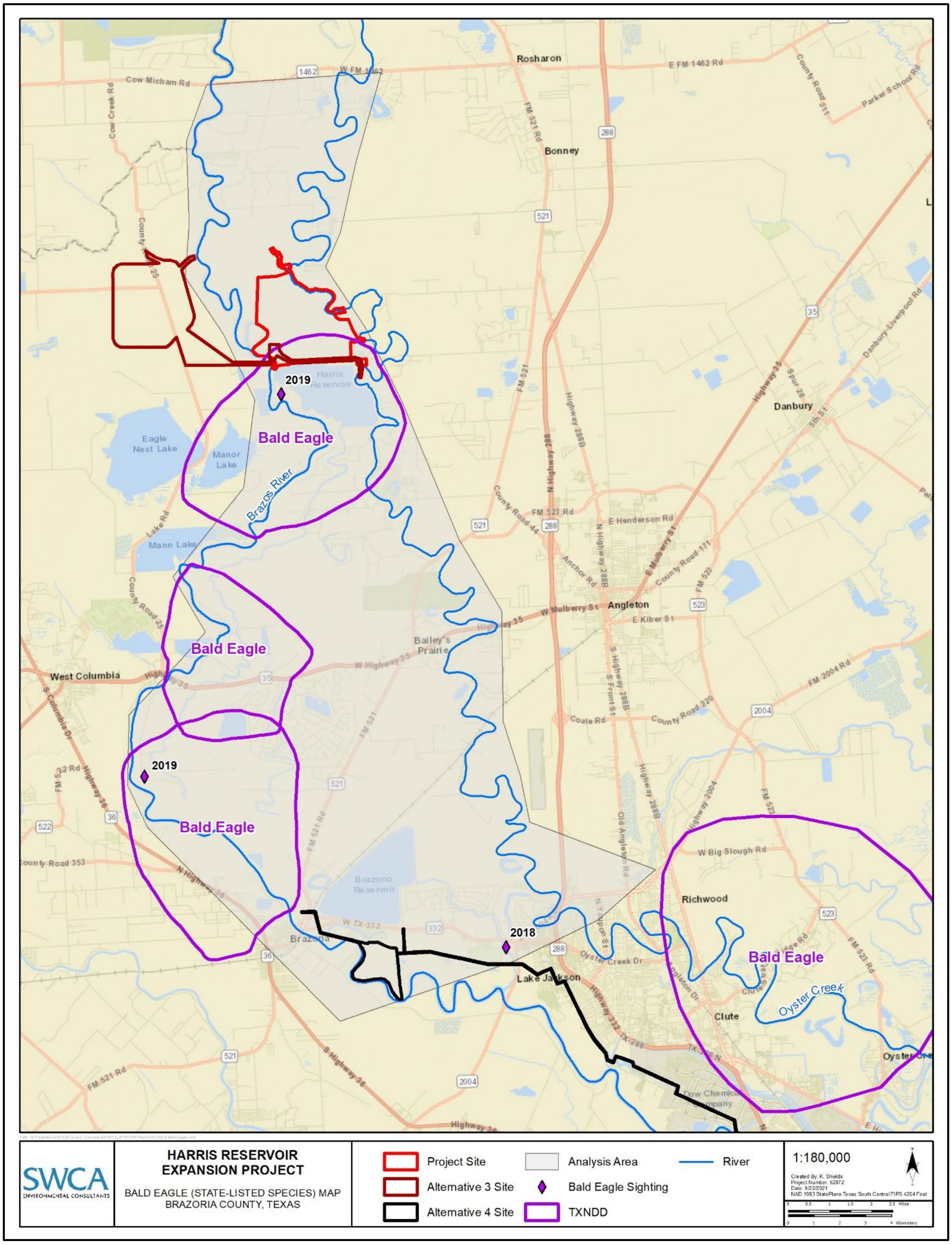


Figure 3.8-1. Bald eagle sightings.

3.8.3 Fish

3.8.3.1 PROPOSED ACTION, ALTERNATIVE 2A, ALTERNATIVE 2B, ALTERNATIVE 3, AND ALTERNATIVE 4

The **blue sucker** is state-listed as threatened. This species may be found in large, deep rivers with cobble or bedrock substrates in the Brazos River drainage (Texas State University 2020). Although potentially suitable habitat may be present in the Project site and analysis area, the current distribution of the species does not include the river near the Project site or alternative sites but may occur within rivers of the analysis area (NatureServe Explorer 2020b).

3.8.4 Mollusks

3.8.4.1 PROPOSED ACTION, ALTERNATIVE 2A, ALTERNATIVE 2B, ALTERNATIVE 3, AND ALTERNATIVE 4

For information on the **Texas fawnsfoot**, see Section 3.6.2.5.

The **Texas pimpleback (syn. smooth pimpleback)** may be found in moderate-sized creeks, rivers, and reservoirs with fine or coarse sediments such as mud, sand, or gravel substrate (Howells 2014; Randklev et al. 2017). Texas pimpleback adults are commonly detected in riffle-and-run habitats where flow may be reduced during high flow events (Randklev et al. 2017). Additional information on the biology and life history of the species is limited (Howells 2014; Randklev et al. 2017).

Randklev et al. (2017) surveyed 59 sites in the Brazos River drainage in areas with recent or historical occurrences of this species and found live individuals at several sites within the Brazos River drainage. There are more than 50 records of the Texas pimpleback in the TXNDD for potential sightings in the Brazos River and Colorado River, but none are within 20 miles of the Project site (TXNDD 2018). A portion of the Project site is within the Brazos River, and there is potential for the Texas pimpleback to occur in reaches of the Brazos River near the Project site (Randklev et al. 2017). Intermittent streams within the Project site are likely to contain high flow velocities during high rainfall events and little habitat where the Texas pimpleback may seek refuge during high flow events. In 2012, a survey was completed within a portion of the Brazos River immediately downstream of the Project site near the existing reservoir (HDR 2012). This survey determined that habitat within this area was not suitable for the Texas pimpleback; additionally, no live or dead shells were observed during this survey (HDR 2012). Texas pimpleback is unlikely to occur on the Project site, but may occur in the analysis area.

3.8.5 Reptiles

3.8.5.1 PROPOSED ACTION, ALTERNATIVE 2A, ALTERNATIVE 2B, ALTERNATIVE 3, AND ALTERNATIVE 4

Alligator snapping turtle is primarily an aquatic species commonly found in low-gradient, low-water velocity rivers, creeks, and streams with slow water velocities, lacustrine habitats, or PFO wetlands and riparian habitats. Basking is uncommon, and alligator snapping turtle uses the terrestrial landscape exclusively for nesting (NatureServe Explorer 2019b). This species nests in excavated cavities on land between May and July, and the incubation period occurs between 70 and 105 days (Herps of Texas 2019). Alligator snapping turtle is omnivorous, consuming a variety of live or dead invertebrate, vertebrates, and aquatic plants (Herps of Texas 2019). The Project site contains small areas of potentially suitable habitat (e.g., PFO wetlands), but these are somewhat isolated by upland open land covers and thus unlikely to be accessible and used by the alligator snapping turtle. Although alligator snapping turtle is included in TPWD's list of state-listed species for Brazoria County (TPWD 2019b), other sources such as the Herps of Texas (2019) do not include Brazoria County as a county of occurrence for this species. Alligator snapping turtle is expected to rarely occur on the Project site and the analysis area; however, it may be a transient along Jennings Bayou during high rainfall events, or it may use the rivers and creeks immediately adjacent to the Project site including the Brazos River and Oyster Creek.

The **timber (canebrake) rattlesnake** is a state-listed threatened species whose range is scattered throughout the eastern third of the state from the Red River to the Gulf Coast (Dixon and Werler 2014). This species prefers moist, lowland forests, hilly woodlands, or heavily vegetated waterways (TPWD 2021). Timber rattlesnake also inhabits palmetto-covered lowlands and cane thickets, as well as abandoned brush-covered fields and woodland clearings that contain decaying logs and tree stumps (Dixon and Werler 2014). During the spring and fall, this species is diurnal but becomes nocturnal during the heat of the summer (TPWD 2021). Data from TXNDD (2018) list no records within proximity to the Project site or alternative sites. The nearest documented occurrence of a timber rattlesnake is approximately 13 miles southwest of the Project site along FM 1459 (iNaturalist 2021d).

3.9 Land Use

Agriculture is a major land use in the county and within the 1-mile analysis area around the Project site. Other than agriculture, land uses within 1 mile of the Project site are the TDCJ prison to the north, residential to the east, and the existing Harris Reservoir to the south. Brazoria County does not regulate land use or have any zoning ordinances in the unincorporated areas of the county. Oil and gas development is another major land use in Brazoria County (RRC 2021).

Brazoria County had 460,005 acres (48%) of land in farms in 2017, down 27% since 2012 (USDA 2017a). This decrease is likely due to population growth converting agricultural lands to residential (Cooley 2015). Of the county farmlands in 2017, 59% of land was pastureland, 29% was cropland, and 12% was woodland/other. Top crops by acres in the county were forage (hay), rice, corn, sorghum, and soybeans. According to the NLCD (2016), 142,278 acres within the county is cultivated cropland and 191,227 acres is pasture/hay.

3.9.1 Proposed Action, Alternative 2A, and Alternative 2B

The Project site for the Proposed Action, Alternative 2A, and Alternative 2B is owned by Dow. Land use in the Project site was identified using the NLCD (2016). As shown in Figure 3.4-1 and Table 3.4-2, approximately 80% of the Project site is mapped as Agricultural (524 acres pasture/hay and 1,490 acres cultivated crops). There are 2,185 acres of soils designated as Prime Farmland (see Section 3.2.2).

A large portion of the Project site has been used for agricultural farming since as early as 1944 with increased agricultural farming apparent in 2012 aerial photographs (Jacobs 2019b). The Project site is currently leased to the TDCJ Ramsey Prison Facility for agricultural farming and cattle grazing (TDCJ 2020). In recent years, crops have included corn and sorghum, according to Farm Service Agency records. Approximately 2,014 acres (79.6%) of the site is agricultural with most of this used for crops (see Table 3.4-1).

During an August 2019 site reconnaissance, the northwest half of the Project site was being used as a cattle pasture and contained four ponds, cattle feeders, and storage for farm equipment (Jacobs 2019b). There is an underground Conoco Phillips pipeline on the Project site within a maintained right-of-way that runs through the center of the site (Jacobs 2019b).

There is one water monitoring well drilled by Dow and 11 plugged oil and gas wells within the Project site (see Table 3.2-1). A site visit in 2019 confirmed that all oil and gas wells are plugged and there are no visible well features on the Project site (Jacobs 2019b). The Conoco Phillips pipeline crosses near the center of the site, generally paralleling Jennings Bayou (RRC 2021). The location of the wells and pipeline are shown on Figure 3.2-2. A CenterPoint Energy power line easement parallels an unnamed north-south road through the Project site. Infrastructure, including utilities, is discussed in Section 3.15.

The Big Slough site and surrounding area has historically been used for agriculture, rangeland management for grazing, and oil well drilling and extraction (Cardno 2021).

3.9.2 Alternative 3

Land uses on the west bank of the Brazos River, where the Alternative 3 site is located, are similar to the Project site under the Proposed Action. The 2,885-acre Alternative 3 site is mainly used for agriculture (56.3%), but the land is primarily pasture/hay (1,552.5 acre; 53.8%) rather than cultivated crops compared to the Proposed Action (see Table 3.4-1). A group of farm buildings is in the center of the Alternative 3 site and five residential properties with homes and outbuildings are along CR 25, which traverses the east side of the site. There is active oil and gas activity, including dry wells and in-service pipelines, within the site (see Section 3.2). All drilled oil and gas wells within the site are dry holes. Land uses within 1 mile include ranches primarily used for pasture/hay and cultivated crops, The 400-acre Nash Prairie Preserve is 500 feet to the south and is protected from development.

3.9.3 Alternative 4

Land uses on the Alternative 4 site consist predominantly of undeveloped shrub-forest lands that are south of the existing Brazoria Reservoir along the Brazos River. The Cornerstone Church property is between the Brazoria Reservoir and the Alternative 4 site and includes a former golf course and lake for fishing. Another small lake, Cut Off Lake, is located on the Alternative 4 site. Three existing oil and gas pipeline ROWs traverse the Alternative 4 site, and there is one drilled well that is dry. Only 5.9% of the Alternative 4 site is categorized as agricultural land. This is primarily pasture/hay land on the west end of the site.

The water pipeline and RO concentrate pipeline would be approximately 8.8 miles long and would be located within a 100-foot-wide corridor (totaling 107 acres). Approximately 3.5 miles of the proposed corridor crosses undeveloped land with the remaining 5.3 miles crossing developed residential and industrial areas in Lake Jackson. Two existing oil and gas pipeline ROWs cross the proposed corridor. Roadways crossed by the corridor include FM 20004, Lake Road, and Oak Drive South. Roadways parallel to the corridor include This Way Street and Medical Drive. Also present adjacent to the proposed corridor are the Wilderness golf course off Brazoria Road, residential neighborhoods, a canal, office buildings, and Dow’s Texas Operations.

3.10 Socioeconomic Resources

Information that assists in evaluating the socioeconomic status (social and economic indicators) of a given population is available from the U.S. Census Bureau (Census) on a national, state, regional, and county level, with select information also available at Census tract, block group, and block levels. Information regarding a community’s facilities and services, such as educational facilities, fire and rescue or medical services, and local employment information, is typically available from federal, state, or county governmental offices such as local chambers of commerce or the Bureau of Labor Statistics, or from public publications or non-government organization data sources, such as a local recreation club website. Measures of social and economic activity described in this section include population, housing, community diversity, community facilities and services, and income and industry.

3.10.1 Proposed Action, Alternative 2A, Alternative 2B, and Alternative 3

The Project site is in Brazoria County, Texas, approximately 10 miles south-southwest of Houston, approximately 27 miles northwest of Freeport, and approximately 3 miles south of Fort Bend County. The Project site, Alternative 2 site, and Alternative 3 site are within Census Tracts 6619.01, 6620, and 6621. The analysis area for socioeconomics is the three Census tracts, all of which are within Brazoria County and total approximately 332 square miles (Figure 3.10-1). Data for all of Brazoria County is included for comparison.

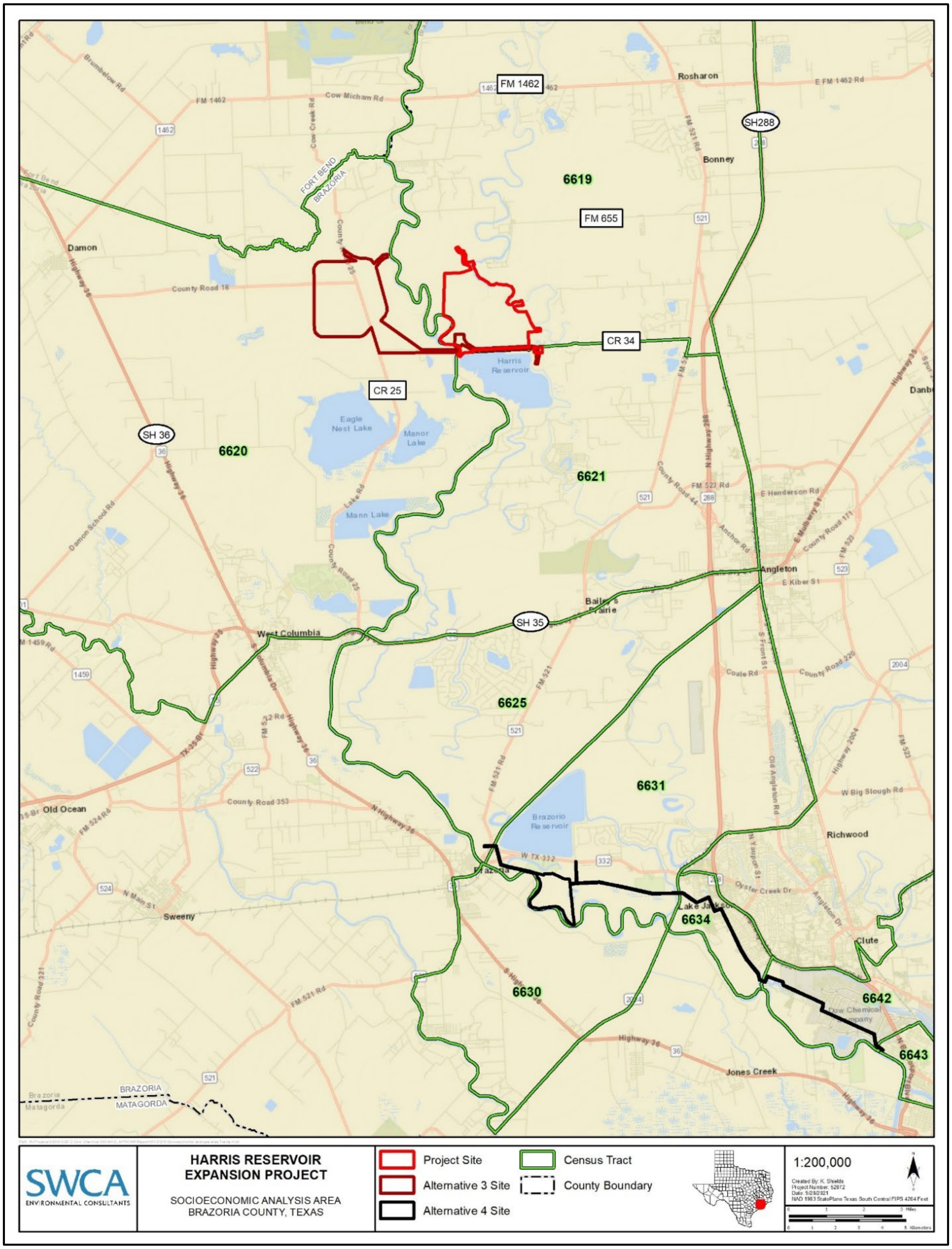


Figure 3.10-1. Socioeconomic analysis areas.

3.10.2 Alternative 4

Most of Alternative 4 is in Census Tract 6631, including the desalinization plant, power line ROW and substation, and a portion of the pipeline ROW (see Figure 3.10-1). The remainder of the pipeline ROW outside Dow's Texas Operations is in Census Tracts 6634 and 6642. The area within these Census tracts is the analysis area for Alternative 4. While small portions of the east and west ends of Alternative 4 are located within Census Tracts 6625 and 6643, activities within these tracts would take place within areas of existing Dow operations, and these tracts have been excluded from the analysis area.

3.10.3 Population and Housing

3.10.3.1 PROPOSED ACTION, ALTERNATIVE 2A, ALTERNATIVE 2B, AND ALTERNATIVE 3

Most of the population in Brazoria County is found north of the Project site near Houston. Other populated areas include the city of Angleton in the center of Brazoria County, approximately 8 miles southeast of the Project site; Lake Jackson 20 miles south; and Freeport on the Gulf Coast, in the southern extent of Brazoria County. The city of Angleton had a population of 19,429 in 2020 (Census 2020b). The primary analysis area surrounding the Project site, Alternative 2 site, and Alternative 3 site is rural with farmland making up most of the land cover, with scattered housing units. The population is less dense compared to the county and has generally grown slightly since the 2010 Census (Table 3.10-1). Although Census Tract 6619.01 has a population of 8,024, over half of the population is within the three prisons located there, which have a total population of 4,277 people (Census 2020c). Holiday Lakes Town in Census Tract 6621 has a population of less than 1,000 (Census 2020d). There are no population centers within Census Tract 6620, but some houses are dispersed through the area.

Table 3.10-1. Population and Housing

Geographic Area	Total Population	Population per Square Mile	Population Change Since 2010	Total Housing Units	Housing Units per Square Mile
Texas	29,145,505	112	3,999,944	11,589,324	44
Brazoria County	372,031	1,517	58,865	141,493	577
Census Tract 6619.01	8,024	157	N/A*	1,384	3
Census Tract 6620	6,637	12	428	3,039	6
Census Tract 6621	6,575	65	726	2,677	25
Census Tract 6631	7,184	262	798	2,490	98
Census Tract 6634	8,101	956	1,112	4,010	508
Census Tract 6642	2,222	32	306	2,287	17

Sources: Census (2010, 2020d).
Note: N/A = information not available.
* Because of redistricting, the geographic boundary of Census Tract 6619.01 is different from previous years and direct comparisons cannot be made.

The percentage of housing units that are occupied in the primary analysis area ranges from 81% to 84%, and the percentage of owner-occupied units is estimated to be between 80% to 86% (Census 2019b). Occupancy and vacancy rates for rental housing is summarized in Table 3.10-2. In addition, there are several hotels in the Angleton area near SH 288. Private land in the area is commonly used for hunting/fishing, and there are rental units available for seasonal recreation.

Table 3.10-2. Occupancy and Vacancy of Rental Housing Units

Geographic Area	Number of Renter-Occupied Housing Units	Percent Renter- Occupied Housing Units	Rental Vacancy Rate
Brazoria County	32,878	28	9.2
Census Tract 6619*	394	14	7
Census Tract 6620	406	19	2
Census Tract 6621	390	20	8
Census Tract 6631	178	9	19
Census Tract 6634	1,334	43	17
Census Tract 6642	331	34	29

* Information was only available for the larger Census Tract 6619, which was used until redistricting until 2020.
Source: Census (2019b).

As described in Section 3.3.2, multiple flood events occurred in Brazoria County from 2015 through 2017. The June 2016 flood event alone resulted in more than 1,500 homes with sustained flood damages equating to $32 million of disaster recovery need (Brazoria County 2018). In 2017, Hurricane Harvey caused widespread floods across the county including major flooding on the Brazos River and Oyster Creek that led to numerous roads and homes flooding. More than 9,000 homes experienced flood damage from the storm (NOAA 2018). FEMA flood claims occur when a property experiences inundation regardless of the source of flooding; however, in the analysis area, the majority of the flooding experienced derives from a combination of storm surge and heavy rainfall associated with tropical events. Between 1996 and 2019, there were 74 flood events in Brazoria County. Claims in Texas average $54,200 per claim (FEMA 2021b). In fiscal year 2020, there were 2,291 NFIP claims in Texas, for a total cost of $40,533,947 in NFIP payments (FEMA 2020).

3.10.3.2 ALTERNATIVE 4

The Alternative 4 analysis area includes portions of the city of Lake Jackson and its surrounding communities, including Brazoria. The population and housing units per square mile is much denser compared to the rural setting of the Proposed Action and Alternatives 2 and 3. The percentage of owner-occupied units is estimated to be 58% to 92% with the most renter-occupied units in Census Tract 6634 (Census 2019b). Several hotels are located along SH 288 and temporary housing is available with a higher vacancy rate compared to the Proposed Action and Alternatives 2 and 3. Most of the Alternative 4 site is located within the 100-year floodplain and properties may experience flood damage requiring FEMA flood claims.

3.10.4 Community Facilities and Services

3.10.4.1 PROPOSED ACTION, ALTERNATIVE 2A, ALTERNATIVE 2B, AND ALTERNATIVE 3

There are no police stations, fire stations, hospitals, or schools within the three Census blocks that make up the primary analysis area. There are six places of worship in the analysis area. The closest schools are located in the nearby cities of Angleton and West Columbia. Hospitals, police stations, and fire stations are located in Angleton and Lake Jackson.

Recreational facilities in the primary analysis area include Brazos River County Park, an 80-acre day-use woodland park alongside the Brazos River near Holiday Lakes. Portions of the San Bernard National Wildlife Refuge are in the area and provide nature tourism. Many visitors stop in nearby communities at gas stations, restaurants, and hotels (USFWS 2020c). The refuge promotes the surrounding communities and encourages visitors to enjoy the many services and opportunities offered nearby. The refuge is open to waterfowl hunting and fishing.

3.10.4.2 ALTERNATIVE 4

Census Tract 6631 where the desalination plant would be located does not include police stations, fire stations, hospitals, or schools; however, these services are available nearby in Lake Jackson and Brazoria. The Cornerstone Church is immediately north of the desalination plant location and there are a golf course and park west of the Alternative 4 site. The portion of the pipeline ROW that crosses Lake Jackson is in Census Tracts 6634 and 6642, which contain the Brazosport Hospital, MacLean Park, a recreation center, and Rasco Middle School. Additional community facilities and services, including police stations and fire stations, are located in adjacent parts of Lake Jackson.

3.10.5 Industry and Employment

3.10.5.1 PROPOSED ACTION, ALTERNATIVE 2A, ALTERNATIVE 2B, AND ALTERNATIVE 3

In Brazoria County, the largest share of civilian employment (25%) is in educational services and health care and social assistance (Census 2019c). Other industries that account for employment in the county include construction (10%), manufacturing (14%), and professional/scientific (10%). Over the next 5 years, employment in Brazoria County is projected to expand by 13,336 jobs, with health care and social assistance as the fastest growing sector (JobsEQ 2019).

Agriculture, forestry, fishing and hunting, and mining industries make up less than 3% of industries in the county; however, agriculture appears to be a leading industry in the primary analysis area based on land use. According to the Census of Agriculture (USDA 2019), there are 2,851 farms in Brazoria County with an average size of 161 acres; 98% are family farms. Total farm production expenses are higher than the market value of products sold, plus government payments, plus farm-related income, resulting in a loss of $6.8 million in 2017 within the county (-$2,386 per farm average).

There is a “chemical” industry cluster (a geographic concentration of interrelated industries or occupations) in Brazoria County with 8,158 workers and an average wage of $143,868 (JobsEQ 2019). Dow Chemical Company in Freeport is a major employer in the county with 3,508 employees (Economic Development Alliance for Brazoria County 2020).

Median household income within the county is higher than the state average and the unemployment rate is slightly lower than the state (Census 2019c) (Table 3.10-3). Table 3.10-3 shows the population age 16 years and over that is employed or unemployed and the median household income in the area. Data is from the Census’ American Community Survey 2015–2019.

Table 3.10-3. Employment and Income

Geographic Area	Population Age 16+ Years	Percentage of Population in Civilian Labor Force	Unemployment Rate (%)	Median Household Income
Texas	21,736,238	64%	5.1%	$61,874
Brazoria County	276,169	64%	4.4%	$81,447
Census Tract 6619.01	13,034	35%	4.7%	$82,636
Census Tract 6620	4,804	61%	8.6%	$75,959
Census Tract 6621	4,507	62%	4.6%	$80,152
Census Tract 6631	6,751	40%	3.5%	$107,232
Census Tract 6634	5,963	68%	1.9%	$67,775
Census Tract 6642	1,766	58%	9.7%	$48,625

Source: Census (2019c).

In Census Tract 6619.01, there are three TDCJ prisons: the Ramsey, Stringfellow, and Terrell units. Ramsey has 429 employees, Stringfellow has 313 employees, and Terrell has 466 employees (TDCJ 2020). The prisoners work in agricultural operations and other industries, including field crops, grains, cattle and swine, a vegetable cannery, security horses, and security canines. Prisoners are also employed in manufacturing and logistics operations for a furniture refinishing factory, mechanical shop, and a distribution and freight terminal. Although the prisoners work in these industries within the TDCJ system, they are not counted as part of the civilian labor force in Table 3.10-3.

3.10.5.2 ALTERNATIVE 4

The unemployment rate is low in Census Tracts 6631 and 6634, which cover residential areas on the west side of Lake Jackson. Census Tract 6642 is an industrial area with a smaller population and the unemployment rate is high (9.7%) compared to the Proposed Action (Census 2019c).

3.10.6 Environmental Justice

EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, was enacted on February 11, 1994, and mandates that federal agencies identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of programs on minority and low-income populations (Executive Office of the President 1994). Demographic indicators of minority populations or non-low-income populations, or both, also include those that are linguistically isolated or have less than a high school education, or both (Table 3.10-4).

Table 3.10-4. Minority and Low-Income Populations

Geographic Area	Minority*	Low-Income Population†	Linguistically Isolated†	Less Than High School Education†
United States	39%	33%	4%	13%
Texas	50%	14.7%	13.7%	16.3%
Brazoria County	49%	8.7%	7.9%	12.1%
Census Tract 6619.01	56%	8.7%	9.0%	24.0%
Census Tract 6620	28%	9.0%	13.1%	14.6%
Census Tract 6621	42%	8.3%	10.0%	14.1%

Geographic Area	Minority*	Low-Income Population†	Linguistically Isolated†	Less Than High School Education†
Census Tract 6631	37%	2.4%	4.5%	12.8%
Census Tract 6634	38%	9.2%	6.6%	5.1%
Census Tract 6642	26%	23.1%	4.1%	14.6%

Sources: Census (2019c, 2019d, 2020a), EPA (2019b).
* Derived from 2020 Decennial Census.
† Derived from 2015–2019 ACS 5-Year Estimates.

3.10.6.1 MINORITY POPULATIONS

3.10.6.1.1 Proposed Action, Alternative 2A, Alternative 2B, and Alternative 3

A minority population is defined by the Census as Black or African-American; Asian; American Indian or Alaska Native; Native Hawaiian or other Pacific Islander; or other nonwhite persons, including persons with two or more races; and Hispanic or Latino persons. As shown in Table 3.10-4, Texas and Brazoria County have higher minority population rates than the national average (39%). One of the three Census Tracts in the analysis area has a higher minority population percentage than the national, state, and county percentages (Census Tract 6619.01) (Census 2020d). Census Tract 6619.01 also has a minority population percentage greater than 50%, which is identified as an indicator for environmental justice analysis (Federal Interagency Working Group on Environmental Justice & NEPA Compliance Committee 2016).

3.10.6.2 ALTERNATIVE 4

The minority population in the Alternative 4 analysis area is similar to the national average but lower than the Proposed Action analysis area.

3.10.6.3 LOW-INCOME POPULATIONS

3.10.6.3.1 Proposed Action, Alternative 2A, Alternative 2B, and Alternative 3

Low-income populations, as an environmental justice demographic factor, are defined as households in which the household income is less than or equal to twice the federal poverty level (EPA 2021c). To determine whether a population in a specific geographic area should be considered low income, the percentage of persons in poverty can be compared with that in another area, such as the state. A summary of the low-income population for the socioeconomic analysis area is presented in Table 3.10-4. Brazoria County and the analysis area have a lower percentage of residents who are considered low-income compared to both the state and national averages. As shown in Table 3.10-3, the median household income in the analysis area is similar to that of Brazoria County, which is slightly higher than the median household income in Texas.

3.10.6.3.2 Alternative 4

Census Tract 6642 is an industrial area where a meaningfully higher percentage of the population (23.1%) is low income (more than twice the percentage for Brazoria County) and household income is almost half of the county median income. The remaining portion of the analysis area contains residential neighborhoods where the income is higher and percentage of residents who are low income is similar to the Proposed Action analysis area.

3.10.6.4 LINGUISTICALLY ISOLATED

3.10.6.4.1 Proposed Action, Alternative 2A, Alternative 2B, and Alternative 3

The percentage of a population in linguistic isolation is the percentage of households in which no one age 14 or over speaks English "very well" or speaks English only (as a fraction of households). This is calculated from the Census' American Community Survey 5-year summary estimates. The linguistically isolated households in Brazoria County speak Spanish (3,588), Asian-Pacific Island languages (856), other Indo-European languages (111), or other languages (92). Approximately 9% to 13% of households in the analysis area are linguistically isolated with almost all of these households speaking Spanish (Census 2019d).

The term "limited English proficient" refers to any person aged 5 years or older who reported speaking English less than "very well" as classified by the Census (2019d). The number of individuals who are limited English proficient within the state of Texas is higher than the national average, which is likely a result of the proximity of Texas to the U.S.-Mexico border.

There is a higher percentage of population of Census Tract 6620 (13.1%) that is linguistically isolated in comparison to Brazoria County (7.9%).

3.10.6.4.2 Alternative 4

The Alternative 4 analysis area has a lower percentage of linguistically isolated households compared to the Proposed Action. The percentage (4%–6%) is comparable to the national average and lower than Brazoria County (see Table 3.10-4).

3.10.6.5 EDUCATION

3.10.6.5.1 Proposed Action, Alternative 2A, Alternative 2B, Alternative 3, and Alternative 4

Level of education has been shown to directly relate to income, poverty, and quality of life. People with less than a high school education are considered to be at a disadvantage in these environmental justice indicators. Table 3.10-4 provides details of the percentage of population with less than a high school education within the analysis area compared to the state and the nation. Although Brazoria County's population is slightly lower compared to the state and national percentage of population with less than a high school education, the primary analysis area has a higher percentage of the population that is not educated to high school level (Census 2019d). Census Tract 669.01 has a higher percentage of the population with less than high school education (24%) than Brazoria County (12%).

3.10.6.6 CHILDREN'S HEALTH AND SAFETY

3.10.6.6.1 Proposed Action, Alternative 2A, Alternative 2B, and Alternative 3

EO 13045, Protection of Children from Environmental Health Risks and Safety Risks, was enacted on April 23, 1997. The order concerns identification of environmental health or safety risks that the EPA has reason to believe may disproportionately affect children. Environmental health risks or safety risks refer to risks attributed to products or substances that the child is likely to come in contact with or ingest (e.g., air, food, water, soil). Children may use the Brazos River County Park but are unlikely to gather as a population. Otherwise, there are no schools or other concentrations of children within the analysis area.

3.10.6.6.2 Alternative 4

There is one park and one middle school near the pipeline ROW that would carry the desalinated water from the Brazos River to Dow's Texas Operations. The pipelines would be buried, and this alternative would not disproportionately affect the health and safety of children.

3.10.7 Navigation and Recreation

3.10.7.1 UPLAND RECREATION

3.10.7.1.1 Proposed Action, Alternative 2A, and Alternative 2B

The analysis area for recreation includes the Project site and a 1-mile buffer. Lands within the Project site are currently either undeveloped or developed for agriculture and are privately held. Recreational use data for these lands are not available. No public recreational hunting is present on upland portions of the Project site, there are no public access roads or pathways, and public access is not allowed. Public recreation access is limited to the immediately adjacent shorelines of the Brazos River and Oyster Creek.

3.10.7.1.2 Alternative 3

Like the Proposed Action Project site, the lands within and adjacent to (within a 1-mile buffer of) the Alternative 3 site are privately held and do not offer public recreation access. Public recreation access is limited to the immediately adjacent shorelines of the Brazos River and Oyster Creek.

3.10.7.1.3 Alternative 4

There are no public recreational opportunities or public access roads or pathways within the Alternative 4 site and a 1-mile buffer. Public recreation access is limited to the immediately adjacent shorelines of the Brazos River. Oyster Creek is just outside the 1-mile buffer.

3.10.7.2 IN-WATER RECREATION

3.10.7.2.1 Proposed Action, Alternative 2A, and Alternative 2B

The Brazos River in the vicinity of the Project site supports numerous recreational freshwater fish species, including catfish, sunfish, and alligator gar. From its confluence with Oyster Creek downstream to the Gulf of Mexico, the Brazos River is tidally influenced, and as the river moves toward high tide, the influx of saltwater brings redfish, sand trout, flounder, and other saltwater fish further upriver. Unlike the Brazos River, Oyster Creek is not tidally influenced and supports only freshwater species (Linam and Kleinsasser 1987). The portion of Oyster Creek within the Project site is freshwater and supports recreational fishing primarily for catfish and sunfish. Recreational fishing near the Project site is open to all species year-round (BRA 2019c; TPWD 2019h).

Seasonal hunting for migratory game birds is managed by TPWD and is allowed throughout this area, including the sections of the Brazos River and Oyster Creek within the analysis area, from November 2 to December 1 and from December 14 to January 26. Other species, such as deer and feral hogs, can be taken in season from the river with landowner permission to retrieve the carcass (TPWD 2019e).

3.10.7.2.2 Alternative 3

In-water recreational opportunities at the Alternative 3 site are largely the same as those present in the Project site.

3.10.7.2.3 Alternative 4

In-water recreational opportunities at the Alternative 4 site are similar to those described for the Brazos River adjacent to the Project site.

3.10.7.3 NAVIGATION

3.10.7.3.1 Proposed Action, Alternative 2A, Alternative 2B, and Alternative 3

Navigation for recreational and commercial (e.g., sand mining dredges) users is possible in the portion of the Brazos River adjacent to the Project site and the Alternative 3 site, as well as Oyster Creek within the Project site and beyond. The portion of the Brazos River navigable under Section 10 within the analysis area includes approximately 4,600 linear feet of active Brazos River and approximately 3,500 linear feet of a partially flooded abandoned oxbow (see Figure 3.3-2). The Brazos River adjacent to the Project ranges from approximately 200 to 250 feet wide and is navigable by recreational boat. Common impediments to recreational navigation in the Project site include many sunken and partially sunken trees. There are no human-made navigation impediments other than the existing intake structure for the Harris Reservoir approximately 0.5 mile south of the Project site (see Figure 3.3-2).

Established boat launches for public access to the Brazos River are located at Brazos River County Park, approximately 3.6 miles south of the Project site, and Brazos Bend State Park, approximately 7.7 miles north. There are no public river access points along the Brazos River within or adjacent to the Project site. Although motorized boat use occurs on the Brazos River near the Project site and the Alternative 3 site, this segment of the Brazos River is well known for its nonmotorized paddling, canoeing, and kayaking. The Stephen F. Austin paddling trail begins at Brazos River County Park approximately 3.6 miles south of the Project. The trail offers multiple public take-out points along the Brazos River from the Brazos River County Park extending downstream to the mouth of the river at Freeport (TPWD 2019h). Motorized boats are permitted on this segment of the Brazos River (TPWD 2019e), but users must be wary of the many natural snags throughout the waterway.

The portion of Oyster Creek within the Project site includes approximately 16,000 linear feet of active stream channel, which ranges from approximately 20 to 80 feet wide. Oyster Creek roughly parallels the Brazos River from Missouri City 22 miles north of the Project site to its mouth at Oyster Creek, Texas, at the Gulf of Mexico. Navigation records for Oyster Creek are not publicly available, but review of aerial imagery (Google Earth 2019) indicates that the stream channel is open and uninterrupted between the Project site and the Gulf of Mexico.

3.10.7.3.2 Alternative 4

Navigation for recreational users at the Alternative 4 site would be similar to that described for the Brazos River adjacent to the Project site; however, there would be no navigational considerations for Oyster Creek under Alternative 4 because no Project activities would occur in or near that waterbody. Formal Brazos River access points near the Alternative 4 site include the Farm to Market 2004 Boat Ramp 7 river miles downstream, and the County Road 849 Boat Ramp directly across the Brazos River. The nearest public park with informal river access is the Lake Jackson Recreation Center 7.2 river miles downstream.

3.10.8 Visual and Aesthetic Resources

The term *visual and aesthetic resources* (visual resources) refers to the composite of basic terrain, geologic and hydrologic features; vegetative patterns; and built features that influence the visual appeal of a landscape.

The analysis area for visual resources (for the Proposed Action and all alternatives) is defined as a 0.5-mile buffer around the perimeter of the Project (or alternative) site (Figure 3.10-2). The 0.5-mile analysis area has been determined based on proposed Project elements and the existing landscape characteristics and represents the area in the surrounding landscape where potential visual effects from the Project may be discerned by the casual observer, which is the limit of the immediate foreground visual distance zone. Key observation points (KOPs) represent common or visually sensitive locations from which the Project site could be viewed. Visual sensitivity reflects attitudes and perceptions held by people regarding the landscape and, in general, reflect the public's level of sensitivity for noticeable change to the landscape. There are no known existing visual resource inventories or analyses that have occurred within the analysis area.

3.10.8.1 PROPOSED ACTION, ALTERNATIVE 2A, AND ALTERNATIVE 2B

3.10.8.1.1 Characteristic Landscape

The visual resources in the analysis area are characterized by low, broad, and horizontal landforms with very few distinctive features. Vegetation within the analysis area consists of dense stands of tall, conical and rounded canopy evergreen and deciduous trees intermixed with low stature grasslands and agricultural fields with indistinct forms. For additional vegetation information, see Section 3.4. As a result of the Coastal Prairies topography (discussed in Section 3.2), water is a dominant feature in the landscape with numerous small body lakes and sinuous rivers and streams. The existing Harris Reservoir, Brazos River, and Oyster Creek all occur within the analysis area and contribute to the visual resources of the area. Color in the area is a composite of dark to yellow-green vegetation that contrasts with the reflective qualities of the adjacent water features and seasonal changes in agricultural fields. The most distinctive elements in the landscape are associated with built and human-made structures that contrast with the more dominant natural elements. Structures are clustered along the southern portion of the analysis area and consist of rectangular, light-colored, one-story structures associated with existing Harris Reservoir operations. North of the Project site are numerous clustered structures and facilities associated with the TDCJ prison farm that are distinctive and contrast with the flat, horizontal landscape.

3.10.8.1.2 Sensitive Viewer Groups

Sensitive viewer groups identified within the analysis area have been categorized based on their expected sensitivity to visual change within the characteristic landscape, as well as activity type and potential duration of time they would be expected to remain within the analysis area. These viewer groups, which may overlap or have dual representation based on location and or use, are used in determining from where in the analysis area the Project could be viewed from a representative public.

Sensitive viewer groups are categorized by the following:

- **Travelers** – origin/destination travelers that use roadways from which the landscape is viewed.
- **Recreational Users** – local and seasonal users engaged in recreational activities.
- **Residents –** people who live and work within the visual analysis area. Generally, they view the landscape from their properties and homes and often from places of employment while engaged in daily activities.

3.10.8.1.3 Key Observation Points

KOPs represent viewing locations where the sensitive viewer groups may view the Project. Five KOPs were identified (Table 3.10-5; see Figure 3.10-2) based on locations within the analysis area that would have potential views of the Project and represent the most critical viewpoints using the criteria above.

Table 3.10-5. KOP Sensitive Viewer Groups and Rationale for Inclusion

KOP Number	KOP Name	Sensitive Viewer Group	Rationale for Inclusion
1	Brazos River	Recreation	Local and regional recreation users with views of Project bank protection/stabilization, pump station, and intake associated with the expansion reservoir.
2	River Lake	Recreation	Local and regional recreation users with views of expansion reservoir from the northwest.
3	Ramsey Bridge	Travelers	Local and regional travelers with views of Oyster Creek restoration project components and the expansion reservoir.
4	Harris Reservoir Road	Travelers / Residents	Local and regional travelers with views of Project staging area.
5	Southwest corner of Project site	Recreation	Local and regional recreation users with views of Project bank protection/stabilization, pump station, and intake associated with the expansion reservoir.

Figure 3.10-2. Project site visual resource analysis area and KOP locations.

3.10.8.2 ALTERNATIVE 3

The analysis area for visual resources associated with the Alternative 3 site is defined as a 0.5-mile radius from the perimeter of the Alternative 3 site, which can be considered the limit of the immediate foreground visual distance zone. There are no known existing visual resource inventories or analyses that have occurred within the analysis area.

3.10.8.2.1 Characteristic Landscape

The characteristic landscape associated with Alternative 3 is similar to the characteristic landscape described for the Proposed Action.

3.10.8.2.2 Sensitive Viewer Groups

Sensitive viewer groups associated with Alternative 3 are similar to the sensitive user groups described for the Proposed Action.

KOPs associated with Alternative 3 were not determined. It can be assumed that sensitive viewer groups and representative KOPs associated with the Proposed Action are representative of sensitive viewer groups associated with Alternative 3 that occur within 0.5-mile (immediate foreground) of the alternative.

3.10.8.3 ALTERNATIVE 4

The analysis area for visual resources associated with the Alternative 4 is defined as a 0.5-mile radius from the perimeter of the Alternative 4 site, which can be considered the limit of the immediate foreground visual distance zone.

3.10.8.3.1 Characteristic Landscape

The characteristic landscape associated with Alternative 4 is similar to the characteristic landscape described for the Proposed Action with the exception of the presence of greater densities and concentrations of industrialized infrastructure associated with Dow's Texas Operations and residential development in the cities of Brazoria and Lake Jackson that introduce bold, geometric forms and textures within the landscape.

3.10.8.3.2 Sensitive Viewer Groups

Sensitive viewer groups associated with Alternative 4 are similar to the sensitive user groups described for the Proposed Action.

KOPs associated with Alternative 4 were not determined. It can be assumed that sensitive viewer groups and representative KOPs associated with the Proposed Action are representative of sensitive viewer groups associated with Alternative 4 that occur within 0.5-mile (immediate foreground) of the alternative.

3.11 Climate and Air Quality

3.11.1 Proposed Action, Alternative 2A, Alternative 2B, Alternative 3, and Alternative 4

Construction and operational emissions would cause air pollutant emissions to be released from the Project site and construction areas into the ambient air. Because the Proposed Action and all other action alternative activities are located in Brazoria County, the County is the analysis area for climate and air.

3.11.2 Regulatory Requirements for Air Pollutants

Both the EPA and TCEQ regulate ambient air quality through enforcement of air quality standards, Clean Air Act General Conformity Requirements, air permitting programs, and stationary source performance standards.

3.11.2.1 NATIONAL AMBIENT AIR QUALITY STANDARDS

The EPA has established National Ambient Air Quality Standards (NAAQS) for criteria pollutants under the authority of the Federal Clean Air Act of 1977. Primary NAAQS standards provide for protection of public health whereas secondary NAAQS standards provide for protection of public welfare including protection against decreased visibility and damage to animals, crops, vegetation, and buildings. Primary and secondary standards have been set for criteria pollutants, which include carbon monoxide (CO), lead, ground-level ozone (O_3), particulate matter (PM_{10}, and $PM_{2.5}$), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2) (EPA 2021d). The NAAQS were developed such that the concentrations of criteria pollutants remain below thresholds that are considered harmful to public health and the environment. The NAAQS are listed in Table 3.11-1.

Table 3.11-1. Primary and Secondary National Ambient Air Quality Standards

Pollutant	Primary/Secondary	Averaging Time	Level	Form of Standard
CO	Primary	8 hours	9 ppm	Not to be exceeded more than once per year
		1 hour	35 ppm	
Lead	Primary and secondary	Rolling 3-month average	0.15 μg/m^3	Not to be exceeded
NO_2	Primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	Primary and secondary	1 year	53 ppb	Annual mean
O_3	Primary and secondary	8 hours	0.070 ppm	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
$PM_{2.5}$	Primary	1 year	12.0 μg/m^3	Annual mean, averaged over 3 years
	Secondary	1 year	15.0 μg/m^3	Annual mean, averaged over 3 years
	Primary and secondary	24 hours	35 μg/m^3	98th percentile, averaged over 3 years
PM_{10}	Primary and secondary	24 hours	150 μg/m^3	Not to be exceeded more than once per year on average over 3 years

Pollutant	Primary/Secondary	Averaging Time	Level	Form of Standard
SO_2	Primary	1 hour	75 ppb	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	Secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year

Source: EPA (2021d)

Notes: ppm = parts per million; ppb = parts per billion; $\mu g/m^3$ = micrograms per cubic meter

Averaging Time indicates the length of time that pollutant concentration averages are averaged over to compare against the standard. For instance, the CO standard averaging time is 8 hours so, to conform to the 9 ppm standard, the 8-hour average concentration cannot exceed the 9 ppm standard more than once per year.

Geographic areas that do not comply with primary NAAQS requirements for criteria pollutants are considered nonattainment areas.

3.11.2.2 CLEAN AIR ACT GENERAL CONFORMITY REQUIREMENTS

Section 176(c)(1) of the Clean Air Act states that federal agencies may not support or approve any activity that does not conform to an implementation plan for achieving and maintaining ambient air quality standards. It must be demonstrated that federal actions conform to an implementation plan's purpose of eliminating or reducing the severity and number of violations of the NAAQS and achieving expeditious attainment of such standards and shall not:

- cause or contribute to any new violations of any standard in any area,
- increase the frequency or severity of any existing violation of any standards in any area, or
- delay timely attainment of any standard or any required interim emission reductions or other milestones in any area.

The General Conformity Rule under the Clean Air Act establishes minimum values, referred to as the de minimis thresholds, for the criteria and precursor pollutants for the purpose of

- identifying federal actions with Project-related emissions that are clearly negligible (de minimis),
- avoiding unreasonable administrative burdens on the sponsoring agency, and
- focusing efforts on key actions that would have potential for significant air quality impacts.

As specified in 40 CFR 93, the de minimis threshold for the Project is 50 tons per year (tpy) each for emissions of nitrogen oxides (NO_x) and volatile organic compounds (VOCs) with respect to General Conformity, because the Project is located in a serious O_3 nonattainment area.

3.11.2.3 NEW SOURCE PERFORMANCE STANDARDS

Section 111 of the Clean Air Act authorizes the EPA to develop technology-based standards that apply to specific categories of stationary sources. These standards are referred to as New Source Performance Standards and are found in 40 CFR 60. New Source Performance Standards apply to new, modified, and reconstructed affected facilities and are designed to regulate criteria air pollutants (as well as greenhouse gases [GHGs] in some instances). A proposed source that is subject to the requirements of a New Source Performance Standards are required to comply with the applicable requirements of the Standard. Diesel-fired pump engines would subject to New Source Performance Standards in 40 CFR Part 60, Subpart IIII and comply with applicable requirements thereunder.

