Geotechnical Data Report

US 550 South Connection to US 160

Durango, Colorado

CDOT Region 5

CDOT Project Code - 22420

Yeh Project No.: 217-376

March 11, 2019

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Yeh and Associates, Inc.
Consulting Engineers & Scientists

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1. PURPOSE AND SCOPE OF STUDY

The Colorado Department of Transportation (CDOT) has proposed to realign a segment of US 550 at its southern intersection with US 160, south of Durango. Yeh and Associates, Inc. (Yeh), as a sub-consultant to Wood, PLC of Denver, Colorado, performed a geotechnical investigation to identify surface and subsurface conditions along the proposed alignment. The purpose of the investigation was to obtain information to be included in this Geotechnical Data Report (GDR), for use in the Design-Build process to construct the proposed roadway alignment.

Planning for the geotechnical investigation was based on the preliminary (Post-FIR) plans provided by CDOT under CDOT Project Code 19378. The subsurface investigation explored conditions at structures shown on the preliminary plans. The Reference Design prepared under CDOT Project Code 22420 changed or eliminated some structures and includes new designations for the proposed retaining walls. This report provides geotechnical data for the preliminary design, presented to address the changes resulting from the Reference Design. Exploratory boring labels throughout the report are consistent with the preliminary plans.

Seventy-four (74) borings and three (3) test pits were drilled/excavated for this investigation within the proposed alignment and at the proposed structure locations. The subsurface exploration was performed between November 2017 and May 2018 within existing CDOT Right-of-Way and on private properties in the proposed project area. Samples of soils and bedrock were recovered from the borings and test pits and returned to the Yeh and Associates Durango and Grand Junction laboratories for testing to classify and evaluate engineering properties of the materials. Selected samples were sent to outside laboratories for specialized testing. A geologic reconnaissance was performed to identify bedrock outcrops, potential landslides and other surface features that could affect the proposed construction.

This report presents the results of the subsurface investigation, including a description of the subsurface conditions encountered and results of the laboratory testing. Logs of the exploratory borings and test pits, site plans showing the locations of subsurface exploration, a geologic map of the area, laboratory test results, photos of recovered core samples and photos of the drilling operations are provided in the appendices. The project site location is shown in Figure 1.

Subsequent to Yeh's completion of the field investigation and laboratory work, CDOT determined that the Design-Build project limits would be extended southward approximately 2.7 miles to connect with the segment of US 550 previously widened near the intersection with La

Plata County Road (CR) 302. A preliminary geotechnical investigation was performed by Yeh in 2008 that included widely spaced borings along this segment. The field and laboratory data for the southern segment has been compiled in a Summary Geotechnical Report that is included in Appendix I of this GDR.

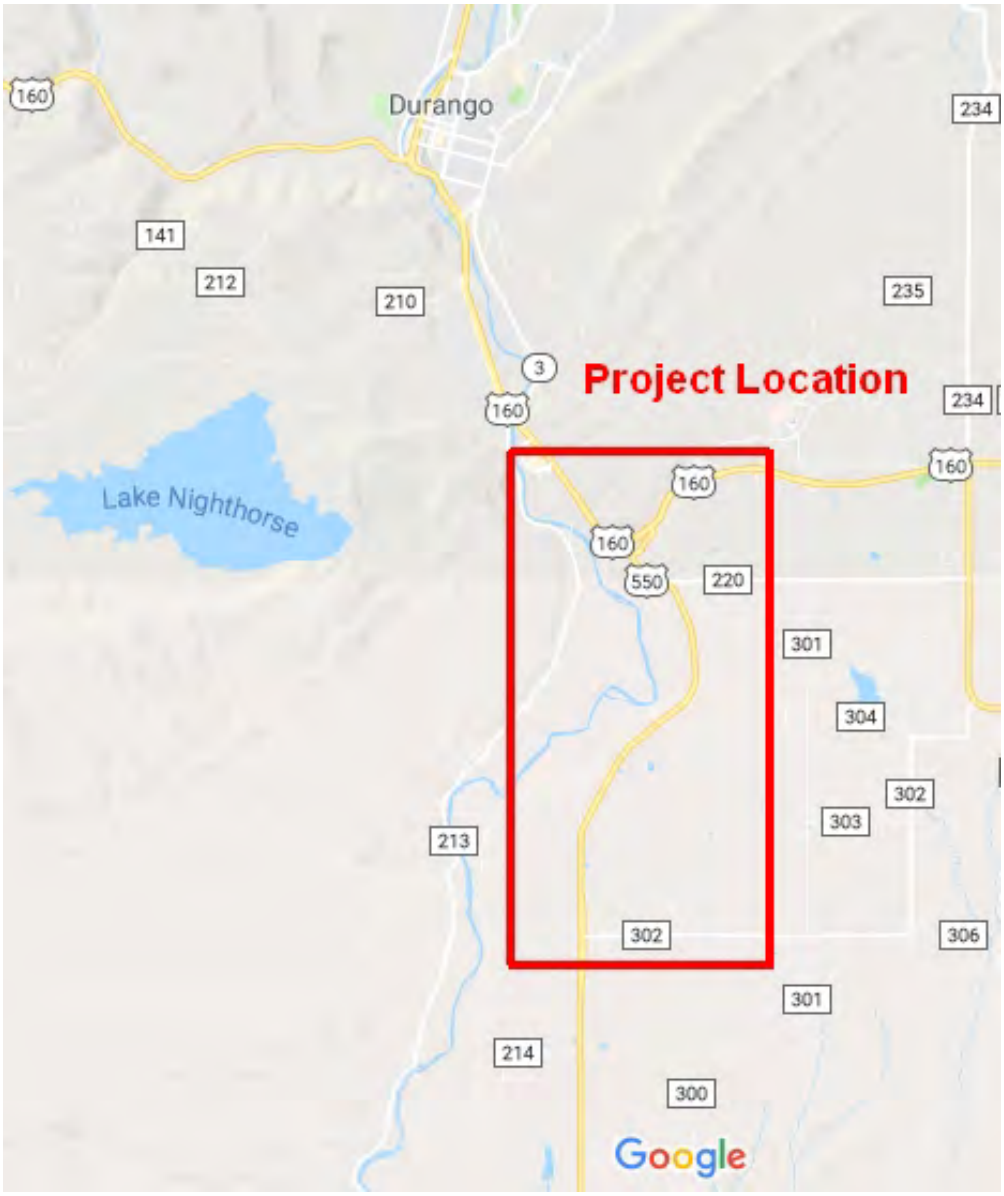


Figure 1 - Project Location Map (Google)

2. PROPOSED CONSTRUCTION

Based on preliminary plans provided by CDOT (Post-FIR dated Dec. 5, 2016, revised January 18, 2019 for the Reference Design), we understand the project will consist of approximately

4.56 miles (24,870 feet) of highway reconstruction and realignment beginning at approximate US 550 Mile Post 12.30 (Station 800+00) at the south and proceeding north to join with an existing bridge (Structure No. P-05-AG) spanning US 160 at approximate Mile Post 16.86 (Station 1040+87). The current two-lane configuration of US 550 will be upgraded to include four lanes with intermittent auxiliary lanes and sections of frontage road for residential and commercial access. Proposed grading consists of relatively shallow cuts and fills of 15 feet or less at the southern end, where the new alignment ties to the existing highway embankment on Florida Mesa, and deep cuts of nearly 150 feet near the north end where the alignment will join the existing bridge in the Wilson Gulch drainage. The proposed realignment of US 550 will transition from a maximum elevation of approximately 6,720 feet on top of the mesa to approximately 6,690 feet at the existing bridge structure P-05-AG.

The realignment of US 550 will incorporate two new bridges: Structure No. P-05-AZ (Bridge 1) and Structure No. P-05-BA (Bridge 2), which cross two unnamed ephemeral drainages that are shown on the plans as Gulches A and B, respectively. Other proposed structures include one wildlife/livestock overpass (Structure No. P-05-BB) and two wildlife underpasses, one of which is located within the Design-Build project extension to the south. As originally conceived, the project would include four cut retaining walls and three fill retaining walls. During preparation of the Reference Design and subsequent to the field investigation and laboratory analysis, two of the cut walls were eliminated. This report provides discussions of all of the walls originally proposed for the preliminary design. Wall locations and designations for the preliminary and Reference designs are summarized in Table 1.

Table 2-1 - Retaining Wall Summary

Wall Designation		Approximate Station			Wall Type
Post-FIR	**Reference Design**	**Begin**	**End**	**Lt. or Rt.**	**Cut or Fill**
A	n/a	1018+85	1023+32	Lt.	Cut
B	D (Shortened)	1019+45	1029+42	Rt.	Cut
C	n/a	1025+14	1029+46	Lt.	Cut
D	E	1039+57	1040+74	Lt.	Fill
E	B	984+50	987+00	Lt.	Fill
F	A	980+00	982+00	Lt.	Fill
G	C	1007+82	1011+25	Rt.	Cut

3. GEOLOGIC SETTING

The project is located in La Plata County, Colorado, along the northwestern margin of the San Juan Basin, a regional geologic structure which extends southward into New Mexico. Along the basin margin, sedimentary bedrock strata strike NE-SW, with a southeast dip due to uplifts associated with the San Juan and La Plata Domes to the north and northwest. The angle of dip flattens southward from Durango, and in the project vicinity dips are mild. Project limits lie within the Loma Linda USGS 7.5-minute quadrangle, at the northwestern corner of Florida Mesa, approximately four miles south of downtown Durango. Surficial deposits above the bedrock consist of terrace alluvium overlain by clayey sand and sandy or silty clay soils, much of which was originally derived from windblown sources.

There is currently no published 7.5 minute geologic map that includes the project site. Yeh has prepared a site specific geologic map depicting the general project area that is provided in Appendix A. Surface and subsurface geology is described in greater detail below.

3.1 Surficial Soils

West of the project, the Colorado Geological Survey (CGS) has mapped surficial soils of the type found in the project area as eolian “Loess,” (Qlo) with an estimated age of late and late middle Pleistocene. The Loess is described as, “Reddish-brown to light-brown sandy silt and silty, very fine sand deposited by wind. Deposits may be slightly clayey.” (CGS, Basin Mountain Quadrangle, 2003). Our investigation revealed that this map unit, Qlo, can also contain zones of gravel which has been washed down from higher terrace levels and comingled with the Loess. Results of the subsurface investigation indicate that the thickness of this surficial soil layer varies with the surface topography, increasing as the ground level rises. The contact with the underlying terrace alluvium tends to be locally a relatively smooth, planar surface.

