Dallas to Houston High-Speed Rail
Final Environmental Impact Statement

Appendix F:
Dallas to Houston High-Speed Rail
Final Conceptual Engineering
Report - FCEv3
Set 2 of 2

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Texas Central

Dallas to Houston High-Speed Rail

Constructability Report v8

234180-AFN-REP-TCRR Constructability Report

July 1, 2019

Job number

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Contents

Appendices

Acronyms

Acronym	Meaning
BNSF	Burlington Northern Santa Fe Railway
CIP	Cast-In-Place
DCE	Draft Conceptual Engineering
DS	Drilled Shaft
EIS	Environmental Impact Statement
FDCE	Final Draft Conceptual Engineering
FRA	Federal Railroad Administration
HSR	High-Speed Rail
IH	Interstate Highway
ILM	Incremental Launching Method
LEDPA	Least Environmentally Damaging and Practicable Alternative
MOW	Maintenance of Way
MSE	Mechanically Stabilized Earth
MSS	Movable Scaffolding System
NEPA	National Environmental Policy Act
ROD	Record of Decision
ROW	Right of Way
TCEQ	Texas Commission on Environmental Quality
TCRR	Texas Central Railroad
TMF	Trainset Maintenance Facility
TxDOT	Texas Department of Transportation
UPRR	Union Pacific Railroad
USACE	US Army Corps of Engineers
zCE	Central Zone (Texas State Plane Coordinates)
zNC	North Central Zone (Texas State Plane Coordinates)
zSC	South Central Zone (Texas State Plane Coordinates)

1 Introduction

This constructability review provides a conceptual engineering evaluation of general construction types, temporary construction facilities, and proposed locations of staging and precasting sites required to construct the Project. This review is based upon the Final Conceptual Engineering (FCE) report and drawings dated November 28, 2018.

The FCE report and drawings provide information on the design of infrastructure and facilities required for development of the six end-to-end alignment alternatives being studied in the environmental analysis by the Federal Railroad Administration (FRA), which will be documented in the Environmental Impact Statement (EIS) resulting from that study. Information in the FCE report and drawings is organized by sections, which are then combined into segments. The segments are assembled into the six alignment alternatives (shown in Appendix A).

At this conceptual design stage, the areas required for construction have been assessed relatively conservatively. It is likely that more advanced planning and design would reduce area requirements, particularly where right-of-way (ROW) purchases are proposed specifically for construction staging and laydown areas.

At this conceptual design stage, the main purpose of the constructability review is to inform the EIS analysis as it is advanced by the FRA. A further detailed constructability analysis would need to be performed to confirm the feasibility of construction and refine the expected construction methods and phasing of project segments when a greater level of design is available. This report is focused on the civil works of the project. Typical construction methods would be used for other structures and buildings.

Texas Central Railroad, LLC (“TCRR”), a private Texas-based company, plans to operate and maintain a reliable, safe, and economically viable passenger rail transportation system between Houston and Dallas, Texas using proven Japanese high-speed rail (“HSR”) technology (hereafter the “Project”). TCRR and its Affiliates (see paragraph below) are seeking multiple regulatory approvals, including a favorable Record of Decision (ROD) resulting from an Environmental Impact Statement (EIS) as required under the National Environmental Policy Act (NEPA). The Federal Railroad Administration (“FRA”) is preparing the EIS for the Project.

TCRR is a wholly-owned subsidiary of Texas Central Rail Holdings, LLC (“TCRH”) which, in turn, is a subsidiary of Texas Central Partners, LLC (“TCP”) a Delaware limited liability company. Other Affiliates of TCRR including Texas Central Railroad & Infrastructure, Inc. (“TCRI”), Integrated Texas Logistics, Inc. (“ITL”), and Texas Central High-Speed Railway, LLC (“TCR”) are collectively referred to as “Texas Central.” TCR is responsible for planning and coordinating with FRA for the NEPA regulatory approvals for the Project. TCRR submitted a petition for a Rule of Particular Applicability to FRA. TCRI would be responsible for constructing the tracks, stations, platforms, and other infrastructure along the route. When completed, the Project would be operated and maintained by TCRR and TCRI. Within this report, the various Texas Central entities (TCP, TCRH, TCRI, TCRR, ITL, and TCR) are collectively referred to as “TCRR.”

2 General Construction Methods

This section presents a summary of the proposed construction methods for each component of the Project. Construction methods described herein would be required to comply with the applicable terms and conditions of construction permits issued by the FRA and other agencies. (See the FCE report for more details regarding USACE permits requirements). All work would be performed in accordance with applicable regulatory requirements and best practices.

2.1 Clearing and Grubbing

After mobilizing and setting up the construction staging area(s), the contractor would commence with clearing and grubbing the Project's ROW in advance of the major building, railroad, embankments, viaducts, roadway, and utility relocations. This activity would involve clearing natural and manmade obstacles such as trees, shrubs, signs, etc. Stripping a layer of topsoil in advance of the excavation activity may also occur at this stage. Where practicable, removed soils and other fill materials would be stockpiled for reuse. Refer to Section 3.10 and Section 13.8 of the FCE report for additional requirements for clearing and grubbing activities in waters of the U.S. All materials not identified as suitable for reuse would be disposed of in accordance with all applicable regulatory requirements.

2.2 Demolition

In conjunction with clearing and grubbing operations, the demolition of building and roadway structures directly impacted by the Project would be conducted. Before the demolition work could commence, the building occupants would be relocated, and roadway diversions or relocations established as necessary. Maintenance and protection of roadway and pedestrian traffic (MTP) plans would be developed as required.

Pre-construction surveys on adjacent properties and demolition surveys would be carried out to define how any structures would be demolished. Plans would be followed to ensure proper disposal of materials, to mitigate impacts such as traffic and dust, and to ensure safety. Once these steps occur and the structures are ready to be demolished, the actual demolition activity would be completed expeditiously. Hazardous materials within demolished would be identified and disposed of in accordance with applicable local, state, and federal regulations. General construction materials would be recycled to the extent possible and remaining waste materials would be sent to approved landfills.

2.3 Earthwork

The earthwork activity involves the movement of soil from one location to another and the process of forming the soil (or earth) into a desired shape. The earthwork component of this Project would be extensive and involve the use of large construction machinery such as the following:

- dozers
- motor graders
- scrapers
- excavators
- off-road earth haul units (trucks)
- on-road earth haul units (trucks)
- water trucks
- earth compaction equipment

Within the job site, multiple types of equipment will be utilized to move earth efficiently. Short haul distances will likely utilize dozers and/or scrapers and longer distances will utilize trucks to move earthen materials. Opportunities to move materials by rail to limit roadway impacts would be pursued. Figure 1 presents general haul distances for various types of equipment as outlined in the Caterpillar Performance Handbook, Edition 38.

2.4 Aggregates

Most of the aggregates used for sub-ballast and the aggregates used for concrete and other needs will come from existing quarries within the State of Texas. However, due to the aggressive schedule of this project it is anticipated that some materials may need to be purchased from out of state quarries. The specific quality and quantity requirements for track ballast may also require the sourcing of these aggregates out of state. Freight railroads typically own, operate, or partner with ballast quarries given their own needs. Therefore, it is expected that the project will work with the freight railroads to deliver ballast for the project. Connections to the freight railroad network have been included in the conceptual design of staging and laydown areas as shown in the FCE drawing set. The initial approach to transportation of aggregates will be to utilize the existing railroad infrastructure as much as possible.

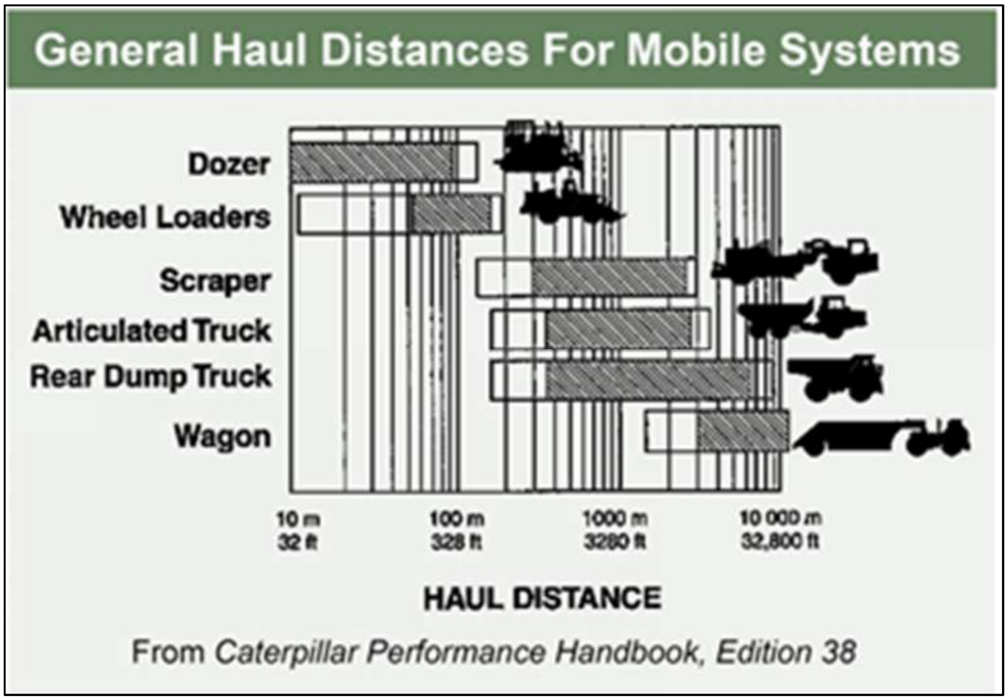


Figure 1: General Haul Distances

The contractor would also be responsible for the stripping and removing any excess materials unsuitable for structural sections of the embankments. This would be hauled off-site to approved landfills, waste areas along the corridor, or areas of the Project where geotechnical requirements are less stringent.

2.5 Highways/Roadways

The proposed Project HSR alignment alternatives would require road and highway realignments. Some of the realignments are associated with grade separations, and some are required due to conflicts with the proposed Project alignment alternatives. The proposed realignments or modifications are shown on the roadway plans. In areas where the Project would run parallel to existing highways (Hempstead Highway and IH-45), construction would be staged in coordination with lane closures developed in close coordination with applicable roadway authority. It is anticipated that highway and roadway work associated with the Project would be done using conventional methods, in the following sequence as appropriate:

- Demolition
- Utility relocations (utility relocation timing may influence the highway work schedule), which could require trenching, pipe installation, storm drain catch basins, or placing precast units.
- Traffic control set up and maintenance.

- Install and remove detours.
- Excavation
- Grading
- Placement of aggregate base.
- Construction of concrete curb and gutter (in some cases this may be carried out before the previous stage), which could be done by building forms and pouring concrete in place, or by using a curb and gutter placing machine.
- Placement of concrete or asphalt concrete top surface base and top surfaces.
- Remove detours and roadway safety measures
- Open final roadway configuration

Coordination with local roadway agencies, TxDOT (for state highways), and various stakeholder and community groups would be required as final design progresses. Special attention would be paid to development of Maintenance and Protection of Traffic (MPT) plans, with a focus on mitigating traffic impacts and ensuring uninterrupted emergency response capabilities to the impacted communities. The plan would provide traffic controls pursuant to the Texas Manual on Uniform Traffic Control Devices' sections on temporary traffic controls (by TxDOT) and would include a traffic control plan. The plan would provide for mitigation of pedestrian impacts, particularly in the more urban areas.

2.6 Drainage

The following aims were used to inform drainage design of the Project:

- Maintain existing drainage flow patterns to the greatest extent possible.
- Disperse on-site runoff to encourage local infiltration when possible.
- Disperse water efficiently to prevent exposure of expansive clays to runoff water.
- Incorporate existing drainage systems into design approach.
- Improve existing drainage capacity if the Project exacerbates existing drainage problems or flooding at a location where the existing system is known to be undersized.
- Treat runoff from pollution-generating impervious surfaces (stations, parking lots, trainset maintenance facilities) to the maximum extent practicable to meet TCEQ water quality objectives and water quality standards before discharging to receiving waters.
- Avoid and minimize impacts to waters of the U.S. to the extent practicable

Where the track is located at-grade on embankment or retained fill, and where new access roads are provided along the HSR alignment, drainage ditches or swales would be required on both sides of the track to collect rainfall and overland flow. The emphasis would be placed on on-site infiltration of runoff or maintaining existing flow patterns where possible. Drainage basins would be designed to facilitate removal of solids (litter and debris) and to manage total suspended solids and pollutants. Storm drains may also be incorporated behind the top of retaining walls to accommodate peak events. All concentrated flow would be addressed in a non-eroding manner.

Tracks set below grade or in a trench section would have drainage elements to collect stormwater and properly connect to existing drainage systems. Pump stations would be used only when needed.

For elevated track segments where the Project crosses an unpaved rural landscape, runoff would be collected and conveyed in pipes down the sides of the pier columns to infiltration swales. Where the guideway crosses developed urban areas, runoff would again be conveyed in pipes down the sides of the piers but would typically be discharged into the local stormwater drainage system.

2.7 Structures

This section provides a general review of alternative methods of construction that could be used where precast concrete trapezoidal box girders or other complex structural configurations are used. Where traditional precast I-beam structures like roadway bridges throughout the state are used, more traditional construction methods would be employed.

2.7.1 Viaducts

There are several proposed viaducts throughout the alignments. Viaducts are in various locations all along the alignments in both developed and undeveloped areas. Viaducts would be used predominantly used in more developed areas where road crossing frequency is high to reduce impacts. Viaducts were used in rural areas to address HSR limitations on grade in rolling topography, to span floodplains, waterbodies, wetlands, and streams, and to facilitate landowner and wildlife movements.

Viaducts may have large diameter bored pile or small diameter driver pile foundations, cast-in-place concrete pile caps, formed concrete columns and precast or cast-in-place concrete decks. The deck design and construction would be partially dependent on the location of the viaduct. Conversely, they may consist of precast arch elements placed on cast in place concrete caps resting on drilled shafts or piling.

It is expected that viaducts will predominately use tradition precast concrete girder with cast-in-place deck superstructure designs to take advantage of contractor expertise and experience in the Texas marketplace. In addition to these traditional methods, below are some alternative viaduct designs that will be also be considered on a case by case basis based on site specific conditions.

Proposed alignment alternatives are generally on the order of 50% viaduct. Viaduct limits for Alternative A were modified following release of the DEIS to increase road over rail crossings and to limit impacts to public roadways, as noted in the FCE report resulting in Alternative A including about approximately 50% viaduct (see Appendix E). During more detailed design, the limits of viaduct would be further refined to mitigate environmental and constructability issues to the extent practicable.

2.7.1.1 Precast Segmental Span by Span Method

For this type of construction, concrete segments of 8 to 12 feet (2.4 to 3.7m) in length are precast in an offsite precasting facility and delivered to site by trucks using the road network. Opportunities to use the previously constructed deck for access to the work site would be investigated during more detailed planning to minimize impacts. Precast segmental span-by-span bridges provide a very high speed of construction and can be constructed over or parallel to existing highways with minimal impact on traffic. Precast segmental bridges can be constructed using an erection truss under the segments or using an overhead erection gantry as shown in Figure 2. The segments are lifted into place, and the joints are post-tensioned together to complete the span construction cycle.

Figure 2: Deep Bay Link Bridge in Hong Kong, Precast Segmental Span-by-Span Method Using Overhead Gantry

2.7.1.2 Concrete Crossover Structures

Nonstandard concrete structures that will bridge over existing infrastructure, such as the UPRR in the Houston Segment may utilize precast beam crossover structures. Typically, this type of construction would involve the following.

A slab section would be constructed using precast, prestressed concrete I-girders and supported on in-situ concrete column cap beams, which would run parallel to the infrastructure being bridged. The I-girder spans would be approximately perpendicular to the infrastructure being bridged, and would be placed immediately adjacent to one another on predetermined centers. A concrete deck slab would act compositely with the beams. The superstructure would be designed to reduce thermal displacements and force effects. Movement between adjacent segments would be controlled with dowelled connections, which would allow relative longitudinal displacements, but not relative transverse displacements.

2.7.1.3 Full Support Method or Cast-in-Place

CIP construction is also considered the full support method and is a traditional method of viaduct construction. With this approach, the superstructure formwork would be supported directly off the ground using substantial scaffold and formwork/falsework. While this type of construction is generally the slowest and most labor intensive of all viaduct construction methods, it has considerable advantages where it would not be practical to construct the viaduct in sequence span by span.

The CIP method would most likely be used for localized short viaduct segments, unique segments, short bridge segments, and other support structures where the economies of scale would not allow for a more efficient linear method.

The full support method would also be the most flexible form of construction because the contractor could reallocate resources from one site to another and the pace of construction could be geared to the availability of resources and program priorities.

Figure 3: Staging and Falsework Supporting the Formwork for In Situ Construction *(Photo courtesy of Taiwan High-Speed Rail Corporation [THSRC])*

2.7.1.4 Incremental Launching Method

Bridge construction using the incremental launching method (ILM) is not very common in the United States but may be used on this project where determined to be the best method to minimize impacts. With this method of construction, the bridge is usually constructed from one side and then launched into place using mechanical jacks. It is also possible to launch from both sides of the obstacle to be crossed, but this can be more expensive due to the requirement of two sets of jacking equipment and supporting equipment or sliding bearings. This method of construction is generally very expensive due to the requirements for a considerable amount of design analysis, specialized construction equipment, and contractor knowledge/experience. However, ILM would be considered where all other means and methods are not feasible.

ILM can be applied to bridges made of either steel or concrete. Concrete bridges built using this method are normally cast in stationary forms behind an abutment with each new segment cast directly against the preceding one. Once the concrete has cured, the entire structure is launched to create sufficient room for casting the subsequent segment. A steel bridge constructed by ILM is completely assembled (typically one segment at a time), including steel cross bracing, prior to launching.

There are two systems that the contractor can use to reduce the cantilever moments and the amount of deflection that occurs during launching, and in some cases both systems may be used. A tapered launching nose on the leading end of the girder can be installed to reduce the dead load of the cantilever span and to assist in lifting the mass of the girders as they are launched forward onto the landing pier. Alternatively, the contractor could elect to use a kingpost system utilizing temporary stays to reduce the deflection of the leading end of the girders during launching.

Figure 4: Incremental Launching Method Equipment Used on the Tou Chien Bridge Second Freeway, Taiwan *(Photo courtesy of Wiecon)*

2.7.1.5 Full-Span Precast Launching Method

The full-span precast launching technique would require the establishment of a dedicated fabrication yard alongside the route of the viaduct where the girders would be prefabricated under factory-like conditions. The girders would weigh upward of 700 US tons (635 tonnes) each. The girders would be cast in molds and allowed to cure, after which a completed girder would be lifted from the yard onto a self-propelled traveling gantry, which would travel along the already completed guideway to where the girder is to be lifted into place. This type of construction would be the fastest construction method, but would require considerable up-front investment by the contractor in the fabrication yard, lifting equipment, and traveling gantries. This method also requires structural design of viaduct sections to support the construction loadings.

With the full-span precast launching, after the foundations and bents are completed, the bulk of the follow-on construction activities would be at the superstructure level. The completed guideway would be the primary route for access between the fabrication yard and the leading edge of the viaduct, which would limit construction impacts. This form of construction is particularly suited to long, continuous viaducts, which are proposed in each of the alignment alternatives.

Figure 5: Launching/High-Speed Rail System under Construction in Taiwan, ROC *(Photo courtesy of THSRC)*

Figure 6: The Full-Span Precast Launching Method Launching/High-Speed Rail under Construction in Taiwan, ROC (Photo courtesy of THSRC)

2.7.1.6 Free Cantilever Method/Balanced Cantilever Construction

The free cantilever method/balanced cantilever construction method allows the superstructure to be constructed in a segmental manner from the top of a bent. Segments could be precast off-site and brought to site on the back of a low loader, where they would be lifted into place and extended outward from the bent. The size of the precast segment is usually constrained by accessibility, meaning that segments transported by road rarely exceed 10 to 12 feet (3 to 3.7m) in length or weigh more than 70 US tons (63.5 tonnes).

Alternatively, where ground access would be severely limited, the segments could be cast in situ and the formwork advanced segment by segment across the span. With this method, segments are held in place by prestressing. The free cantilever method/balanced cantilever construction would be particularly useful for constructing longer spans and for crossing rivers, railroads, and roadways where ground support might not be practical. CIP segmental construction is often used where non-prismatic sections are used to reduce depth (and weight) at midspan. In these situations, girder stems are often made vertical to facilitate mold depth adjustment.

Figure 7: Balanced Cantilever, STAR Light Rail, Kuala Lumpur, Malaysia *(Photo courtesy Arup)*

2.7.1.7 Movable Scaffolding System/Advance Shoring System

The movable scaffolding system (MSS) and advance shoring system involves construction of the main formwork between two adjoining bents. The girder is then cast in place. After curing, the formwork is not dismantled, but is instead pushed forward to the next span where the casting and curing is repeated. There is no need to reassemble the formwork at the next span.

The formwork is mechanically advanced and is supported at all times off the previously constructed structure bents. This technique is considered one of the fastest methods of in-situ construction but is only economical where there is a continuous series of spans.

Figure 8: MSS in Place Awaiting in Situ Construction, Taiwan High-Speed Rail, ROC *(Photo courtesy of THSRC)*

Figure 9: MSS Moving Forward to the Next Span, Bent Construction Well Advanced of the Girder Placement, Taiwan High-Speed Rail, ROC *(Photo courtesy of THSRC)*

2.7.2 Grade Separations

The Project's alignment alternatives would need to be fully segregated from road or rail traffic. As such, any HSR crossing with roadways, private drives, or railroads would be grade separated. Grade crossing elimination could be achieved in the following ways:

- Elevate the HSR over the road. The HSR would be on a viaduct or short bridge structure with either embankment or retained fill approaches. Build Alternative A was refined to increase road over rail crossings, as noted in the FCE report. All active freight railroad crossings were designed so the HSR passes above the freight railroad without reprofiling of the freight line.
- Elevate the road so it passes over the HSR. The roadway approaches to the structure were predominately proposed as embankments in the conceptual engineering to minimize maintenance requirements and for the most conservative approach to evaluating property and environmental impacts. Roadway approaches could be mechanically stabilized earth (MSE) retaining walls to minimize project footprint and impact based on results of environmental reviews. The roadway bridge would typically be a standard highway-over-rail bridge.
- Lower the road so it passes beneath the HSR. The roadway approaches were predominately proposed as sloped cuts in the conceptual engineering to minimize maintenance requirements and for the most conservative approach to evaluating property and environmental impacts. Roadway approaches could be lowered using mechanically stabilized earth (MSE) retaining walls to minimize project footprint and impact based on results of environmental reviews. The HSR would typically be on bridge structure where these crossings were within HSR embankment sections.
- Reroute or close the road at the crossing location. This would happen only in rare cases where adjacent landowner access would be negligible or non-existent, such as where the Project acquires the full parcel. No public roads are shown as closed in the design.

2.7.3 Bridges

Throughout the alignment alternatives there would be several locations where surface features such as rivers and washes would be crossed using bridges or viaducts. At this stage it is assumed that no intermediate supports would be acceptable in river channels, except for where the long span makes intermediate supports unavoidable. During more detailed design, the contractor would review the placement of individual piers to avoid and minimize impacts to wetlands and other sensitive environmental features to the extent practicable.

2.7.4 Open Trench Excavation

Widths and depths of rail trenches would vary depending on track configuration and location. The structural form of the trench would likely be standard along its length.

There are several candidate wall systems for trench structures, outlined in Table 1.

Table 1: Candidate Wall System for Trench Structures

System	Description
Secant Pile Wall	Formed from overlapping drilled piers installed next to each other
Structural Diaphragm Slurry Wall	Formed from adjacent reinforced concrete panels
Contiguous Pile Wall	Formed from a row of piles installed next to each other, spaced with a gap between adjacent piles.
Soldier Pile and Lagging Wall	Vertical steel members embedded in piles with wood or shotcrete lagging forming the wall face
Deep Soil Mix Wall	Formed from overlapping soil-cement piles
MSE Wall in cut	TBD
Anchor Tie Back walls	TBD
Soil Nail Walls	TBD
Sheet Pile Walls	TBD

The trench walls would be constructed before the material between the walls would be excavated to form the trench. The walls would then be exposed during the excavation, except for the soldier pile and lagging method where the lagging is installed in parallel with the material excavation. As excavation proceeds, temporary shoring would be added to control wall movement. Any facing required for the walls for aesthetic or maintenance reasons could be constructed following the completion of the trench construction.

It is possible that permanent struts would be required to brace the tops of retaining walls. At the ends of trenches, struts would not be possible due to the required Project vertical clearance. At these locations, tie-back supports may be required. They would be installed when the trench has been partially excavated. A permanent subsurface easement would be required for the tie-backs to protect against future subsurface developments including foundations and utilities. A photo of a trench under construction is shown in Figure 10.

Figure 10: Trench Diridon Tunnels, San Jose, CA

2.7.5 Retaining Walls

Retaining walls would be used on the approaches to structures where there is no room for sloped embankments. The retaining walls may be constructed using conventional CIP methods, crib walls, T-Walls, or by the MSE method which uses precast concrete facing panels and either metal or fabric reinforcement between layers of compacted engineered fill to create embankment with vertical or near-vertical sides.

An example of an MSE wall under construction is shown in Figure 11.

Figure 11: MSE Wall, Route 85/US 101 (South) Interchange Project, CA

2.8 Utility Relocations

Utility relocation would be performed in advance of the main works where possible. The contractor would provide temporary construction utilities as required.

2.9 Trackwork

Mainline tracks would be typical sections of ballast with concrete crossties, elastic fasteners, and standard rail materials to meet the Tokaido Shinkansen technical requirements. Track in stations would be direct fixation track of reinforced concrete sections, to ensure correct horizontal and vertical positioning of the vehicles relative to the platform edges.

2.10 Systems

No major constructability issues are anticipated with regards to systems sites on this alignment. However, there are many sites that are in the vicinity of new roadway overpasses/access roads, and the clearing and grubbing of the sites would be coordinated with the overpass and access road construction.

2.11 Non-Standard Structures

All bridge spans greater than 120ft (36.6m) and all skewed crossings requiring straddle bent or crossover structures were considered non-standard structures within the constructability review.

Appendix B lists all the proposed non-standard structures. The span lengths provided are based on a preliminary level of design in support of conceptual engineering and is subject to revision as the design develops. Span lengths may vary from those shown based on further structural and geotechnical investigations, constructability reviews, or environmental concerns as identified within the DEIS. To determine typical spans shown in Appendix B the following assumptions were used.

- For steel trusses, a single span of the required crossing distance was assumed.
- For a required crossing distance of between 120ft (36.6m) and 140ft (42.7m), a three-span concrete system was adopted. The system would consist of segmentally precast post-tensioned concrete trapezoidal box girders spanning continuously over concrete piers. The box girders would have a constant depth in this system. The longest span of the three spans is the crossing distance. The other two spans would typically be 120ft, but may vary to suit the adjacent spans and structural design. These crossings are noted as “Long Span” in Appendix B and only the longest span is called out.
- For a required crossing distance between 140ft (42.7m) and 200ft (61.0m), a similar three span system was applied. However, the middle span is the crossing distance and the first and last spans were assumed to be 70% of the crossing distance. Stationing shown in Appendix B assumed the span distance would be symmetrical. These crossing are also noted as “Long Span” in Appendix B, but all 3 spans are called out.
- For a required crossing distance larger than 200ft (61.0m), a similar three span system was applied, but with haunched viaducts at the piers. The middle span is the crossing distance and the first and last spans were assumed to be 70% of the crossing distance. Stationing shown in Appendix B assumed the span distance would be symmetrical. These crossings are noted as “Haunched Girder” in Appendix B.
- For skewed crossings, structures are noted as “Crossover” in Appendix B. The stationing shown in Appendix B provides the overall length of the crossing and span segments of 120ft (36.6m) between bents were used. The span of straddle bent underneath the crossover would vary based on location. Typical straddle bent spans would be 60ft, 80ft, 100ft, 120ft, and

140ft (18.3m, 24.4m, 30.5m, 36.6m, and 42.7m). Stationing assumes the span distance is symmetrical.

- When a pier would need to be replaced with a straddle bent to avoid utility lines or existing infrastructure, it was noted as "Straddle Bent" in Appendix B.
- For spans greater than 300 feet at "Network Tied Arch" will be used. These bridge types are designed so that the outward horizontal forces of the arch are carried in tension by a chord tying the arch ends, rather than by bridge foundations.

2.12 Preliminary Structural Alternatives

Several structural alternatives are being considered at this point and would be further defined as design develops. For the typical viaduct section, several superstructure alternatives are being considered such as precast I-beams, precast arch sections, precast U-beams or isostatic single-cell concrete box girders. Typical spans for the alternatives range between 70 and 140 ft. (21 to 43m). For larger spans, which may be needed in select locations due to geometric constraints, hyperstatic (continuous) single-cell concrete box girders are being considered along with steel plate girders, steel trusses, steel arches, or cable stayed. Design of structures in these locations would require more detailed site-specific analyses.

With respect to substructure, column and foundation configurations would be dependent on the viaduct height as well as local geotechnical conditions. Preliminarily, multicolumn solutions are proposed for bents shorter than 30ft (9.1m) with two columns with one drilled shaft (DS) each. DS and pile diameters range from 4 to 10ft (1.2 to 3m) for the multicolumn solutions depending on height and location along the alignment.

For tall bents (above 30ft (9.4m)), a hammerhead column with pile cap foundation would typically be required to reduce flexibility and minimize displacements at top of bent. A footing with 4 drilled shafts would typically be designed for such locations.

2.13 Material Haul

The Project would require large quantities of various construction materials to be transported to project locations from various sources. The materials listed below would be brought in from off site:

- Earthworks: Common earthwork design and construction practice is to make efforts to balance earthwork cut and fill volumes to the extent practicable, however it is expected that all materials excavated will not be of the quality required for construction of the Project and associated structural fills. Therefore, materials of suitable quality will need to be secured. Efforts will be made to excavate from borrow sites as near to the fill as possible to minimize transportation costs and impacts. Since no sites have currently been identified along the alignment for sourcing the material, a 10-30 mile radius from the corridor has been estimated for transport by truck. A potential alternative approach would be to bring in fill from existing stockpiles or borrow sites along the BNSF or UPRR railroad lines since construction staging areas along the alignment have been located close to these freight railroads. To the extent practicable, all excavated materials will be used to support project finish grading on site. Where excess materials must be removed from the project site efforts will also be made to transport materials to local fill or waste sites by truck or to more distant sites by rail. All borrow and fill efforts will be done in strict accordance with all applicable regulatory requirements.

- Ballast/Sub-Ballast: Railroad ballast is produced from natural deposits of high quality granite, trap rock, quartzite, or dolomite. No area between Dallas and Houston has been identified as a source for these materials that has the acceptable quality or combination of deposits. Although aggregate specifications have not yet been established, UPRR or BNSF qualified quarries may be considered as sources to support transport by freight rail to the Project.
- Steel: Sources, foreign and domestic, of steel are dynamic in nature. Sourcing of steel for the project will respond to market conditions and be influenced by other ongoing projects in the corridor. The focus of steel procurement efforts will be to source steel materials and fabrication efforts from domestic sources to the extent practicable.
  - Reinforcing Steel: It is assumed that there are local steel manufacturers that can provide reinforcing steel close to the project site. The average distance from these suppliers to the project mid-point is estimated to be roughly 100 miles. It would not be uncommon for fabrication companies to receive steel shipments from manufacturers, tie sections of reinforcement together, and then to ship them to the construction site for installation.
  - Rail: Rail fabrication of the quality required for the project will not be available locally along the project corridor. Rails will be shipped via train to project staging areas. Upon reaching the material staging site the rail will then be further fabricated and pulled into place by specialty rail construction equipment.
  - Structural Steel: The largest structural steel member requirements will be for truss bridges required for the project and potentially for project stations and facilities. Fabricators of manufactured steel are located regionally. Current construction practice is to fabricate and assemble pieces as large as possible with the limiting factor being transportation restrictions.
  - Other minor structural steel shapes will be incorporated into various components of the project such as bridges, stations, and facilities.
- Concrete: Significant quantities of concrete will be used for ties, viaduct foundations, subgrade piers, footings, and pre-cast elements of the superstructure.
  - Railroad Ties: It is common practice in the industry to install new tie plants near the alignment for projects of this magnitude. Concrete tie companies commonly seek to secure a long-term contract and build a tie plant near the alignment for initial construction and for ongoing maintenance of concrete ties needed for the project.
  - Subgrade Piers and Foundations: Concrete for the subgrade piers and foundations will be mixed, batched, and dispatched from batch plants at various locations along and

immediately adjacent to the HSR right of way. Haul distances would be expected to be between 0 and 50 miles.

- Precast Concrete: Concrete for use in the manufacture of pre-cast elements will be mixed and batched at pre-cast manufacture facilities constructed for the project and sited immediately adjacent to the ROW. Large pre-cast girders would be hauled along and or on top of the HSR ROW a maximum of 50 miles.
- Sand and rock aggregates and cementious materials utilized for concrete mixes will come from regional sources of commercially established quarries and mills within 5 to 200 miles.