3.11.2.4 NATIONAL EMISSION STANDARDS FOR HAZARDOUS AIR POLLUTANTS

Section 112 of the Clean Air Act authorizes the EPA to develop standards for stationary sources of hazardous air pollutant (HAP) emissions, known as National Emission Standards for Hazardous Air Pollutants (NESHAPs). NESHAPS promulgated after the 1990 Clean Air Act Amendments are found in 40 CFR 63. These standards require application of technology-based standards for new and existing stationary sources and are referred to as maximum achievable control technology (MACT) standards. MACT standards may apply to both major and non-major stationary sources of HAP emissions. A proposed source that is subject to the requirements of a MACT standard are required to comply with the applicable requirements of the standard. Diesel-fired pump engines would subject to MACT standards in 40 CFR 63 (ZZZZ) and comply with applicable requirements thereunder.

3.11.2.5 STATE REGULATIONS

The TCEQ has codified air quality regulations in 30 TAC Chapters 101–122 to establish general air quality requirements, implement state-specific stationary source requirements, develop minor source construction permitting programs, and to exercise its delegated authority to implement federal permitting programs. The State of Texas regulates criteria air pollutants, O_3 precursors, and HAP emissions through their state-specific permitting requirements and air quality standards. The concrete batch plant operations and the diesel-fired pump engines would be subject to applicable permitting requirements in 30 TAC Chapters 101–122. It is likely that these activities and operations could be authorized under Permit by Rule Requirements in 30 TAC Chapter 106.

3.11.3 Air Quality

Criteria pollutants and HAPs have the potential to contribute to a variety of adverse health effects. Certain criteria air pollutants may result in visibility impairment; damage to animals, crops, or vegetation; and deposition of nitrogen and sulfur compounds in the environment (EPA 2021e). But criteria air pollutants and HAPs typically have localized air quality effects and relatively short atmospheric lifetimes. Therefore, the analysis area for criteria air pollutants and HAPs is Brazoria County.

Brazoria County is currently classified as “marginal nonattainment” with respect to the 2015 8-hour O_3 standard and “serious” nonattainment under the 2008 8-hour ozone standard and “unclassifiable” or “attainment” for all other criteria pollutants (EPA 2021f).

The 2020 Air Quality Index (AQI) Report for Brazoria County is listed in Table 3.11-2. The AQI is an indicator of overall air quality based on available monitoring data for criteria air pollutants measured within a geographic area. Lower AQI values correspond with better air quality and higher AQI values correspond with unhealthier air quality. For Brazoria County, the basis of the AQI data is NO_2 and O_3 monitoring data.

Table 3.11-2. 2018 Air Quality Index for Brazoria County, Texas

Good days (AQI 0–50)	Moderate days (AQI 51–100)	Unhealthy for Sensitive Groups Days (AQI 101–150)	Unhealthy Days (AQI 151–200)	Very Unhealthy (AQI 201+)	Maximum AQI	90th Percentile AQI	Median AQI
328	34	2	1	–	182	51	33

Source: EPA (2021g)

Based on the AQI data for 2020, the air quality in Brazoria County reached potentially unhealthy levels during 2 days in 2019. The median AQI values for 2020 correspond with “good” air quality (EPA 2021g).

3.11.3.1 AIR QUALITY POLLUTANTS

The criteria pollutants in Table 3.11-3 are O_3 precursors, and HAPs that affect ambient air quality and are regulated by the EPA and TCEQ.

Table 3.11-3 shows the EPA’s Brazoria County National Emission Inventory Data for stationary, mobile, and natural sources of criteria pollutants, O_3 precursors, and HAP emission sources from 2017 (EPA 2020a). These data are listed to show the existing levels of pollutant emissions in the analysis area.

Table 3.11-3. Brazoria County 2017 National Emission Inventory Data

Pollutant	Tpy
CO	78,441
Lead	1.10
NO_x	15,311
VOCs	40,918
HAPs	5,120
SO_2	1,025
PM_{10}	20,435
$PM_{2.5}$	7,594

Source: EPA (2020d)

3.11.4 Climate

Climate in Texas is influenced primarily by three geographic features: the Rocky Mountains, which block moist Pacific air from the western portion of the state and channel arctic air masses southward during the winter; the flatlands characteristic of the central North American continent, which allow easy north and south movement of air masses; and the Gulf of Mexico, which is the primary source of moisture for the state. Because of the large size of the state and relative locations with respect to the geographic features that primarily influence climate, there is substantial variability in temperature and precipitation patterns throughout the state; however, Texas climate is generally characterized by hot summers and cool, mild winters with precipitation trends varying from east to west because the warm, moist air from the Gulf of Mexico is most readily available in the eastern part of the state. Annual precipitation varies from less than 10 inches in west Texas to greater than 50 inches in the easternmost portion of the state. The mean annual temperature in Texas has increased by approximately 1°F since the first half of the 20th century (Runkle et al. 2017).

Brazoria County has an average annual rainfall of 57 inches, an average January minimum temperature of 43.7°F, and a July average maximum temperature of 91.8°F (Brazoria County 2020). The average hourly wind speed in Brazoria County varies seasonally and ranges from 7.7 miles per hour in August to up to 11.2 miles per hour in April. Predominant average hourly wind direction also varies throughout the year. From early February through early September and from late October through early December, the predominant wind direction is from the south. From early September through late October, the predominant wind direction is from the east, and from early December through early February, the predominant wind direction is from the north (Weather Spark 2020).

3.11.4.1 GREENHOUSE GAS POLLUTANTS

GHG emissions are long lasting in the atmosphere and although they generally do not have direct impacts to human health, GHGs present in the atmosphere absorb outgoing infrared radiation that would otherwise have escaped back to space (U.S. Global Change Research Program 2018). This phenomenon is known as the "greenhouse effect." Though the increase in atmospheric GHG concentrations impacts the global net energy balance, GHGs are discussed at the regional and statewide levels.

GHGs are emitted from mobile and stationary source fuel combustion, as well as industrial and agricultural processes. There are currently no federal or state ambient air quality standards that have been promulgated for GHGs; however, GHGs are considered a climate pollutant. GHGs include multiple pollutants, the molecular structure of which allows the absorption of outgoing infrared radiation. The primary anthropogenic GHGs emitted are:

- Carbon dioxide (CO_2), which is emitted through burning fossil fuels, solid waste, trees, and other biological materials and as a result of certain chemical reactions used in industrial processes (EPA 2020b)
- Methane, which is emitted during the production and transport of coal, natural gas, and oil; livestock and agricultural practices; and decaying organic waste (such as in municipal solid waste landfills) (EPA 2020b)
- Nitrous oxide, which is emitted during agricultural and industrial activities, combustion of fossil fuels and solid waste, and during treatment of wastewater (EPA 2020b)
- Fluorinated gases, which are emitted from a variety of industrial processes (EPA 2020b)

GHGs have differing lifespans in the atmosphere and different degrees of absorptive capacities for infrared radiation. The degree to which a compound contributes to climate impacts depends on its global warming potential (GWP) over a specific time frame. The Intergovernmental Panel on Climate Change has determined the GWPs for specific GHGs based on their average atmospheric lifespan and relative absorptive capabilities on 100-year and 20-year time scales (Intergovernmental Panel on Climate Change 2014). These GWP values allow expression of GHG emissions in terms of CO_2 equivalent (CO_2e) to quantify GHG emissions on a common basis.

3.11.4.2 GREENHOUSE GAS EMISSIONS

The EPA's Mandatory GHG Reporting Rule requires large, stationary source facilities to report GHG emissions on an annual basis. The 2019 GHG emission inventory data are included in Table 3.11-4 for Brazoria County, the state of Texas, and the United States (EPA 2020c). The CO_2e data presented below are based on the 100-year GWP values listed in 40 CFR 98.

Table 3.11-4. 2019 Greenhouse Gas Emissions from Large Facilities

Sector	Brazoria County (MT CO_2e)	Texas (MMT CO_2e)	United States (MMT CO_2e)
Power Plants	3,934,029	203	1,669
Petroleum and natural gas systems	213,601	31	341
Refineries	2,084,990	56	178
Chemicals	11,281,594	57	186
Other	129,061	5.8	127

Sector	Brazoria County ($MT\ CO_2e$)	Texas ($MMT\ CO_2e$)	United States ($MMT\ CO_2e$)
Minerals	0	13	115
Waste	620,081	11	110
Metals	0	2.2	90
Pulp and paper	0	1	35
Total	18,263,356	380	2,850

Source: EPA (2020f)

Note: Units are reported in metric tons (MT) CO_2e for Brazoria County and million metric tons (MMT) CO_2e for state and federal emissions. Total reported GHG emissions may not sum exactly from individually reported GHG emissions grouped by industry due to rounding.

Major sources of GHG emissions that are also major sources of one or more criteria pollutants with respect to the EPA's Prevention of Significant Deterioration Program are subject to federal construction permitting requirements, which include best available control technology review and public notice. Various New Source Performance Standards regulations apply to stationary sources that emit GHGs and promulgate limits or standards for GHG emissions.

3.12 Noise

Sound is created when an object moves. These movements cause vibrations that travel through a medium such as air. When these vibrations reach human ears, that is called sound.

Noise is generally defined as loud, unpleasant, unexpected, or undesired sound typically associated with human activity and that interferes with or disrupts normal activities. Noise is characterized by many variables, including frequency, duration, and intensity. Sound pressure level, described in decibels (dB), is used to quantify sound intensity. The dB is a logarithmic unit that expresses the ratio of the sound pressure level being measured to a standard reference measure.

Sound is composed of various frequencies, but the human ear does not respond to all frequencies. Frequencies to which the human ear does not respond must be filtered out when measuring noise levels, so an adjustment or weighting of high-pitched and low-pitched sounds is made to approximate average human perception. When such adjustments are made to sound levels, the adjustments are called *A-weighted levels* (dBA). The ability to perceive changes in sound levels varies from person to person, as do individuals' responses to perceived changes. In general, a 3 dBA change is barely perceptible, a 5 dBA change is typically noticeable, and a 10 dBA change is normally perceived as doubling (or halving) the sound level. Figure 3.12-1 illustrates some of the common sound levels one might experience.

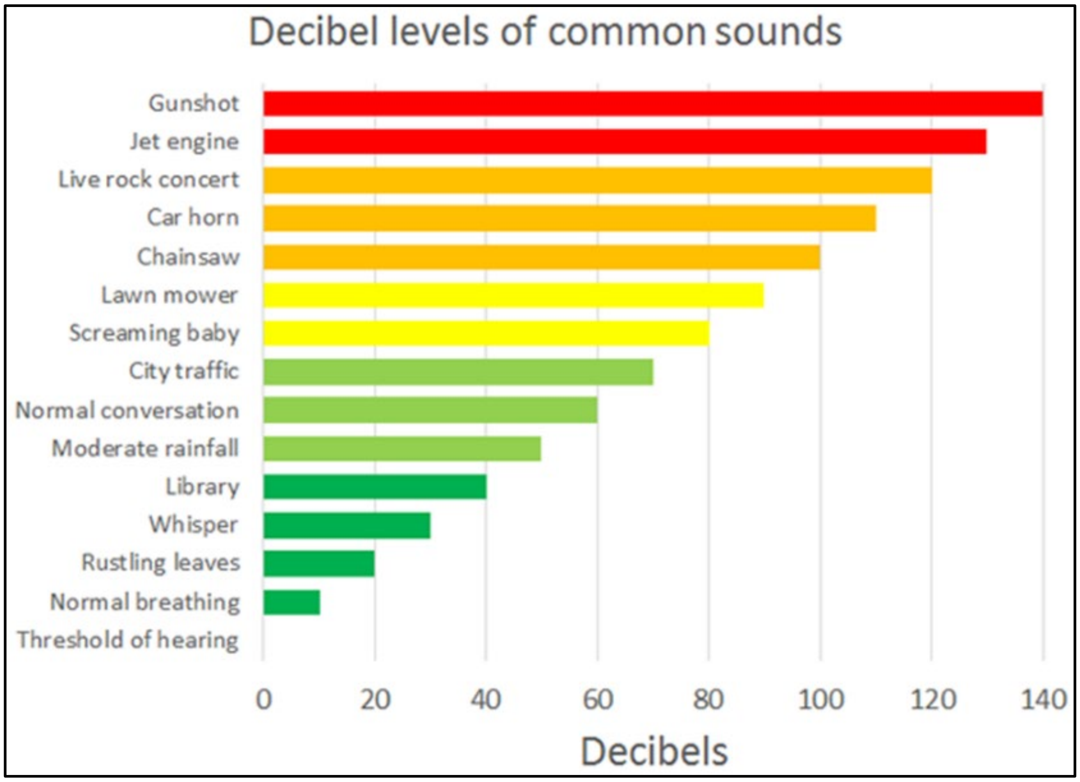


Figure 3.12-1. Decibel levels of common sounds (Science Buddies Staff 2018).

Sound level statistical descriptors are used to describe sound levels averaged over a standard duration. The day-night average sound level (L_{dn}) describes the A-weighted noise level for a 24-hour period with a 10 dBA penalty applied to the nighttime hours from 10 p.m. to 7 a.m.

Texas does not regulate noise at the state level. The Project site and all alternatives are within the unincorporated area of Brazoria County and there are no applicable local noise ordinances. However, the EPA has published guidelines that address the issue of community noise that contain goals for noise levels affecting residential land use. An indoor L_{dn} of 45 dBA will permit speech communication in the home, whereas an outdoor L_{dn} not exceeding 55 dBA will permit normal speech communication at approximately 3 meters (EPA 1974).

Noise-sensitive receptors generally are defined as locations where people reside or where the presence of unwanted sound may adversely affect the existing land use. Typically, noise-sensitive land uses include residences, hospitals, places of worship, libraries, performance spaces, offices, and schools, as well as nature and wildlife preserves, recreational areas, and parks.

For most construction projects, noise impacts decrease to background levels at distances of less than 1 mile from the noise source. Therefore, the analysis area for noise for the proposed Project is the Project site plus a 1-mile buffer.

3.12.1 Proposed Action, Alternative 2A, and Alternative 2B

The Project site and analysis area is generally rural and agricultural in nature. The TDCJ prison is to the north and the existing Harris Reservoir is to the south. Some rural residences are present within the 1-mile buffer with the closest residence approximately 225 feet south from the Project site. No schools, churches, cemeteries, or other sensitive receivers are present within the analysis area.

Existing noise conditions were evaluated based on land use. Given that the surrounding area is rural, the analysis area would be expected to have a background L_{dn} of less than 45 dBA, with a typical day L_{dn} of 40 dBA and night L_{dn} of 34 dBA (American National Standards Institute 2013). In addition to natural background noise, noise sources could include agricultural activities, the TDCJ prison, low-density traffic on rural roads, recreational activities, and aircraft overflights.

3.12.2 Alternative 3

The Alternative 3 site is 2 miles west of the Project site on the west side of the Brazos River. Land uses on the west bank of the Brazos River are similar to the Project and existing noise conditions would be similar. Some rural residences are present within the 1-mile buffer with the closest residence adjacent to the Alternative 3 site boundary. No schools, churches, cemeteries, or other sensitive receivers are present within the analysis area.

3.12.3 Alternative 4

The Alternative 4 site would be located along the Brazos River near the city of Lake Jackson. Land uses on the site consist predominantly of undeveloped shrub-forest lands that are south of the existing Brazoria Reservoir along the Brazos River. Existing noise conditions would be similar to the Proposed Action. The Cornerstone Church property is approximately 960 feet north of the Project site (approximately 1,100 feet from the site of the new substation that would be built as part of Alternative 4). Some residences are present within the 1-mile buffer. The nearest residence is approximately 55 feet north of the power line corridor ROW. The water conveyance pipeline runs through the city of Lake Jackson and existing noise levels at this portion of the Alternative 4 site would be higher with a background L_{dn} in the range of 50 to 55 dBA, with a typical day L_{dn} of 50 dBA and night L_{dn} of 44 dBA (American National Standards Institute 2013).

3.13 Historic and Archeological Resources

Texas is a large state with many diverse environments and a plethora of natural resources that have been exploited throughout a long span of human occupation. This has created a vast array of archaeological sites as humans have adapted to the various biotic communities across the state. The archaeology of Texas has been divided into a series of regions that roughly correspond with the various geographic and environmental regions of the state. The Project site is in the Southeast Texas archaeological region as defined by Perttula (2004).

3.13.1 Regulatory Setting

NEPA recognizes that a unique character of an environment is its relationship to "historic or cultural resources" and requires agency officials to consider the degree that an action might "adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the National Register of Historic Places [NRHP]" (40 CFR 1508.27(b)(3) and 40 CFR 1508.27(b)(8)); however, under NEPA, no definition is provided for "cultural resources."

Under Section 106 of the NHPA, agencies are required to make a reasonable and good faith effort to identify, in coordination with other interested parties, including the State Historic Preservation Officers (SHPOs) and Native American tribal groups, whether historic properties are present within the Permit Area of an undertaking and whether they would be significantly impacted by that undertaking. Projects that are directed, overseen, funded, partially funded or permitted by a federal agency are considered undertakings. This draft EIS coordinated with a Section 106 review because the processes are substantially similar and involve the same parties (36 CFR 800.8). The Corps' Procedures for the Protection of Historic Properties (33 CRF 325) defines Permit Area as those areas comprising the WOUS that will be directly affected by the Project or structures, and uplands directly affected as a result of authorizing the Project or structures. For this Project, the Permit Area is defined as the 2,533-acre Project site.

Projects in Texas can come under the purview of two primary cultural resources regulations: the NHPA and the Antiquities Code of Texas (ACT). Both acts are administered by the lead federal agency and the SHPO of Texas at the Texas Historical Commission (THC) in Austin, Texas.

Cultural resources located on land owned or controlled by the State of Texas or one of its political subdivisions are protected by the ACT. The ACT requires that state agencies and political subdivisions of the state (in this case the TDCJ), including cities, counties, river authorities, municipal utility districts, and school districts, notify the THC of any action on public land involving 5 or more acres of ground disturbance, 5,000 or more cubic yards of earth moving, or those that have the potential to disturb recorded archaeological sites. The THC's Archeology Division manages compliance with the ACT, including the issuance of formal Texas Antiquities Permits, which stipulate the conditions under which scientific investigations will occur. Under the ACT, any historic or prehistoric property located on state land may be determined eligible as a State Antiquities Landmark.

This section provides a general description of cultural and historic resources in the county, as well as within the Permit Area and a 1-mile buffer (Figure 3.13-1).

3.13.2 Prehistoric and Historic Setting

3.13.2.1 PROPOSED ACTION, ALTERNATIVE 2A, ALTERNATIVE 2B, ALTERNATIVE 3, AND ALTERNATIVE 4

The prehistoric archaeology of Texas within the Project site and alternative sites begins in the Paleoindian period approximately 12,000 to 8,500 years before present (B.P.) (Perttula 2004:9; Ricklis 2004). The Paleoindian period was succeeded by the Archaic period (8,500–2,200/1,500 B.P.), which is divided into Early, Middle, and Late components (Ricklis 2004; Story 1990). The Archaic period ended between 2,000 and 1,000 years ago and was followed by the Late Prehistoric or Ceramic period in southeast Texas (Ricklis 2004), which began between 1,200 and 1,000 years ago and lasted until approximately 250 years ago (Ricklis 2004) when native groups came into contact with the Spanish and French colonists, traders, and missionaries who were beginning to infiltrate the area. Prior to European contact, the central Gulf Coast of Texas was occupied by the Karankawa Indians (La Vere 2004; Lipscomb 2020).

The Historic period in Brazoria County begins with the arrival of the Spanish at the beginning of the seventeenth century (Campbell 1989; Creighton 1975; Henson 1998). Anglo-American settlement did not begin in earnest until after 1824 when Stephen F. Austin received the first official colonization grant from the Mexican government to bring 300 Anglo settlers into the area. Of Austin's original Old Three Hundred colonists, 89 were issued land grants in what is now Brazoria County; this includes the Quarles, El Dorado (Drayton), Waverly, and Bolivar Plantations within the Permit Area. Texas was formally annexed to the United States in 1845, just as plantation life in Brazoria County began to flourish. During the next decade and throughout the antebellum period, the county became the wealthiest in Texas based on the economic model of slavery (Campbell 1989; Ivan 2010; Kleiner 2020a; Wilke 2020).

Following the end of the Civil War, many plantations were divided into smaller farms or turned into pastures, while others eventually became part of the Ramsey, Retrieve, Clemens, and Darrington state prison farms; the Ramsey Prison Farm Number Four Camp was located within the Permit Area. On March 22, 1871, the Texas Legislature ordered the state's penitentiary system to be self-sufficient. Under this arrangement, the prison administrators leased the convicts to work in private industry. As a result of the convict lease system, Brazoria's agricultural economy began to recover, as low-cost convict labor was attractive to Brazoria's sugar producers. The convict lease system ended when the state regained complete control of the prison system in 1914 (Ivan 2010).

In 1939, the Dow Chemical Company, drawn to the presence of natural resources at Freeport, came to the county and soon established the Brazosport industrial and port community. In 1946, Brazoria County ranked fourth in oil production among Texas counties with 29,308,106 barrels produced (Creighton 1975). A second phase of industrialization began in the 1950s as "customer companies," including Monsanto and processors of chemical fertilizers, established operations to make use of Dow products (Henson 1998). By 1949, additional transportation needs were established, and railroads arrived in the area, such as the Gulf, Colorado and Santa Fe Railway; the Missouri Pacific Railroad, which operated the Houston and Brazos Valley Railway; the St. Louis, Brownsville and Mexico Railway; the International-Great Northern Railroad; and the Texas and New Orleans Railroad (Kleiner 2020b).

3.13.3 Previously Recorded Resources

Cultural resources background reviews were conducted to determine if the Project site and Alternatives 2 through 4 sites had been previously surveyed for cultural resources and to identify all previously recorded archaeological sites and all previously recorded potential aboveground resources (i.e., historic structures, cemeteries, and archaeological sites) within the Permit Area and within an approximate 1-mile buffer of the Project site. To conduct these reviews, archaeologists reviewed the relevant USGS 7.5-minute quadrangles on the THC's Texas Historic Sites Atlas (Atlas) online restricted archaeological sites database (THC 2021). These sources provided information on the nature and location of previously conducted archaeological surveys, previously recorded cultural resources sites, sites designated as State Antiquities Landmarks, official Texas historical markers, Recorded Texas Historic Landmarks, cemeteries, and local neighborhood surveys.

3.13.3.1 PROPOSED ACTION, ALTERNATIVE 2A, AND ALTERNATIVE 2B

Cultural resources studies within the Project site have been composed of both background desktop reviews and intensive field surveys of selected resources and locations (Cardenas 2018; Griggs et al. 2018; Griggs and Bernhardt 2019; THC 2021).

As a result of background reviews and completed cultural resources surveys of the Project site, six archaeological sites and one cemetery have been identified within the Permit Area (see Figure 3.13-1).

A small (approximately 1 acre) portion of the Permit Area, located in the northwest corner of the Project site, was assessed for cultural resources for Phillips 66 in 2014 under ACT Permit No. 6758. As a result of those investigations, no cultural resources were identified (Griggs and Bernhardt 2019:31). Griggs and Bernhardt (2019) identified two archaeological sites (41BO285 and 41BO286), the Quarles Cemetery, and four artifact scatters (Scatters 1 through 4) during their cultural resources survey for the proposed Project encompassing 295.4 acres. Sites 41BO285 and 41BO286 appear to be the remains of structures associated with Ramsey Prison Camp Number Four, constructed in the late nineteenth and early to midtwentieth century, respectively; these sites are positioned on a natural terrace on the south bank of Oyster Creek. The Quarles Cemetery, associated with the Quarles Plantation, is located in the north-central portion of the Project site. Finally, the four historic scatters were not recorded as sites because the artifacts were recovered from secondary (i.e., disturbed) contexts.

Griggs and Bernhardt (2019) recommended 41BO285 and 41BO286 eligible for the NRHP under Criteria A and D because intact cultural deposits representative of the early twentieth century Texas prison system may be represented. In addition, 41BO285 may also have been constructed in the late nineteenth century as part of the Waverly Plantation, which would provide insights into the activities and history of the plantation. Neither the Quarles Cemetery nor the four historic scatters were considered eligible for the NRHP.

Based on a desktop review, no historic resources have been recorded within 1 mile of the Big Slough mitigation site (Cardno 2019). Nine archeological sites have been recorded within 1 mile of the mitigation site. These sites include three ineligible prehistoric campsites, one ineligible cattle-dipping trench, and one ineligible partial railroad bed; there is no information available for the remaining sites. No cultural resources were recorded during a 2019 archeological reconnaissance survey of the area (Cardno 2019).

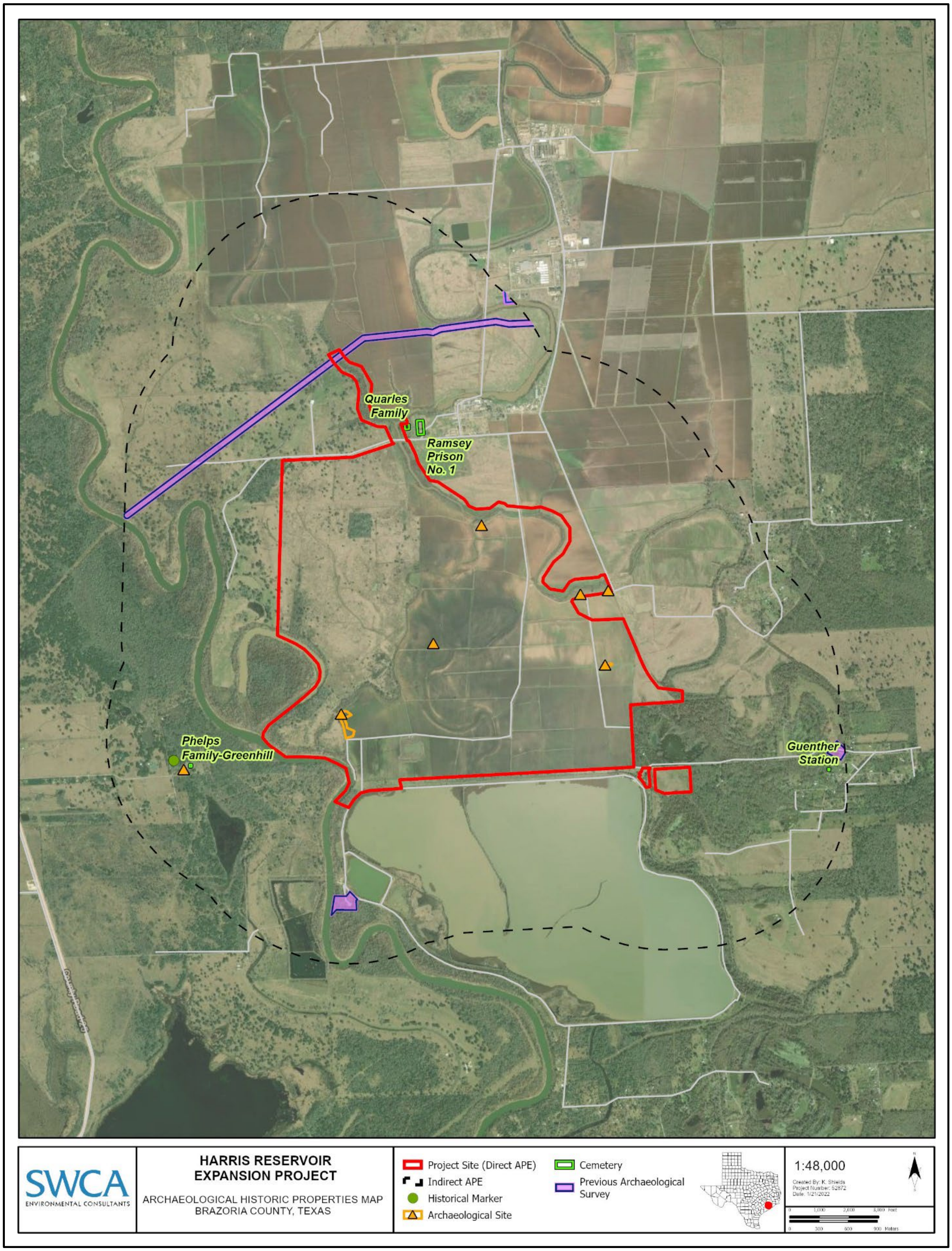


Figure 3.13-1. Archaeological and historic sites identified on the Project site.

Griggs et al. (2018) identified three archaeological sites during their cultural resources survey. Site 41BO271 is a stratified, prehistoric Archaic shell midden with abundant faunal remains, whereas 41BO272 and 41BO273 were nineteenth century historic scatters. Site 41BO271 was identified by mechanical backhoe trenching and was encountered between 175 and 250 centimeters (68.9–98.4 inches) below the ground surface. Conventional radiocarbon dates collected from the midden deposits suggest that the site was in use between 4180 ± 30 B.P. and 3330 ± 30 B.P.

Site 41BO272, recorded as an extensive nineteenth century surface scatter and one feature, is interpreted as the homesite of Henry Austin, associated with the Historic period Bolivar Plantation. Henry Austin was the first cousin to Stephen F. Austin and resided on the plantation from 1831 to the mid-1840s; Henry’s sister, Mary Austin Holley, also wrote the first Anglo history of Texas while staying with Henry at the plantation. Site 41BO273 was recorded as a small nineteenth-century historic artifact scatter located in an agricultural field. Although it was identified in a disturbed context, a historical plat of the property indicates that a nineteenth-century structure once stood in this approximate location.

Griggs et al. (2018) recommended 41BO271 eligible for the NRHP under Criterion D because intact, stratified cultural deposits representative of the Archaic period may be present. Site 41BO272 is considered eligible for the NRHP under Criteria A and D because the intact nineteenth-century cultural deposits are potentially associated with notable figures from Texas history. Site 41BO273 is considered not eligible for the NRHP.

Site 41BO292 was identified by Perennial Environmental Services in April of 2020 (THC 2021); the site consists of diffuse historic artifact scatter identified in a 50 × 36–meter area within a plowed cornfield, approximately 60 meters to the south of the Oyster Creek. Low densities of brown, clear, green, and solarized glass, whiteware, and miscellaneous metal were noted on the ground surface; none of the shovel tests excavated through the site boundary encountered subsurface cultural materials. Site 41BO292 was considered not eligible for the NRHP by the site recorders; no concurrence from the THC on this recommendation was noted in the Atlas.

3.13.3.2 ALTERNATIVE 3

Studies within the Alternative 3 site Permit Area have been composed of both background desktop reviews and intensive field surveys of selected resources and locations (Cardenas 2018; Griggs et al. 2018; THC 2021).

The majority of the Alternative 3 site has not been subjected to systematic cultural resources investigations. As a result of background reviews and completed cultural resources surveys of the analysis area, as defined above, two archaeological sites and one cemetery (Phelps Family – Greenhill) have been identified within the Alternative 3 site Permit Area (Figure 3.13-2).

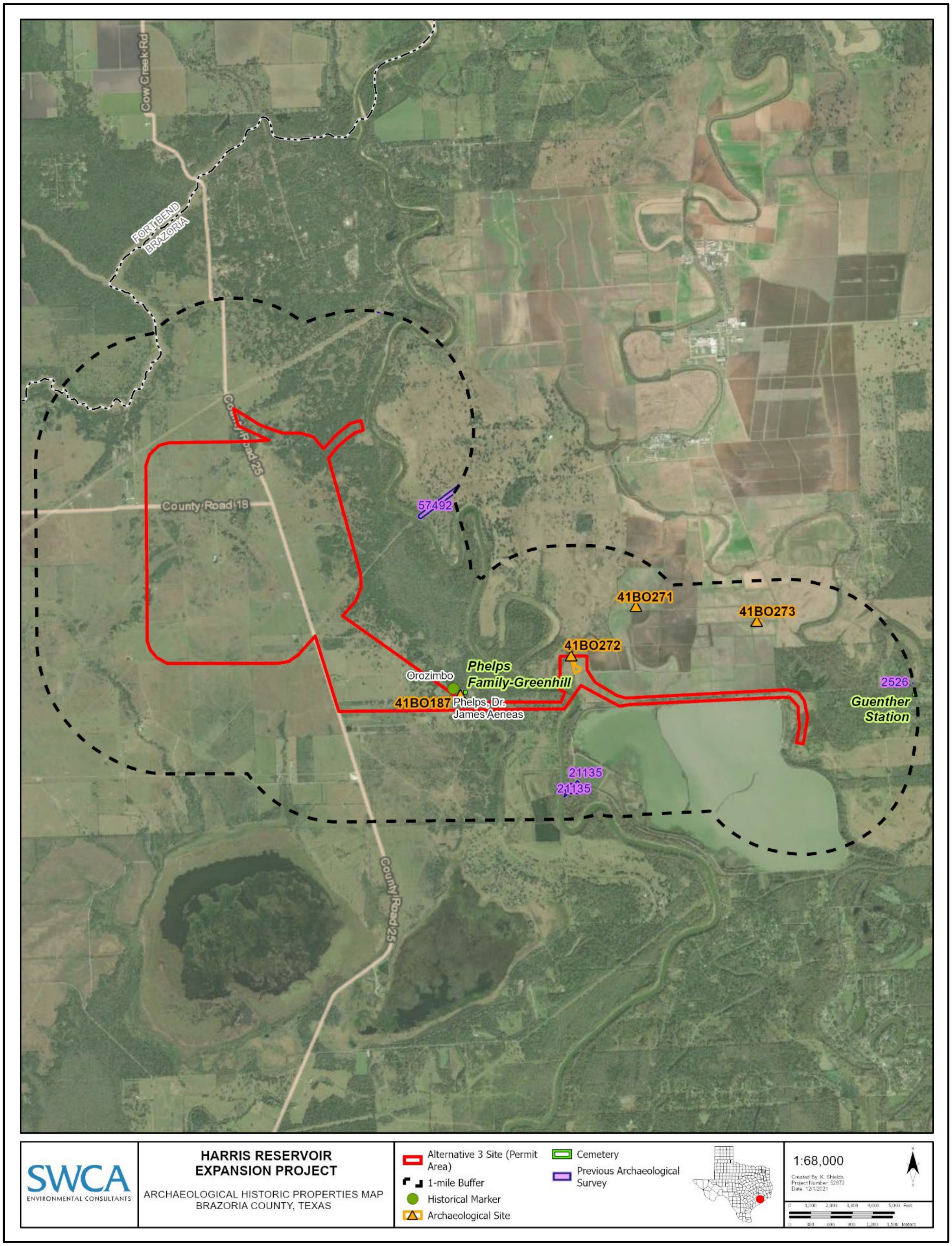


Figure 3.13-2. Archaeological sites identified in the Alternative 3 site.

Sites 41BO187 and 41BO272 are within the Alternative 3 site; however, Site 41BO272 has already been discussed as part of the Proposed Action (see above). Site 41BO187, the Orizimbo/Phelps Plantation, was identified by Barto Arnold from the THC in 1994. Very limited information is provided in the Atlas (2021) regarding this site, other than noting that the remains of a brick cistern and a collapsed twentieth-century structure were present within the site. The cotton plantation and two-story house were established after the 1824 land grant, and the house was destroyed by a hurricane in 1932. The plantation is where General Antonio López de Santa Anna was held prisoner between July and November 1836 (Kleiner 2021); the THC considers the site eligible for the NRHP. The Phelps Family – Greenhill Cemetery, associated with the Orizimbo/Phelps Plantation (Site 41BO187), also contains four interments dating between 1975 and 2021. As noted in Section 3.13.1, all human burials in the state of Texas are protected by law.

3.13.3.3 ALTERNATIVE 4

Studies within the Alternative 4 site Permit Area have been composed of both background desktop reviews and intensive field surveys of selected resources and locations. These studies include Atlas Surveys No. 1183, 2375, 2490, 2491, 9735, 9736, and 9738 (no additional author information on Atlas); Antiquities Permit No. 2887 (Fulmer and Bishop 2002); Antiquities Permit No. 3771 (Mooney et al. 2005); Antiquities Permit No. 6275 (Soltysiak et al. 2014); Antiquities Permit No. 8057 (Burden 2017); and Antiquities Permit No. 8057 (Scott and Hinton 2020).

The majority of the Alternative 4 site has not been subjected to systematic cultural resources investigations. As a result of background reviews and completed cultural resources surveys of the Permit Area and 1-mile buffer, one archaeological site (41BO122), also known as the Velasco Cemetery, has been identified within the Alternative 4 site at the east end of the Permit Area (Figure 3.13-3).

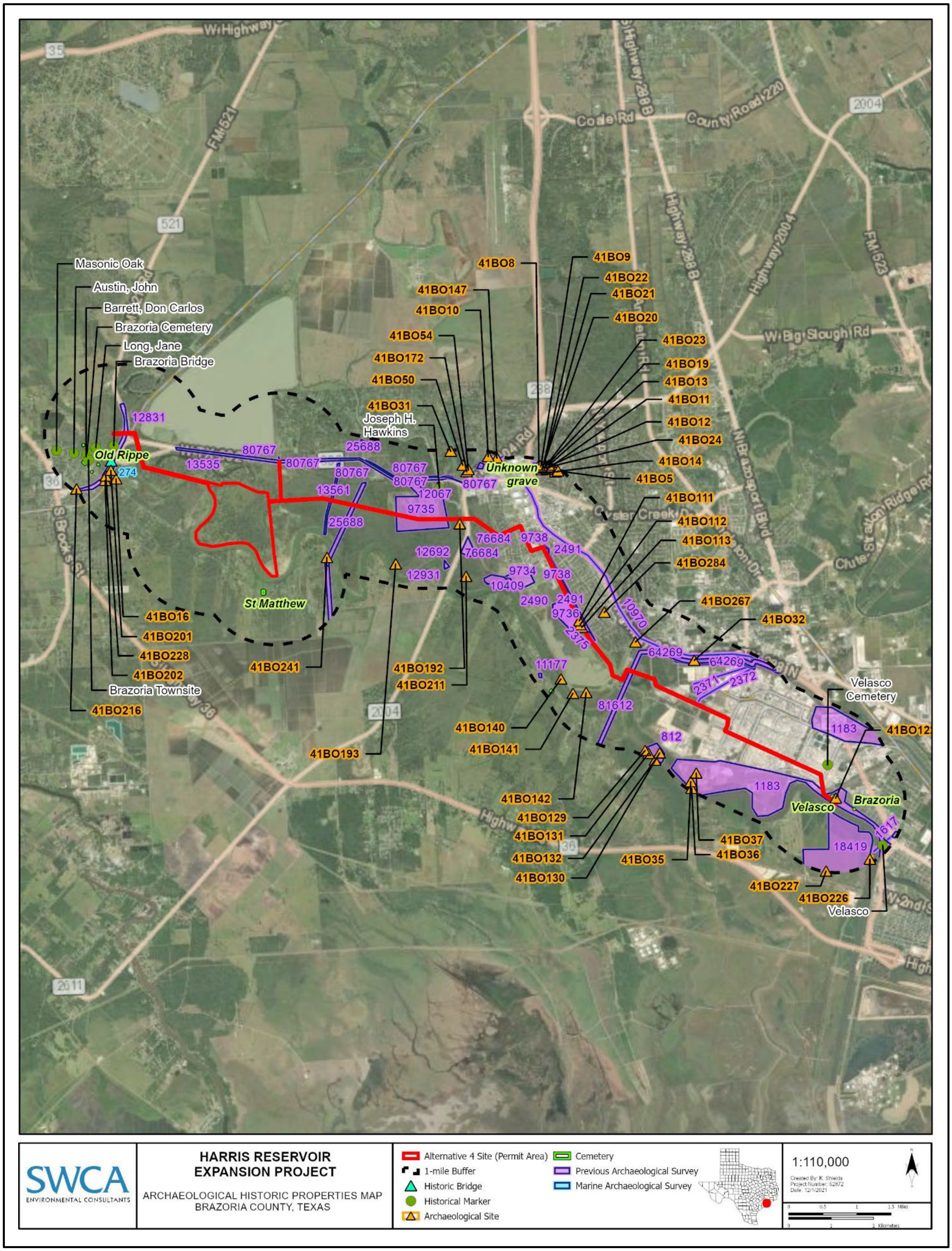


Figure 3.13-3. Archaeological sites identified in the Alternative 4 site.

Site 41BO122 (the Velasco Cemetery) contains interments from 1816 through to the late 1950s (Find A Grave 2021; THC 2021). The historic cemetery is currently in a state of disrepair and neglect and contains approximately 163 interments. As noted in Section 3.13.1, all human burials in the state of Texas are protected by law.

3.14 Hazardous Waste and Materials Management

3.14.1 Regulatory Setting

Hazardous waste/hazardous materials (HW/HM) include substances that, because of their quantity; concentration; or physical, chemical, or infectious characteristics, may present substantial danger to the public health, welfare, or the environment when released. The EPA regulates hazardous chemicals, substances, and wastes under the Resource Conservation and Recovery Act (RCRA), the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA or Superfund), and the Toxic Substances Control Act. Underground storage tanks (USTs) containing regulated substances, including petroleum products and those hazardous substances included in CERCLA, are subject to the requirements of RCRA Subtitle I.

CERCLA provides a “[f]ederal ‘Superfund’ to clean uncontrolled or abandoned hazardous waste sites as well as accidents, spills, and other emergency releases of pollutants and contaminants into the environment” (EPA 1980). The RCRA of 1976 amended the Solid Waste Disposal Act of 1965 and provides a system for the safe management of solid and hazardous waste, including generation, transportation, treatment, storage, and disposal of hazardous waste. In addition, the RCRA authorizes the EPA to regulate USTs. Under the cleanup enforcement program managed by the RCRA, a facility owner or operator, or both, may conduct the cleanup activities themselves or pay for the cleanup to be conducted by another party (EPA 1986).

The Toxic Substances Control Act of 1976 authorizes the EPA to “require reporting, recordkeeping, and testing requirements and restrictions relating to chemical substances and/or mixtures” (EPA 1976). This act addresses the production, importation, use, and disposal of specific chemical substances such as polychlorinated biphenyls, asbestos, radon, and lead-based paint, among others.

Tanks used to store hazardous wastes are regulated under the RCRA’s hazardous waste regulations. Texas has an approved UST program, meaning owners and operators of UST systems are subject to both federal and state requirements. No single comprehensive regulation governs aboveground storage tanks. Federal laws that regulate aboveground storage tanks include the CWA, the Oil Pollution Act, the Clean Air Act, and the RCRA. The specific regulatory requirements depend on the substances contained in the tanks.

This regulatory framework means that these wastes and materials are measured, recorded, tracked, controlled, and otherwise policed. This also means that instances in which HW/HM are used, generated, spilled, released, collected, remediated, and disposed of are recorded in publicly available databases managed by one or more of the regulatory bodies mentioned above. Having a record in one of these regulatory databases is not necessarily an indication that a company or entity has violated any regulations or is otherwise noncompliant, but instead could mean that the company or entity is operating a facility that uses or generates HW/HW safely, legally, and properly per the regulations.

3.14.2 Area of Analysis and Ongoing Activities

3.14.2.1 PROPOSED ACTION, ALTERNATIVE 2A, AND ALTERNATIVE 2B

The Project site located north of and adjacent to the existing Harris Reservoir and bordered by the Brazos River to the west, Oyster Creek to the east, and the TDCJ Ramsey Prison Facility land to the north. There are stables, cattle feeders, and an area used for storing farm equipment and supplies on the site. A portion of the Project site is currently leased to the TDCJ for agricultural farming and cattle grazing. There are a ConocoPhillips pipeline right-of-way and a CenterPoint power line easement through the property.

In 2019, a records review and a Phase I environmental site assessment (Phase I ESA) were completed for the Project site (Jacobs 2019b). The northwest half of the property was identified as a cattle pasture containing four ponds, stream tributaries, and feeders for the cattle currently on-site. The Phase I ESA states that farm equipment and supplies are stored in this area. No specifics on farming equipment or supplies were provided in the Phase I ESA. The south half of the property is currently leased to the TDCJ for agricultural farming (e.g., cotton, corn, and milo) (Jacobs 2019b). Agricultural operations include grazing and herd operations, as well as edible crops and field crops operations. No additional information about agricultural uses, including the potential use and storage of regulated hazardous wastes or hazardous materials typically used in agricultural operations (such as pesticides, herbicides, and fertilizers) on the Project site is provided in the Phase I ESA.

Available hazardous waste and regulated facility records from databases managed by the EPA and TCEQ, as well as the TCEQ Inventory of Closed Municipal Solid Waste Landfills, were obtained to evaluate the presence of permitted hazardous materials or hazardous waste management facilities in the vicinity of the Project site. No regulated facilities are present within the Project site. Additionally, there was no evidence of uncontrolled or abandoned hazardous waste (e.g., accidents, spill monitoring, wells) at this site (Jacobs 2019b). A TCEQ database review of municipal solid waste sites/landfills, Superfund sites, Superfund site boundaries, and permitted industrial and hazardous waste sites found no sites within 0.5 mile of the Project (Jacobs 2019b). A total of 22 federal, state, and local databases were searched. No spills or chemical releases are known to have occurred at the Project site (Jacobs 2019b).

As described above (see Section 3.2.1; see Figure 3.2-2 and Table 3.2-1), there are 11 total plugged oil and gas wells (one oil, three gas, and seven dry holes) and one water well located on the Project site. Based on preliminary design figures and aerial photographs, four of the 11 plugged wells and dry holes may be avoided or buried beneath the berm portion of the Project. The remaining seven appear to be located within the boundaries of the reservoir basin. The Project site is crossed by an active ConocoPhillips pipeline with a right-of-way maintained in good condition.

No hazardous substances, petroleum products, storage tanks, or other recognized environmental conditions (RECs) were observed on the property during the site reconnaissance or in the historic aerial photographs (Jacobs 2019b). Additionally, no chemicals or wastes were observed at the Project site, and there are no records or visual indications of underground or aboveground storage tanks—currently or in the past. Because no RECs or potential RECs were identified in the Phase I ESA, no additional sampling or studies were required.

The Phase I ESA did identify regulated HW/HM activities occurring on neighboring properties. A liquid petroleum gas storage tank is located approximately 900 feet east of the Project site and another is located approximately 1,550 feet from the northern boundary of the Project site (RRC 2021). The size and construction of the storage tanks are not identified in the Phase I ESA.

There are currently no hazardous materials or chemicals on-site at Dow-managed reservoirs and therefore no site-specific stormwater pollution prevention plan (SWPPP) or spill prevention, control, and countermeasures (SPCC) plan beyond a construction general permit. Additionally, there are no pesticides stored at the existing Dow-managed reservoirs. An outside landscape maintenance contractor operating under the TEC Pesticide Application General Permit supplies and manages pesticides used at Dow sites. Dow's Emergency Management Plan and Communications Plan (Dow n.d. [2021]) outlines safety protocols to be used in the event of an emergency and outlines the communications protocol for alerting Dow staff and local emergency responders.

3.14.2.2 ALTERNATIVE 3

The Alternative 3 site is largely undeveloped agricultural land bordered by green space and improved with several farmsteads, roadways, and cleared pipeline ROWs. There are several domestic water wells within the Alternative 3 site (see Section 3.3.5). Two oil and natural gas pipelines run through the site (see Section 3.2.1). There are no operations that involve HW/HM management identified at the Alternative 3 site.

An environmental database search report generated by Environmental Data Resources, Inc. (EDR), on October 1, 2021, was used to access environmental records for the subject property and surrounding properties. The databases searched by EDR include those specified for Phase I ESAs by ASTM Standard E1527-13 (ASTM International [ASTM] 2013), as well as several additional federal and state databases and databases proprietary to EDR (EDR 2021a). The EDR database search report (EDR report) was supplemented with reviews of records from the EPA (2021h, 2021i, 2021j, 2021k), TCEQ (2021a, 2021b), RRC (2021), U.S. Department of Transportation (2021), and Pipeline Safety Trust (2021).

The review of the EDR report and review of supplemental environmental databases did not identify any relevant listings at the Alternative 3 site. As a result, there are no indications of historic usage, storage, collection, cleanup, or remediation of HW/HM in the area of analysis.

3.14.2.3 ALTERNATIVE 4

Three existing oil and gas pipeline ROWs traverse the proposed desalination plant portion of the Alternative 4 site, and there is one drilled well that is dry. There are two existing oil and gas pipelines along the proposed water and RO concentrate pipeline corridor portion of the site. There are no existing power lines or water wells on the Alternative 4 site. No operations that involve HW/HM management have been identified at the Alternative 4 site.

An environmental database search report generated by EDR on October 1, 2021, was used to access environmental records for the subject property and surrounding properties. The databases searched by EDR include those specified for Phase I ESAs by ASTM Standard E1527-13, as well as several additional federal and state databases and databases proprietary to EDR (EDR 2021b). The EDR database search report was supplemented with reviews of records from the EPA (2021h, 2021i, 2021j, 2021k), TCEQ (2021a, 2021b), RRC (2021), U.S. Department of Transportation (2021), and Pipeline Safety Trust (2021).