The channel bottoms of Gulches A and B are covered with unconsolidated alluvium and colluvium (Qac), consisting of clay, silt, sand, gravel, cobbles and boulders that have been eroded from higher ground and deposited into the drainage channels below. There are also thin colluvial soils that mantle the steeper slopes of the gulches and mesa edges. The deposits of thin colluvial soils are laterally discontinuous and were not individually mapped along the steeper slopes. This report uses the term, “hillside colluvium” in reference to this material. The hillside colluvial materials were transported by erosion and gravity and are expected to be less stable over the long term than undisturbed materials. The landslides identified within the project limits and shown on the geologic map in Appendix A appear to be composed of the hillside

colluvial deposits that have slid on the underlying bedrock. Ground movements (landslides) may occur at other locations where the hillside colluvial materials are present on steep slopes with relatively shallow bedrock.

The Natural Resources Conservation Service (NRCS) has designated the soil deposit on top of Florida Mesa the "Falfa clay loam". Areas of this soil type have historically been tapped for agricultural use and tend to be irrigated. Soils on the slopes are described by the NRCS as fine soil mixed with varying amounts of sand, gravel, cobble, and occasional boulders transported by erosion from upper regions of the mesa onto the slopes. Within the project area, these surfaces tend to be vegetated with native pinyon-juniper growth.

3.2 Terrace Alluvium

Underlying the Loess are terrace alluvium deposits, labeled collectively as Qt on the geologic map in Appendix A. The published geologic map for the 7.5-minute quadrangle directly north of the project describes these deposits, Qt_1 through Qt_4, as:

> "Chiefly stream alluvium that underlies several terraces… above the Animas River… The unit is poorly sorted, clast-supported, locally bouldery, pebble, and cobble gravel in a sandy matrix…Clasts are mainly subround to round and are composed of varied lithologies that reflect the diverse rock types in drainage basins." (CGS, Durango East Quadrangle, 1999.)

At a nearby gravel mining operation, the terrace alluvium deposit has been found to include cemented zones which are not easily excavated. Large boulders, approaching 10 cubic yards in size, have also been reported. At some locations, the upper few feet of the alluvium has been infiltrated by fine particles from the overlying Loess deposit.

Within the project limits, there appear to be at least three separate terrace surfaces. At the northern end of the project is a terrace at an elevation of approximately 6820 feet. Between Gulches A and B, the top of the terrace alluvium rises from to 6759 to 6765 feet in elevation. The upper surface of the terrace alluvium south of Gulch A is at an elevation of approximately 6710 feet, and results of our subsurface investigation indicate that the upper surface of this terrace may be generally planar southward toward the intersection with County Road 220.

3.3 Bedrock

The bedrock unit within the project area is mapped as the Tertiary Upper member of the Animas Formation, Ta. Outcrops of the formation are visible on the north- and west-facing cliffs at the edges of Florida Mesa. The Basin Mountain geologic map provides the following description:

> "Olive-brown, light-brown, gray-green, and light-reddish-brown shale, sandstone, conglomerate, and minor lithic tuff, tuffaceous sandstone and thin coal and carbonaceous shale… Conglomerate clasts are chiefly of volcanic origin. Siliceous clasts are more abundant in upper part of member." (CGS, Basin Mountain Quadrangle, 2003.)

The contact with the overlying terrace alluvium is irregular, with significant bedrock surface undulations encountered over relatively short distances.

4. SUBSURFACE INVESTIGATION

Subsurface exploration was performed by drilling at intervals along the alignment (Roadway Borings); where deep excavation is proposed (Excavation Borings); and at proposed structure locations (Structure Borings and Wall Borings). A representative from Yeh obtained necessary access permits, staked the boring locations, arranged underground utility locates at each location, and was on-site to observe drilling operations and log the subsurface conditions encountered in each boring. The locations, total depths drilled, proposed grading and depths to significant subsurface strata are summarized for each boring in Tables 4-1 through 4-10 below. The locations of the borings are shown on the Boring Location Plan and Profile sheets in Appendix B. The subsurface investigation program included of a total of 74 borings. Logs of the borings are provided in Appendix B, Appendix C - Structure Engineering Geology Sheets; and in Appendix D - Legend and Boring Logs. Photographs of drilling operations are provided in Appendix G - Site and Drilling Operations Photos.

Samples of the soils and bedrock encountered were collected from each boring. At selected intervals, a modified California sampler with a 2-inch interior diameter (ID) and 2.5 inch outside diameter (OD), or a standard split spoon sampler with a 1⅜-inch ID and 2 inch OD were used to record blow counts and obtain samples. The sampler was seated at the bottom of the test hole, then advanced by a 140 pound slide hammer falling a distance of 30 inches. The number of blows required to drive the sampler two 6-inch intervals, or fraction thereof, constitutes the N-value. The N-value, when properly evaluated, is an index of the consistency or relative density

of the material tested. Representative bulk samples of the soils were collected from selected borings. The collected samples were transported to our laboratory where they were examined by the project engineer and a program of laboratory testing was prepared.

The steep terrain, heavy vegetation and avoidance requirements for sensitive archeological sites made access to many proposed boring locations difficult. Borings drilled outside the existing Right-of-Way were advanced with All-Terrain, Track-Mounted, and Portable drilling rigs that were set in place by helicopter. Drilling services were provided by two vendors contracted with Yeh and Associates.

Authentic Drilling, Inc. of Colorado Springs, Colorado utilized three drill rigs for the US 550/160 Connection subsurface investigation. An Acker Renegade track mounted drill rig was used for Roadway Boring R-12; Walls A, B, C, E and F; Animal Overpass “A”; and some of the excavation borings. A CME 750X All-Terrain Buggy rig was used for Roadway borings R-01 through R-11, Wildlife Crossing WX (Station 958+00), and some of the Excavation borings. Additional borings at the south abutment of Bridge 1 and Wildlife Crossing WX2 (Sta.902+50) were drilled with a CME 55/300 track mounted drill rig. Each of Authentic’s drill rigs were capable of advancing continuous flight auger, air rotary auger, down-hole hammer (ODEX) drilling, and wire line coring. Each rig was equipped with a calibrated automatic hammer, used to advance driven samplers. The hammer has a weight of 140 pounds, a 30 inch stroke, and operates between 50 and 55 blows per minute

Salisbury and Associates is a drilling company based out of Spokane, Washington, specializing in difficult access drilling. Salisbury utilized two different types of portable drill rigs to drill the geotechnical borings for Bridge 1, Bridge 2, Roadway Boring R-13 and the Wall D boring. All of their drill rigs arrived on site as separate components to be transported by helicopter to locations in steep terrain, then re-assembled for drilling. Each rig was moved between drill locations by Mountain Air Helicopters of Albuquerque, New Mexico. The drill rigs Salisbury used on the US 550/160 Connection project were referred to as a Viper rig and a Burley rig. The Viper is the smaller rig used in steep terrain, and in areas where bedrock was anticipated to be encountered at shallower depths. The auger head rotation is powered by a hydraulic motor and drill casing is advanced manually with a gear reduced crank. The Burley is the larger of the two, and is powered with a 4 cylinder diesel motor. This rig was used at the abutment locations and for Roadway boring R-13. The drilling capabilities of both rigs is coring only. The core barrel is advanced through the overlying soil and gravel and into the bedrock. Salisbury’s rigs are not equipped with an automatic hammer to advance the samplers. On these rigs, the 140-pound

hammer is hoisted manually with a cat-head winch and rope approximately 30 inches and is then allowed to free fall and strike the head of sample rod.

Hollow stem auger was suitable for drilling through the surficial soils. Bulk samples were obtained for laboratory analysis from various depths.

Downhole hammer (ODEX), air-rotary drilling and wire-line coring was needed to penetrate the cobbles, boulders and gravel of the terrace alluvium. Where bedrock was encountered, air-rotary and wire-line coring methods were used to penetrate the interlayered claystone/shale and sandstone of the Animas Formation. Portable drilling rigs placed by helicopter used wire-line coring to drill at bridge foundations locations on steep slopes. Samples were obtained from the auger, ODEX and air-rotary borings at selected intervals.

Continuous core samples were obtained in the bedrock and partial samples of terrace alluvium were obtained from coring operations by the portable rigs. Photographs of the cores collected are provided in Appendix F, Core Photos.

A backhoe was used to excavate test pits into the terrace alluvium at the north end of the project. The purpose of the pits was to obtain bulk samples more representative of the deposit than what can be recovered from relatively small diameter borings.

4.1 Roadway Borings

Thirteen (13) roadway borings were drilled between November 2017 and March 2018 to evaluate subsurface conditions for the proposed pavement subgrade. Borings R-01 through R-06 were drilled within the travel lanes or shoulders of existing US 550. Traffic control, as required by the CDOT access permits, was provided by Alert Traffic Control as a subcontractor to Yeh. Borings R-07 through R-12 were located along the proposed new alignment on the Webb Ranch property where excavation (cut) is proposed to construct the roadway grade. These borings were located south of Bridge 1. Borings R-10 and R-11 were drilled in the far right of the proposed alignment in anticipation of a possible retaining wall at this location. Wall G is proposed for this site and is described later in this report. Boring R-13 was drilled within the area of deep cut proposed north of Bridge 2. The locations, drilled depths, and a summary of the subsurface conditions encountered in the Roadway Borings are provided in Table 4-1.