3 Construction Staging and Precast Operations

Locations of each temporary construction facility and the surrounding infrastructure can be seen in the table in Appendix C and aerial imagery of each location is included in Appendix G.

The sites presented in Appendix G have been initially selected for temporary construction facilities, that could be used for temporary staging and precast operations. Appendix C includes the segment, area, location and alignment alternatives' stationing of those sites. The contractor may elect to find additional properties for construction activities subject to all applicable regulations and requirements. The contractor would be able to utilize the permanent construction areas such as station footprints, maintenance-of-way, and heavy maintenance facilities for temporary purposes. These areas are not shown in Appendix C or Appendix G. Several of the areas identified for construction staging in the conceptual engineering drawings were selected because they are adjacent to existing freight rail lines and would allow for the placement of circular or parallel rail spurs to allow for the delivery of materials by rail. These areas typically are approximately no smaller than 100 acres (40,4686m^2) so freight cars would be able to be completely removed from the main track. Any additional areas required for freight connections that are ultimately agreed upon between contractors and freight rail operators would require separate pursuit of any required property and applicable regulatory approvals.

4 Sites for Precast Operations

The precast operation yards were located near to extended lengths of precast viaduct to minimize distances between the precast operations yards and the locations of erection. A precasting facility could be set up in most of the construction staging areas identified in this report.

4.1 Summary of Precast Operations

Several sites have been preliminarily chosen as precast operation yards. The final locations for precast facilities within the staging areas identified would be subject to change as the design of the permanent facilities is refined and as the construction schedule develops.

Where possible, the footprint of permanent construction facilities would be used for temporary work to reduce the overall land purchase. For this initial analysis, at least one precast operation yard has been selected in each segment as shown in Appendix C. Aerial imagery for each location is included in Appendix G.

4.2 Site Selection Criteria

Fabrication sites were chosen carefully since large precast sections would only be used for significant lengths of viaduct. Site selection would greatly affect the production efficiency of the large precast members, particularly the length of time to fabricate and the time and cost to transport and erect precast members.

There are several key considerations to selection of a fabrication site. Fabrication sites must have access to existing utilities to reduce construction site development time and costs. Potential impacts to traffic were also be a main consideration in the selection of suitable sites. The contractor would put a location-specific, activity-based trip schedule in place to minimize impacts. Sufficient access to the sites would be required for delivery of materials and efficient rates of production.

Sites must meet the minimum area requirements because the amount of available space affects the production schedule, especially for the precast structural sections. The following five criteria are guidelines for choosing precast operations yards. The locations discussed in this document meet these minimum criteria.

4.2.1 Utilities

Precasting facilities would require a full range of standard utilities, including communications, power, potable and industrial water, drainage, and sewer. Ideally, existing utilities would have sufficient capacity. In the event they are not sufficient, the site selection would consider the proximity of existing utility connections and the cost of bringing the required utilities to the site.

The overlap of temporary facilities with later permanent support installations would be cost-effective. For example, a high-speed train station, heavy maintenance facility, or maintenance-of-way facility would provide ample utility service improvements that could be reused. In addition, other site improvements that could support both construction operations and long-term use would include building foundations and slabs, offices, parking improvements, fencing, and security.

4.2.2 Access

Effort was undertaken to select sites with direct access to arterials from major highways, and to freight railroads where practicable. The sites were also selected to be directly adjacent to the Project's ROW to afford direct transport of materials and equipment to construction sites with minimal impacts on traffic. Transporting materials by rail would reduce impacts to roadway traffic. Direct access to roadways is required to facilitate delivery of materials to the yard receiving from the precast operations yards and minimizes travel on side roads.

Precast operations yards were generally located and sized to support construction staging areas within the same footprint to minimize cost and potential environmental impacts.

The load and volume capacity of existing structures and roads would need to support construction operations. An analysis of existing roads and structures along planned construction and material delivery routes would be undertaken by the contractor prior to commencement of operations. Preliminary routes are shown in Appendix G. Similarly, a site-specific investigation of horizontal and vertical clearances and of existing geometric road conditions, as they pertain to construction equipment mobility and transport, would be undertaken by the contractor.

4.2.3 Area

Areas would be necessary for casting operation, equipment storage, a maintenance yard, shipping and receiving of materials, and possibly precast storage. Table 2 outlines how the space within a typical precast yard would be allocated. The table shows a typical desired size. Locations of precast yards vary based on infrastructure configurations along the alignment. Site specific constraints at each location limit available size. Where construction staging areas exceed this size, the site selected would also support staging of materials and equipment. Detailed quantities for the different operating areas and specific equipment of each individual site have not been set.

Figure 12 graphically shows the proportions into which the area would be divided.

Table 2: Composition of Precast Operations Yards

Facility Type	Area (ft^2)	Area (m^2)
Batch Plant	80,000	7,432
Ancillary Space	70,000	6,503
Rebar Storage & Bending Area	43,000	3,995
Power Station	11,000	1,022
Equipment Yard	22,000	2,044
Material Storage Yard	3,000,000	278,710
Molding Area	50,000	4,645
Rebar Jig Area	65,000	6,039
Material Testing & Office Area	65,000	6,039
Access Roads	65,000	6,039
Total	3,771,000 (86.5 acres)	350,337

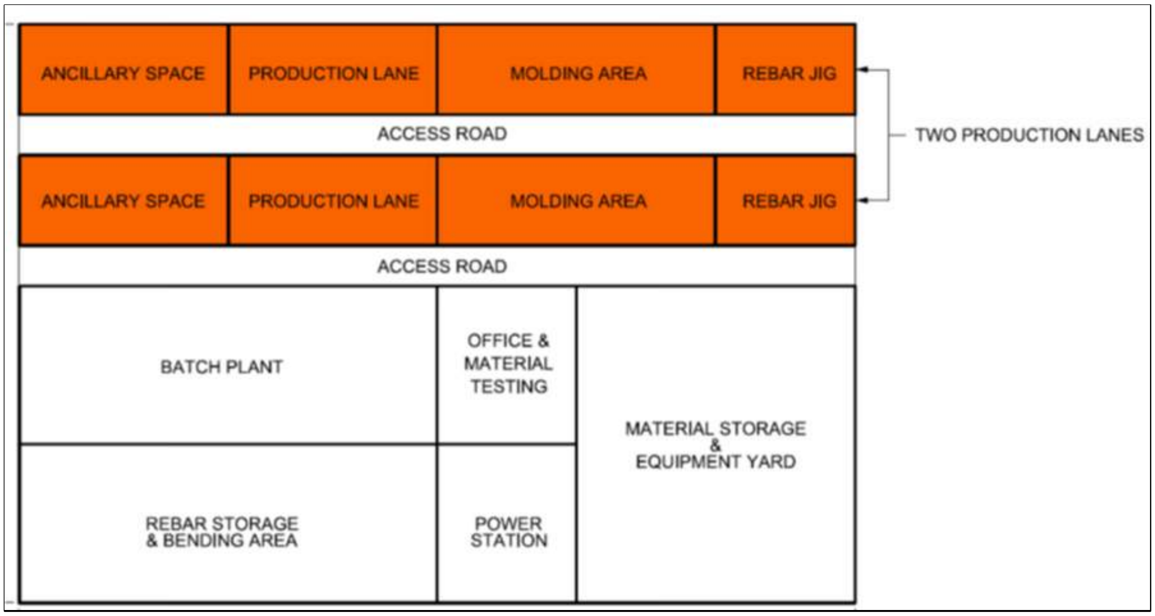


Figure 12: Proportions of Typical Precast Operations Yards, Material Storage and Staging Yard Not Shown

4.2.4 Location

To minimize the distances that the large precast sections would be transported, proposed precast operations yards were located close to where the precast sections would be erected. Impact to floodplains and environmentally sensitive areas were minimized to the extent practicable.

5 Sites for Construction Staging Area

The construction staging areas would house incoming materials; provide areas for material preparation, equipment storage, equipment maintenance, operations preparation, and construction offices; and, would allow good housekeeping throughout the alignment. Haphazard staging of materials and equipment throughout the alignment alternatives would not be conducive to the construction process or safety. As such, preliminary locations for construction staging areas were identified at regular intervals along the Project alignments. Each site would regularly receive materials and equipment; therefore, proximity to main roads and direct access to construction side roads and arterial roads was considered to reduce the impact on the general flow of traffic.

As discussed for the fabrication yards above, the key criteria used in selection of proposed staging areas were accessibility, traffic impact, utilities provision, environmental sensitivity, location, spacing, and size of site available.

5.1 Site Selection Criteria

The areas in Appendix C have been identified as temporary construction staging areas. Locations would be refined through more detailed design development and stakeholder engagement, and would be adjusted to mitigate impacts as practicable based on environmental analyses. The following four criteria were used as guidelines for the selection of construction staging areas.

5.1.1 Traffic

Selected areas were identified with reasonably direct access to arterials from major highways, and to freight railroads where practicable. Direct access to the Project ROW would allow efficient transport of materials and equipment to construction sites with minimal impacts on traffic. Sites were also selected to minimize interference with pedestrians, bicyclists, and transit to the extent practicable.

As mentioned above, construction staging areas would be located within the same footprint as precast operations where practicable. Potential impacts of construction on traffic were also considered in the selection of suitable sites. The contractor would establish a location-specific, activity-based trip schedule to minimize those impacts.

The load and volume capacity of existing structures and roads along transport routes would need to support construction operations. An analysis of existing roads and structures along construction routes would be undertaken by the contractor prior to final site selection. Preliminary routes are shown in Appendix G. Similarly, a site-specific investigation of horizontal and vertical clearances and of existing geometric road conditions, would be undertaken by the contractor to ensure construction equipment mobility and transport.

5.1.2 Area

The size of the staging areas would vary and depend on environmental constraints, development, and parcel boundaries in each location.

5.1.3 Location

Construction staging areas were distributed along the alignments to minimize the distances between construction sites. The staging areas were generally spaced 15 to 25 miles (24.1 to 40.2km) apart.

5.1.4 Accessibility

The locations selected are generally close to major roadways and to on- and off-ramps. Access to major roadways would aid in shipping to and receiving from the construction site and would minimize travel on side roads, reducing traffic impacts. Transport of materials by rail could also be used to reduce traffic impacts.

Proximity of existing utilities was considered in selection of sites to reduce construction-site development time and costs. Accessibility to construction staging would be a key factor in efficient rates of production which would in turn deliver the Project on-schedule.

6 Construction Considerations

Typical and specific constructability concerns are described in the following sections. A more detailed analysis would need to be performed as the design progresses.

6.1 Accessibility

The ease of access to the construction area is a critical element in the constructability assessment. Access limitations would determine the amount of auxiliary work required to reach work sites with equipment and materials such as temporary access roads, with obvious implications to project cost and schedule. Access would also determine the types of equipment that would be required to reach the work zone and perform the work. Insufficient access might preclude large precast elements or large construction equipment from accessing the construction area and could require additional work to improve existing adjacent infrastructure. A 25'(7.6m) minimum clear access road adjacent to proposed embankment and structures is required to ensure the safety of the workforce and timely construction in addition to future access by first responders and emergency personnel.

The availability of space for construction operations (free of conflicting infrastructure or obstacles) would be another constructability factor. Sufficient space for staging, storage, and construction operations would be needed along the alignment. Space would be required for not only large equipment and major construction operations, but also for construction crew access, parking lots, and work areas.

6.2 Pre-Construction Activities

Roads and freight rail lines would be used for hauling materials and equipment. Construction haul routes would add traffic to local areas and could damage infrastructure not designed for heavy loads. Preliminary routes are shown in Appendix G. Thus, reinforcement of local roads and bridges would likely be required in advance of major works.

Freight rail lines were also considered, and sites were identified for proposed freight rail connections to deliver and haul larger quantities of construction materials and equipment. These proposed freight rail connections were strategically identified to support not only Project construction but long-term freight rail access at the TMFs and select MOW bases, which would serve as construction staging sites during Project development. Construction of auxiliary freight tracks to access these construction sites would be part of the early works.

6.3 Floodplain Crossings

Alignments passing through major floodplains, wetland, and environmentally sensitive areas would require mitigation measures and bring construction difficulties. Long lengths of the alignments in wetland areas would require viaducts with long spans to avoid disruption of the original conditions of soil and vegetation. Additionally, construction in floodplain areas, which typically contain poor soil conditions, would result in cost increases associated with the removal of inadequate materials and require the excavation and hauling of significant amounts of borrow pit materials.

6.4 Road Crossings

Grade separations at intersections between the alignments and existing roadways requiring bridge structures for either the HSR line or for the roadway, would require complex coordination efforts that would increase the schedule, and the schedule risk, of the project. Road crossings frequently require complicated structures and carefully phased construction to maintain existing traffic operations. The number of such road crossings would be minimized by running the alignment on a viaduct crossing over the existing roadways where possible.

6.5 Traffic

In developed areas the Project would frequently cross significant roadways, which provide adequate construction access. In rural areas, fewer road crossings are anticipated. Existing private and local access roads in these areas could be used for construction access. Site specific traffic control plans would be developed for all roadways impacted by the project. This plan would address in detail the activities to be carried out in each construction phase, with the requirement of maintaining traffic flow during peak travel periods. Such activities include but are not limited to the routing and scheduling of materials deliveries, materials staging and storage areas, construction employee arrival and departure schedules, employee parking locations, and temporary road closures, if needed.

6.6 Railroad Coordination

Construction of crossings over freight railroad lines (fully grade separated) and all work adjacent to existing freight railroad lines would require coordination and approval from railroad operators. Construction near live freight operations would require additional safety considerations and defined procedures such as the use of flagmen. Consideration would need to be taken in both Houston and Dallas where long viaducts run parallel with active freight railroads. Close coordination will be required to minimize risk to schedule of railroad.

6.7 Complex and Skewed Structures

When intersecting with current infrastructure (e.g. highways, roadways, railways), skewed elevated crossings add to construction complexity. Perpendicular crossings can typically be designed and constructed as a conventional bridge with smaller spans, whereas skewed structures would require a more complicated site-specific design and construction with longer spans or long straddle bents.

6.8 Utilities

Utility relocations would increase construction cost and schedule risk due to third-party coordination and protection requirements. Working in the proximity of utilities such as electric power lines or gas pipelines would require careful site management and coordination with the respective utilities. An existing utility investigation will be performed as part of the design phase.

6.9 Right-of-Way (ROW)

Lack of site access would cause schedule delays and increased construction costs. Accordingly, alignments with more complicated ROW acquisition requirements would require significant advance efforts and third-party coordination. Therefore, alignment alternatives with lower requirements for acquisitions would reduce project cost and schedule risks.

6.10 Ground Improvements

A variety of ground improvement techniques are expected for the Project to mitigate both expansive soil and soft ground conditions. The primary ground improvement technique is expected to be cut and replacement with imported materials. It may also be feasible to engineer suitable materials in-place by amending the existing soil with the application of some combination of hydrated lime, Portland cement, and/or fly-ash, or to moisture-condition the expansive soil and encapsulate it to limit moisture variations. Other techniques are available and would be used as deemed necessary. These could include wick drains, controlled modulus columns, deep soil mixing, vibro-compaction, permeation or compaction grouting, jet grouting, dynamic falling-weight compaction, pile-slab solutions and stone columns.

6.11 Environmental Restoration

Construction in environmentally sensitive areas, such as federally-listed threatened and endangered species habitat or wetlands, would require advanced coordination with applicable regulatory bodies (i.e. FRA, USFWS, USACE, etc.) to determine restoration and protection measures required before, during, and after construction. During detailed design, the contractor would develop restoration plans for environmentally sensitive areas in accordance with applicable regulatory requirements.

7 Major Quantities

The following section details the major construction quantities along the six potential route options.

7.1 Construction Materials Quantities

An estimate of construction quantities was developed for each alignment alternative and is provided in Appendix D. These numbers are rough order-of-magnitude estimates at this planning level of design development, but allow for a comparative evaluation of construction requirements for environmental analyses.

The list below describes several of the line items in Appendix D:

- Excavation includes excavation, topsoil stripping, and undercut
- Filling includes embankment core and shell, undercut replacement
- Construction waste quantities do not include building, road or any other infrastructure demolition
- Hazardous waste material has not been quantified separately
- Miscellaneous other refers to crash walls, noise walls, MSE, retained cut wall, catenary bases, and facilities

In addition, several assumptions were made in this estimate, including:

- To produce a 3000 psi cubic yard of concrete (27 cubic feet) the typical concrete mixture ratio of 517 pounds of cement, 1560 pounds of sand, 1600 pounds of stone, and 32 - 34 gallons of water was used.
- Water will be available at batching/precasting sites
- 1 delivery of ballast every two weeks via locomotive
- 1 delivery of cement, sand and gravel every two weeks via locomotive
- 12 pm^2 for station structural steel
- No construction waste for earthworks operations as any spilloff will be transported to borrow sites or deposited along the job site.
- Construction waste for overall concrete operations is 5.0%; it is assumed that 0.5% will finally be deposited in landfill or recycled

Most of the aggregates used for ballast, sub-ballast and aggregates for concrete will come from within the State of Texas to meet the majority of the project's needs. However, due to the aggressive schedule of this project, the Project does anticipate the need to purchase some aggregates from out-of-state quarries. The initial approach for transportation of aggregates will be to utilize the existing freight railroad infrastructure as much as possible. Some alternatives and some alignment segments will rely more heavily on truck transport given distance from freight railroad network and proximity to highway infrastructure, for example along IH-45.

Appendix C provides infrastructure configuration types per linear route mile, and linear kilometer, for the HSR.

7.2 Construction Equipment

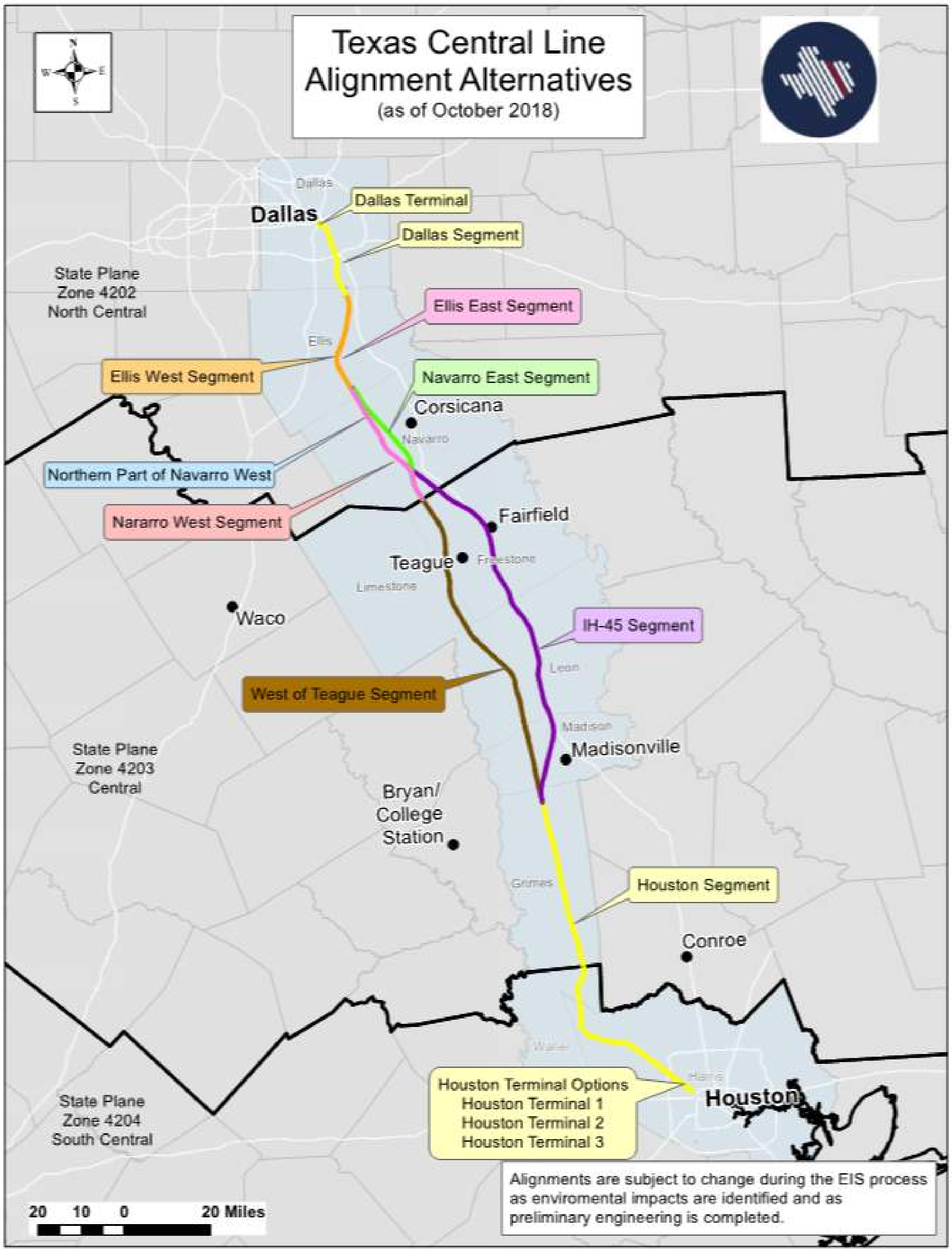
An estimate of construction equipment needs was developed for each alignment alternative and is provided in Appendix F. These numbers are rough order-of-magnitude estimates at this planning level of design development, but allow for a comparative evaluation of construction requirements for environmental analyses. As the design continues to be finalized, quantities will be adjusted.

8 Construction Cost Estimate and Schedule

Appendix H provides TCRR's expected project capital cost and construction schedule.

TCRR has been closely coordinating with the construction community within Texas and with HSR owners, operators, and systems suppliers worldwide over the course of project development to gather insight into project infrastructure and facilities design and delivery approaches. TCRR has also undertaken early contractor engagement by bringing a design-build partner on board the project development team to ensure that likely construction means and methods are adequately considered in the development of our financial modeling.

Appendix A: Segments



Segment Name (ID; abbreviation)	Section Name (and ID)	Start	End	Length		FRA Alignment Alternatives					
				mi	km	**A**	**B**	**C**	**D**	**E**	**F**
Dallas (1, DS)	Dallas zNC (DT)	DT 10+00	DT 216+59	3.9	6.3	X	X	X	X	X	X
	Dallas zNC (DS)	DS 10+00	DS 770+78	14.4	23.2	X	X	X	X	X	X
Ellis West (2A, EW)	Ellis West zNC (EW)	EW 10+00	EW 1246+26	23.4	37.7	X	X	X			
Ellis East (2B, EE)	Ellis East zNC (EE)	EE 9+56	EE 1232+15	23.2	37.3				X	X	X
Navarro West (3A, NW)	Navarro West zNC (NW)	NW 10+00	NW 1638+12	30.8	49.6	X			X		
Navarro East (3B, NE)	Navarro East zNC (NE)	NE 10+00	NE 1652+05	31.1	50.0		X			X	
IH-45 (3C, IH)	Navarro West zNC (NWIH)	NW 518+39	NW 1638+12	21.2	34.1			X			X
	IH-45 zNC (IH2)	IH2 10+00	IH2 540+81	10.1	16.2			X			X
	IH-45 zCE (IH1)	IH1 10+00	IH1 4329+69	81.8	131.7			X			X
West of Teague (4, WT)	West of Teague zCE (WT)	WT 10+00	WT 4118+87	77.8	125.2	X	X		X	X	
Houston (5, HN)	Houston zCE (HN2)	HN2 10+00	HN2 2073+80	39.1	62.9	X	X	X	X	X	X
	Houston zSC (HN1)	HN1 10+50	HN1 2387+96	45.0	72.5	X	X	X	X	X	X
	Houston Terminal Industrial Site (HT3)	HT3 10+00	HT3 54+70	0.8	1.4						
	Houston Terminal Northwest Mall Site (HT2)	HT2 10+00	HT2 55+86	0.9	1.4	X	X	X	X	X	X
	Houston Terminal Northwest Transit Center Site (HT1)	HT1 11+00	HT1 110+36	1.9	3.1						
Total Length in miles assuming HT2 (miles)						235	236	240	235	235	240
Total Length in miles assuming HT2 (km)						379	379	386	378	379	385

Appendix B: Non-Standard Structures

Section	STA Start	STA End	Structure Type	Key Considerations	Typical Span (Ft)	Typical Span (m)
HT1	56+20	62+25	Crossover with Straddle Bents (Concrete)	UPRR Crossing	1 – 115’ span and 4 – 120’ span	1 – 35m span and 4-37m span
HT1	64+05	79+35	Crossover with Straddle Bents (Concrete)	UPRR Crossing	13 – 120’ span	13 – 37m span
HT2	32+28	33+92	Long Span (Concrete)	Karbach St	164	50
HT2	40+93	42+49	Long Span (Concrete)	McAllister Rd	155	17
HT2	43+70	53+43	Crossover with Straddle Bents (Concrete)	Hempstead Rd	9-120’span	9-37m span
HT3	29+10	35+19	Crossover with Straddle Bents (Concrete)	UPRR Crossing	5-120’ span	5-37m span
HT3	35+19	36+75	Crossover with Straddle Bents (Concrete)	UPRR Crossing	1 – 155’ span	47m span
HN1	40+12	41+42	Long Span (Concrete)	Antoine Dr.	140	43
HN1	76+53	77+93	Long Span (Concrete)	W. 34th St	140	43
HN1	118+20	121+80	Long Span (Concrete)	Bingle Rd	140	43
HN1	164+50	165+93	Long Span (Concrete)	W. 43rd St	163.5	50
HN1	243+79	245+55	Long Span (Concrete)	Blalock Rd/ Fairbanks Rd	180	55
HN1	262+72	264+21	Long Span (Concrete)	Tidwell Rd	150	45
HN1	325+66	327+11	Long Span (Concrete)	Gessner Rd	145’	44
HN1	330+10	357+63	Crossover with Straddle Bents (Concrete)	UPRR Crossing	22-120’ spans	22-37m spans
HN1	358+65	367+99	Long Span Haunched Girder (Concrete)	W. Little York Rd and Emergent Wetland	192-275-275-192	59-84-84-59
HN1	403+70	406+45	Long Span Haunched Girder (Concrete)	Sam Houston Parkway/ Beltway 8 Access Road/Senate Ave	275	84
HN1	421+44	422+87	Long Span (Concrete)	Brittmoore Rd	141	43
HN1	430+72	433+54	Long Span Haunched Girder (Concrete)	FM 529	192-282-197	59-86-60
HN1	436+79	438+26	Long Span (Concrete)	FM 529	147	45
HN1	490+24	494+62	Long Span Haunched Girder (Concrete)	Jones Rd	184	56
HN1	451+55	453+23	Long Span (Concrete)	West Rd	168	51
HN1	564+14	565+79	Long Span (Concrete)	N Eldridge Pkwy	164	50
HN1	631+89	638+79	Long Span Haunched Girder (Concrete)	TX 6	201-288-201	61-88-61
HN1	669+58	671+14	Long span (Concrete)	Huffmeister Rd	158	48

Section	STA Start	STA End	Structure Type	Key Considerations	Typical Span (Ft)	Typical Span (m)
HN1	753+79	760+39	Long Span Haunched Girder (Concrete)	Telge Road	192-275-192	59-84-59
HN1	778+03	782+70	Long Span Haunched Girder (Concrete)	Wetland	275-192	84-59
HN1	792+23	837+01	Long Span Haunched Girder (Concrete)	Stream	192-275-275-192 (20 spans total)	59-84-84-59 (20 spans total)
HN1	851+20	854+94	Network Tied Arch	Barker Cypress Rd	375	114
HN1	963+21	964+93	Long Span (Concrete)	Fry Rd	171	52
HN1	985+39	998+61	Crossover with Straddle Bents (Concrete)	Relocated US290/ Hempstead Tollway	121-121	37-37
HN1	1185+53	1188+03	Long Span Haunched Girder (Concrete)	Grand Parkway/ SH99	250	76
HN1	1446+83	1447+90	Long Span (Concrete)	Warren Ranch Rd and Stream	150	45
HN1	1633+55	1637+42	Long Span Haunched Girder (Concrete)	Hempstead/ US290 and UPRR freight line/ Old Washington Rd	216	69
HN1	1683+96	1686+57	Long Span Haunched Girder (Concrete)	US 290	275	84
HN1	1720+54	1721+30	Long Span (Concrete)	FM 2920	140	43
HN1	1881+69	1883+08	Long Span (Concrete)	Castle Rd	140	43
HN1	2073+68	2074+71	Long Span (Concrete)	FM 1488	140	43
HN2	64+16	70+50	Long Span Haunched Girder (Concrete)	Stream	192-260-182	59-79-56
HN2	122+45	123+85	Long Span (Concrete)	Stream and County Rd 302	130-130	40-40
HN2	284+41	287+26	Long Span Haunched Girder (Concrete)	Stream	230-120	71-37
HN2	354+22	366+35	Long Span Haunched Girder (Concrete)	Chandler Yard, UPRR, and BNSF Crossings	125-300-106-125-169-125	38-91-32-38-52-38
HN2	634+59	635+94	Long Span (Concrete)	FM 2445	180	55
HN2	1141+06	1142+89	Long Span Haunched Girder (Concrete)	County Rd 220	183	56
HN2	1193+80	1195+63	Long Span Haunched Girder (Concrete)	County Rd 219	185	56
HN2	1248+33	1254+87	Long Span Haunched Girder (Concrete)	SH 90	192-275-192	59-84-59
HN2	1273+85	1281+44	Long Span Haunched Girder (Concrete)	Stream	192-275-192	59-84-59
HN2	1290+95	1292+60	Long Span (Concrete)	SH 30	165	50
HN2	1468+05	1472+12	Long Span Haunched Girder (Concrete)	Stream	240-168	73-51
HN2	1553+00	1570+36	Long Span Haunched Girder (Concrete)	Stream and Pond	160-130-124-171-	49-40-38-52-72-90-64-49

Section	STA Start	STA End	Structure Type	Key Considerations	Typical Span (Ft)	Typical Span (m)
					235-296-210-160	
HN2	1570+36	1572+74	Crossover with Straddle Bents (Concrete)	FM 39 and BNSF Crossing	3-120' spans	3-37m spans
HN2	1572+74	1576+90	Long Span Haunched Girder (Concrete)	County Road 155	180-235	55-72
HN2	2045+73	2047+48	Long Span (Concrete)	FM 1696	175	53
HN2	2049+93	2055+55	Long Span Haunched Girder (Concrete)	Creek	164-234-164	50-71-50
WT	139+79	146+36	Long Span Haunched Girder (Concrete)	Stream	192-275-192	59-84-59
WT	426+87	431+67	Crossover with Straddle Bents (Concrete)	Clark Rd	4-120' span	4-37m spans
WT	500+00	515+00	Long Span Haunched Girder (Concrete)	Streams	95-110-95-170-240-190	29-34-29-52-73-58
WT	544+43	554+97	Long Span Haunched Girder (Concrete)	Stream	192-275-192-275	59-84-59-84
WT	649+90	657+74	Long Span Haunched Girder (Concrete)	Stream	174-192-280-194	54-59-86-59
WT	806+77	808+56	Long Span (Concrete)	FM 2289	180	55
WT	860+35	866+10	Crossover with Straddle Bents (Concrete)	Dawkins Rd	4-120' spans	4-37m spans
WT	899+40	901+19	Long Span (Concrete)	Creek	180	55
WT	951+14	956+03	Long Span Haunched Girder (Concrete)	Creek	201-288-110	62-88-34
WT	1810+90	1818+10	Long Span Haunched Girder (Concrete)	BNSF Crossing	250	76
WT	2060+90	2068+10	Long Span (Concrete)	UPRR Crossing	180	55
WT	2204+03	2206+23	Long Span Haunched Girder (Concrete)	FM 1469	220	67
WT	2877+13	2883+71	Long Span Haunched Girder (Concrete)	FM 39 and TX 164/ Donie Rd	192-275-192	59-84-59
WT	3260+81	3262+59	Long Span (Concrete)	County Rd 890	180	55
WT	3262+59	3271+35	Long Span Haunched Girder (Concrete)	Patton Creek	155-220-180-145-180-120	47-67-55-44-55-37
WT	3313+23	3319+77	Long Span Haunched Girder (Concrete)	FM 1365	192-275-192	59-84-59
WT	3743+93	3745+43	Long Span (Concrete)	County Rd 960	150	46
WT	4035+02	4037+40	Long Span Haunched Girder (Concrete)	Assume a 79.5ft TUEX freight line (rail spur) ROW width.	280	85
IH1	175+49	177+00	Long Span (Concrete)	Electrical Transmission Pole	180	55