The review of the EDR report and of supplemental environmental databases identified two entities located at the Alternative 4 site: one in the EPA's Facility Indexing System (FINDS) database and one in TCEQ's Tier II database.

The entity listed in the FINDS database is Jackson Oaks Golf Club Wastewater Treatment Plant located at 1200 North Highway 288B, Richwood, Texas, 77531. The FINDS database is a central and common inventory of facilities monitored or regulated by the EPA. As a wastewater treatment plant, this entity was likely recorded in the FINDS database based on the entity's use of hazardous chemicals for daily wastewater treatment operations whose discharges are regulated under an NPDES permit. According to the EDR report, there are no violations in the FINDS database for this entity. Additionally, upon review of aerial photographs, this entity is shown to be located roughly 1.5 miles to the east of the Alternative 4 site and is therefore not a concern for HW/HM management at the Alternative 4 site.

The entity listed in the TCEQ's Tier II database is Tanner Construction Company of Texas, Inc., located at Loop 522 (Highway 59 Bypass), Ganado, Texas, 77962. The TCEQ's Tier II I database is a central inventory of facilities monitored or regulated by TCEQ that must report stored hazardous chemicals. According to the EDR report, there are no violations in the TCEQ's Tier II database for this entity. Additionally, upon review of aerial photographs, this entity is shown to be located roughly 75 miles to the west of the Alternative 4 site and is therefore not a concern for HW/HM management at the Alternative 4 site.

As a result, there are no indications of historical usage, storage, collection, cleanup, or remediation of HW/HM in the area of analysis.

3.15 Infrastructure

Infrastructure refers to both publicly and privately owned structures and facilities that support the functioning of a community. Infrastructure includes transportation structures and facilities such as roadways, railways, airports, and waterways; utility structures and facilities such as sewers, water lines, power lines, power stations, wind turbines, and solar panels; and public safety structures and facilities such as emergency services (e.g., fire stations, police stations, and hospitals). The analysis area for infrastructure is the area within 10 miles of the Project site or within 10 miles of the alternative sites (Figures 3.15-1 and 3.15-2).

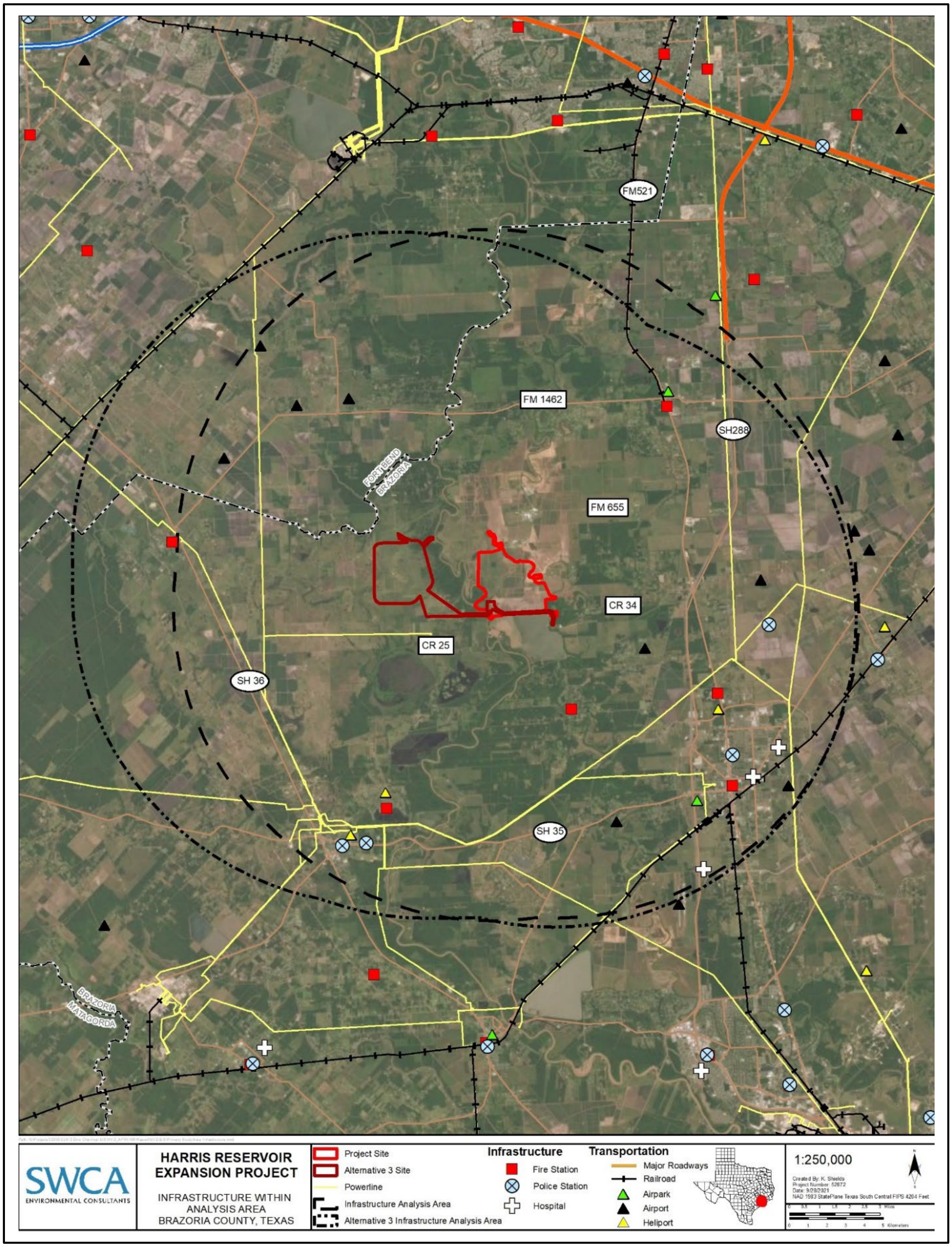


Figure 3.15-1. Infrastructure within 10 miles of the Project site and Alternative 3 site.

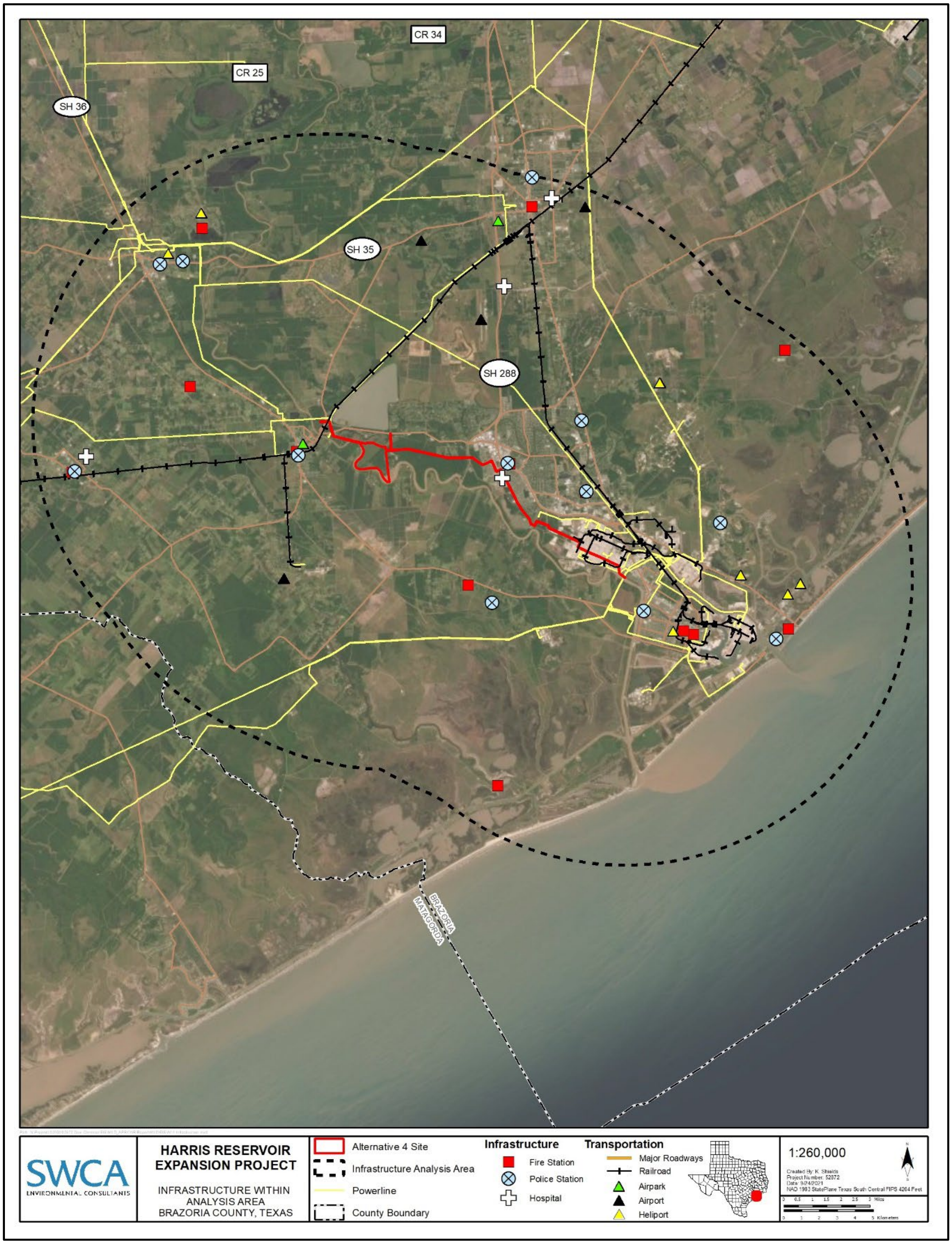


Figure 3.15-2. Infrastructure within 10 miles of the Alternative 4 site.

3.15.1 Public Health and Safety

3.15.1.1 PROPOSED ACTION, ALTERNATIVE 2A, ALTERNATIVE 2B, AND ALTERNATIVE 3

There are four police stations, six fire stations, and three hospitals in the analysis area. The closest hospitals, police departments, and fire stations are located in Angleton and Lake Jackson (see Figure 3.15-1).

Access to the Project site is currently limited to Dow's Harris Reservoir operational staff; there is no public access. All visitors are required to have operational staff escorts for the duration of their visit to the Project site. Access by the general public is not permitted.

3.15.1.2 ALTERNATIVE 4

There are no police stations, fire stations, hospitals, within 1 mile of the proposed desalination plant location within the western portion of Alternative 4 site. The proposed conveyance pipeline ROW is within 1 miles of Brazosport Hospital. Additional community facilities and services, including police departments and fire stations, are located in the cities of Brazoria and Lake Jackson within 10 miles of the Alternative 4 site (see Figure 3.15-2).

3.15.2 Transportation

A metropolitan planning organization is responsible for establishing transportation policies, coordinating transportation planning activities within the region, and allocating federal transportation funds for capital projects and planning studies in a metropolitan region. The HGAC and the Transportation Policy Council serve as the metropolitan planning organization for the greater Houston transportation management area that consists of Harris County, Montgomery County, Liberty County, Chambers County, Galveston County, Brazoria County, Fort Bend County, and Waller County. The Transportation Policy Council includes city and county representatives, the Texas Department of Transportation (TxDOT), and the Metropolitan Transit Authority of Harris County. The Project is within the TxDOT's Houston District, which includes Brazoria, Fort Bend, Galveston, Harris, Montgomery, and Waller Counties.

Transportation in the analysis area is available by roadways, freight and railroads, and airports. The following regional, statewide, and local transportation plans were reviewed to determine the existing conditions and planned improvements:

- 2045 Regional Transportation Plan (HGAC 2019b)
- 2019–2022 Transportation Improvement Program (HGAC 2018)
- 2019–2022 Statewide Transportation Improvement Program (TxDOT 2018a)
- 2020 Unified Transportation Program (TxDOT 2019a)
- 2018 Brazoria County Regional Thoroughfare Plan Map (Brazoria County 2018)
- 2020 Draft Brazoria County Regional Thoroughfare Plan Map (Brazoria County 2019)

3.15.2.1 ROADWAYS

3.15.2.1.1 Proposed Action, Alternative 2A, Alternative 2B, and Alternative 3

Regional, state, and local roadways in the analysis area include FM 1462 located approximately 4.5 miles north of the Project site, FM 655 located directly north, FM 521 located approximately 4.5 miles east, SH 288 located approximately 5.3 miles east, CR 34 located directly south of the Project site, SH 35 located approximately 5.7 miles south, CR 25 located approximately 2 miles west, and SH 36 located approximately 8.5 miles west (see Figure 3.15-1).

The Project site is accessible on the east side from CR 34 and FM 655 via FM 521. FM 521 is a two-lane undivided highway with shoulders and turning lanes at some intersections. FM 655 and CR 34 are both paved two-lane undivided roadways with no shoulders. The intersection of FM 521 and FM 655 is controlled with a flashing yellow signal and has dedicated turn lanes in either direction on FM 521. The intersection of FM 521 and CR 34 does not have traffic signals or stop signs, and no turn lanes are present in either direction. Some private and county non-maintained roads have direct access to CR 34 and FM 655.

TxDOT is responsible for the maintenance of FM 1462, FM 655, FM 521, SH 288, SH 35, and SH 36. The Brazoria County Engineering Department is responsible for the management and maintenance of CR 25 and CR 34. Several funded and planned roadway improvement projects for Brazoria County are included in the 2045 Regional Transportation Plan. Future roadway improvements in the analysis area include roadway widening, intersection improvements, and bicycle accommodations on SH 36 and roadway widening on FM 521. Improvements to SH 36 are funded projects (HGAC 2019b). Brazoria County has not proposed any improvements for roadway segments providing direct access to the Project site.

Roadways are assigned functional classifications within a hierarchy based on their functional role in the overall roadway network and the type of travel service, including traffic mobility and accessibility. Roadways that provide a high level of mobility are called *arterials*, roadways that provide a high level of accessibility are called *locals*, and roadways that provide a balance of mobility and access are called *collectors* (Federal Highway Administration [FHWA] 2013). Principal arterials serve major centers of metropolitan areas, provide a high degree of mobility, and can provide mobility through rural areas. Minor arterials provide service for trips of moderate length, serve smaller geographic areas, and offer connectivity to the higher arterial system (FHWA 2013). Generally, major collectors provide more mobility and minor collectors provide more access. Major collector routes are longer, have higher traffic volumes, and may have more travel lanes than minor collector routes (FHWA 2013).

TxDOT is responsible for maintaining the functional classification designation of roads within Texas. SH 288 is classified as a principal arterial and SH 35 is classified as a minor arterial. FM 1462, FM 521, and CR 25 are classified as major collectors, and FM 655 is classified as a minor collector. CR 34 and other connecting routes are classified as local roads (TxDOT 2019b).

3.15.2.1.2 Alternative 4

The proposed desalination plant location within the western portion of Alternative 4 site is accessible from SH 332, which can be reached from SH 36 or FM 521 to the west, FM 2004 to the south, and SH 288 to the east. SH332 and FM 2004 are classified as minor arterials, SH 36 and SH 288 are classified as principal arterials, and FM 521 is classified as a major collector (TxDOT 2019b).

3.15.2.2 TRAFFIC VOLUME AND ACCIDENTS

3.15.2.2.1 Proposed Action, Alternative 2A, Alternative 2B, and Alternative 3

TxDOT provides traffic counts on the regional and local roadways. Traffic counts are based on the average 24-hour volume of traffic passing a point or segment of a highway. The annual average daily traffic (AADT) is the volume of traffic passing a point or segment of a highway in both directions for 1 year divided by the number of days in the year. Limited traffic data in the analysis area were available for FM 655, FM 521, and SH 288; these data are presented below. No traffic data were available for CR 34. Traffic volume is generally low on roadways surrounding the Project site and has not significantly increased over the past few years. Generally, traffic volume increased from 2015 to 2016 and decreased from 2016 to 2018. Table 3.15-1 summarizes AADT counts between 2018 and 2015 on roadways within 10 miles of the Project site and Alternative 3 site.

Traffic volume on FM 655 has decreased since 2015. Near the intersection of FM 521 and FM 1462, traffic counts have increased overall since 2015. Traffic volume on FM 521 near the intersection of FM 655 has decreased slightly since 2017 but overall has increased since 2015. Traffic volumes on SH 288 in the vicinity of the Project site decreased slightly from 2017 but increased overall since 2015 (TxDOT 2019c). The existing congestion level on SH 288 is “moderately congested” from SH 6 to SH 36. The congestion level is projected to increase to “congested” from SH 6 to FM 1462 and between CR 48 and Business SH 288 (TxDOT 2019c).

Table 3.15-1. Annual Average Daily Traffic 2018–2015

Roadway	Location/Intersection	2018 AADT	2017 AADT	2016 AADT	2015 AADT
FM 655	FM 521	1,997	2,027	2,201	2,185
FM 655	FM 655	531	718	584	559
FM 1462	FM 521 (east)	5,175	4,818	5,941	4,595
FM 1462	FM 521 (west)	5,495	5,926	5,540	5,276
FM 521	FM 1462 (north)	5,798	5,615	5,822	5,431
FM 521	FM 1462 (south)	6,858	6,912	7,204	6,510
FM 521	Between FM 1462 and FM 655	7,310	7,109	7,298	6,601
FM 521	FM 655	6,518	6,531	7,192	6,087
SH 288	Between FM 1462 and CR 48	33,564	34,851	35,015	28,897
SH 288	Between FM 1462 and Business SH 288	29,234	33,863	34,287	29,382
CR 25	South of CR 18	NA	NA	216	NA

Source: TxDOT 2019c.

Regional crash data were obtained from the TxDOT Crash Records Information System and HGAC. In 2018, a total of 5,708 crashes occurred in Brazoria County resulting in 31 fatalities and 77 serious injuries (TxDOT 2018b). Traffic crash fatalities in rural areas of Texas account for approximately 55% of the state’s total traffic fatalities (TxDOT 2018c). A total of 1,754 fatal crashes with 2,001 fatalities occurred on US and state highways, farm-to-market roads, county roads, and city streets in rural counties in Texas in 2018; 18 fatal crashes with 18 fatalities occurred in the rural areas of Brazoria County (TxDOT 2018d).

Between 2014 and 2018, 68 crashes occurred within 5 miles of the Project site (HGAC 2020). A few fatal crashes have occurred on FM 521 near the intersection of FM 1462 near the entrance to Suncreek Estates neighborhood and between CR 30 and CR 30S (HGAC 2020).

3.15.2.2.2 Alternative 4

Table 3.15-2 summaries AADT counts between 2018 and 2015 on roadways near the Alternative 4 site (TXDOT 2019c). The existing congestion level on SH 288 north and south of SH 322 is “moderately congested.” Between 2015 and 2019, 10 fatal crashes occurred within 5 miles of the Project site (HGAC 2020).

Table 3.15-2. Annual Average Daily Traffic 2018 to 2015

Roadway	Location/Intersection	2018 AADT	2017 AADT	2016 AADT	2015 AADT
SH 332	Between SH 288 and FM 521	12,387	12,126	13,497	12,434
SH 36	North of SH 332	7,220	7,598	7,141	7,975
SH 36	South of SH 332	5,777	6,456	6,007	7,625
SH 288	At SH 322	64,828	60,226	65,175	28,479
FM 521	Between SH 332 and SH 35	4,292	4,355	4,073	4,479
FM 2004	Between SH 322 and the Brazos River	9,302	7,820	8,500	7,643

Source: TxDOT (2021)

3.15.2.3 RAILROADS AND FREIGHT SYSTEM

3.15.2.3.1 Proposed Action, Alternative 2A, Alternative 2B, and Alternative 3

FM 521, SH 288, SH 35, and SH 36 within the 10-mile analysis area are part of the regional freight network through which goods are transported to statewide, national, and global markets. An active Union Pacific Railroad line is located approximately 9 miles south of the Project site (TxDOT 2019d).

3.15.2.3.2 Alternative 4

SH 36, SH 288 and SH 35 within 10 miles of the Alternative 4 site are part of the regional freight network. The Union Pacific Railroad line running between Brazoria and Angleton is immediately west of the Alternative 4 site.

3.15.2.4 AIRPORTS

3.15.2.4.1 Proposed Action, Alternative 2A, Alternative 2B, and Alternative 3

The Texas Gulf Coast Regional Airport, located approximately 10 miles south of the Project site along SH 288, is a general aviation reliever airfield owned and operated by Brazoria County. The airport supports an average of 214 aircraft operations per day (AirNav 2019a). There are seven privately owned airports and heliports within 10 miles of the Project site. The closest is the Clover Lakes Farms Airport, approximately 3.5 miles southeast of the Project site, which consists of an unpaved runway with one based aircraft (AirNav 2019b).

3.15.2.4.2 Alternative 4

The Texas Gulf Coast Regional Airport is approximately 4 miles north of the Alternative 4 site along SH 288. There is one privately owned airport and seven heliports within 10 miles of the Alternative 4 site AirNav 2019b).

3.15.3 Utilities

3.15.3.1 PROPOSED ACTION, ALTERNATIVE 2A, ALTERNATIVE 2B, AND ALTERNATIVE 3

Utilities in the analysis area include water wells, oil and gas wells, underground pipelines, and overhead utilities. Pipelines and wells are shown on Figure 3.2-2. A CenterPoint Energy power line parallels a portion of CR 34 along the southern boundary of the Project site and traverses north to south through the center of the Project site, paralleling an unnamed road (see Figure 3.15-1).

There are three underground ConocoPhillips pipelines within one corridor that traverses northeast to southwest through the central portion of the Project site.

3.15.3.2 ALTERNATIVE 4

Three existing oil and gas pipeline ROWs traverse desalination plant location within the western portion of Alternative 4 site, and there is one drilled well that is dry. There are two existing oil and gas pipelines along the proposed water and RO concentrate pipeline corridor.

There are no existing power lines or water wells within the desal plant location of the Alternative 4 site. Exiting power lines on the east and west ends of the Alternative 4 site are shown on Figure 3.15-2.

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4 ENVIRONMENTAL CONSEQUENCES

4.1 Introduction

Dow has applied for a DA permit pursuant to Section 404 of the CWA and a Section 10 of RHA permit from the Corps' Galveston District to authorize placing fill material in jurisdictional WOUS, including wetlands. The fill material would be used to construct a proposed reservoir that is needed to provide additional water storage to be used during periods of drought. The Corps has determined that an analysis of the significant natural and human environmental effects from the proposed Harris Reservoir and a reasonable range of alternatives is necessary to provide for full public disclosure and to aid in decision making.

The Proposed Action and alternatives, including the Applicant's preferred alternative, would result in direct impacts to WOUS, including wetlands. The Proposed Action and action alternatives require authorization under Section 404 of the CWA and Section 10 of the Rivers and Harbors Act of 1899. This draft EIS was prepared in accordance with NEPA and the Corps' regulations for implementing NEPA (33 CFR 325, Appendix B). This draft EIS has also been formulated to address the information requirements of the Section 404(b)(1) guidelines (40 CFR 230). The Corps is the lead federal agency responsible for preparing the EIS. The Corps has been assisted by a team of third-party contractors working under the Corps' direction in accordance with December 17, 1997, guidance from the Chief of Engineers regarding preparing an EIS. Information contained in the EIS serves as the basis for a decision regarding issuance of a Section 404 permit and provides information for local and state agencies having jurisdictional responsibility for affected resources.

Chapter 4 assesses the potential environmental consequences associated with the No Action alternative and four action alternatives: the Proposed Action alternative (Alternative 1), the Alternate Embankment Configuration alternative (Alternative 2A), Alternate Reservoir Location alternative (Alternative 2B), the West Bank alternative (Alternative 3), and the Brackish Water Desalination alternative (Alternative 4).

The terms *impacts* and *effects* are used interchangeably in this chapter. Potential environmental consequences are discussed under each resource topic for the five alternatives:

1. **No Action alternative**: The reservoir and all associated facilities would not be built and Dow would continue operations under existing conditions.
2. **Proposed Action alternative** (Alternative 1 and the Applicant's preferred alternative): Dow would construct and operate the expanded Harris Reservoir and associated facilities including the stream restoration on Oyster Creek at the Project site in Brazoria County, Texas.
3. **Alternate Embankment Configuration alternative** (Alternative 2A): This alternative is similar to the Proposed Action with the exception of the embankment design, which would require a slightly larger footprint and would provide approximately 5,760 AF more water storage.
4. **Alternative Reservoir Layout alternative** (Alternative 2B). This alternative is similar to the Proposed Action with the exception of the embankment design, which would require a slightly smaller footprint to set the embankment back from the Brazos River oxbow.
5. **West Brazos River alternative** (Alternative 3): This alternative is also similar to the Proposed Action but differs in that the Alternative 3 site would be located on the opposite side of the Brazos River. This alternative also differs from the Proposed Action in that the Alternative 3 site is outside the floodplain and would require an extensive water conveyance system and bridge over the Brazos River for access from the Dow facility and for the attachment of the water conveyance system.
6. **Brackish Water Desalination alternative** (Alternative 4): This alternative would include construction of a desalination plant and associated facilities (utilities, pipelines, sediment ponds, etc.) located downstream of the Project site nearer to the Brazos Reservoir.

4.1.1 Spatial Scope of Analysis

The analysis area in this draft EIS may be specific to each resource discussed in Section 3.1 through Section 3.15. For many resources, the analysis area is synonymous with the physical footprint of features, facilities, and construction area of the action alternatives (that is, the Project site). For some resources, potential impacts to individual resources may require a larger analysis area. Resources for which the analysis area differs from the Project site have been described in Section 3.1 through Section 3.15, and the environmental consequences and impact determinations for these resources have been developed according to the spatial context appropriate to each resource.

4.1.2 Determining the Level of Impact

The CEQ issued new NEPA regulations that went into effect on September 14, 2020. The new regulations apply to any NEPA process begun after September 14, 2020. Both context and intensity as well as cumulative analyses are not part of the required NEPA analysis under the new NEPA regulations. The new regulations allow for documents that began prior to the effective date to proceed under the old NEPA regulations. Because the NOI for this draft EIS was issued on April 7, 2020, this draft EIS follows the requirements of the regulations effective prior to September 14, 2020, and will address impacts in terms of context and intensity and includes a cumulative impact analysis.

This draft EIS describes and evaluates both adverse and beneficial impacts to the natural and human environments. To determine whether an action has the potential to result in significant impacts under NEPA, the magnitude of the impact, with respect to context and intensity of the action, should be considered. The assessment of impacts to each resource is based the following:

- On original analyses conducted by the Corps and the third-party NEPA consultants
- A review and assessment of technical accuracy by appropriate subject-matter experts of all data and materials submitted by the Applicant
- A review of available and relevant reference material and professional judgment
- The use of standards that include consideration of the permanence of an impact
- The uniqueness of or ability to replace the resource
- The abundance or scarcity of the resource

Context refers to the area of impacts (local, statewide, etc.) and the duration of the impact (e.g., whether they are short- or long-term impacts. In general, the impacts of construction and associated activities (e.g., vehicle use, use of staging areas for equipment or area closure) undertaken prior to operation and maintenance of the Project are expected to be temporary, short-term impacts and would persist for a finite period of time after construction concludes. Impacts that persist beyond the post-construction finite period are expected to be long term.

Intensity refers to the severity of the impact and could include the timing of the action (e.g., more intense impacts would occur during critical periods such as high visitation or wildlife breeding/rearing). Intensity is also described in terms of whether the impact would be beneficial or adverse. A single action might result in adverse impacts on one resource and beneficial impacts on another resource. An adverse impact is one having unfavorable or undesirable outcomes on the human-made or natural environment. In some cases, there is neither an adverse nor is there a beneficial effect from a proposed action. In these instances, a no effect determination will be made for a resource in this draft EIS.

4.1.3 Determination of Impacts

Under NEPA, federal agencies must consider the potential environmental impacts of proposed actions. These effects may include impacts to social, cultural, and economic resources, as well as impacts to natural resources. To identify those resources that could be significantly affected by the Proposed Action and alternatives, appropriate definitions of impacts must first be identified.

The conclusions for most analyses in this EIS use a four-level classification scheme (negligible, minor, moderate, and major) to characterize the environmental impacts predicted if the Proposed Action or alternatives are implemented. Definitions of impacts are presented in two separate groups: one for biological and physical resources and one for socioeconomic resources. The CEQ interprets the human environment "to include the natural and physical environment and the relationship of people with that environment" (40 CFR 1508.14).

4.1.3.1 IMPACT LEVELS FOR BIOLOGICAL AND PHYSICAL RESOURCES

The following impact-level definitions are used for biological and physical resources, which include the following resources and associate subsections:

- Geology and soils
- Water resources
- Vegetation
- Wildlife
- State-listed species
- Land use
- Climate and air quality

These levels are based on population-level impacts rather than impacts on individuals. Federally listed species use determinations from the Biological Assessment.

4.1.3.1.1 Negligible

- No measurable impacts.

4.1.3.1.2 Minor

- Most impacts on the affected resource could be avoided with proper mitigation.
- If impacts occur, the affected resource would recover completely without any mitigation once the impacting agent is eliminated.

4.1.3.1.3 Moderate

- Impacts on the affected resource are unavoidable.
- The viability of the affected resource is not in question, although some impacts may be permanent, or the affected resource would recover completely if proper mitigation is applied during the life of the Project or proper remedial action is taken once the impacting agent is eliminated.

4.1.3.1.4 Major

- Impacts on the affected resource are unavoidable.
- The viability of the affected resource may be threatened, and the affected resource would not fully recover even if proper mitigation is applied during the life of the Project or remedial action is taken once the impacting agent is eliminated.

4.1.3.2 IMPACT LEVELS FOR SOCIOECONOMIC ISSUES

The following impact levels are used for the analysis of socioeconomic resources, other human use resources, and associated subsections that affect individuals or communities that include the following:

- Socioeconomics
- Noise
- Hazardous waste and materials management
- Infrastructure

4.1.3.2.1 Negligible

- No measurable impacts.

4.1.3.2.2 Minor

- Adverse impacts on the affected individuals, the community, or their associated activities could be avoided with proper mitigation.
- Impacts would not disrupt the normal or routine functions of the affected individuals, the community, or their associated activities.
- Once the impacting agent is eliminated, affected individuals, the community, or their associated activities would return to a condition with no measurable effects without any mitigation.

4.1.3.2.3 Moderate

- Impacts on the affected individuals, the community, or their associated activities are unavoidable.
- Proper mitigation would reduce impacts to affected individuals, the community, or their associated activities substantially over the life of the Project.
- The affected individuals, the community, or their associated activities would require some adjustments that account for disruptions due to impacts of the Project, or once the impacting agent is eliminated, the affected individuals, the community, or their associated activities would return to a condition with no measurable effects if proper remedial action is taken.

4.1.3.2.4 Major

- Impacts on the affected individuals, the community, or their associated activities are unavoidable.
- Proper mitigation would reduce impacts to affected individuals, the community or their associated activities somewhat during the life of the Project.
- The affected individuals, the community, or their associated activities would experience unavoidable disruptions to a degree beyond what is normally acceptable, and once the impacting agent is eliminated, the affected individuals, the community, or their associated activities may retain measurable effects indefinitely, even if remedial action is taken.

4.1.4 Impact Types and Durations

The analysis of impacts requires capturing all types of impacts. As discussed above, there are both beneficial and adverse impacts. In identifying the impacts, it is necessary to look both at the immediate effects of an action as well as effects that may occur later in time; these are called direct and indirect effects, respectively. They are defined as follows:

- A **direct impact** is an impact that would be caused by an action and would occur at the same time and place as the action.
- An **indirect impact** is an impact that would be caused by an action, but it would occur later in time, or at another location, and yet is reasonably foreseeable in the future. Examples of indirect impacts include changes to habitat over time that result from the operation of a facility or other impacts related to changes over time and related effects on the biological or physical environment.
- A **temporary impact** would occur primarily during construction activities and would end at the conclusion of Project construction.
- A **short-term impact** would last from the time construction ceases to within 3 years following construction.
- A **long-term impact** would last longer than 3 years following completion of construction. In some cases, a long-term impact could be considered a permanent impact.

4.2 Geology and Soils

4.2.1 Topography and Geology

4.2.1.1 NO ACTION

Under the No Action alternative, the proposed reservoir would not be built. Over the short term, topographic and geologic features would remain essentially in their present condition. Channelization, which includes erosion and downcutting, would continue for the foreseeable future. This would affect topography in the immediate vicinity of the creeks and river by causing additional widening and deepening of the channels, as well as steeper unstable banks.

4.2.1.2 PROPOSED ACTION, ALTERNATIVE 2A, AND ALTERNATIVE 2B

Construction of the reservoir expansion upstream of the existing reservoir site would not be expected to impact subsurface geology, as no deep excavation is proposed. Clayey soils may potentially be exposed due to the removal of the overlying alluvium layer. Some erosion is likely to occur from grading vehicle use and vegetation removal. However, grading, construction of roadways and other features for placement of the 1,950-acre reservoir and associated facilities would alter the topography and surface geology permanently. In addition, floodplain enhancements and stream restoration activities would result in changes to topography and surface geology for approximately 227 acres. Although these effects would be permanent, due to the availability of similar topography and geology in the region, these impacts would be minor. Vegetation clearing would also be expected along the Brazos River for the intake and Oyster Creek stream restoration areas. Construction BMPs described in Section 2.8 would avoid and minimize potential erosion effects.

Although, in most places reservoir bank slopes would be relatively low, given the relatively gentle topography of the area, if slope stability became an issue along the embankment and shoreline of the reservoir, there could be impacts to topography and geology from fluctuating water levels that have the potential to create unstable slopes, thus increasing the potential for small slides and erosion. However, the reservoir embankment would be regularly inspected as part of Dow's O&M plan, and if any integrity issues are identified, remediation would be implemented.

The pipelines and oil and gas well heads would be relocated for the Project. The portion of the pipelines that cross the Project would be relocated by Conoco Phillips in a 100-foot-wide easement along the toe of the perimeter access road at the west and north sides of the reservoir. Pipeline availability would be temporarily disrupted during construction. The relocation would take approximately 4 months. The oil and gas wells have been plugged, abandoned, and closed in accordance with RRC regulations. Closure would be validated, and appropriate steps would be taken so proper closure occurs during construction, if required. Well heads would be lowered if they interfere with the reservoir construction. Impacts from the Project site on topography and geology would be minor.

4.2.1.3 ALTERNATIVE 3

Under Alternative 3, the impacts of the reservoir construction to topography and geology would be similar to those for Proposed Action and Alternative 2. Alternative 3 includes the development of an 1,864-acre reservoir, a 1,500-linear-foot spillway to the Brazos River, 16,300 linear feet of Route 25 realignment, a bridge over the Brazos River, an approximately 2.7-mile-long pipeline conveying water to the pump station, and an approximately 2.3-mile-long unlined channel conveying water from the pump station to the existing reservoir. Placement of the reservoir and associated facilities would permanently alter the topography and surface geology of 1,918 acres. In addition, temporary impacts to topography and surface geology from construction would account for 130 acres. Although the total area of permanent disturbance is slightly less under Alternative 3 when compared to the Proposed Action and Alternative 2, effects to topographic and geological features would be minor, similar as those described under the Proposed Action and Alternative 2.

There are two highly volatile liquid transmission lines (one natural gas gathering line and one crude oil transmission line) that cross Alternative 3 and are currently in service (RRC 2021). These lines are summarized in Table 3.2-3. In-service oil, gas, and volatile liquid transmission lines could seep or leach into surrounding soils during ground-disturbing activities associated with construction, resulting in adverse effects. Prior to construction, these pipelines would be properly abandoned and/or removed and relocated. Therefore, impacts from in-service pipelines would not be anticipated.

4.2.1.4 ALTERNATIVE 4

Alternative 4 includes the development of a water treatment plant, sludge basins, and pre-sedimentation basin, development of a 20-foot wide, 1.4-mile-long access road to the desalination plant, development of a 0.3-mile-long gravel road to the intake pump station, installation of approximately 8.8 mile long conveyance pipelines, installation of an overhead power line, and the installation of a new power substation to feed the desalination plant. The construction activities for the treatment plant, sludge basins, and pre-sedimentation basin would temporarily alter approximately 103 acres and permanently alter approximately 377 acres from grading and construction activities and placement of Project features. Impacts to topography and surface geology would be similar to those described under the Proposed Action and considered minor, but would be affect substantially less acreage.

Numerous highly volatile liquid transmission lines, refined liquid product transmission lines, natural gas transmission lines, and other gas transmission lines traverse through the Alternative 4 site and corridor (RRC 2021). The majority of these pipelines are in service as depicted in Table 3.2-4. In-service oil, gas, and volatile liquid transmission lines could seep or leach into surrounding soils during ground-disturbing activities associated with construction, resulting in adverse effects. Prior to construction, these pipelines would be properly abandoned and/or removed and relocated. Therefore, impacts from in-service pipelines would not be anticipated.

4.2.2 Soils

4.2.2.1 NO ACTION

Under the No Action alternative, the proposed reservoir expansion would not be built. Soils in the Project site would remain essentially in their present condition.

4.2.2.2 PROPOSED ACTION, ALTERNATIVE 2A, AND ALTERNATIVE 2B

Construction activities have the potential to disturb soils within approximately 2,016 acres of the Project site. Approximately 66 acres would be for temporary work areas, while the remaining Project components would cause permanent impacts to soils. Heavy equipment operations would cause soil compaction, which can lead to decreased infiltration rates and increased runoff rates. Soils within the Project site are primarily clayey and loamy with low erosional potential under normal conditions and high shrink-swell potential; however, removal of vegetation would expose soils and increase the potential for erosion.

During construction, soils would be excavated for the reservoir and the embankment would be constructed with the clayey excavated soils and soils from borrow sites. Erosion and settling may occur along the reservoir berm. However, the reservoir has been designed to reduce the potential for erosion and slumping by including a stabilizing berm, soil-cement armoring, wave wall, filters and drains, perimeter toe ditch, and seepage barrier wall. The soil within the reservoir embankment would be permanently altered once inundated by water. These soils would become anaerobic with altered chemical and biological processes. Sediment would also be expected to gradually accumulate within the reservoir bottom.

Erosion of riverbanks along the Brazos River may temporarily increase during the installation of the intake and pump station and the withdrawal of water. After construction, the Proposed Action would stabilize the streambank along the Brazos River. A temporary increase in erosion of the Oyster Creek bank may also occur during construction of the 227-acre floodplain enhancement and stream restoration area and in the Big Slough mitigation site. After construction, the restoration area would improve bank stabilization along the creek, reduce erosion, and trap sediment over the long term.

Standard BMPs and applicant-committed measures would be used to control erosion during construction (see Section 2.8) and mitigation activities. Regular inspections as part of Dow's O&M plan would note any erosion issues during reservoir operations. With these measures, the long-term impacts to soils from the Proposed Action, Alternative 2A, and Alternative 2B would be expected to be moderate.

4.2.2.3 ALTERNATIVE 3

Impacts to soils from excavation of the reservoir and construction of the embankment under Alternative 3 would be similar to those described for the Project Action. The river intake and pump station would be at the same location on the Brazos River and impacts would be the same. Like the Proposed Action, soils within the Alternative 3 site are primarily clayey and loamy with low erosional potential under normal conditions; however, removal of vegetation would expose soils and increase the potential for erosion.

Alternative 3 would have additional impacts to soils due to the realignment of Route 25, the inlet/outlet pipelines, and the proposed bridge over the Brazos River. These components would have a moderate temporary impact on soil from grading and excavation by heavy road construction equipment. Approximately 16.5 acres of permanent impacts would occur where Route 25 is paved with asphalt and 0.5 acre where the bridge structures are installed.

Standard BMPs and applicant-committed measures would be used to control erosion during construction (see Section 2.8). Regular inspections as part of Dow's O&M plan would note any erosion issues during operations. With these measures, long-term impacts to soils from Alternative 3 would be moderate.

4.2.2.4 ALTERNATIVE 4

Alternative 4 includes construction activities for the desalination plant, sludge basins, pre-sedimentation basin, access road, substation, and conveyance pipelines, which would disturb approximately 103 acres of soils temporarily and approximately 377 acres permanently from grading and construction activities and placement of Project features. The types of impacts to soils under Alternative 4 would be similar to those described under the Proposed Action; however, the footprint would be smaller compared to the Proposed Action, so less soils would be affected. Although there would be no reservoir requiring excavation of soils or construction of an embankment like the other action alternatives, there would be sludge basins and a pre-sedimentation basin requiring excavation of soils. Alternative 4 would also have an intake on the Brazos River and construction could temporarily increase erosion of the riverbanks. The soils in these areas are primarily clayey and loamy with low erosional potential under normal conditions and high shrink-swell potential.

The 8.8-mile-long conveyance pipeline ROW would temporarily impact approximately 107 acres of soils due to vegetation removal and the use of heavy machinery to excavate a trench and lay the pipeline. After construction, the pipeline ROW would be revegetated and soils would stabilize. Alternative 4 also includes 2 acres where soils would be permanently impacted by the power substation. Impacts to soils within the power line ROW would be temporary other than minor amounts of soil removed for the pole foundations.

Standard BMPs and applicant-committed measures would be used to control erosion during construction (see Section 2.8). With these measures, the long-term impacts to soils from Alternative 4 would be expected to be moderate.

4.2.2.5 PRIME FARMLAND SOILS

4.2.2.5.1 No Action

Under the No Action alternative, the proposed reservoir would not be built or operated. Soils would continue to be available for agricultural use. Therefore, there would be no impact on existing Prime Farmlands.

4.2.2.5.2 Proposed Action, Alternative 2A, and Alternative 2B

Construction of the proposed reservoir expansion would have a long-term, moderate impact on Prime Farmland soils by eliminating these soils from potential use in agriculture. Approximately 2,185.1 acres of the Project site contains soils that are considered potential Prime, Unique, and Important Farmland by the NRCS. These soils would no longer be available for agricultural use once the land is converted to a reservoir; impacts would be moderate. However, the NRCS considers Prime Farmland soils found in areas of proposed water supply reservoirs to be exempt from restrictions under the Farmland Protection Policy Act, which aims to minimize federally aided irreversible conversions of prime, unique, or important farmland to other non-agricultural uses. Prime farmland soils in the Big Slough mitigation site would remain undeveloped.

4.2.2.5.3 Alternative 3

Long-term, moderate impacts on Prime Farmlands would occur from the construction of Alternative 3. There are approximately 2,633.4 acres of soils in the Alternative 3 site that are considered Prime, Unique, and Important Farmland that would be eliminated from future agricultural use. This is an additional 448 acres compared to the Proposed Action. Impacts would be moderate.

4.2.2.5.4 Alternative 4

Long-term, moderate impacts on Prime Farmlands would occur from the construction of Alternative 4. There are approximately 677.4 acres of soils in Alternative 4 that are considered Prime, Unique, and Important Farmland that would be eliminated from future agricultural use. This is 1,507.7 acres less than the Proposed Action. Impacts would be moderate.

4.2.2.6 LAND SUBSIDENCE

4.2.2.6.1 No Action

Under the No Action alternative, the reservoir would not be constructed and there would be no impacts to land subsidence beyond existing conditions. Natural land subsidence within this area of Brazoria County is estimated to be up to 1 foot by 2050 according to the BCGCD (BCGCD 2013).

4.2.2.6.2 Proposed Action, Alternative 2A, Alternative 2B, Alternative 3, and Alternative 4

Primarily land subsidence within the Gulf Coast area occurs from the withdrawal of groundwater and oil, gas, and groundwater associated with the production of oil and gas. During the withdrawal of groundwater or oil and gas, a pressure difference is established between the sands and the clays in soils, which allows water to move from the clays into the sands. The Proposed Action and alternatives do not involve withdrawal of groundwater or oil and gas. The movement of water from the clay would cause the clays to compact, which would cause a long-term moderate effect on land subsidence within the Project site. According to the BCGCD, natural land subsidence is estimated to be up to 1 foot by 2050 (BCGCD 2013).

Heavy construction equipment would be used, which could likely cause minor additional compaction of the clayey and loamy soils found within all action alternative sites. As subsidence occurs, the proposed facility foundations, basins, bridge, roadway realignments, and access roads may show signs of movement that would be maintained as part of the O&M plan over time.

4.2.3 Sedimentation and Erosion

4.2.3.1 NO ACTION

Under the No Action alternative, the reservoir would not be constructed or operated. As a result, no construction activities would occur and there would be no impacts on sedimentation and erosion beyond existing conditions.

4.2.3.2 PROPOSED ACTION, ALTERNATIVE 2A, AND ALTERNATIVE 2B

The Proposed Action, Alternative 2A, and Alternative 2B would increase erosion and sedimentation within the Project site due to vegetation clearing, grading, and excavating activities. Under the existing conditions, soils in the Project site have a low K-factor (0.17), indicating a low potential for soil erosion. These soils also have a T-factor of 5, indicating 5 tons per acre per year is lost to wind and/or water erosion. However, wind and water can cause the soils disturbed by Project activities to move off-site, including into waterbodies. Suspended sediments from erosion would change the riverbed morphologically through the transport and settlement within the adjacent Brazos River and Oyster Creek. To reduce impacts, BMP measures such as erosion control measures, weed management, and sedimentation measures would be implemented throughout construction, as described in Section 2.8, BMPs. These impacts would be temporary and minor during construction.

During operations, the higher flows in conjunction with the low-sediment reservoir discharge into Oyster Creek is likely to result in erosion downstream (Watearth 2021). Because the proposed reservoir would not be continually releasing water, there would also be a wetting and drying cycle that could increase the bed and bank erosion when the sediment-deprived reservoir water is released. This could cause channel incision and widening, thus increasing the sediment load farther downstream, and could result in long-term moderate impacts in erosion and channel incision downstream during drought operations. The likelihood and magnitude of these potential impacts is unclear. As described in Section 2.8, when the proposed reservoir is operated during drought conditions, bank stability monitoring and proper remediation would be implemented to avoid and minimize these impacts.

4.2.3.3 ALTERNATIVE 3

Similar to the Proposed Action, wind and water can cause the soils disturbed by Project activities to move off-site, including into waterbodies. The Alternative 3 site has soils with a higher K-factor (0.43) compared to the Proposed Action, which indicate a moderate to high potential for soil erosion to occur due to the high rate of runoff. The site is on the west bank of the Brazos River, and most Project-related sedimentation would affect this river. With the implementation of BMPs described in Section 2.8, these impacts would be temporary and minor during construction. Bridge foundations and piers would be installed on the banks of the Brazos River, causing a temporary increase in sedimentation, which would be minimized with implementation of BMPs described in Section 2.8. The riverbanks would be protected from scour with riverbank slope protection and riprap, and long-term sedimentation impacts would not be anticipated.

4.2.3.4 ALTERNATIVE 4

Soils within the Alternative 4 site have a higher K-factor (0.32) compared to the Proposed Action, which is indicate a moderate potential for soil erosion to occur. The types of impacts from increased erosion and sedimentation would be similar to those described for the Proposed Action; however, the Alternative 4 site is smaller and less soils would be disturbed. The Alternative 4 site is on the bank of the Brazos River where the intake would be placed and, with implementation of BMPs described in Section 2.8, potential sedimentation effects to the Brazos River from Alternative 4 would be temporary and minor. This alternative would have no effect on Oyster Creek. With BMPs, the impacts would be short term and minor during construction.

4.3 Water Resources

4.3.1 Surface Water

4.3.1.1 WATER QUALITY

4.3.1.1.1 No Action

Under the No Action alternative, the proposed Project would not be constructed or operated. As a result, no construction activities would occur and there would be no impacts on water quality.

4.3.1.1.2 Proposed Action, Alternative 2A, and Alternative 2B

As discussed in Section 4.2.2, upland construction activities for the proposed reservoir and associated facilities could result in discharges of sediment in adjacent waterways. Installation of the intake on the Brazos River also has potential to result in in sedimentation and erosion in the Brazos River. Stream restoration activities could also result in sedimentation and erosion in the portions of Oyster Creek where construction activities are proposed. However, implementation of BMPs as described in Section 2.8, as well as implementation of the mitigation plan for Oyster Creek (SWCA 2021b), would avoid and minimize temporary minor effects to water quality.

As described in Section 4.2.2 above, operation of the proposed reservoir only during drought conditions may result in a wetting and drying cycle that could increase the bed and bank erosion when the sediment-deprived reservoir water is released. This could cause channel incision and widening, thus increasing the sediment load farther downstream and result in long-term moderate impacts to water quality. The likelihood and magnitude of these potential impacts is unclear. As described in Section 2.8, when Dow operates the proposed reservoir during drought conditions, bank stability monitoring and proper remediation would be implemented to avoid and minimize water quality impacts.