Table 4-1 - Summary of Roadway Borings

Boring	Station	Offset	Depth of Boring (ft)	Elev. Top of Boring (ft)	Approx. Proposed Fill(F) / Cut(C) (ft)	Depth to Alluvium (ft)	Elev. Top of Alluvium (ft)	Depth to Bedrock (ft)	Elev. Top of Bedrock (ft)
R-01	954+11	69' LT	20.5	6718.8	3 F	n/a	n/a	n/a	n/a
R-02	964+42	88' LT	20.5	6713.4	3 C	n/a	n/a	n/a	n/a
R-03	969+58	85' LT	20.5	6719.1	8 C	n/a	n/a	n/a	n/a
R-04	974+57	30' LT	20.0	6728.5	15 C	n/a	n/a	n/a	n/a
R-05	979+51	103' RT	20.5	6728.3	8 C	n/a	n/a	n/a	n/a
R-06	984+16	55' RT	20.5	6727.5	8 C	n/a	n/a	n/a	n/a
R-07	991+05	48' RT	14.5	6723.9	3 C	13.0	6710.9	n/a	n/a
R-08	995+13	11' LT	21.5	6733.1	11 C	21.0	6712.1	n/a	n/a
R-09	1002+94	27' LT	23.5	6732.0	20 C	22.0	6710.0	n/a	n/a
R-10	1008+72	129' RT	35.0	6732.0	8 C	20.0	6712.0	n/a	n/a
R-11	1009+60	127' RT	35.0	6734.1	5 C	20.0	6714.1	n/a	n/a
R-12	1009+68	19' LT	30.5	6718.0	10 C	5.0	6713.0	n/a	n/a
R-13	1034+32	35' RT	112.6	6824.7	103 C	0	6824.7	61.5	6763.2

4.2 Excavation Borings

Ten (10) borings were drilled to identify subsurface conditions in the area of the deep cut proposed near the north end of the project between Stations 1035+00 and 1039+50, right of centerline. The boring locations were selected to avoid archeologically sensitive zones. Borings E-04 and E-08 were drilled in the existing cut for the CDOT-Knaggs property driveway where bedrock was exposed at the ground surface. The conditions encountered in the Excavation Borings are summarized in Table 4-2.

Table 4-2 - Summary of Excavation Borings

Boring	Station	Offset	Depth of Boring (ft)	Elev. Top of Boring (ft)	Approx. Proposed Cut (ft)	Depth to Alluvium (ft)	Elev. Top of Alluvium (ft)	Depth to Bedrock (ft)	Elev. Top of Bedrock (ft)
E-01	1035+18	195' RT	119.5	6830.7	100	7.0	6823.7	70.0	6760.7
E-02	1036+88	198' RT	148.0	6828.2	90	7.0	6821.2	55.0	6773.2
E-03	1038+62	200' RT	91.0	6837.2	120	12.0	6825.2	45.0	6792.2
E-04	1039+11	172' RT	69.9	6769.5	60	n/a	n/a	0.0	6769.5
E-05	1036+94	257' RT	69.3	6837.6	90	15.0	6822.6	62.0	6775.6
E-06	1037+92	334' RT	103.0	6842.1	70	20.0	6822.1	55.0	6787.1

E-07	1038+90	403' RT	100.0	6840.9	60	18.0	6822.9	38.0	6802.9
E-08	1039+49	307' RT	69.8	6754.2	65	n/a	n/a	0.0	6754.2
E-09	1039+09	485' RT	80.0	6848.8	35	26.0	6822.8	48.0	6800.8
E-10	1039+45	580' RT	76.5	6857.3	8	35.0	6822.3	46.5	6810.8

4.3 Structure P-05-AZ (Bridge 1) Borings

The preliminary layout for Bridge 1 shows a structure approximately 520 feet long, with north and south abutments and three piers. Borings were drilled at each abutment and each pier. The south abutment borings are located in a proposed roadway cut and the north abutment borings are located on the canyon side slope. The material encountered at the ground surface in Borings B1-03 through B1-12 consists of unconsolidated hillside colluvium. Bridge 1 borings are summarized in Table 4-3.

Table 4-3 - Summary of Bridge 1 Borings

Boring	Station	Offset	Depth of Boring (ft)	Elev. Top of Boring (ft)	Approx. Proposed Cut (ft)	Depth to Alluvium (ft)	Elev. Top of Alluvium (ft)	Depth to Bedrock (ft)	Elev. Top of Bedrock (ft)
B1-01B	1013+18	36’ LT	79.1	6733.3	20	16.5	6716.8	66.5	6666.8
B1-02A	1013+38	31’ RT	89.2	6741.0	30	27.0	6714.0	79.0	6662.0
B1-01A	1013+80	17’ RT	122.0	6731.3	17	18.0	6713.3	100.4	6630.9
B1-01	1013+94	24’ LT	106.0	6721.0	9	9.0	6712.0	89.0	6632.0
B1-02	1014+08	29’ RT	101.0	6721.8	7	0	6721.8	88.0	6633.8
B1-03	1014+68	24' RT	48.5	6692.0	n/a	15.0	6677.0	35.0	6657.0
B1-04	1015+09	1' RT	55.0	6659.9	n/a	n/a	n/a	1.5	6658.4
B1-05	1015+39	20' LT	45.0	6639.0	n/a	n/a	n/a	9.0	6630.0
B1-06	1015+60	24' RT	32.7	6649.0	n/a	n/a	n/a	10.3	6638.7
B1-07	1015+72	41' LT	40.0	6620.4	n/a	n/a	n/a	21.0	6599.4
B1-08	1016+11	0'	70.0	6621.4	n/a	n/a	n/a	7.0	6614.4
B1-09	1016+55	0'	70.0	6613.1	n/a	n/a	n/a	5.0	6608.1
B1-10	1017+80	1' LT	70.0	6659.8	n/a	n/a	n/a	6.7	6653.1
B1-11	1019+17	21' LT	70.2	6725.2	n/a	0	6725.2	15.2	6710.0
B1-12	1019+20	25' RT	70.4	6723.2	n/a	0	6723.2	13.0	6710.2

4.4 Structure P-05-BA (Bridge 2) Borings

The Post-FIR plans show Bridge 2 as a two-span structure with an overall length of approximately 240 feet. The abutments are located on the canyon side slopes and the single

pier is located in the bottom of the drainage. Borings B2-01, B2-03 and B2-04 were drilled at the south abutment, pier and north abutment, respectively. Boring B2-02 was drilled on the canyon side slope below the south abutment to investigate subsurface conditions at a suspected landslide. The gravel soils encountered in these borings consist of hillside colluvium deposits. Table 4-4 presents a summary of the Bridge 2 borings.

Table 4-4 - Summary of Bridge 2 Borings

Boring	Station	Offset	Depth of Boring (ft)	Elev. Top of Boring (ft)	Approx. Cut (ft)	Depth to Alluvium (ft)	Elev. Top of Alluvium (ft)	Depth to Bedrock (ft)	Elev. Top of Bedrock (ft)
B2-01	1029+55	3' RT	58.8	6722.0	n/a	n/a	n/a	5.0	6717.0
B2-02	1030+32	0'	70.2	6682.0	n/a	n/a	n/a	7.8	6674.2
B2-03	1030+88	3' LT	69.0	6664.1	n/a	n/a	n/a	4.0	6660.1
B2-04	1032+19	2' RT	69.9	6714.2	n/a	n/a	n/a	7.2	6707.0

4.5 Structure P-05-BB (Wildlife/Livestock Overpass) Borings

This structure has been proposed as an overpass of US 550 where roadway profile plans show a cut of approximately 30 feet deep. The plans show two abutments and a single pier near the US 550 centerline. Borings for Structure P-05-BB are summarized below in Table 4-5.

Table 4-5 - Summary of Wildlife/Livestock Overpass (A) Borings

Boring	Station	Offset	Depth of Boring (ft)	Elev. Top of Boring (ft)	Depth to Alluvium (ft)	Elev. Top of Alluvium (ft)	Depth to Bedrock (ft)	Elev. Top of Bedrock (ft)
A-01	999+53	81’ LT	70.0	6745.8	32.5	6713.3	67.0	6678.8
A-02	999+74	11’ RT	70.5	6742.6	32.0	6710.6	70.3	6672.3
A-03	1000+59	88’ RT	69.5	6743.8	37.0	6706.8	n/a	n/a

4.6 Structures P-05-AS and P-05-AT (Wildlife Underpass A) Borings

This crossing is proposed beneath US 550 at approximate Station 902+00. The proposed structure is assumed to be a CBC or similar construction. The borings are summarized below in Table 4-7. The borings were drilled for the portion of the structure in the southbound lane where access was in CDOT right-of way. Access to the proposed northbound lanes was not available.

Table 4-6 - Summary of Wildlife Underpass A (WX2) Borings

Boring	Station	Offset	Depth of Boring (ft)	Elev. Top of Boring (ft)	Depth to Alluvium (ft)	Elev. Top of Alluvium (ft)	Depth to Bedrock (ft)	Elev. Top of Bedrock (ft)
WX2-01	902+22	60’ LT	34.5	6676.9	23.0	6653.9	n/a	n/a
WX2-02	902+78	61’ LT	38.8	6676.9	23.5	6653.4	35.0	6641.9
WX2-03	902+27	14’ LT	29.5	6670.7	19.0	6651.7	n/a	n/a
WX2-04	902+75	14’ LT	29.5	6670.1	18.0	6652.1	27.0	6643.1

4.7 Structures P-05-AU and P-05-AV (Wildlife Underpass B) Borings

This series of structures has been proposed to cross beneath US 550 and the Frontage Road near the southern end of the project, at approximate Station 958+00. The structures are shown on the Post-FIR plans as a series of three Concrete Box Culverts (CBCs). The borings are summarized in Table 4-6, below.

Table 4-7 - Summary of Wildlife Underpass B (WX) Borings

Boring	Station	Offset	Depth of Boring (ft)	Elev. Top of Boring (ft)	Depth to Alluvium (ft)	Elev. Top of Alluvium (ft)	Depth to Bedrock (ft)	Elev. Top of Bedrock (ft)
WX-01	957+95	71’ RT	31.8	6714.6	30	6684.6	n/a	n/a
WX-02	958+30	4’ RT	45.5	6711.9	28	6683.9	n/a	n/a
WX-03	958+37	69’ LT	35.0	6712.7	28	6684.7	n/a	n/a
WX-04	958+65	153’ LT	34.3	6705.8	22	6683.8	n/a	n/a

4.8 Walls A, B and C Borings

The Post-FIR plans show three walls retaining the proposed deep cut between Gulch A and Gulch B. Walls A and C are located left of centerline and Wall B is located on the right. The walls are intended to retain gravel and claystone/sandstone/shale bedrock materials. Maximum wall heights shown on the Post-FIR plans range from 40 to 67.5 feet. Boring WB-10 did not encounter alluvial gravel but was drilled through slightly gravelly, sandy clay hillside colluvium to encounter bedrock at 4.5 feet. A summary of the borings for Walls A, B and C is presented below in Table 4-8. The Engineering Geology sheet for Wall B (Wall D in the Reference Design) is included in Appendix C.