Section	STA Start	STA End	Structure Type	Key Considerations	Typical Span (Ft)	Typical Span (m)
IH1	276+61	278+12	Long Span (Concrete)	FM 1372	151	46
IH1	439+84	441+64	Long Span (Concrete)	US 190	180	55
IH1	645+52	646+91	Long Span (Concrete)	FM 978	140	43
IH1	2495+00	2496+21	Long Span (Concrete)	FM 27/ Commerce Street	145	45
IH1	2573+31	2574+96	Long Span (Concrete)	Donie Rd / TX 164	165	50
IH1	3040+42	3041+79	Long Span (Concrete)	E FM 489	140	43
IH1	3077+92	3080+00	Long Span Haunched Girder (Concrete)	County Rd 675	145-208-145	45-63-45
IH1	4104+99	4107+38	Long Span Haunched Girder (Concrete)	FM 80	240	73
IH2	124+00	125+69	Long Span (Concrete)	Stream	150	46
IH2	150+20	151+80	Long Span (Concrete)	Stream	160	49
IH2	205+40	208+10	Long Span (Concrete)	County Road 2348	140-130	43-40
IH2	255+45	256+85	Long Span (Concrete)	Stream	140	43
IH2	266+45	269+65	Long Span (Concrete)	SH 14	140-180	43-55
IH2	274+93	281+47	Long Span Haunched Girder (Concrete)	UPRR crossing	192-275-192	59-84-59
IH2	450+28	451+72	Long Span (Concrete)	County Rd 0040	170	52
IH2	481+69	483+08	Long Span (Concrete)	Creek	140	43
NW	24+80	26+10	Long Span (Concrete)	County Rd 2420	130	40
NW	68+18	69+38	Long Span (Concrete)	County Rd 2380	140	43
NW	115+91	120+06	Long Span Haunched Girder (Concrete)	UPRR crossing	237	72
NW	205+72	207+13	Long Span (Concrete)	Stream	140	43
NW	208+31	210+13	Long Span (Concrete)	County Rd 2190	180	55
NW	324+08	325+87	Long Span (Concrete)	FM 1394	180	55
NW	471+87	478+46	Long Span Haunched Girder (Concrete)	Creek	192-275-192	59-84-59
NW	622+57	629+91	Long Span Haunched Girder (Concrete)	Creek	192-275-192	59-84-59
NW	677+20	680+60	Long Span (Concrete)	Stream	160-180	49-55
NW	689+63	698+94	Long Span Haunched Girder (Concrete)	Stream	192-275-275-192	59-84-84-59
NW	726+53	729+93	Long Span (Concrete)	Wetland	180-160	55-49
NW	733+54	736+88	Long Span (Concrete)	Wetland	155-180	47-55
NW	862+88	871+53	Long Span Haunched Girder (Concrete)	SH 31	180-200-285-200	55-61-87-61
NW	960+35	962+15	Long Span (Concrete)	FM 744	180	55
NW	1171+70	1173+35	Long Span (Concrete)	County Rd 2070	180	55
NW	1193+89	1200+48	Long Span Haunched Girder (Concrete)	FM 22	192-275-192	59-84-59
NE	323+46	325+07	Long Span (Concrete)	FM 1394	160	49
NE	415+78	419+93	Long Span Haunched Girder (Concrete)	SW County Rd 30	192-275-192	59-84-59
NE	549+90	559+21	Long Span Haunched Girder (Concrete)	SW county Rd 30	192-275-275-192	59-84-84-59

Section	STA Start	STA End	Structure Type	Key Considerations	Typical Span (Ft)	Typical Span (m)
NE	590+00	591+20	Crossover with Straddle Bents (Concrete)	SW County Rd 30	2-120' spans	2-37m spans
NE	1138+62	1145+21	Long Span Haunched Girder (Concrete)	SH 22	192-275-192	59-84-59
NE	1525+01	1528+40	Long Span (Concrete)	Stream	140	43
EW	434+55	440+75	Long Span Haunched Girder (Concrete)	BNSF crossing	181-258-181	55-78-55
EW	673+11	674+60	Long Span (Concrete)	UPRR crossing	150	46
EW	821+82	822+71	Long Span (Concrete)	Ebenezer Rd	180	55
EW	905+58	906+50	Long Span (Concrete)	Emergent wetland	180	55
EW	1193+60	1199+33	Long Span Haunched Girder (Concrete)	Stream and FM 983	167-239-167	51-73-51
EE	55+99	61+19	Long Span (Concrete)	Emergent wetland	160-180-180	49-55-55
EE	66+02	70+62	Long Span (Concrete)	Creek	140-180-140	43-55-43
EE	71+79	73+19	Long Span (Concrete)	Creek	140	43
EE	75+59	79+19	Long Span (Concrete)	Creek	180-180	55-55
EE	282+60	287+69	Long Span (Concrete)	Creek	160-180-170	49-55-52
EE	288+80	290+60	Long Span (Concrete)	FM 984	180	55
EE	332+19	339+99	Long Span Haunched Girder (Concrete)	Stream	192-275-192	59-84-59
EE	347+19	348+60	Long Span (Concrete)	Walker Rd	140	43
EE	380+40	386+99	Long Span Haunched Girder (Concrete)	BNSF crossing	192-275-192	59-84-59
EE	408+49	410+09	Long Span (Concrete)	Stream	160	49
EE	416+08	419+49	Long Span (Concrete)	Stream	160-180	49-55
EE	474+43	479+02	Long Span Haunched Girder (Concrete)	US 287	192-275-192	59-84-59
EE	493+77	495+55	Long Span Haunched Girder (Concrete)	Stream	190	58
EE	526+62	530+32	Long Span Haunched Girder (Concrete)	Old Church Rd	190-180	58-55
EE	553+70	556+75	Long Span (Concrete)	Old Boyce Rd and stream	152-152	46-46
EE	574+43	575+83	Long Span (Concrete)	Stream	140	43
EE	655+53	657+33	Long Span (Concrete)	UPRR crossing	180	55
EE	662+93	664+43	Long Span (Concrete)	FM 879	140	43
EE	780+78	782+59	Long Span (Concrete)	Stream	180	55
EE	793+83	795+23	Long Span (Concrete)	Stream	140	43
EE	843+41	844+81	Long Span (Concrete)	FM 878	140	43
EE	894+65	904+00	Long Span Haunched Girder (Concrete)	Creek and forested wetland	192-275-275-192	59-84-84-59
EE	912+09	913+49	Long Span (Concrete)	FM 813	140	43
EE	919+06	923+65	Long Span Haunched Girder (Concrete)	Almand Rd	135-192-135	41-59-41
EE	1008+45	1010+25	Long Span (Concrete)	Palmyra Rd	180	55

Section	STA Start	STA End	Structure Type	Key Considerations	Typical Span (Ft)	Typical Span (m)
EE	1010+25	1011+76	Long Span (Concrete)	Stream	151	46
EE	1041+55	1042+97	Long Span (Concrete)	Risinger Rd	142	43
EE	1109+87	1111+07	Long Span (Concrete)	Wester Rd	140	43
EE	1180+99	1187+59	Long Span Haunched Girder (Concrete)	FM 983	192-275-192	59-84-59
DS	25+82	27+42	Long Span (Concrete)	FM 664	160	49
DS	198+50	200+30	Long Span (Concrete)	Tenmile Creek and forested wetland	180	55
DS	245+29	246+77	Long Span (Concrete)	Beltline Rd	147	45
DS	363+89	365+30	Long Span (Concrete)	Wintergreen Rd	141	43
DS	378+51	383+41	Crossover with Straddle bents (Concrete)	Lancaster Hutchins Rd	5-120' spans	5-37m spans
DS	401+30	402+80	Long Span (Concrete)	Witt Rd	150	46
DS	483+91	488+11	Long Span (Concrete)	Whites Branch Creek	120-180-120	37-55-37
DS	495+04	496+74	Long Span (Concrete)	Langdon Rd	170	52
DS	506+53	509+41	Long Span Haunched Girder (Concrete)	I-20	176-255-285-198	54-78-87-60
DS	525+67	542+00	Long Span (concrete)	JJ Lemmon Rd and Newtown Creek	150-90-140-115-160-105-160-120-120-120-120-100-175	46-27-43-35-49-32-49-37-37-37-37-30-53
DS	586+57	588+32	Long span (concrete)	Fivemile Creek	130-175	40-54
DS	591+49	593+12	Long span (concrete)	Forested wetland and pond	163	50
DS	595+73	597+52	Long span (concrete)	Simpson Stuart Rd	180	55
DS	665+18	679+89	Long Span Haunched Girder (concrete)	Loop 12	141-150-145-180-212-170-184-168	43-46-44-55-65-52-56-51
DS	720+17	726+65	Long Span Haunched Girder (concrete)	Illinois Rd	192-264-192	59-81-59
DS	759+10	761+56	Network Tied Arch	Over Honey Springs Cemetery	340-486-340	104-148-104
DT	18+35	27+54	Long Span Haunched Girder (concrete)	Pond	176-275-275-192	54-84-84-59
DT	31+00	37+00	Long Span Haunched Girder (concrete)	Proposed 16" Sanitary Sewer, Proposed 16" Non-potable water line, and Future 96" sanitary sewer (all by others)	192-275-192	59-84-59
DT	53+38	58+05	Long span (concrete)	Trinity River and emergent wetland	192-275-192	59-84-59

Section	STA Start	STA End	Structure Type	Key Considerations	Typical Span (Ft)	Typical Span (m)
DT	65+25	65+25	Crossover with straddle bent (Concrete)	24in sanitary sewer	1-120' span	1-37m span
DT	119+65	129+01	Long Span and Crossover with straddle bent (Concrete)	BNSF Crossing	192-275-275-192	59-84-84-59
DT	139+70	146+29	Long Span Haunched Girder (concrete)	Forest Ave	192-275-192	59-84-59
DT	213+15	214+77	Long span (concrete)	Cadiz St and Hotel St	174	53

Appendix C: Temporary Construction Facility Information

Ref #		Section	Station	Area (Acres)	Area (m^2)	Notes
HOUSTON STATION (HT1)				22.9	92672	Northwest Transit Center Site
1	Staging Area	HT1	11+00	16.3	65963	
2	Staging Area	HT1	45+00	6.6	26709	
HOUSTON STATION (HT2)				64.3	260335	Northwest Mall Site
3	Staging Area	HT2	10+00	57.7	233490	
4	Staging Area	HT2	45+00	6.6	26845	
HOUSTON STATION (HT3)				39.5	159850	Northwest Industrial Site
5	Staging Area	HT3	10+00	39.5	159850	
HOUSTON (HN1)				453.5	1834992	
6	Staging Area	HN1	310+00	13.2	53281	
7	Staging Area	HN1	440+00	8.9	36171	
8	Staging Area	HN1	660+00	14.6	59286	
9	Staging Area	HN1	980+00	14.6	58948	
10	Proposed Precasting Yard	HN1	1170+00	314.6	1272960	Short railroad connection proposed
11	Staging Area	HN1	1530+00	29.7	120019	
12	Staging Area	HN1	1620+00	57.9	234327	
HOUSTON (HN2)				310.8	1259777	
13	Proposed Precasting Yard	HN2	350+00	133.7	541095	Adjacent to existing railroad
14	Staging Area	HN2	950+00	14.7	59458	
15	Staging Area	HN2	1250+00	18.3	73891	
16	Proposed Precasting Yard	HN2	1580+00	129.1	522640	Adjacent to existing railroad
17	Staging Area	HN2	1930+00	15.0	62693	
WEST OF TEAGUE (WT)				535.7	2167192	
18	Staging Area	WT	440+00	40.0	161857	
19	Proposed Precasting Yard	WT	970+00	75.1	303866	Railroad connection proposed
20	Staging Area	WT	1740+00	12.3	49622	
21	Staging Area	WT	2050+00	161.2	651955	
22	Staging Area	WT	2200+00	16.8	68038	
23	Staging Area	WT	2730+00	23.0	92882	
24	Staging Area	WT	3440+00	20.9	84444	
25	Proposed Precasting Yard	WT	4070+00	186.4	754528	Adjacent to existing railroad
IH-45 (IH1)				382.7	1548720	
26	Proposed Precasting Yard	IH1	1530+00	62.2	251713	Potential location for precasting facility, construction of a short railroad spur proposed
27	Staging Area	IH1	2490+00	5.3	21448	
28	Staging Area	IH1	2500+00	6.0	24281	
29	Staging Area	IH1	2560+00	23.6	95505	
30	Proposed Precasting Yard	IH1	4150+00	285.6	1155773	Adjacent to existing railroad
IH-45 (IH2)				107.5	434862	

Ref #		Section	Station	Area (Acres)	Area (m^2)	Notes
31	Staging Area	IH2	280+00	16.3	65894	
32	Staging Area	IH2	390+00	91.2	368968	
NAVARRO WEST (NW)				155.3	628418	
33	Proposed Precasting Yard	NW	320+00	88.4	357729	
34	Staging Area	NW	860+00	26.6	107537	
35	Proposed Precasting Yard	NW	1330+00	40.3	163152	
NAVARRO EAST (NE)				169.7	687014	
36	Proposed Precasting Yard	NE	320+00	106.9	432649	
37	Staging Area	NE	880+00	24.7	100068	Railroad connection proposed
38	Proposed Precasting Yard	NE	1340+00	38.1	154297	
ELLIS WEST (EW)				189.3	765706	
39	Staging Area	EW	200+00	19.7	79642	
40	Staging Area	EW	540+00	14.8	59817	
41	Proposed Precasting Yard	EW	665+00	81.5	329734	Adjacent to existing railroad
42	Staging Area	EW	675+00	28.4	114813	Adjacent to existing railroad
43	Staging Area	EW	1120+00	44.9	181700	
ELLIS EAST (EE)				199.8	808504	
44	Staging Area	EE	200+00	19.7	79642	
45	Staging Area	EE	530+00	18.8	76127	
46	Proposed Precasting	EE	645+00	82.3	333018	Adjacent to existing railroad
47	Staging Area	EE	660+00	28.2	114051	Adjacent to existing railroad
48	Staging Area	EE	1100+00	50.8	205666	
DALLAS (DS)				203.1	821749	
49	Staging Area	DS	70+00	37.4	151439	
50	Proposed Precasting Yard	DS	260+00	104.8	423918	
51	Staging Area	DS	370+00	27.4	110952	Short railroad connection proposed
52	Staging Area	DS	690+00	12.4	50191	
53	Staging Area	DS	720+00	4.4	17755	
54	Staging Area	DS	730+00	13.2	53277	
55	Staging Area	DS	760+00	3.5	14217	
DALLAS (DT)				82.2	332638	
56	Staging Area	DT	10+00	6.2	25141	
57	Staging Area	DT	100+00	23.8	96290	Dallas Station
58	Staging Area	DT	200+00	52.2	211207	Dallas Station

Appendix D: Construction Material Quantities

		Quantity					
Item	**Unit**	**End to End Alignment A**	**End to End Alignment B**	**End to End Alignment C**	**End to End Alignment D**	**End to End Alignment E**	**End to End Alignment F**
Total Length	miles	235.25	235.48	239.65	234.94	235.18	239.35
Drill Shafts	CY	2,000,121	2,051,551	2,052,266	2,070,356	2,121,786	2,122,500
Column	CY	1,455,586	1,482,308	1,477,796	1,492,880	1,519,603	1,515,090
Cap (Bent & Pile)	CY	547,677	549,547	553,815	561,906	563,776	568,044
Beams	CY	0	0	0	0	0	0
Deck / Girder	CY	3,292,237	3,289,197	3,326,978	3,379,743	3,376,703	3,414,485
Drainage	CY	250,000	250,000	250,000	250,000	250,000	250,000
Systems	CY	135,000	135,000	135,000	135,000	135,000	135,000
Electrical	CY	20,000	20,000	20,000	20,000	20,000	20,000
Stations	CY	330,000	330,000	330,000	330,000	330,000	330,000
Misc. Other	CY	221,534	221,534	221,534	221,534	221,534	221,534
Total Concrete	CY	8,252,154	8,329,138	8,367,389	8,461,419	8,538,402	8,576,653
Cement	Ton	1,650,431	1,665,828	1,673,478	1,692,284	1,707,680	1,715,331
Sand	Ton	3,300,862	3,331,655	3,346,955	3,384,567	3,415,361	3,430,661
Gravel	Ton	3,300,862	3,331,655	3,346,955	3,384,567	3,415,361	3,430,661
Reinforcement	lbs.	2,063,038,545	2,082,284,381	2,091,847,178	2,115,354,685	2,134,600,521	2,144,163,318
Structural Steel	lbs.	13,205,875	13,219,165	13,453,067	13,188,864	13,202,154	13,436,055
Sub-Ballast	CY	814,095	817,075	837,394	780,866	783,845	804,165
Ballast	CY	1,779,269	1,781,357	1,812,753	1,771,694	1,773,782	1,805,178
Concrete Ties	Each	1,381,829	1,383,156	1,406,516	1,380,130	1,381,457	1,404,817
Rail	TF	2,634,605	2,637,137	2,681,695	2,631,364	2,633,896	2,678,454
Excavation*	CY	7,808,138	7,883,171	7,857,546	7,707,746	7,782,778	7,757,154

		Quantity					
Item	**Unit**	**End to End Alignment A**	**End to End Alignment B**	**End to End Alignment C**	**End to End Alignment D**	**End to End Alignment E**	**End to End Alignment F**
Filling**	CY	25,098,515	24,469,109	26,585,082	23,212,337	22,582,930	24,698,904
Construction waste - concrete	CY	57,765	58,304	58,572	59,230	59,769	60,037
Construction waste - rebar	Lbs.	30,945,578	31,234,266	31,377,708	31,730,320	32,019,008	32,162,450
Notes:							
To produce a 3000 psi cubic yard of concrete (27 cubic feet) the concrete mixture ratio is: 1. 517 pounds of cement 2. 1560 pounds of sand 3. 1600 pounds of stone 4. 32 - 34 gallons of water							
Assume water available at batching/precasting sites							
Assume 1 delivery of ballast every two weeks via locomotive							
Assume 1 delivery of cement, sand and gravel every two weeks via locomotive							
Assume 12 psf for station structural steel							
Assuming no construction waste for earthworks operations as any spilloff will be transported to borrow sites or deposited along the job site.							
Construction waste for overall concrete operations is 5.0%, it is assumed that 0.5% will finally be deposited in landfill or recycled							
Construction waste for reinforcement is 7.5%, it is assumed that 1.5% will finally be deposited in landfill or recycled							
Hazardous waste material has not been quantified separately							
Construction waste quantities do not include building, road or any other infrastructure demolition							
*Excavation includes excavation, drilled shaft spoil, topsoil stripping, and undercut (4' deep)							
**Filling includes embankment, undercut replacement, filling at road over rail crossings							

Appendix E: Infrastructure Configuration Types

Infrastructure Configuration Types by Alignment (miles)

Alignment	End to End A		End to End B		End to End C		End to End D		End to End E		End to End F	
Section Type	Total (miles)	% of Route	Total (miles)	% of Route	Total (miles)	% of Route	Total (miles)	% of Route	Total (miles)	% of Route	Total (miles)	% of Route
Retained Cut	2.7	1.2%	3.6	1.5%	2.3	0.9%	2.7	1.2%	3.6	1.5%	2.3	0.9%
Cut	24.6	10.5%	24.0	10.2%	21.6	9.0%	24.6	10.5%	24.0	10.2%	21.6	9.0%
Embankment	78.1	33.2%	77.9	33.1%	67.2	28.1%	74.2	31.5%	74.1	31.5%	63.3	26.5%
Retained Fill	0.9	0.4%	0.9	0.4%	3.3	1.4%	0.7	0.3%	0.7	0.3%	3.1	1.3%
Viaduct	129.1	54.8%	129.1	54.8%	145.1	60.6%	132.9	56.5%	133.0	56.5%	148.9	62.3%
Total Length (miles)	235	100%	236	100%	239	100%	235	100%	235	100%	239	100%

Infrastructure Configuration Types by Alignment (km)

Alignment	End to End A		End to End B		End to End C		End to End D		End to End E		End to End F	
Section Type	Total (km)	% of Route	Total (km)	% of Route	Total (km)	% of Route	Total (km)	% of Route	Total (km)	% of Route	Total (km)	% of Route
Retained Cut	4.4	1.2%	5.8	1.5%	3.6	0.9%	4.4	1.2%	5.8	1.5%	3.6	0.9%
Cut	39.6	10.5%	38.6	10.2%	34.7	9.0%	39.6	10.5%	38.7	10.2%	34.7	9.0%
Embankment	125.6	33.2%	125.4	33.1%	108.2	28.1%	119.4	31.5%	119.2	31.5%	101.9	26.5%
Retained Fill	1.5	0.4%	1.5	0.4%	5.4	1.4%	1.1	0.3%	1.2	0.3%	5.0	1.3%
Viaduct	207.7	54.8%	207.8	54.8%	233.5	60.6%	213.9	56.5%	214.0	56.5%	239.7	62.3%
Total Length (miles)	379	100%	379	100%	385	100%	378	100%	379	100%	385	100%

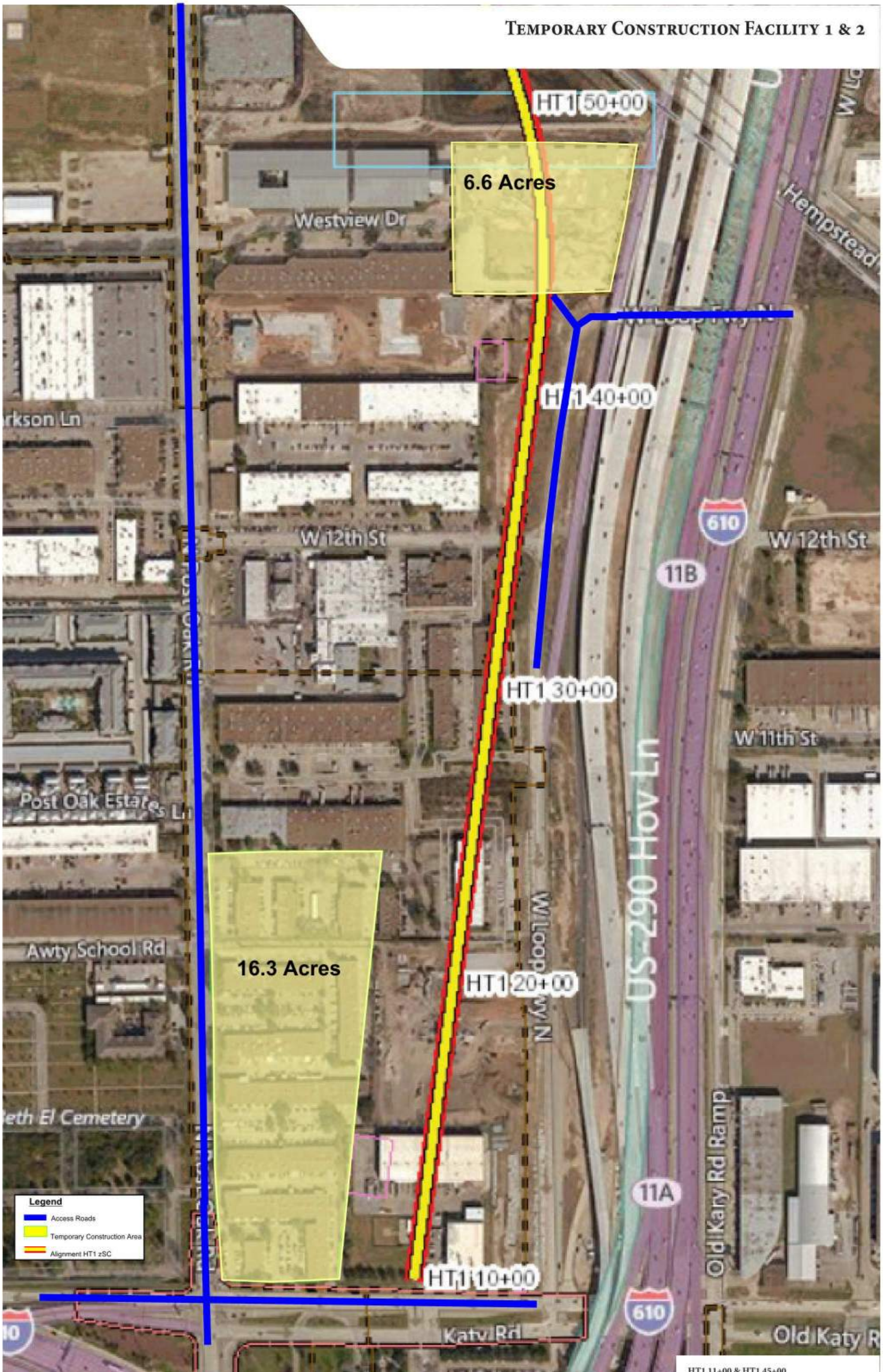
*During more detailed design, the limits of viaduct could be refined to mitigate environmental and constructability issues to the extent practicable.

Appendix F: Construction Equipment Quantities

		End to End Alignment A			End to End Alignment B			End to End Alignment C			End to End Alignment D			End to End Alignment E			End to End Alignment F		
Total Length (miles)		235.4			235.6			239.8			235.1			235.4			239.5		
PRODUCTION EQUIPMENT		Months	Concurrent Months		Months	Concurrent Months		Months	Concurrent Months		Months	Concurrent Months		Months	Concurrent Months		Months	Concurrent Months	
Backhoe/Loaders	Cat 416 Comb BH/LDR 240	96	2	23	96	2	23	97	2	23	96	2	23	96	2	23	97	2	23
	Cat 436 Comb BH/LDR 1,296	822	17		823	17		838	17		821	17		822	17		837	17	
	Cat 446 Comb BH/LDR 60	177	4		177	4		180	4		177	4		177	4		180	4	
DOZERS	Cat D3 1,080	736	15	22	737	15	22	750	16	23	735	15	22	736	15	22	749	16	23
	Cat D6N 432	325	7		325	7		331	7		325	7		325	7		331	7	
Demo / Drills	Hyd Hammer 5000 ft-lb 120	177	4	4	177	4	4	180	4	4	177	4	4	177	4	4	180	4	4
	Hyd Hammer 7500 ft-lb 72	14	0		14	0		15	0		14	0		14	0		15	0	
EXCAVATORS	Cat 320BL Backhoe 1,584	1,171	24	59	1,173	24	59	1,193	25	60	1,170	24	59	1,171	24	59	1,192	25	60
	Cat 325BL Backhoe 360	371	8		371	8		377	8		370	8		371	8		377	8	
	Cat 330BL Backhoe 1,728	1,243	26		1,245	26		1,266	26		1,242	26		1,243	26		1,265	26	
	Cat 345BL Backhoe 36	18	0		18	0		18	0		18	0		18	0		18	0	
	Cat 365BL Backhoe 36	18	0		18	0		18	0		18	0		18	0		18	0	
GRADERS	Cat 140G Grader 1,728	574	12	17	574	12	17	585	12	18	573	12	17	574	12	17	584	12	18
Hoisting/Lifting Equip; Rough Terrain Cranes	60Ton R/T Crane 1,728	191	4		191	4		195	4		191	4		191	4		195	4	
	80Ton RT Crane 432	62	1		62	1		63	1		62	1		62	1		63	1	
Hoisting/Lifting Equip; Crawler Cranes	110 Ton Crawler Crane 360	55	1	9	55	1	9	56	1	9	55	1	9	55	1	9	56	1	9
	150 Ton Crawler Crane 1,440	163	3		163	3		166	3		162	3		163	3		165	3	
	200-Ton LS248 / 14000 Crawler 720	91	2		91	2		93	2		91	2		91	2		92	2	
	230 Ton Crawler Crane / 888 576	57	1		57	1		58	1		57	1		57	1		58	1	
	275 Ton Crawler Crane / 999 216	22	0		22	0		22	0		21	0		22	0		22	0	
	300 Ton Crawler Crane 72	26	1		26	1		27	1		26	1		26	1		27	1	
LOADERS	VME L120B Wheel Loader 72	131	3	46	132	3	46	134	3	47	131	3	46	131	3	46	134	3	47
	VME L90CWheel Loader 4,176	1,970	41		1,972	41		2,007	42		1,968	41		1,970	41		2,005	42	
	Bobcat 743 24	108	2		108	2		110	2		107	2		108	2		109	2	
MANLIFTS	120' Aerial Lift 1,080	253	5	39	254	5	39	258	5	39	253	5	39	253	5	39	258	5	39
	30' Aerial Lift 1,248	287	6		287	6		292	6		287	6		287	6		292	6	
	60' Aerial Lift 4,416	1,033	22		1,034	22		1,052	22		1,032	21		1,033	22		1,051	22	
	80' Aerial Lift 1,248	287	6		287	6		292	6		287	6		287	6		292	6	
Pile Hammer & Acc	D46-32: 100-125K-ft-lb PILE HMR 252	63	1	4	63	1	4	65	1	4	63	1	4	63	1	4	64	1	4
	350HP VIB HMR/EXT I416 264	65	1		65	1		66	1		64	1		65	1		66	1	
	SWINGING LEADS 252	63	1		63	1		65	1		63	1		63	1		64	1	
ROLLERS/ COMPACTORS	Cat 433 CS Roller	275	6	22	275	6	22	280	6	23	275	6	22	275	6	22	280	6	23
	Cat 563 -CS (84" Smooth Drum)	239	5		239	5		244	5		239	5		239	5		243	5	

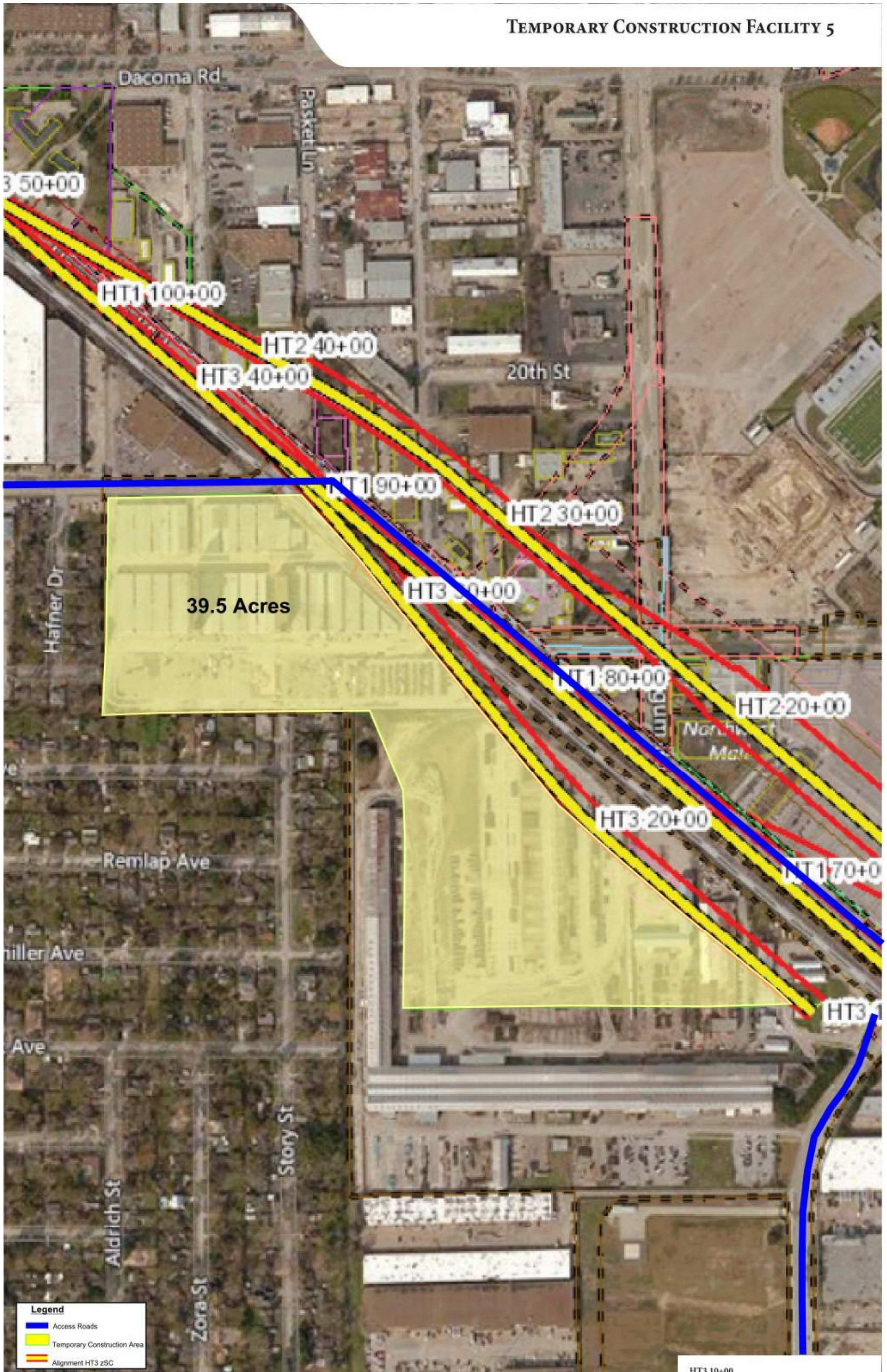
		End to End Alignment A			End to End Alignment B			End to End Alignment C			End to End Alignment D			End to End Alignment E			End to End Alignment F		
	Cat 563 -CP (84" Padfoot)	311	6		311	6		317	7		310	6		311	6		316	7	
	PS 130Pneumatic Compactor	139	3		139	3		141	3		139	3		139	3		141	3	
	Cat RM 500 Reclaimer	108	2		108	2		110	2		107	2		108	2		109	2	
TRUCKS	Flatbed F350	1,147	24	1,291	1,149	24	1,293	1,169	24	1,316	1,146	24	1,290	1,148	24	1,291	1,168	24	1,314
	Flat Bed F700	837	17		838	17		852	18		836	17		837	17		851	18	
	Fuel Truck	2,068	43		2,070	43		2,107	44		2,066	43		2,068	43		2,104	44	
	Mechanic's Truck (small)	1,351	28		1,352	28		1,376	29		1,349	28		1,351	28		1,375	29	
	Pick-Up 1/2 Ton	28,018	584		28,049	584		28,544	595		27,987	583		28,018	584		28,513	594	
	Pick-Up 3/4 Ton	17,977	375		17,997	375		18,315	382		17,958	374		17,978	375		18,295	381	
	Semi Tractor	944	20		945	20		962	20		943	20		944	20		961	20	
	Concrete - Mixer truck	2,244	47		2,246	47		2,286	48		2,241	47		2,244	47		2,283	48	
	Heavy Truck - Excavation	2,934	61		2,937	61		2,989	62		2,930	61		2,934	61		2,985	62	
	Heavy Truck - Filling	2,836	59		2,839	59		2,890	60		2,833	59		2,836	59		2,886	60	
	Heavy Truck - Rebar	335	7		336	7		341	7		335	7		335	7		341	7	
	Heavy Truck - Structural Steel	147	3		147	3		150	3		147	3		147	3		149	3	
	Water Truck 4000 Gal	1,149	24		1,150	24		1,171	24		1,148	24		1,149	24		1,169	24	
MISC EQUIPMENT	Air Compressors	968	20	112	969	20	112	986	21	114	967	20	111	968	20	112	985	21	113
	Equipment - GPS	215	4		215	4		219	5		215	4		215	4		219	5	
	Generators	1,104	23		1,106	23		1,125	23		1,103	23		1,104	23		1,124	23	
	Grout Pump	588	12		589	12		599	12		587	12		588	12		598	12	
	Walk behind roller	545	11		546	11		555	12		544	11		545	11		555	12	
	Small Vac Sweeper	1,147	24		1,149	24		1,169	24		1,146	24		1,148	24		1,168	24	
	All Welders	574	12		574	12		585	12		573	12		574	12		584	12	
	Trench Box	167	3		168	3		170	4		167	3		167	3		170	4	
	Bidwell Deck Finishers	43	1		43	1		44	1		43	1		43	1		44	1	
	Total Months	79,079	N/A	N/A	79,168	N/A	N/A	80,564	N/A	N/A	78,992	N/A	N/A	79,081	N/A	N/A	80,477	N/A	N/A
	Concurrent Months		1,647	1,647		1,649	1,649		1,678	1,678		1,646	1,646		1,648	1,648		1,677	1,677