Roughly 80 percent of the proposed Project site is currently used for agriculture. The proposed Project would change the land use from agriculture to water storage and associated facilities (e.g., access roadways, pump station etc.). The reduction of agriculture would reduce the amount of agricultural runoff into the Brazos River and Oyster Creek, which could provide minor improvements to water quality in the immediate vicinity of the Project site. Operation of the proposed reservoir and the pump station could require use of transmission fluids or other products and oil products that could make their way to the Brazos River or Oyster Creek. Implementation of the O&M plan includes measures to handle and store these materials in accordance with appropriate regulations; therefore, these potential affects would not be expected to occur.

4.3.1.1.3 Alternative 3 and Alternative 4

Potential temporary effects to water quality on the Brazos River from construction under Alternative 3 and Alternative 4 would be similar as described under the Proposed Action. Alternative 3 proposes to construct a bridge over the Brazos River for access from the Dow facility that would be used to affix the proposed water pipeline. Potential effects to water quality from construction of the bridge would be similar to construction of the intake described above, and the same BMPs would be used to reduce the effects to a minor impact. Alternative 4 also involves withdrawal of brackish water from the Brazos River and use of desalination to convert the water to freshwater that would be used in the Dow facility. The process results in a byproduct referred to as sludge that would be placed in a series of open storage and treatment ponds, which if discharged into the Brazos River could result in adverse effects to water quality. Alterative 4 would implement an O&M plan that includes proper removal, handling and disposal of sludge to avoid and minimize this potential negligible to minor impact.

4.3.1.2 BRAZOS RIVER SYSTEM FLOWS

4.3.1.2.1 No Action

Under the No Action alternative, the proposed Project would not be constructed or operated. As a result, no construction activities would occur and there would be no impacts on the Brazos River.

4.3.1.2.2 Proposed Action, Alternative 2A, and Alternative 2B

Under the Proposed Action, Alternative 2A, and Alternative 2B, an intake structure would be constructed on the banks of the Brazos River and would be similar to the existing structure for the Harris Reservoir. Temporary impacts during the construction of the intake structure on the banks of the Brazos River could result in potential impacts to system flows during excavation, removal of vegetation, or temporary dewatering. To avoid and minimize these potential impacts, BMP measures such as erosion control measures, weed management, and sedimentation measures would be implemented throughout construction, as described in Section 2.8. Impacts to system flows in the Brazos River would be negligible and would not be affected once the intake and associated bank stabilization are constructed. Long-term effects to Brazos River system flows would not be anticipated as Dow is not proposing to increase its water right withdrawal. Additionally, the intake would be maintained during operation through routine inspections and maintenance as described in the O&M plan.

To determine if the Proposed Action has an impact on the system flows within and downstream of the Project site, a hydrologic and hydraulic analysis was completed. The hydrologic and hydraulic analysis consisted of running several models following the USACE Hydrology Modeling Guidelines (USACE 2018c). Three models were used to analyze the existing, Proposed Action, and Alternative 2 conditions. The three models are Hydrologic Engineering Center-Hydrologic Modeling System (HEC-HMS), Hydrologic Engineering Center-River Analysis System (HEC-RAS), and Riverware. The HEC-HMS analyzes the hydrologic (river basin water supply, water withdrawal, flood hydrology, and watershed runoff) processes of the watershed, HEC-RAS analyzes the hydraulics (water flow) through channels, streams, rivers, and other water bodies, and Riverware analyzes the reservoir operation. The modeling used various sources of data including USGS gage data from the Richmond and Rosharon gages, rainfall data from the NOAA National Climatic Data Center Richmond and Thompsom gages, BRA Lower Brazos Flood Protection Planning Study (Halff 2019), and data obtained from Dow. Full modeling descriptions, methodology, assumptions, and analysis for the Brazos River can be found in the *Brazos River Hydrology and Hydraulics Final Report* (Watearth 2021a). Based on the modeling results for the Brazos River, flows and velocities downstream of the Rosharon gage despite the pumping (diversion of water) into the proposed Harris Reservoir during peak flows, only negligible effects to system flows would be anticipated from the Proposed Action, Alternative 2A, or Alternative 2B.

4.3.1.2.3 Alternative 3

Effects to the Brazos River system flows from construction and operation of the intake structure would be negligible, similar to those described under the Proposed Action. Alternative 3 also includes construction of a proposed bridge structure crossing the Brazos River. The bridge foundations and piers would be installed on the banks of the river and be protected from scour with riverbank slope protection and riprap. There could be some changes to system flows once the bridge is constructed as water would flow around the structure and could be restricted during high flows and backwater circumstances may occur.

The bridge would require a permit from the U.S. Coast Guard (USCG 2021). The bridge would be designed in accordance with standard engineering practices and would be anticipated to have negligible long-term effects to system flows on the Brazos River.

4.3.1.2.4 Alternative 4

The intake structure for Alternative 4 would be constructed within the banks of the Brazos River and would be similar to the intake proposed under the Proposed Action and other alternatives, but it would be located farther downstream and closer to the existing Dow facility. Potential impacts associated with this structure would be negligible, the same as described under the Proposed Action.

4.3.1.3 OYSTER CREEK SYSTEM FLOWS

4.3.1.3.1 No Action

Under the No Action alternative, the proposed Project would not be constructed or operated. As a result, no construction activities would occur and there would be no impacts on Oyster Creek.

4.3.1.3.2 Proposed Action, Alternative 2A, and Alternative 2B

The analysis for Oyster Creek consisted of using HEC-HMS, HEC-RAS, and Better Assessment Science Integrating Point and Nonpoint Sources (BASINS). The Oyster Creek analysis, including modeling descriptions, methodology, assumptions, and analysis, can be found in the *Oyster Creek Downstream Hydrologic and Hydraulic Impacts Draft Technical Memorandum* (Watearth 2021b). The HEC-HMS is used to determine peak flows downstream of the proposed Harris Reservoir, HEC-RAS uses the peak flows form the HEC-HMS model to determine flow within Oyster Creek, and the BASINS was used to determine potential effects of the reservoir operations during drought conditions. Results from the Flood Insurance Study for Brazoria County, Texas (site) and the Lower Brazos Flood Protection Planning Study (Halff 2019) showed flows between the Brazos River basin and the Oyster Creek basin are occurring. These interbasin flows are captured in the HEC-HMS model as sources (positive flows) and sinks (negative flows). The analysis found that under existing conditions, 12 interbasin flows are occurring between the Brazos River Basin and the Oyster Creek Basin during both the 50- and 100-year storm events. Three of these interbasin flows are occurring within the location of the Proposed Harris Reservoir. The removal of these flow paths results in a shift of the interbasin flows downstream of the existing Harris reservoir resulting in an increase in the timing and magnitude of peak flows in Oyster Creek. The increase in peak flows demonstrates the potential for changes in water surface elevations and hydromodification of the downstream reaches of Oyster Creek. The loss of the interbasin flows would be the same for Alternatives 2a and 2b. The modeling also analyzed four operational scenarios evaluating discharge rates into Oyster Creek from the outlet works of the Proposed Project to the existing Harris Reservoir outfall to evaluate hydromodification (Watearth 2021b). The conditions for the modeling are 180 days of continuous flow during drought conditions to simulate operations. Discharge from Harris Reservoir Expansion during drought conditions would result in increased average velocities, increased bank erosion, increased bed scour, and decreased water temperatures in Oyster Creek. The operational discharge flows would be the same for Alternatives 2A and 2B. Impacts to Oyster Creek system flows would be moderate.

4.3.1.3.3 Alternative 3 and Alternative 4

Under Alternatives 3 and 4, the proposed Project would be located within the Brazos Creek watershed and not the Oyster Creek watershed. As a result, there would be no impacts to system flows. Alternative 3 discharges into Oyster Creek at the existing Harris Reservoir outfall.

4.3.1.4 ENVIRONMENTAL FLOWS

4.3.1.4.1 No Action

Under the No Action alternative, the proposed Project would not be constructed or operated. As a result, no construction activities would occur and there would be no impacts on environmental flows.

4.3.1.4.2 Proposed Action, Alternative 2A, and Alternative 2B

Under the Proposed Action, Alternative 2A and Alternative 2B, the hydrologic and hydraulic modeling results for the Brazos River show negligible impacts on the Brazos Rivers flows and velocities downstream of the Rosharon gage despite the pumping (diversion of water) into the proposed Harris Reservoir during peak flows (Watearth 2021a). Modeling also indicated no significant changes to water surface elevation levels of the Brazos River downstream of the Rosharon gage. Therefore, long-term impacts to environmental flows on the Brazos River would be negligible.

The modeling results for Oyster Creek show there could be changes on Oyster Creek system flows depending in the modeled scenario (Table 4.3-1), which could in turn affect environmental flows. Full modeling descriptions, methodology, assumptions, and analysis for the Brazos River and Oyster Creek can be found in the Preliminary Hydrology & Hydraulics Reports (Watearth, 2021a, 2021b).

Table 4.3-1. Modeled Effects to Oyster Creek

Scenario (discharge from proposed reservoir)	No Reservoir	Scenario 1 (334 cfs)	Scenario 2 (216 cfs)	Scenario 3 (133 cfs)	Scenario 4 (22 cfs)
Proposed Reservoir					
Maximum suspended sediment outflow (ton/ac-ft)	0.0508	0.0821	0.0706	0.0630	0.0530
Average velocities (ft/s)	1.68 ft/s	2.36 ft/s	-2.20 ft/s	2.03 ft/s	1.71 ft/s-
Average temperature (°F)	71.86	52.00	53.78	55.52	63.56

Within Oyster Creek, these analyses also found the proposed diversion into the Proposed Harris Reservoir and associated discharge into Oyster Creek significantly increase peak flows out of the combined Harris Reservoirs (see Table 4.3-1) into Oyster Creek, from an existing maximum of 278 cfs to a proposed maximum of 1,256 cfs (Watearth 2021b). There are two peak flows in the HEC-RAS model results, the smaller magnitude peak flow associated with the design storm rainfall that arrives within days after the storm event has ceased (Watearth 2021b). Later, a larger peak flow associated with the crossing of interbasin flows into Oyster Creek from Brazos River that arrives weeks later and is larger in magnitude. This increase in flows increases the potential for erosion and hydromodification during larger storm events. All the reaches downstream of the Proposed Harris Reservoir experience increases in peak flows. The peak flow increase is associated directly with the Proposed Harris Reservoir blocking the interbasin flows from Brazos River into Oyster Creek (Watearth 2021b). Additionally, the increase in peak flows shown in the HEC-HMS model demonstrate that there is potential for increases in the water surface elevations in Oyster Creek between the existing Harris Reservoir and the end of the model at Lake Jackson.

When modeling for 180 days of drought conditions, results indicate that sediment erosion and scouring would increase downstream of the Proposed Harris Reservoir in Oyster Creek. The erosion and scour would increase the concentration of suspended sediments in Oyster Creek downstream of the Proposed Harris Reservoir which are 0.0508 tons/ac-ft for under existing conditions. Four scenarios reservoir drawdown scenarios were modeled

- Scenario 1 – 334 cfs outflow from proposed reservoir: reservoir would be empty at simulation day 72
- Scenario 2 – 216 cfs outflow from proposed reservoir: reservoir would be empty at simulation day 111
- Scenario 3 – 133 cfs outflow from proposed reservoir: reservoir would be empty at simulation day 180
- Scenario 4 – 22 cfs outflow from proposed reservoir: reservoir would still be between 60 ft and 65 ft at the end of 180 days of simulation

Modeled increases in suspended sediment for the scenarios found that there would be an increase of 0.0821 tons/ac-ft under Scenario 1, 0.0706 tons/ac-ft under Scenario 2, 0.0630 tons/ac-ft under Scenario 3 and 0.0530 tons/ac-ft under Scenario 4 (see Table 4.3-1). It should be noted that only Scenarios 3 and 4 achieve 180 days of water availability per the TCEQ recommendation.

During drought conditions, models also found the average velocity in Oyster Creek would increase as the discharge from the Proposed Harris Reservoir increases, from existing conditions of 1.68 ft/s up to 2.36 ft/s under Scenario 1 (334 cfs), 2.20 ft/s under Scenario 2 (216 cfs), 2.03 ft/s under Scenario 3 (133 CFS) and 1.71 ft/s under Scenario 4 (22 cfs) (see Table 4.3-1). Model results also indicate a decrease in water temperatures with outflows from the Proposed Harris Reservoir into Oyster Creek. The average water temperate in Oyster Creek for existing conditions is 78.29 degrees Fahrenheit, with a maximum decrease in average water temperatures to 52 degrees Fahrenheit under Scenario 1. Although not modeled, there would be some impact on Oyster Creek bank stability when constant discharge from the Proposed Harris Reservoir stops after 180 days of operation. This could have potential impact on bank erosion as velocity decreases and potential impact on vegetation on the banks. The wet bank soils would dry when the constant discharge stops causing erosion.

Flows from the proposed Harris Reservoir would only be released into Oyster Creek during drought conditions or if the reservoir levels must be lowered to accommodate storm events. Discharge from the Proposed Harris Reservoir would likely result in downstream erosion of Oyster Creek because the reservoir water is deprived of sediment. Since the Proposed Harris Reservoir would not be continually releasing water, a wetting and drying cycle may occur that can lead to increases in bed and bank erosion when the sediment deprived reservoir water is released. This can cause channel incision and widening, thus increasing the sediment load further downstream. Repeated filling and draining to create wet, then dry conditions over the short term can result in hydromodification to the reservoirs and the receiving waters, which is specifically a concern for Oyster Creek, which has low natural flows. The repeated wet/dry conditions can break down the soil structure and lead to minor to moderate erosion impacts. Oyster Creek between the proposed Project discharge point and the existing Harris Reservoir discharge point are at highest near-term risk due to the changed conditions, and regular inspection would be required along with a management plan to minimize erosion. The potential for and extent of erosion on Oyster Creek to occur is unclear and requires an adaptive management approach. See Section 2.8. for further discussion of the proposed monitoring and mitigation associated with the adaptive management approach for Oyster Creek. Impacts to environmental flows would be moderate.

See Sections 4.4.2 and 4.5.2 below for further discussion of potential impacts to aquatic vegetation and wildlife.

4.3.1.4.3 Alternative 3

Under Alternative 3, there would be negligible impacts anticipated to environmental flows on the Brazos River and Oyster Creek. Water intake effects would occur on the Brazos River, similar to the Proposed Action. Discharges of reservoir water during drought conditions to Oyster Creek would occur just below the outfall for the existing Harris Reservoir where Oyster Creek already functions as water conveyance for Dow's facility. Discharge outputs to Oyster Creek at this location would not be anticipated to affect this portion of Oyster Creek when compared to existing conditions.

Placement of a bridge over the Brazos River would alter stream hydrogeomorphology, particularly downstream of the structure. Bridges create a restriction of flow, leading to changes in velocity, water surface level, and erosional and depositional patterns (Thomason 2019). Upstream of the bridge, water surface elevations are higher, known as backwater, caused by an increase in depth upstream to adjust for changes in stream flow through the restriction. Downstream of the bridge, minor to moderate increases in scour, incision, and widening of the channel would likely occur in the localized area around the bridge over the long term. Additionally, bridges can also restrict flow of snags or other debris through the area, which are used by aquatic life for shelter.

4.3.1.4.4 Alternative 4

Under Alternative 4, there would be no impacts to Oyster Creek as water would be conveyed via a pipeline directly to the Dow facility. Potential impacts for water withdrawals from the Brazos River are anticipated to be similar to the Proposed Action.

4.3.2 Flood Hazards and Flood Hazard Values

4.3.2.1 NO ACTION

Under the No Action alternative, the proposed reservoir would not be constructed or operated. As a result, there would be no changes in the floodplain that result of reservoir placement. Therefore, no impacts associated with the Proposed Action or alternatives to the existing flood hazards and flood hazard values would occur. However, future developments within the watershed, or any increase in impervious surfaces within the watershed, could result in heightened flood hazards in the watershed.

4.3.2.2 PROPOSED ACTION, ALTERNATIVE 2A, AND ALTERNATIVE 2B

As discussed in Section 3.3.1.2, the Project site for the Proposed Action, Alternative 2A, and Alterative 2B is located between the Brazos River and Oyster Creek in the 100-year floodplain for both river systems and includes the construction and operation of an expanded Harris Reservoir, as well as the proposed stream restoration on Oyster Creek.

As discussed above in Section 4.3.1.3, modeling of Oyster Creek found that the proposed diversion into the proposed Harris Reservoir and associated discharge into Oyster Creek would increase peak flows out of the combined Harris Reservoirs. There are two peak flows in the HEC-RAS model results: 1) a smaller magnitude peak flow associated with the design storm rainfall that arrives days after the storm event has ceased, and 2) a larger peak flow associated with the crossing of interbasin flows into Oyster Creek from the Brazos River that arrives weeks later and is larger in magnitude. This increase in flows increases the potential for erosion and hydromodification during larger storm events. All the reaches downstream of the proposed Harris Reservoir would experience increases in peak flows, and therefore greater flood risk. The peak flow increase is associated directly with the proposed Harris Reservoir, blocking the three interbasin flows from the Brazos River into Oyster Creek. Additionally, the increase in peak flows shown in the

HEC-HMS model demonstrates that there is potential for changes in water surface elevations and hydromodification of the downstream reaches of Oyster Creek.

The Project is estimated to result in a 1,028 AF (1%) loss of floodplain storage during a modeled 100-year storm event (Watearth 2021b). To address this floodplain storage loss, the reservoir could be operated to counter the effects. Existing conditions and four operational scenarios were modeled to analyze floodplain gain or loss during 50-year and 100-year storm events for a total of eight scenarios. The scenarios modeled using a combination of HEC-HMS and HEC-RAS are shown in Table 4.3-2.

Table 4.3-2. Existing Conditions and Operational Scenarios

Scenario	Action
Scenario 1	No drawdown prior to a storm event for 50-year, 24-hour design storm event.
Scenario 2	Drawdown 18 inches prior to a storm event and hold 6 inches of floodplain storage in the reservoir before spillway discharge for 50-year, 24-hour design storm event.
Scenario 3	Drawdown 18 inches prior to a storm event and hold 9 inches of floodplain storage in the reservoir before spillway discharge for 50-year, 24-hour design storm event.
Scenario 4	Drawdown 18 inches prior to a storm event and hold 12 inches of floodplain storage in the reservoir before spillway discharge for 50-year, 24-hour design storm event.
Scenario 5	No drawdown prior to a storm event for 100-year, 24-hour design storm event.
Scenario 6	Drawdown 18 inches prior to a storm event and hold 6 inches of floodplain storage in the reservoir before spillway discharge for 100-year, 24-hour design storm event.
Scenario 7	Drawdown 18 inches prior to a storm event and hold 9 inches of floodplain storage in the reservoir before spillway discharge for 100-year, 24-hour design storm event.
Scenario 8	Drawdown 18 inches prior to a storm event and hold 12 inches of floodplain storage in the reservoir before spillway discharge for 100-year, 24-hour design storm event.

A summary of model results for floodplain gain or loss for the eight scenarios is shown in Table 4.3-3. Modeling concluded that several operational measures result in floodplain storage gain and that the floodplain storage loss resulting from the Proposed Action can be countered. Additional floodplain storage gains may also be used to counter the smaller magnitude peak flows resulting from loss of the three interbasin flows discussed above. Overall, flood hazard impacts would be moderate.

Table 4.3-3. Operational Plan Scenarios to Offset Floodplain Storage Loss

	Loss of Floodplain Storage	50-Year Design Storm				100-Year Design Storm			
		Floodplain Storage (AF)							
		Proposed No Drawdown	Proposed 18-Inch Drawdown and 6-Inch Floodplain Storage	Proposed 18-Inch Drawdown and 9-Inch Floodplain Storage	Proposed 18-Inch Drawdown and 12-Inch Floodplain Storage	Proposed No Drawdown	Proposed 18-Inch Drawdown and 6-Inch Floodplain Storage	Proposed 18-Inch Drawdown and 9-Inch Floodplain Storage	Proposed 18-Inch Drawdown and 12-Inch Floodplain Storage
50-year	-525	-525	+993	+1,371	+1,715	N/A	N/A	N/A	N/A
100-year	-1,028	N/A	N/A	N/A	N/A	-1,028	+807	+1,309	+1,632
Total		**-525**	**+468**	**+846**	**+1,190**	**-1,028**	**-221**	**+281**	**+604**

During non-hurricane season, the pool level will be operated to stay close to the maximum normal pool elevation and would be maintained at 68 feet, which would provide adequate capacity to capture up to 6 inches of rain. Dow would implement emergency drawdown of the proposed reservoir in advance of a tropical storm or hurricane making landfall near the Project site or any other extreme storm events outside of hurricane season, and because of embankment instability. Emergency releases could also occur via the emergency spillway in a full reservoir condition.

During non-hurricane season, the pool level would be operated to stay close to the maximum normal pool elevation. During hurricane season, the pool elevation would be slowly lowered 1 foot from the maximum normal pool elevation. When hurricanes are expected, if the pool elevation is at target drawdown levels due to evaporation or water supply releases, no additional drawdown would occur. If the pool elevation is not at target drawdown, it would be lowered to reach the 1.7 feet below the seasonal maximum pool elevations. WSEL and targeted drawdown levels are provided in the O&M plan for seasonal drawdown levels, and emergency release conditions from large storm events including tropical storms and hurricanes are shown in Table B of the O&M Plan (see Appendix L).

Between May 15 and December 1, Dow would monitor weather events, and in the event of a hurricane making landfall, would drawdown the reservoir to allow 1.7 feet of capacity, which would capture up to 19 inches of rainfall. The reservoir would drawdown over a 6-hour period to bring water surface elevations in the reservoir down to between 66.3 and 65.3 feet, depending on the month (see Table B of the O&M plan [see Appendix L]). Emergency releases could also occur via the emergency spillway in a full reservoir condition.

The proposed reservoir and stepped spillway have been designed to capture rainfall on the reservoir and allow for controlled release from the stepped spillway. The design is specifically intended to reduce both the volume of discharge and the rate of discharge to the Oyster Creek floodplain relative to pre-Project conditions. These design features consist of the following:

- During many normal rain events and when the reservoir is below the full pool elevation, no discharge would occur at WSEL 68 feet or less.
- At full pool elevation (68 feet WSEL), the reservoir would capture a rain event of 6 inches with an incidental maximum release rate of 4.2 cfs through the stepped spillway.
- The reservoir operation and the stepped spillway design allow accumulation of 2 feet (WSEL 70 feet) of rainfall before the discharge rate reaches 110.8 cfs. The 2 feet is marginally more than the 100-year rainfall event. The 110.8 cfs discharge rate resulting from the reservoir discharge at elevation 70 feet is estimated to be significantly below the pre-Project discharge rate of approximately 1,000 cfs from the property in Oyster Creek for the 100-year 24-hour storm (rainfall depth of approximately 13.5 inches on the property).
- With implementation of the seasonal and emergency drawdown procedures, potential flood impacts from reservoir placement would be moderate.

4.3.2.3 ALTERNATIVE 3

Alternative 3 would likely not exacerbate flooding as the Alternative 3 site is largely located out of the 100-year floodplain for both Oyster Creek and the Brazos River. The new bridge constructed as part of Alternative 3 has a bottom elevation of 54 feet. As discussed in Section 3.3.1.4, record high water levels due to Hurricane Harvey experienced crest elevations of 52.54 on the Brazos River. Therefore, even in an event as large as Hurricane Harvey, it is unlikely that the bridge deck would flood causing transportation difficulties. Alternative 3 would result in negligible to minor impacts to the existing flood hazards and flood hazard values.

4.3.2.4 ALTERNATIVE 4

Most of the structures proposed under Alternative 4 are located within the 100-year floodplain. The Alternative 4 site sits at a much lower elevation that would likely become completely inundated during a large flood event. The proposed desalination facilities and the sludge ponds necessary for desalination waste product could result in displacement of some of the existing flood flows within the watershed that could lead to minor to moderate increased flooding in nearby structures. If the ponds become inundated in a flood event, waste product could be released and result in health concerns such as potential for waterborne illnesses due to the contamination of the flood waters. These minor to moderate effects would be expected to dissipate once flood waters recede. Similar to the Proposed Action, during larger events where interbasin flows and flood flows may occur, infrastructure could be inundated and create temporary minor to moderate hazards for local residents.

4.3.3 Water Rights

4.3.3.1 NO ACTION, PROPOSED ACTION, ALTERNATIVE 2A, ALTERNATIVE 2B, ALTERNATIVE 3, AND ALTERNATIVE 4

Dow does not intend to increase the use of their water right under the No Action, Proposed Action, or any action alternative. Under the action alternatives, Dow would fill the proposed reservoir over a 3 to 4-month period once construction is complete and does not propose withdrawing water over their existing right to do so. Under Alternative 4, Dow would move the withdrawal of their water right approximately 23 river miles downstream on the Brazos River. The water at this location becomes substantially more brackish, and this could result in nominal increases in freshwater availability during drought conditions in upstream reaches between the Proposed Action, Alternative 2, and Alternative 3 sites and the Alternative 4 intake location. There would be no impact on water rights.

4.3.4 Waters of the United States, Including Wetlands

4.3.4.1 NO ACTION

Under the No Action alternative, the proposed Project would not be constructed or operated. As a result, no construction activities would occur and there would be no impacts on wetlands or waterbodies, including potential WOUS.

4.3.4.2 PROPOSED ACTION, ALTERNATIVE 2A, AND ALTERNATIVE 2B

Under the Proposed Action, Alternative 2A, and Alternative 2B, compensatory mitigation requirements for WOUS by the Corps would be determined based on the 2019 wetland delineation (SWCA 2019a), which was verified by the Corps on October 22, 2019 (USACE 2019a), within the Project site. As part of Dow's application for the proposed Harris Reservoir, they requested the Corps issue an AJD. However, Dow withdrew their AJD request on May 23, 2019. Therefore, at this time, an AJD has not been completed. For the purpose of Dow's permit application, the Corps assumes that all wetlands and waterbodies that have been delineated are WOUS. Dow may request an approved jurisdictional determination during any part of the permitting process. Compensatory mitigation requirements would be determined based on the amount of wetland and waterbody features determined to be jurisdictional WOUS by the Corps, as well as the functional assessment of the wetlands and WOUS that would be filled.

As described in Section 2.3.3, for the Proposed Action, within the 2,533-acre Project site, approximately 77% of land would be permanently developed, 3% would be temporarily disturbed during construction, 11% would remain undeveloped, and 9% would be improved as part of mitigation (at Oyster Creek) (see Table 2.3-1). The Proposed Action would permanently impact 15.97 acres of the 21.38 acres of wetlands on the Project site, and 78,038.40 linear feet (31.89 acres) of the 109,338 linear feet (74.10 acres) of waterbodies on the Project site. Different Project components would result in varying levels of impacts; however, overall impacts would be moderate due to changes in Oyster Creek. Table 4.3-4 below lists delineated wetland and waterbody features per Project component.

Table 4.3-4. Wetlands and Waterbodies by Project Component for the Proposed Action

Project Component	Total Wetland Acreage	Number of Wetlands	Total Waterbody Acreage	Total Waterbody Length (feet)	Number of Waterbodies
Reservoir					
PEM wetland	4.04	6	–	–	–
PSS wetland	4.55	2	–	–	–
PFO wetland	5.22	2	–	–	–
Ephemeral stream	–	–	8.06	48,998.40	26
Intermittent stream	–	–	12.88	24,340.80	3
Perennial pond	–	–	2.84	0.00	3
Reservoir subtotal	*13.81*	*10*	*23.78*	*73,339.20*	*32*
River intake and pump station					
Ephemeral stream	–	–	0.06	264.00	2
Intermittent stream	–	–	0.06	105.60	2
Perennial stream	–	–	2.17	1,478.40	2
River intake and pump station subtotal	–	–	*2.29*	*1,848.00*	*6*
Spillway/outlet					
PEM wetland	0.20	1	–	–	–
Temporary staging and work areas					
PEM wetland	0.38	2	–	–	–
PFO wetland	1.58	2	–	–	–
Perennial stream	–	–	5.82	2,851.20	1
Temporary staging and work areas subtotal	*1.96*	*4*	*5.82*	*2,851.20*	*1*
Total Project site	**15.97**	**15**	**31.89**	**78,038.40**	**39**

The Alternative 2A embankment would roughly parallel the Project site boundary so the reservoir footprint for this alternative would be slightly larger and therefore overlap 5.10 more acres of the delineated wetlands and 9,187.20 more linear feet more of the waterbodies. Compared to the Proposed Action, Alternative 2B would impact 1,372.80 linear feet less waterbodies (ephemeral and intermittent streams), but impacts to wetlands would be the same as the Proposed Action. Other Project components would be the same as those described for the Proposed Action. Different Project components would result in varying levels of impacts. Tables 4.3-5 and 4.3-6 below lists delineated wetland and waterbody features per Project component for these alternatives.

Table 4.3-5. Wetlands and Waterbodies by Project Component for Alternative 2A

Project Component	Total Wetland Acreage	Number of Wetlands	Total Waterbody Acreage	Total Waterbody Length (feet)	Number of Waterbodies
Reservoir					
PEM wetland	8.79	13	–	–	–
PSS wetland	4.90	4	–	–	–
PFO wetland	5.22	2	–	–	–
Ephemeral stream	–	–	9.00	54,489.60	30
Intermittent stream	–	–	15.29	26,822.40	3
Perennial stream	–	–	1.29	1,531.20	4
Perennial pond	–	–	2.84	0.00	3
Reservoir subtotal	*18.91*	*19*	*28.42*	*82,843.20*	*40*
River intake and pump station					
Intermittent stream	–	–	0.06	105.60	2
Perennial stream	–	–	2.17	1,478.40	2
River intake and pump station subtotal	–	–	*2.23*	*1,531.20*	*4*
Spillway/outlet	**–**	**–**	**–**	**–**	**–**
Temporary staging and work areas					
PEM wetland	0.38	2	–	–	–
PFO wetland	1.58	2	–	–	–
Perennial stream	–	–	5.82	2,851.20	1
Temporary staging and work areas subtotal	*1.96*	*4*	*5.82*	*2,851.20*	*1*
Total Project site	**20.87**	**23**	**36.47**	**87,225.60**	**45**

Table 4.3-6. Wetlands and Waterbodies by Project Component for Alternative 2B

Project Component	Total Wetland Acreage	Number of Wetlands	Total Waterbody Acreage	Total Waterbody Length (feet)	Number of Waterbodies
Reservoir					
PEM wetland	4.05	7	–	–	–
PSS wetland	4.55	2	–	–	–
PFO wetland	5.22	2	–	–	–
Ephemeral stream	–	–	8.02	47,995.20	26
Intermittent stream	–	–	12.81	24,288.00	3
Perennial stream	–	–	2.84	0.00	3
Reservoir subtotal	*13.82*	*11*	*23.67*	*72,283.20*	*32*

Project Component	Total Wetland Acreage	Number of Wetlands	Total Waterbody Acreage	Total Waterbody Length (feet)	Number of Waterbodies
River intake and pump station					
Intermittent stream	–	–	0.06	105.60	2
Perennial stream	–	–	2.17	1,478.40	2
River intake and pump station subtotal	–	–	*2.23*	*1,531.20*	*4*
Spillway/outlet	**–**	**–**	**–**	**–**	**–**
Temporary staging and work areas					
PEM wetland	0.38	2	–	–	–
PFO wetland	1.58	2	–	–	–
Perennial stream	–	–	5.82	2,851.20	1
Temporary staging and work areas subtotal	*1.96*	*4*	*5.82*	*2,851.20*	*1*
Total Project site	**15.78**	**15**	**31.72**	**76,665.60**	**37**

The September 2019 Level I Stream Condition Assessment identified 31 ephemeral channels, and data for a Level 2 Stream Condition Assessment were collected on the three intermittent channels within the Project site (Appendix D). Of the 34 channels evaluated within the proposed reservoir area, the Corps has identified six with functional streams that must be compensated for. The remaining ephemeral channels are human-made and currently function as agricultural ditches in an active agricultural operation.

For both the Proposed Action, Alternative 2A, and Alternative 2B, all wetlands and waterbodies within the boundaries of the proposed reservoir and associated intake station and spillway would be considered permanent loss and filled. The largest impact would be to Jennings Bayou, which is an intermittent distributary of Oyster Creek. Construction of the reservoir would disconnect and permanently flood Jennings Bayou. The surrounding area would be converted from a fluvial to a lacustrine aquatic resource. There is a small portion of Jennings Bayou that would not be directly impacted as a result of the reservoir placement, but stream functions of this small remaining area would be eliminated.

To assess the condition of a stream's function, the Galveston District developed the June 2013 Galveston District Stream Condition Assessment Standard Operating Procedure (SOP) as a qualitative assessment designed to evaluate relative potential of a stream to support and maintain a diverse community of organisms; however, it is not intended to take the place of project-specific review. When proposed stream projects are complex or controversial, additional information is required to complete an appropriate evaluation of the proposed impacts and compensatory mitigation.

These assessments are used effectively to establish a baseline of stream condition for a without-project analysis. It is also frequently used effectively for analyzing changes in stream condition in a with-project scenario, but it is limited. The SOP makes the assumption in a with-project scenario that the stream would present post-construction. The SOP allows for a post-construction minimum score of 1 for a stream; these are typically culverted streams or streams that are engineered without stream function. The Proposed Action, Alternative 2A, and Alternative 2B would eliminate six functioning streams, including Jennings Bayou, by filling and flooding.

Stream enhancements that provide functional lift to Oyster Creek have been developed to serve as mitigation for unavoidable impacts to aquatic resources as part of the proposed reservoir development. There would be temporary effects to Oyster Creek during construction, as well as short-term effects post-construction while riparian vegetation and other enhancements stabilize and become self-sustaining. While these enhancements would largely result in permanent alterations and effects to Oyster Creek, creation of a higher-functioning stable stream system with an established riparian corridor would be beneficial in the long term. In addition to the Oyster Creek enhancement, compensatory mitigation on Big Slough would also be completed. A number of studies, including a watershed analysis estimating peak flows through regression modeling and a hydraulic assessment that estimates bankfull flow, shear stress, and stream power, have been completed on Big Slough (see the Conceptual Compensatory Mitigation Plan in Appendix G). Implementation of mitigation on Oyster Creek and Big Slough would occur concurrent with or prior to construction of the Proposed Action, Alternative 2A, or Alternative 2B. Based on the combination of the proposed Oyster Creek enhancements and the proposed Big Slough restoration functions that the existing WOUS are providing, overall, the level of impact would be moderate.

4.3.4.3 ALTERNATIVE 3

Based on a desktop review, the Alternative 3 site contains 144 NWI wetlands, totaling 384.25 acres, 18 NHD waterbodies, totaling 4.21 miles, and 25 NWI waterbodies, totaling 15.12 acres (USFWS 2021a; USGS 2021b). Not all of these wetlands and waterbodies would be within the footprint of development; however, most would be affected. As described in Section 2.6.3, within the 2,885-acre Alternative 3 site, approximately 66.5% of land would be permanently developed and 4.5% would be temporarily disturbed during construction (see Table 2.5-1). The remaining 29% of the site would remain undisturbed. Different Project components would result in varying levels of impacts. All wetlands and waterbodies within the boundaries of the proposed reservoir and associated intake and pump station and spillway would be considered permanent loss due to fill. Impacts along the pipeline would be typical to other pipeline projects, with most impacts considered temporary and minor except for a permanently maintained right-of-way. The bridge over the Brazos River would result in moderate permanent impacts to the Brazos River, including permanent loss or fill within the Brazos River where the bridge piers are located and along the banks where surface protection material (riprap) would be added for slope protection and bank stabilization.

If Alternative 3 is selected, a delineation of WOUS would be required to confirm the locations and size of wetlands and waterbodies within the Alternative 3 site as additional wetland and waterbody features not identified through a desktop study could be present. Compensatory mitigation requirements would be based on the results of the delineation. Based on the desktop review, Alternative 3 would likely contain a larger number and size of wetlands and a smaller number and size of waterbodies than the Proposed Action Project site. Permanent impacts to wetlands would be similar to the Proposed Action, but total acreage of impacts to WOUS would be less. The Corps would require compensatory mitigation commensurate with impacts to wetlands and WOUS. Overall, the level of impact would be moderate.

4.3.4.4 ALTERNATIVE 4

Based on a desktop review, the Alternative 4 site contains 25 NWI wetlands, totaling 199.15 acres, 17 NHD waterbodies, totaling 0.97 mile, and 19 NWI waterbodies, totaling 22.61 acres (USFWS 2021a; USGS 2021b). Not all of these wetlands and waterbodies would be within the footprint of development; however, most would be affected. If Alternative 4 is selected, a delineation of WOUS would be required to confirm the locations and size of wetlands and waterbodies within the Alternative 4 site as additional wetland and waterbody features not identified through a desktop study could be present. Compensatory mitigation requirements would be based on the results of the delineation. Based on the desktop review, Alternatives 4 would likely contain a larger number and size of wetlands but would likely contain a smaller number and size of waterbodies than the Proposed Action Project site.

As described in Section 2.7.3, the Brackish Water Desalination alternative site is approximately 733 acres of which approximately 51% would be permanently developed and 14% would be temporarily disturbed during construction, and the remainder of the site would not be disturbed (see Table 2.6-1). Different Project components would result in varying levels of impacts. Wetland and waterbodies within the footprint of the proposed desalinization plant would be filled and considered permanent loss. Impacts along the pipeline would be typical to other pipeline projects, with most impacts considered temporary except for a permanently maintained right-of-way. Overall, permanent impacts to wetlands would be greater than the Proposed Action, but total acreage of impacts to WOUS would be less. The Corps would require compensatory mitigation commensurate with impacts to wetlands and WOUS. Overall, the level of impact would be moderate.

4.3.5 Groundwater

4.3.5.1 NO ACTION

Under the No Action no construction or operation if any facilities would be constructed and existing wells would not be exposed to any potential effects.

4.3.5.2 PROPOSED ACTION, ALTERNATIVE 2A, ALTERNATIVE 2B, ALTERNATIVE 3, AND ALTERNATIVE 4

As described in Section 4.2.1, no deep excavation that may affect subsurface geology is proposed for reservoir construction or associated facilities for the Proposed Action, Alternative 2A, Alternative 2B, and Alternative 3, nor for any Project features proposed under Alternative 4. Therefore, effects to existing groundwater would not be anticipated. For all alternatives, Dow would plug and abandon wells within the construction footprint prior to any Project construction. All wells would be plugged by a licensed driller or pump installer in accordance with state and local regulations. Therefore, impacts to groundwater are not anticipated.

Geotechnical borings conducted in the proposed reservoir site for the Proposed Action, Alternative 2A, and Alternative 2B encountered groundwater at depths ranging from 8 to 38 feet (Fugro 2013a, 2013b, 2013c). Excavation for the proposed reservoir may encounter groundwater. All action alternatives would require a TPDES stormwater general construction permit which indicates that if groundwater can be discharged with appropriate controls and filters if there is no known contamination. Therefore, effect related to discharges of groundwater would not be anticipated.

4.4 Vegetation

4.4.1 Terrestrial

4.4.1.1 NO ACTION

Under the No Action alternative, the proposed Project would not be constructed or operated. As a result, no construction or operational activities would occur and there would be no impacts on existing terrestrial vegetation/land cover types.

4.4.1.2 PROPOSED ACTION

Approximately 79.6% of the Project site consists of agricultural land covers (i.e., pasture/hay or cultivated crop); grassland/herbaceous land cover makes up 13.4%; and forest, scrub-shrub, wetlands, and waterbodies make up the remaining 6.9% (see Table 3.4-1 and Figure 3.4-1). Within the 2,533-acre Project site, approximately 77% of land would be permanently developed, 3% would be temporarily disturbed during construction, and 9% would be improved as part of mitigation. The Proposed Action would permanently remove approximately 1,950.1 acres within the Project site, converting existing vegetation to developed lands for the reservoir. Based on the availability of similar terrestrial vegetation in the area, this would be considered a long-term moderate impact. An additional 70.1 acres would be temporarily disturbed during construction but returned to grassland/herbaceous land cover once construction is completed. The embankment slopes would be vegetated and mowed during operations.

The Proposed Action would result in permanent effects to terrestrial vegetation in areas that would be converted to the reservoir, roadways, and other associated facilities. Surface disturbance for the Proposed Action could lead to the spread of existing invasive plant species and/or introduction of new weeds. Bermuda grass, golden crown grass, Johnsongrass, and Chinese tallow are invasive plants that have been observed on the Project site (SWCA 2019a). Dow would manage the introduction and spread of non-native invasive plant species throughout construction and operations as described in Section 2.8 to avoid and minimize these potential impacts and would remediate any temporarily disturbed areas in accordance with the revegetation plan. Because the majority of the Project site is in pasture/hay or other cultivated agriculture use, and given the availability of similar vegetation type areas in the vicinity, long-term moderate effects to terrestrial vegetation would be anticipated.

Additionally, activities proposed as part of the Oyster Creek stream restoration would enhance native vegetation within approximately 227.0 acres of the Project site. As described in the mitigation plan, the banks would be planted with native riparian, grassland, and upland seed mixes. Riparian trees would be planted including rough leaf dogwood (*Cornus drummond*), common persimmon *(Diospyros virginiana*), red maple (*Acer rubrum*), and dwarf palmetto (*Sabal minor*). Upland trees would include live oak (*Quercus virginiana*) and pecan (*Carya illinoinensis*). Similar habitat restoration would occur at the Big Slough off site mitigation area. Overall, restoration along Oyster Creek and Big Slough would improve existing terrestrial vegetation in the vicinity of the stream and riparian areas, which would benefit existing vegetation in these areas over the long term.

4.4.1.3 ALTERNATIVE 2A

The Alternative 2A site is the same as the Project site. Approximately 79.6% of the site consists of agricultural land covers (i.e., pasture/hay or cultivated crop); grassland/herbaceous land cover makes up 13.4%; and forest, scrub-shrub, wetlands, and waterbodies make up the remaining 6.9% (see Table 3.4-1 and Figure 3.4-1). The larger reservoir would permanently remove an additional 252 acres on the southwest portion of the Project site that is pasture/hay, mixed forest, and woody wetland habitat. Because Alternative 2A occurs within the same Project envelope as the Proposed Action, existing conditions are the same as the Proposed Action and types, duration, and intensity of impacts to terrestrial vegetation under Alternative 2 would be similar, with the exception of the additional 252 acres of permanent impacts to terrestrial vegetation. Dow would still implement the Oyster Creek and Big Slough stream restoration, and those benefits would be realized under Alternative 2A, although Oyster Creek would need to be redesigned to not overlap the expanded reservoir area. Even with the additional 252 acres of vegetation removal over the Proposed Action, based on the availability of similar vegetation types in the region, this would be considered a moderate impact. Dow would manage the introduction and spread of non-native invasive plant species throughout construction and operations as described in

Section 2.8 to avoid and minimize these potential impacts and would remediate any temporarily disturbed areas in accordance with the revegetation plan.

4.4.1.4 ALTERNATIVE 2B

The Alternative 2B site is the same as the Project site, consisting primarily of agricultural land covers (i.e., pasture/hay or cultivated crop). Impacts to vegetation would be the same as the Proposed Action, except the reservoir footprint would be 10 acres less. These 10 acres are located along the Brazos River oxbow where vegetation is primarily grasslands/herbaceous, agricultural, and woody wetlands. Dow would still implement the Oyster Creek and Big Slough stream restoration, and those benefits would be realized under Alternative 2B, resulting in an overall moderate impact to vegetation.

4.4.1.5 ALTERNATIVE 3

Land cover in the Alternative 3 site is predominately pasture/hay (53.8%), grassland/herbaceous (21.5%), and woody wetlands (15.0%) (see Table 3.4-1). Impacts to vegetation under Alternative 3 would be similar to the impacts described for the Proposed Action. Within the 2,885-acre site, approximately 29.0% of the site would remain undeveloped; however, indirect impacts could affect the quality of the vegetation communities. The 84-acre staging area, which is pasture/hay and shrub/scrub habitats, would be temporarily disturbed during construction and revegetated during operations. Approximately 66.5% of land would be permanently developed, resulting in long-term moderate impacts to vegetation. Dow would manage the introduction and spread of non-native invasive plant species throughout construction and operations as described in Section 2.8 to avoid and minimize these potential impacts and would remediate any temporarily disturbed areas in accordance with the revegetation plan.

4.4.1.6 ALTERNATIVE 4

Land cover within the 733-acre Alternative 4 site is predominately categorized as woody wetland (53.9%) and evergreen forest (15.8%) and is within an area mapped as Columbia Bottomland Hardwood (see Table 3.4-1 and Figure 3.4-2). Impacts to vegetation under Alternative 4 would differ to the impacts described for the Proposed Action, Alternative 2, and Alternative 3 because this site is predominantly woody wetland and evergreen forest, which is less available in the region and provides valuable ecosystem services to soils, water storage, habitats, and species. Approximately 51% of land would be permanently converted for Project features. These impacts would occur in primarily in undeveloped forested and woody wetland habitat, whereas the Proposed Action would mostly occur in agricultural lands, resulting in long-term moderate impacts. Approximately 14% would be temporarily disturbed during construction and revegetated during operations. Less land is required for this alternative relative to the Proposed Action and therefore less vegetation removal and disturbance overall. Within the 733-acre site, approximately 35% of the site would remain undeveloped, but remaining areas may experience fragmentation that could affect the quality of the vegetation communities over the long term. The pipeline corridors would be revegetated in accordance with the remediation plan and BMPs, and Dow would manage non-native and invasive plant species throughout construction and operations as described in Section 2.8.

4.4.2 Aquatic

4.4.2.1 NO ACTION

Under the No Action alternative, the proposed Project would not be constructed or operated. As a result, no construction activities would occur and there would be no impacts on existing aquatic vegetation/land cover types.

4.4.2.2 PROPOSED ACTION

As described in Section 4.3.4, delineated PEM wetlands in the Project site would be impacted by development of the reservoir. Vegetation in these areas that would be removed includes jungle-rice, sand spike-rush, tall scouring-rush, common rush, golden crown grass (invasive), mild water-pepper, and swamp smartweed. In addition, PSS wetland communities dominated by black willow, poison-bean, Chinese tallow (invasive), and golden crown grass (invasive) would be removed. PFO wetland communities dominated by pecan, sugarberry, green ash, and American elm would be removed for the Proposed Action. Tree density in the Project site's PFO wetlands is 100 to 200 trees per acre; therefore, up to 680 to 1,300 trees would be removed. Removal of aquatic vegetation would be a permanent moderate impact. The Oyster Creek stream restoration would offset some losses of aquatic vegetation. Compensatory wetland mitigation would be required as part of the Corps permit.

The quality of adjacent aquatic vegetation would decrease since surface disturbance could lead to weed and invasive species proliferation. Surface disturbance could lead to erosion and sedimentation into the Brazos River and Oyster Creek, resulting in sediment increases that could kill or reduce vegetation located in and around these waterways. No Columbia Bottomlands are present in the Project site, but downstream, this habitat could be affected. BMPs described in Section 2.8 include erosion control measures, and Dow would manage the introduction and spread of non-native invasive plant species throughout construction and operations as described in Section 2.8.

During drought, water would be released from the reservoir into Oyster Creek. The higher flows in conjunction with the low-sediment reservoir discharge is highly likely to result in downstream erosion (Watearth 2021b). Water releases from the proposed reservoir would not be continual and only occur during drought periods. This would result in wetting and drying cycle that could increase the bed and bank erosion in Oyster Creek when water is released (Watearth 2021b). As discussed in Section 4.3.1.3, water released into Oyster Creek during drought conditions would likely result in a decrease in water temperature and an increase in erosive velocities and scour downstream of the proposed outfall, which would impact aquatic vegetation in Oyster Creek. Bank erosion and scour could impact vegetation along the banks while increased sediment and decreased temperature could cause some aquatic vegetation to die off. The degree to which these potential impacts may occur is not clearly understood at this time and long-term monitoring and adaptive management would be required to determine these effects. These impacts would be minimized and mitigated as part of the mitigation, monitoring, and adaptive management plan described in Section 2.8.

Riparian and aquatic vegetation along and within the nearshore areas of the Brazos River where the proposed intake would be placed would be permanently altered from placement of riprap and other hard structure necessary to prevent scour. These effects would be moderate. The change in water withdrawal from the Brazos River would not be affected; once filled, the proposed reservoir would not be used unless drought conditions occurred (although it may require infrequent minor refilling). The proposed reservoir would not be expected to cause a change to the river hydrology due to the large natural flows through the Project vicinity except possibly at the lowest of river flows during drought (Watearth 2021a). Therefore, the Project would not noticeably impact aquatic vegetation in the Brazos River during normal operations.