Table 4-8 - Summary of Walls A, B and C Borings

Boring	Station	Offset	Depth of Boring (ft)	Elev. Top of Boring (ft)	Approx. Cut (ft)	Depth to Alluvium (ft)	Elev. Top of Alluvium (ft)	Depth to Bedrock (ft)	Elev. Top of Bedrock (ft)
WA-01	1019+74	92' LT	64.0	6761.5	42	2.0	6759.5	49.7	6711.8
WA-02	1020+97	86' LT	67.0	6766.5	47	6.0	6760.5	52.0	6714.5
WA-03	1022+07	84' LT	69.6	6765.7	45	3.0	6762.7	52.0	6713.7
WB-01	1020+41	67' RT	69.8	6762.7	43	3.5	6759.2	54.0	6708.7
WB-02	1021+09	96' RT	71.0	6765.0	45	6.5	6758.5	51.5	6713.5
WB-03	1021+81	71' RT	70.0	6771.1	50	11.0	6760.1	54.0	6717.1
WB-04	1023+08	100'RT	70.0	6775.7	56	16.0	6759.7	56.5	6719.2
WB-05	1024+06	82' RT	69.9	6782.0	61	21.0	6761.0	55.0	6727.0
WB-06	1025+09	108' RT	69.0	6787.0	63	24.5	6762.5	56.0	6731.0
WB-07	1026+08	90' RT	69.2	6780.7	58	17.5	6763.2	44.0	6736.7
WB-08	1026+99	93' RT	69.8	6789.2	69	25.0	6764.2	52.0	6737.2
WB-09	1027+88	65' RT	68.2	6790.0	69	25.5	6764.5	49.8	6740.2
WB-10	1029+10	72' RT	50.0	6741.8	23	n/a	n/a	4.5	6737.3
WC-01	1026+24	84' LT	61.8	6766.0	50	1.0	6765.0	33.0	6733.0
WC-02	1027+61	84' LT	53.5	6767.2	49	1.0	6766.2	30.3	6736.9
WC-03	1028+50	74' LT	67.6	6768.6	44	1.5	6767.1	29.0	6739.6

4.9 Walls D, E and F Borings

Wall D has been proposed to retain fill on US 550 near the roundabout at the northern limit of the project. Walls E and F are proposed for retaining the Frontage Road embankment where it abuts two private parcels west of the County Road 220 intersection. Proposed fill wall heights will range from 15 to 20 feet. The Wall D, E and F borings are summarized in Table 4-9. Engineering Geology sheets for Walls D, E and F (Reference Design Walls E, B and A, respectively) are included in Appendix C.

Table 4-9 - Summary of Walls D, E and F Borings

Boring	Station	Offset	Depth of Boring (ft)	Elev. Top of Boring (ft)	Depth to Alluvium (ft)	Elev. Top of Alluvium (ft)	Depth to Bedrock (ft)	Elev. Top of Bedrock (ft)
WD-01	1039+79	94’ LT	39.9	6688.1	n/a	n/a	2.5	6685.6
WE-01	985+25	125’ LT	29.5	6707.6	14.5	6693.1	n/a	n/a
WE-02	985+72	125’ LT	30.5	6706.2	16.0	6690.2	n/a	n/a
WF-01	979+74	214’ LT	33.2	6714.5	24.0	6690.5	n/a	n/a

WF-02	981+74	195' LT	29.3	6706.9	16.0	6690.9	n/a	n/a

4.10 Wall G Borings

Wall G has been proposed to retain a cut slope on US 550 near an existing well pad on the Webb property. The proposed height of the wall is approximately 15 feet, and it is located 75.5 feet right of US 550 centerline. Three Roadway borings were drilled in the vicinity of Wall G and are summarized in Table 10. The Engineering Geology sheet for Wall G (Reference Design Wall C) is included in Appendix C.

Table 4-10 – Summary of Wall G Borings

Boring	Station	Offset	Depth of Boring (ft)	Elev. Top of Boring (ft)	Depth to Alluvium (ft)	Elev. Top of Alluvium (ft)	Depth to Bedrock (ft)	Elev. Top of Bedrock (ft)
R-10	1008+72	129' RT	35.0	6732.0	20.0	6712.0	n/a	n/a
R-11	1009+60	127' RT	35.0	6734.1	20.0	6714.1	n/a	n/a
R-12	1009+68	19' LT	30.5	6718.0	5.0	6713.0	n/a	n/a

5. LABORATORY TESTING

Samples recovered during the subsurface investigation were transported to Yeh's laboratory in Durango, Colorado. The samples and field logs of the borings and pits were reviewed by the Project Engineer and a program of laboratory testing was assigned. Some samples were forwarded to the Yeh and Associates laboratories in Grand Junction and Denver for testing. Specialized testing for soil corrosivity was performed by Green Analytical Laboratories of Durango, Colorado. Unconfined Compressive Strength tests on bedrock and Point Load tests on cobbles were performed by Advanced Terra Testing of Lakewood, Colorado and Trautner Geotech of Durango, Colorado. R-value tests on samples of the proposed subgrade materials were performed by the CDOT Central Laboratory.

The laboratory tests included sieve analysis, Atterberg limits, natural moisture content, dry density, swell / consolidation, unconfined compressive strength, point load strength and Resistance "R"-value. In addition, selected samples were subjected to chemical analyses to evaluate soil corrosivity: pH, water-soluble sulfate, water-soluble chloride and resistivity. The laboratory test results are included in Appendix E and are shown on the boring logs in Appendix D.

Results from the Atterberg limits determination and sieve analysis were used to classify the soils according to AASHTO and the Unified Soil Classification System (USCS) standards. Atterberg limits were performed in accordance with AASHTO T89 and T90, and sieve analyses were performed in accordance with ASTM D421. Soil classifications are shown on the boring logs in Appendix D and on the summaries in Appendix E.

The moisture content and density of a soil can be useful for characterizing soil consistency, compressibility, and strength. Dry density tests and moisture content tests were performed in accordance with ASTM D2937 and ASTM D2216, respectively.

Twenty (20) swell/consolidation tests were performed to determine the swell or collapse potential of selected samples of the subsurface materials in accordance with ASTM D4546 Procedure B. The swell was measured by applying a surcharge of either 200 pounds per square foot (psf), 500 psf or 1,000 psf to the samples and adding water. Table C-3 in Appendix E presents a summary of the swell/consolidation test results. The test results are also shown on the applicable boring logs in Appendix D, and graphical results of the swell/consolidation tests are presented in Appendix E.

Unconfined compressive strength tests were conducted on 21 rock core samples by Advanced Terra Testing (ATT) of Denver, Colorado. Trautner Geotech of Durango tested the unconfined compressive strength of three (3) core samples. The tests were performed in conformance with ASTM D7012, Method C. ATT also conducted point-load strength testing on ten cobbles collected from the terrace alluvium test pits. Unconfined compressive strength and Point Load test results are provided in Appendix E.

Resistance “R”-value tests were performed by the CDOT Central Laboratory on bulk samples representative of the surficial soils. Appendix E presents the R-value test results as well as their corresponding AASHTO soil classifications. The test results were provided by CDOT.

Water-soluble chloride measurements were performed by Green Analytical Laboratories, Inc. on 28 samples obtained from the borings. The test results are summarized in Appendix E and presented on applicable boring logs in Appendix D.

6. SUBSURFACE CONDITIONS

Subsurface conditions along the proposed alignment generally consist of 0 to 37 feet of surficial soil – eolian Loess (Qlo) or hillside colluvium (unmapped) overlying cobble-rich terrace alluvium

(Qt). Where borings penetrated the full depth of the alluvium, the deposit was found to range in thickness from 5 to 88 feet. Beneath the alluvium lies the claystone and interbedded shale, sandstone and conglomerate of the Upper member of the Animas Formation (Ta). Upper portions of the bedrock tended to be moderately to severely weathered, while at depth the rock was hard to very hard and unweathered. No groundwater was reported on the logs for any of the borings. Because water was used as a drilling fluid, reliable measurements of groundwater levels could not be obtained.

The US 550 project is divided into segments for the sake of discussion of the subsurface conditions. The segment limits roughly correlate to the proposed depth of excavation or structure type and location. Subsurface conditions within each roadway segment are discussed first below, followed by structures. Logs of the exploratory borings are presented in Appendix D. Engineering Geology plan sheets for each major structure are provided in Appendix C. A discussion of the subsurface conditions between station 800+00 and 940+00 is provided in the Summary Report in Appendix I.

6.1 Sta. 940+00 to Sta. 991+00 – Beginning of Connection Alignment to Webb Ranch Boundary

The soils beneath the existing US 550 consist of the Quaternary Loess / Falfa clay loam deposit or clayey gravel fill throughout this section. Borings R-01 through R-05 were drilled through the existing asphalt pavement and base course, while Boring R-06 was located adjacent to the pavement, on the gravel shoulder. Each boring was drilled to a depth of 20.5 feet below the surface, and none encountered the underlying terrace alluvium layer. Penetration Resistance N values in the surficial soils ranged from 8 to 33 blows per foot (bpf), with an average of 19 bpf.

Seven samples of surficial soil were tested for purposes of classification. Gradation test results show the soils have 72 to 87 percent fines (passing the No. 200 standard sieve) with the remaining percentage as sand. Atterberg Limits testing showed Liquid Limits (LL) between 31 and 46 percent and a Plasticity Index (PI) of 15 to 27 percent. Under the AASHTO system, six samples were classified as A-6, with group indices ranging from (9) to (17). One sample from Boring R-04 was classified as A-7-6 (20). All seven samples fell within the Unified Soil Classification System (USCS) classification CL, Lean Clay.

Four soil specimens were collected using a modified California sampler. These were found to have natural moisture contents between 11.9 and 18.1 percent and natural dry densities ranging

from 107.5 to 117.9 pounds per cubic foot (pcf). Swell/consolidation results for these four samples ranged from +0.4 percent (swell) to +3.9 percent (swell).