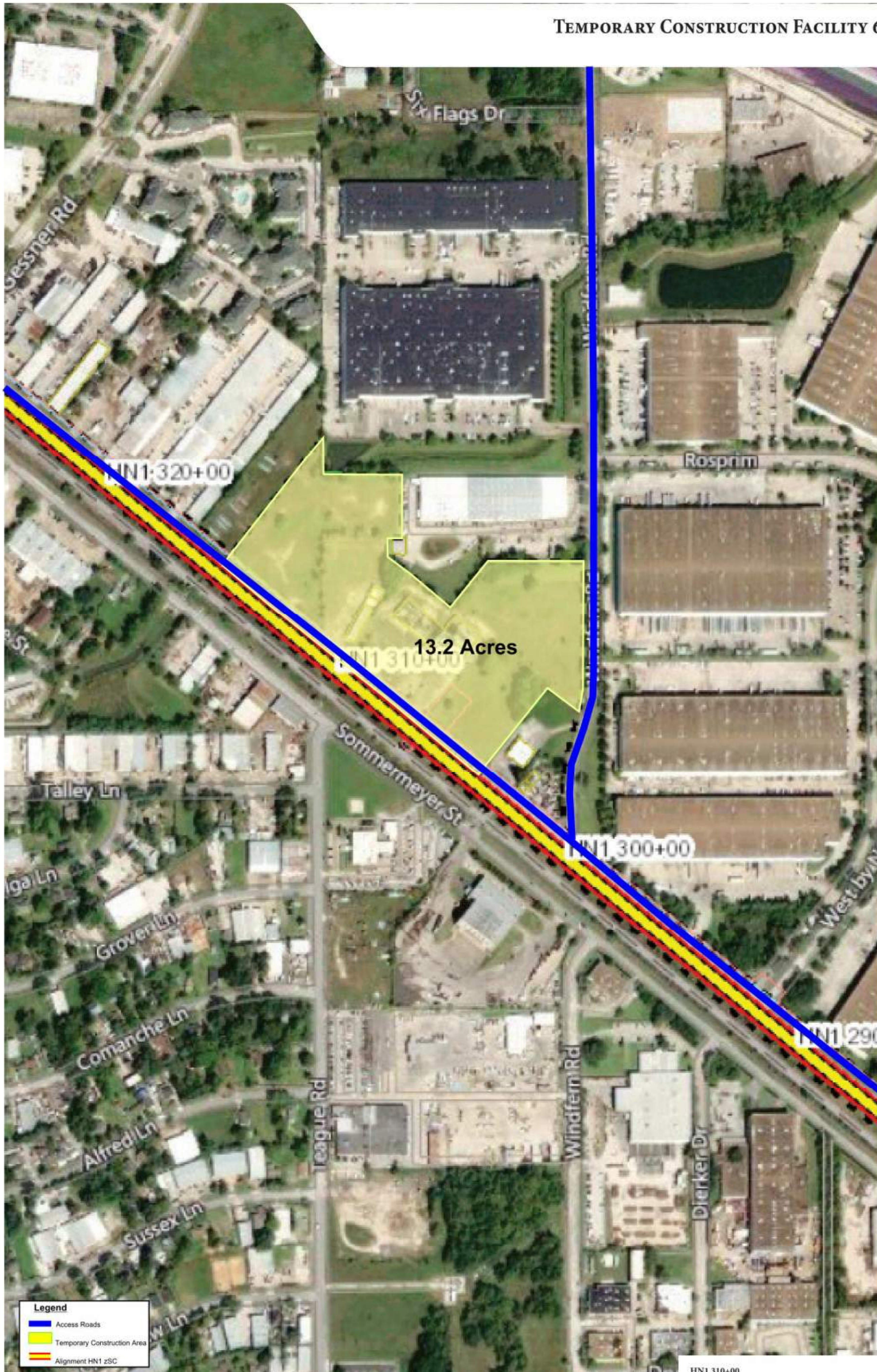
Appendix G: Construction Staging Areas Maps

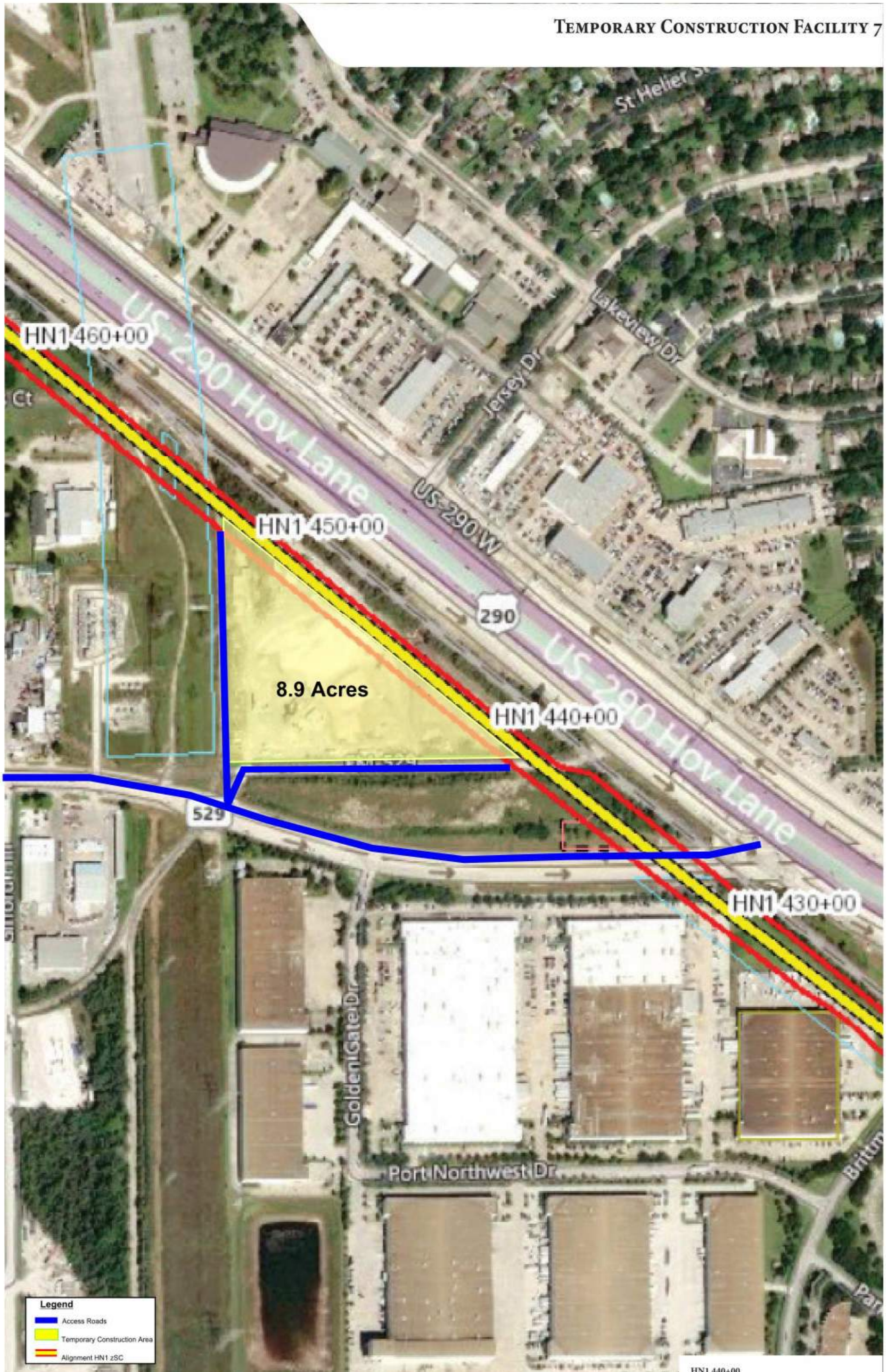


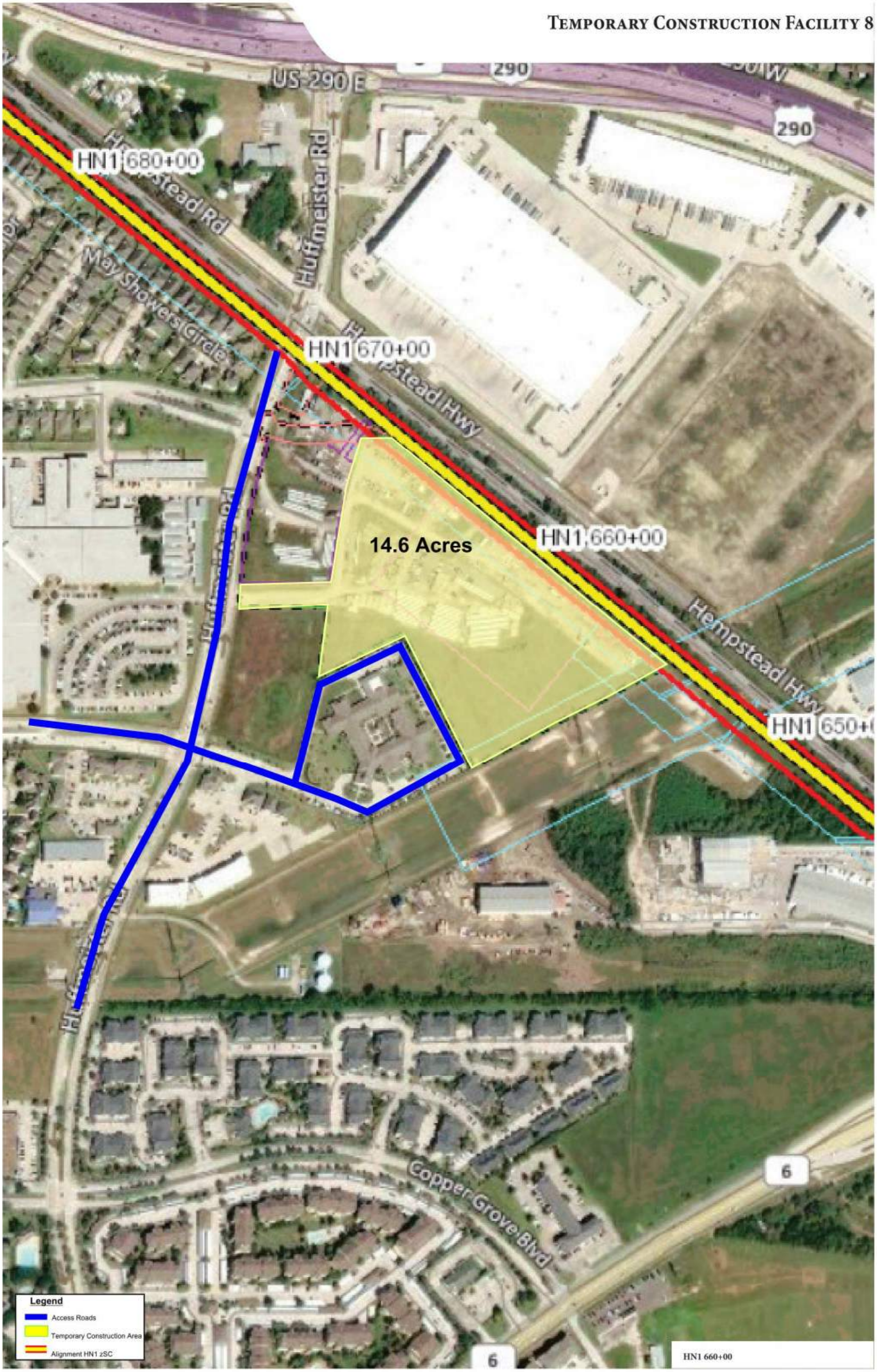
HT1 11+00 & HT1 45+00


290 Hov Lane
Northwest Fwy
Sherwood Ln
Helberg Rd
Brookwoods Dr
Randwick Dr
Ascot Ln
Ramus St
Fairway Park Dr
Central Pkwy
McAllister Rd
Hurfus Dr
Dacoma Rd
W Governors Circle
290
Ora St
Karbach St
Paskett Ln
Silber Rd
HN1 20+00
6.6 Acres
HT2 50+00
HT2 40+00
20th St
HT2 30+00
W 18th St
HT2 20+00
57.7 Acres
HT2 10+00
Teluco Ave
Housman St
Remlap Ave
Schiller Ave
Saxet Ave
Sivley Ave
Aldrich St
Story St
Corbin Ave
Zora St
Wharton St
Westview Dr
Clawson St
Rolla St
Clarkson Ln
11B
Legend
Access Roads
Temporary Construction Area
Alignment HT2 zSC


Dacoma Rd
Pasket Ln
20th St
Hafner Dr
Remlap Ave
hiller Ave
Ave
Aldrich St
Zora St
Story St
3 50+00
HT1 100+00
HT2 40+00
HT3 40+00
HT1 90+00
HT2 30+00
HT3 30+00
HT1 80+00
HT2 20+00
HT3 20+00
HT1 70+0
HT3 1
39.5 Acres
Legend
Access Roads
Temporary Construction Area
Alignment HT3 zSC
HT3 10+00


Six Flags Dr
Gessner Rd
Rosprim
HN1 320+00
13.2 Acres
HN1 310+00
Sommermeyer St
Talley Ln
HN1 300+00
West by North
Grover Ln
Comanche Ln
HN1 290
Windfern Rd
Dierker Dr
Teague Rd
Alfred Ln
Sussex Ln
Legend
Access Roads
Temporary Construction Area
Alignment HN1 zSC

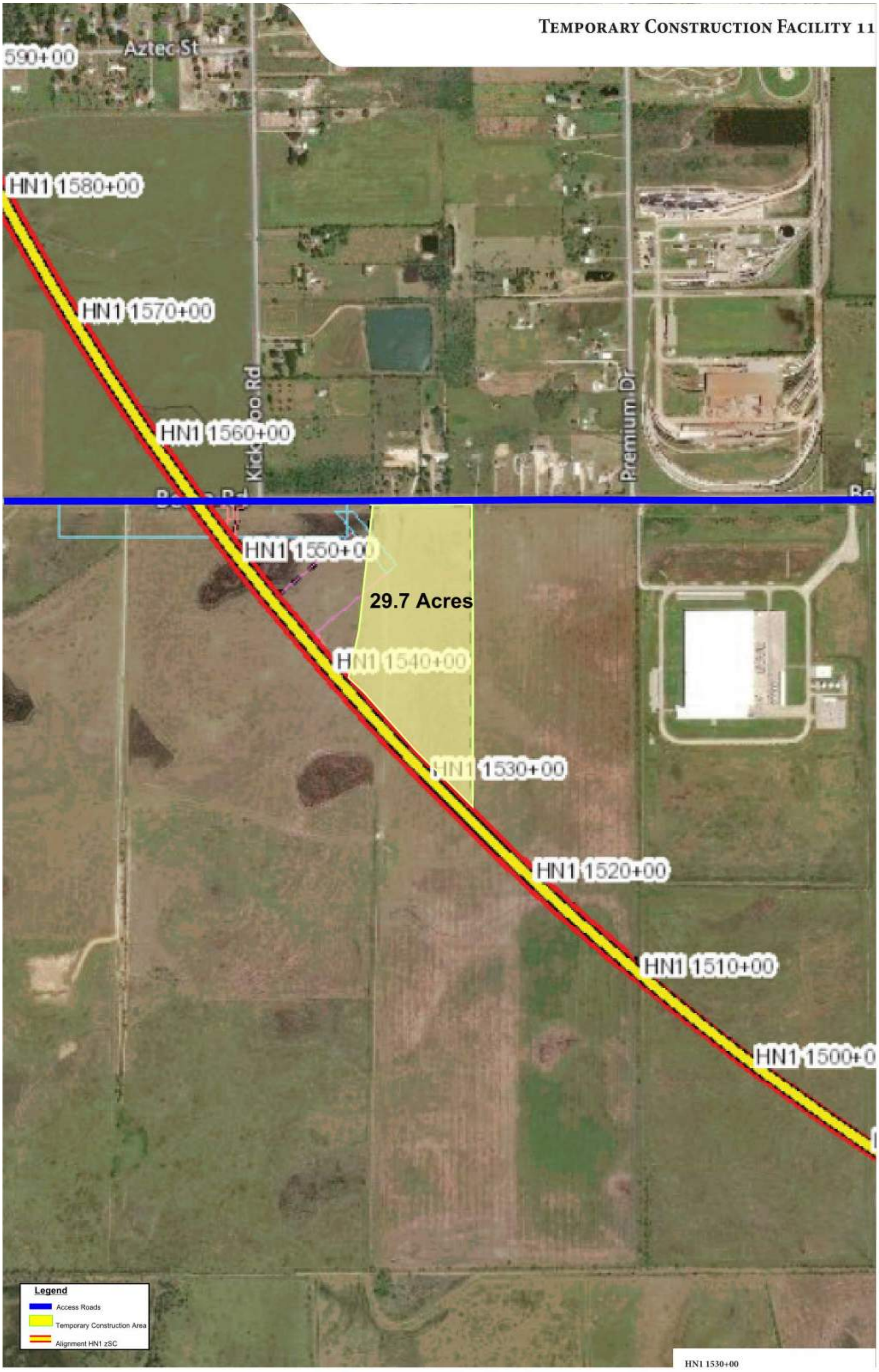

St Helier St
Lakeview Dr
Jersey Dr
HN1 460+00
Ct
US-290 Hov Lane
US-290 W
HN1 450+00
290
8.9 Acres
HN1 440+00
US-290 Hov Lane
529
HN1 430+00
Golden Gate Dr
Port Northwest Dr
Legend
Access Roads
Temporary Construction Area
Alignment HN1 zSC


US-290 E
290
290
HN1 680+00
Hempstead Rd
Huffmeister Rd
May Showers Circle
HN1 670+00
Hempstead Hwy
14.6 Acres
HN1 660+00
Hempstead Hwy
HN1 650+0
Copper Grove Blvd
6
6
Legend
Access Roads
Temporary Construction Area
Alignment HN1 zSC
HN1 660+00

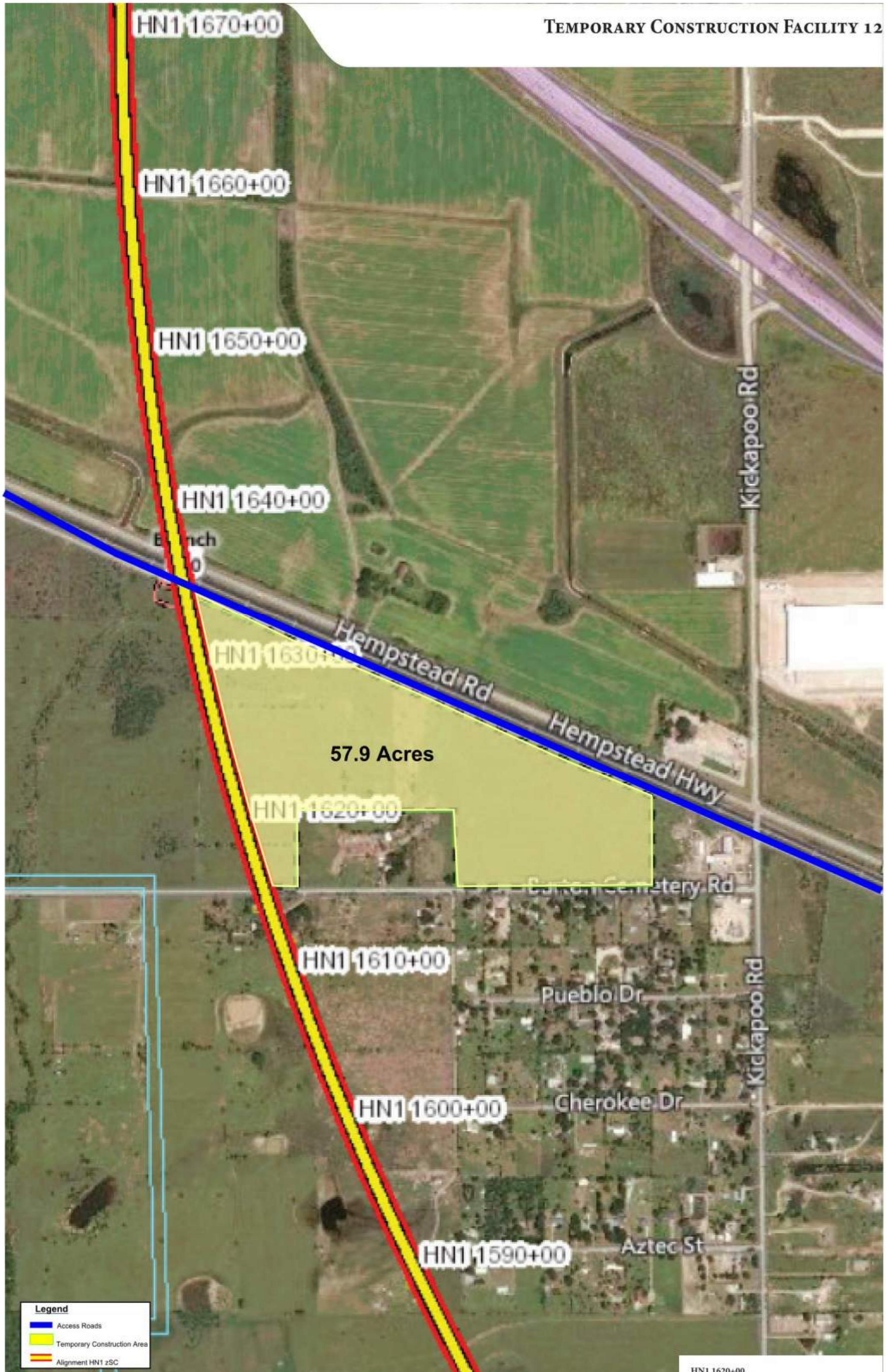

US-290 W
Harmony Estates Ln
Hempstead Hwy
Branch
290L
Northwest Fwy
6
290
US-290 W
HN1 990+00
HN1 980+00
HN1 970+00
Branch
290L
The Shoppes at Fry Road
Hempstead Hwy
Cypress
Hempstead
14.6 Acres
Fry Rd
Mound Rd
Wedgewood Park
Wildwood Bend
Legend
Access Roads
Temporary Construction Area
Alignment HN1 zSC


Coco St
Bauer Rd
Heath Gre
Place Dr
US-290
US-290
Houston Premium Outlets
290
Cypresswood Dr
290
Toll 99
314.6 Acres
HN1 1200+00
Toll 99
Legend
Access Roads
Temporary Construction Area
Alignment HN1 zSC

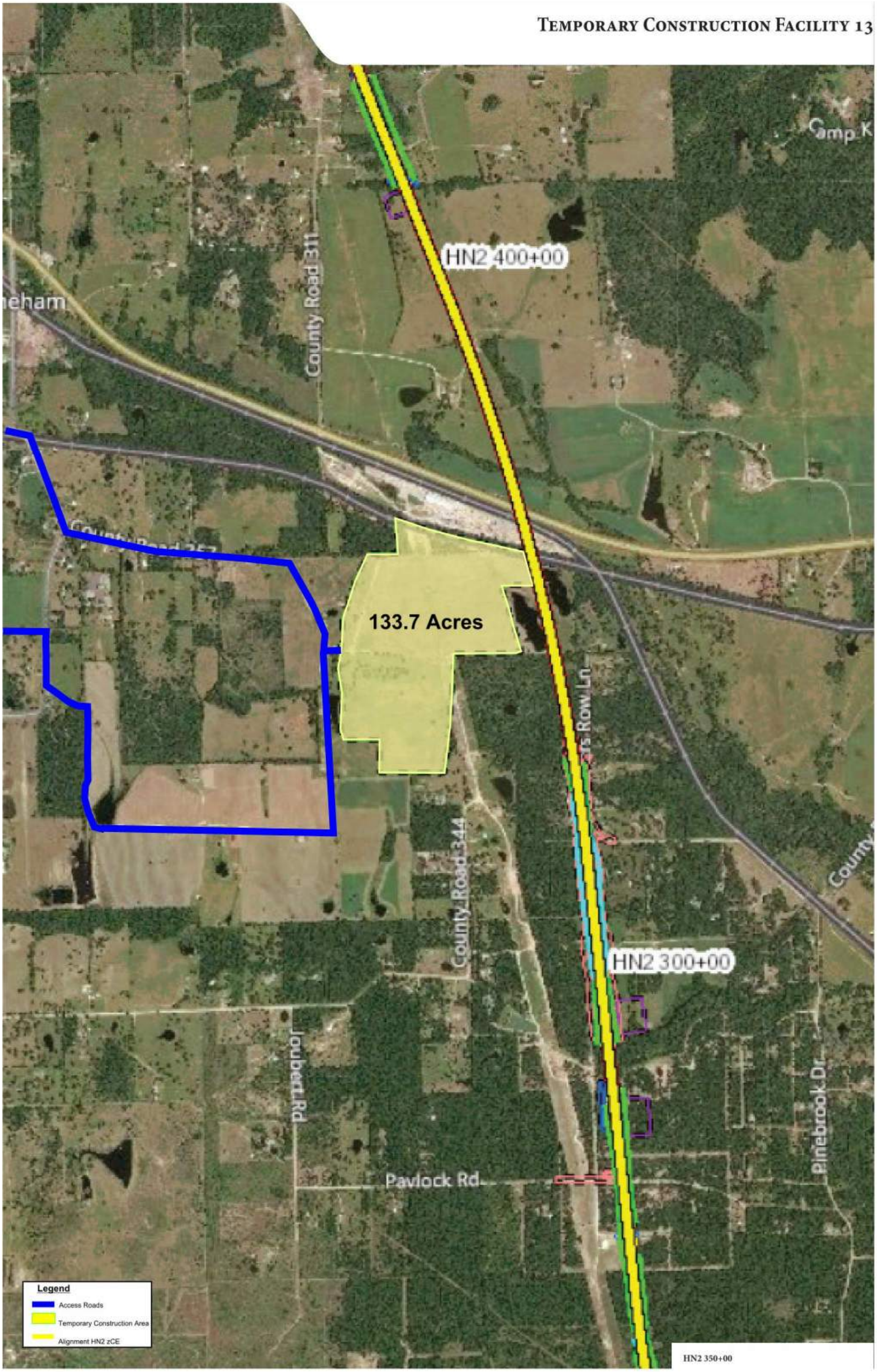
HN1 1170+00



590+00
Aztec St
HN1 1580+00
HN1 1570+00
HN1 1560+00
Kickapoo Rd
Premium Dr
HN1 1550+00
29.7 Acres
HN1 1540+00
HN1 1530+00
HN1 1520+00
HN1 1510+00
HN1 1500+0
Legend
Access Roads
Temporary Construction Area
Alignment HN1 zSC

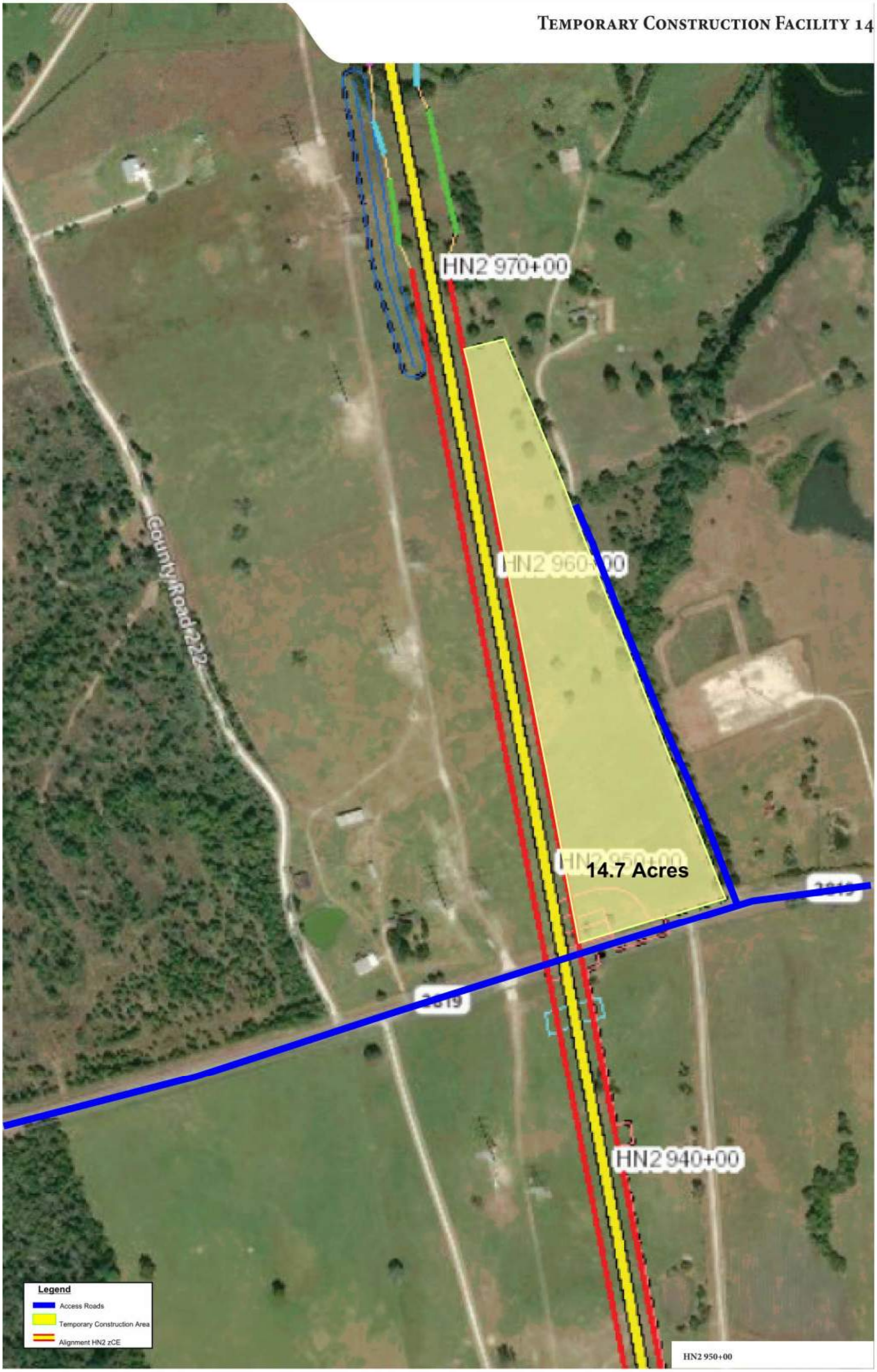

HN1 1670+00
HN1 1660+00
HN1 1650+00
HN1 1640+00
HN1 1630+00
HN1 1620+00
HN1 1610+00
HN1 1600+00
HN1 1590+00
Kickapoo Rd
Hempstead Rd
Hempstead Hwy
57.9 Acres
Pueblo Dr
Cherokee Dr
Aztec St
Legend
Access Roads
Temporary Construction Area
Alignment HN1 zSC