Floodplain and stream enhancement projects along Oyster Creek would improve the quality of native vegetation within the site, including wetland and riparian habitats. Additional enhancement projects would occur off-site along Big Slough (see the Conceptual Compensatory Mitigation Plan in Appendix G). The key mitigation components of the enhancement projects include riparian buffer restoration, bank stabilization, reestablishment, and preservation of riparian buffer habitats. Native vegetation plantings would occur within the on-site restoration, enhancement, and reestablishment projects. Invasive plant species would be selectively removed and controlled. With the enhancement projects and wetland mitigation, overall impacts from the Project would result in moderate, long-term impacts to aquatic vegetation.

4.4.2.3 ALTERNATIVE 2A

Impacts to aquatic vegetation under Alternative 2A would be moderate, similar to the Proposed Action; however, the larger reservoir would permanently remove additional vegetation within PEM and PSS wetland habitat.

4.4.2.4 ALTERNATIVE 2B

Impacts to aquatic vegetation under Alternative 2B would be moderate, similar to the Proposed Action. Although the reservoir would be 10 acres smaller than the Proposed Action, it would permanently remove the same amount of PEM and PSS wetland habitat.

4.4.2.5 ALTERNATIVE 3

As described in Section 4.3.4.3, Alternative 3 would impact PEM, PSS, PFO wetland communities, as mapped by NWI. No field surveys have occurred, but the impacts to plant species found in the wetlands are expected to be moderate, similar to those described for the Proposed Action. If this alternative is selected, surveys would be completed to determine required mitigation for impacts to wetland vegetation.

4.4.2.6 ALTERNATIVE 4

As described in Section 4.3.4.4, Alternative 4 would impact PEM, PSS, PFO wetland communities, as mapped by NWI, including Columbia Bottomland Forest. The acreage of Columbia Bottomland forests and other forests that would be permanently lost would make up less than 0.5% of the existing acreage of the Columbia Bottomland forests (Barrow et al. 2005; Rosen et al. 2008). Therefore, the viability of this resources is not expected to be threatened from the impacts of Alternative 4.

No field surveys have occurred, but the plant species found in the wetlands are expected to be similar to those described for the Proposed Action. Since the Alternative 4 site has more wetland habitat than the Proposed Action site, impacts to aquatic vegetation would likely be greater. If this alternative is selected, surveys would be completed to determine required mitigation for impacts to wetland vegetation. Since water would not be released into Oyster Creek, the downstream impacts to aquatic vegetation described for the Proposed Action would not occur. Overall, there would be moderate, long-term impacts to aquatic vegetation.

4.5 Wildlife

4.5.1 Terrestrial

4.5.1.1 NO ACTION

Under the No Action alternative, the Project would not be constructed, and there would be no impacts on general terrestrial wildlife species from the Project. However, existing and reasonably foreseeable trends and actions would continue to affect wildlife in the analysis areas. The analysis areas are predominantly cultivated cropland, and typical agricultural activities would continue under the No Action alternative. These activities currently affect vegetation, water resources, and wetlands, which are components of wildlife habitat.

4.5.1.2 PROPOSED ACTION, ALTERNATIVE 2A, AND ALTERNATIVE 2B

Potential impacts to terrestrial wildlife from construction include the loss, degradation, and fragmentation of breeding, feeding, and sheltering habitats; loss of underground nesting or burrowing animals and their shelter in areas where grading would occur; and increased noise and vibration levels. Additionally, there could be an increased risk to wildlife related to vehicular collisions and there would be an increased potential for invasive species spread.

Approximately 1,950 acres of the Project site (77% of the site) would be cleared of vegetation for installation of the reservoir and associated facilities (i.e., pump station, long-term access road, power line) for the life of the Project. An additional 66 acres (3% of the Project site) would be temporarily disturbed during construction. The Project would mostly remove cultivated crops, pasture/hay, grassland/herbaceous habitats, as well as emergent and woody wetlands that provide habitat for the common mammals, birds, reptiles, and amphibians discussed in Section 3.5. Removal of forested habitats would affect bird and bat nesting and roosting. These habitats would be converted to the open water reservoir with a mowed/maintained grass embankment that would likely be used by common wildlife, particularly amphibians, freshwater aquatic reptiles, small fish, and birds that would be attracted to the reservoir. The remaining areas of vegetation removal would become the gravel perimeter road and pump station, which would not be available for use by wildlife. Permanent conversion of 1,950 acres of existing habitat for the proposed reservoir and associated facilities would be a long-term moderate impact to wildlife that use it. The periphery of the Project site and areas some revegetated areas post-construction may continue to support wildlife. In addition, to offset the impacts to the floodplain and wetlands, the Project includes the enhancement of approximately 227 acres along Oyster Creek and additional 1,1113 acres off-site at Big Slough. Improvements would include native vegetation plantings, bank stabilization, and invasive plant species removal to enhance the riparian buffer. The quality of habitat in these areas would improve and support a variety of general wildlife.

In addition to the temporary and long-term habitat loss or degradation, placement of the proposed reservoir and associated facilities could lead to habitat fragmentation that alters species movement and dispersal or shifts local species population composition. Fragmentation impacts would be greatest for habitat specialists, such as amphibians that rely on specific wetland habitats. Habitat generalists use a range of habitat types and therefore would be less impacted by habitat fragmentation. However, even some generalist species have poor (short distance) dispersal abilities that can make them sensitive or intolerant of any habitat disturbance (Büchi 2016). Because there are available undeveloped lands surrounding the Project site, most species would be able move into adjacent available habitat. Some less-mobile species (e.g., small mammals, amphibians, and reptiles) would not be able to move out of the way of construction equipment resulting in injury or mortality of individuals.

Noise, human activity, and vibration associated with construction activities would also change habitat use patterns for some species. Some individuals would move away from the source of the noise or vibration to adjacent habitats, which could increase competition for resources within adjacent areas with other individuals. Noise and vibration and other disturbances (e.g., introduction of invasive plant species) could also lead to increased stress on individuals.

The perimeter fencing would permanently exclude wildlife species that cannot pass through or under fence openings, such as white-tailed deer (*Odocoileus virginianus*) or other large mammals. Perimeter fencing does not pose as a barrier to the movement and dispersal for small wildlife (e.g., mammals, amphibians, reptiles), and birds would be able to fly though or over and perch on perimeter fencing.

To limit or minimize impacts to wildlife, as well as vegetation, water resources, and wetlands, Dow would implement BMPs and applicant-committed measures summarized in Section 2.8. The key mitigation components of the Oyster Creek enhancement projects include riparian buffer restoration, bank stabilization, re-establishment, and preservation of riparian buffer habitats. The restoration of forested riparian habitats along Oyster Creek would provide increases in function and value to wildlife habitats on-site. Overall, impacts from the Project would result in moderate, long-term impacts to terrestrial wildlife.

4.5.1.3 ALTERNATIVE 3

The type of impacts to terrestrial wildlife from Alternative 3 would be moderate, the same as those described for the Proposed Action. The acres of impact and vegetation types impacted would be slightly different compared to the Proposed Action. Approximately 1,918 acres of the Alternative 3 site (67% of the site) would be cleared of vegetation for installation of the reservoir and associated facilities (i.e., pump station, long-term access road, power line) for the life of the Project. An additional 130 acres (5% of the site) would be temporarily disturbed during construction. The remaining area would be undeveloped. More pasture/hay, grassland/herbaceous, and forested habitats would be cleared compared to the Proposed Action, which would primarily remove cultivated crops.

The Project is not in a floodplain; however, impacts to wetlands and waterbodies would require mitigation similar to the Oyster Creek enhancement, which would improve wildlife habitat after construction.

4.5.1.4 ALTERNATIVE 4

The type of impacts to terrestrial wildlife from Alternative 4 would be similar to those described for the Proposed Action. There would be no open water reservoir or mowed/maintained embankment; however, Alternative 4 would also convert available wildlife habitats, including bird stopover habitat of the Columbia Bottomlands, into the developed desalination plant. Open water would occur in the large pre-sedimentation basin.

The total temporary and permanent acres of impact would be less compared to the Proposed Action. Approximately 377 acres of the Alternative 4 site (51% of the total site) would be cleared of vegetation for installation of the desalination plant for the life of the Project including the access road, substation, and power line. Long-term impacts would also occur along the conveyance pipeline corridor, which would be mowed/maintained; however, this maintained habitat could support some general wildlife, such as small mammals. An additional 103 acres (5% of the site) would be temporarily disturbed during construction. The remaining 14% of the Alternative 4 site would remain undeveloped. More forested and woody wetland habitats would be cleared compared to the Proposed Action site. Therefore, this alternative could have a greater impact on birds and bats that use these habitats compared to the Proposed Action, but overall long-term impacts to these species would be moderate.

4.5.2 Aquatic

4.5.2.1 NO ACTION

Under the No Action alternative, the Project would not be constructed, and there would be no impacts on general aquatic wildlife species from the Project. However, existing and reasonably foreseeable trends and actions would continue to affect wildlife in the analysis areas. Agricultural activities in analysis areas would continue under the No Action alternative, and the existing reservoirs would continue operations. These activities currently affect water resources and habitats used by aquatic wildlife.

4.5.2.2 PROPOSED ACTION, ALTERNATIVE 2A, AND ALTERNATIVE 2B

Potential impacts to aquatic wildlife from construction include the loss, degradation, and fragmentation of breeding, feeding, and sheltering habitats. Invasive plants may be introduced and spread into aquatic habitats that would impact aquatic wildlife by degrading habitat. As a water resources project, aquatic species within the Project site and downstream in the analysis area are likely to be affected by changes in flows in the Brazos River and Oyster Creek, as well as potential erosion and sedimentation.

Aquatic wildlife within the Project site would be impacted due to clearing emergent and woody wetlands for installation of the reservoir and associated facilities, including jurisdictional wetlands (see Section 4.3.4). During construction of the intake and pump station on the Brazos River, there would be temporary impacts to aquatic vegetation from substrate disturbance and sedimentation. These minor effects would be temporary and would dissipate once construction of the features is completed. Aquatic habitat within the Brazos River would be permanently converted by placement of riprap for scour protection.

The open water in the new reservoir would support some aquatic wildlife. Birds, amphibians, freshwater aquatic reptiles, and insects would be attracted to the water source. Some aquatic species may be introduced to the reservoir (e.g., by birds or as larvae), and species that are ubiquitous and tolerant of variety of physiochemical conditions, such as the western mosquitofish, could become established in the new reservoir.

As discussed in Section 4.3.1.3, water released into Oyster Creek during drought conditions would likely result in a decrease in water temperature and an increase in erosive velocities and scour downstream of the proposed outfall, which would impact aquatic species in Oyster Creek. Bank erosion and scour could impact vegetation along the banks while increased sediment and decreased temperature could affect aquatic species. The changes in the creek could affect vegetative growth, and the physical and chemical conditions of the water. Based on the Oyster Creek Aquatic Assessment (SWCA 2021b) which looked at the high flow Scenario 1 (334 cfs) as it had the most potential to affect aquatic species and that velocity was the most notable change of the factors analyzed, velocity, temperature and suspended sediment (see Table 4.3-1). The study looked at representative fish species found in Oyster Creek or similar waterways in the region (brook silverside (*Labidesthes sicculus*), tadpole madtom (*Noturus gyrinus*), white crappie (*Pomoxis annularis*), and largemouth bass (*Micropterus salmoides*). These species are tolerant of or prefer turbid waterbodies with poor dissolved oxygen and often have adaptations that allow them to thrive under these circumstances (SWCA 2021b) and therefore effects to these species would be negligible to minor. Similar results were found when looking at benthic macroinvertebrate community which was represented by caddisflies, mayflies, and the unionid mussels endemic to area streams (SWCA 2021b). However, because the extent of downstream erosion and hydromodification that may occur as a result of drought operations, long-term monitoring and adaptive management would be required to determine the extent of these effects. Therefore, impacts would be minimized and mitigated as part of the mitigation, monitoring, and adaptive management plan described in Section 2.8.

Water withdrawal from the Brazos River would not be anticipated to cause a change to the river hydrology due to the large natural flows through the Project vicinity and the fact that once the reservoir is filled (which would take approximately 3 to 4 months following construction completion), additional withdrawals would occur infrequently if reservoir levels needed to be topped off due to evapotranspiration. Impacts to aquatic wildlife could occur at the Brazos River intake, but it is anticipated that the intake would be properly screened to avoid entrainment of fish or other aquatic species. Overall, the Proposed Action, Alternative 2A, and Alternative 2B would not be anticipated to impact aquatic wildlife in the Brazos River during normal operations.

To offset the impacts to the floodplain and wetlands, the Proposed Action, Alternative 2A, and Alternative 2B include the enhancement of approximately 227 acres in and around Oyster Creek and an additional 1,113 acres off-site at Big Slough. Improvements would include native vegetation plantings, bank stabilization, and invasive plant species removal to enhance the riparian buffer. The quality of habitat in these areas would improve and support a variety of aquatic wildlife. The Oyster Creek stream restoration is also designed to provide additional flood storage capacity. The channel would consist of nearly flat terraces or benches separated by a series of transition slopes to create micro-topographies for enhancing biodiversity. Depressions within each terrace would create wildlife habitat and promote dense vegetation, while also adding scour protection. With BMPs and applicant-committed measures described in Section 2.8, over the long-term, impacts to aquatic wildlife from the Proposed Action and would be moderate.

4.5.2.3 ALTERNATIVE 3

Like the Proposed Action, water would be withdrawn from Brazos River, stored in the reservoir, and released into Oyster Creek during drought. The type of impacts to aquatic wildlife from Alternative 3 would be the same as those described for the Proposed Action and Alternative 2. Water would be routed to the Dow facility through an open channel and released into Oyster Creek downstream of the existing reservoir outfall in a portion of the creek that is already highly modified through Dow's use of it as water conveyance; therefore, it does not provide quality aquatic habitat for wildlife and no effect is anticipated. The Alternative 3 site is not in a floodplain but impacts to wetlands and waterbodies would require mitigation as part of the Corps permit. BMPs, design features, and applicant-committed measures other than the Oyster Creek stream restoration would be the same as those described for the Proposed Action and Alternative 2. This alternative includes additional impacts within the Brazos River for the pipeline bridge. Overall, long-term impacts to aquatic wildlife would be moderate.

4.5.2.4 ALTERNATIVE 4

Most of the Alternative 4 site is located within the 100-year floodplain, but this alternative does not include a reservoir to store water. Like the other action alternatives, Alternative 4 would withdraw water from the Brazos River (23 river miles downstream of the Proposed Action) but does not release the water into Oyster Creek during drought. Water is desalinated and moved through pipelines to Dow's Texas Operations. Some impacts to aquatic wildlife could occur at the Brazos River intake, but there would be no downstream impacts to aquatic wildlife in Oyster Creek. Impacts to wetlands and waterbodies would require mitigation as part of the Corps permit. Overall, long-term impacts to aquatic wildlife would be moderate. High TDS concentrations in sludge ponds necessary for the brackish water desalination facility could be harmful to wildlife. These ponds would have the potential to attract wildlife seeking water, and the high mineral content in the brine could pose health risks to wildlife, potentially resulting in mortality or reduced reproductive success (FERC 2012). BMPs would be implemented to reduce the potential effects, which would be long-term and minor.

4.5.3 Migratory Birds

4.5.3.1 NO ACTION

Under the No Action alternative, the reservoir would not be constructed, and there would be no impacts on migratory birds from the Project. Existing and reasonably foreseeable trends and actions would continue to affect migratory birds in the analysis areas. Migratory birds would continue to use agricultural lands in the Project site, as well as available habitats, existing reservoirs, and other water resources within the analysis area.

4.5.3.2 PROPOSED ACTION, ALTERNATIVE 2A, AND ALTERNATIVE 2B

Similar to impacts described above for general wildlife, potential impacts to migratory birds from construction include the loss, degradation, and fragmentation of breeding, feeding, and sheltering habitats; collisions with construction vehicles or equipment; increased invasive species establishment and spread; and increased noise and vibration levels. Structures such as the existing power line would be removed but replaced with new structures. Existing habitats used by migratory birds would be converted to the open water reservoir with a mowed/maintained grass embankment. Some bird species (e.g., waterfowl, shorebirds, wading birds) may use the reservoir for feeding and resting, but nesting and sheltering opportunities for most birds would be permanently removed from this area. The proposed Oyster Creek stream restoration riparian and aquatic habitat areas would improve habitat for migratory birds using this corridor.

Noise, human activity, and vibration associated with construction activities would also change habitat use patterns for migratory birds. Most individuals would move away from the source of the noise or vibration to adjacent habitats, which could increase competition for resources within adjacent areas. During nesting season, disturbance from construction activities could cause nesting birds to abandon their nest.

To avoid and minimize potential impacts to migratory birds within the analysis area, Dow would implement BMPs and design features as described in Section 2.8. This includes pre-construction nest surveys and avoidance of active nests during the nesting season. With BMPs and applicant-committed measures, constriction-related impacts from the Proposed Action Alternative 2A, and Alternative 2B would result in temporary moderate impacts to migratory birds. Removal of trees for placement of the reservoir and associated facilities would result in a permanent impact to nesting and foraging birds. Implementation of the Oyster Creek stream restoration would include planting of riparian trees and shrubs, which may offset these impacts at least partially over the long term once these trees have matured. However, loss of mature, tall nesting trees would be an unavoidable impact and would result in moderate impacts to migratory birds.

4.5.3.3 ALTERNATIVE 3

Impacts to migratory birds under Alternative 3 would be moderate, similar to those described under the Proposed Action. The Alternative 3 site contains a similar combination of pasture/hay, grassland/herbaceous, and forested habitats, but it has less cultivated crop area in comparison to the Proposed Action Project site. However, this would not substantively change the overall long-term effects and moderate impacts to migratory birds described above. BMPs and applicant-committed measures as described in Section 2.8 would avoid and minimize potential effects to migratory birds.

4.5.3.4 ALTERNATIVE 4

The type of impacts to migratory birds under Alternative 4 would be similar to those described for the Proposed Action, although the total acreage of disturbed area for the desalination plant and associated facilities for both temporary and permanent would be less. However, the Alternative 4 site is predominately categorized as woody wetland and evergreen forest and is also within an area mapped as Columbia Bottomland Hardwood. This alternative would likely require removal of a large number of mature trees that could be used by nesting and foraging migratory birds. Additionally, the open water created by the large sludge ponds could pose an attractive nuisance to waterfowls and other shorebirds. High TDS concentrations in these sludge ponds could be harmful to birds and other wildlife. These ponds would have the potential to attract birds seeking water, and the high mineral content in the brine could pose health risks to birds, potentially resulting in mortality or reduced reproductive success (FERC 2012). BMPs would be implemented to reduce the potential effects, which would be long-term and minor.

Alternative 4 could result in greater impacts over the long term to migratory birds compared to the Proposed Action due to the large number of mature trees that would likely be removed. Alternative 4 would implement the same BMPs and applicant-committed measures as the other action alternatives, which would assist in avoiding and minimizing the potential moderate impacts to migratory birds.

4.5.4 Commercial Game Animals

4.5.4.1 NO ACTION

Under the No Action alternative, the Project would not be constructed, and there would be no impacts on commercial game animals. The Project site would continue to support game species such as feral hog, eastern cottontail, and white-tailed deer; however, the site would continue to be closed to hunting. Fishing and hunting opportunities would continue within the surrounding analysis area.

4.5.4.2 PROPOSED ACTION, ALTERNATIVE 2A, AND ALTERNATIVE 2B

The Project site would not be open to public hunting or fishing. Public hunting grounds in the analysis area would not be affected by the Proposed Action, Alternative 2A, or Alternative 2B. Populations of commercial game species such as those documented within the Project site (i.e., American alligator, feral hog, eastern cottontail, squirrels, white-tailed deer, and mourning dove) would not be impacted. However, individuals within the Project site would be impacted by loss, degradation, and fragmentation of breeding, feeding, and sheltering habitats and loss of nesting or burrowing habitats in areas where grading would occur. Additionally, there could be an increased risk to game animals related to vehicular collisions, and there would be an increased potential for invasive species spread. During construction, there would be increased noise and vibration levels that would disturb game animals in the vicinity of the Project site and cause them to avoid the area. The Project site would be fenced, which would help prevent feral hogs and deer from accessing the Project site both during construction and post-construction. Implementation of BMPs in Section 2.8 and the Oyster Creek restoration would help avoid and minimize most of these potential impacts. Similar suitable game animal habitat is abundant in the vicinity of the Project site. Overall, the effects to these species would be moderate.

4.5.4.3 ALTERNATIVE 3 AND ALTERNATIVE 4

Due to similarities in the site location and Project design, the impacts to commercial game animals for Alternative 3 and Alternative 4 would be the same as those described for the Proposed Action. The Alternative 4 site contains more suitable forested and woody wetland habitats, which may provide higher quality game animal habitat, but total acreage of habitat removed for Alternative 4 is less than the area proposed for removals under the Proposed Action. Overall, the effects to these species would be moderate.

4.5.5 Invasive Wildlife

4.5.5.1 NO ACTION

Under the No Action alternative, the Project would not be constructed. Invasive wildlife would continue to occur within the Project site and analysis area.

4.5.5.2 PROPOSED ACTION, ALTERNATIVE 2A, ALTERNATIVE 2B, ALTERNATIVE 3, AND ALTERNATIVE 4

Increased disturbance from the Proposed Action and all action alternatives could result in an increase in invasive wildlife and in turn the loss or reduction of biodiversity. Larger mammals such as feral hog would be excluded due to fencing. Birds such as house sparrow and European starling would continue to use the sites. Invasive fish and mollusks are unlikely to pass through the pump station intake. BMPs and applicant-committed measures described in Section 2.8 would avoid and minimize these impacts, which would be minor.

4.6 Threatened and Endangered Species

4.6.1 No Action

Under the No Action alternative, the proposed Project would not be constructed or operated. As a result, no construction or operational activities would occur and there would be no impacts on existing threatened and endangered species from the Project. However, existing and reasonably foreseeable trends and actions such as development, loss or degradation of habitats, climate change, etc. would continue to affect threatened and endangered species habitat in the analysis areas. Agricultural activities in analysis areas would continue under the No Action alternative, and the existing reservoirs would continue operations.

4.6.2 Proposed Action, Alternative 2A, and Alternative 2B

Overall potential impacts to threatened and endangered species from construction would be similar to those described for terrestrial and aquatic wildlife and migratory birds and would include injury or mortality; the loss, degradation, and fragmentation of breeding, feeding, and sheltering habitats; and effects from increased noise, light, vibration levels, and traffic as a result of human presence and activities. These impacts are discussed in Sections 4.5.1, 4.5.2, and 4.5.3. Specific effects to listed species with potential to occur within the Project site or the analysis area beyond those described above are discussed below.

4.6.2.1 BLACK RAIL

Impacts to the black rail from the Proposed Action, Alternative 2A, and Alternative 2B include the permanent removal or modification of saltmarsh habitat with appropriate wetlands, saline soils, and vegetation (*Spartina* and *Scirpus* species).

The black rail could use appropriate marsh habitats within the Project site or analysis area including the airspace above during migration or for overwintering. For the Proposed Action, Alternative 2A, and Alternative 2B, 23 wetlands totaling 21.38 acres would be permanently lost and/or filled within the Project site. However, due to lack of saline soils and lack of *Spartina* and *Scirpus* species that are associated with occurrences of black rails in wetland habitat, it is unlikely that these birds would use the wetlands present within the Project site. Additionally, there is available suitable habitat at Brazoria National Wildlife Refuge and San Bernard National Wildlife Refuge (with documented occurrences of black rail [iNaturalist 2021e]) that are likely more attractive to black rails in the vicinity of the Project site and analysis area. Black rail are anticipated to avoid the area during construction activities, which would prevent potential construction effects. Implementation of BMPs described in Section 2.8 would avoid and minimize effects to black rail.

Although black rails may occur on the Project site or in the vicinity, it is unlikely they would be adversely impacted by construction and operations activities. There is more suitable habitat available in the analysis area and the Proposed Action, Alternative 2A, or Alternative 2B would have no effect on the black rail.

4.6.2.2 WHOOPING CRANE

Impacts to the whooping crane from the Project include the permanent removal or modification of wetland and cropland habitats that may be used by whooping crane. The whooping crane could stopover within the Project site or analysis area near wetlands, in flooded cropland, or in dry cropland near wetlands and waterbodies during construction. Approximately 131.3 acres of suitable wetland and waterbodies, as well as 1,490.2 acres of cropland that could be used by whooping cranes during migration would be removed and converted to open water or other Project features.

Although this species may occur within the Project site, there are more suitable areas for stopover near this area (i.e., Brazoria National Wildlife Refuge and San Bernard National Wildlife Refuge), and no whooping cranes have been observed within the Project site (eBird 2021; iNaturalist 2021f). Based on the availability of nearby suitable habitat, and with implementation of BMPs described in Section 2.8, the Proposed Action, Alternative 2A, or Alternative 2B may affect, but are not likely adversely affect, the whooping crane.

4.6.2.3 TEXAS FAWNSFOOT

No Texas fawnsfoot have been reported from the Project site or analysis area (HDR 2012; iNaturalist 2021g; Randklev et al. 2017; TXNDD 2018) and the habitat present on the Project site has been determined to be unsuitable primarily due to lack of appropriate substrate (HDR 2012). The nearest potential occurrence is over 11 miles away on the Brazos River (HDR 2012). Potential impacts to the Texas fawnsfoot from the Proposed Action, Alternative 2A, and Alternative 2B include changes in water quality (e.g., sedimentation, turbidity, temperature, dissolved oxygen, suspended solids) or the possible introduction of contaminants from hazardous spills from construction equipment and machinery. These activities could result in habitat effects and may impact Texas fawnsfoot individuals if present.

For the Proposed Action, Alternative 2A, and Alternative 2B, placement of the intake along the banks of the Brazos River could result in temporary water quality effects described previously. There would be temporary effects to potential habitat on Oyster Creek in the stream restoration area during construction, as well as short-term effects post-construction while riparian vegetation and other enhancements stabilize and become self-sustaining. Creation of a higher functioning stable stream system with an established riparian corridor would be beneficial to potential Texas fawnsfoot habitat in the long term. BMPs as described in Section 2.8 would be implemented during construction to avoid and minimize water quality impacts to any potential Texas fawnsfoot in the Project site or analysis area.

Although water quality improvements may occur after construction of the stream restoration on Oyster Creek upstream of the proposed reservoir, there could be effects to Oyster Creek downstream of the proposed reservoir outfall. As discussed in Section 4.3., Oyster Creek may experience sedimentation, increases in velocity, temperature changes, etc., downstream of the reservoir during drought condition operations. While the completed modeling does characterize the key factors that would cause hydromodification at different discharge rates, their limitations in predicting hydromodification impacts emphasize the need for a monitoring and adaptive management plan. See Section 2.8 for further discussion of the proposed monitoring and mitigation associated with the adaptive management approach for Oyster Creek. Overall, because of the limited availability of suitable habitat on the Project site, the Project may affect, but would not likely adversely affect, Texas fawnsfoot.

4.6.2.4 MONARCH BUTTERFLY

The monarch butterfly is not federally listed but is a candidate for federal listing and is currently assigned for a Proposed Listing/ Proposed Critical Habitat determination in fiscal year 2024 (USFWS 2021c).

Impacts to monarch butterflies from the Proposed Action, Alternative 2A, or Alternative 2B include the permanent removal or modification of vegetation, which may remove milkweeds and other flowering nectar that the monarch butterfly relies on.

The monarch butterfly could use grassland/herbaceous land cover types within the Project site and analysis area during spring and fall migration and for breeding in the spring. Under the Proposed Action Alternative 2A, and Alternative 2B, approximately 339.9 acres of grassland/herbaceous land cover would be removed and converted to open water. No monarch butterflies have been documented within the Project site and adjacent available suitable habitat is present nearby at the Nash Prairie Preserve, which is known to contain milkweed and flowering nectar plants and has several documented occurrences of monarch butterflies. Monarch butterflies would likely avoid the Project site during construction due to noise and other construction activities. BMPs described in Section 2.8 would be implemented. Because of the low likelihood of monarch butterfly presence on the Project site and because more suitable habitat is present in the area, the Project may affect, but would not likely adversely affect, monarch butterflies.

4.6.3 Alternative 3

4.6.3.1 BLACK RAIL

Based on a desktop review, the Alternative 3 site contains 25 NWI wetlands totaling approximately 15.12 acres (see Section 4.3.4). No black rails have been documented within the Alternative 3 site (eBird 2021; iNaturalist 2021e) and similar to the Proposed Project, available nearby suitable habitat exists to the west and east of this alternative at San Bernard and Brazoria National Wildlife Refuges. Based on the availability of nearby suitable habitat and the low likelihood of black rail to be present on the Alternative 3 site, Alternative 3 would have no effect on the black rail.

4.6.3.2 WHOOPING CRANE

Impacts to whooping crane under Alternative 3 would be similar to those described under the Proposed Action, but far less suitable habitat is present. Approximately 15.12 acres of suitable wetland and waterbodies and 73.1 acres of cropland present in the Alternative 3 site that could be used by whooping cranes during migration would be removed. Given the low likelihood of occurrence and the limited amount of suitable habitat, Alternative 3 may affect, but would not likely adversely affect, whooping crane.

4.6.3.3 TEXAS FAWNSFOOT

No freshwater mussel surveys were performed within the Alternative 3 site. Alternative 3 proposes to discharge water from an open canal below the existing Harris Reservoir and discharge water into the portion of Oyster Creek that is currently used for conveyance by Dow, so no new impacts would be anticipated. However, Alternative 3 includes placement of an intake along the Brazos River and may affect, but would not likely adversely affect, Texas fawnsfoot.

4.6.3.4 MONARCH BUTTERFLY

Although no monarch butterflies have been documented within the Alternative 3 site, approximately 620.3 acres of grassland/herbaceous land cover that may contain suitable habitat and could be used by monarch butterflies during migration and spring breeding would be removed. Like the Proposed Action, suitable habitat for the monarch butterfly is available within the adjacent Nash Prairie Preserve and to the north at Brazos Bend State Park. If a monarch were to migrate through this area, it is likely that habitat present at the Nash Prairie Preserve and Brazos Bend State Park would attract individual butterflies. Therefore, Alternative 3 may affect, but would not likely adversely affect, monarch butterfly.

4.6.4 Alternative 4

4.6.4.1 BLACK RAIL

No observations of black rails have been documented within or nearby the Alternative 4 site. Based on a desktop review, the Alternative 4 site contains 19 NWI wetlands, totaling approximately 22.61 acres (see Section 4.3.4). Vegetation present at the Alternative 4 site differs from the other three action alternatives in that it contains more wooded habitat, which is less suitable for black rails. Alternative 4 would have no effect on the black rail.

4.6.4.2 WHOOPING CRANE

Impacts to whooping crane under Alternative 4 would be similar to those described under the Proposed Action, but far less suitable habitat is present. Approximately 22.61 acres of suitable wetland and waterbodies and 5.9 acres of cropland present in the Alternative 4 site that could be used by whooping cranes during migration would be removed. Given the low likelihood of occurrence and the limited amount of suitable habitat, Alternative 4 may affect, but would not likely adversely affect, whooping crane.

4.6.4.3 TEXAS FAWNSFOOT

No freshwater mussel surveys were performed in the Alternative 4 sites. Alternative 4 would have no effect on Oyster Creek as the creek is outside the Project envelope. Placement of an intake along the Brazos River and would have the same potential for impacts to Texas fawnsfoot as described under the Proposed Action. Alternative 4 may affect, but would not likely adversely affect, Texas fawnsfoot.

4.6.4.4 MONARCH BUTTERFLY

The Alternative 4 site contains more wooded areas and less grassland/herbaceous habitat when compared to the other three action alternatives. Although the types of potential negligible to minor impacts to monarch butterflies would be the same as the other three action alternatives, these impacts are less likely to occur under Alternative 4. Alternative 4 may affect, but would not likely adversely affect, monarch butterfly.

4.7 State-Listed Wildlife

4.7.1 No Action

Under the No Action alternative, the proposed Project would not be constructed or operated and there would be no impacts to state-listed wildlife species from the Project. However, existing and reasonably foreseeable trends and actions would continue to affect state-listed wildlife species habitat in the analysis areas. Agricultural activities in the analysis areas would continue under the No Action alternative, and the existing reservoirs would continue operations.

4.7.2 Proposed Action, Alternative 2A, and Alternative 2B

Potential impacts to state-listed wildlife species from construction are similar to those for terrestrial and aquatic wildlife and migratory birds (Sections 4.5.1, 4.5.2, and 4.5.3) and include direct injury or mortality; the loss, degradation, and fragmentation of breeding, feeding, and sheltering habitats; and indirect consequences such as increased noise, light, vibration levels, and traffic as a result of human presence and activities. State-listed wildlife species with potential to occur in the Project site and analysis area are described in Table 3.8-1. Most state-listed species discussed have a low potential of occurring on the Project site and in the analysis area. Bald eagle, wood stork, and white-faced ibis have a moderate potential of occurring on the Project site. Whooping crane is also listed under the ESA and discussed in Section 4.6.

Approximately 1,950.1 acres of the Project site (77%) would be cleared of vegetation and converted to open water or permanently developed as part of the Project; in addition to long-term impacts to habitat, an additional 70.1 acres (3%) of the Project site would be impacted during construction and experience habitat modification (see Section 4.4). This includes habitats suitable for state-listed wildlife species including forested habitats used by roosting or overhead foraging raptors (e.g., bald eagle, swallow-tailed kite) and the timber rattlesnake; wetland habitats used for migration stopovers and foraging (e.g., white-faced ibis, wood stork) and for potential residence by the alligator snapping turtle; and croplands that are also used for migration stopovers and foraging (e.g., white-tailed hawk, whooping crane). However, available suitable habitat is present near the Project site at Brazoria and San Bernard National Wildlife Refuges and Justin Hurst Wildlife Management Area to the south; Nash Prairie Preserve, Eagle Nest Lake, Manor Lake, and Mann Lake to the west; and Brazos Bend State Park to the north, as well as privately held agricultural and woodland and wetland areas. The conversion of terrestrial habitat to open water may provide additional roosting and/or foraging habitat for some species (e.g., bald eagle, wood stork, white-faced ibis). The Proposed Action, Alternative 2A, and Alternative 2B include enhancement of approximately 227 acres of habitat along Oyster Creek as part of the stream restoration that would offset impacts to floodplains and wetlands and could function as improved wildlife habitat for state-listed wildlife species that use wetlands and water features.

It is anticipated that if any adult terrestrial state-listed species were present within the Project site during the construction period, they would move away from the source of disturbance to avoid direct impacts and would limit exposure to indirect impacts as a result of human presence (e.g., noise, vibration).

State-listed aquatic species that may be present on the Project site, the Brazos River and Oyster Creek, and the larger analysis area have potential for impacts similar to those described in Section 4.5.2. Aquatic wildlife within the Project site would be impacted due to clearing emergent and woody wetlands for installation of the reservoir and associated facilities, including jurisdictional wetlands (see Section 4.3.4). Aquatic habitat within the Brazos River would be temporarily impacted during construction of the intake and pump station. Aquatic habitats along Oyster Creek would be temporarily impacted during construction of the reservoir outlet. The open water in the new reservoir would support some aquatic wildlife. Birds, amphibians, freshwater aquatic reptiles, and insects would be attracted to the water source. Some aquatic species may be introduced to the reservoir (e.g., by birds or as larvae), and species that are ubiquitous and tolerant of a variety of physiochemical conditions, such as the western mosquitofish, could become established in the new reservoir.

During drought, water would be released from the reservoir into Oyster Creek. The higher flows in conjunction with the low-sediment reservoir discharge is highly likely to result in downstream erosion (Watearth 2021b).

As discussed in Section 4.3.1.3, water released into Oyster Creek during drought conditions would likely result in a decrease in water temperature and an increase in erosive velocities and scour downstream of the proposed outfall, which would impact aquatic species in Oyster Creek. Bank erosion and scour could impact vegetation along the banks while increased sediment and decreased temperature could affect aquatic species. The changes in the creek could affect vegetative growth, and the physical and chemical conditions of the water. As described in Section 4.5.2, the Oyster Creek Aquatic Assessment (SWCA 2021b) looked at the high flow Scenario 1 (334 cfs) because it had the most potential to affect aquatic species and that velocity was the most notable change of the factors analyzed, velocity, temperature and suspended sediment (see Table 4.3-1). The study looked at representative fish species found in Oyster Creek or similar waterways in the region, as well as the benthic macroinvertebrate community, which is represented by caddisflies, mayflies, and the unionid mussels endemic to area streams and was found to be tolerant of the analyzed factors in stream conditions (SWCA 2021b). Because the extent of downstream erosion and hydromodification that may occur as a result of drought operation is not entirely understood, long-term monitoring and adaptive management would be required to determine the extent of these effects. Therefore, long-term impacts would be minimized and mitigated as part of the mitigation, monitoring, and adaptive management plan described in Section 2.8.

Water withdrawal from the Brazos River would not be anticipated to cause a change to the river hydrology due to the large natural flows through the Project vicinity and the fact that once the reservoir is filled (which would take approximately 3 to 4 months following construction completion), additional withdrawals would occur infrequently if reservoir levels needed to be topped off due to evapotranspiration. Impacts to aquatic wildlife could occur at the Brazos River intake, but it is anticipated that the intake would be properly screened to avoid entrainment of fish or other aquatic species. Overall, the Proposed Action, Alternative 2A, and Alternative 2B would not be anticipated to impact aquatic wildlife in the Brazos River during normal operations.

To offset the impacts to the floodplain and wetlands, the Proposed Action, Alternative 2A, and Alternative 2B include the enhancement of approximately 227 acres in and around Oyster Creek. Improvements would include native vegetation plantings, bank stabilization, and invasive plant species removal to enhance the riparian buffer. The quality of habitat in this area would improve and support a variety of aquatic wildlife. The Oyster Creek stream restoration is also designed to provide additional flood storage capacity. The channel would consist of nearly flat terraces or benches separated by a series of transition slopes to create micro-topographies for enhancing biodiversity. Depressions within each terrace would create wildlife habitat and promote dense vegetation while adding scour protection. With BMPs and the applicant-committed measures described in Section 2.8, over the long term, impacts to state-listed aquatic species from the Proposed Action, Alternative 2A, and Alternative 2B would be negligible to moderate.

4.7.3 Alternative 3

Impacts to state-listed wildlife would be similar as those for the Proposed Action. However, the location and magnitude of these impacts would differ slightly. For Alternative 3, approximately 1,918 acres (67% of the site) would be permanently cleared of vegetation for installation of the reservoir and associated facilities. An additional 130 acres (5% of the site) would be temporarily modified. The remaining Alternative 3 site area (18%) would be undeveloped. No restoration of Oyster Creek would occur because impacts are outside the floodplain. Other BMPs and applicant-committed measures would be the same as those described for the Proposed Action. Overall, impacts to state-listed species would be negligible to moderate.

4.7.4 Alternative 4

Impacts to state-listed wildlife would be similar as those for the Proposed Action. However, the location and magnitude of these impacts would differ. There would be no open water reservoir; instead, Alternative 4 would include the installation of a desalination plant and conveyance pipeline. Alternative 4 would likely remove portions of the Columbia Bottomlands, a popular bird stopover site (e.g., swallow tailed kite and wood stork) and habitat for other terrestrial wildlife species including bats, for development of the desalination plant.

The total magnitude of temporary and permanent acres of impact would be less compared to the Proposed Action. However, of those acres of impact, more forested and woody wetland habitats would be cleared compared to the Project site for the Proposed Action. Approximately 377 acres of the Alternative 4 site (51%) would be permanently cleared of vegetation for installation of the desalination plant. Long-term impacts would also occur along the conveyance pipeline corridor, which would be mowed/maintained. An additional 103 acres (5%) would be temporarily disturbed during construction. The remaining 14% of the Alternative 4 site would remain undeveloped. Overall, impacts to state-listed species from Alternative 4 would be negligible to moderate.

4.8 Essential Fish Habitat

4.8.1 No Action

Under the No Action alternative, the proposed Project would not be constructed or operated. As a result, there would be no impacts on either EFH or on the fishery resources managed by the Gulf of Mexico FMC.

4.8.2 Proposed Action, Alternative 2A, Alternative 2B, and Alternative 3

The Proposed Action, Alternative 2A, Alternative 2B, and Alternative 3 are not located in or near any areas designated as EFH (see Figure 3.7-1). The hydrologic and hydraulic modeling (Watearth 2021a and 2021b) show that impacts to surface waters of the Brazos River and Oyster Creek would attenuate upstream and outside any areas designated areas of EFH. Therefore, no impacts are expected from proposed activities associated with the Proposed Action, Alternative 2, or Alternative 3.

4.8.3 Alternative 4

The Alternative 4 site is not located in an area designated as EFH, but the proposed intake facility along the Brazos River is located 7.3 linear miles and 11.8 river miles north of designated EFH for red drum, reef fishes, coastal migratory pelagic fishes, shrimp species, blacktip shark, and finetooth shark (see Figure 3.7-2). Although unlikely, larval or juveniles of these species could move upstream toward the proposed intake facility and potentially become entrapped or entrained (movement through surface diversion via screens) at surface intakes from water diversions (NMFS and FHWA 2018), which could cause injury or death to individuals. Dow would avoid and minimize these potential impacts with implementation of BMPs for water diversions developed by NMFS and FHWA (2018) and TPWD and the Texas General Land Office (2018). Dow would also implement BMPs that would reduce sedimentation and erosion during construction activities. These BMPs are described in Section 2.8. Given the location of the Alternative 4 site relative to EFH and the implementation of BMPs, Alternative 4 would result in negligible impacts to EFH or to individual species managed under EFH by the Gulf of Mexico FMC.

4.9 Land Use

4.9.1 No Action

Under the No Action alternative, the proposed Project would not be constructed or operated. Land use would likely remain as agricultural.

4.9.2 Proposed Action, Alternative 2A, and Alternative 2B

The Project site for the Proposed Action, Alternative 2A, and Alternative 2B is owned by Dow and would be converted from farmland to a reservoir. The 522.6 acres of pasture/hay and 1,490.2 acres of cultivated crops and all farm amenities would be removed and replaced with the reservoir and associated infrastructure. The land within the Project site would no longer be used for crops, hay, or pasture. The farm would no longer be operational or leased to the TDCJ. Impacts to agriculture are unavoidable and overall would be moderate due to the extent of similar agricultural areas (e.g., crops, grazing land) available within Brazoria County.

The ConocoPhillips pipeline and right-of-way would be relocated around the reservoir but would remain in service, so no effects are anticipated. All oil and gas wells on the site have already been plugged and abandoned. The existing CenterPoint Energy power line would be relocated to the eastern perimeter of the Project site and would remain in service, providing power to the reservoir. An electrical power line would be constructed to convey power from this power line to the pump station. Impacts to these land uses would be minor.

4.9.3 Alternative 3

Dow does not currently own the Alternative 3 site. Similar to the Proposed Action, land currently used for pasture/hay (1,552.5 acres) and cultivated crops (73.1 acres) would be converted from farmland to a reservoir. A group of farm buildings is in the center of the Alternative 3 site and five residential properties with homes and outbuildings along CR 25 would be removed to develop the site. Impacts to agriculture are unavoidable and overall would be moderate within Brazoria County.

The oil and gas wells on the site are dry holes that would need to be plugged and abandoned. The three pipelines would remain in service but would be relocated in a 100-foot-wide easement along the toe of the perimeter access road at the west and north sides of the reservoir. Impacts to these land uses would be minor.

4.9.4 Alternative 4

Dow does not currently own the Alternative 4 site but owns the Brazoria Reservoir land to the north of the proposed desalination plant and Dow’s Texas Operations at the east end of the proposed corridor. Land at the western portion of the site is undeveloped with 37.6 acres used for pasture/hay that would be permanently converted for the treatment plant and basins and the power line and substation. The three existing oil and gas pipeline ROWs that traverse the west side of the Alternative 4 site would be relocated around the desalination plant, and the one drilled well that is dry would need to be plugged and abandoned.

The proposed pipeline corridor from the desalination plant to Dow’s Texas Operations would be approximately 8.8 miles long and would be located within a 100-foot-wide corridor (totaling 107 acres) that would be temporarily disturbed during construction. The pipeline corridor would not change land use in the developed residential and industrial areas in Lake Jackson. The two existing oil and gas pipeline ROWs that cross the proposed corridor would not be affected. The pipelines would run under roads (FM 20004, Lake Road, and Oak Drive South), but construction activity may result in temporary minor impacts to the use of roads. The adjacent land uses including a golf course, residential neighborhoods, a canal, office buildings, and Dow’s Texas Operations, would not be impacted by Alternative 4.

There would be fewer impacts to agricultural lands compared to the Proposed Action. Approximately 43.5 acres of agricultural lands on the Alternative 4 site would be permanently removed and converted to the desalination plant. These lands on the west end of the site would no longer be available to produce hay or be used as a pasture. Impacts to agriculture are unavoidable and overall would be minor within Brazoria County.

4.10 Socioeconomic Resources

The following section details anticipated impacts to socioeconomic resources associated with the construction, operation, and maintenance of the Project. Impacts are discussed in terms of potential disturbance economic activity, salaries and wages, employment, and social landscape, availability of housing and public services, and community cohesion, within analysis areas determined by Census tracts and within the greater Brazoria County area. Impacts are categorized in terms of severity, duration, size, and likelihood.

4.10.1 Population and Housing

4.10.1.1 NO ACTION

Under the No Action alternative, the proposed Project would not be constructed or operated. There would be no Project to bring in the additional workforce for the 2.5 years of construction that would fill rental vacancies, hotel rooms, and support local businesses. The population and housing within the analysis area would be unaffected.

4.10.1.2 PROPOSED ACTION, ALTERNATIVE 2A, ALTERNATIVE 2B, AND ALTERNATIVE 3

During a large construction project such as the Proposed Action, there can be an influx of a new population and workforce. When demand for housing increases, especially beyond current availability, affordability of homes, especially temporary (rental) homes can increase to a level that can make accommodations within the area out of reach for some lower-income families. This, in turn, can result in an increased pressure on local housing authorities, as well as an increase in the levels of homelessness, crime, and drug use.

Project construction would continue for approximately 2.5 years. The additional population could apply pressure to available local public resources, including available sources of housing and temporary accommodations. Construction of the Project would require engineering, construction management, and construction personnel. The construction labor force is estimated to average approximately 80 to 90 persons over the construction period, and peak staffing could be close to 130 persons.

There is an available local construction workforce in Brazoria County. Most workers are likely to commute from nearby Angleton, Brazoria, Lake Jackson, and southern Houston. Other workers coming from longer distances may require temporary housing such as long-term rental units and hotels. As discussed in Chapter 3, the primary analysis area surrounding the Project site and Alternative 3 site is rural with scattered housing units. There is a vacancy rate of 2% to 7% for renter-occupied housing units in the analysis area (see Table 3.10-2). The workforce could fill these units during the construction period, which could benefit local landlords. Hotels are available in nearby Angleton if the workforce population requires short-term stays. Other local businesses could experience moderate benefits due to the influx of the workforce population. Since the requirement for temporary housing is expected to be minimal, housing prices and community cohesion of the existing population would not be expected to be affected.

Once construction of the Project is complete, the Project workforce would be minimal for the operational phase, with an anticipated 20 workers or less maintaining the new reservoir. As such, no noticeable impacts to population or housing would be anticipated for the Project during the operational phase. Overall, the proposed Project is anticipated to have a minor temporary impact to population and housing during both construction and operational phases.

The addition of the reservoir within the floodplain (Proposed Action, Alternative 2A, and Alternative 2B) could increase potential for flooding of properties downstream, which may affect populations and housing in existing flood-prone portions of the analysis area. Flooding can cause property damage resulting in increased insurance claims that could raise insurance rates. As discussed in 3.3.2.1, Brazoria County is required to manage the county's floodplain to minimize potential impacts to other properties through floodplain development regulations. The Brazoria County Floodplain Administrator is appointed to administer and implement the provisions of the Development Regulations of Brazoria County, Texas for Floodplain Management as Adopted September 24, 2007, and revised November 24, 2020, and other appropriate sections of 44 CFR (National Flood Insurance Program Regulations) pertaining to floodplain management.

The floodplain administrator must also assure all necessary permits have been obtained from those Federal, State or local governmental agencies, including the DA permit and TCEQ dam and reservoir permits. The Corps evaluation is being conducted in accordance with the requirements of Executive Order 11988–Floodplain Management as part of the public interest review. The Brazoria County Floodplain administrator will make the final determination of compliance pertaining to floodplain management.

4.10.1.3 ALTERNATIVE 4

The impacts to population and housing from Alternative 4 would be similar to the Proposed Action. The analysis area includes portions of the city of Lake Jackson and its surrounding communities, including Brazoria. There is a larger population and the vacancy rate for rental units is higher within the Alternative 4 analysis area compared to the Proposed Action (see Table 3.10-2). Several hotels are available along SH 288 if required by the workforce. The influx of the workforce population is not likely to be noticeable to the existing population but would have a minor temporary benefit for local landlords, hotels, and other local businesses.

Alternative 4 is located entirely within the 100-year floodplain and would have similar effects as those described under the Proposed Action.