Chemical properties were evaluated for five soil samples to provide data useful in evaluating soil corrosivity. The pH was slightly alkaline, ranging from 7.6 to 8.8. Water-soluble sulfate was measured for each of the five samples and ranged from 0.002 to 0.020 percent. Water-soluble chloride was detected, with concentrations ranging from 0.00164 to 0.10600 percent, while resistivity values ranged between 340 and 3000 Ohm-cm. The bulk sample from Boring R-06, at 4 to 9 feet depth, had the lowest pH and resistivity and highest sulfate and chloride readings of the four samples tested.

Bulk samples for Hveem Resistance R-value testing were obtained at approximate subgrade depth from Borings R-01 and R-05. The samples were delivered to CDOT for testing and the results are presented in Appendix E. The reported R-value for the surficial soils from Boring R-01 is 10 and from Boring R-05 is 22.

6.2 Sta. 991+00 to Sta. 1014+23 –Webb Ranch Boundary to Gulch A

The proposed US 550/160 Connection alignment diverges from existing CDOT Right-of Way in this section, entering a segment where proposed grading consists of continuous cut as it crosses the Webb Ranch boundary to approach the south side of Gulch A. The mesa surface is capped with the surficial soil throughout this portion of the project. Borings R-07 through R-12 were drilled within this section, to depths ranging from 14.5 to 35 feet. The terrace alluvium deposit was encountered beneath the overlying loess in each of these borings. The depth to alluvial materials ranged from 22 feet at Boring R-09 to just 5 feet at Boring R-12.

Subsurface conditions encountered below the proposed depth of cut indicate that the subgrade soil along the proposed highway alignment will be the surficial sandy clay soil until approximate Station 1000+00, at which point the Reference Design profile grade descends into the terrace alluvium deposit. Bedrock was not encountered in any of the borings for this segment, and bedrock is not expected in the proposed excavation for the roadway in this section.

Penetration resistance N values in the surficial soils ranged from 14 to 40 bpf, with an average of 25 bpf. Penetration resistance in the terrace alluvium was high due to the significant component of coarse materials – gravel, cobbles, and boulders. N values greater than 70 bpf were recorded, but the majority of drive sampling using the split spoon or modified California

samplers advanced only a few inches before refusal was encountered, prohibiting further advancement of the sampler.

Six bulk samples of surficial soil were tested for purposes of classification. Gradation test results show the soils have 34 to 85 percent fines (passing the No. 200 standard sieve) with the remaining percentage as sand and trace amounts of gravel. The soil samples generally become more coarse proceeding north along the alignment, with the measured Plasticity Index also decreasing. AASHTO classifications of the sandy loess ranged from A-7-6 (18) at Boring R-07 to A-2-4 (0) at Boring R-10 and A-4 (0) at Boring R-11. A similar transition was observed in the USCS classifications, with sandy clay (CL) in the south and non-plastic silty sand (SM) to low plasticity silty, clayey sand (SM-SC) further north.

Four relatively undisturbed samples of surficial soil were recovered using a modified California sampler. These samples were found to have natural moisture contents between 8.9 and 13.6 percent and natural dry densities ranging from 93.6 to 107.0 pcf. Swell/consolidation test results for two samples ranged from -1.8 percent (consolidation) to +1.1 percent (swell).

Chemical properties were evaluated for three surficial soil and two alluvium samples. The clayey surficial soil had a slightly alkaline pH, ranging from 8.2 to 8.8. Samples of the alluvial layer had measured pH values of 8.5 and 8.6. Water-soluble sulfate was measured for each of the five samples and ranged from 0.007 to 0.027 percent for the surficial soil and 0.014 to 0.019 percent for the alluvium. Water-soluble chloride was detected in two of the surficial soil samples, with concentrations of 0.00534 and 0.00647 percent. Values of 0.00118 and 0.00576 percent were reported for the alluvium. Resistivity values ranged from 1300 to 2800 Ohm-cm for the surficial soil and 1600 to 2700 Ohm-cm in the alluvium.

Samples of soils from the proposed subgrade depth were provided to CDOT for R-value testing. R-value results are presented in Appendix E and ranged from 9 to 22.

6.3 Sta. 1032+05 to Sta. 1040+87 – Gulch B to End of Project

North of Gulch B (Bridge 2) the ground surface elevation rises and the proposed roadway grading will be a cut with a maximum depth of approximately 100 feet. Boring R-13 was drilled 35 feet right of Sta. 1034+32 to a depth of 113 feet. Borings E-01 through E-10 were located from 172 to 580 feet right of centerline between Stations 1035+18 and 1039+45. Depths of these borings ranged from 69 to 148 feet. Test Pits 1, 2 and 3 were excavated on the CDOT-

Knaggs property, at the north end of this segment, for the purpose of obtaining representative bulk samples of the terrace alluvium deposit that could not be recovered from borings.

The surficial soil layer for this segment, a combination of loess and hillside colluvium, ranges in thickness from 6.5 feet to 35 feet, except at Borings E-04 and E-08, where previous excavation for a driveway exposed the bedrock at the ground surface. The thickness of the terrace alluvium deposit ranged from 11.5 feet to 63 feet, with the thinner deposit near the top of the proposed cut. Depth to bedrock encountered in the borings (other than Borings E-04 and E-08) ranged from 38 feet to 70 feet. The contact between the surficial soil and the alluvial deposit appears to be roughly planar throughout this excavation area. The top surface of the bedrock appears to gradually rise from southwest to northeast, gaining an estimated 50 feet in elevation from Gulch B to the End of Project near Station 1039+50.

Penetration resistance N values in the surficial soils ranged from 15 to 73 bpf, with an average of 32 bpf. Penetration resistance in the terrace alluvium was generally high due to the significant component of coarse materials – gravel, cobbles, and boulders. N values of 40 to 60 bpf were recorded, but the majority of drives made using the split spoon or modified California samplers advanced only a few inches before refusal was encountered, prohibiting further advancement of the samplers.

Five bulk samples of surficial soil were tested to determine soil classification. Gradation test results show the soils have 68 to 84 percent fines (passing the No. 200 standard sieve) with the remaining percentage as sand and trace amounts of gravel. Four of the five samples had AASHTO classifications of A-7-6, with group indices ranging from (23) to (45). One sample was classified as A-6 (9). Using the USCS method, three samples were classified as CH, high-plasticity clay, and the remaining two were CL, low-plasticity or lean clay. The Liquid Limit (LL) of the tested samples ranged from 30 to 72 percent, and the Plasticity Index (PI) ranged from 17 to 50 percent. An ODEX bit was used to advance the borings through the alluvium. As a result, the recovered samples were not suitable for classification purposes because the drilling process caused loss of fines and fragmented larger particles. Sieve analyses were performed on samples of the alluvium from the test pits. The AASHTO classifications are A-1-a (0) and A-1-b (0), and USCS results are GP and GM. Samples of the Animas Formation Bedrock were pulverized to measure plasticity index. The bedrock had Liquid Limit values of 28 to 38 percent and Plasticity Index was found to range from 2 to 17 percent.

Four specimens of surficial soil were collected using a modified California sampler. These were found to have natural moisture contents between 7.9 and 20.4 percent and natural dry densities ranging from 88.3 to 112.5 pcf. Results of swell/consolidation testing on the one sample tested showed -1.7 percent (consolidation). Moisture content of the Animas Formation bedrock ranged from 3.8 to 12.7 percent and dry density of bedrock core samples ranged from 98.7 to 149.1 pcf.

Chemical properties were evaluated for one alluvium and five bedrock samples. The alluvium sample from E-06 had a pH of 8.6 and water-soluble sulfate of 0.007 percent. Water-soluble chlorides of 0.00196 percent were detected, and the resistivity was 4,000 Ohm-cm. The pH values for bedrock ranged from 8.4 to 9.4. Water-soluble sulfate was measured for four of the five bedrock samples and ranged from 0.002 to 0.015 percent. No water-soluble chloride was detected in the bedrock samples. Resistivity values ranged from 1,400 to 2,000 Ohm-cm.

Nine bedrock core samples were selected from these borings for testing of unconfined compressive strength. Measured values ranged from 1,122 to 7,021 psi.

A sample of alluvium from Test Pit 3 was tested by CDOT and found to have an R-value of 79. CDOT also tested a sample of crushed shale bedrock core from Boring E-02 and reported an R-value of 28. The test results are included in Appendix E.

6.4 Sta. 1014+23 to Sta. 1019+00 – Gulch A Bridge Structure P-05-AZ (Bridge 1)

This proposed bridge across Gulch A, will have a total length of approximately 520 feet, and will be a four span structure with 2 abutments and 3 piers. The proposed roadway profile will require cuts to depths ranging from approximately 25 to 40 feet at the abutments.

Fifteen (15) borings were drilled to investigate subsurface conditions at Bridge 1. Subsurface conditions encountered in the borings generally consist of 5 to 20 feet of clayey sand soil (loess) or clayey sand and gravel (alluvium and hillside colluvium) over dense alluvial terrace gravel or claystone/shale bedrock.

Borings B1-01 and B1-02 were drilled at the planned location of Abutment 1 and encountered bedrock at depths of 89 and 88 feet, respectively. The immediate area has been mapped as a landslide, and the bedrock surface elevation is, in general, lower in these borings than in borings made nearby. Boring B1-01A was drilled south of the abutment in an effort to identify the lateral extent of the deeper bedrock. Bedrock was encountered in Boring B1-01A at a depth of approximately 100 feet. Two additional borings were drilled approximately 80 feet south of the

proposed abutment. The depth to bedrock was 50 and 52 feet at Borings B1-1B and B1-2A, respectively. Borings B1-1B and B1-2A encountered clayey surficial soils overlying terrace alluvium that appears to be unaltered by recent erosion. These in-place alluvial materials appear to be outside the landslide extents. Irregular erosion of the bedrock near the proposed location of Abutment 1 may have resulted in a bedrock surface depression that was subsequently infilled with a mixture of clayey soils and terrace deposits that contains cobbles and boulders (hillside colluvium). The hillside colluvium materials, transported by erosion and gravity from their original alluvial deposit, may be less stable in the long term than the undisturbed alluvium.