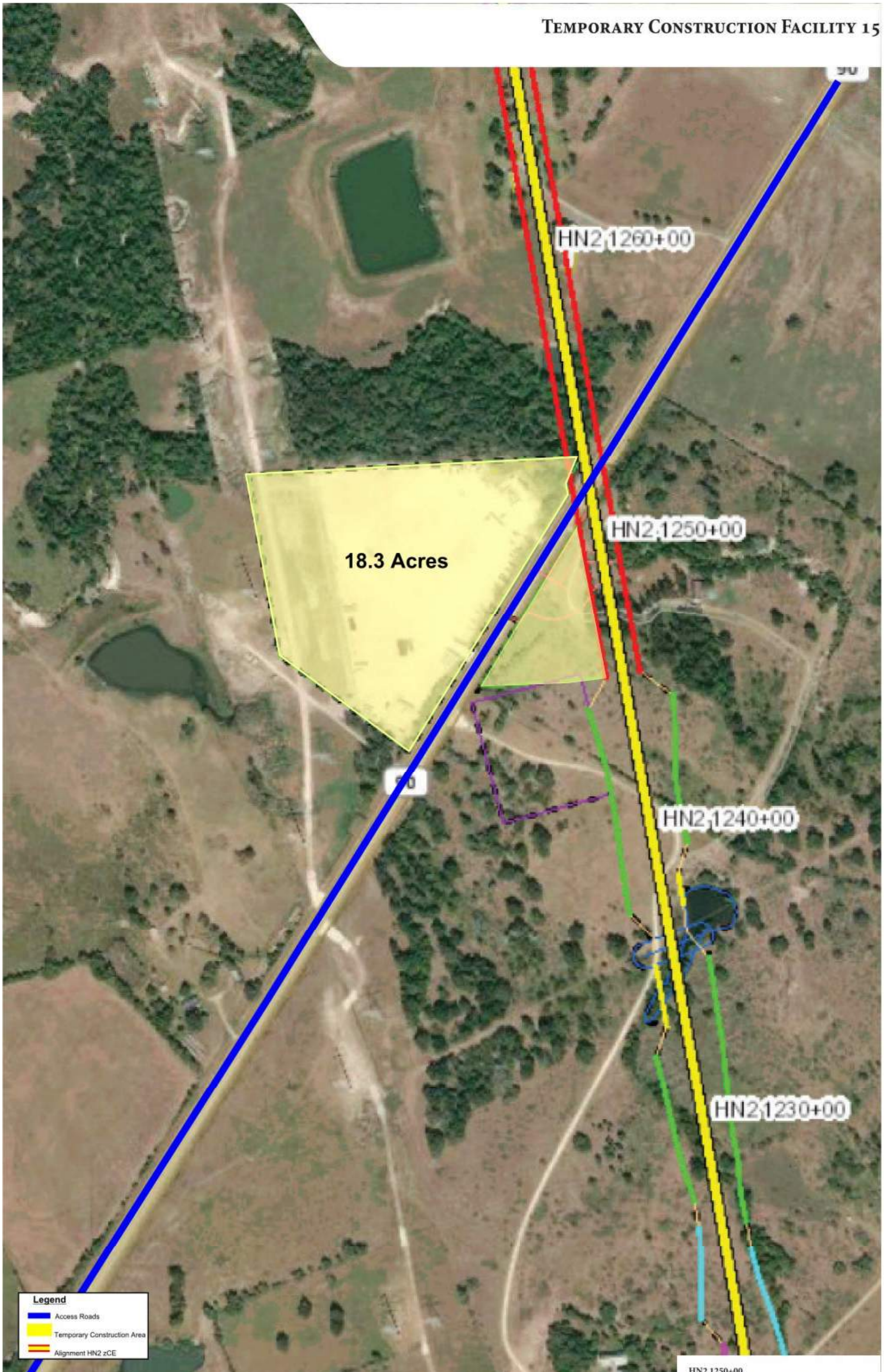
HN1 1620+00

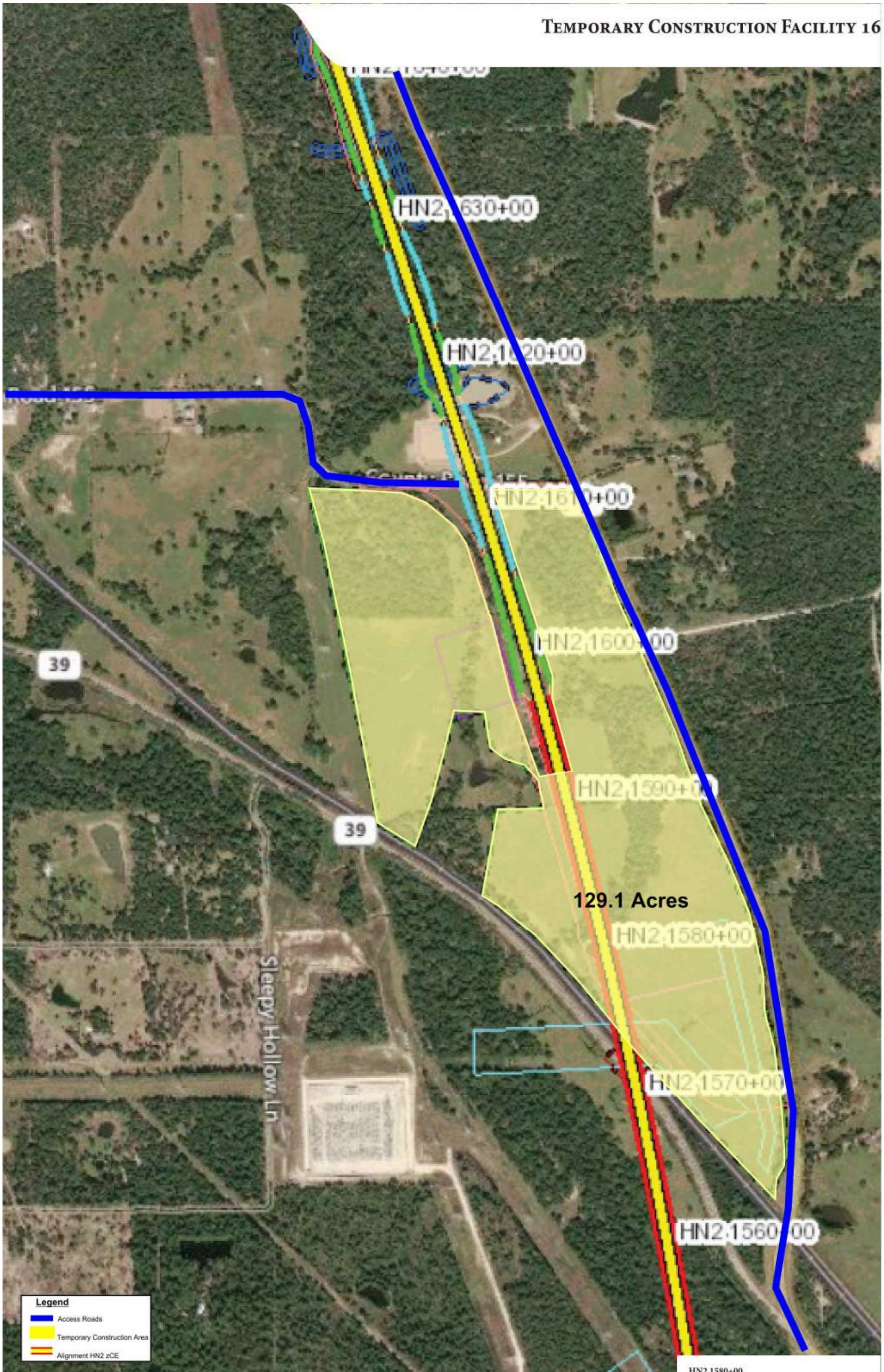


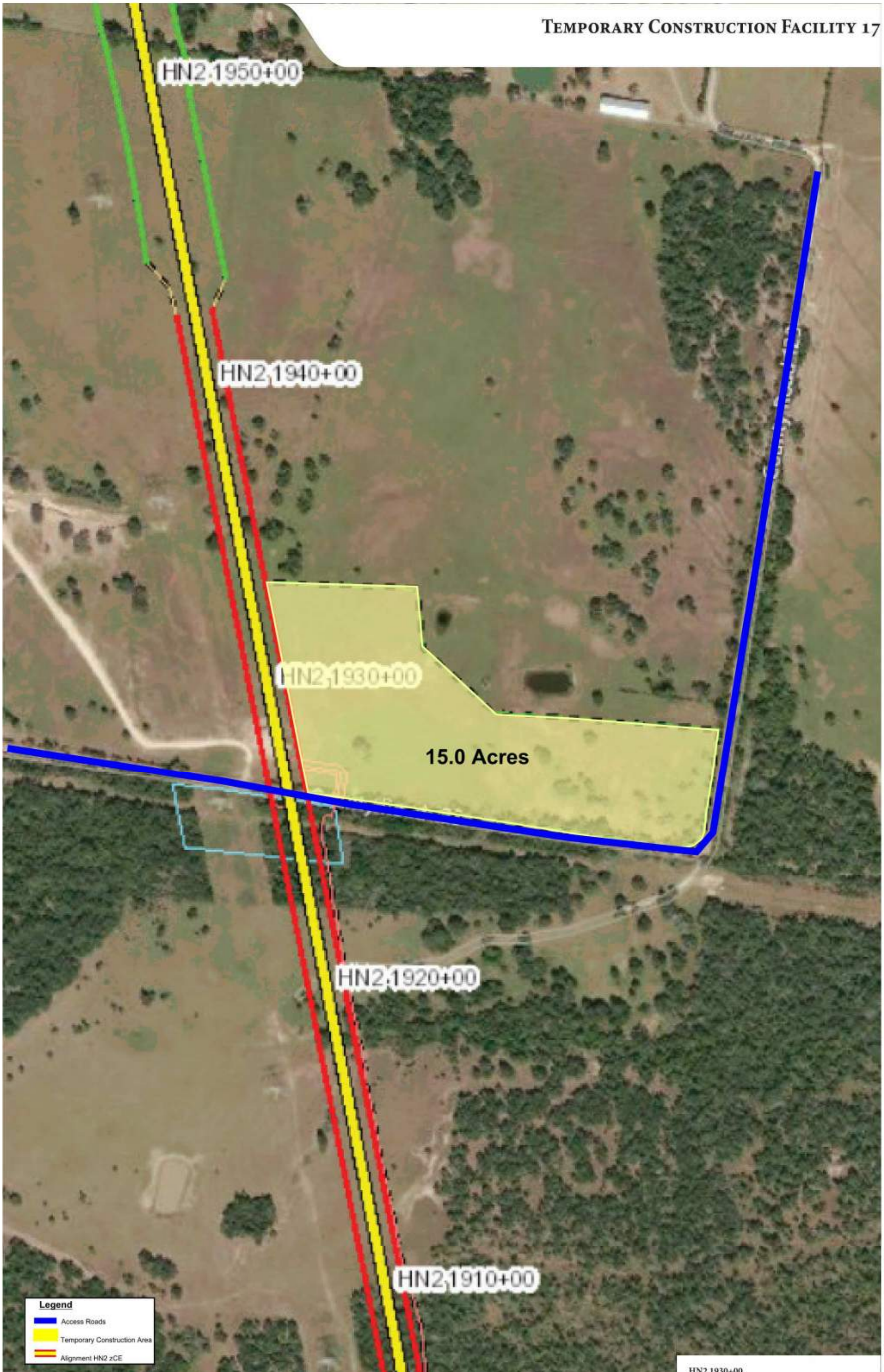
Camp K
HN2 400+00
County Road 311
County Road 257
133.7 Acres
County Road 344
HN2 300+00
Joubert Rd
Pavlock Rd
Pinebrook Dr
County
Legend
Access Roads
Temporary Construction Area
Alignment HN2 zCE

HN2 350+00


HN2 970+00
County Road 222
HN2 960+00
HN2 950+00
14.7 Acres
3819
HN2 940+00
Legend
Access Roads
Temporary Construction Area
Alignment HN2 zCE
HN2 950+00


90
HN2 1260+00
HN2 1250+00
18.3 Acres
HN2 1240+00
90
HN2 1230+00
Legend
Access Roads
Temporary Construction Area
Alignment HN2 zCE

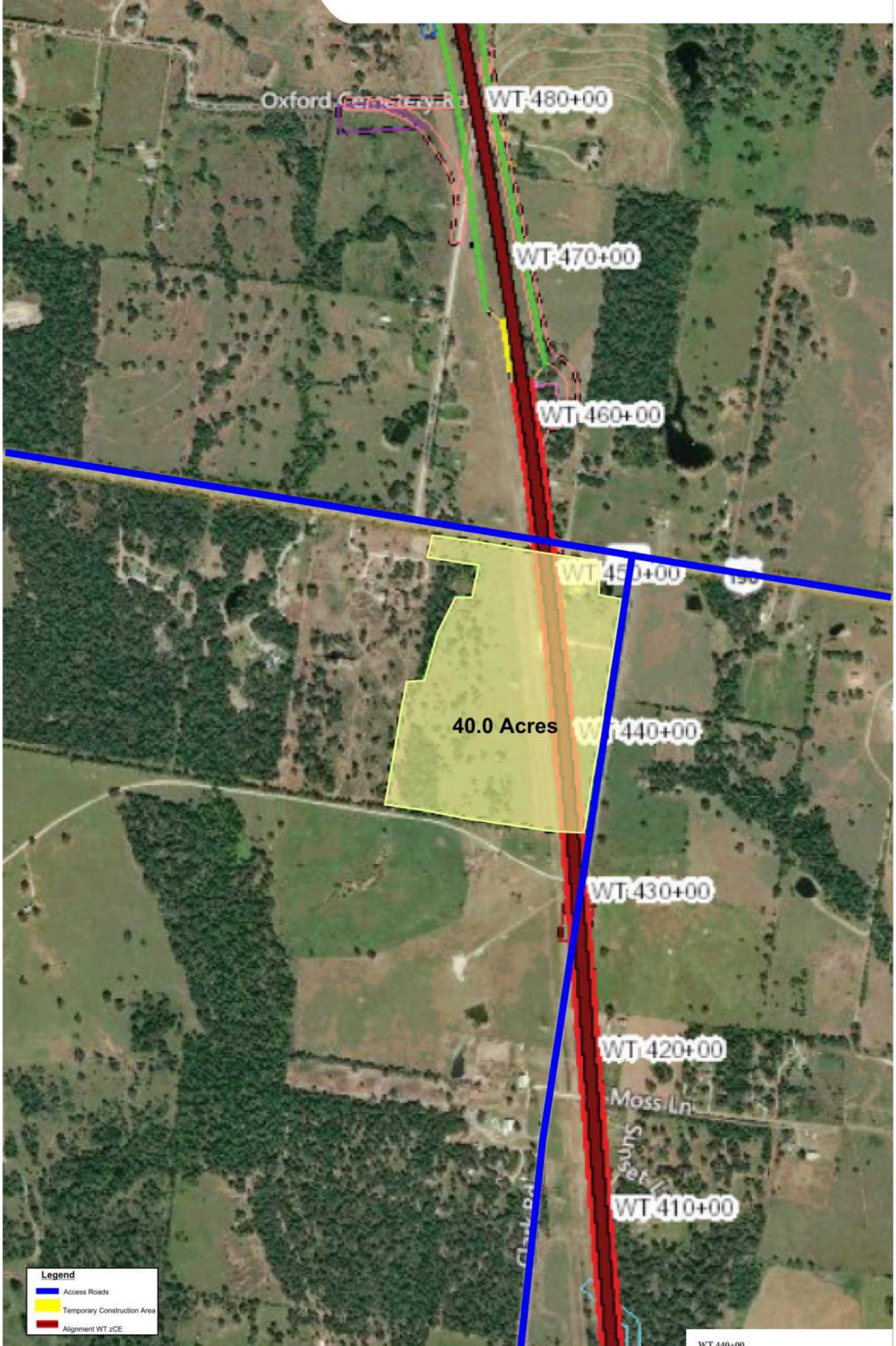

HN2 1630+00
HN2 1620+00
HN2 1610+00
HN2 1600+00
HN2 1590+00
129.1 Acres
HN2 1580+00
HN2 1570+00
HN2 1560+00
39
39
Sleepy Hollow Ln
Legend
Access Roads
Temporary Construction Area
Alignment HN2 zCE



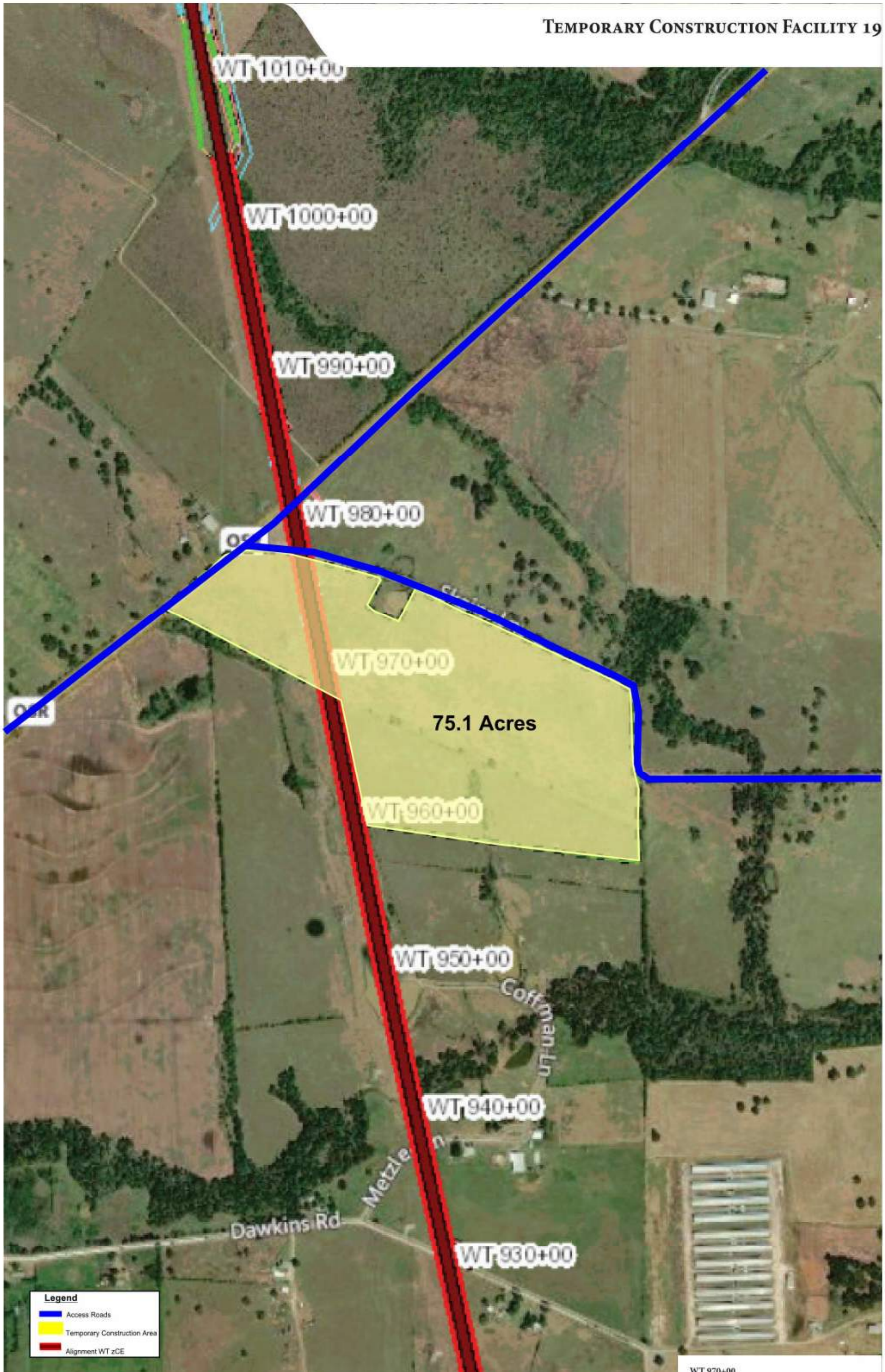
HN2 1950+00
HN2 1940+00
HN2 1930+00
15.0 Acres
HN2 1920+00
HN2 1910+00
Legend
Access Roads
Temporary Construction Area
Alignment HN2 zCE

HN2 1930+00

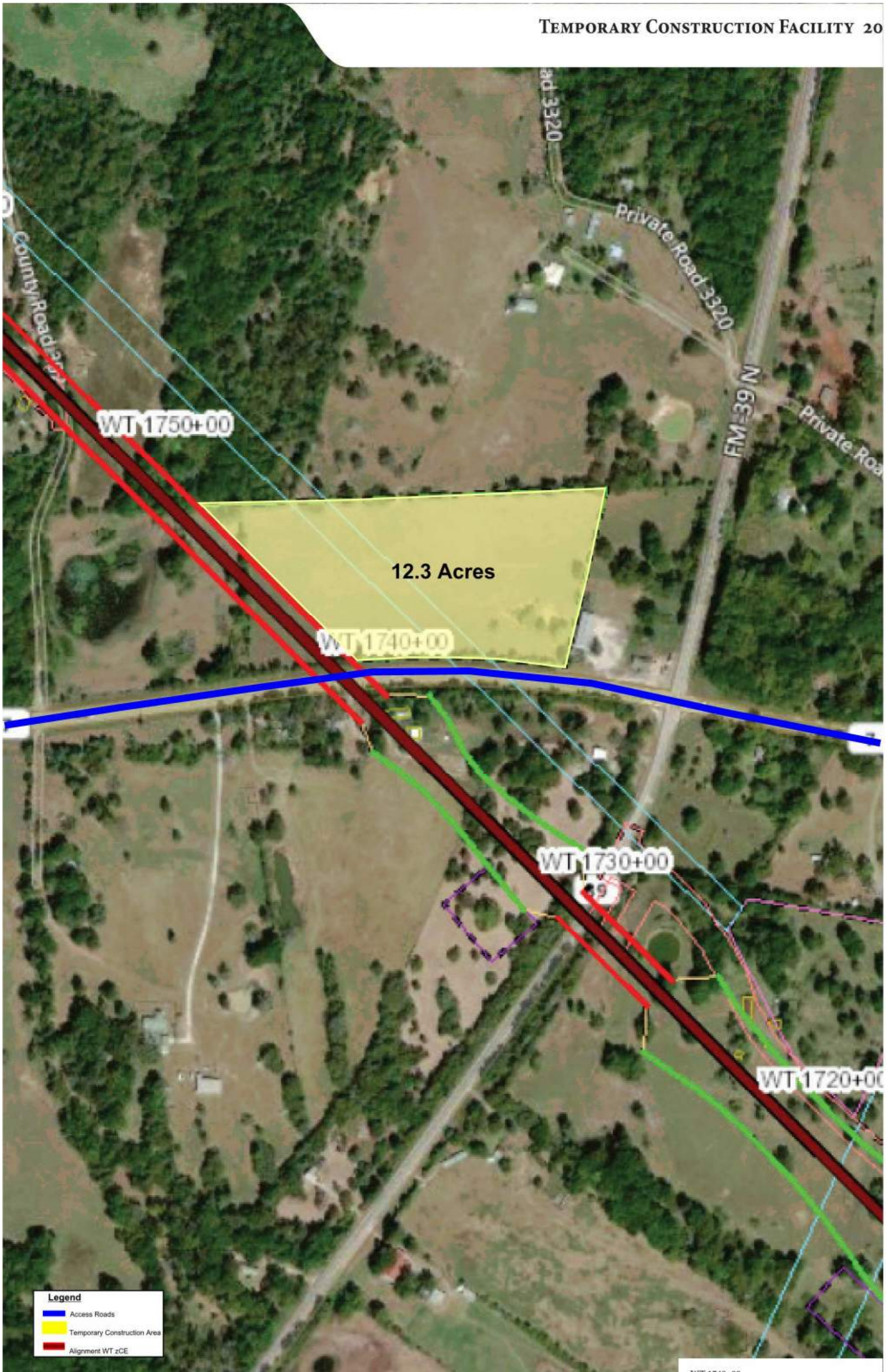
Temporary Construction Facility 18



WT 440+00

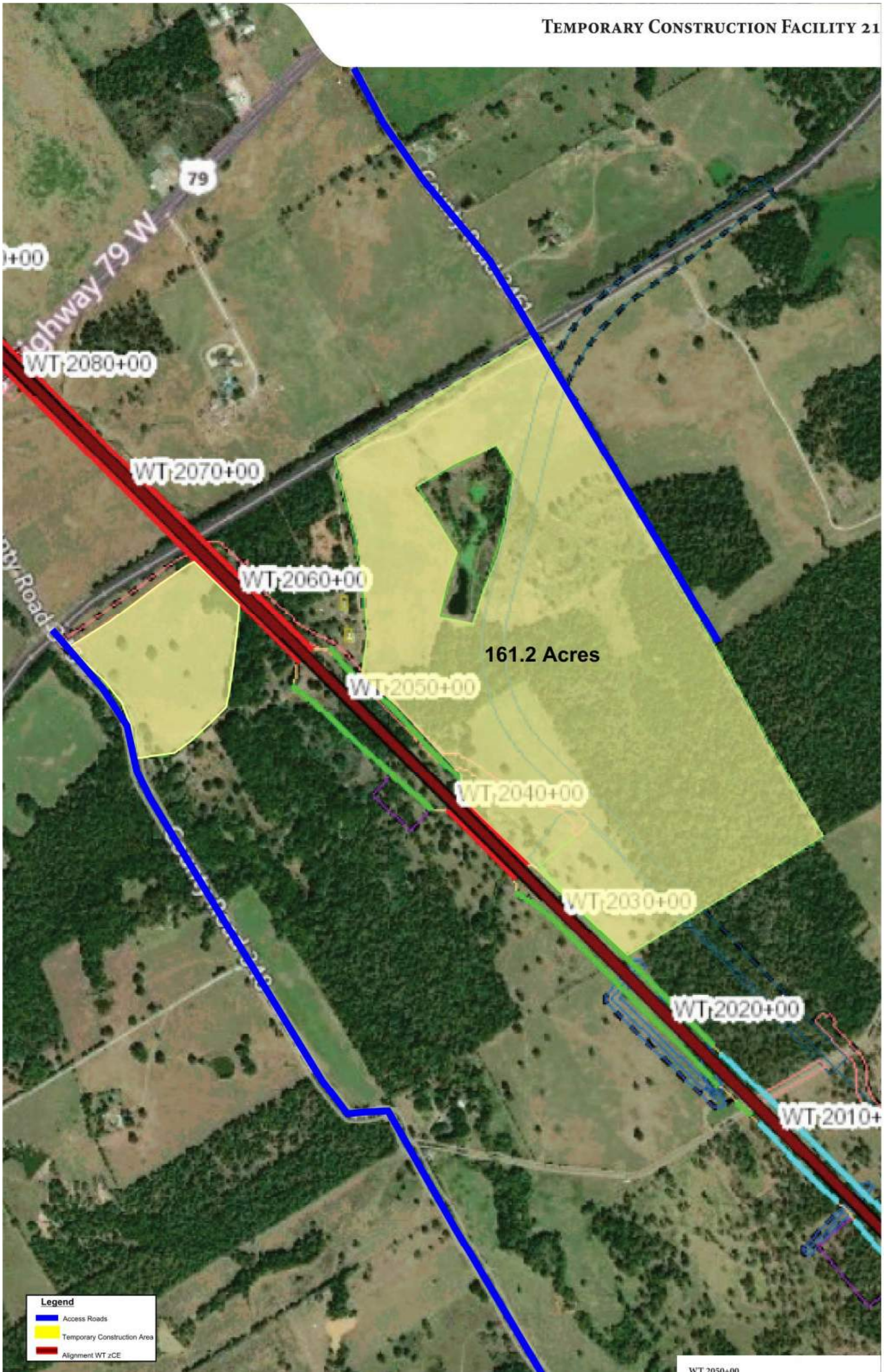

WT 1010+00
WT 1000+00
WT 990+00
WT 980+00
WT 970+00
75.1 Acres
WT 960+00
WT 950+00
Coffman Ln
WT 940+00
Metzler Ln
Dawkins Rd
WT 930+00
Legend
Access Roads
Temporary Construction Area
Alignment WT zCE

WT 970+00

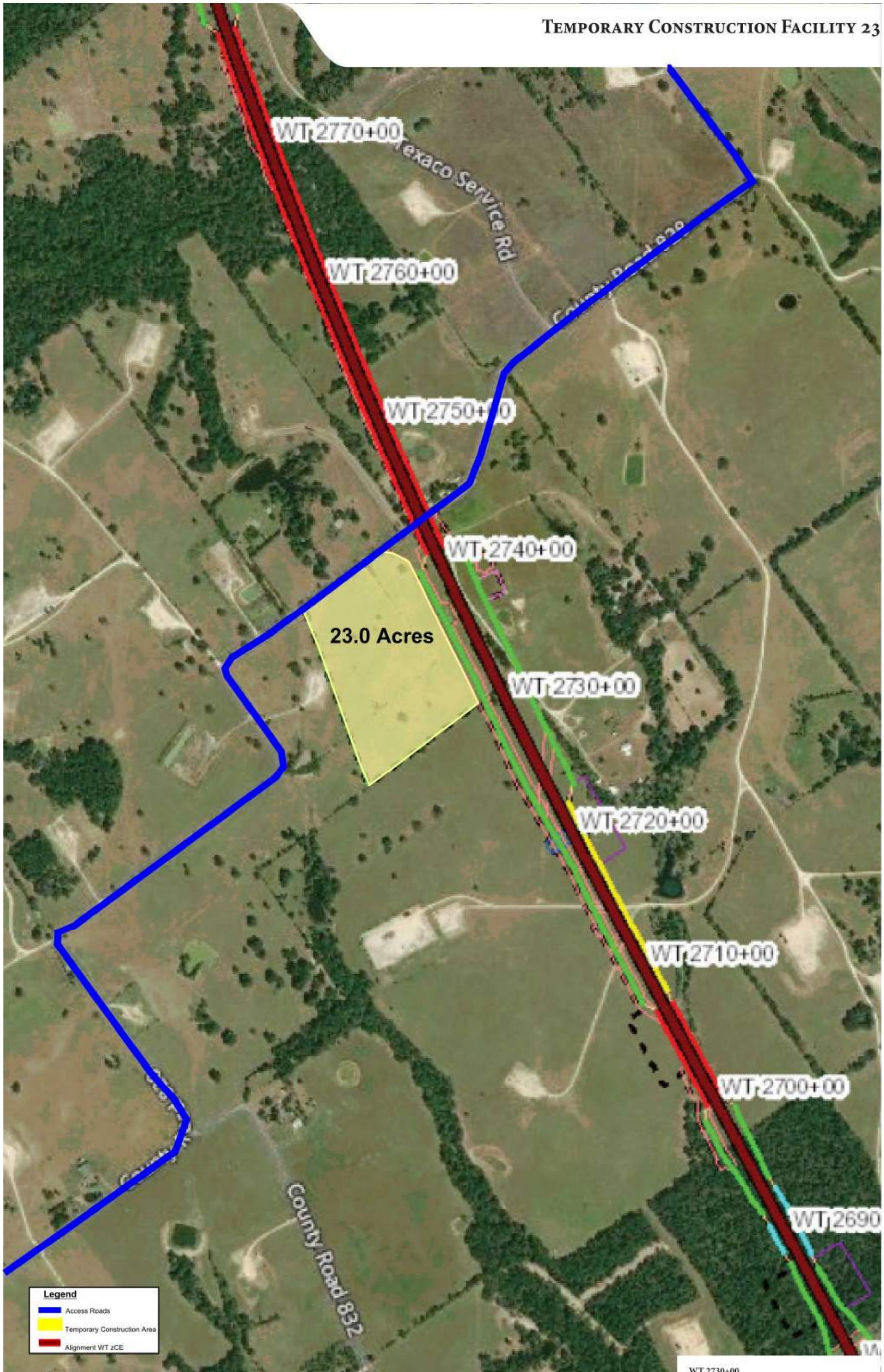


Private Road 3320
Private Road 3320
FM 39 N
Private Roa
County Road
WT 1750+00
12.3 Acres
WT 1740+00
WT 1730+00
WT 1720+00
Legend
Access Roads
Temporary Construction Area
Alignment WT zCE