4.10.2 Community Facilities and Services

4.10.2.1 NO ACTION

Under the No Action alternative, the proposed Project would not be constructed or operated and population and workforce within the analysis area would be unaffected. There would be no additional strain on community facilities or services due to the Project or workforce.

4.10.2.2 PROPOSED ACTION, ALTERNATIVE 2A, ALTERNATIVE 2B, ALTERNATIVE 3, AND ALTERNATIVE 4

The construction labor force is estimated to average approximately 80 to 90 persons over the construction period and peak staffing could be close to 130 persons. Under all action alternatives, the majority of construction phase workforce would be both temporary and local, and it is anticipated that very few workers would relocate to the analysis area. As such, the migration of such a small number of temporary workers to the local area would have a negligible impact to public services during the Project construction phase.

Under all action alternatives, operation of the proposed facilities would not increase the workforce substantively, with an anticipated 20 workers or less working to maintain a new reservoir or desalination plant. As such, no noticeable impact to public services is anticipated during the operational phase. On a rare occasion, emergency public safety services may be needed at the new facility. Emergency services for the new reservoir are discussed in Section 4.15.1.

In addition, the proposed Project would not require the relocation of population or demolition of any community resources within the footprint of the Project or elsewhere in the analysis area. As such, the proposed Project is anticipated to have no impact to community cohesion in either the construction or operational phases.

4.10.3 Industry and Employment

4.10.3.1 NO ACTION

Under the No Action alternative, the proposed Project would not be constructed or operated and the workforce within the analysis area would be unaffected. There would be no additional construction jobs in the analysis area.

4.10.3.2 PROPOSED ACTION, ALTERNATIVE 2A, ALTERNATIVE 2B, ALTERNATIVE 3, AND ALTERNATIVE 4

All action alternatives would have minor benefits on employment opportunities in the analysis area and Brazoria County. The analysis area would experience an increase in temporary construction jobs and it is likely that the Project would employ construction workers who are already located in the analysis area or within Brazoria County. The construction labor force is estimated to average approximately 80 to 90 persons over the construction period, and peak staffing could be close to 130 persons. Operation of any of the action alternatives would result in approximately 20 workers or less working to maintain the new reservoir or desalination plant, which would be a negligible benefit.

4.10.4 Environmental Justice and Protection of Children

4.10.4.1 NO ACTION

Under the No Action alternative, the proposed Project would not be constructed or operated and the workforce within the analysis area would be unaffected. There would be no additional construction jobs in the analysis area.

4.10.4.2 PROPOSED ACTION, ALTERNATIVE 2A, ALTERNATIVE 2B, AND ALTERNATIVE 3

The minority population of Census Tract 6619.01 is greater than 50% and 7 percentage points greater than the minority population of Brazoria County. The Proposed Action, Alternative 2A, Alternative 2B, and Alternative 3 would not displace any population, and environmental or human health impacts that would specifically or disproportionately occur within the area of Census Tract 6619.01 would not be anticipated.

All action alternatives include the introduction of an open waterbody that theoretically could affect the protection of children if access is not properly limited. However, all alternative sites would be fully fenced and gated with no public access. There are no concentrations of children within the analysis area that would be affected by the action alternatives. Impacts to environmental justice communities and children would be negligible.

4.10.4.3 ALTERNATIVE 4

Impacts to environmental justice communities and children from Alternative 4 would overall be negligible, same as the Proposed Action, with a few exceptions. Census tract 6642 is an industrial area with a meaningfully higher percentage of low-income population (23.1%) when compared with low-income populations in Brazoria County (8.7%) and the other Census tracts in the analysis area, which range from 2.4% to 9.2%. Alternative 4 would add a pipeline that would carry desalinated water within this area. Alternative 4 would have temporary impacts during construction of the desalinated water pipeline; however, the effects would be limited to the period of construction and impacts to local populations would be minimized to the extent practicable by proposed Project design features (see Section 2.8). Operation of the pipeline would not have human health or environmental effects.

There is one park and one middle school near the proposed pipeline ROW, which would carry the desalinated water from the Brazos River to the Dow facility. The pipelines would be buried, and this alternative would not disproportionately affect the health and safety of children.

4.10.5 Navigation and Recreation

4.10.5.1 UPLAND RECREATION

4.10.5.1.1 No Action

Under the No Action alternative, the proposed Project would not be constructed or operated, and upland recreation would be unaffected.

4.10.5.1.2 Proposed Action, Alternative 2A, Alternative 2B, Alternative 3, and Alternative 4

Under all action alternatives the land is privately held and there is no public recreation. Therefore, impacts to upland recreation in the analysis area (a 1-mile buffer around each action alternative) would not be anticipated.

4.10.5.2 IN-WATER RECREATION

4.10.5.2.1 No Action

Under the No Action alternative, the proposed Project would not be constructed or operated, and in water recreation would be unaffected.

4.10.5.2.2 Proposed Action, Alternative 2A, and Alternative 2B

Recreational activities in the Brazos River under the Proposed Action, Alternative 2A, and Alternative 2B near the intake structure would be prevented during construction for public safety. However, adjacent fishing, boating, and other in-water recreational uses would not be impeded during construction, which suggests in-water recreational users would experience short-term, minor, and localized impacts. Long term operations that could affect in-water recreation would be the existence of the new intake structure in the Brazos River and occasional intake cleaning activities. Operational impacts on in-water recreation in the Brazos River would long term, but infrequent and therefore negligible.

Unlike the Brazos River, Oyster Creek during construction is assumed to require full exclusion of in-water recreators due to the smaller size of the water body and extent of planned activities. However, because boating and fishing in Oyster Creek is less common (due to the many sunken snags and surrounding private land), and recreators can instead use the Brazos River, impacts on in-water recreational uses of Oyster Creek would be short term and minor. Operational activities in Oyster Creek that could affect recreational users would include occasional stream channel maintenance and slight fluctuations in water levels based on discharge from the new reservoir. Operational impacts on in-water recreation in Oyster Creek would be long term but infrequent and therefore negligible.

4.10.5.2.3 Alternative 3

In-water recreational impacts in the Brazos River under Alternative 3 would be negligible and similar to those described for the Project site but would also include additional shoreline scour-protection upstream and downstream of bridge abutments on both sides of the Brazos River. Construction impacts on in-water recreation in the Brazos River would be short term and minor. Operational impacts would be the same as those described for the Brazos River around the intake, and once the bridge is constructed, effects to in-water recreation would not be affected, although the presence of bridge abutments could benefit recreational fishing. No effects to in-water recreation would occur on Oyster Creek under Alternative 3.

4.10.5.2.4 Alternative 4

In-water recreational impacts at the Alternative 4 site would be negligible, similar to those described for the Brazos River under the Proposed Action. No effect to Oyster Creek would occur as a result of Alternative 4.

4.10.5.3 NAVIGATION

4.10.5.3.1 No Action

Under the No Action alternative, the proposed Project would not be constructed or operated, and navigation would be unaffected.

4.10.5.3.2 Proposed Action, Alternative 2A, Alternative 2B, Alternative 3, and Alternative 4

Navigation for recreational users under the Proposed Action and all alternatives would be limited to navigation of the Brazos River as Oyster Creek is largely unnavigable due to the large number of sunken snags and narrow channel. Through-navigation would be maintained along the Brazos River under the Proposed Action and all alternatives, and the in-water structures under each scenario would have about the same minor, temporary impacts on navigation during construction. Operational activities at the planned in-water structures under the Proposed Action and all alternatives would include routine cleaning and maintenance. These activities would result in negligible impacts to navigational uses along the Brazos River.

The USCG permits the location and plans for bridges and causeways and imposes any necessary conditions relating to the construction, maintenance, and operation of these bridges in the interest of public navigation. The Alternative 3 bridge across the Brazos River would require a permit from the USCG and conditions would be applied as dictated by the USCG to reduce potential impacts associated with the bridge. Due to bridge construction, impacts to navigation from Alternative 3 would be minor.

4.10.6 Visual and Aesthetic Resources

For the purposes of this analysis, impacts on visual and aesthetic resources (visual resources) are characterized by the criteria presented in Table 4.10-1.

The following impact levels correspond to impact levels previously described for socioeconomic issues (Section 4.1.3.2).

Table 4.10-1. Criteria for Assessing the Level of Impacts on Visual Resources

Level of Impacts	Contrast Perceived by Viewers	Magnitude of Change to Landscape Character
Negligible	• Project components would repeat elements/patterns common in the landscape • Project components would not be visually evident	• Landscape would appear to be intact and not attract attention • Project components would repeat form, line, color, texture, or scale common in the landscape and not be visually evident (no contrast)
Minor	• Project components would introduce elements/patterns common in the landscape that would be visually subordinate • Project components would create weak contrast, compared with other features in the landscape	• Landscape would be noticeably altered and begin to attract attention • Project components would introduce form, line, color, texture, or scale common in the landscape and would be visually subordinate (weak contrast)
Moderate	• Project components would introduce elements/patterns not common in the landscape • Project components would be visually prominent in the landscape and would create moderate contrast, compared with other features in the landscape	• Landscape would appear to be substantially altered • Project components would introduce form, line, color, texture, or scale not common in the landscape and would be visually prominent in the landscape (moderate contrast) • Project components would attract attention • Project components would begin to dominate the visual setting
Major	• Project components would introduce elements/patterns that would be visually dominant and create strong contrast, compared with other features in the landscape	• Landscape would appear to be severely altered • Project components would introduce form, line, color, texture, or scale not common in the landscape and would be visually dominant in the landscape (strong contrast) • Project components would demand attention • Project components would dominate in the visual setting

4.10.6.1 NO ACTION

Under the No Action alternative, the proposed Project would not be constructed or operated, and visual and aesthetic resources would be unaffected.

4.10.6.2 PROPOSED ACTION, ALTERNATIVE 2A, AND ALTERNATIVE 2B

During construction, the existing visual character of the analysis area (area within 0.5 miles of the Project site) would be affected during the period of construction by the generation of fugitive dust; movement of equipment and vehicles in and out of the Project site; and the presence of staged construction vehicles, equipment, and material stockpiles. The construction activities would introduce forms, lines, colors, and textures that would temporarily attract attention and create moderate contrast with the existing setting. Removal of vegetation would expose potentially lighter-color soils in the cleared areas for staging, access roads, pump station facilities and during excavation of the expansion reservoir.

The construction-related impacts to the characteristic landscape would be perceivable to the casual observer within the immediate foreground area and range from weak to strong (see Table 4.10-1) within the analysis area based on the type of construction activity taking place, time of day and viewer location. Overall, there would be minor to moderate, temporary impacts to visual resources as a result of construction activities.

Visual effects during operation of the Project would result from the visibility of the above-ground pumps station facilities and the introduction of a large body of water similar to the existing Harris Reservoir. The magnitude of change to the landscape character within the analysis area would be minor (see Table 4.10-1) as a result of the addition of these Project components within the characteristic landscape. Project components would introduce form, line, color, texture, or scale common in the landscape, creating weak contrast that would be visually subordinate. Overall, there would be long-term minor effects to visual resources as described in Table 4.10-1 as a result of operation and maintenance activities.

4.10.6.2.1 Effects on Sensitive Viewer Groups

Travelers

The degree of visual change for travelers viewing the Proposed Action, Alternative 2A, and Alternative 2B would be negligible for KOPs 3 and 4. The overall change in landscape character as a result of Project activities would be similar to that of the existing Harris Reservoir. Impacts associated with KOP 3 would be long term and beneficial resulting from improved vegetative features and stream restoration design, which would increase the overall visual variety of the natural landscape when viewed from this KOP. There would be temporary negligible impacts associated with KOP 4 during construction as the Project staging area would be somewhat visible, although predominately obscured from this KOP as well as most portions of Harris Reservoir Road due to the intervening vegetative tree stands that occur in the foreground.

Recreational Users

The degree of visual change for recreational users viewing the Proposed Action, Alternative 2A, and Alternative 2B would range from minor to moderate (as described in Table 4.10-2) for KOPs 1, 2, and 5. Moderate long-term impacts associated with KOP 1 would result from the introduction of contrasting elements associated with form, line, color, and texture associated with the addition of the intake infrastructure located along the water's edge, as well as the addition of bank protection and stabilization along the shoreline, which would create an uncharacteristic geometric form and continuous horizontal line in the immediate foreground when viewed from this KOP. There would be long-term minor impacts associated with KOP 2 associated with form, line, color, and texture associated with the addition of bank protection and stabilization, which would create an uncharacteristic geometric form and continuous horizontal line in the immediate foreground when viewed from this KOP. Minor long-term impacts associated with KOP 5 would result from the introduction of contrasting elements of form, line, color, and texture associated with the addition of the pump station and intake infrastructure, which is viewed to the left of the field of view from this KOP, as well as bank protection and stabilization, which would create an uncharacteristic geometric form and continuous horizontal line in the immediate foreground when viewed from this KOP.

Residents

The degree of visual change for residents viewing the Proposed Action, Alternative 2A, and Alternative 2B would be negligible for KOP 4. There would be temporary negligible impacts associated with KOP 4 during construction from Project staging, although the area would be predominately obscured from this

KOP, as well as most portions of Harris Reservoir Road and associated residences due to the intervening vegetative tree stands that occur in the foreground.

Table 4.10-2. Impacts to KOP Sensitive Viewer Groups – Proposed Action, Alternative 2A, and Alternative 2B

KOP Number	KOP Name	Sensitive Viewer Group	Level of Impact*
1	Brazos River	Recreation	Moderate, long-term
2	River Lake	Recreation	Minor, long-term
3	Ramsey Bridge	Travelers	Negligible, long-term beneficial
4	Harris Reservoir Road	Travelers/residents	Negligible, temporary
5	Southwest corner of Project site	Recreation	Minor, long-term

* See Table 4.10-1 and Section 4.1.3.2.

4.10.6.3 ALTERNATIVE 3

Visual resource impacts associated with construction and operation of this alternative would be negligible, similar to the Proposed Action.

4.10.6.3.1 Effects on Sensitive Viewer Groups

Sensitive viewer groups were not identified as part of this alternative, but due to its proximity to the Project site, impacts to viewer groups are assumed to be similar to the Proposed Action based on aerial imagery and similarities in Project design and associated infrastructure components.

4.10.6.4 ALTERNATIVE 4

During construction the existing visual character of the analysis area (area within 0.5 miles of the Project) would be affected during the period of construction by the generation of fugitive dust; movement of equipment and vehicles in and out of the Alternative 4 site; and the presence of staged construction vehicles, equipment, and material stockpiles. The construction activities would introduce forms, lines, colors, and textures that would temporarily attract attention and create moderate contrast with the existing setting. Removal of vegetation would expose potentially lighter-color soils in the cleared areas for staging, access roads, desalination plant, substations, and trenching associated with the co-located water and concentrate pipelines. The desalination plant and other supporting structures would be of similar design and character as existing industrial infrastructure located throughout the area.

The construction-related impacts to the characteristic landscape would be perceivable to the casual observer within the immediate foreground area and range from negligible to moderate (see Table 4.10-1) within the analysis area based on the type of construction activity taking place, time of day, and viewer location and orientation. Overall, there would be temporary, negligible to moderate impacts to visual resources as a result of construction activities.

Visual effects during operation of the Project would result from the visibility of the aboveground infrastructure (i.e., desalination plant, substation, and associated transmission line). The magnitude of change to the landscape character within the analysis area would be moderate (see Table 4.10-1) as a result of the addition of these Project components within the characteristic landscape. The Project components, which would introduce form, line, color, texture, or scale not common in the landscape, would create moderate contrast and therefore would be visually prominent. Overall, there would be long-term, moderate impacts to visual resources as a result of operation and maintenance activities.

4.10.6.4.1 Effects on Sensitive Viewer Groups

Sensitive viewer groups were not identified as part of this alternative. Based on aerial imagery, adverse impacts to viewer groups are anticipated to range from long-term negligible to minor to viewers in the immediate foreground area of the transmission line and pipeline infrastructure. Adverse impacts to viewers are anticipated to be long term and moderate in the immediate foreground of the desalination plant and substation resulting from the introduction of visually prominent Project elements of form, line, and texture that would contrast with the characteristic landscape.

4.11 Climate and Air Quality

Emission calculations for construction and ongoing operation activities were completed for the Project based on available construction and operating details and are presented in Sections 4.11.1 and 4.11.2. Where sufficient detail regarding certain aspects of the construction, maintenance, and operation of the Project are not yet known, conservative assumptions are used to estimate emissions or impacts are discussed qualitatively. The criteria air pollutant, HAP, and GHG emissions during construction would be temporary during construction and be minor. Indirect impacts of the GHG emissions to climate change would be long-term since GHGs are long-lived in the atmosphere. Since the impacts of GHG to climate change are inherently cumulative (based on global concentrations of GHGs in the atmosphere), and the Project contribution is small, the Project contribution to climate change is considered negligible (no measurable impact). Impacts from areas disturbed during the Project would be short-term and upon reclamation of disturbed acreages which have potential to generate fugitive dust, would permanently subside. Ongoing operational and maintenance activity emissions and associated impacts would be long term. These ongoing impacts would be minor to moderate in intensity with respect to air quality depending on the alternative and would occur over the entire life of the Project. The ongoing impacts to climate change would be negligible. Impacts to ambient air quality are discussed in Section 4.11.1, and impacts to climate are discussed in Section 4.11.2.

4.11.1 Air Quality

4.11.1.1 NO ACTION

Under the No Action alternative, the proposed Project would not be constructed or operated and air quality would be unaffected.

4.11.1.2 PROPOSED ACTION, ALTERNATIVE 2A, AND ALTERNATIVE 2B

The Proposed Action, Alternative 2A, and Alternative 2B have effectively the same air quality impacts due to their location in the 2,533-acre Project site and the location of the proposed reservoir adjacent to the existing Harris Reservoir. Impacts from Project construction (described in Section 2.3.4) are emissions of fugitive dust (consisting of PM_{10} and $PM_{2.5}$) from earthmoving and disturbance activities; combustion exhaust (criteria pollutants, ozone precursors, and HAPs) and fugitive dust from off-road construction equipment operation; combustion exhaust and fugitive dust from on-road vehicle trips on paved and unpaved roads; and fugitive dust from concrete batch plant operations. Operational and maintenance emissions would be limited to diesel pump exhaust emissions and exhaust/fugitive dust emissions from vehicle travel on paved and unpaved roads. The Proposed Action would not cause a change in operation at Dow’s Texas Operations integrated chemical manufacturing facility and therefore, the Project would not result in indirect air quality impacts at this site.

The Project is located in an ozone nonattainment area (classified as serious nonattainment under the 2008 ozone standard and as moderate under the 2015 ozone standard). As discussed in Section 3.11.2, the

General Conformity Rule under the Clean Air Act establishes de minimis thresholds, which establish levels of emissions that are clearly negligible with respect to impacts to ambient air quality. The de minimis thresholds applicable to the Project is 50 tons per year for NO_x and VOC. Project emission rates during each year of construction, as well as ongoing operational emissions, were quantified and compared against the relevant General Conformity Rule de minimis thresholds to determine whether the impacts to air quality exceed these thresholds. The emission rates in tons per year during each construction year, as well as emissions during the ongoing operational phase of the Project (Proposed Action or Alternative 2), are listed in Table 4.11-1.

Table 4.11-1. Proposed Action, Alternative 2A, and Alternative 2B Construction and Operational Criteria Pollutant and Ozone Precursor Emissions

Year	CO	NO_x	VOC	SO2	PM_{10}	$PM_{2.5}$	HAP
2020 Pipeline Relocation (Total tons)	0.72	0.79	0.07	0.00	0.46	0.11	0.03
2021 (Total tons)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2022 (Total tons)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2023 (Total tons)	19.61	25.61	1.66	0.05	43.49	6.22	0.76
2024 (Total tons)	25.29	29.97	1.96	0.07	71.70	9.52	0.87
2025 (Total tons)	20.96	23.96	1.56	0.07	61.50	8.18	0.66
2026 (total tons – construction only)	2.82	5.47	0.33	0.01	11.94	1.87	0.14
ongoing annual operational emissions (tons/yr)	2.90	2.54	0.20	0.72	0.02	0.02	0.01
De minimis threshold	N/A	50	50	N/A	N/A	N/A	N/A
Exceeds in any year?	No	No	No	No	No	No	No

Note: N/A = not applicable

Estimates of emissions are based on information provided by the Applicant and reasonable assumptions where details needed to calculate emissions are not known. The estimates are based on assumptions and professional judgement, and actual equipment and operations may differ. However, the estimates provided give a reasonable approximation of emissions and thereby impacts. Note that estimated emissions from the 50-horsepower pump engines are based on maximum daily operating hours for the entire year (19 hours per day for one pump and 10 hours per day for the other two pumps).

Construction emissions include estimates of emissions during the ConocoPhillips pipeline relocation (occurring in 2020), the Oyster Creek improvements phase (2023–2024), the reservoir construction phase (2023–2026), the pump station construction phase (2024–2025), and the high-voltage overhead electrical service and 15-kV circuit breaker activities by CenterPoint (2023–2024). Operational emissions include operation of the three 50-horsepower diesel-fired pumps. Ongoing operational emissions from worker commutes and periodic maintenance activities are not estimated but would be negligible. Operational activities are assumed to commence in 2026.

Because the Project would not emit VOC or NO_x emissions in excess of the general conformity de minimis thresholds, it is not anticipated that the Project would substantially worsen existing ambient air quality within the region with respect to ozone concentrations. Because the Project is located in an area that is attainment or unclassified with respect to the other criteria pollutants, no threshold of significance exists with respect to these pollutants. However, to contextualize impacts, the Proposed Action construction emissions (during the worst-case year) and ongoing annual operational emissions can be compared against the most recent EPA National Emission Inventory data from Brazoria County presented in Table 3.11-3. The Project would represent a small incremental increase in emissions within the analysis area as shown in Table 4.11-2.

Table 4.11-2. Proposed Action, Alternative 2A, and Alternative 2B Highest Annual Emission Rate Compared with 2017 National Emission Inventory Data for Brazoria County

Year	CO	NO_x	VOC	SO2	PM_{10}	$PM_{2.5}$	HAP
Proposed Action (2024 total tons)	25.29	29.97	1.96	0.07	71.70	9.52	0.87
Brazoria County (2017 total tons)	78,441	15,311	40,918	1,025	20,435	7,594	5,120
Proposed Action % of county emissions	0.03%	0.20%	0.00%	0.01%	0.35%	0.13%	0.02%

Source EPA (2020d)

A majority of the impact (particularly to ozone precursors) would be temporary and would terminate upon completion of the Project construction. Impacts from disturbed acreage windblown fugitive dust would be short term and would cease upon completion of reclamation activities. The Project applicant is implementing the BMPs specified in Chapter 2 during the construction phase to reduce potential impacts to ambient air quality. The Proposed Action, Alternative 2A, and Alternative 2B temporary impacts from construction would be minor because although some degree of impact to air quality would occur, these are minimized through implementation of BMPs described in Section 2.8. The impacts are also considered minor since the level of emissions would be less than the General Conformity de minimis thresholds as shown in Table 4.11-1, and the impacts would cease upon completion of construction and reclamation and are thus, temporary.

Long-term impacts to air quality would be minor during the operation phase of the Project because the level of emissions from the three 50-horsepower stationary diesel engines are mitigated through compliance with federal New Source Performance and MACT standards during operation. The units would comply with EPA Tier 4 Standards and levels of emissions from ongoing vehicle traffic associated with operation and maintenance activities would be negligible.

4.11.1.3 ALTERNATIVE 3

Alternative 3 construction emissions would be very similar to emissions from the Proposed Action. However, Alternative 3 would differ slightly during the construction phase. The Alternative 3 site would be 2,200 acres, which is less than the Proposed Action and would be expected to have less acres of disturbance. These differences would result in a change in construction emissions. However, it is not anticipated that Alternative 3 emissions would exceed the General Conformity thresholds or cause a violation of ambient air quality standards and the same BMPs would be implemented for this alternative. It is assumed that construction emissions for Alternative 3 are substantively similar to those disclosed in Table 4.11-1.

Alternative 3 would require larger pumps during the operation phase than would be needed for the Proposed Action. It is estimated that two larger pumps (3,500-horsepower) would be needed under this alternative, which would increase ongoing operational emissions from the Project substantially. However, it is not anticipated that the annual operational emissions would exceed general conformity thresholds. For instance, if the pumps operated similar hours as those of the Proposed Action (19 hours per day for one pump and 10 hours per day for the other pump), the emissions during operations would be less than General Conformity thresholds. Note that the higher emissions would potentially trigger more stringent construction new source review permitting requirements for the site than would be required under the Proposed Action. However, the emissions calculations shown here are estimated for disclosure purposes and actual operation schedule may be different. It is also likely that the values presented in Table 4.11-3 are conservative as the maximum daily operation is assumed to occur over the entire year.

Table 4.11-3. Alternative 3 Ongoing Operational Criteria Pollutant and Ozone Precursor Emissions

Year	CO	NO_x	VOC	SO2	PM_{10}	$PM_{2.5}$	HAP
Ongoing annual operational emissions (tons/yr)	106.18	20.42	5.72	0.2	0.90	0.90	0.49
De minimis threshold	N/A	50	50	N/A	N/A	N/A	N/A
Exceeds in any year?	No	No	No	No	No	No	No

Note: N/A = not applicable

Estimates of emissions are based on information provided by the Applicant and reasonable assumptions where details needed to calculate emissions are not known. The estimates are based on assumptions and professional judgement, and actual equipment and operations may differ. However, the estimates provided give a reasonable approximation of emissions and thereby impacts. Note that estimated emissions from the 3,500-horsepower pump engines are based on maximum daily operating hours for the entire year (19 hours per day for one pump and 10 hours per day for the other pump).

Additional maintenance activities associated with the conveyance pipeline, bridge, and canal would be required under Alternative 3; however, the emissions associated with these maintenance activities are expected to be negligible. Although the operational emissions under Alternative 3 would be higher than under the Proposed Action, impacts to air quality would be minor during the operation phase of the Project because the level of emissions from the diesel engines are mitigated through compliance with federal New Source Performance and MACT standards during operation, the units would comply with EPA Tier 4 standards and levels of emissions from ongoing vehicle traffic associated with operation and maintenance activities would be negligible.

4.11.1.4 ALTERNATIVE 4

Under Alternative 4, a brackish water desalinization plant would be constructed on 500 acres approximately 8 miles northwest of Dow’s Texas Operations along the Brazos River. During construction, 103.5 acres of temporary construction areas would be disturbed to allow for trailers and equipment laydown. Additionally, a new access road, power line, and substation would be constructed and approximately 8.8 miles of pipeline would be constructed to allow conveyance of RO water to the Dow’s Texas Operations, resulting in permanent disturbance of 377.1 acres. The desalinization plant would require 60 megawatts of electrical load to operate. Construction details in terms of equipment and fleet roster are not known for this alternative at this time; however, the total disturbed acreage during construction would be significantly less than the Proposed Action, Alternative 2, and Alternative 3. However, ongoing operational emissions associated with plant operation (worker and delivery commutes) would likely be more substantial and requiring additional electrical load during operation. Additionally, Alternative 4 would require significantly more power than the other alternatives, which would potentially require more power from electric generating units. This could result in the indirect effect of increased criteria pollutant and HAP emissions within the analysis area. Despite these distinctions, air quality impacts are anticipated to be minor with respect to both construction and operational impacts to air quality, similar to the Proposed Action.

4.11.2 Climate

4.11.2.1 NO ACTION

Under the No Action alternative, the proposed Project would not be constructed or operated and no additional GHG emissions would occur.

4.11.2.2 PROPOSED ACTION, ALTERNATIVE 2A, AND ALTERNATIVE 2B

Emissions from on-road and off-road vehicle exhaust would result in emissions of CO_2, CH_4, and N_2O. The magnitude of emissions would be greatest during the construction phase of the Project but would cease upon completion of construction and reclamation activities. The ongoing diesel pump and the ongoing vehicle traffic associated with operation and maintenance would result in relatively low levels of annual GHG emissions but would continue for the life of the Project. Total estimated GHG emissions during each year of construction and GHG emissions associated with annual operation and maintenance activities are listed in Table 4.11-4 below.

Table 4.11-4. Proposed Action, Alternative 2A, and Alternative 2B Construction and Operational GHG Emissions

Year	CO_2	CH_4	N_2O	CO_2e
2020 (total MT)	479.2	0.01	0.01	482.1
2021 (total MT)	N/A	N/A	N/A	N/A
2022 (total MT)	N/A	N/A	N/A	N/A
2023 (total MT)	0.76	16,239.0	0.15	0.36
2024 (total MT)	0.87	22,249.6	0.18	0.48
2025 (total MT)	0.66	20,493.7	0.15	0.44
2026 (MT – construction only)	0.14	4,490.7	0.03	0.10
Ongoing operational Emissions (MT/yr)	370.63	0.015	0.003	371.84

Note: MT = metric tons. Estimates of emissions are based on information provided by the Applicant and reasonable assumptions where details needed to calculate emissions are not known. The estimates are based on assumptions and professional judgement, and actual equipment and operations may differ. However, the estimates provided give a reasonable approximation of emissions and thereby impacts. Note that estimated emissions from the 50-horsepower pump engines are based on maximum daily operating hours for the entire year (19 hours per day for one pump and 10 hours per day for the other two pumps).

The GHG emissions over the life of the Project consist of the entire construction phase emissions, and 50 years of ongoing operation and maintenance activities. Cumulative total emissions over the life of the Project would be 82,927 MT CO_2e. During the construction phase, the maximum annual GHG emissions would represent 0.12% of Brazoria County's and 0.006% of Texas' GHG emissions from large facilities subject to the Mandatory GHG Reporting Rule (see Table 3.11-4). During the operation and maintenance phase, the annual GHG emission from the Project would represent approximately 0.002% of Brazoria County's and 0.0001% of Texas' GHG emissions from large facilities subject to the Mandatory GHG Reporting Rule (see Table 3.11-4) due to operation of diesel-fired pumps. Fugitive equipment leaks from switchgear and circuit boards containing SF_6 were not estimated, but BMPs discussed in Section 2.8 would be applied.

During Project construction, acreage disturbance would alter carbon sequestration capacities of the land; however, upon reclamation of the disturbed area to its previous condition, carbon sequestration capacity would be returned to baseline conditions. During operation of the Project, methane emissions from reservoirs through ebullition may occur. To quantify levels of sequestration loss during construction and methane ebullition emissions during operation would be highly speculative as it would be based on multiple complex variables such as soil carbon density, anaerobic activity, and reservoir depth. However, based on the relatively small land area impacted, it is anticipated that changes in carbon or methane sequestration would be negligible in the context of global climate change. Additionally, leaks from insulated circuit boards and switchboards containing SF_6 have the potential to leak, releasing SF_6 which is a potent GHG. The applicant will properly maintain all SF_6–containing equipment and implement BMPs discussed in Section 2.8.

There is no established threshold of significance for GHG emissions. However, based on the relative magnitude of emissions from the Project, it is expected that the overall Project impacts to climate change would be negligible. This conclusion is based on the 40 CFR 98 Mandatory Greenhouse Gas Reporting Threshold value of 25,000 metric tons of CO_2e. The Proposed Action, Alternative 2A, and Alternative 2B emissions would be below this threshold during each year of construction and operation. As noted, impacts to global climate change are inherently cumulative, and cumulative impacts to climate change would be based on national and global initiatives to respond to the threat of global climate change.

4.11.2.3 ALTERNATIVE 3

GHG emissions from Alternative 3 during construction would be similar in magnitude to the GHG emissions in the Proposed Action. The operational emissions associated with the larger pump engines would increase GHG emissions relative to the Proposed Action. The estimated operational phase emissions from the pump engines would be 19,472 MT CO_2e on an annual basis. Assuming the total construction emissions were similar to the Proposed Action, the total GHG emissions would be and 1,038,284 MT CO_2e over the 50-year life of the Project. During the operation and maintenance phase, the annual GHG emission from the Project would represent approximately 0.11% of Brazoria County's and 0.005% of Texas' GHG emissions from large facilities subject to the Mandatory GHG Reporting Rule (see Table 3.11-4) due to operation of diesel-fired pumps. Fugitive equipment leaks from SF_6 containing switchgear and circuit boards were not estimated, but BMPs discussed in Section 2.8 would be applied. Based on the relative magnitude of emissions from the Project, it is expected that the overall Project impacts to climate change would be negligible, though emissions during operations would be greater than under the Proposed Action.

4.11.2.4 ALTERNATIVE 4

Sufficient detail to calculate construction and operational impacts for Alternative 4 are not available. However, construction impacts are likely to have a negligible impact on climate change due to temporary nature of the Project. Ongoing operational emissions are likely to be higher under Alternative 4 than the Proposed Action due to the need for staff to operate the plant (commute emissions), haul trips needed to manage waste, and increased electricity use associated with the Dow's Texas Operations (which would require GHG emissions associated with power generation if the electricity is generated via fossil fuels). Overall, this alternative is likely to have more GHG emissions than the Proposed Action during operation; however, it is still likely that the impacts to climate change would be negligible.

4.12 Noise

This section describes the potential noise impacts from the Project associated with the construction, operation and maintenance of the reservoir. The analysis area for evaluating noise impacts is the Project site plus a 1-mile buffer. This analysis area was chosen because for most construction projects, noise impacts attenuate to background levels at distances of less than 1 mile from the noise source. Potential effects of the proposed Project and alternatives, both during construction and once operations begin, include changes in the ambient noise levels at sensitive noise receptor sites, including residences and any adjacent wilderness and recreation areas. Impacts during construction would result from the use of equipment and vehicles but would be limited to the immediate vicinity of the Project site construction area and along transport access routes. Construction noise would be short-term and sporadic in nature. During operation, reservoir maintenance and noise from the pumps would elevate the current ambient noise levels within the immediate vicinity of the Project site.

Impacts to noise are discussed in terms of noise levels expected to be produced by the Proposed Action and the alternatives as compared to baseline conditions (i.e., the No Action alternative) and relative to applicable laws and regulations.

4.12.1 No Action

Under the No Action alternative, there would be continued operations and capacity at Harris Reservoir as it currently exists. Noise impacts from construction and operation and maintenance of the Proposed Action would not occur. Under the No Action alternative, noise conditions would likely continue at current levels and trends.

4.12.2 Proposed Action, Alternative 2A, and Alternative 2B

The construction noise level at the nearest sensitive receptor to construction activity was estimated using the FHWA Roadway Construction Noise Model (RCNM). The RCNM is FHWA's national model for the prediction of construction noise and has noise levels for various types of equipment pre-programmed into the software; therefore, the noise level associated with the equipment is typical for the equipment type and not based on any specific make or model. The maximum noise levels presented at a specified distance from the source are based on a roster of likely construction equipment operating (Table 4.12-1). Although the project is not a road construction project, the RCNM includes the same types of equipment that would be used in the construction of the Project.

Worker commutes and material delivery vehicles would cause noise that would be short term and have little effect on the hourly average noise level. Therefore, this traffic was not included in the construction or operations noise analysis.

Table 4.12-1. Construction Equipment and Typical Equipment Noise Levels

Type of Equipment	Typical Maximum Noise Levels (dBA at 50 feet)
Crane	81
Excavator	81
Air compressor	78
Concrete batch plant	83
Crawler tractor/dozers	82
Tractors/loaders/backhoes	78
Rubber tire loaders	79
Off-highway trucks	74
Graders	85
Scrapers	84
Industrial saws	90
Roller	80
Pump	81
Plate compactor	83
Skid steer loaders	84
Trencher	80

Type of Equipment	Typical Maximum Noise Levels (dBA at 50 feet)
Welder	74
Generator	81
Bore/drill rigs	84
Chainsaw	90
Pile driver	101

Estimated noise level at the nearest sensitive receptor to piling driving and all other construction activities was used to characterized noise impact of construction. Pile driving is anticipated to occur in two areas of the project. The first area includes approximately 750 square feet of sheet piling for grade control on the east side of the reservoir. This sheet piling activity is planned for late 2023 and is estimated to require 2 days to complete. The second area includes approximately 55,500 square feet of sheet piling for the pump station and intake structure located at the southwest corner of the reservoir. This sheet piling activity is planned for late 2024 through early 2025 and is estimated to require approximately 95 days to complete. In general, the sheet piling activities at the two areas would not occur simultaneously and would occur periodically during the anticipated 5 days per week and 10 hours per day construction work schedule. The nearest sensitive receptor to the Proposed Action, Alternative 2A, and Alternative 2B pile driving activities is a residence 4,000 feet south of the pump station site. The nearest sensitive receptor to the other construction activities besides pile driving is a residence 225 feet south of the Project site. The estimated construction noise level at the nearest sensitive receptor is presented in Table 4.12-2.

Table 4.12-2. Noise Levels at the Nearest Sensitive Receptor to the Project Site

	Calculated L_{max} (dBA)	Calculated L_{eq} Total (dBA)	Noise Level, Ambient + Construction (dBA) L_{day}
Ambient baseline noise level*	–	–	40.0
Noise level at nearest sensitive receptor (225 feet away)	70.9	63.9	62.2
Noise level at nearest sensitive receptor to pile driving activities (4,000 feet away)	62.9	55.9	54.4

* Baseline noise level obtained based on estimated local land use.

The L_{max} at the nearest residence to the Project site would be approximately 70.9 dBA. This noise level is similar to listening to city traffic. The estimate of noise generated by the construction equipment used for the Proposed Action, Alternative 2A, and Alternative 2B has been conservatively calculated based on the loudest piece of construction equipment operating at the Project boundary nearest to the sensitive receptor. The calculated noise level does not take into account further attenuation (i.e., sound reduction) due to atmospheric interference or intervening structures. The noise due to construction would be temporary. Impacts due to the noise generated by the construction of the Proposed Action, Alternative 2A, and Alternative 2B would be minor to moderate and temporary.

Operational noise would consist of reservoir maintenance and the operation of pumps. The noise from these operational activities would be substantially less than construction noise. There would be no impact to the nearest sensitive receptors after construction is completed. The nearest sensitive receptor would be approximately 0.50 mile from the pump station. The pump station would be partially underground with reinforced concrete walls and would be enclosed on three sides aboveground and have a roof. At that distance, noise from the pump station would have attenuated to below noticeable noise levels. Long-term impacts on noise levels from operation of the Proposed Action, Alternative 2A, and Alternative 2B would be negligible.

4.12.3 Alternative 3

The nearest sensitive receptor is a residence adjacent to the Alternative 3 site boundary. The nearest sensitive receptor to the pile driving activities is a residence 5,200 feet northwest of the pump station site. The L_{max} at the nearest sensitive receptor would be approximately 84.0 dBA (Table 4.12-3). This noise level is similar to a power lawn mower 3 feet away. The estimated noise generated by the construction equipment used at the Alternative 3 site has been conservatively calculated based on the loudest piece of construction equipment operating at the site boundary adjacent to the sensitive receptor. The calculated noise level does not take into account further attenuation due to atmospheric interference or intervening structures. The noise due to construction would be temporary. Impacts due to the noise generated by the construction of Alternative 3 would be moderate and temporary.

Table 4.12-3. Noise Levels at the Nearest Sensitive Receptor to the Alternative 3 Site

	Calculated L_{max} (dBA)	Calculated L_{eq} Total (dBA)	Noise Level, Ambient + Construction (dBA) L_{day}
Ambient baseline noise level*	–	–	50.0
Noise level at nearest sensitive receptor (adjacent to the site boundary)	84.0	77.0	75.3
Noise level at nearest sensitive receptor to pile driving activities (5,200 feet away)	60.7	53.7	54.1

* Baseline noise level obtained based on estimated local land use.

Operational noise would consist of reservoir maintenance and the operation of pumps. The noise from these operational activities would be substantially less than construction noise. There would be no impact to the nearest sensitive receptors after construction is completed. The nearest sensitive receptor would be approximately 2.3 miles from the pump station. At that distance, noise from the pump station would have attenuated to below noticeable noise levels. Long-term impacts on noise levels from operation of Alternative 3 would be negligible.

4.12.4 Alternative 4

The nearest sensitive receptor is 960 feet from the Alternative 4 site boundary. No pile driving activities are anticipated for Alternative 4. The L_{max} at the nearest residence to the Alternative 4 site would be approximately 58.3 dBA (Table 4.12-4). This noise level is similar to normal conversation. The estimated noise generated by the construction equipment used at the Alternative 4 site has been conservatively calculated based on the loudest piece of construction equipment operating at the Alternative 4 site boundary adjacent to the sensitive receptor. The calculated noise level does not take into account further attenuation due to atmospheric interference or intervening structures. The noise due to construction would be temporary. Impacts due to the noise generated by the construction of the Alternative 4 would be moderate and temporary.

Table 4.12-4. Noise Levels at Nearest Sensitive Receptor to the Alternative 4 Site

	Calculated L_{max} (dBA)	Calculated L_{eq} Total (dBA)	Noise Level, Ambient + Construction (dBA) L_{day}
Ambient baseline noise level*	–	–	40.0
Noise level at nearest sensitive receptor (960 feet away)	58.3	51.3	50.0

* Baseline noise level obtained based on estimated local land use.

Operational noise associated with Alternative 4 would consist of reservoir maintenance and the operation of pumps. The noise from these operational activities would be substantially less than construction noise. Under Alternative 4, there would be no impact to the nearest sensitive receptors after construction is completed. The nearest sensitive receptor to the desalination plant is a church located approximately 960 feet from the new substation. At that distance, and considering people would only be present at the church during the day when ambient noise levels are higher, noise from the substation would have attenuated to below noticeable noise levels. Long-term impacts on noise levels from operation Alternative 4 would be negligible.

4.13 Historic and Archeological Resources

The following section details anticipated impacts to cultural resources associated with the construction, operation, and maintenance of the Project. Impacts are discussed in terms of potential disturbance to previously recorded sites and historic built environment resources that are listed in, eligible for listing in, or that are assumed to be eligible for listing in the NRHP (historic properties).

The following impact indicators were considered when analyzing potential impacts to cultural resources:

- Number of NRHP-listed, determined eligible, or assumed eligible cultural resources/historic properties (historic and prehistoric) to be directly or indirectly affected and acres to be disturbed at each historic property
- Qualitative descriptions of changes in skylines or other visual settings in relation to cultural sites

Under Section 106 of the NHPA, adverse effects on historic properties occur when "an undertaking may directly or indirectly alter characteristics of a historic property that qualify it for inclusion in the Register" (36 CFR 800.5[a][1]). Impact levels for cultural resources are shown in Table 4.13-1.

Table 4.13-1. Impact Levels for Cultural Resources

	Negligible Impact	Minor Impact	Moderate Impact	Major Impact
Historic and archaeological resources	No measurable impacts.	Impacts would occur, but cultural resources would retain existing characteristics that make them eligible for the NRHP.	Impacts and alterations would occur, but overall, cultural resources would partially retain characteristics that make them eligible for the NRHP, or impacts would alter the characteristics that make them eligible for the NRHP.	Impacts would occur, that overall would substantially alter or destroy characteristics of cultural resources that make them eligible for the NRHP.

If moderate or major impacts to a historic property are identified, steps must be taken, in consultation with federal agencies, SHPO, other consulting parties, and potentially the ACHP, to avoid, minimize, or mitigate the adverse effects. Avoidance and minimization may include changing construction parameters, instituting more restrictive BMPs, or other administrative or engineering controls. Mitigation of effects may include intensive investigations to glean all significant data from affected portions of the resource, or other more far-ranging programs such as purchase and preservation of other historic resources, creation of preservation easements, documentation of resources outside the area of effect, or even development of research or education programs related to historic preservation.

4.13.1 No Action

Under the No Action alternative, the proposed Project would not be constructed or operated. Land use would likely remain as agricultural and no additional impacts to cultural and historical resources would be anticipated.

4.13.2 Proposed Action, Alternative 2A, and Alternative 2B

The Permit Area is the area analyzed for potential physical impacts and direct impacts. This consists of the approximately 2,533-acre Project site proposed for development for the Project between the Brazos River and Oyster Creek and the 1,100-acre mitigation site at Big Slough in Brazoria County, Texas. The area within 1 mile of the Permit Area was analyzed for potential non-physical, indirect impacts. Direct and indirect effects to historic properties could occur within any portion of the Permit Area. Direct effects could include physical, visual, auditory, or olfactory effects to historic properties. Indirect effects may be of the same range of effects; however, indirect effects are those caused by the Project that occur later in time or are farther removed in distance.

The cultural and historic resources environmental consequences discussion for each action alternative presents:

- A list of potential historic properties within the area analyzed for potential physical impacts.
- A list of potential historic properties within the area analyzed for potential non-physical impacts.
- A list of potential historic properties that occur outside the permit area that were brought to Dow’s attention through public comments prior to submitting their permit application to the Corps.

Dow currently owns the Project site. In July 2020, Dow prepared a *Cultural Resources Avoidance and Minimization Plan for Three Sites* to the USACE and THC for their review and comment (Dow 2020a:2). This document presented proposed avoidance and minimization measures for sites 41BO272, 41BO285 and 41BO286 (Ramsey Prison Camp), and the Quarles Cemetery; these measures included the erection of protective barriers (fencing), signage, and no work zones (Dow 2020a:3–13). As a result, temporary, minor impacts to the above four cultural and historical resources are anticipated. In addition, as noted in Section 3.13.1, all human burials in the state of Texas are protected by law; therefore, avoidance of direct impacts at the Phelps Family – Greenhill Cemetery would also be recommended.

As site 41BO271 cannot be avoided, a permanent, major impact is anticipated; however, mitigation measures are proposed to collect all significant data from the affected cultural resource. In July 2020, Dow submitted the *Scope of Work (SOW) for Data Recovery at Prehistoric Site 41BO271, Harris Expansion Project* to the USACE and THC for their review and comment. Because impacts to site 41BO271, a stratified, prehistoric Archaic shell midden, could not be avoided, the SOW provided a methodology and approach “for data recovery at the site to recover and interpret a representative sample of the site and curate that sample for future study" (Dow 2020b:2). The proposed data recovery plan included additional mechanical backhoe trenching to delineate the subsurface cultural deposits, the controlled hand excavation of 10 cubic meters of midden deposits within the site, the artifact analysis protocols, and finally reporting requirements (Dow 2020b:3).

Based on the results of the 2019 Big Slough survey and previous investigations within the mitigation site Permit Area, Cardno concluded that the area is unlikely to contain archeological or historic sites, and that the proposed mitigation bank project should not affect any sites or properties (Cardno 2019).

4.13.3 Alternative 3

Dow does not currently own the Alternative 3 site. No field surveys have occurred, but the cultural and historical resources are anticipated to be similar to those described for the Proposed Action. If this alternative is selected, systematic cultural resources surveys would need to be completed to determine required mitigation for impacts to cultural and historical resources.

Site 41BO272 is within the Alternative 3 Permit Area. Dow prepared the *Cultural Resources Avoidance and Minimization Plan for Three Sites* to the USACE and THC for their review and comment (Dow 2020a:2) in July 2020. This document presented proposed avoidance and minimization measures for site 41BO272, amongst others; these measures included the erection of protective barriers (fencing), signage, and no work zones (Dow 2020a:3–13). As a result, temporary, minor impacts to site 41BO272 are anticipated.

Site 41BO187 (the Orizombo/Phelps Plantation) is considered eligible for the NRHP by the THC; in addition, the Phelps Family – Greenhill Cemetery is associated with the plantation. Once field surveys are completed for Alternative 3 and it is determined that impacts to site 41BO187 could be avoided or minimized, then Dow would prepare a Cultural Resources Avoidance and Minimization Plan for USACE and THC review and commentary. Like the plan for the Proposed Action (Dow 2020a), this document would present proposed avoidance and minimization measures for the site, including but not limited to the erection of protective barriers (fencing), signage, and no work zones. As a result, temporary, minor impacts to site 41BO187 would be anticipated.

However, if site 41BO187 cannot be avoided, then Dow would develop mitigation measures to collect all significant data from the affected cultural resource and submit a *Scope of Work (SOW) for Data Recovery* for USACE and THC review and commentary. The proposed data recovery plan would include mechanical and hand excavation methods, artifact analysis protocols, and reporting requirements.

As noted in Section 3.13.1, all human burials in the state of Texas are protected by law; therefore, avoidance of direct impacts at the Phelps Family – Greenhill Cemetery would also be recommended.

4.13.4 Alternative 4

Dow does not currently own the Alternative 4 site but owns the Brazoria Reservoir land to the north of the proposed desalination plant and Dow's Texas Operations at the east end of the proposed corridor. No field surveys have occurred, but the cultural and historical resources are anticipated to be similar to those described for the Proposed Action. If this alternative is selected, systematic cultural resources surveys would need to be completed to determine required mitigation for impacts to cultural and historical resources.

As noted in Section 3.13.1, all human burials in the state of Texas are protected by law; therefore, avoidance of direct impacts at site 41BO122 (the Velasco Cemetery) would be recommended.