The landslide identified on the Geologic Map near Abutment 1, and shown on the Engineering Geology sheet, appears to consist of hillside colluvium materials and possibly underlying weathered and fractured bedrock that are slowly moving down the slope. Inclinometers were installed in Borings B1-03, B1-05, B1-06 and B1-07 to measure the rate, direction and depth of slope movement. Data collection from the instrumentation began in early April 2018 and minor movement of less than 0.25 inches had been observed in some of the inclinometers as of December 21, 2018. Inclinometer data is provided in Appendix H. Positive movement shown on the “A” axis plot indicates downhill movement of the slide mass. The upper portion of the materials that form the landslide is expected to be removed during grading for the roadway. The removal may reduce the potential for landslide activation by decreasing the forces that drive movement.

Borings B1-05, B1-06, B1-09 and B1-10 were drilled at proposed pier locations for Bridge 1. These borings encountered approximately 5 to 10 feet of sandy gravel hillside colluvial deposits over highly weathered to unweathered bedrock. The bedrock consists of claystone, sandstone and interbedded claystone/sandstone/shale. Generally, the upper 20 to 30 feet of the bedrock is weathered or weak and should be considered an Intermediate Geo Material (IGM) as defined in the American Association of State Highway and Transportation Officials (AASHTO) LRFD Bridge Design Specifications (AASHTO Specifications). Below the IGM, bedrock consists of hard sandstone and shale. Unconfined compressive strengths of samples from the IGM ranged from 1,072 psi to 1,405 psi. The unconfined compressive strength of samples from the hard sandstone and shale ranged from 2,843 psi to 5,496 psi.

Subsurface conditions at the proposed location of Abutment 5 were investigated by drilling Borings B1-11 and B1-12. The conditions encountered below about 5 feet of hillside colluvium deposit (gravel in a sandy clay matrix, cobbles and boulders) consist of medium dense to dense

terrace alluvium (gravel in a silty sand matrix, cobbles and scattered boulders). Interbedded sandstone and claystone bedrock was encountered below the terrace alluvium at depths ranging from 13 to 15 feet.

6.5 Sta. 1029+68 to Sta. 1032+05 – Gulch B Bridge Structure P-05-BA (Bridge 2)

The proposed Bridge 2, across Gulch B, is a two-span structure with a total length of 264 feet. The bridge will have two abutments and a single center pier. The roadway profile shows the cut depths below existing ground at the approaches ranges from approximately 30 to 40 feet.

The subsurface conditions at Bridge 2 were investigated by drilling four (4) borings: Boring B2-01 at Abutment 1, Boring B2-03 at Pier 2, Boring B2-04 at Abutment 3 and Boring B2-02 on the slope below Abutment 1. The subsurface conditions encountered in the borings generally consisted of about 4 to 8 feet of hillside colluvium deposits of sandy clay soil or sand and gravel, overlying moderately weathered to hard claystone, sandstone and shale of the Animas Formation. The boring locations and logs are shown on the Engineering Geology plan sheet found in Appendix C.

A potential landslide was identified at the location of Abutment 1 as shown on the Geologic Map in Appendix A. The landslide consists of the hillside colluvial deposits encountered at Abutment 1 and in Boring B2-02. The proposed cut for the roadway at this location will effectively remove most of the upper portion of this landslide feature, thereby reducing forces that drive movement and improving the long term stability of this slope. Landslides are also shown on the Geologic Map west of Abutment 3. These features appear to be shallow soil slips of hillside colluvium on the bedrock surface, that can move following seasonal heavy precipitation events or snowmelt runoff.

Unconfined compressive strengths were measured on rock core samples collected at various depths from two of the four borings. Test results show strengths ranging from 2,230 to 5,400 psi.

6.6 Sta 1000+00 – Wildlife/Livestock Crossing Structure P-05-BB

The proposed bridge crosses over the planned realignment of US 550 in the vicinity of Station 1000+00. Post-FIR plans dated December 5, 2016 indicate the bridge will be 207 feet in length with two spans, having abutments at each end and a center pier. The cross-section plans show that US 550 at this location will be in a cut approximately 30 feet in depth. The top of the bridge deck at the abutments will be at or near the existing ground surface.

Subsurface conditions for this structure were investigated by drilling three (3) borings. Boring A-01 was drilled at Abutment 1, Boring A-02 was located at Pier 2, and Boring A-03 was drilled at Abutment 3. The borings encountered 32 to 37 feet of surficial soil; near the base of this layer, the material became more sandy. The surficial soil is underlain by the terrace alluvium deposit. Claystone bedrock was encountered beneath the alluvium in Boring A-01 at a depth of 67 feet and in Boring A-02 at 70 feet. Boring locations and logs are shown on the Engineering Geology sheet provided in Appendix C.

Penetration Resistance N values in the surficial soils ranged from 19 to 53 blows per foot (bpf), with an average of 35 bpf. Penetration resistance in the terrace alluvium was high, as expected, due to the significant component of gravel, cobbles, and boulders. N values greater than 33 bpf were recorded, but the majority of drive sampling using the split spoon or modified California samplers advanced only a few inches before refusal was encountered, prohibiting further advancement of the sampler.

Seven samples of surficial soil were tested in the laboratory for purposes of classification. Gradation test results show the soils have 24 to 89 percent fines (passing the No. 200 standard sieve) with the remaining percentage as sand. Atterberg Limits testing produced Liquid Limits (LL) results between 26 and 43 percent and Plasticity Index (PI) results of 4 to 23 percent. One sample from Boring A-02 was non-plastic. Under the AASHTO system, two samples were classified as A-7-6, with group indices of (17) to (18); two samples were classified as A-6, with group indices of (14) and (18), and one sample was classified as A-4 (5). Each of these five samples fell within the Unified Soil Classification System (USCS) classification CL, Lean Clay. The remaining two samples were collected nearer the base of the surficial soil layer, where the sand content is greater. These samples were classified as A-2-4 (0) and A-4 (0), with a USCS classification of SM, Silty Sand.

Four soil samples collected using a modified California sampler were selected for laboratory testing. These were found to have natural moisture contents between 8.7 and 13.1 percent and natural dry densities ranging from 85.2 to 113.0 pounds per cubic foot (pcf). Swell/consolidation results for one sample tested, at Pier 2, was -3.4 percent (consolidation).

Chemical properties were determined for one soil sample to provide data useful in evaluating soil corrosivity. The pH for the sample tested was 8.5. No water-soluble sulfate was detected, and water-soluble chloride was measured at a concentration of 0.00114 percent. A laboratory

soil resistivity of 3,500 Ohm-cm was measured. Unconfined compressive strengths of 7,063 and 8,357 psf were measured for two soil samples, one from each abutment boring.

CDOT performed R-value testing on a sample of surficial soil from Boring A-02. The results indicate an R-value of 28 and are included in Appendix E.

6.7 Sta. 958+00 Wildlife Underpass A (Structures P-05-AS and P-05-AT)

The Wildlife Crossing designated as "WX2" is located on US 550 near Station 902+50. The Reference Design refers to this structure as Wildlife Underpass A. Four borings, numbered WX2-01 through WX2-04, were drilled near the west side of the proposed location of structure WX2. The east side was inaccessible at the time of our field work. The depths of the borings ranged from approximately 30 to 39 feet. Boring locations and logs are shown on the Engineering Geology sheet provided in Appendix C.

Borings WX2-01 and WX2-02 were drilled in the shoulder of the northbound lane of existing US 550. Below about 1 foot of shoulder gravel, embankment fill consisting of gravel with some sand and clay was encountered to a depth of seven feet in Boring WX2-01 and to a depth of 10 feet in Boring WX2-02. Borings WX2-03 and WX2-04 were located in agricultural land east of the existing roadway. Native surficial soils were encountered at the ground surface in these borings.

Stiff to very stiff native soils consisting of clay with some sand were encountered in the borings to depths ranging from 18 to 23.5 feet. Medium dense to very dense alluvial gravel with occasional sand layers was encountered below the clay surficial soil to depths ranging from 27 to 34.5 feet. Animas Formation claystone bedrock was encountered in Boring WX2-02 at a depth of 35 feet to the bottom of the boring at 38.8 feet and in Boring WX2-04 at a depth of 27 feet to the bottom of the boring at 29.5 feet. Groundwater was not encountered in the borings.

Penetration resistance N values in the surficial soils ranged from 13 to 36 blows per foot (bpf), with an average of 21 bpf. Penetration resistance in the terrace alluvium was high due to the presence of gravel and cobbles. N values ranged from 16 to 41 bpf, with an average of 29 bpf. At several locations, drive sampling using the split spoon sampler advanced only a few inches before refusal was encountered, prohibiting further advancement of the sampler.

Two samples of surficial soil were tested for purposes of classification. Gradation test results show the soils have 80 to 92 percent fines (passing the No. 200 standard sieve) with the remaining percentage as sand. Atterberg Limits testing produced Liquid Limits (LL) results of 40

and 47 percent and Plasticity Index (PI) results of 28 and 31 percent. Under the AASHTO system, the samples were classified as A-6 (25) and A-7-6 (24). Each of the samples fell within the Unified Soil Classification System (USCS) classification CL, Lean Clay.

Four soil samples collected using a modified California sampler were tested in the laboratory. These were found to have natural moisture contents between 15.7 and 17.3 percent and natural dry densities ranging from 105.9 to 111.4 pounds per cubic foot (pcf). The relatively high moisture contents may be due to seasonal fluctuations in groundwater levels or the result of irrigation. Swell/consolidation results ranged from -0.3 percent (consolidation) to -0.1 percent (consolidation). A pH of 8.6 was measured, water-soluble sulfate was present at 0.024 percent, and 0.00543 percent concentration of water-soluble chloride was detected. Resistivity was found to be 1,100 Ohm-cm.

6.8 Sta. 902+50 Wildlife Underpass B (Structures P-05-AU and P-05-AV)

Wildlife Crossing “WX” consists of a proposed series of three underpass structures beneath the US 550 southbound and northbound lanes and the Frontage Road. The crossing is located in the vicinity of US 550 Station 958+00. The Post-FIR plans dated 12/05/2016 show the structures to be a concrete box culverts (CBCs) 23 feet wide and 14 feet high, with an overall length of 241 feet. The bottoms of the CBCs will be 13 to 16 feet below the existing ground surface.

Four borings, designated Boring WX-01 through Boring WX-04, were drilled at the approximate location of proposed wildlife crossing WX. Boring locations and logs are shown on the Engineering Geology sheet provided in Appendix C. The thickness of surficial soil ranged from 22 to 30 feet, and terrace alluvium was encountered directly beneath the soil. Bedrock was not encountered in any of the borings, which ranged in depth from approximately 32 to 45 feet.