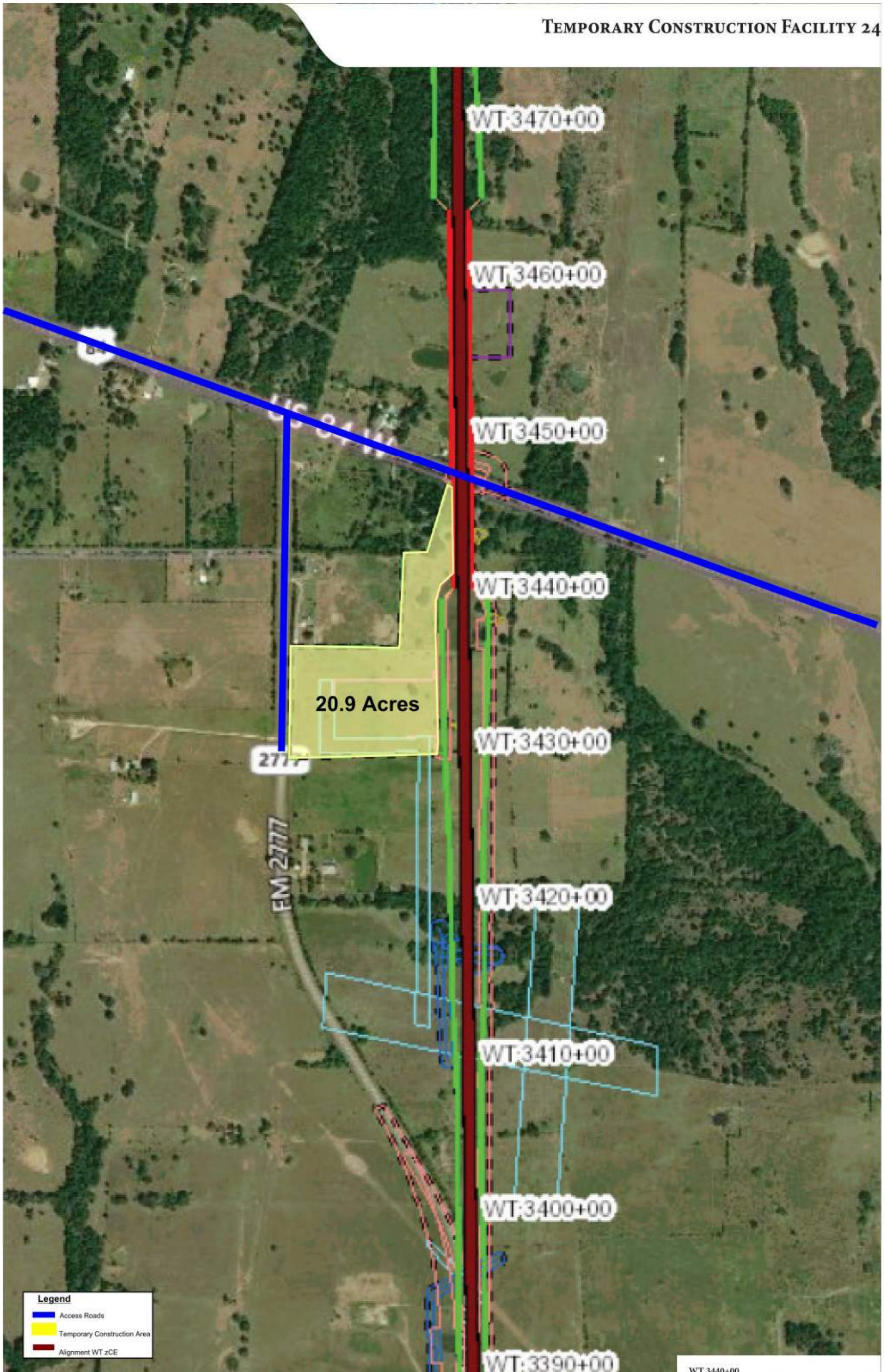
WT 1740+00


79
Highway 79 W
WT 2080+00
WT 2070+00
WT 2060+00
WT 2050+00
WT 2040+00
WT 2030+00
WT 2020+00
WT 2010+
161.2 Acres
Legend
Access Roads
Temporary Construction Area
Alignment WT zCE
WT 2050+00


2220+00
WT 2210+00
1489
WT 2200+00
16.8 Acres
WT 2190+00
WT
Legend
Access Roads
Temporary Construction Area
Alignment WT zCE

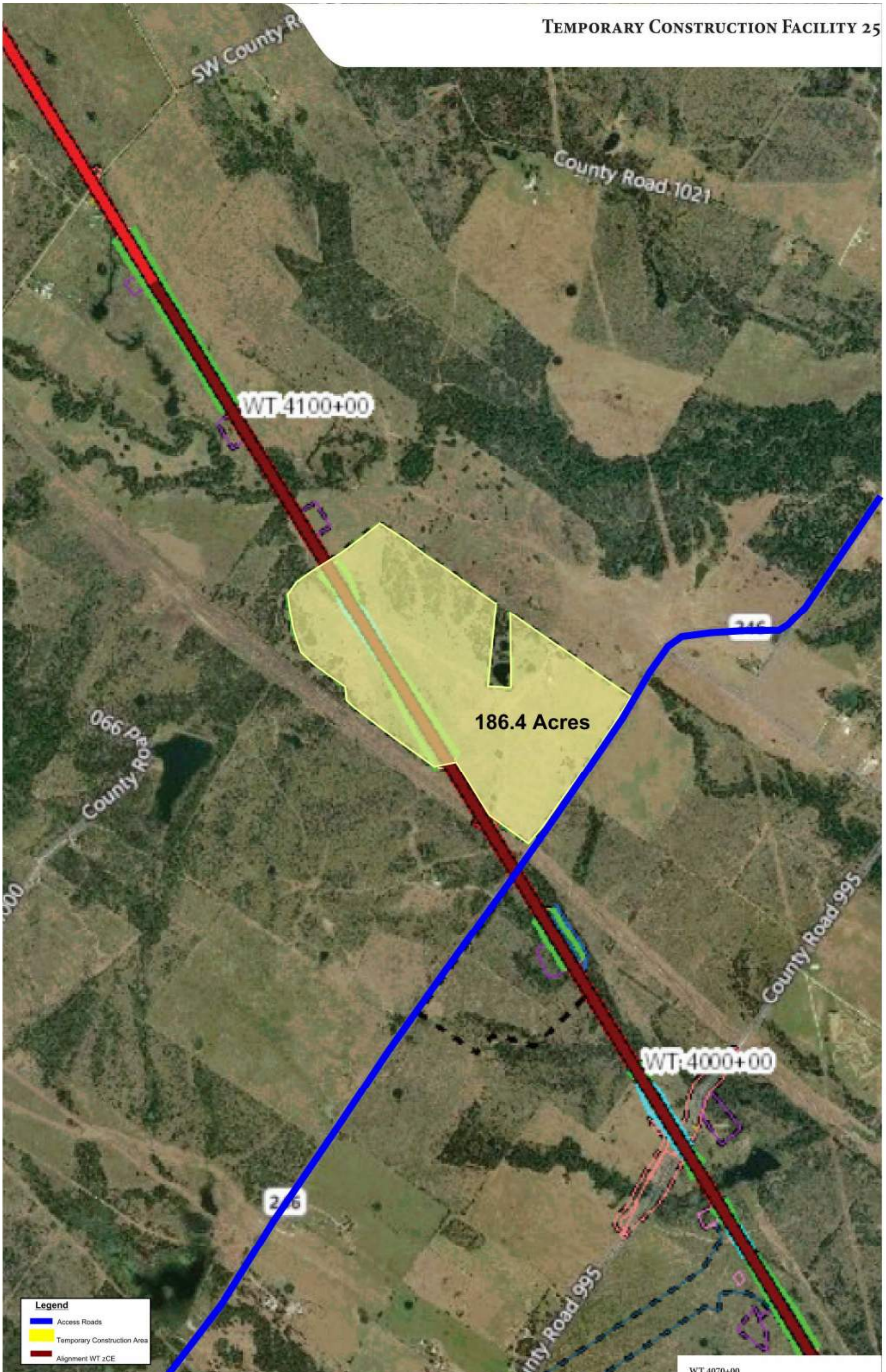

WT 2770+00
Texaco Service Rd
WT 2760+00
WT 2750+00
WT 2740+00
23.0 Acres
WT 2730+00
WT 2720+00
WT 2710+00
WT 2700+00
WT 2690
County Road 832
Legend
Access Roads
Temporary Construction Area
Alignment WT zCE

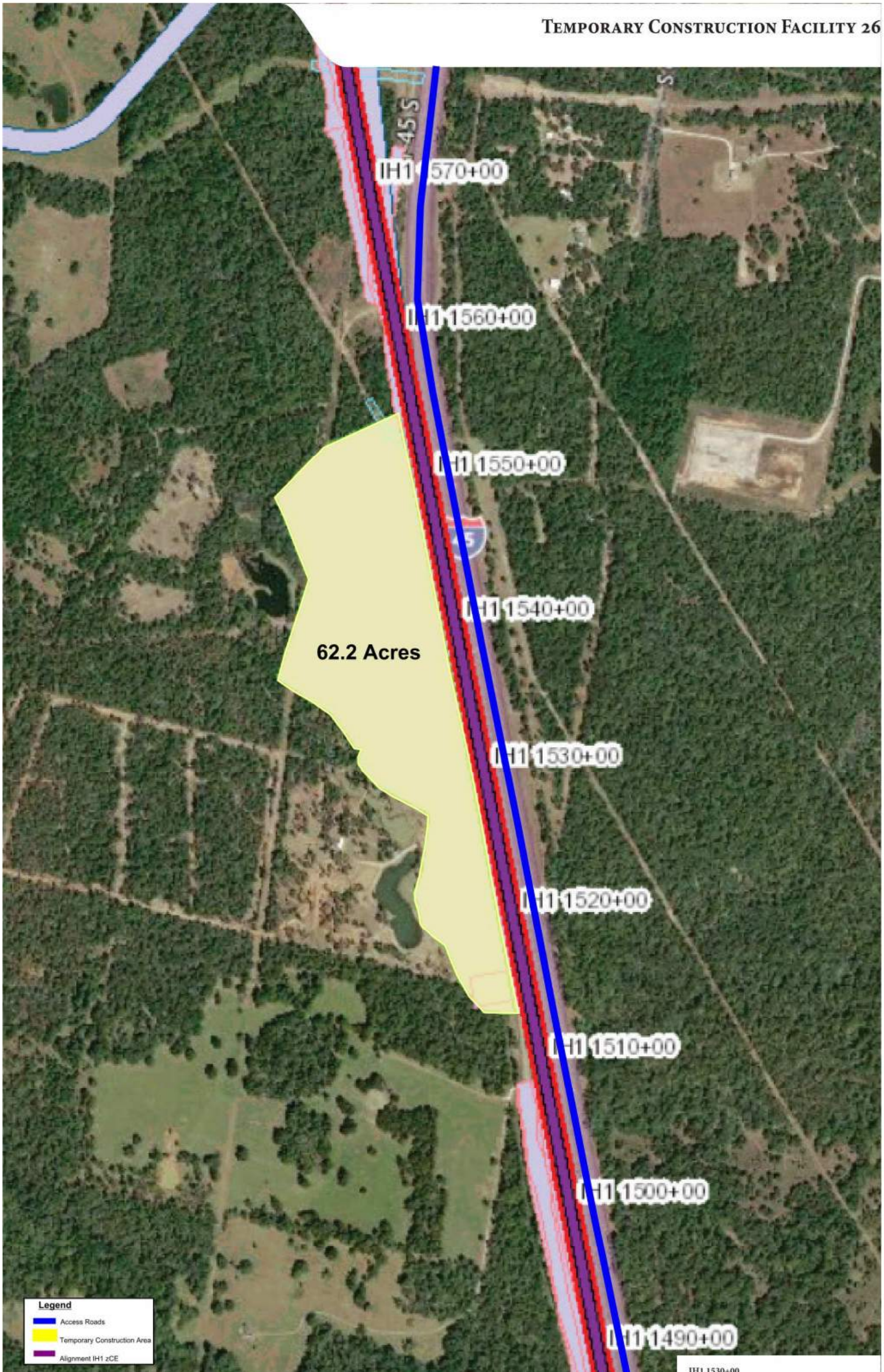
WT 2730+00


WT 3470+00
WT 3460+00
84
US 84 W
WT 3450+00
WT 3440+00
20.9 Acres
WT 3430+00
2777
FM 2777
WT 3420+00
WT 3410+00
WT 3400+00
WT 3390+00
Legend
Access Roads
Temporary Construction Area
Alignment WT zCE

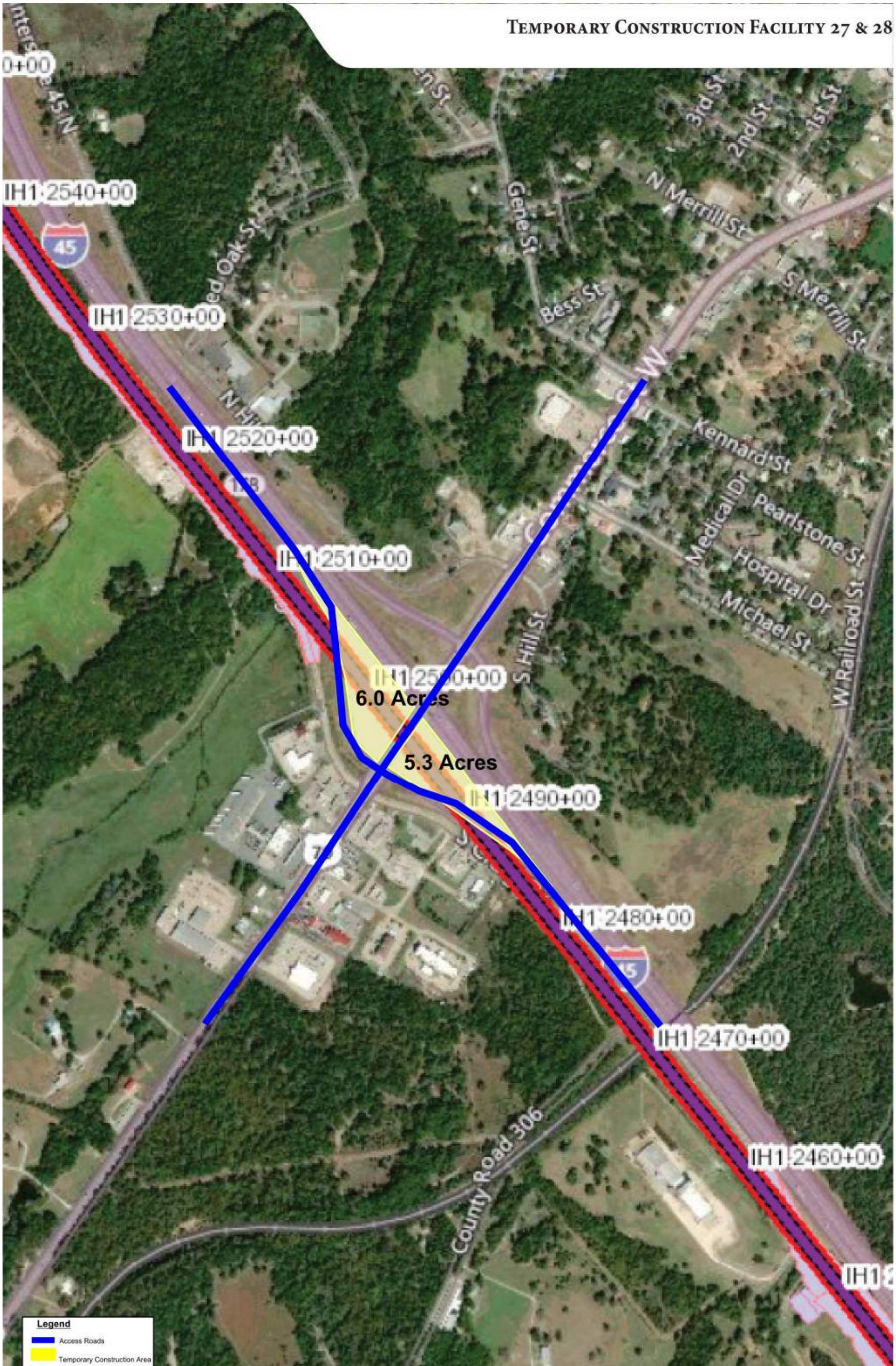
WT 3440+00

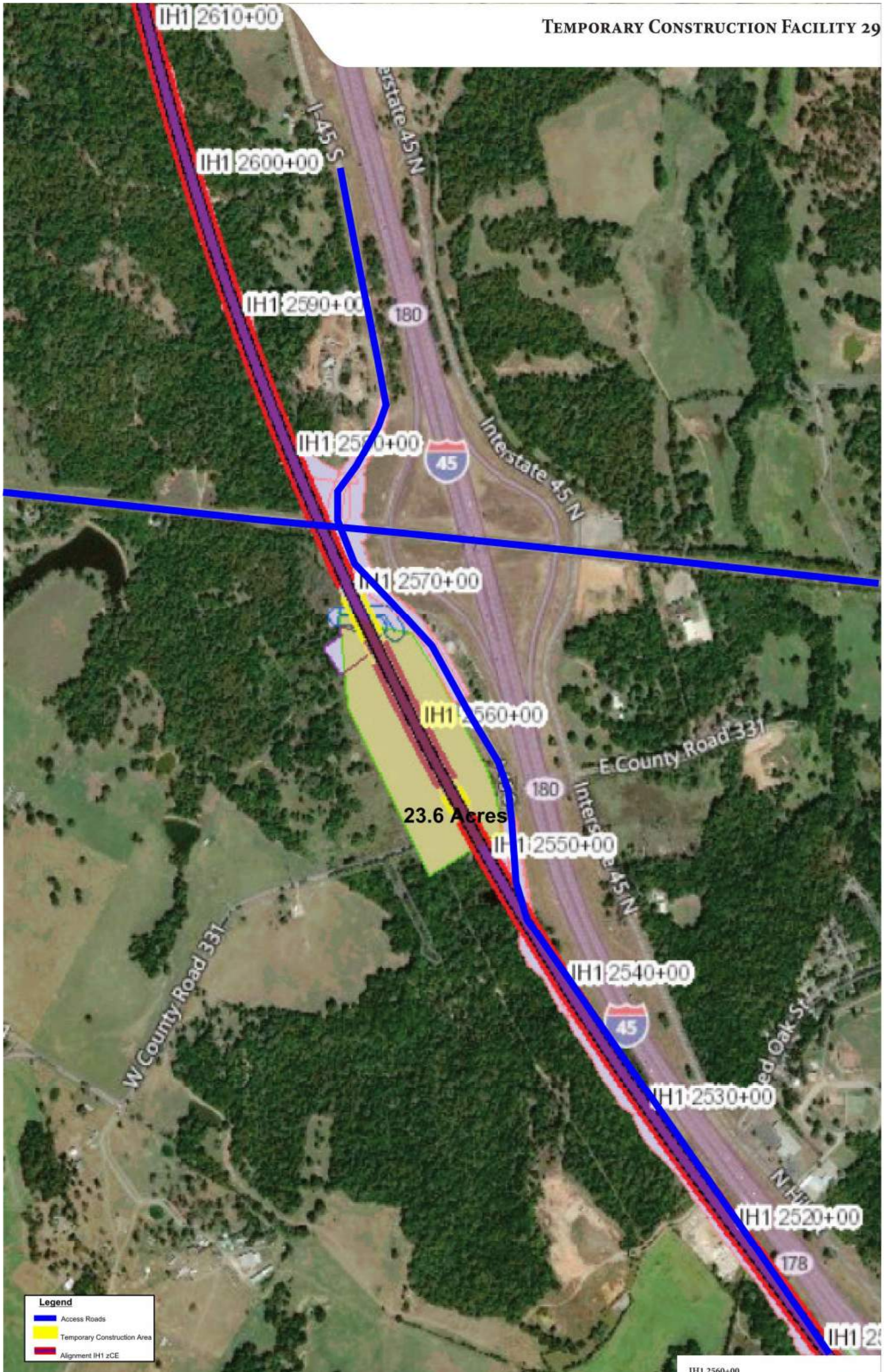
Temporary Construction Facility 25

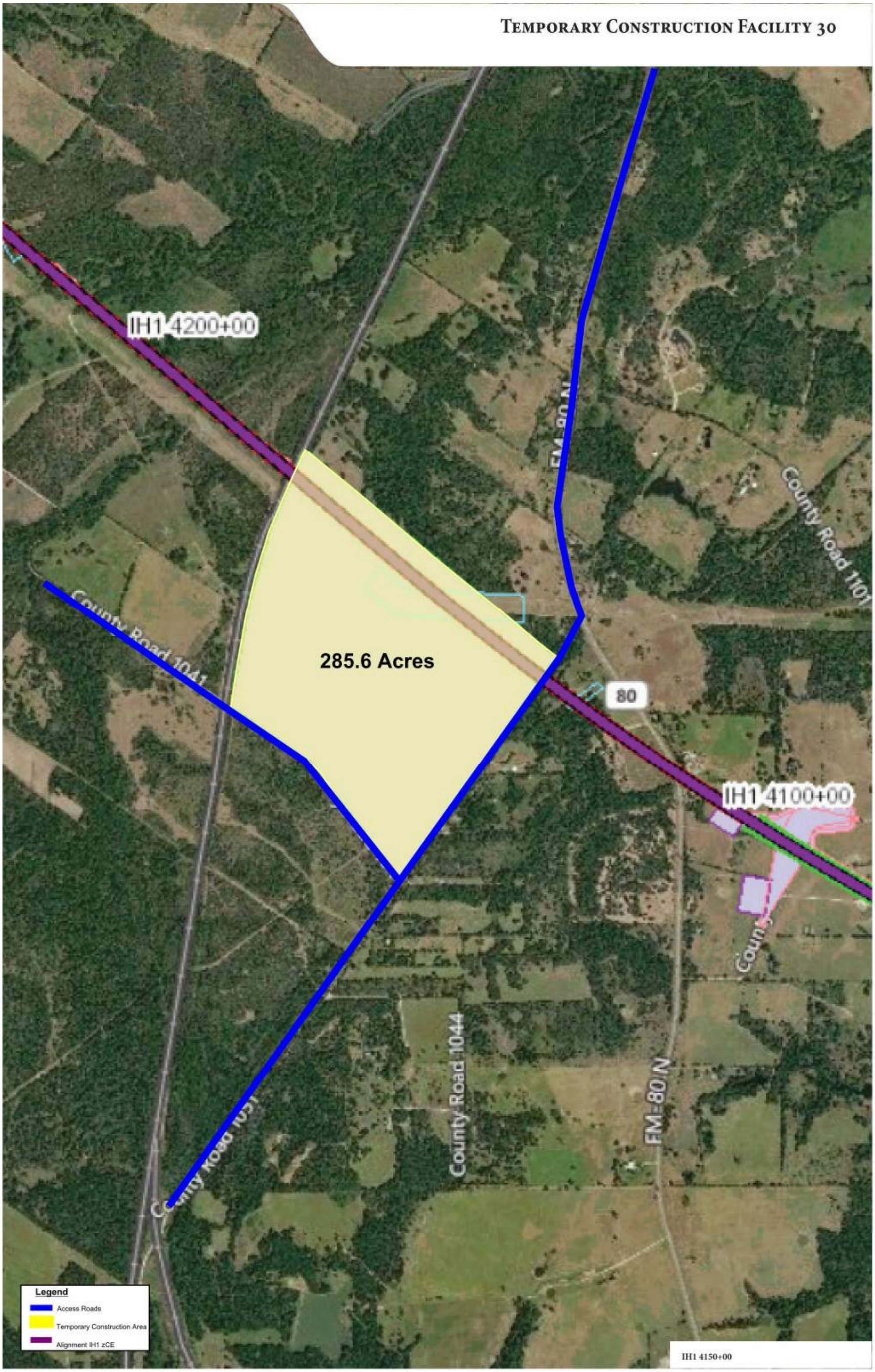


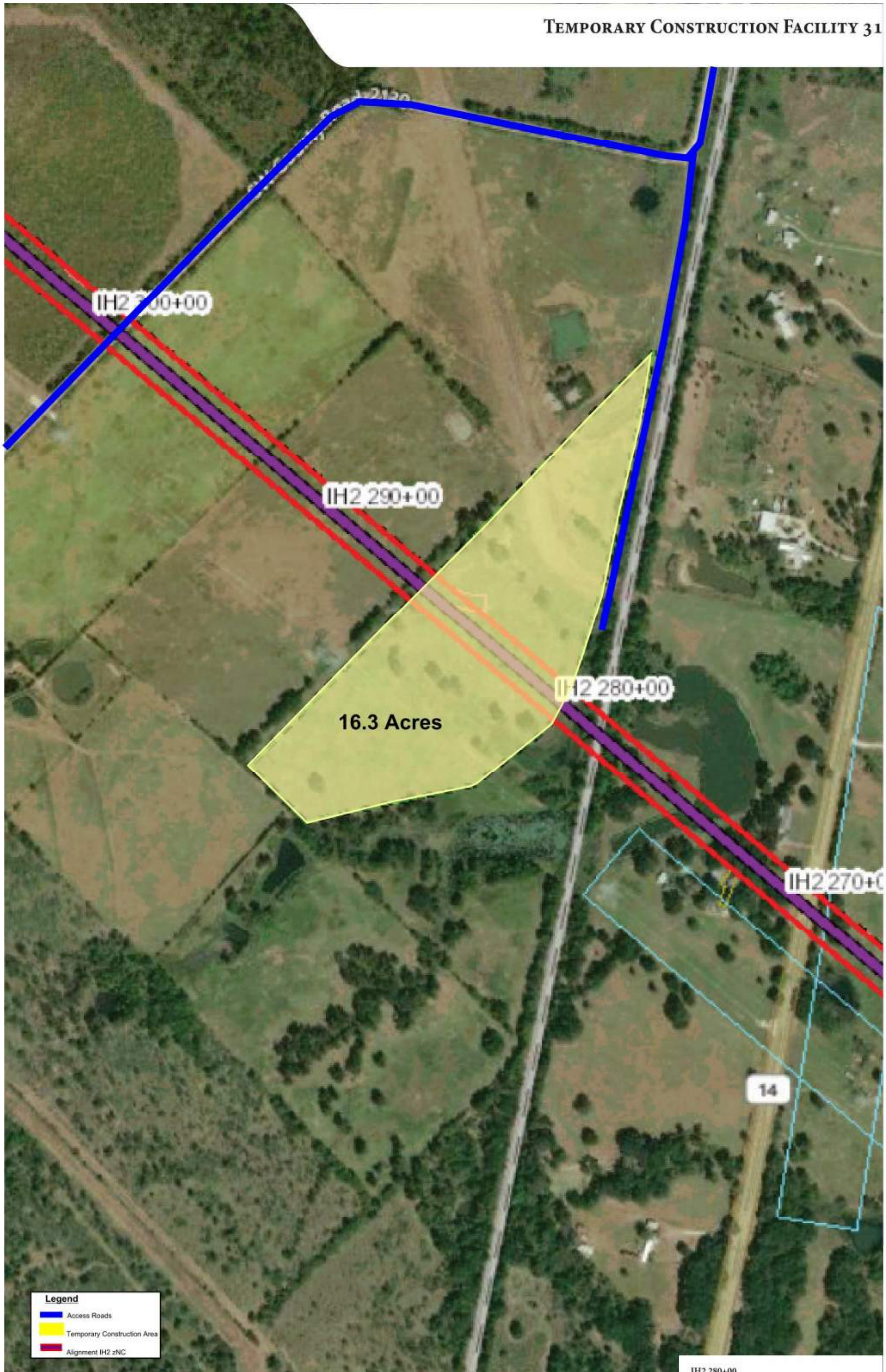

45 S
IH1 1570+00
IH1 1560+00
IH1 1550+00
IH1 1540+00
IH1 1530+00
IH1 1520+00
IH1 1510+00
IH1 1500+00
IH1 1490+00
62.2 Acres
Legend
Access Roads
Temporary Construction Area
Alignment IH1 zCE

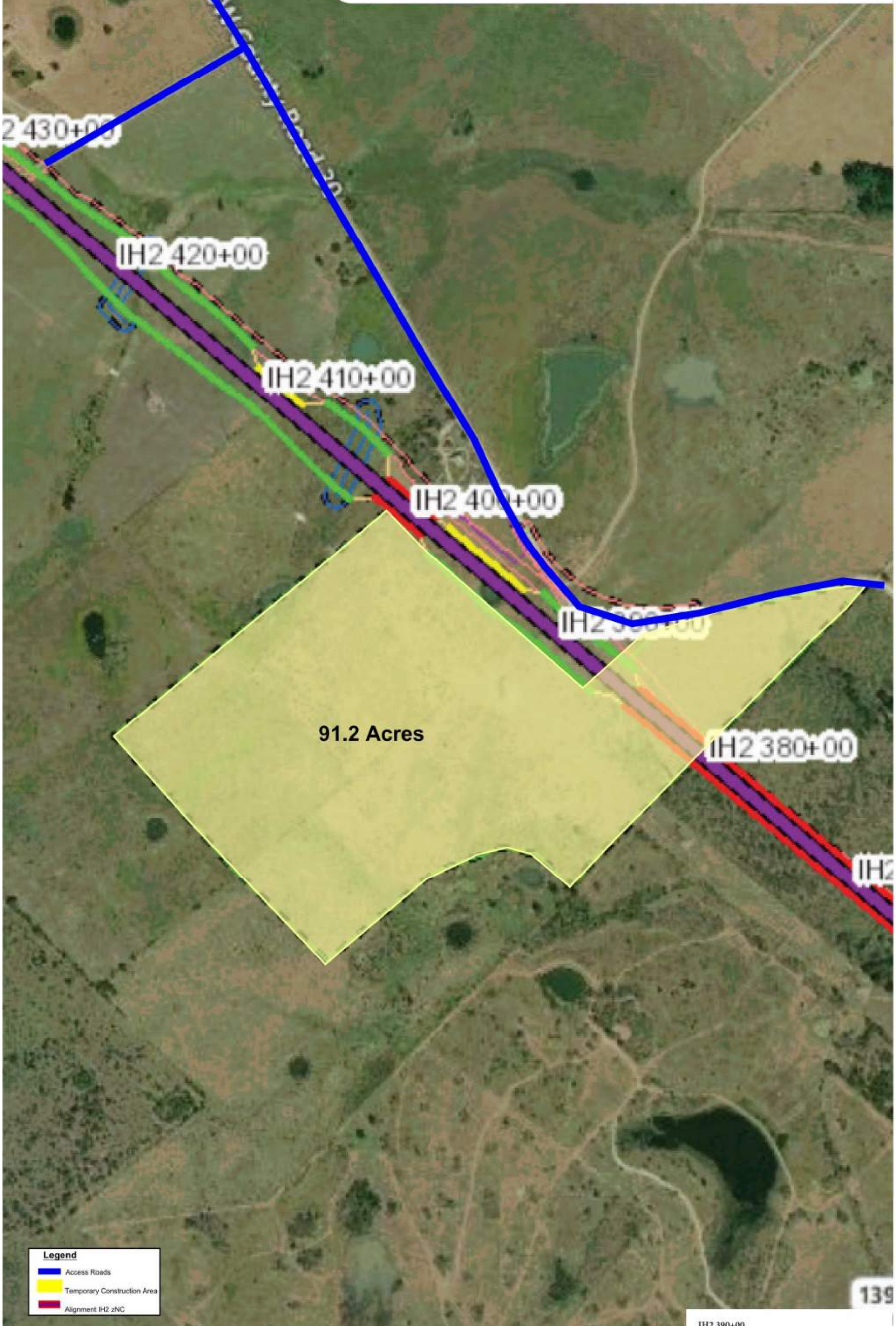
IH1 1530+00

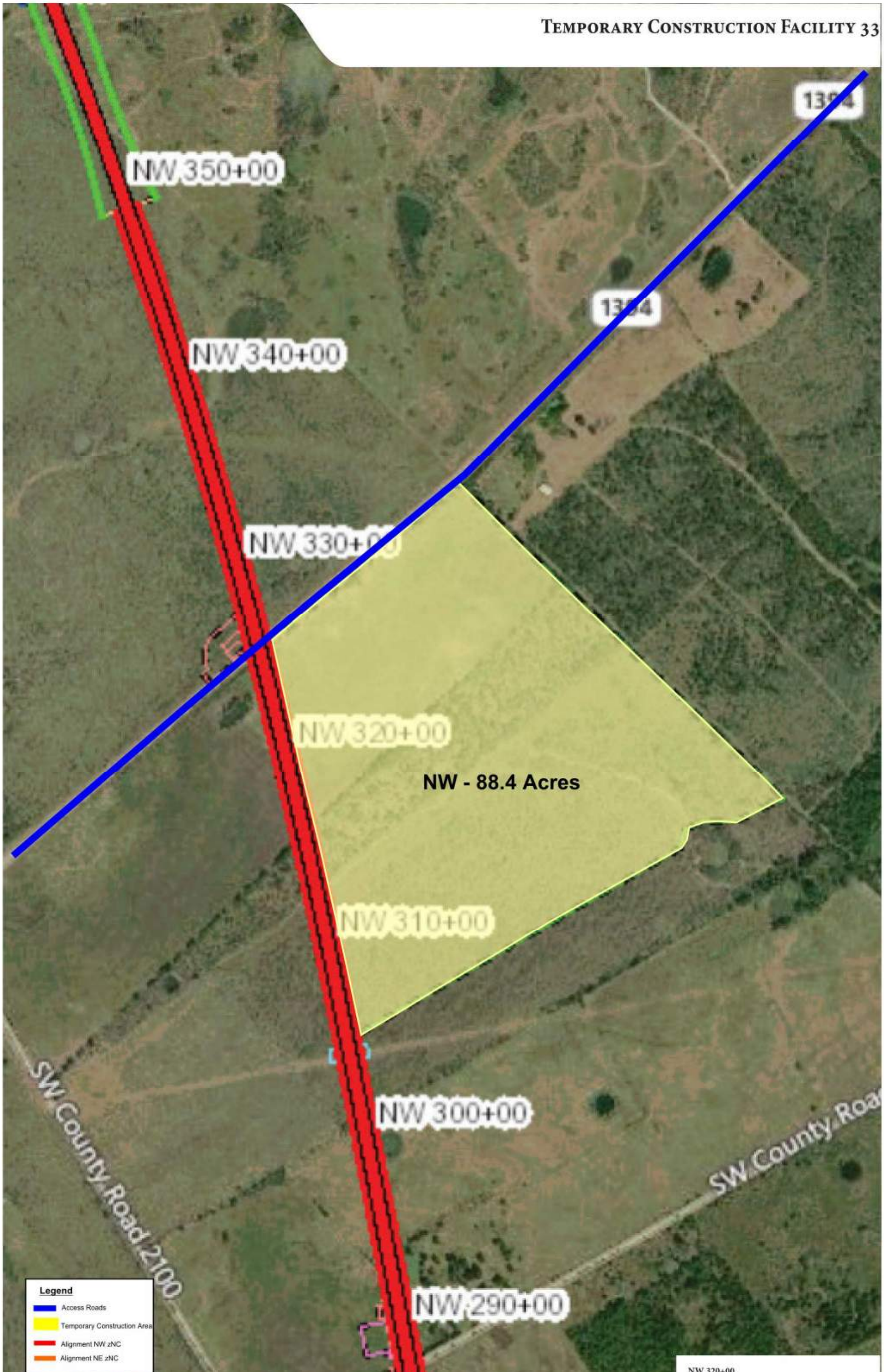

IH1 2540+00
IH1 2530+00
IH1 2520+00
IH1 2510+00
IH1 2500+00
6.0 Acres
5.3 Acres
IH1 2490+00
IH1 2480+00
IH1 2470+00
IH1 2460+00
N Merrill St
S Merrill St
Gene St
Bess St
Kennard St
Medical Dr
Pearlstone St
Hospital Dr
Michael St
S Hill St
W Railroad St
3rd St
2nd St
1st St
County Road 306
45
Legend
Access Roads
Temporary Construction Area
Alignment IH1 zCE