4.14 Hazardous Waste and Materials Management

The following section discusses anticipated impacts from HW/HM management associated with the construction, O&M, and decommissioning of the Project.

4.14.1 No Action

Under the No Action alternative, no additional water storage facilities would be constructed or operated and the Project would not take place. Dow would continue to operate its existing water supply system as is currently done, and the Project site would continue in its present state being used for agricultural farming and cattle grazing.

4.14.2 Proposed Action, Alternative 2A, and Alternative 2B

Three ConocoPhillips pipelines cross the Project site in a single pipeline corridor owned by Phillips 66 (see Figure 2.3-6). During construction of the Proposed Action, Alternative 2A, or Alternative 2B, these three pipelines would be relocated in a 100-foot-wide easement along the toe of the perimeter access road at the western and northern sides of the proposed reservoir. ConocoPhillips would demolish and remove the pipelines from the Project site and install new pipelines with conventional open-cut construction methods. The new pipelines would be installed at a depth of approximately 6 feet below grade, matching the design of the existing pipelines.

There are 11 abandoned and plugged oil and gas wells on the Project site that have been closed in accordance with RRC regulations (see Figure 2.3-8). At least seven of the 11 wells are located in the area of the proposed reservoir basin. During construction, closure of these wells would be validated, and appropriate steps would be taken so proper closure occurs during construction, if required. Protocols would be established for lowering well heads interfering with the reservoir construction.

The Project excavation would require the removal and placement of more than 12 million cy of material, in addition to the installation of several large pipelines, concrete structures, sheet piling, and a pumping station. Major equipment that may require mobilization by the contractors would include excavators, scrapers, loaders, dozers, blades, compactors, water trucks, bobcats, tractors, backhoes, electrical trenchers, lifts, and cranes.

Opportunities for the spill or release of HW/HM during construction include the removal or other modification of abandoned and plugged oil and gas wells, the relocation of existing pipelines, and the use and maintenance of typical construction equipment and fleet vehicles. Dow would be required to abide by all federal, state, and local HW/HM management regulations during construction of the Proposed Action to include establishment of a Project- and site-specific SWPP plan, and other waste and materials management guidelines, as appropriate. Dow would also apply the BMPs and applicant-committed measures as outlined in Section 2.8. With these plans and measures in place, accidental spills or releases to the land, air, or water during construction of the Proposed Action, Alternative 2A, or Alternative 2B, would result in localized, contained, infrequent, temporary, and negligible to minor impacts.

O&M of the water supply system under the Proposed Action, Alternative 2A, or Alternative 2B, would be similar to current Dow water supply system operations.

Dow would be required to abide by all federal, state and local HW/HM management regulations during operations of the Proposed Action to include establishment of a Project- and site-specific SPCC plan, SWPP plan, and other waste and materials management guidelines, as applicable. Dow would also apply the BMPs and applicant-committed measures as outlined in Section 2.8. With these plans and measures in place, accidental spills or releases to the land, air, or water during O&M and decommissioning of the Proposed Action would be expected to result in localized, contained, infrequent, temporary, and negligible to minor impacts.

4.14.3 Alternative 3

Alternative 3 would require relocation of two oil and natural gas pipelines that currently run through the Alternative 3 site (see Figure 2.5-6). These pipelines would be relocated to run along the outside of the proposed reservoir embankment to the west and north. It is also assumed that the existing farmsteads on the Alternative 3 site would be improved with domestic water wells. During construction, appropriate steps would be taken so proper closure occurs, if required. Protocols would be established for lowering well heads interfering with the reservoir construction.

Impacts related to potential spill or release of HW/HM during construction under Alternative 3 would be similar to those described under the Proposed Action. Dow would apply the BMPs and applicant-committed measures as outlined in Section 2.8.

Impacts related to potential spill or release of HW/HM during O&M of Alternative 3 would be minor, similar to the Proposed Action.

4.14.4 Alternative 4

Three existing oil and gas pipeline ROWs traverse the desal plant location within the Alternative 4 site that would need to be relocated during construction. Additionally, there are two existing oil and gas pipelines that run along the proposed water and RO concentrate pipeline corridor. It is not anticipated that these pipelines would need to be relocated.

There is also one dry oil and gas well on the Alternative 4 site. During construction, closure of this well would be validated, and appropriate steps would be taken so proper closure occurs during construction, if required. Protocols would be established for lowering well heads interfering with facility components.

Impacts related to potential spill or release of HW/HM during construction under Alternative 4 would be similar to those described under the Proposed Action. Dow would apply the BMPs and applicant-committed measures as outlined in Section 2.8.

Alternative 4 would require the handling and management of HW/HM (i.e., process chemicals) for proper operations. The annual estimated chemical usage in dry tons (dt) would be 500 dt sodium hypochlorite, 1,200 dt sodium hydroxide, 1,500 dt citric acid, 20 dt sodium bisulfite, 8,000 dt sulfuric acid, 4,000 dt ferric chloride, 400 dt polymer, 2,000 dt scale inhibitor, and 600 dt trisodium phosphate. Disposal would occur at a landfill such as the Seabreeze Environmental Landfill in nearby Angleton.

Dow would be required to abide by all federal, state, and local HW/HM management regulations during operations of Alternative 4 to include establishment of a Project- and site-specific SPCC Plan, SWPP Plan, and other waste and materials management guidelines, as applicable. Dow would also apply the BMPs and applicant-committed measures as outlined in Section 2.8. With these plans and measures in place, accidental spills or releases to the land, air, or water during operations of Alternative 4 would be expected to result in localized, contained, infrequent, temporary, and negligible to minor impacts.

4.15 Infrastructure

A description of proposed infrastructure is detailed in Dow's construction plan and summarized in Chapter 2. Impacts to infrastructure from Alternative 2A, Alternative 2B, and Alternative 3 are expected to be similar to the Proposed Action. Impacts from Alternative 4 would be slightly different than the Proposed Action due to the location and Project design.

4.15.1 Public Safety

4.15.1.1 NO ACTION

Under the No Action alternative, the proposed Project would not be constructed or operated. The property would continue to be closed to the public and only accessed by Dow staff. There would not be an increase in construction traffic that could increase the risk of the public using the surrounding roads.

4.15.1.2 PROPOSED ACTION, ALTERNATIVE 2A, ALTERNATIVE 2B, AND ALTERNATIVE 3

Project construction and operation would not affect the four police stations, four fire stations, and three hospitals in the analysis area.

During construction, access to the sites could increase the risk for personal injury. There would be an increase in the number of construction vehicles (e.g., dump trucks) and traffic on the public roads used for access, which could increase risk of personal injury of the public using those roads. All action alternatives include substantial earthmoving. Dow would work with the contractors to determine the safety requirements to include in each construction work package. As part of the contract, the selected contractor would be responsible for initiating, maintaining, and supervising all safety precautions and programs, including the safety of its employees and its subcontractors, as well as protection of property, equipment, and materials. Safety plans would include details on standards of conduct, reporting unsafe conditions, hazard controls, personal protective equipment, safety training and inspection requirements, and incident reporting.

During operations, all facilities would be fenced and gated, and access would be limited to Dow's operational staff. Embankment failure could threaten life and damage property in the surrounding area. Dow's O&M plan details inspection and maintenance guidelines for the embankment, as well as an evacuation plan in case of failure. The embankment condition would be inspected annually plus before and after large rain (5 inches) or wind (74 mph) events. Weekly inspections would note any seepage or drainage issues. Alternative 2B would be set back 273 feet from the Brazos River oxbow, compared to 90 feet for the Proposed Action, which would improve safety in this area. Facilities and equipment would be inspected weekly for any maintenance issues.

Dow's O&M plan also includes its security policy and emergency response plan. Dow has a community awareness and emergency response call program that allows the public to report suspicious activities. The emergency response plan includes procedures for weather, freeze, pandemic, general emergency (e.g., fire, flood, or explosion). Contact information and communication protocols are included. Overall impacts to public safety would be minor.

4.15.1.3 ALTERNATIVE 4

Access to the Alternative 4 site would be limited to Dow's operational staff; there would be no public access. Although there is no embankment and the types of facilities and equipment would differ, the safety procedures during construction and operations would be similar to the Proposed Action. Overall impacts to public safety would be minor.

4.15.2 Transportation

4.15.2.1 NO ACTION

Under the No Action alternative, the proposed Project would not be constructed or operated. As a result, impacts to roads and transportation would not occur.

4.15.2.2 PROPOSED ACTION, ALTERNATIVE 2A, AND ALTERNATIVE 2B

Impacts to transportation would be moderate during construction. The majority of the construction workers would come from the local communities, which have an ample construction labor pool. An estimated 50% of the construction workers would drive to the Project site from within a 25-mile radius, another 35% would come from within a 50-mile radius, and the other 15% would be from beyond 50 miles. Therefore, traffic on roads surrounding the Project site would increase during the 2.5 years of construction. The degree of increase would vary depending on construction phase, but an increase in AADT counts would be noticeable on the roads listed in Table 3.15-1 compared to current conditions.

Estimated truck trips by phase, vehicle type, and distance are provided in Table 4.15-1. Construction trucks could impact traffic flows due to their larger size, reduced speed, and reduced maneuverability compared to standard automobiles, on the roadway. The largest impact to traffic and roads would be from dump truck traffic during reservoir construction.

Table 4.15-1. Estimated Truck Trips

Phase	Vehicle Type	Trips	Miles
Reservoir construction	Box truck	3	25
Reservoir construction	Concrete truck	1,139	25
Reservoir construction	Flatbed	62	25
Reservoir construction	Flatbed	361	35
Reservoir construction	TR dump truck	1,655	25
Reservoir construction	TR dump truck	34,976	50
Pump station construction	Flatbed	203	25
Pump station construction	Flatbed	25	50
Pump Station construction	Flatbed	12	100
Oyster Creek improvements	53-foot Trailer	18	25
Oyster Creek improvements	Flatbed	4	50
Oyster Creek improvements	Box truck	2	25
Oyster Creek improvements	Box truck	18	50

Source: Estimates provided by Dow.

There would be a temporary increase in the AADT during construction. Construction would cause an increase in large truck traffic associated with equipment and material deliveries, which could mean slower moving traffic on roadways and delays in travel times. Traffic delays could occur at intersections without designated turn lanes due to the additional construction vehicles. There would also be an increase of personal vehicle traffic generated by workers commuting to the site. Increased traffic would increase the possibility of accidents with more vehicles on roadways. Large trucks using the roads around the site would cause an increased rate of pavement deterioration.

These impacts would be temporary and minor and would be further minimized with use of signage and traffic control measures to assist with transportation of construction equipment and materials in coordination with the local road authority. Contractors would be required to remove or clean mud and debris from construction equipment. Roads would be repaired to pre-construction conditions in coordination with TxDOT.

During operations, roadway traffic would return to current conditions. There would be no impacts to transportation related to airports or railroads during construction or operation.

4.15.2.3 ALTERNATIVE 3

Impacts to transportation would be the same as for the Proposed Action. In addition, Alternative 3 would requires approximately 3 miles of CR 25 intersecting the site to be relocated to the east side of the reservoir. Traffic on CR 25 (AADT count = 216) would experience temporary minor impacts as a result.

4.15.2.4 ALTERNATIVE 4

Impacts to transportation would be moderate during construction of Alternative 4. Construction vehicles would drive in and out of the site during construction of the desal facility and drying beds and installing pipelines within the ROW. Truck trip estimates were not provided; however, they are expected to be generally similar to the Proposed Action with the largest number of trips for dump trucks during construction of pre-sedimentation basin and the 20 sludge drying beds. The degree of increase would vary depending on construction phase, but an increase in AADT counts would be noticeable on the roads listed in Table 3.15-2 compared to current conditions.

During operations, any large vehicle traffic would be related to dredging the sludge beds. Other traffic would be limited to a few employee vehicles. There would be no impacts to transportation related to airports or railroads during construction or operations.

4.15.3 Utilities

4.15.3.1 NO ACTION

Under the No Action alternative, the proposed Project would not be constructed or operated. As a result, there would be no change in the existing utilities. The pipelines and power line would remain in their current locations.

4.15.3.2 PROPOSED ACTION, ALTERNATIVE 2A, AND ALTERNATIVE 2B

Impacts to utilities would be temporary and minor. The pipelines, power line, and oil and gas well heads would be relocated for the Project. The portion of the pipelines that cross the Project would be relocated by Conoco Phillips in a 100-foot-wide easement along the toe of the perimeter access road at the western and northern sides of the reservoir. Pipeline availability would be temporarily disrupted during construction. The relocation would take approximately 4 months.

The relocation of the power line by CenterPoint would occur in two phases. The first phase is the demolition and re-route of the 12.47-kV line that currently runs through the proposed reservoir site. The re-routed line would tie into the existing line running along CR 34 at the northeast corner of the existing Harris Reservoir, run along the proposed reservoir toe road, and tie back into the existing line along the northeast side of the Project site. Relocation would take approximately 3 months and temporary power disruptions may occur in the local area occasionally during construction. After the existing line is rerouted, two new power lines would be constructed: one to the pump station and the other to the outlet structure. Construction of new power lines would take approximately 2 months.

The oil and gas wells have been plugged, abandoned, and closed in accordance with RRC regulations. Closure would be validated and appropriate steps would be taken so proper closure occurs during construction, if required. Well heads would be lowered if they interfere with the reservoir construction.

Other on-site utilities would include a new potable water well to supply water for the operations building restrooms, eyewash, vacuum pump seal water, utility hose water, water pump seal flushing and bearing cooling, and gear reducer oil cooling, if needed.

4.15.3.3 ALTERNATIVE 3

Impacts to utilities would be minor and similar to the Proposed Action. For Alternative 3, approximately 3 miles of CR 25 intersecting the site would need to be relocated to the east side of the reservoir. The temporary construction ROW would be 64 feet wide, and the permanent ROW would be 44 feet wide. Alternative 3 would also require relocation of two oil and natural gas pipelines. The pipelines would be relocated to run along the outside of the reservoir embankment to the west and north. Approximately 2.0 miles of the natural gas pipeline operated by Energy Transfer and approximately 3.6 miles of the highly volatile liquid pipeline operated by Enterprise Products Partners L.P. would need to be relocated. The total temporary impacts for the pipeline relocations would be 2,125 acres; the total permanent impacted area would be 2,110 acres.

4.15.3.4 ALTERNATIVE 4

Impacts to utilities would be minor and similar to the Proposed Action. The three existing oil and gas pipeline ROWs that traverse the west side of the Alternative 4 site would be relocated around the desal plant, and the one drilled well that is dry would need to be verified and head lowered, as described for the Proposed Action.

Relocation of existing power lines would not be required for Alternative 4. Under Alternative 4, the power company would need to build a new power substation to feed the desalination plant. Two acres of land for a new power corridor would be acquired by the power company. The power line would tie into the double pole on the west side of CR 674 and the single pole on the east side of CR 674. Construction impacts would occur within a 2-mile-long power line ROW requiring 30 acres. Other than the power line structures, the land within the ROW would be temporarily impacted.

The desalination plant, including pump stations for product water and brine disposal, is estimated to have a 60-megawatt electrical load. The product water and concentrate disposal pump stations would require 40- and 30-pounds per square inch (psi) discharge pressure, respectively.

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5 CUMULATIVE EFFECTS

5.1 Introduction

This chapter examines the potential cumulative impacts (effects) of the proposed Harris Reservoir Expansion Project (Proposed Action) and Alternatives 2, 3, and 4, as described in Chapter 2. Cumulative impacts are the incremental impacts that a project has on a resource, taking into account impacts on that resource resulting from other past, present, and future unrelated activities. Therefore, cumulative effects include a project’s impacts to a certain resource plus the impacts of other actions not caused by the project. Cumulative effects may be adverse or beneficial. The objective of this cumulative effects analysis (CEA) is to focus on key resource issues where effects of the Proposed Action or alternatives could contribute to cumulative effects of the overall condition of the resource.

As discussed in Section 4.1.2, the CEQ issued new NEPA regulations that went into effect on September 14, 2020, (CEQ 2020) and do not specifically require CEA. The NOI for this DEIS was issued on April 7, 2020, and this DEIS follows the requirements of the regulations effective at the time of issuance of the NOI and therefore includes a CEA.

The CEQ regulations for NEPA implementation, under which this draft EIS is being prepared, defines cumulative effects as

> *the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-federal) or person undertakes such other actions*. (40 CFR 1508.7)

The concept of cumulative effects considers that development projects can lead to further development. Additionally, every resource has a limited capacity to sustain effects. A resource can only absorb so many additional effects before it fails. Simply stated, analyzing cumulative effects addresses the sustainability of a resource (TxDOT 2019e). An illustration of the concept of cumulative impacts is presented in Figure 5.1-1. Evaluating cumulative effects should be completed for a resource found to be affected by the Project. Resource impacts that do not have a reasonably close causal relationship to the Proposed Action or alternatives are not considered in the CEA.

The CEA presented in this chapter is consistent with the CEQ regulations (40 CFR 1500-1508), CEQ’s 1997 *Considering Cumulative Effects Under the National Environmental Policy Act*, and the EPA’s *Consideration of Cumulative Impacts in the EPA Review of NEPA Documents* (EPA 1999).

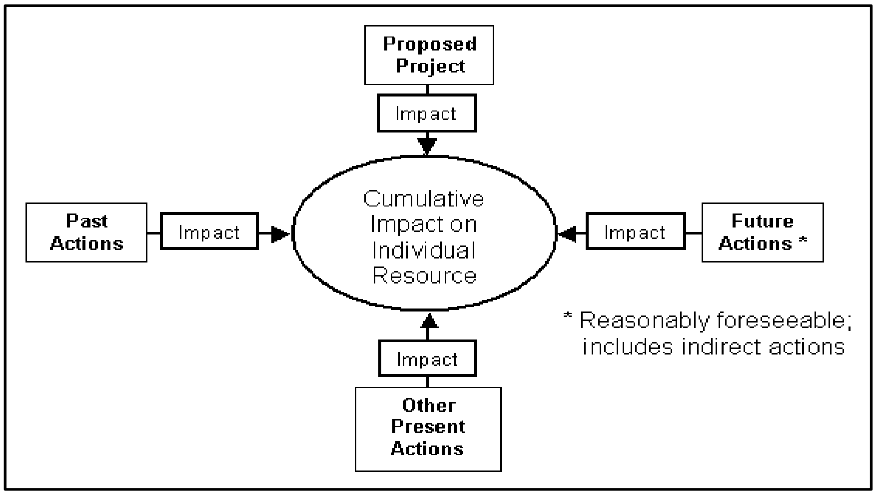

Figure 5.1-1. Cumulative impacts illustration.

5.2 Spatial and Temporal Boundaries

Cumulative impact assessments for each resource must consider spatial (physical) and temporal (duration) boundaries. For this analysis, the spatial boundaries for the consideration of cumulative effects are identified in the discussion of cumulative impacts below. Spatial and temporal boundaries for the CEA were based on potential impacts to relevant resources presented in Chapters 3 and 4. With consideration of the general condition of resources within the defined spatial boundary, resources that are anticipated to be impacted by the Proposed Action or the alternatives were evaluated for inclusion in the CEA. Resources retained for the CEA generally included 1) those resources for which the Project or alternatives would have moderate or major long-term impacts, and/or 2) resources in poor or declining health or at risk even if the Project impacts were relatively minor. Key resources retained for the CEA consist of the following:

- Soils/sedimentation and erosion
- Prime farmland soils/agriculture
- Land subsidence
- Surface water/water quality
- Environmental flows/system flows
- Floodplains/flood hazards
- WOUS, including wetlands
- Terrestrial vegetation
- Aquatic vegetation
- Terrestrial/aquatic wildlife
- Threatened and endangered species (Texas fawnsfoot)
- Climate/air quality
- Visual resources

5.2.1 Spatial Boundaries

As Project alternatives are located along the Brazos River and/or Oyster Creek, the CEA study area has been broadly defined as the lower portion (below the confluence of Allens Creek and the Brazos River) of the Lower Brazos River Basin (HUC 12070104) and the Austin-Oyster Creek River Basin (HUC 12040205) (Figure 5.2-1). This watershed-based CEA study area was selected as the Project is located along the Brazos River and Oyster Creek, affects both streams, and could potentially affect resources downstream of proposed Project components. The upper portion of the Lower Brazos Watershed, which primarily falls within Waller, Washington, and Austin Counties, has not been included in the CEA study area, as the Project is not anticipated to affect resources in the upper portion of the Lower Brazos Watershed. When appropriate, resource-specific study areas were utilized for certain resources and are presented and discussed in subsequent sections. Spatial boundaries for specific resources are summarized in Table 5.2-1.

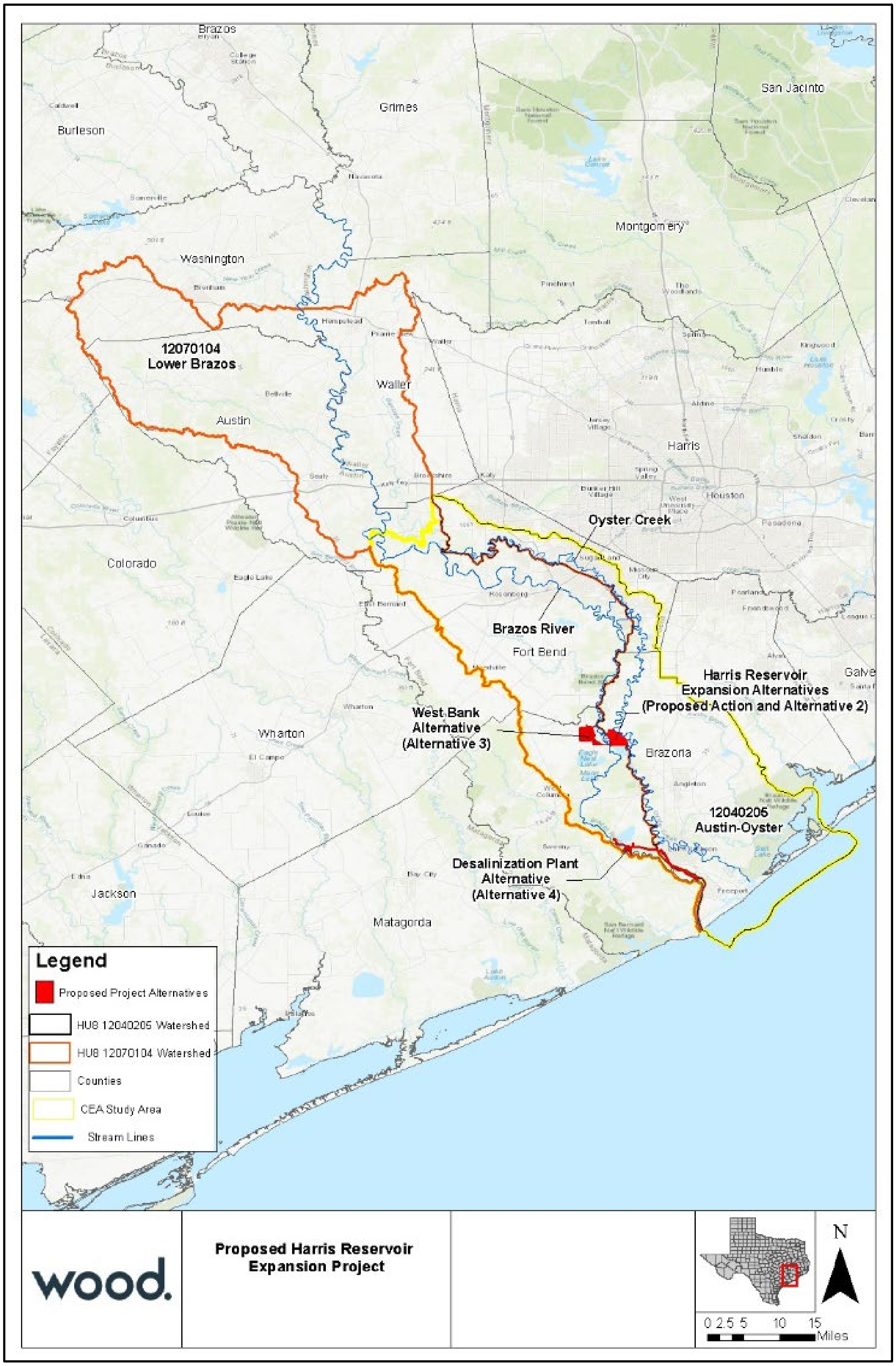

Figure 5.2-1. CEA study area.

Table 5.2-1. Spatial Boundaries for Specific Resources

Resource Area	Specific Resource	Resource-Specific Spatial Limits for CEA
Topography, Geology, and Soils	Topography	CEA study area
	Geology	CEA study area
	Soils/prime farmland	Brazoria and Fort Bend Counties
	Sedimentation and erosion	CEA study area
	Land subsidence	Brazoria and Fort Bend Counties
Water Resources	Surface water/water quality	CEA study area
	Groundwater	CEA study area
	Hydrology	CEA study area
	Floodplains/flood hazards	CEA study area
	Water rights	Lower Brazos River and Oyster Creek Basins
	WOUS, including wetlands	CEA study area
Vegetation	Terrestrial vegetation	CEA study area
	Aquatic vegetation	CEA study area
Wildlife	Terrestrial wildlife	CEA study area
	Aquatic wildlife	CEA study area
	Migratory birds	CEA study area
	Commercial game animals	Brazoria County
	Invasive wildlife	Brazoria County
Threatened and Endangered Listed Species	Whooping crane	CEA study area
	Texas fawnsfoot	CEA study area
	Monarch butterfly	CEA study area
Listed or Sensitive Species	State-listed species	CEA study area
Land Use	Pasture/agriculture	CEA study area
Socioeconomic Resources	Population and housing community facilities and services Industry and employment Environmental justice	Brazoria/Fort Bend Counties
	Visual and aesthetic navigation and recreation	CEA study area
Climate and Air Quality	Climate	Brazoria and Fort Bend Counties
	Air quality	Brazoria and Fort Bend Counties
Noise	Noise	Brazoria and Fort Bend Counties
Historic and Archeological Resources	Historic and archeological resources	CEA study area
Hazardous Waste and Hazardous Materials	Hazardous waste/hazardous materials	CEA study area
Infrastructure	Public health and safety	CEA study area
	Transportation	Brazoria and Fort Bend Counties
	Utilities	Brazoria and Fort Bend Counties

5.2.2 Temporal Limits

Temporal limits for evaluated projects within the CEA are generally defined to capture relatively recent, ongoing, and reasonably foreseeable future actions that may contribute to the decline of a resource. For this assessment, we have identified projects that have been completed within the past 5 years (2016–2020) or will be constructed within approximately 5 years to include in this CEA. The temporal limits for specific resource cumulative effects analyses vary among resources and are consistent with anticipated impacts presented in Chapter 4.

5.3 Past, Present, and Reasonably Foreseeable Activities

Existing conservation plans, civil works projects, regional planning documents, and specific information used by the USACE pertaining to issued permits in the CEA study area were used to identify projects to be considered in the CEA. Publicly available information, such as NEPA documentation and USACE permit records for each project, was reviewed to assess potential Project-related impacts to resources considered. Based on whether and how projects would affect the resources in Table 5.2-1, the following projects (or suite of projects) were identified for the CEA:

- Sienna Plantation Master Planned Community
- Brazos River floodgates
- Freeport Harbor Channel improvement projects
- Allens Creek Reservoir (proposed)
- Freeport liquid natural gas (LNG) projects
- USACE–permitted projects with permanent impacts between 2016 and 2020
- The Nature Conservancy (TNC) Brazos Woods Preserve

A description and summary of each of these projects or groups of projects is included in Table 5.3-1, and their locations are shown on Figure 5.3-1. Potential contributing cumulative impacts of the projects included in this CEA are based on previous NEPA and permit documentation, if available.

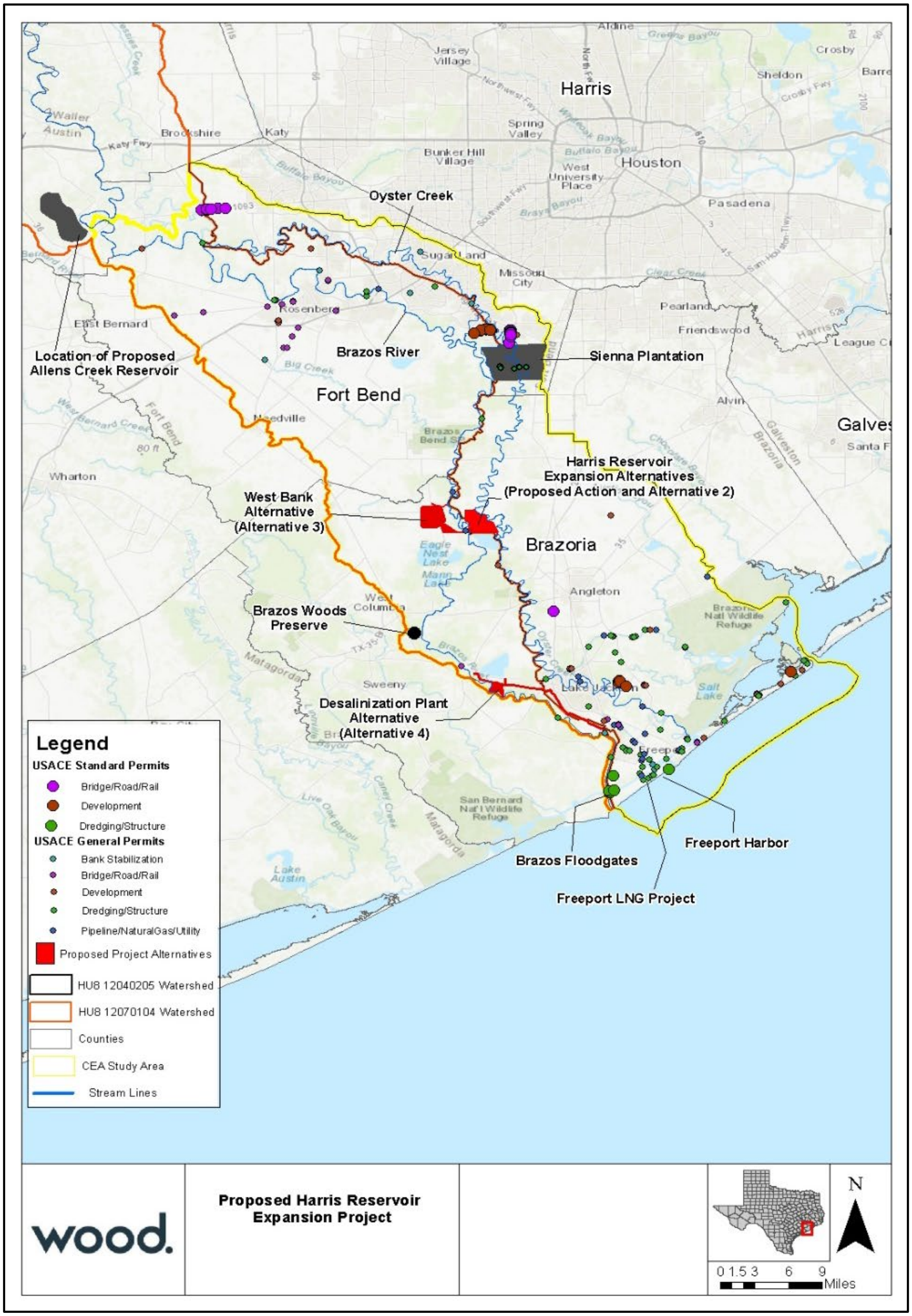

Figure 5.3-1. Projects included in cumulative effects analysis.

Table 5.3-1. Past, Present, and Reasonably Foreseeable Projects Included in the Cumulative Effects Analysis

Project	Description (purpose, scope, known issues)	Status	Key Resources* Affected
Sienna Plantation Master Planned Community	Sienna Plantation is an approximately 10,000-acre master planned community in Fort Bend County, Texas. The development is on the east side of the Brazos River in Missouri City. There is a levee system surrounding the development that requires routine maintenance and alterations to effectively manage the flooding in the area. The Sienna Plantation stormwater reservoir regulates flows because it removes 63% of the Oyster Creek flows and moves them to the Brazos River (Watearth 2021a).	Ongoing	Brazos River and Oyster Creek system and environmental flows
Brazos River floodgates	The Brazos River Floodgates are located where the Gulf Intercoastal Waterway intersects with the Brazos River southwest of Freeport in Brazoria County, Texas. Features of the Brazos River floodgates project are the removal of the existing gates on both sides of the river crossing, the construction of a 125-foot-wide open channel on the west side, and a new 125-foot-wide sector gate structure on the east side. The open channel would have a bottom depth of -12 feet North American Vertical Datum of 1988 (NAVD88) with a bankfull width of approximately 500 feet. The new sector gate on the east side would be set back approximately 1,200 feet from the existing gate structure, providing increased safety and efficient vessel operation through the system, reducing collisions (USACE 2019b).	Ongoing	WOUS, including wetlands; water quality; threatened and endangered species; air quality
Freeport Harbor Channel improvement projects	These projects include widening the Freeport Harbor Jetty and Entrance Channel (USACE 2008) and deepening the Freeport Harbor channel and turning basins and implementing a dredged material management plan and compensatory mitigation plan (USACE 2012). After the General Conformity Determination and FEIS for the Freeport Harbor Channel Improvement Project was approved, it was determined that additional widening and slope stabilization would be required in Reach 2 around the Dow Thumb area. The recommended plan involves widening the channel at the Dow Thumb to 400 feet and constructing the bend easing and turning notch, all to 46 feet deep. No additional environmental effects (USACE 2018f).	Ongoing	Erosion and sedimentation; WOUS including wetlands; water quality; vegetation; wildlife; threatened and endangered species; air quality
Allens Creek Reservoir (proposed construction to begin in 2025)	The Brazos River Authority proposes to create an off-channel reservoir near the City of Wallis in Austin County, which is more than 60 miles upstream of the proposed Project. Once completed, water will be pumped into Allens Creek Reservoir from the Brazos River during periods of high streamflow and available for release back into the Brazos River to meet downstream needs during periods of low flow. Water stored in Allens Creek Reservoir will be used to meet the anticipated growth in demand for surface water in the Lower Brazos Basin due to projected population increases. The reservoir will also help satisfy regulatory requirements to reduce groundwater pumping, which contributes to subsidence in the Houston area. The reservoir will provide 95,000–100,000 acre-feet of water per year of firm water supply—the annual water use of over 150,000 families (BRA 2021c). Allens Creek Reservoir would inundate approximately 7,000 acres. This project is configured as a scalping reservoir that would divert stormwater flows from the Brazos River and impound these flows in the reservoir to create storage yield. The conservation storage quantity is approximately 145,500 acre-feet at an elevation of 121 feet msl. The projected firm yield of this project is 99,650 acre-feet per year. Supplies from the reservoir could be used to meet needs in the lower Brazos and San Jacinto River Basins, as well as in adjoining coastal basins (TWDB 2020f).	Future†	Although not formally evaluated, potential impacts are assumed to be similar in nature as Proposed Action for this CEA.

Project	Description (purpose, scope, known issues)	Status	Key Resources* Affected
Freeport LNG projects	The Liquefaction Project and Phase II Modification Project would involve the construction and operation of the liquefaction plant, pretreatment plant, other aboveground facilities, and the associated pipeline and utilities. The environmental analysis contained in the FEIS evaluates the facilities proposed for both the Liquefaction Project and the Phase II Modification Project (FERC 2014).	Completed	WOUS including wetlands; water quality; land subsidence
USACE-permitted projects with permanent impacts between 2016–2020	Includes various standard (individual) and general (including nationwide) permits issued by the Galveston District for permanent impacts to wetlands and/or streams within the CEA study area between 2016 and 2020. Types of projects included bank stabilization, development (commercial and/or industrial), pipelines and other utility corridors, roadways and railroads, and dredging and structures (USACE 2020c). Similar activities expected to continue to occur within the CEA study area in the future.	Ongoing	WOUS including wetlands; water quality
TNC Brazos Woods Preserve	The 681-acre Brazos Woods Preserve and the neighboring 1,656-acre San Bernard Woods Preserve were established in 2016 in the largest infusion of private conservation funding in the Columbia Bottomlands to date. These areas lie within the USFWS's Austin Woods Conservation Plan Boundary (TNC 2021) along the Brazos River between the Harris and Brazoria Reservoirs.	Completed	WOUS including wetlands; vegetation; wildlife

Notes: A project partnership agreement was signed between Port Freeport and the USACE on June 25, 2020, moving the project into the construction phase.

* Key resources included 1) those resources for which the Project or alternatives would have moderate or major long-term impacts, and/or 2) resources in poor or declining health or at risk even if the Project impacts were relatively minor.

† Water rights permit secured, land purchased, pending federal and state permits, proposed construction estimated to begin 2025 (BRA 2021c).

5.4 Cumulative Impacts

5.4.1 Summary of Effects from Proposed Action and Alternatives

Chapter 4 details anticipated impacts from the Proposed Action and the alternatives. In general, the Proposed Action, Alternative 2A, and Alternative 2B have similar impacts due to the similarity of these alternatives. For both alternatives, the proposed reservoir expansion is sited within the floodplain between the Brazos River and Oyster Creek, with relatively minor differences between the footprints of these alternatives. Alternative 3 includes the construction of a reservoir; however, it would be located on the west side of the Brazos River outside the floodplain. Alternative 4 includes the construction of a desalinization plant along the Brazos River farther downstream (see Figure 5.3-1) and does not include the construction of a reservoir. Alternative 4 is located within the 100-year floodplain and would result in short-term impacts associated with construction (e.g., potential erosion and sedimentation due to land disturbance) and long-term impacts such as loss of terrestrial and wetland habitats similar to the Proposed Action, Alternative 2A, and Alternative 2B but would impact more bottomland forest habitat than any other alternative. Specific impacts of alternatives for key resources are fully discussed in Chapter 4 and summarized in Section 5.3.

5.4.2 Key Resources Retained for Cumulative Effects Analysis

Resources potentially susceptible to cumulative impacts were retained for the CEA (Table 5.4-1). Resources retained for the CEA generally included resources that would sustain long-term moderate or major impacts and/or impacted resources in poor or declining health. This includes resources that would potentially sustain impacts during construction or operation of the proposed alternatives. Resources that were dismissed from the CEA are those resources that would be expected to sustain only temporary minor or negligible effects and/or resources that are not susceptible to cumulative impacts.

Table 5.4-1. Key Resources Retained for the CEA

Resource Area	Specific Resource	Key Resource Determination
Topography, Geology and Soils	Topography	No. As potential impacts to topography would be minor for all action alternatives and geographically separated from projects considered in this CEA, topography is not considered a key resource.
	Soils/sedimentation and erosion	✓ Yes. Potential impacts would be moderate for all action alternatives, and potential cumulative effects due to other projects in the CEA study area would have similar impacts.
	Prime farmland	✓ Yes. Moderate effects for all action alternatives and potential for cumulative effects due to the loss of a finite resource in the region.
	Land subsidence	✓ Yes. Potential for cumulative effects as there is ongoing subsidence within the CEA study area, resulting in moderate increased risk of effects from all action alternatives' incremental contribution to cumulative effects.
Water Resources	Surface water/water quality	No. As potential impacts to water quality would be minor for all action alternatives and geographically separated from projects considered in this CEA, water quality is not considered a key resource.
	Environmental flows/system flows	✓ Yes. An increase in peak flows in Oyster Creek under the Proposed Action and Alternatives 2A and 2B would potentially cause moderate effects to Oyster Creek (scour, incision, widening likely).
	Groundwater	No. Impacts to groundwater are not anticipated under any of the action alternatives; therefore, groundwater is not included as a key resource.
	Floodplains/flood hazards	✓ Yes. Potential moderate flood hazards from the Proposed Action, Alternatives 2A and 2B, and Alternative 4. Potential cumulative effects such as flooding are a major issue within the CEA study area.
	Water rights	No. As no impact is anticipated under any alternative, this is not considered a key resource for cumulative assessment.
	WOUS, including wetlands	✓ Yes. All action alternatives are considered to have overall moderate impacts. Potential cumulative effects due to the loss of a finite resource in the region and other projects in the CEA study area that would have similar impacts to the action alternatives.
Vegetation	Terrestrial vegetation	✓ Yes. Potential cumulative effects due to other projects in the CEA study area that would have similar impacts. All action alternatives are considered to have moderate impacts.
	Aquatic vegetation	✓ Yes. Potential cumulative effects to aquatic vegetation due to other projects within the CEA study area having similar impacts. All action alternatives are considered to have moderate impacts.
Wildlife	Terrestrial wildlife	✓ Yes. Potential cumulative effects due to other projects in the CEA study area that would have similar impacts. All action alternatives are considered to have moderate impacts.
	Aquatic wildlife	✓ Yes. Potential cumulative effects due to other projects in the CEA study area that would have similar impacts. All action alternatives are considered to have moderate impacts.
	Migratory birds	✓ Yes. Potential cumulative effects due to other projects in the CEA study area that would have similar impacts. All action alternatives are considered to have moderate impacts.
	Commercial game animals	✓ Yes. Potential cumulative effects due to other projects in the CEA study area that would have similar impacts. All action alternatives are considered to have moderate impacts.
	Invasive wildlife	No. As potential impacts to invasive wildlife are anticipated to be ***minor*** and localized, and the Proposed Action or alternatives would not specifically introduce invasive wildlife. This resource is not considered a key resource issue in this CEA.

Resource Area	Specific Resource	Key Resource Determination
Threatened and Endangered Listed Species	Whooping crane	✓ Yes. All action alternatives may affect, but are not likely adversely affect the whooping crane. This resource is considered a key resource issue for this CEA. Migratory birds are also considered in the CEA.
	Texas fawnsfoot	✓ Yes. All action alternatives may affect, but are not likely adversely affect the Texas fawnsfoot (proposed threatened). This resource is considered a key resource issue for this CEA.
	Black rail	No. As impacts from all action alternatives would have no effect, this resource is not specifically considered a key resource issue for this CEA. However, general wildlife is considered in the CEA.
	Monarch butterfly	✓ Yes. All action alternatives may affect, but are not likely adversely affect the Monarch butterfly (candidate). This resource is considered a key resource in this CEA. Cumulative impacts to vegetation are also included.
Other Listed or Sensitive Species	State-listed species	✓ Yes. All action alternatives are considered to have moderate impacts to some listed species. Potential impacts to other listed species would be negligible to minor.
Essential Fish Habitat	Essential fish habitat	No. As negligible impacts are anticipated under Alternative 4 and no impact is anticipated under the other action alternatives, this is not considered a key resource for cumulative assessment.
Land Use	Pasture/agriculture	✓ Yes. Proposed Action, Alternatives 2A and 2B, and Alternative 3 would have a moderate impact on agriculture. Prime farmlands are also considered in the CEA.
Socioeconomic Resources	Population and housing	No. As impacts would be relatively minor and localized, this resource is not considered a key resource for the CEA. Cumulative effects would not be anticipated as impacts of evaluated projects would be separated by distance and/or time.
	Community facilities and services	No. This resource is not considered a key resource issue as impacts are considered negligible. Cumulative effects would not be anticipated as impacts of evaluated projects would be separated by distance and/or time.
	Industry and employment	No. Due to the localized and minor impact to industry and employment, this resource is not considered a key resource issue. Cumulative effects would not be anticipated as impacts of evaluated projects would be separated by distance and/or time.
	Environmental justice and protection of children	No. As impacts are considered negligible, environmental justice communities and children are not considered a key resource issue in this CEA.
	Navigation and recreation	No. As potential impacts to navigation and recreation would be negligible to minor and separated by time and/or distance from projects considered in this CEA, it is not considered a key resource issue in this CEA.
	Visual resources	✓ Yes. Impacts from action alternatives would have moderate effects to some sensitive viewers at some viewing locations.
Climate and Air Quality	Climate and air Quality	No. There would be potential minor construction-related and long-term impacts from alternatives. Brazoria County has a “marginal attainment” status. Potential impacts to climate change considered negligible.
Noise	Noise	No. As potential minor to moderate impacts to noise would be temporary and separated by time and/or distance from projects considered in this CEA, noise is not considered a key resource issue in this CEA. Operational noise impacts would be negligible for all alternatives.
Historic and Archeological Resources	Archaeological resources	No. Although the Proposed Action or alternatives would have a major impact to cultural resources, it is not included in the CEA due to the implementation of mitigation measures that have been developed and would be implemented for the Project as described in Section 4.13. Mitigation measures for potential resources would be implemented under each alternative. Additionally, this impact would be localized and would not contribute to the cumulative effects to other cultural resources within the CEA study area.

Resource Area	Specific Resource	Key Resource Determination
Hazardous Waste/Hazardous Materials	Hazardous waste and hazardous materials	No. Impacts associated with hazardous waste/hazardous materials are regulated by federal, state, and local regulations and are not considered a key resource. Cumulative impacts are not anticipated as potential impacts would result in localized, contained, infrequent, temporary, and negligible to minor adverse impacts. Potential impacts would likely be separated by time and/or distance from other projects included in this CEA.
Infrastructure	Public health and safety	No. The Proposed Action and alternatives would not affect police stations, fire stations, or hospitals.
	Transportation	No. For the Proposed Action and alternatives, the largest impact to traffic and roads would be from traffic during construction. Potential impacts to transportation would be temporary and separated by time and/or distance from other projects included in this CEA.
	Utilities	No. Potential impacts to utilities would be temporary and minor and separated by time and/or distance from other projects included in this CEA.

5.4.3 Cumulative Effects

The potential for a cumulative impact contribution to key resources from the Proposed Action or alternatives is discussed in this section under each key resource. The potential contribution to cumulative impacts for key resources is based on potential impacts identified in Chapter 4, as compared to the overall current health and condition of that resource within the CEA study area, as well as the potential impacts of past, present, and reasonably foreseeable projects (see Table 5.3-1).

5.4.3.1 SEDIMENTATION AND EROSION

5.4.3.1.1 Current Health and Historical Context

Section 3.2.3 presents detailed information on the affected environment pertaining to sedimentation and erosion. This section provides a brief summary of the resource area as it pertains to the CEA study area.

The Brazos River is an incised, meandering, sand-bed channel with unstable banks (Dunn and Rains 2001). Brazos River discharges are dominated by upstream riverine processes such as erosion, sedimentation transport, and deposition rather than precipitation-induced discharges locally in the coastal plain. The Brazos River in the vicinity of the Proposed Action exhibits signs of sedimentation and erosion, which reflects the cumulative effects of past actions on erosion and sedimentation.

Historical sediment loads for the Brazos River have decreased for particles larger than sand (e.g., gravel and cobble) and have increased overall for sand and smaller particles (Fields 1988) due to upstream control structures. The reduced sediment load can increase the amount of sediment picked up and carried downstream with a corresponding reduction in the amount of sedimentation, which results in steep-sided channels (incised), loss of sinuosity (bends in the creek or river), and undercut banks. Neither the Brazos River nor Oyster Creek are considered impaired for sediment within the CEA study area (TCEQ 2020a).

5.4.3.1.2 Cumulative Effects Summary

The Proposed Action and other present and reasonably foreseeable future projects identified in Table 5.4-2 have the potential to cause increased erosion and sedimentation during construction activities. Increased erosion and sedimentation within the watershed as a result of multiple projects affecting the same resource would be greater than individual projects on their own. However, potential erosion and sedimentation impacts associated with construction are typically relatively short-term and minor, as standard erosion and sediment control BMPs are generally required for construction projects. Potential erosion and sedimentation impacts associated with the construction of the Proposed Action or the alternatives would not be expected to lead to increased erosion and sedimentation within the CEA study area, and temporary effects of construction would not be expected to affect waterways in the long term. With the implementation of BMPs and compliance with regulatory requirements, the cumulative contribution of construction-related erosion and sedimentation from each action on waterways would be minor.

As shown in Table 5.4-2, potential erosion and sedimentation impacts associated with the operation of the Proposed Action or the alternatives is considered moderate. This impact may contribute to erosion and sedimentation issues within the CEA study area; however, the potential contribution of the Project to cumulative effects would be reduced through the implementation of mitigation measures and Dow's O&M plan, which includes inspections and would help to identify any erosion issues during operations. Additionally, implementation of BMPs as described in Section 2.8, as well as implementation of the mitigation plan (SWCA 2022), would avoid or minimize the potential contribution to cumulative impacts within the CEA study area.

Table 5.4-2. Potential Contribution to Sedimentation and Erosion Identified for CEA Projects

Project	Summary of Potential Contribution to Cumulative Impacts
Proposed Action and alternatives	Construction-related impacts (for all alternatives) due to vegetation clearing, grading, and/or excavating activities would be relatively short-term and considered minor with the implementation of BMPs. Operation of Proposed Action and Alternatives 2A and 2B could cause erosion and sedimentation impacts to both Oyster Creek and the Brazos River due to reservoir releases. Similarly, Alternatives 3 and 4 could cause erosion and sedimentation impacts to the Brazos River. This potential impact is considered moderate.
Freeport Harbor Channel improvement projects	Potential impacts would be expected to sediment patterns in coastal areas; impacts would be considered negligible.
Allens Creek Reservoir (proposed construction 2025)	Potential impacts would be expected to be similar in nature as the Proposed Action, Alternatives 2A and 2B, and Alternative 3.
Freeport LNG projects	Potential construction-related erosion and sedimentation impacts would occur.
USACE–permitted projects with permanent impacts between 2016–2020	Potential construction-related erosion and sedimentation impacts may occur.