Penetration resistance N values in the surficial soils ranged from 8 to 34 blows per foot (bpf), with an average of 21 bpf. Penetration resistance in the terrace alluvium was relatively high due to the presence of gravel and cobbles. N values ranged from 20 to 81 bpf, with an average of 40 bpf. At two locations, drive sampling using the split spoon or modified California samplers advanced only a few inches before refusal was encountered, prohibiting further advancement of the sampler.

Three samples of surficial soil were tested for purposes of classification. Gradation test results show the soils have 81 to 94 percent fines (passing the No. 200 standard sieve) with the

remaining percentage as sand. Atterberg Limits testing produced Liquid Limits (LL) results between 29 and 34 percent and Plasticity Index (PI) results of 13 to 18 percent. Under the AASHTO system, the samples were classified as A-6, with group indices of (9) to (16). Each of the samples fell within the Unified Soil Classification System (USCS) classification CL, Lean Clay.

Four soil samples were collected using a modified California sampler. These were found to have natural moisture contents between 11.2 and 19.3 percent and natural dry densities ranging from 106.2 to 111.4 pounds per cubic foot (pcf). The relatively high moisture contents from Borings WX-02 and WX-03 may be due to seasonal fluctuations in groundwater levels or the result of irrigation. Swell/consolidation results ranged from -0.1 percent (consolidation) to 0.3 percent (swell).

6.9 Sta. 1019+00 to Sta. 1029+68 – Gulch A to Gulch B: Walls A, B and C

Walls A and C were eliminated during preparation of the Reference Design. Wall B was reduced in height and length and renamed Wall D on the Reference Design plans. The existing ground surface in this section is generally 35 to 55 feet above the proposed roadway profile grade. Consequently, the proposed grading for the alignment between Bridge 1 and Bridge 2 is entirely excavation. The Post-FIR plans show three separate retaining walls for this area. Walls A and C are to be located left of centerline and Wall B will be located on the right. The walls are intended to retain cuts in terrace alluvium and claystone/shale bedrock materials. Maximum proposed wall heights range from 25 to 45 feet. Three borings (Boring WA-01 through Boring WA-03) were drilled at the proposed location of Wall A, three at Wall C (Boring WC-01 through Boring WC-03) and ten at Wall B (Boring WB-01 through Boring WB-10). Boring WB-10 was drilled on the side slope of Gulch B, with the top of hole located below the level of the alluvium/bedrock (Qt/Ta) contact. The terrace alluvium, Qt, was encountered near the surface at Wall A, at depths ranging from 1.5 to 3 feet; and Wall C, at depths ranging from 1 to 1.5 feet. The borings at Wall B encountered 11 to 25.5 feet of surficial soils over the alluvial deposit. The thickness of the terrace alluvium deposit, Qt, was approximately 50 feet near the south ends of Walls A and B and thinned to approximately 24 feet at the north ends of Walls B and C, near Gulch B. Bedrock of the Animas Formation (Ta), was encountered in each of the 16 borings drilled at the walls. Depth to bedrock ranged from 44 to 56.5 feet.

Penetration resistance N values in the surficial soils indicate very stiff to hard materials. N values ranged from 23 to 44 with an average of 35 bpf. Resistance to penetration was high in

the terrace alluvium, as expected, due to the prevalence of coarse gravel, cobbles, and boulders. Blows per foot (N values) ranging from 24 to 87 were recorded. Dense materials or cobbles and boulders allowed the driven samplers to advance only a few inches before refusal was encountered.

Six bulk samples of surficial soil were tested to determine soil classifications. Gradation tests showed percent passing the No. 200 Sieve (fines) for samples taken at Wall B ranged from 64 to 90 percent. The fines proportion in the shallow soils at Wall A was 23 to 28 percent, and may be more typical of hillside colluvium material. AASHTO classifications for surficial soils at Wall B were A-7-6 and A-6 with group indices ranging from (10) to (35). The USCS classification for Wall A soils was silty sand (SM) and for Wall B was lean clay (CL). One sample at WB-07 did meet the criteria for high plasticity clay (CH). Bulk samples were taken from the alluvium, but due to the drilling methods, the larger clasts were fragmented and some of the fines were lost. Sieve analyses resulted in AASHTO A-1-a to A-2-4 and A-2-6 classifications for these fragmented materials, and USCS classifications of SP, SM, GP, and GM, poorly sorted or silty sands and gravels. These sieve analysis results are not representative of the in-place alluvium.

Eight relatively undisturbed samples of surficial soil were collected from Wall B borings using a modified California sampler. The samples were found to have natural moisture contents ranging from 7.5 to 14.8 percent and natural dry densities ranging from 94.9 to 117.4 pcf. Swell/consolidation results for four samples tested ranged from -1.0 percent (consolidation) to +1.5 percent (swell).

The potential for soil corrosivity was evaluated for one sample of surficial soil, one sample of alluvium and six bedrock samples. The values of pH, water-soluble sulfates and chlorides, and resistivity from the surficial soil were consistent with those measured at other borings. The alluvium sample from WB-01 had a pH of 8.5 and water-soluble sulfate of 0.002 percent. No chlorides were detected, and the resistivity was 14,000 Ohm-cm, notably higher than was measured elsewhere for this material. The pH values for bedrock ranged from 8.3 to 8.6, with the exception of WA-03 which measured 9.5. Water-soluble sulfate was measured for each of the six bedrock samples and ranged from 0.010 to 0.018 percent. No water-soluble chloride was detected in the bedrock samples. Resistivity values ranged from 1100 to 2000 Ohm-cm.

Six bedrock core samples were selected from these borings for testing of unconfined compressive strength. Measured values ranged from 263 psi to 7224 psi.

R-value tests were performed by CDOT on subgrade soil samples from Boring WC-01. An R-value of 25 was reported and the results are presented in Appendix E.

6.10 Sta. 1040+00 - Wall D

Wall D is shown as Wall E on the Reference Design plans. Retaining Wall D will support embankment fill to widen for the proposed roundabout and shoulder near Station 1040+00, south of the existing US 160 interchange. The proposed wall is located along approximately 140 feet of the southbound shoulder and has a maximum height of about 21 feet. Subsurface exploration for Wall D consisted of a single wire-line core boring drilled with the portable Viper drilling rig. Boring WD-01 encountered 2.5 feet of sandy clay overlying 24 feet decomposed to moderately weathered claystone. Moderately weathered to very hard sandstone with occasional shale layers was encountered at 26.5 feet to the bottom of the boring at 39.9 feet.

6.11 Sta. 979+00 to Sta. 987+00 - Walls E and F

Walls E and F are shown as Walls B and A respectively, on the Reference Design plans. The two retaining walls are proposed to support embankment fill for the frontage road that is to provide access to commercial and residential properties west of the County Road 220 intersection. Borings WE-01 and WE-02 were drilled near the location of Wall E and Borings WF-01 and WF-02 were drilled near the location of Wall F. The borings encountered 14.5 to 24 feet of stiff to hard clay and silt soils overlying approximately 9 to 15 feet of loose to very dense gravel with sand, cobbles and boulders. Bedrock was not encountered in the borings for the full depth of exploration that ranged from 29.5 to 33.2 feet.

Clay soil encountered in Boring WE-01 had low to medium plasticity, USCS classifications of CL and AASHTO classifications of A-4 with group indices ranging from (4) to (7). A relatively undisturbed Modified California drive sample from a depth of 9 feet had a moisture content of 14.8 percent and a dry density of 107.4 pcf. The sample consolidated 0.2 percent when wetted under light loading. Results of tests to evaluate soil corrosivity were: pH 8.5, water soluble sulfates 0.054 percent, chlorides 0.00784 percent and soil resistivity of 100 Ohm-cm. A sample of clay soil from Boring WE-02 had medium plasticity and classified as CL per the USCS system with an AASHTO classification of A-6 (11).

High plasticity clay soil was encountered in Boring WF-01 to a depth of 24 feet. The soil has a USCS classification of CH and an AASHTO classification of A-7-6 (32). A sample from a depth of 9 feet had a moisture content of 13.1 percent, dry density of 116.6 pcf and swelled 4.3

percent when wetted under light load. Boring WF-02 encountered stiff to hard silt with some sand to a depth of 16 feet. The soil has low plasticity, a USCS classification of ML and an AASHTO classification of A-4 (5). A relatively undisturbed Modified California drive sample from a depth of 3 feet had a moisture content of 13.8 percent, dry density of 101.7 pcf and consolidated 0.8 percent when wetted under a light load.

6.12 Station 1007+82 to Station 1011+25 – Wall G

This wall is shown as Wall C on the Reference Design plans. Wall G is proposed to retain a slope cut into surficial soil and terrace alluvium adjacent to a gas well pad on the Webb property. Roadway borings R-10, R-11 and R-12 were drilled in the vicinity of Wall G. Borings R-10 and R-11, located approximately 50 feet behind the wall, encountered 12 to 16 feet of medium dense silty sand. This layer was underlain by sandy clay or silt to a depth of 20 feet, where sandy gravel of the terrace alluvium deposit was encountered. Boring R-12 was located approximately 95 feet in front of the wall and approximately 15 feet lower in elevation than R-10 and R-11. At R-12, 5 feet of stiff to very stiff clay was encountered above a gravel layer and cobbles were encountered beginning at a depth of 14.5 feet.

Silty sand encountered in R-10 and R-11 had zero to low plasticity. USCS classifications for these soils were SM and SM-SC, and AASHTO classifications were A-2-4 (0) and A-4 (0). Relatively undisturbed Modified California drive samples from depths of 14.5 feet had a moisture contents from 9.4 to 13.6 percent and dry densities of 93.6 to 103.9 pcf. No swell-consolidation tests were conducted at R-10 and R-11. Results of tests to evaluate soil corrosivity were: pH 8.8, water soluble sulfates 0.007 percent, and soil resistivity of 2800 Ohm-cm. No chlorides were detected.