IH1 2610+00
IH1 2600+00
I-45 S
Interstate 45 N
IH1 2590+00
180
IH1 2580+00
45
Interstate 45 N
IH1 2570+00
IH1 2560+00
E County Road 331
180
23.6 Acres
IH1 2550+00
Interstate 45 N
IH1 2540+00
45
W County Road 331
IH1 2530+00
IH1 2520+00
178
Legend
Access Roads
Temporary Construction Area
Alignment IH1 zCE

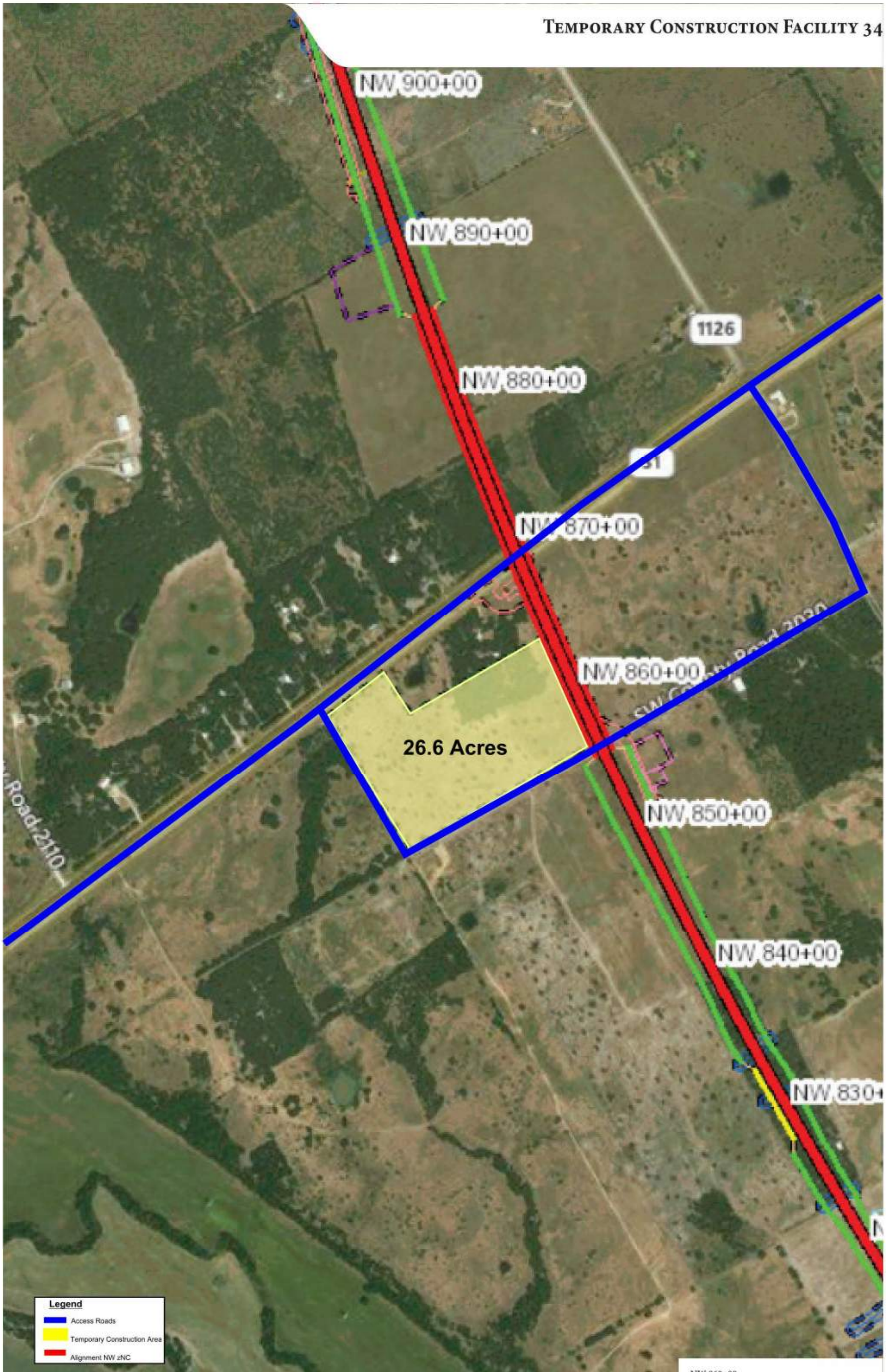

IH1 4200+00
285.6 Acres
80
IH1 4100+00
FM-80 N
County Road 1101
County Road 1041
County Road 1044
County Road 1051
FM-80 N
Legend
Access Roads
Temporary Construction Area
Alignment IH1 zCE

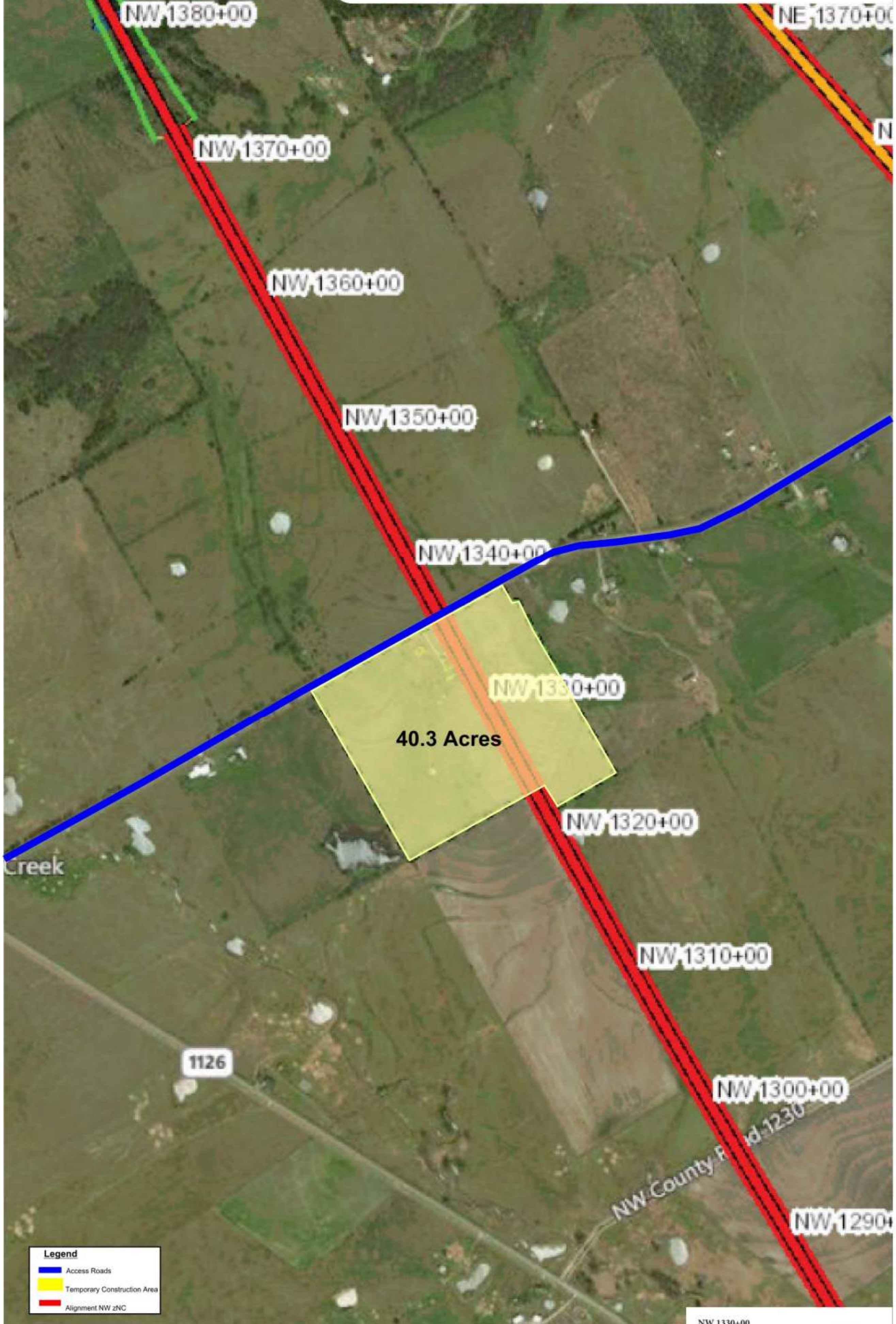

IH2 290+00
IH2 280+00
IH2 270+0
16.3 Acres
14
Legend
Access Roads
Temporary Construction Area
Alignment IH2 zNC
IH2 280+00


2 430+00
IH2 420+00
IH2 410+00
IH2 400+00
IH2 390+00
91.2 Acres
IH2 380+00
IH2
139
Legend
Access Roads
Temporary Construction Area
Alignment IH2 zNC

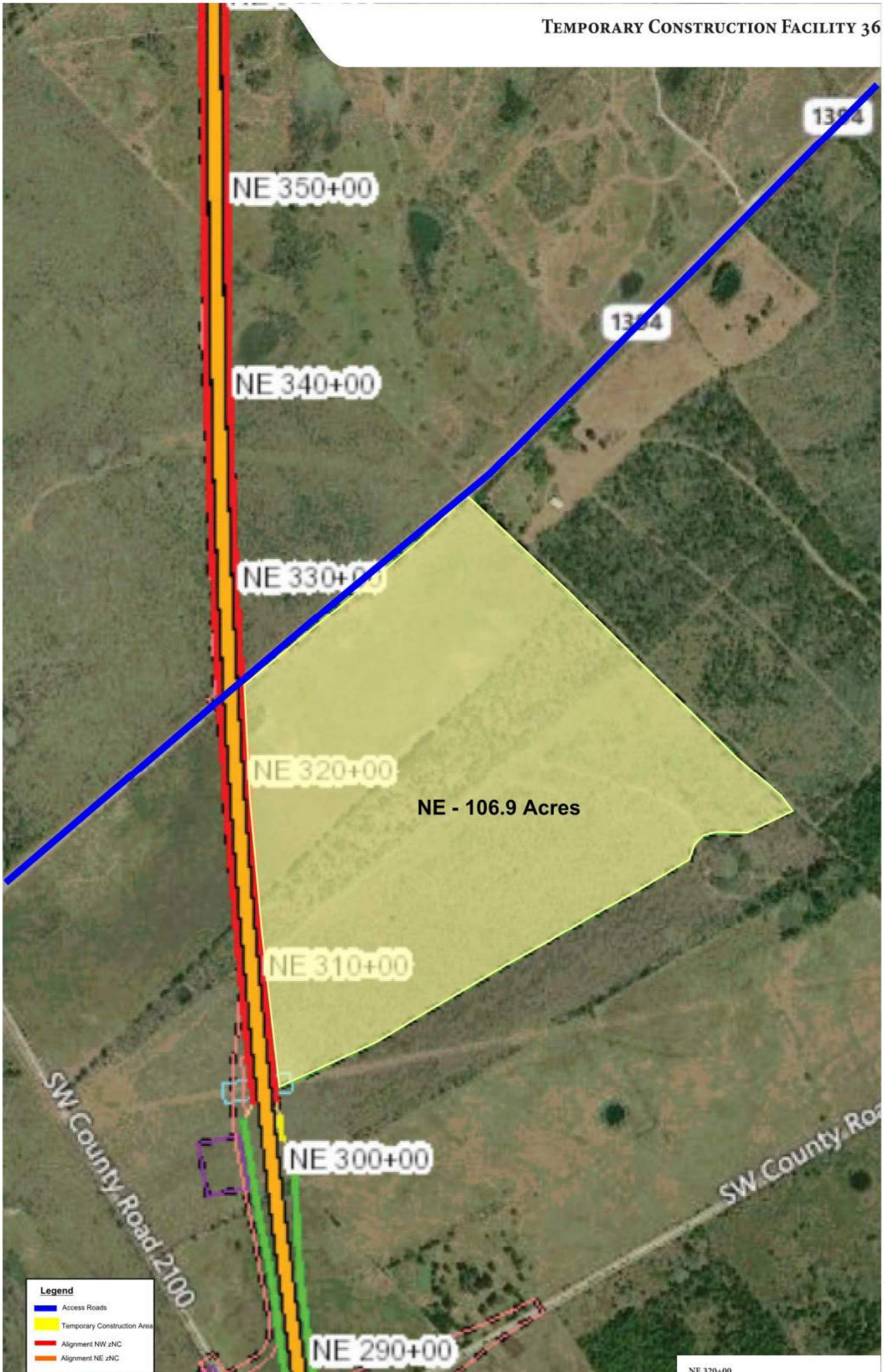

1394
NW 350+00
1394
NW 340+00
NW 330+00
NW 320+00
NW - 88.4 Acres
NW 310+00
NW 300+00
SW County Road 2100
SW County Road
NW 290+00
Legend
Access Roads
Temporary Construction Area
Alignment NW zNC
Alignment NE zNC

NW 320+00

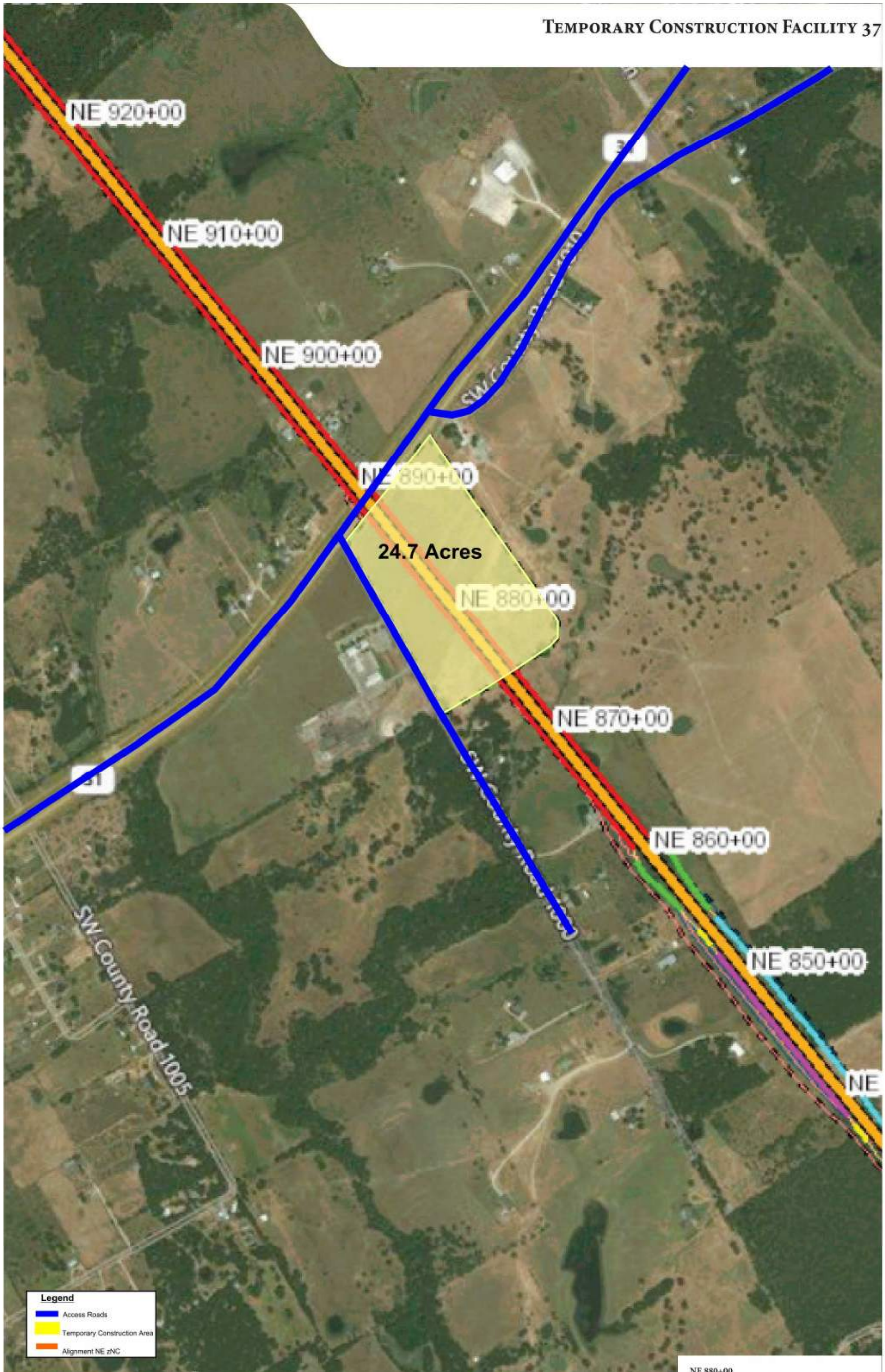

NW 900+00
NW 890+00
1126
NW 880+00
NW 870+00
NW 860+00
26.6 Acres
NW 850+00
NW 840+00
Legend
Access Roads
Temporary Construction Area
Alignment NW zNC


NW 1380+00
NW 1370+00
NW 1360+00
NW 1350+00
NW 1340+00
NW 1330+00
40.3 Acres
NW 1320+00
NW 1310+00
NW 1300+00
Creek
1126
Legend
Access Roads
Temporary Construction Area
Alignment NW zNC

NW 1330+00


NE 350+00
NE 340+00
NE 330+00
NE 320+00
NE 310+00
NE 300+00
NE 290+00
NE - 106.9 Acres
SW County Road 2100
SW County Road
Legend
Access Roads
Temporary Construction Area
Alignment NW zNC
Alignment NE zNC

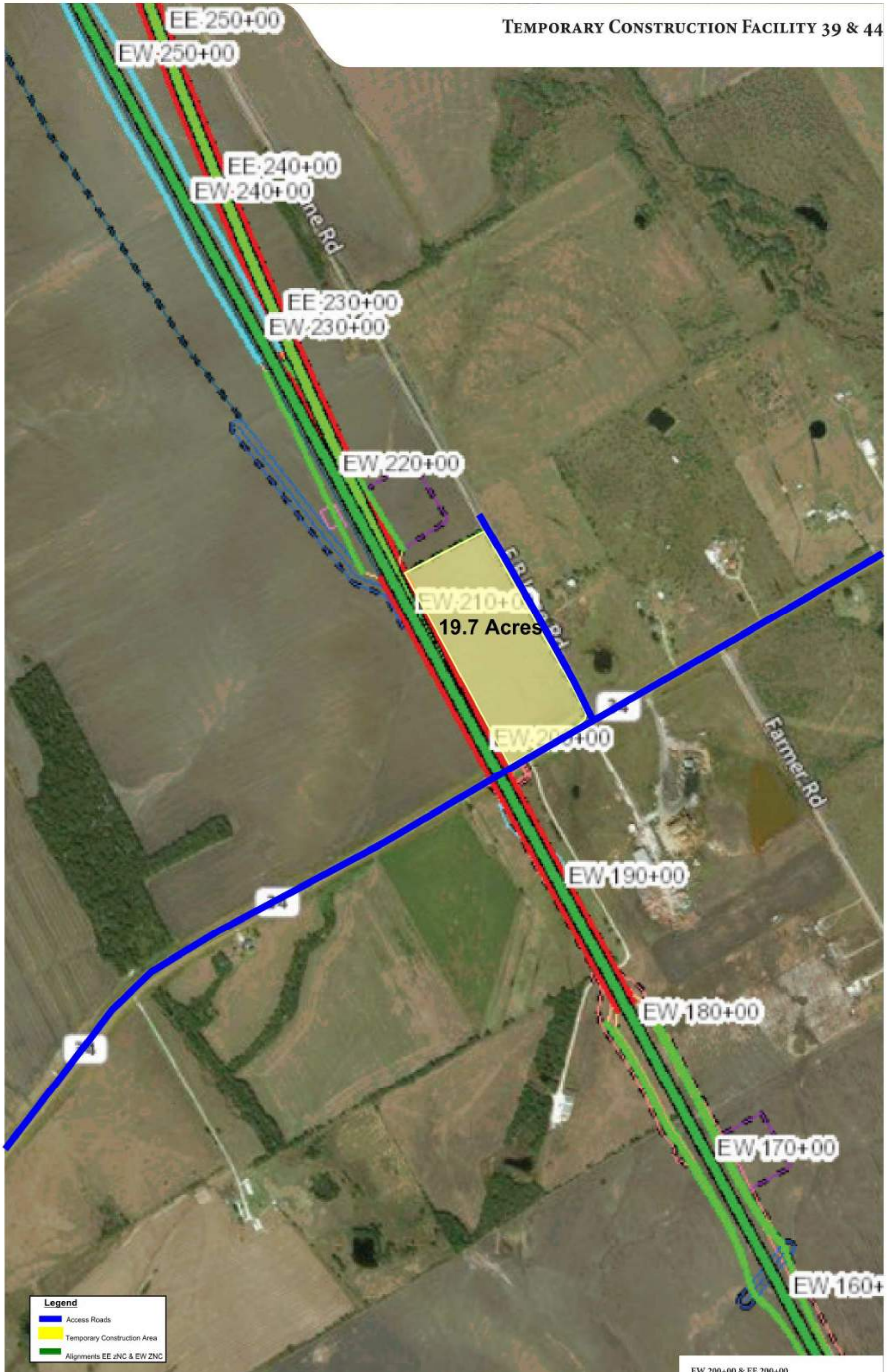
NE 320+00


NE 920+00
NE 910+00
NE 900+00
NE 890+00
24.7 Acres
NE 880+00
NE 870+00
NE 860+00
NE 850+00
NE
SW County Road 1005
Legend
Access Roads
Temporary Construction Area
Alignment NE zNC

NE 880+00


NE 1370+00
NE 1360+00
NE 1350+00
38.1 Acres
NE 1340+00
NE 1330+00
NE 1320+00
NE 1310+00
NW County Road 1230
Legend
Access Roads
Temporary Construction Area
Alignment NE zNC

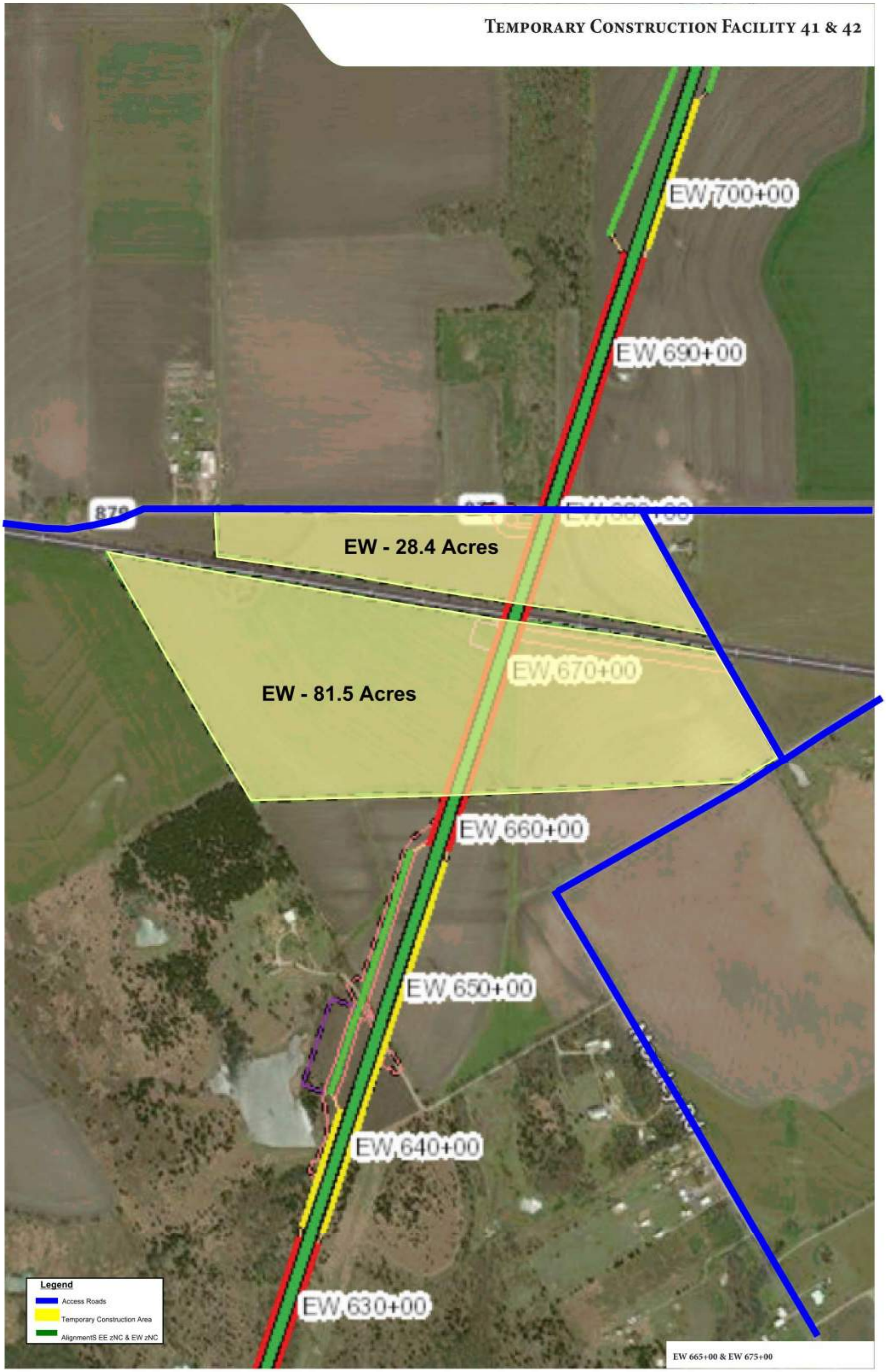
Temporary Construction Facility 39 & 44




EW 560+00
EW 550+00
EW - 14.8 Acres
EW 540+00
EW 530+00
Legend
Access Roads
Temporary Construction Area
AlignmentS EE zNC & EW zNC

EW 540+00

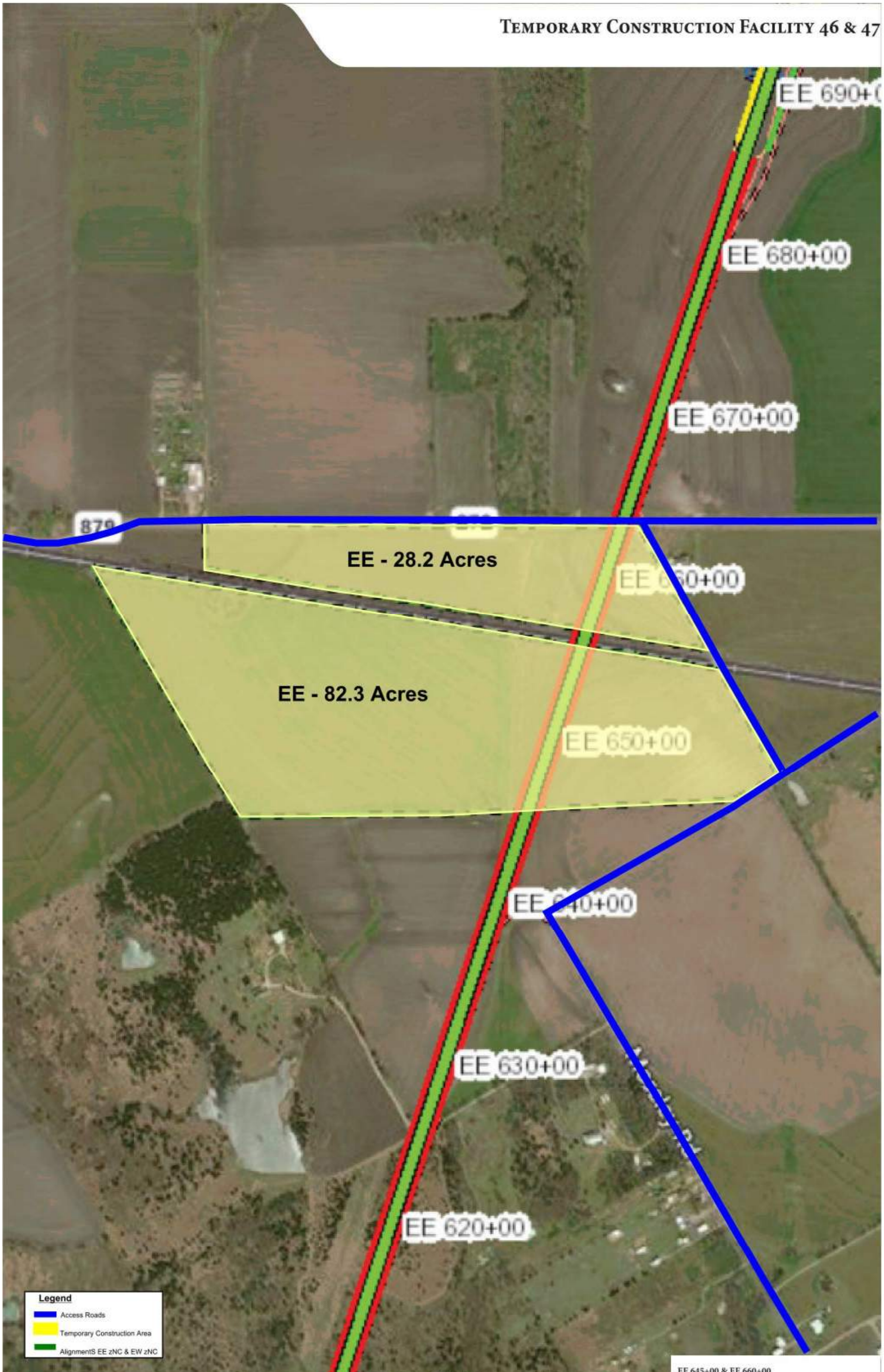
Temporary Construction Facility 41 & 42



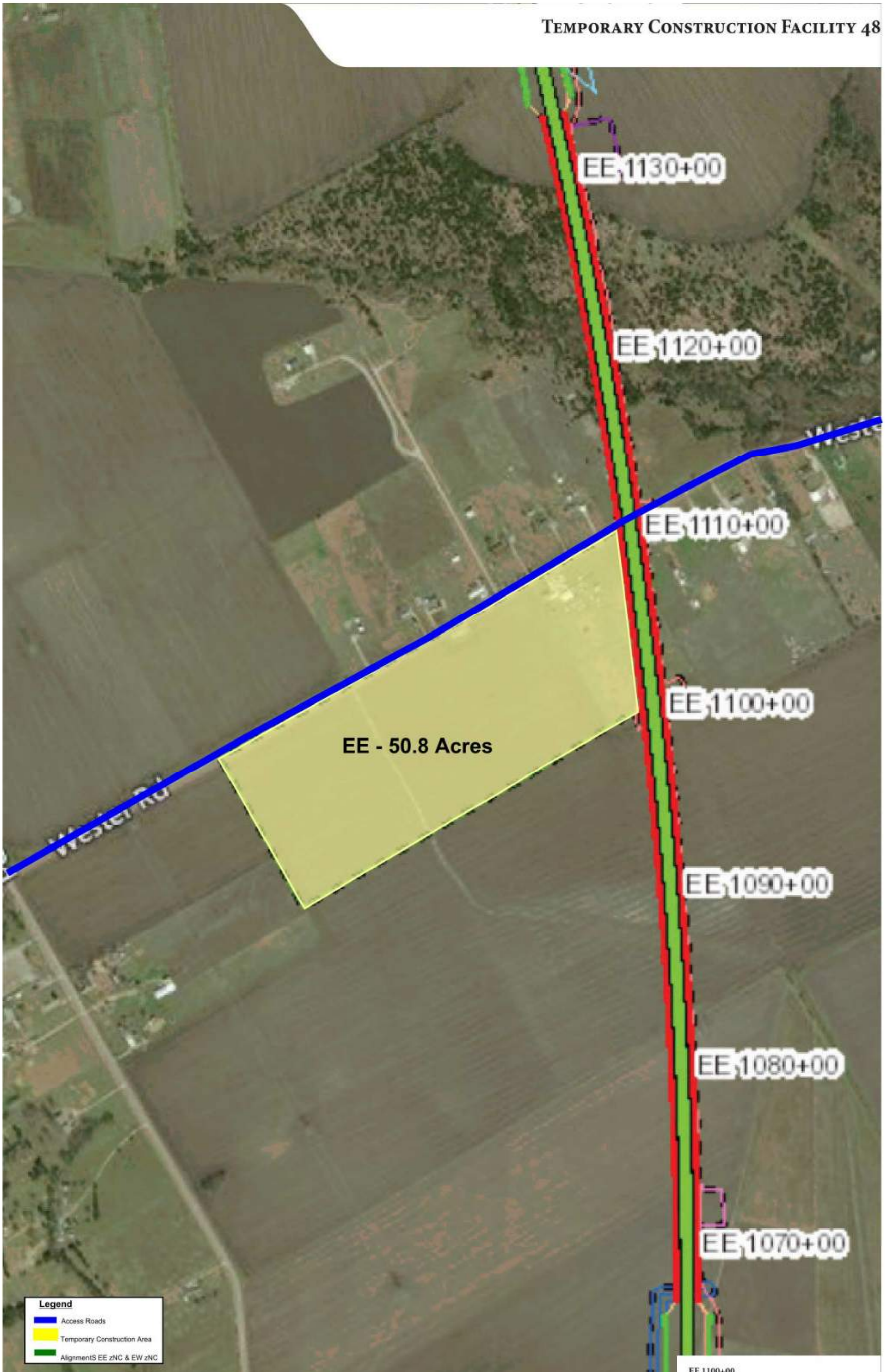

EW 1140+00
EW 1130+00
EW 1120+00
EW - 44.9 Acres
Wester Rd
EW 1110+00
EW 1100+00
EW 1090+00
EW 1080+00
Legend
Access Roads
Temporary Construction Area
AlignmentS EE zNC & EW zNC