5.4.3.2 PRIME FARMLAND SOILS/AGRICULTURE

5.4.3.2.1 Current Health and Historical Context

Section 3.2.2 presents detailed information on the affected environment pertaining to soils, including prime farmland. This section provides a brief summary of the resource area as it pertains to the CEA study area.

Brazoria County had 460,005 acres (48%) in farms in 2017, down 27% since 2012 (USDA 2017a). This decrease is likely due to the conversion of agricultural lands to residential (Cooley 2015) because of population growth. Of the farmlands in 2017, 59% was pastureland, 29% was cropland, and 12% was woodland/other. Top crops by acres in the county were forage (hay), rice, corn, sorghum, and soybeans. According to the NLCD (2016) 142,278 acres within the county is cultivated cropland and 191,227 acres is pasture/hay.

Fort Bend County had 279,483 acres (50%) in farms in 2017, down 18% since 2012 (USDA 2017b). This decrease is likely due to the conversion of agricultural lands to residential (Cooley 2015). Of the farmlands in 2017, 50% was cropland, 43% was pastureland, and 7% was woodland/other. Top crops by acres in the county were cotton, corn (for grain), sorghum, forage (hay), and rice.

USDA Census of Agriculture data shows that, since 1997, irrigated acreage within Region H has declined by 24%. Rural land data obtained from the Texas Agri-Life Extension at Texas A&M indicates that rural land use is decreasing across the region, including large reductions in cropland acreage due to urbanization in the southern and central parts of the region. However, the amount of grazing land has increased in Brazoria County due to conversion of former cropland and native rangeland to improved, non-irrigated pasture. Use of rural land for wildlife management has also increased across the region (TWDB 2019d).

There has been a historical loss of prime farmland in both Brazoria and Fort Bend Counties, specifically in the past 10 years due to increased development. This loss reflects the cumulative effects of past and present actions on prime farmland soils. However, based on NRCS soils data, 719,320 acres are categorized as prime farmland soils in Brazoria County and 482,611 acres in Fort Bend County. Therefore, the CEA study area has approximately 1.2 million acres designated as prime farmland soils.

5.4.3.2.2 Cumulative Effects Summary

The Proposed Action and other projects identified in Section 5.3 would impact prime farmland (Table 5.4-3). The majority of the impact area for the Proposed Action and Alternatives 2 and 3 encompass agricultural and/or pastureland, which would be lost under these alternatives. Prime farmland soils and agricultural land use have the potential to sustain cumulative impacts due to ongoing development and conversion from farmland to other land uses, including residential, industrial, commercial, or other uses (e.g., reservoir).

Although cumulative impacts from past, present, and reasonably foreseeable projects, including the Proposed Action and alternatives, are anticipated, given the total amount of prime farmland within the CEA study area, this impact is not expected to result in substantive impacts to prime farmlands in the CEA study area. Therefore, the Proposed Action or alternatives would have an incremental contribution to the cumulative loss of prime farmlands and agricultural lands in the CEA study area.

Table 5.4-3. Potential Contribution to Prime Farmland Impacts Identified for CEA Projects

Project	Summary of Potential Contribution to Cumulative Effects*
Proposed Action and alternatives	Proposed Action, Alternative 2A, Alternative 2B: 2,185 acres Alternative 3: 2,633 acres Alternative 4: 677 acres
Allens Creek Reservoir (proposed construction 2025)	Potential loss of prime farmland within footprint of proposed reservoir would occur.

* *Farmland impacts are estimated and not verified by the NRCS.*

5.4.3.3 LAND SUBSIDENCE

5.4.3.3.1 Current Health and Historical Context

Within the CEA study area, land subsidence is generally caused by compaction of fine-grained aquifer sediments (silts and clays) below the land surface due to groundwater withdrawals. Most compaction that occurs as a result of groundwater withdrawals is irreversible; even if groundwater levels rise, compacted sediments and the associated land-surface lowering would remain as is (Oklahoma-Texas Water Science Center 2021).

Past actions have resulted in large-scale subsidence within the CEA study area resulting in land-surface subsidence in Brazoria County up to 1.5 feet between 1943 and 1964 (Sandeen and Wesselman 1973). Based on maps provided by the Fort Bend Subsidence District, subsidence within the CEA study area was generally less than 0.5 cm/year between 2016 and 2020. The Brazoria County Groundwater Conservation District (BCGCD) predicts subsidence will continue, and estimated between 1 and 3 feet of additional subsidence throughout the county by 2050. Subsidence in the Project site is estimated to be up to 1 foot by 2050, according to the BCGCD (BCGCD 2013).

5.4.3.3.2 Cumulative Effects Summary

The Proposed Action and other projects identified in Section 5.3 have the potential to cause subsidence. Table 5.4-4 provides a summary of potential subsidence impacts for projects included in this CEA. Although projects are anticipated to have localized effects on subsidence, none are expected to change the rate of land subsidence within the CEA study area, thus there would be no long-term impacts that would increase the rate of subsidence. Potential subsidence caused by the Proposed Action or the alternatives would be localized and no groundwater withdrawals would occur, which is the primary cause of regional subsidence. As such, neither the Proposed Action nor the alternatives would be expected to contribute to the cumulative rate of regional land subsidence within the CEA study area.

Table 5.4-4. Potential Contribution to Subsidence Impacts Identified for CEA Projects

Project	Summary of Potential Contribution to Cumulative Impacts
Proposed Action and alternatives	Potential localized subsidence resulting from compaction caused by construction equipment and/or weight of reservoir (Proposed Action and Alternatives 2 and 3).
Allens Creek Reservoir (proposed construction 2025)	Potential impacts may be similar to the Proposed Action, Alternatives 2A and 2B, and Alternative 3.
Freeport LNG projects	Potential minor impacts occurred.

5.4.3.4 SYSTEM FLOWS/ENVIRONMENTAL FLOWS

5.4.3.4.1 Current Health and Historical Context

Section 3.3.1 presents detailed information on the affected environment pertaining to surface waters, including system flows and environmental flows within the Brazos River and Oyster Creek watersheds, which encompass the CEA study area.

There are no major structures that control the river flow in the Lower Brazos River, but the river system is highly managed for water rights and flood control through the use of off-channel reservoirs, weirs, and other diversions. Oyster Creek and the Brazos River share the 100-year floodplain near the Proposed Action and Alternatives 2 and 3. The two stream systems are also hydrologically connected to the north near the Sienna Plantation development, which includes a large stormwater detention basin that diverts approximately 63% of the Oyster Creek flows and discharges them to the Brazos River (Watearth 2021a).

5.4.3.4.2 Cumulative Effects Summary

Long-term effects to environmental flows from the Proposed Action, Alternative 2A, and Alternative 2B may occur in Oyster Creek below the reservoir outfall. Table 5.4-5 provides a summary of potential system and environmental flow impact for projects included in this CEA. However, this would not be considered a substantial contribution to cumulative effects to environmental flows of Oyster Creek. System flows on Oyster Creek and the Brazos River would be affected under the Proposed Action, Alternative 2A, and Alternative 2B as implementation of either may result in a shift of the interbasin flows downstream of the existing Harris Reservoir. This would cause an increase in the timing and magnitude of peak flows and water surface elevations associated with the arrival of interbasin flows from the Brazos River into Oyster Creek. In addition, discharge from the proposed reservoir under the Proposed Action, Alternative 2A, and Alternative 2B during drought conditions would result in increased average velocities, increased bank erosion, increased bed scour, and decreased water temperatures in Oyster Creek. There would be an incremental contribution to cumulative effects to system and environmental flows on Oyster Creek under the Proposed Action, Alternative 2A, and Alternative 2B.

Table 5.4-5. Potential Contribution to System/Environmental Flow Impacts Identified for CEA Projects

Project	Summary of Potential Contribution to Cumulative Impacts
Proposed Action and alternatives	The Proposed Action and Alternatives 2A and 2B would affect the system flows on the Brazos River and Oyster Creek, while Alternatives 3 and 4 would affect only the Brazos River. The Proposed Action and the alternatives would have negligible effects to system flows in the Brazos River. The Proposed Action and Alternative 2 could produce higher peak flows, water surface elevation, and hydromodification on Oyster Creek; Alternatives 3 and 4 would not impact the system or environmental flows of Oyster Creek. Long-term impacts to system and environmental flows on the Brazos River would be negligible for the Proposed Action and alternatives.
Sienna Plantation Master Planned Community	Oyster Creek and the Brazos River are hydrologically connected to the north near the Sienna Community that includes a large stormwater detention basin that diverts flows from Oyster Creek and discharges them to the Brazos River has resulted in a major change to Oyster Creek system flows (Watearth 2021a).

5.4.3.5 FLOODPLAINS/FLOOD HAZARDS

5.4.3.5.1 Current Health and Historical Context

Section 3.3.1 presents detailed information on the affected environment pertaining to floodplains and flood hazards. This section provides a brief summary of the resource area as it pertains to the CEA study area.

Past and present actions such as ongoing development and channelization of waterways has resulted in a higher risk of flooding and storm damage within the CEA study area. As discussed in Section 3.3.2, flooding is a major problem within the watershed. Major flood events, including Hurricane Harvey, occurred in 2015 and 2016. During both years, widespread major flooding on the Brazos River and Oyster Creek led to numerous roads and homes flooding throughout the County, causing record damages. In addition, high flows from the Brazos River caused navigation problems for several weeks.

To mitigate flooding risk, federal, state, and local authorities have implemented structural projects and regulatory measures. At the local level, Brazoria County requires hydraulic modeling to show that downstream properties will not be impacted by proposed development (Forister 2017; Brazoria County 2020). Attaining a No-Rise Certification is one way to confirm properties located downstream of proposed development will not be impacted (Brazoria County 2020). Brazoria County also requires demonstration that properties upstream will not be impacted by flooding as a result of proposed development. Fort Bend County also has strict floodplain regulations (Flood Damage Prevention Regulation) to regulate projects with potential impacts to floodplains and flood hazards.

5.4.3.5.2 Cumulative Effects Summary

A summary of potential impacts to floodplains/flood hazards from projects included in this CEA are listed in Table 5.4-6. Cumulative effects to floodplains and flood hazards could potentially occur, primarily due to future development affecting floodplains. Federal, state, and local regulations help prevent cumulative impacts to floodplains and flood hazards by putting into place design criteria to reduce and/or mitigate for potential impacts to floodplains and flood hazards.

The Proposed Action, Alternative 2A, and Alternative 2B may contribute to cumulative effects to flooding and flood hazards within the CEA study area. Modeling concluded that several operational measure result in floodplain storage gain and the floodplain storage loss resulting from the Proposed Action, Alternative 2A, and Alternative 2B can be countered. With implementation of operational measures, the Proposed Action, Alternative 2A, and Alternative 2B would not substantively contribute to cumulative effects to flood hazards.

Table 5.4-6. Potential Contribution to Floodplains/Flood Hazards Identified for CEA Projects

Project	Summary of Potential Contribution to Cumulative Impacts
Proposed Action and alternatives	The Proposed Action and Alternatives 2A and 2B would increase peak flows in Oyster Creek (and flood risk) below proposed reservoir. It is unlikely that Alternative 3 would cause any notable impacts to the existing flood hazards and flood hazard values due to its elevation above the floodplain. Under Alternative 4, infrastructure could be inundated and create hazards for local residents during larger events where interbasin flows and flood flows may occur.
Allens Creek Reservoir (proposed construction 2025)	The proposed Allens Creek reservoir is sited within the 100-year floodplain. As such, potential impacts to the floodplain/flood hazards may occur.

5.4.3.6 WATERS OF THE UNITED STATES, INCLUDING WETLANDS

5.4.3.6.1 Current Health and Historical Context

Section 3.3.4 presents detailed information on the affected environment pertaining to WOUS, including wetlands. This section provides a brief summary of the resource as it pertains to the CEA study area. Based on National Hydrography Dataset (NHD) and National Wetlands Inventory (NWI) data, approximately 100,000 acres of wetlands are currently present within the CEA study area (ponds, lakes, and deep-water habitats excluded). Past and present actions associated with residential, commercial, and industrial development and associated infrastructure have resulted in substantial loss of wetlands within the CEA study area over time. Although specific data detailing the loss of wetlands within the CEA study area is not available, there have been studies in the region that detail wetland losses. The Texas Coastal Watershed Program directed a study, *Houston-Area Freshwater Wetland Loss, 1992-2010,* that illustrates wetland losses in Brazoria and Fort Bend Counties. Based on results of the study, Brazoria County wetland losses between 1992 and 2010 totaled approximately 855 acres, or 0.9% of wetlands within the county, and Fort Bend County losses between 1992 and 2010 totaled approximately 1,442 acres, or 6% of the wetlands within the county (Jacob et al. n.d. [2012]).

5.4.3.6.2 Cumulative Effects Summary

A summary of potential impacts to WOUS from projects included in this CEA are listed in Table 5.4-7. Impacts to aquatic vegetation are generally included as either wetlands or within limits of other WOUS. Based on potential impacts presented in the table, cumulative effects to WOUS could potentially occur as a result of ongoing development within the watershed. Existing CWA regulations prohibit impacts to WOUS without permit approval.

The Proposed Action, Alternative 2A, and Alternative 2B would have the greatest impact on streams, and Alternative 3 would result in the greatest wetland impact. Based on NWI data, this accounts for less than 0.4% of total wetland acres within the CEA study area. Mitigation would be required for impacts to wetlands and streams under all alternatives. In addition, the Oyster Creek Stream restoration (under the Proposed Action, Alternative 2A, and Alternative 2B) would offset some losses to wetlands adjacent to the stream.

As Project impacts require mitigation, cumulative effects to WOUS, including wetlands, would be reduced through BMPs and/or required mitigation measures for unavoidable impacts. With the incorporation of mitigation measures, the Proposed Action or the alternatives are not anticipated to have a substantive contribution to cumulative effects within the CEA study area.

Table 5.4-7. Potential Contribution to WOUS, including Wetlands, Impacts for CEA Projects

Project	Summary of Potential Contribution to Cumulative Impacts
Proposed Action and alternatives	~16 acres wetlands; ~15 miles stream (Proposed Action) ~21 acres, ~17 miles stream (Alternative 2A) ~16 acres wetlands; ~15 miles stream (Alternative 2B) ~384 acres wetlands, ~4 miles stream (Alternative 3) ~199 acres; ~1 mile stream (Alternative 4) Mitigation measures would be included with all alternatives.
Brazos River floodgates	Impacts to wetlands and open water habitats occurred.
Freeport Harbor Channel improvement projects	Impacts to wetlands and open water habitats occurred.
Allens Creek Reservoir (proposed construction 2025)	Potential for impacts to wetlands and aquatic habitats exists.
Freeport LNG projects	Impacts to wetlands and open water habitats occurred.
USACE–permitted projects with permanent impacts between 2016–2020	Impacts to wetlands and other WOUS; permitted impacts would require mitigative measures to reduce potential for cumulative effects.
TNC Brazos Woods Preserve	Preserved Columbia bottomland forest, including wetlands.

5.4.3.7 TERRESTRIAL VEGETATION

5.4.3.7.1 Current Health and Historical Context

Section 3.4.1 presents detailed information on the affected environment pertaining to terrestrial vegetation. This section provides a brief summary of the resource area as it pertains to the CEA study area.

The majority of the CEA study area, including all of Brazoria and Fort Bend Counties, falls within the West Gulf Coastal Plan Level III Ecoregion. Only the upper reaches of the CEA study area fall within the East Central Texas Plains and the Texas Blackland Prairies (see Figure 5.2-1).

The alternatives are located within the Floodplains and Low Terraces (Level IV) ecoregion of the Western Gulf Coastal Plain (Level III). Mixed forest and savannah vegetation communities are found toward inland areas, and grassland communities are found toward the coast. The Columbia Bottomlands ecosystem lies within the CEA study area and is ecologically important for many wildlife species. Refer to Section 3.4 for a detailed description of potential ecosystems in the CEA study area.

Within the CEA study area, native terrestrial vegetation has been impacted by the loss of undeveloped land and the introduction of non-native or invasive species, primarily associated with development activities and conversion for agricultural purposes. The resulting terrestrial vegetative landscape within the CEA study area consists of fragments of native vegetation, often mixed with invasive or non-native species.

5.4.3.7.2 Cumulative Effects Summary

Due to current and projected growth in the region, which will likely continue to cause the conversion of undeveloped land to other uses, including residential, commercial, and industrial, the loss of terrestrial vegetation from the area is likely to occur over time.

A summary of potential impacts to terrestrial vegetation from projects included in this CEA are listed in Table 5.4-8. Based on potential impacts presented in the table, cumulative effects to terrestrial vegetation could potentially occur as a result of ongoing development and conversion of native habitats to improved lands. The Proposed Action, Alternative 2A, Alternative 2B, and Alternative 3 would result in the conversion of undeveloped and agricultural lands from inundation and construction of associated facilities, resulting in an incremental contribution to cumulative effects to terrestrial vegetation impacts. Alternative 4 would have a smaller contribution to cumulative effects on terrestrial vegetation in the CEA study area.

Table 5.4-8. Potential Contribution to Terrestrial Vegetation Impacts for CEA Projects

Project	Summary of Potential Contribution to Cumulative Impacts
Proposed Action and alternatives	Approximately ~1,950 acres terrestrial vegetation, mostly agricultural lands (Proposed Action) ~2,202 acres terrestrial vegetation, mostly agricultural lands (Alternative 2A) Approximately ~1,940 acres terrestrial vegetation, mostly agricultural lands (Alternative 2B) ~1,917 acres terrestrial vegetation, mostly agricultural lands (Alternative 3) ~377 acres, mostly forested wetlands (Alternative 4)
Brazos River floodgates	Minor impacts to upland shrub/woods occurred.
Freeport Harbor Channel improvement projects	Impacts to forest vegetation; mitigation would include preservation of riparian forest and creation of new forest wetland.
Allens Creek Reservoir (proposed construction 2025)	Potential impacts to terrestrial vegetation within footprint of proposed reservoir similar to Proposed Action, Alternative 2 and Alternative 3.
Freeport LNG projects	Impacts to herbaceous and shrub-scrub terrestrial vegetation occurred.
TNC Brazos Woods Preserve	Preservation of Columbia bottomland forest.

5.4.3.8 AQUATIC VEGETATION

5.4.3.8.1 Current Health and Historical Context

Wetlands within the CEA study area are discussed in Section 5.4.3.6. In addition to vegetation that occurs in wetland environments, there are many native aquatic plants that are beneficial to lakes, ponds, and waterways and may occur in the study area. These include white water lily, tape grass and pondweed. These aquatic plants also provide food for waterfowl and an excellent food and habitat for fish. However, many introduced species may also occur, primarily as a result of past and present actions such as commercial and recreational hunting, fishing, and navigation. Construction of linear facilities and other infrastructure has also resulted in the introduction of non-native or invasive species within the CEA study area, as has commercial and residential landscaping. These species may cause issues due to the lack of natural controls. Non-native plants that have been introduced to Texas waterways and may occur in the CEA study area include hydrilla, water hyacinth, alligatorweed, and water lettuce. These plants are difficult to control and tend to create extensive mats of vegetation that crowd out native plants. The majority of aquatic plants live in the littoral zones of lakes (BRA 2021d).

5.4.3.8.2 Cumulative Effects Summary

A summary of potential impacts to aquatic vegetation from projects included in this CEA is listed in Table 5.4-9. Based on potential impacts presented in the table, cumulative effects to aquatic vegetation could potentially occur as a result of ongoing development within the watershed.

As impacts to aquatic vegetation typically fall under WOUS rules and regulations, mitigation requirements would apply to reduce potential cumulative effects within the CEA study area. The Proposed Action and the alternatives are not likely to introduce invasive aquatic plants, thus little to no contribution is expected. However, increased sedimentation and erosion from construction and operation activities could indirectly result in loss of aquatic vegetation. This loss would be localized to an area downstream of the proposed reservoir and is thus spatially isolated within the CEA study area. Alternative 4 is not expected to contribute to cumulative impacts to aquatic vegetation within the CEA study area. Overall, impacts to aquatic vegetation associated with the Proposed Action or the alternatives are not expected to result in a substantive contribution to cumulative impacts on aquatic vegetation.

Table 5.4-9. Potential Contribution to Aquatic Vegetation Impacts for CEA Projects

Project	Summary of Potential Contribution to Cumulative Impacts
Proposed Action and alternatives	Under the Proposed Action and Alternatives 2A and 2B, Alternative 3, and Alternative 4, surface disturbance could lead to erosion and sedimentation into the Brazos River and also to Oyster Creek under the Proposed Action and Alternative 2. This would, result in sediment increases that could smother or reduce vegetation located in and around these waterways. Under the Proposed Action and Alternatives 2A and 2B, bank erosion and scour could occur along Oyster Creek and impact vegetation along the banks while increased sediment and decreased temperature could cause some aquatic vegetation to die off.
Brazos River floodgates	Wetland/aquatic vegetation impacts occurred.
Freeport Harbor Channel improvement projects	Wetland/aquatic vegetation impacts occurred.
Allens Creek Reservoir (proposed construction 2025)	Potential for impacts to aquatic vegetation would be similar in nature to Proposed Action, Alternatives 2A and 2B, and Alternative 3.
Freeport LNG projects	Potential introduction of exotic aquatic nuisance species – reduced to less than significant with USCG guidelines. Wetland/aquatic vegetation impacts occurred.
USACE–permitted projects with permanent impacts between 2016–2020	Potential impacts to aquatic vegetation in association with impacts to wetlands and other aquatic habitats may occur.
TNC Brazos Woods Preserve	No adverse impact; preservation of wetlands occurred.

5.4.3.9 TERRESTRIAL AND AQUATIC WILDLIFE

5.4.3.9.1 Current Health and Historical Context

Section 3.5 presents detailed information on the affected environment pertaining to terrestrial and aquatic wildlife including migratory birds and commercial game animals. This section provides a brief summary of the resource area as it pertains to the CEA study area.

Terrestrial wildlife expected to occur in the region are discussed in Section 3.5. As previously noted, past and present activities in the CEA study area have resulted in a fragmented landscape with multiple invasive or opportunistic species. The faunal diversity in the Western Gulf Coastal Plains ecosystem has shifted toward species adapted to landscapes converted for agriculture, ranching, and urban development (Griffith et al. 2007).

Despite the generally degraded condition of the area, there remain pockets of habitat that support important species. Columbia Bottomlands habitat, which occurs within the CEA study area, is important for wildlife, particularly migratory birds. Urbanization and development continue to threaten this region and jeopardize the millions of migratory songbirds that use the Columbia Bottomlands as critically important resting, feeding, and stopover habitat. Radar evidence indicates that as many as 29 million birds from 237 species move through the Columbia Bottomlands annually (TNC 2021).

Birds protected by the MBTA occur in every habitat type, and nests may be found in trees and on forest floors, in grassland or shrubland, and in uplands and wetlands. Migratory birds occur throughout the CEA study area.

Most streams within the CEA study area have low condition assessment scores associated with limited riparian buffer, channel erosion and alteration, and generally low biotic integrity indices (SWCA 2019b). However, there are also unique coastal aquatic habitats that are important for the life cycle of many aquatic wildlife species. In the CEA study area, this includes estuarine environments along the Brazoria County coastline.

5.4.3.9.2 Cumulative Effects Summary

A summary of potential impacts to terrestrial and aquatic wildlife from projects included in this CEA is summarized in Table 5.4-10. Based on potential impacts presented in the table, cumulative effects to terrestrial and aquatic wildlife could occur as a result of continuous loss of both terrestrial and aquatic habitats due to ongoing development. Conservation and mitigation measures required by permitting authorities help reduce impacts to wildlife habitat. Additionally, projects such as the TNC Brazos Woods Preserve are intended to preserve habitat for wildlife, balancing some of the loss associated with past, present, and ongoing activities.

Although the Proposed Action or the alternatives would impact terrestrial and aquatic wildlife habitat, the contribution to cumulative effects would not be substantive as the potential impacts would be separated by time and/or distance from other projects likely to affect terrestrial and aquatic wildlife habitat. Additionally, the Proposed Action, Alternative 2A, and Alternative 2B could result in a contribution to cumulative effects to terrestrial and aquatic species in the CEA study area due to the effects to Oyster Creek downstream of the proposed reservoir outfall. A beneficial contribution to cumulative effects on Oyster Creek from the stream restoration may result from the Proposed Action, Alternative 2A, and Alternative 2B, and the addition of open water habitat from reservoir construction may also provide a beneficial contribution to aquatic species and some birds that may use the reservoir.

Table 5.4-10. Potential Contribution to Terrestrial and Aquatic Wildlife Impacts for CEA Projects

Project	Summary of Potential Contribution to Cumulative Impacts
Proposed Action and alternatives	Proposed Action and alternatives: Potential impacts would be to terrestrial and aquatic wildlife, including migratory birds and commercial game animals, from construction and long-term loss of habitat. Proposed reservoirs (Proposed Action, Alternatives 2A and 2B, and Alternative 3) would provide open water habitat that would support aquatic species and bird species such as waterfowl, shorebirds, and wading birds. The Proposed Action and Alternatives 2A and 2B would provide improved aquatic habitat in Oyster Creek from stream restoration but may adversely affect Oyster Creek downstream of the reservoir outfall.
Freeport Harbor Channel improvement projects	Potential impacts would be to terrestrial and aquatic wildlife, including migratory birds and commercial game animals, from construction and long-term loss of habitat. Potential impacts to sea turtles are possible, associated with dredging.
Allens Creek Reservoir (proposed construction 2025)	Potential impacts would be similar to Proposed Action, Alternative 2A, Alternative 2B, and Alternative 3.
TNC Brazos Woods Preserve	Preserved terrestrial and aquatic habitat for wildlife.

5.4.3.10 FEDERAL AND STATE THREATENED AND ENDANGERED SPECIES

5.4.3.10.1 Current Health and Historical Context

Sections 3.6 and 3.8 presents detailed information on the affected environment pertaining to federal and state-listed species. This section provides a brief summary of the resource as it pertains to the CEA study area. The Texas fawnsfoot (proposed federally threatened, state threatened) is a freshwater mussel endemic to the Colorado River and Brazos River Basins and occurs in moderate to large rivers and streams with moderate flow and fine or coarse sediments such as mud, sand, or gravel substrate (Howells 2014; Randklev et al. 2017). The CEA is in the migratory corridor of whooping crane (threatened) and contains suitable wetlands and croplands. The CEA contains monarch butterfly (candidate) fall and spring migration corridors, as well as spring breeding habitat. In addition, some state-listed wildlife species are likely to occur in the CEA due to the presence of terrestrial, wetland, and aquatic habitats. State-listed species including bats, birds, reptiles, mollusks, and fish may occur within the CEA study area where suitable habitat is available.

5.4.3.10.2 Cumulative Effects Summary

A summary of potential impacts to the Texas fawnsfoot from projects included in this CEA are listed in Table 5.4-11. Based on potential impacts presented in the table, cumulative effects to this species could potentially occur as a result of cumulative impacts to water quality and/or sedimentation. However, the Proposed Action and the alternatives would result in a may affect, not likely to adversely affect determination under the ESA and would not be expected to contribute to cumulative effects to this species.

Table 5.4-11. Potential Contribution to Texas Fawnsfoot Impacts for CEA Projects

Project	Summary of Potential Contribution to Cumulative Impacts
Proposed Action and alternatives	Proposed Action and the alternatives are not likely to adversely affect this species from potential impacts to water quality.
USACE–permitted projects with permanent impacts between 2016–2020	Potential impacts if projects affect Texas fawnsfoot habitat.

A summary of potential impacts to the whooping crane from projects included in this CEA are listed in Table 5.4-12. Based on potential impacts presented in the table, cumulative effects to this species could potentially occur as a result of cumulative impacts to wetlands and croplands. However, the Proposed Action and the alternatives would result in a may affect, not likely to adversely affect determination under the ESA and would not be expected to contribute to cumulative effects to this species.

Table 5.4-12. Potential Contribution to Whooping Crane Impacts for CEA Projects

Project	Summary of Potential Contribution to Cumulative Impacts
Proposed Action and alternatives	Proposed Action and alternatives are not likely to adversely affect this species from potential impacts to suitable habitat.
Brazos River floodgates	Impacts to wetland habitats occurred.
Freeport Harbor Channel improvement projects	Impacts to wetland habitats occurred.
Allens Creek Reservoir (proposed construction 2025)	Potential for impacts to wetlands and aquatic habitats.
Freeport LNG projects	Impacts to wetland habitats occurred.
USACE–permitted projects with permanent impacts between 2016–2020	Impacts to wetlands and other WOUS; permitted impacts require mitigative measures to reduce potential for cumulative effects.
TNC Brazos Woods Preserve	Preserved bottomland forest, including wetlands.

A summary of potential impacts to monarch butterfly from projects included in this CEA are listed in Table 5.4-13. Based on potential impacts presented in the table, cumulative effects to this species could potentially occur as a result of cumulative impacts to grassland/herbaceous land cover types. However, the Proposed Action and alternatives would result in a may affect, not likely to adversely affect determination under the ESA and would not be expected to contribute to cumulative effects to this species.

Table 5.4-13. Potential Contribution to Monarch Butterfly Impacts for CEA Projects

Project	Summary of Potential Contribution to Cumulative Impacts
Proposed Action and alternatives	Proposed Action and alternatives are not likely to adversely affect this species from potential impacts to suitable habitat.
Allens Creek Reservoir (proposed construction 2025)	Potential impacts to terrestrial vegetation would be within footprint of proposed reservoir.
Freeport LNG projects	Impacts to herbaceous and shrub-scrub terrestrial vegetation occurred.

5.4.3.10.3 State-Listed Species

A summary of potential impacts to state-listed wildlife species with low to high potential of occurring on the Project site and in the CEA study area are listed in Table 5.4-14. Potential impacts to state-listed wildlife species would be similar to those for terrestrial and aquatic wildlife and migratory birds and would be negligible to moderate.

Table 5.4-14. Potential Contribution to State-Listed Wildlife Impacts for CEA Projects

Project	Summary of Potential Contribution to Cumulative Impacts
Proposed Action and alternatives	Proposed Action and Alternatives 2–4: Potential impacts to terrestrial and aquatic wildlife, including migratory birds and commercial game animals, from construction and long-term loss of habitat. Proposed reservoirs (Proposed Action and Alternatives 2 and 3) would provide open water habitat that would support aquatic species and bird species such as waterfowl, shorebirds, and wading birds. Proposed Action and Alternative 2 would provide improved aquatic habitat in Oyster Creek from stream restoration but may adversely affect Oyster Creek downstream of the reservoir outfall.
Freeport Harbor Channel improvement projects	Potential impacts to terrestrial and aquatic wildlife, including migratory birds and commercial game animals, from construction and long-term loss of habitat. Potential impacts to sea turtles are possible, associated with dredging.
Allens Creek Reservoir (proposed construction 2025)	Potential impacts would be similar to Proposed Action, Alternative 2A, Alternative 2B, and Alternative 3.
TNC Brazos Woods Preserve	Preserved terrestrial and aquatic habitat for wildlife.

5.4.3.11 VISUAL RESOURCES

5.4.3.11.1 Current Health and Historical Context

Due to the large extent of the CEA study area, visual resources vary throughout. Overall, the visual landscape has been affected by development of residential, commercial, and industrial facilities, or conversion to agricultural uses. However, the CEA study area is also interspersed with undeveloped areas that include forests, streams, reservoirs, and coastal environments. The landscape surrounding the alternatives is similar in nature, with the presence of greater densities and concentrations of industrialized infrastructure and residential development near Alternative 4. As discussed in Section 3.10.8, Harris Reservoir, Brazos River, and Oyster Creek contribute to the visual resources of the area. Color in the area is a composite of dark to yellow-green vegetation that contrasts with the reflective qualities of the adjacent water features and seasonal changes in agricultural fields. The most distinctive elements in the landscape are associated with built and human-made structures that contrast with the more dominant natural elements. Continued development within the CEA study area continually changes the landscape and visual resources.

5.4.3.11.2 Cumulative Effects Summary

A summary of potential impacts to visual resources from projects included in this CEA is listed in Table 5.4-15. Although visual resources tend to be localized, the effect of many projects modifying the landscape often have a cumulative effect on the visual resources of an area. Based on anticipated impacts, the implementation of Alternative 4 would contribute to the changing landscape within the vicinity of the Alternative 4 site. Likewise, implementation of other alternatives would introduce new elements into the vicinity. However, changes are consistent with the existing landscape and the Proposed Action and Alternatives 2A, 2B, and 3 would introduce an aquatic landscape that would blend with the existing topography. Thus, the Proposed Action and alternatives would have a minor contribution to visual resources impacts within the CEA study area.

Table 5.4-15. Potential Contribution to Visual Resources Impacts for CEA Projects

Project	Summary of Potential Contribution to Cumulative Impacts
Proposed Action and alternatives	Proposed Action and Alternatives 2A and 2B, and Alternative 3 would have minor impacts to visual resources. Impacts from Alternative 4 would be considered moderate due to the visibility of aboveground infrastructure associated with the desalination plant.
Freeport LNG projects	Impacts to visual resources associated with constructed facilities occurred.

5.4.4 Potential Mitigation Opportunities

Based on the CEA, several resources have the potential for cumulative impacts; however, with appropriate mitigation measures, many impacts may be reduced, including potential impacts to water quality and wetlands, as well as terrestrial and aquatic wildlife and vegetation. Impacts of ongoing development may be reduced through the implementation of existing environmental programs and regulations that are aimed to protect key resources such as prime farmland, water quality, WOUS, floodplains, and natural communities, protected species, and migratory birds. Examples include the following:

- Farmland Protection Policy Act, which is intended to minimize the impact federal programs have on the unnecessary and irreversible conversion of farmland to nonagricultural uses
- CWA regulations, which protect surface waters, water quality, and wetlands through permit programs. Private developers are required to identify and mitigate impacts to all WOUS during the permitting process
- NHPA regulations, which protect historic and archaeological resources
- Texas solid and hazardous waste regulations that require the management and reduction of waste
- NRCS programs, such as the Wetland Reserve Program and the Conservation Reserve Program, which protect wetlands
- ESA and state regulations protecting sensitive species and habitats
- Federal, state, and local floodplain regulations that require No-Rise Certifications for proposed developments
- Conservation projects, such as the Columbia Bottomlands Project, to preserve existing resources in the region

Ongoing studies of key resources play and important role in protecting those resources. As an example, the BRA completed the Lower Brazos Floodplain Protection Planning Study in 2019. The information produced from the study may be used by communities to identify potential flood risks during significant storm events and determine impacts to the flood risk for potential development along the river. The water surface elevations, discharges, flow timing, and inundation extents are also useful to floodplain administrators, emergency management operations personnel, levee operators, and others in helping to protect the public. The study also recommended several steps to improve flood protection planning and response for the region (BRA 2019).

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6 MITIGATION

Mitigation for the Proposed Action's environmental consequences and for implementing the Project would be developed in accordance with state, federal, and local laws, regulations, ordinances, executive orders, and permit provisions. Mitigation or management activities to be performed during construction, operation, and maintenance may only occur under permit or as required by other approvals or authorizations, all of which are discussed in Chapter 3 and Chapter 4.

Unless otherwise noted in Chapter 3 or Chapter 4, the proposed avoidance, minimization, and mitigation activities apply to each action alternative under consideration. These include Alternative 1 (Proposed Action), Alternative 2A (Alternate Embankment Configuration alternative), Alternative 2B (Alternate Reservoir Layout alternative), Alternative 3 (West Bank alternative), and Alternative 4 (Brackish Water Desalination alternative).

Section 2.8 describes the BMP and applicant-committed measures that would be implemented as part of Proposed Action or other action alternatives as applicable to avoid and minimize these potential impacts for each resource. Dow's O&M plan defines responsibilities and prescribes procedures for inspection, maintenance, repairs, and operation of the reservoir. Dow is responsible for ensuring that reservoir maintenance and inspection activities are conducted, including integrity inspections. Slope erosion, vegetative cover, and embankment condition would be inspected regularly. In addition to the regular schedule, inspections would occur prior to and after major rain or windstorms.

A conceptual mitigation plan to compensate for lost ecological functions and values of WOUS is provided in Appendix G. Final compensatory mitigation will include performance standards that must be met as a condition of the DA permit.

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7 CONSULTATION AND COORDINATION

7.1 Scoping Activities

From March 29, 2018, to June 2, 2018, the Corps issued a public notice to inform the agencies and the general public of a proposal of work from Dow and to solicit comments and information to better enable to Corps to make reasonable decisions on factors affecting the public interest. During the public notice, major concerns were raised by the public and state and federal agencies; the Corps determined that the project requires the preparation of an EIS.

On April 7, 2020, the Corps issued an NOI to inform agencies and the general public that this EIS was being prepared and invited comments on the scope and content of the document and participation at a public scoping meeting. In addition to publishing the NOI in the *Federal Register*, the Corps sent email notices to its EIS mailing list, and the NOI was posted on the Corps website. The public comment period ended on July 2, 2020.

An agency scoping meeting was held on May 12, 2020. Agencies that attended the meeting included the EPA, USFWS, TCEQ, TPWD, and the THC. Interagency coordination assisted the Corps in determining the scope of this EIS; developing Project components and objectives; identifying the range of alternatives; identifying constraints; and defining potential environmental impacts, impact significance, and feasible mitigation measures. The Corps held a public scoping meeting on June 17, 2020, to solicit input from the community and public agencies regarding Project design, alternatives selection, and the scope and content of the EIS. Appendix I presents all comment letters received during scoping. The *EIS Scoping Report* and *EIS Agency Meeting Scoping Report* are also available on the project website, https://doweisproject.com/.

7.2 Agency Consultation

The DEIS was prepared under the direction of the Corps. The Proposed Action has been coordinated with several federal, state, regional, and local agencies including the EPA, the USFWS, NMFS, the TCEQ, the Texas General Land Office, the THC, and the TPWD. Federal and state agencies that were consulted throughout the development of the DEIS and provided direction, data, or information and received copies of the DEIS are described below.

7.2.1 Environmental Protection Agency

Under Section 309 of the Clean Air Act (CAA), the EPA is required to review and publicly comment on the environmental impacts of major federal actions including actions that are the subject of draft and final EISs, proposed environmental regulations, and other proposed major actions. The EPA provides review and comment on the adequacy of the analysis and the environmental impacts of the proposed action. The EPA comments on issues related to its "duties and responsibilities," which include all environmental media (i.e., air, water, etc.), methodologies related to media-impact assessment, and areas related to its regulatory responsibilities. The process is carried out to ensure the independence of the EPA review, to consultant with the lead agency, and to inform interested parties of EPA actions and concerns.

The EPA is a cooperating agency for this EIS. The EPA has provided scoping comments and consultation on wetlands and WOUS, air quality, tribal consultation, and environmental justice.

7.2.2 U.S. Fish and Wildlife Service

The ESA of 1973 ensures that any actions authorized, funded, or carried out by federal agencies do not jeopardize the continued existence of any listed endangered or threatened species or species proposed to be listed endangered or threatened, or adversely modify or destroy critical habitat of such species. The Fish and Wildlife Coordination Act of 1958 requires that federal agencies obtain comments from the USFWS and the TPWD. This coordination is required whenever a project involves impounding, diverting, or deepening a stream channel or other body of water.

The USFWS is a cooperating agency for this EIS. The Corps consulted with the USFWS Coastal Ecological Services Field Office to determine whether the proposed Project would affect federal- or state-listed endangered, threatened, proposed, or candidate plants or animal species. An impacts discussion was included in the DEIS for species whose habitat requirements are found within the Project site and the alternative sites. The BA is provided in Appendix J.

- On May 6, 2020, the Corps and USFWS corresponded and established that the USFWS is a cooperating agency on the EIS.
- On June 22, 2020, the Corps provided the USFWS with an ESA Section 7 informal consultation letter to initiate informal consultation. The letter details the preliminary species lists, area of analysis, and effects analysis on species with potential for occurrence in the analysis area. The Corps requested review and concurrence with the conclusions that the Proposed Action may affect but is not likely to adversely affect least tern, whooping crane, and Texas fawnsfoot.
- On July 2, 2020, during scoping the USFWS provided scoping comments and consultation related to riparian zones, water quality, wetland mitigation, and habitat loss as they relate to wildlife, including trust resources (e.g., federally listed species, migratory birds, and aquatic resources).
- On July 20, 2020, the Corps provided the USFWS a schedule of concurrence points as described in the Corps Memorandum for the Implementation Guidance for Regulatory Compliance with EO 13807 issued September 19, 2018.

7.2.3 National Marine Fisheries Service

In 1996, amendments to the Magnuson-Stevens Fishery Management and Conservation Act (MSFMCA) – 16 USC 1801–1882) mandated that the NMFS, regional fishery management councils, and other federal agencies identify and protect important marine and anadromous fish habitat. EFH provisions of MSFMCA support one of the nation's marine resource management goals: maintaining sustainable fisheries. With assistance from NMFS, EFH has been designated for managed species.

The Proposed Action does not include tidally influenced areas and NMFS does not have trust resources that may be affected. Therefore, on May 29, 2020, the NMFS stated in an email correspondence with the Corps that they would not be commenting on the permit application (see Appendix I).

EFH information from NOAA and the NMFS were reviewed to determine EFH areas within the Proposed Action analysis area for aquatic species. Only Alternative 4 is within EFH.

7.2.4 Texas Commission on Environmental Quality

The TCEQ is responsible for conducting Section 401 certification reviews of USACE Section 404 permit applications for the discharge of dredged or fill material into WOUS, including wetlands. The TCEQ is the lead state agency that administers the Section 401 certification program in Texas. The purpose of these certification reviews is to determine whether a proposed discharge will comply with state water quality standards.

The TCEQ has provided scoping comments and recommendations on mitigation of aquatic resources and water quality (see Appendix I).

7.2.5 Texas Parks and Wildlife Department

Under Section 12.0011 of the Parks and Wildlife (TPW) Code, TPWD is charged with "providing recommendations that will protect fish and wildlife resources to local, state, and federal agencies that approve, permit, license, or construct developmental projects" and "providing information on fish and wildlife resources to any local, state, and federal agencies or private organizations that make decisions affection those resources."

TPWD provided comments and recommendations on environmentally critical habitats including wetlands, streams, coastal prairie, neotropical songbird nesting and foraging areas, and federal/state threatened and endangered species habitat (see Appendix I).

7.2.6 Texas Historical Commission

The Texas Antiquities Code and its implementing rules require that agencies notify the state historic preservation officer at the Texas Historical Commission, State Historic Preservation Officer (THC/SHPO) on proposed projects that have the potential to affect cultural resources. Section 106 of the NHPA sets forth the requirement that federally funded or permitted projects must consider the effects of the project on historic properties and afford the Advisory Council on Historic Preservation an opportunity to comment. The regulations to complete this process are set forth in 36 CFR 800.

The NHPA (see Section 106 regulations) requires the Corps to consider the effects of federally funded and permitted projects on historic properties, to coordinate these effects with the staff of THC/SHPO, and to avoid, minimize, or mitigate any adverse effects on historic properties. Regulations implementing Section 106 of the NHPA are found at 36 CFR 800.

The THC has not yet provided comments on the Project.

7.3 Tribal Consultation

Consultation with Tribes must occur if the activities requiring Department of the Army authorization, regardless of permit type, have the potential to significantly (i.e., materially) affect protected tribal resources, tribal rights (including treaty rights), and tribal lands. The Proposed Action was coordinated with the tribes, as appropriate.

No response was received from any federally recognized Native American Tribes and/or affiliated groups.

7.4 Public Meeting

The Corps will hold a virtual public meeting on the DEIS on May 3, 2022, from 11:00 a.m. to 2:00 p.m. central time and from 4:00 p.m. to 7:00 p.m. central time. Access information, instructions, an opportunity to subscribe to project updates, and additional information regarding this proposed Project will be made available prior to the public hearings on the Project website at: https://doweisproject.com/.

Comments on the DEIS will be accepted during the meeting and will be recorded at the public comment table. Written comments may also be submitted throughout the comment period as described above. Once all comments have been assembled and reviewed, responses will be prepared to address substantive environmental issues raised in the comments. The responses will be included in the FEIS. All comments received by the Corps are public records and are subject to disclosure under the Freedom of Information Act or the Public Records Act.

8 PREPARERS AND REVIEWERS

8.1 List of Preparers and Reviewers by Organization

This EIS was prepared by a third-party contractor, SWCA Environmental Consultants, and subcontractors at the direction of the Corps. SWCA also conducted the wetland delineation, hydrogeomorphic functional assessment, and aquatic assessment. Watearth, Inc., conducted the hydrologic and hydraulic modeling. Wood prepared the cumulative impacts analysis. The following individuals directed, managed, prepared, and/or reviewed sections of this EIS; conducted related fieldwork or modeling; and/or provided significant background materials (Tables 8.1-1 through 8.1-4).

Table 8.1-1. U.S. Army Corps of Engineers

Title/Responsibility	Name	Experience
Regulatory Division Chief	Joseph A. McMahan	
Regulatory Chief, Policy Analysis Branch	Robert W. Heinly	
Attorney-Advisor Office of Counsel		
Regulatory Project Manager	Jayson M. Hudson	B.S. Marine Biology M.S. Wildlife Biology 23 years of experience

Table 8.1-2. SWCA Environmental Consultants

Title/Responsibility	Name	Experience
Project Manager, Water Rights	Whitney Fiore	B.S. Natural Resource Management, Public Policy M.S. Natural Resource Management 22 years of experience
Deputy Project Manager, Hazardous Materials	Christine Hartmann	B.S. Civil Engineering M.S. Environmental Engineering 25 years of experience
Project Coordinator, Land Use, Socioeconomics, Environmental Justice, Transportation	Kara Giblin	B.S. Biology M.A.S. Environmental Policy and Management 20 years of experience
Stream Design and Restoration	Lee Forbes	B.S. Petroleum Engineering M.S. Civil Engineering 32 years of experience
Air, Noise	Brad Sohm	B.S. Chemical Engineering 18 years of experience
Air, Noise	Michele Rowe	B.S. Environmental Geoscience 8 years of experience
Geology, Soils	Jennifer Gonzales	B.S. Horticulture 19 years of experience
Sedimentation and Erosion	Ryan Joyce	B.S. History 20 years of experience

Title/Responsibility	Name	Experience
Water Resources, Sedimentation and Erosion	Crystal Allgood	B.S. Biology M.S. Environmental Science 32 years of experience
Flood Hazards	Josh Allen	B.S. Biological and Environmental Engineering 14 years of experience
Flood Hazards	Shanna Kistler	B.S. Biological and Environmental Engineering 5 years of experience
Wetlands, Environmental Flows	Natalie Bue	M.A. Geography 4 years of experience
Vegetation, Wildlife, Threatened/Endangered Species	Nicole Smolensky	Ph.D. Ecology and Evolution Biology M.S. Conservation Biology 17 years of experience
Vegetation, Wildlife, Threatened/Endangered Species	Brittany Irle	B.S. Natural Resource Management M.S. Environmental Sciences and Policy 6 years of experience
Cultural Resources	Martin Handly	B.A. Archaeology M.A. Anthropology 30 years of experience
Navigation, Recreation	Patrick Blair	M.S. Environmental Science 15 years of experience
Navigation, Recreation	Ryan Rausch	B.S. Biology M.S.E.L. Environmental Law 16 years of experience
Visual	Chris Bockey	B.S. Landscape Architecture 12 years of experience
Visual	Spenser Branch	B.S. Urban Planning 6 years of experience
GIS Lead	Kelly Shields	B.S. Biology and Environmental Science 3 years of experience
Technical Editing Lead	Linda Tucker Burfitt	B.A. Communications A.S. Ecosystem Management 18 years of experience
Technical Editor	Kerri Linehan	B.J. Journalism 22 years of experience

Table 8.1-3. Watearth

Title/Responsibility	Name	Experience
Principal, Hydrology and Hydraulics	Jennifer Walker	B.S. Civil Engineering, Water Resources MCE Civil Engineering, Water Resources 30 years' experience
Hydrology and Hydraulics	Jennifer Lundberg	B.S. Environmental Science MES Environmental Studies
Hydrology and Hydraulics	Ryan Hoskins	

Table 8.1-4. Wood

Title/Responsibility	Name	Experience
Cumulative Impacts	Angela Love	B.S. Biology M.S. Biological Sciences 23 years' experience
Cumulative Impacts	Mary Motte Fikri	B.S. Natural Resources M.S Forest Resources 23 years of experience

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