EW 1120+00


EE 540+00
EE - 18.8 Acres
EE 530+00
Old Church Rd
EE 520+00
Legend
Access Roads
Temporary Construction Area
AlignmentS EE zNC & EW zNC
EE 530+00

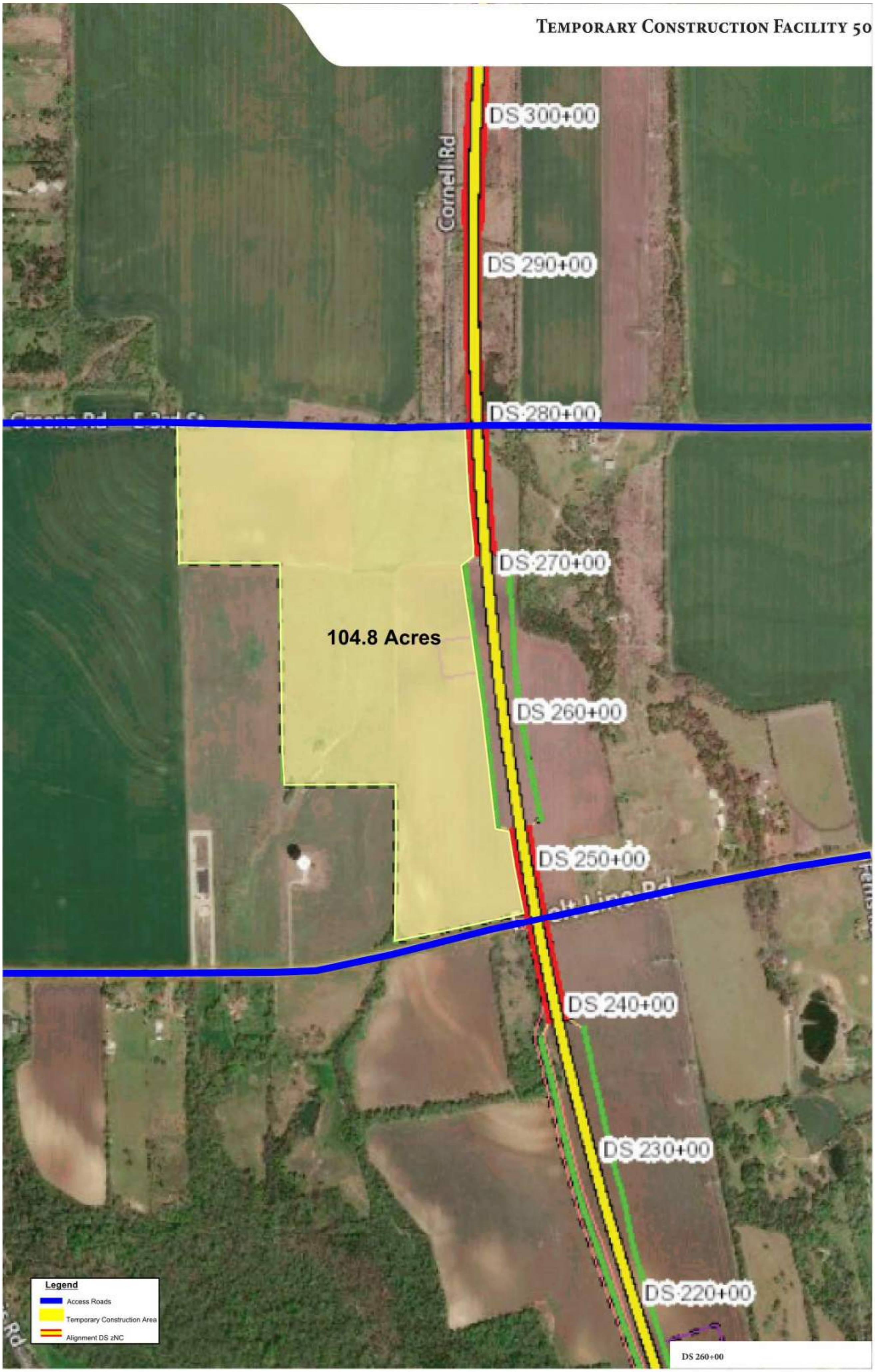


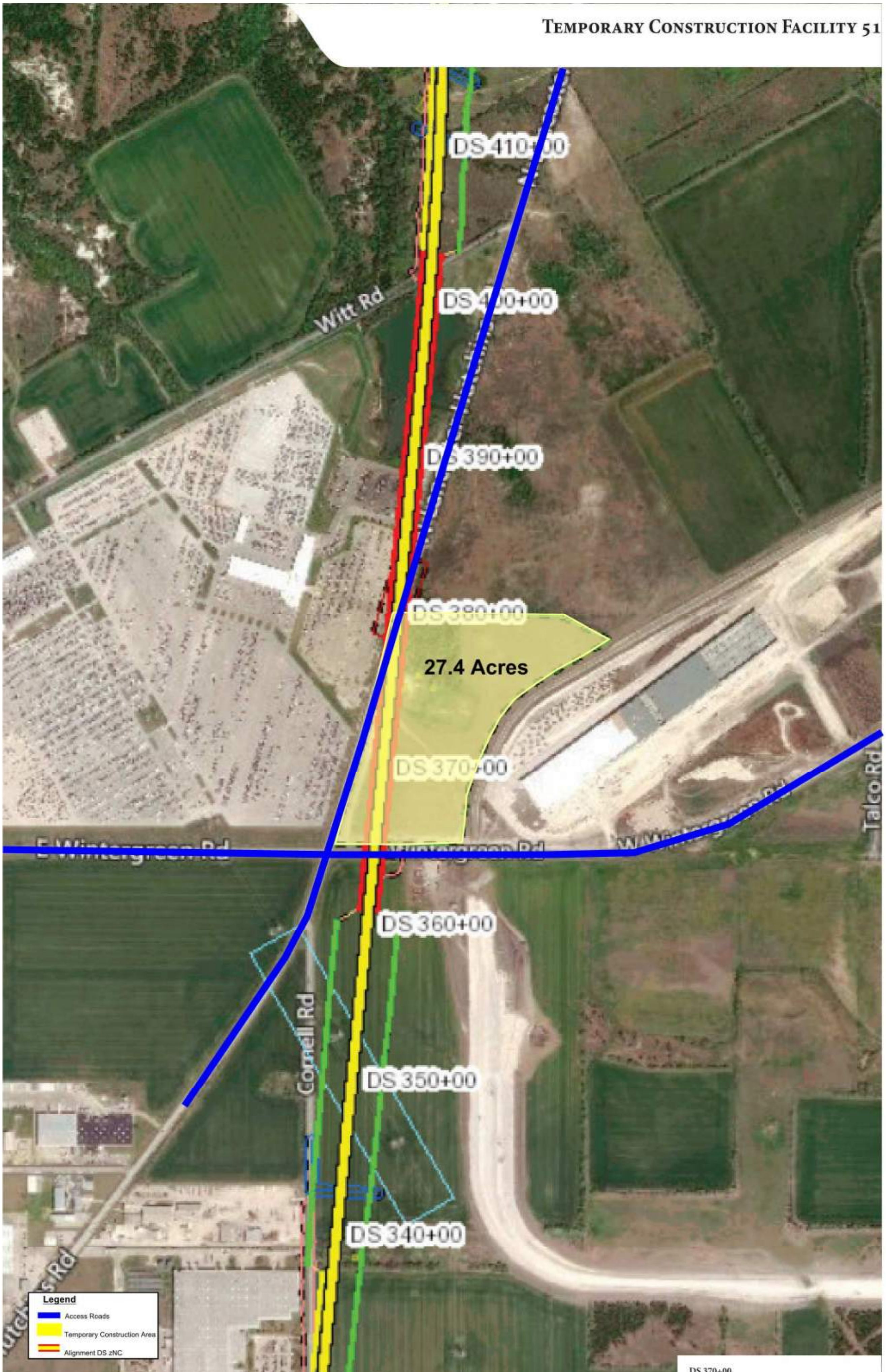
EE 645+00 & EE 660+00


EE 1130+00
EE 1120+00
EE 1110+00
EE 1100+00
EE - 50.8 Acres
Wester Rd
EE 1090+00
EE 1080+00
EE 1070+00
Legend
Access Roads
Temporary Construction Area
AlignmentS EE zNC & EW zNC

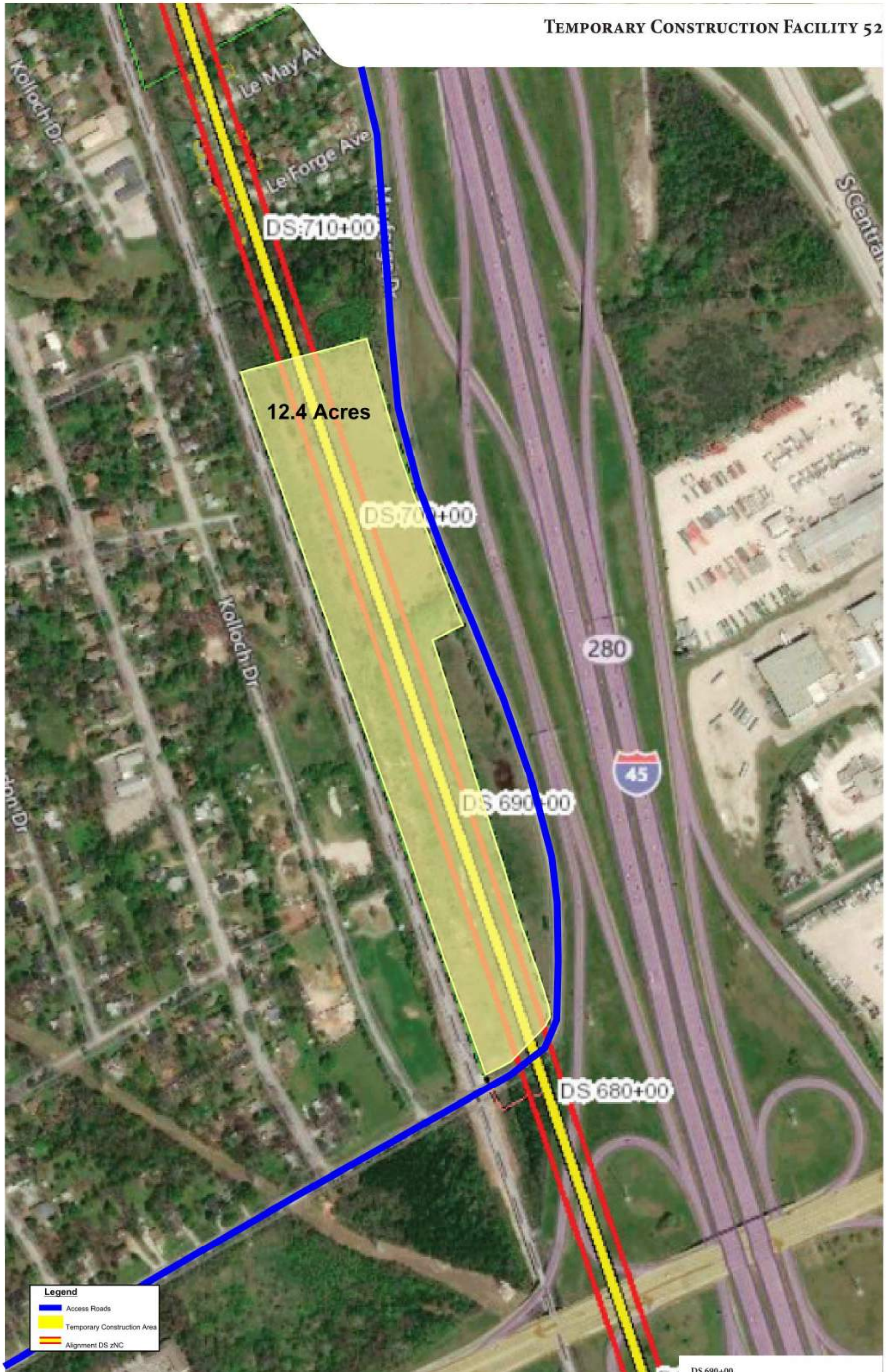

DS 120+00
Lake Trail Dr
DS 110+00
DS 100+00
Raintree Dr
DS 90+00
Stainback Rd
DS 80+00
Nokomis Circle
37.4 Acres
DS 70+00
Stainback Ct
DS 60+00
DS 50+00
Crump Circle
DS 40+00
DS 30
Ovilla Rd
Legend
Access Roads
Temporary Construction Area
Alignment DS zNC

DS 70+00

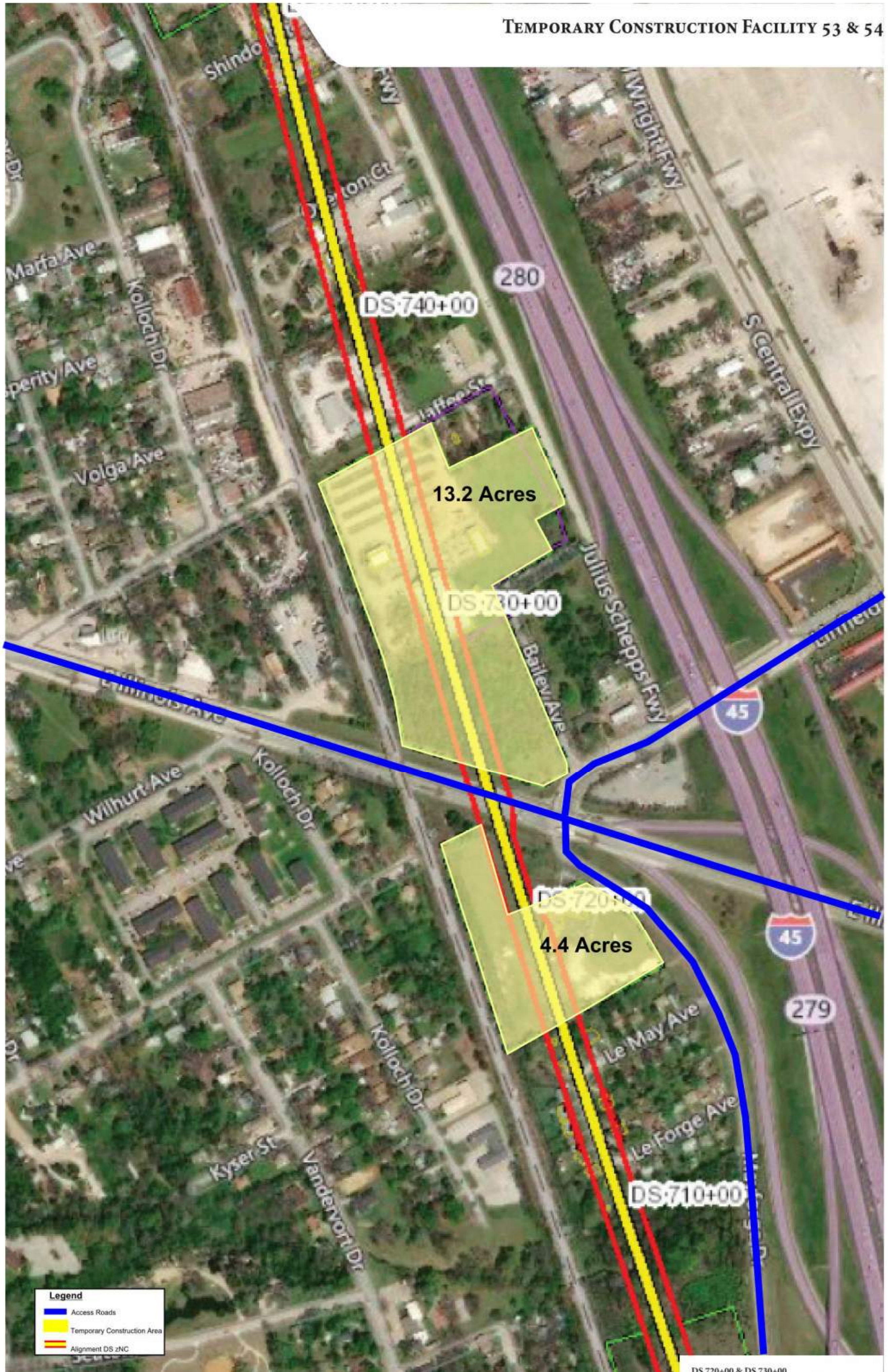

DS 300+00
Cornell Rd
DS 290+00
DS 280+00
DS 270+00
104.8 Acres
DS 260+00
DS 250+00
DS 240+00
DS 230+00
DS 220+00
Legend
Access Roads
Temporary Construction Area
Alignment DS zNC
DS 260+00


DS 410+00
Witt Rd
DS 400+00
DS 390+00
DS 380+00
27.4 Acres
DS 370+00
E Wintergreen Rd
W Wintergreen Rd
Talco Rd
DS 360+00
Cornell Rd
DS 350+00
DS 340+00
Legend
Access Roads
Temporary Construction Area
Alignment DS zNC

DS 370+00


Le May Ave
Le Forge Ave
Kolloch Dr
Kolloch Dr
DS 710+00
12.4 Acres
DS 690+00
280
45
DS 680+00
Legend
Access Roads
Temporary Construction Area
Alignment DS zNC
DS 690+00

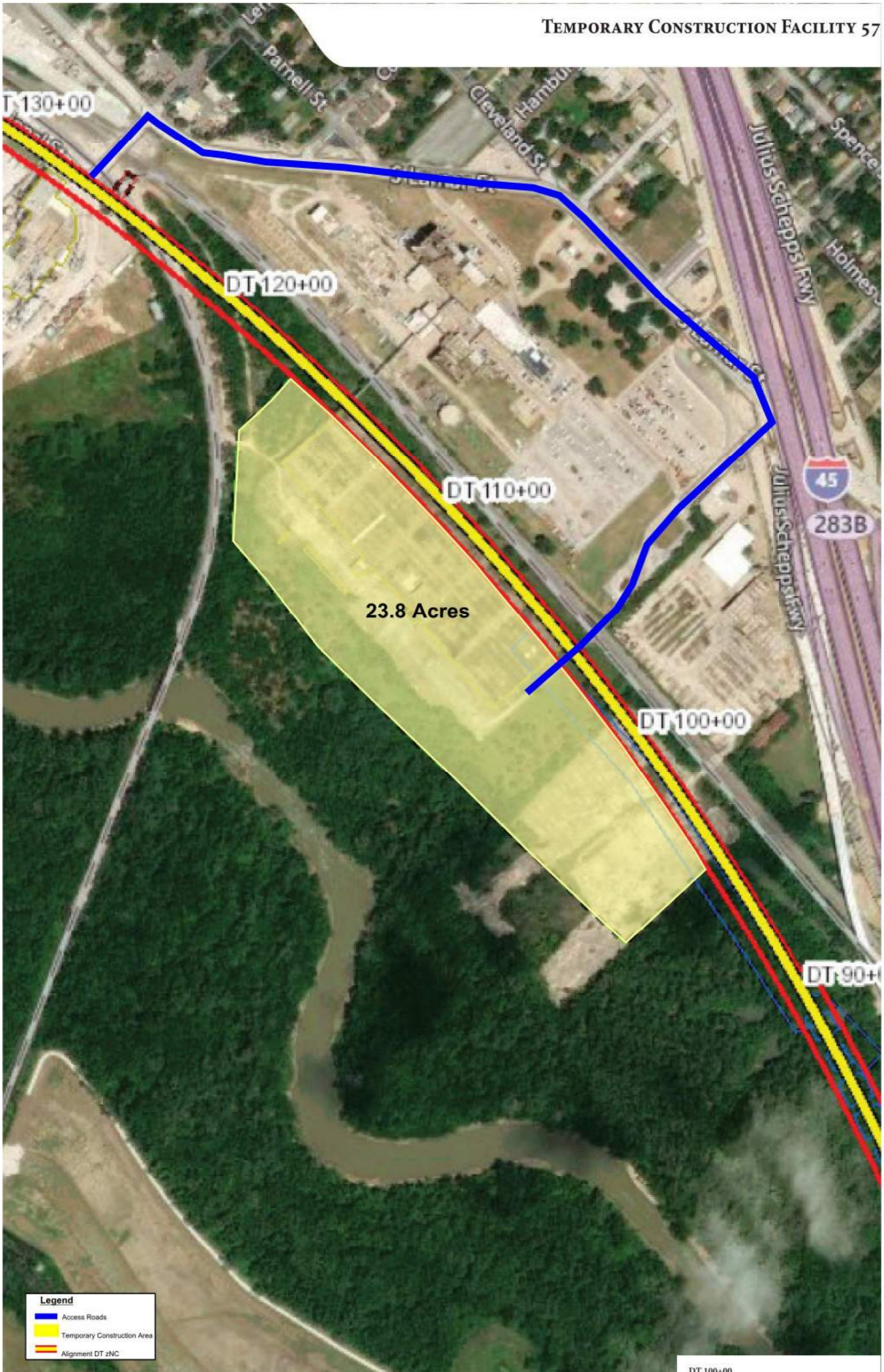
Temporary Construction Facility 53 & 54

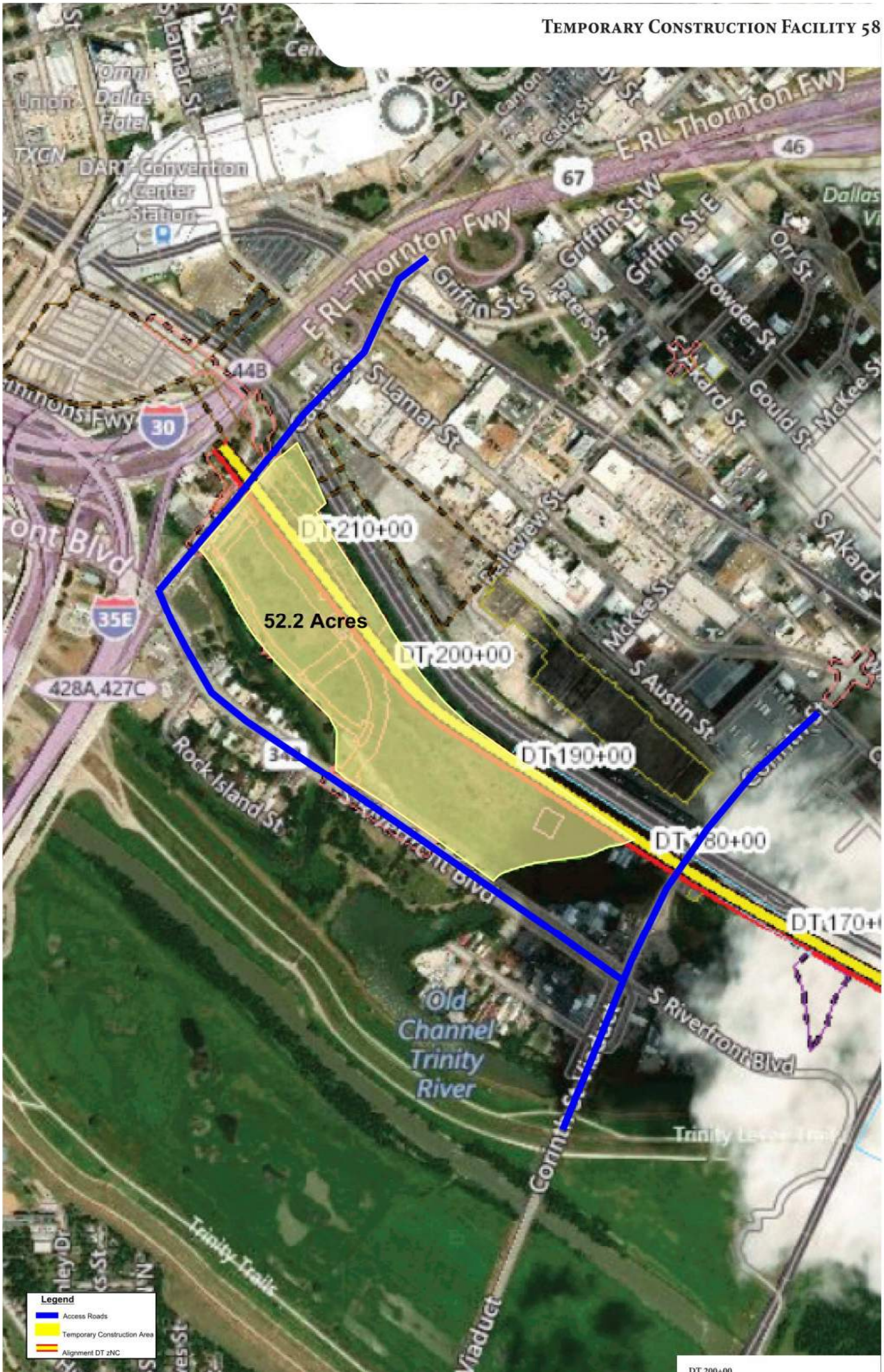


DS 720+00 & DS 730+00

DS 760+00
45
45
Works Ave
3.5 Acres
Arocha Dr
Armor Dr
Overton
Legend
Access Roads
Temporary Construction Area
Alignment DS zNC
DS 760+00


281
45
6.2 Acres
DT 10+00
DS 770+00
DS 760+00
Legend
Access Roads
Temporary Construction Area
Alignment DT zNC

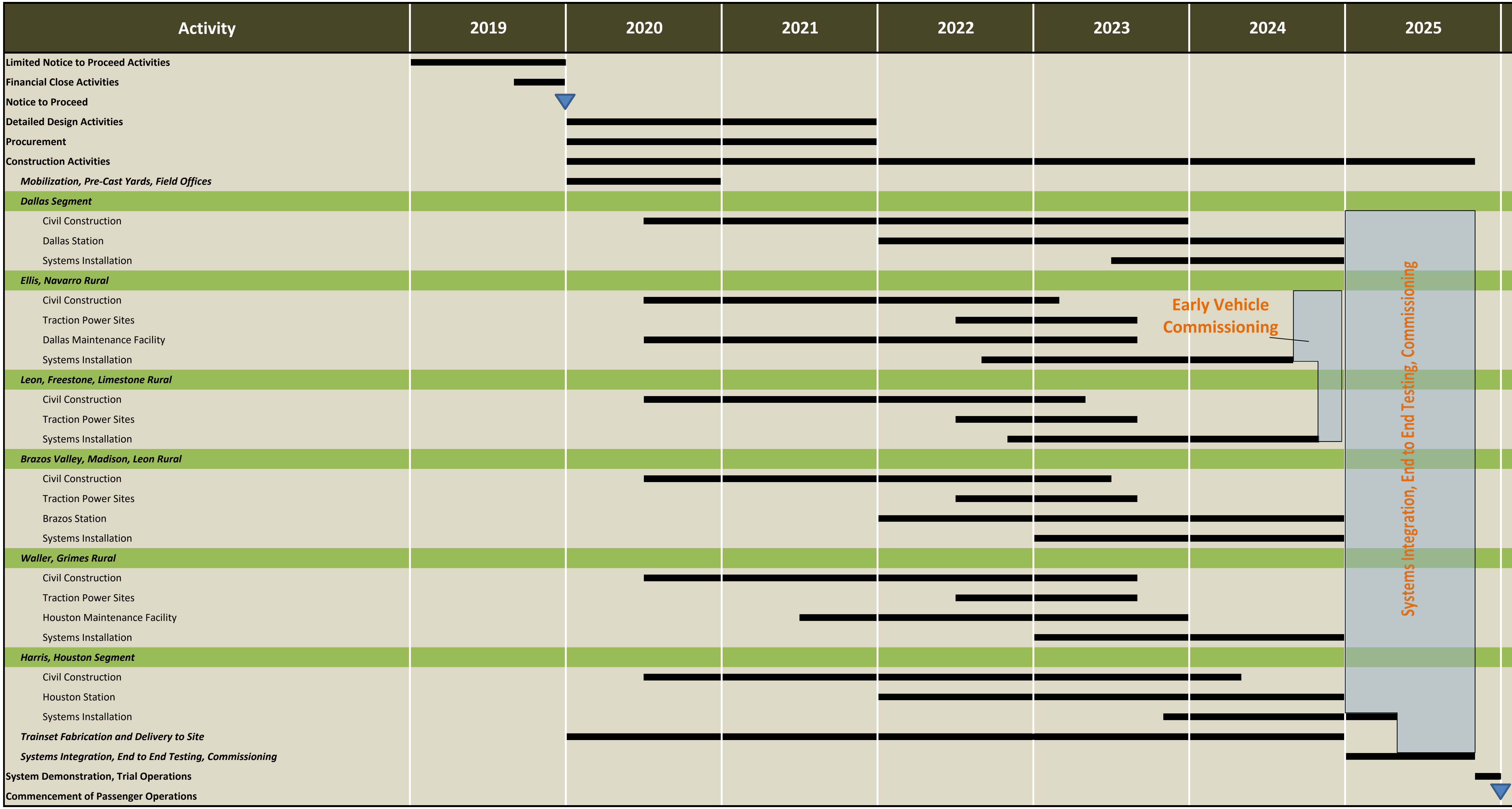

DT 130+00
Parnell St
Cleveland St
Hambu
S Lamar St
Julius Schepps Fwy
Spence
Holmes
DT 120+00
DT 110+00
45
283B
23.8 Acres
Julius Schepps Fwy
DT 100+00
DT 90+
Legend
Access Roads
Temporary Construction Area
Alignment DT zNC


E RL Thornton Fwy
52.2 Acres
DT 210+00
DT 200+00
DT 190+00
DT 170+0
S Lamar St
Griffin St W
Griffin St E
Browder St
Akard St
Gould St
S McKee St
Peters St
S Austin St
McKee St
Rock Island St
S Riverfront Blvd
Old Channel Trinity River
Trinity Trails
Corinth St Viaduct
DART Convention Center Station
Omni Dallas Hotel
Union
TXCN
428A,427C
44B
30
35E
67
46
Legend
Access Roads
Temporary Construction Area
Alignment DT zNC

DT 200+00

Appendix H: Construction Cost Estimate and Schedule

TCRR Summary Schedule



HSR Construction Cost Estimate, June 2019*

Direct Labor Costs (28%)	$2.4B
Direct Materials & Equipment Costs (72%)	$6.3B
Total Direct Costs[1] (61%)	$8.7B
Total Indirect Costs[2] (39%)	$5.6B
Total Civil Infrastructure & Fixed Facilities	**$14.3B +/- $1B**
Systems & Rolling Stock[3]	**$2.5B +/- $0.5B**
Total Construction Cost Estimate	**$16.8B +/- $1.5B**

[1]Includes Labor, Material, Equipment, and Subcontractors to perform the specific civil work items
[2]Includes OH & P, Design Services, Safety, QA/QC, Project Administration, etc.
[3]Includes Signals, Power Distribution, Communications, Train Control, Fare Collection, and Rolling Stock
*Cost estimates are in current year (2019) dollar value.