At Boring R-12, tests on a bulk sample from the gravel layer resulted in a USCS classification of GC and an AASHTO classification of A-2-6 (0). Chemical analysis of the gravel sample measured pH 8.5, water soluble sulfates 0.019 percent, chlorides of 0.0018 percent, and soil resistivity of 1600 Ohm-cm. A Hveem Resistance test was performed by CDOT, with a resulting “R” value of 18.

7. GROUNDWATER AND SEEPAGE AREAS

The subsurface investigation was accomplished during the winter months in an unusually dry year. No groundwater was encountered in any of the borings, although water was introduced during the coring process; and as a result, any water already present may have gone unnoticed.

While no groundwater was encountered in the borings, seeps have been observed in previous years on the slopes of Gulch A and Gulch B, and their presence should be anticipated in wetter years and during summer months due to irrigation of the agricultural lands adjacent to the project. The presence of groundwater may contribute to reduced bearing resistance for structure foundations and may create challenges for roadway and structure excavation activities. Seepage at the alluvium/bedrock contact and through hillside colluvial deposits could reactivate or accelerate landslide movements.

8. LIMITATIONS

This report documents the subsurface investigation for the US 550 South Connection with US 160 realignment and was prepared for the exclusive use of Wood and CDOT for specific use on the US 550-US 160 Connection Design-Build project. Within the limitations of the scope, schedule, and budget, the work presented in this report was performed in accordance with generally accepted geotechnical engineering principles and practices in this area at the time this report was prepared. We make no other warranty, either explicit or implied.

The conclusions regarding subsurface conditions presented in this report are based on the data obtained from published maps, reports, laboratory tests, and the widely spaced exploratory borings drilled at the approximate locations shown on the boring location sheets. When assigning laboratory tests, it was assumed that these widely spaced borings are representative of the subsurface conditions throughout the US 550 project alignment discussed in the report and that the subsurface conditions throughout the project alignment are not significantly different from those identified by the borings. The subsurface conditions observed in the borings may not necessarily reflect the field variations in the subsurface conditions and water levels at other locations. The nature and extent of subsurface variations across the project area may not become evident until construction activities are initiated.

The scope of work of this investigation did not include hazardous materials sampling and chemical analyses and evaluation of potential impacts to natural resources, including wetlands, endangered species, or environmentally critical areas.

9. REFERENCES

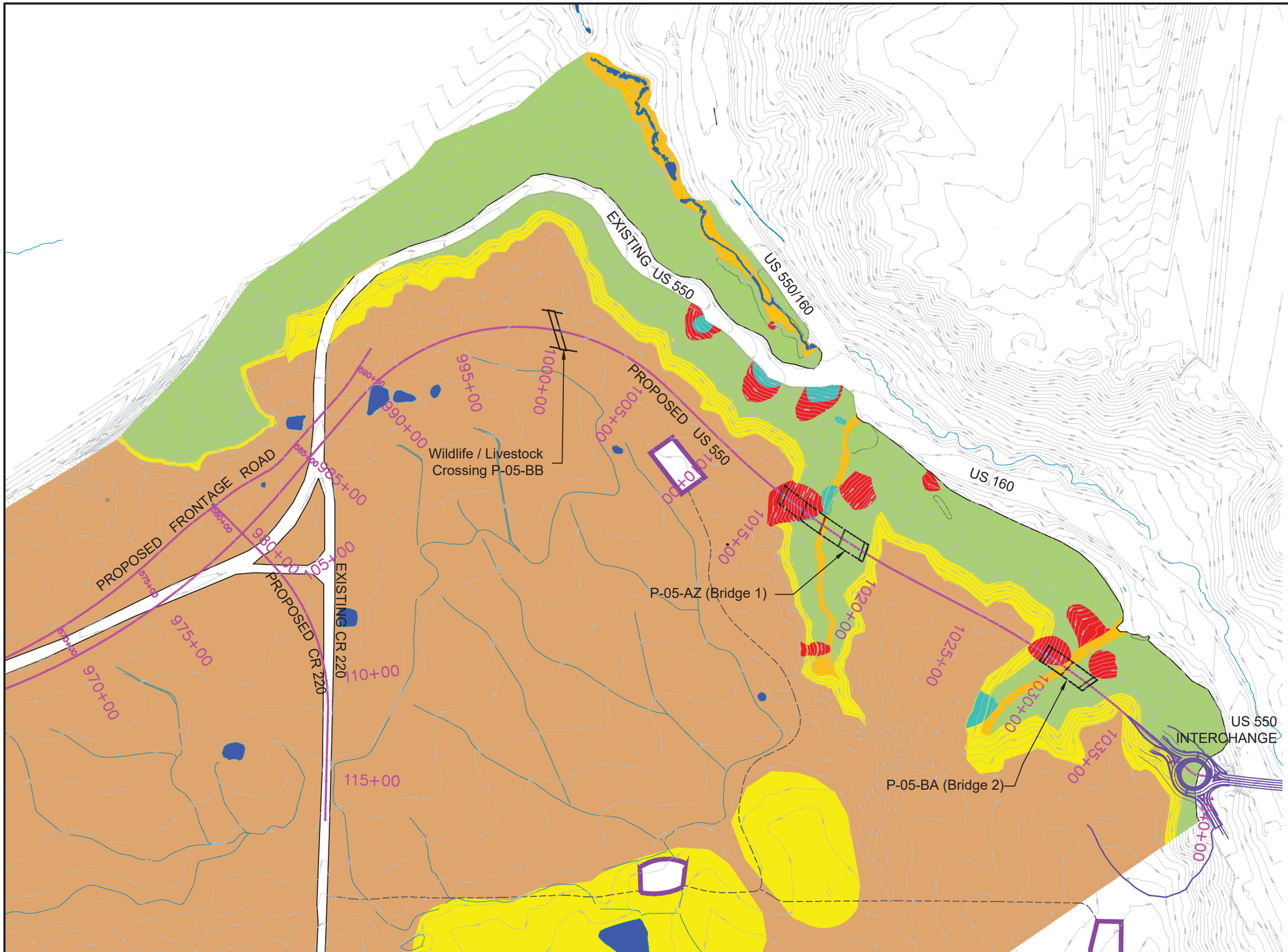
Colorado Department of Transportation (2017), Standard Specifications for Road and Bridge Construction.

Carroll, C. J., et al. (1999) Geologic Map of the Durango East Quadrangle, La Plata County, Colorado, Colorado Geological Survey, 1:24,000.

Kirkham, R. M. and Navarre, A. K. (2003) Geologic Map of the Basin Mountain Quadrangle, La Plata County, Colorado, Colorado Geological Survey, 1:24,000.

Yeh and Associates, Inc. (2014) Preliminary Geotechnical Evaluation Report US 550 South Connection to US 160: Independent Alternatives Analysis, FSA 5501-021 (19378)
La Plata County, Colorado

Appendix A – Geologic Map



Geologic Map Legend

- Existing Gravel Roadways
- Existing Asphalt Roadway
- Water - Streams, irrigations ditches, and stockponds
- Seep - Water observed seeping from ground surface or hillside.
- Qac - Alluvium and colluvium (Holocene) - stream-channel deposits, poorly sorted, unstratified clayey, silty sand, bouldery sand.
- Qls - Landslide Deposits (Holocene and Pleistocene) - Relatively fresh morphological features or vegetation changes, indicating historical movement.
- Qlo - Loess (late Pleistocene) - Reddish-brown to light-brown sandy silt, slightly clayey. May include gravel zones of slope wash.
- Qt - Terrace alluvium (middle Pleistocene) - underlies terrace surface of Florida Mesa. Cobbles, locally boulders, in gravel and sand matrix.
- Ta - Animas Formation - Upper member (Paleocene) - olive to gray weathered claystone overlying gray interbedded shale, sandstone, and conglomerate, medium to very hard.
- Well Pad (Existing)

N

500 0 250 500

Scale: 1 Inch = 500 Feet

Yeh and Associates, Inc.
Consulting Engineers & Scientists

NO.	SHEET REVISION	BY	DATE

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DESIGNED FOR:	
PROJECT NUMBER: 217-376	
SCALE	
HORIZ: 1:6000	VERT: N/A

PROJECT:

US 550 South Connection to US 160
Geotechnical Data Report

Appendix A - Geologic Map

SHEET 1 OF 1

Appendix B – Boring Location Plan and Profile

Appendix B.1 – Boring Log Legend

LEGEND

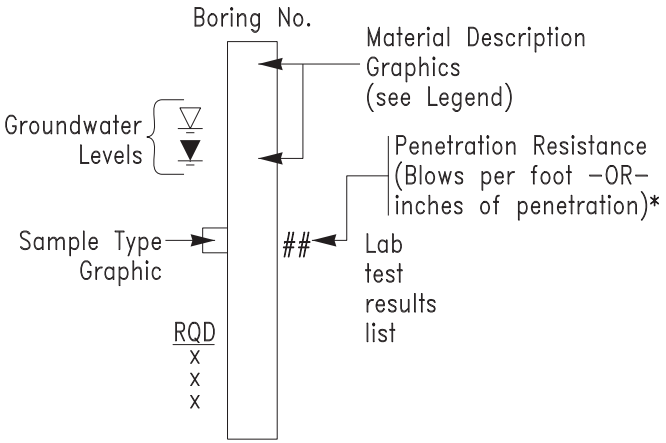
Soil Lithology

- Asphalt
- Fill with Gravel as major soil
- Fill with Clay as major soil
- USCS Low Plasticity Sandy Clay
- USCS Clayey Sand
- USCS Clayey Gravel
- USCS Low Plasticity Sandy Clay
- USCS Poorly-graded Gravel with Clay
- USCS Poorly-graded Sandy Gravel
- USCS Silty Sand
- USCS Low Plasticity Silty Clay
- Boulders and cobbles
- USCS Clayey Sand
- USCS Poorly-graded Gravelly Sand
- USCS Low Plasticity Clay
- USCS Sandy Silt
- USCS Poorly-graded Gravel
- USCS Silt
- USCS Poorly-graded Gravel with Silt
- USCS High Plasticity Clay

Rock Lithology

- Alternating layers of sandstone and shale
- Weathered Bedrock
- Sandstone
- Alternating layers of sandstone and claystone
- CLAYSTONE
- Shale
- Sandy Shale
- Breccia

TYPICAL BOREHOLE LOG



*e.g. A value of 50/3 or 50:3 indicates that 50 blows were applied to the sampler, with a penetration of 3 inches.

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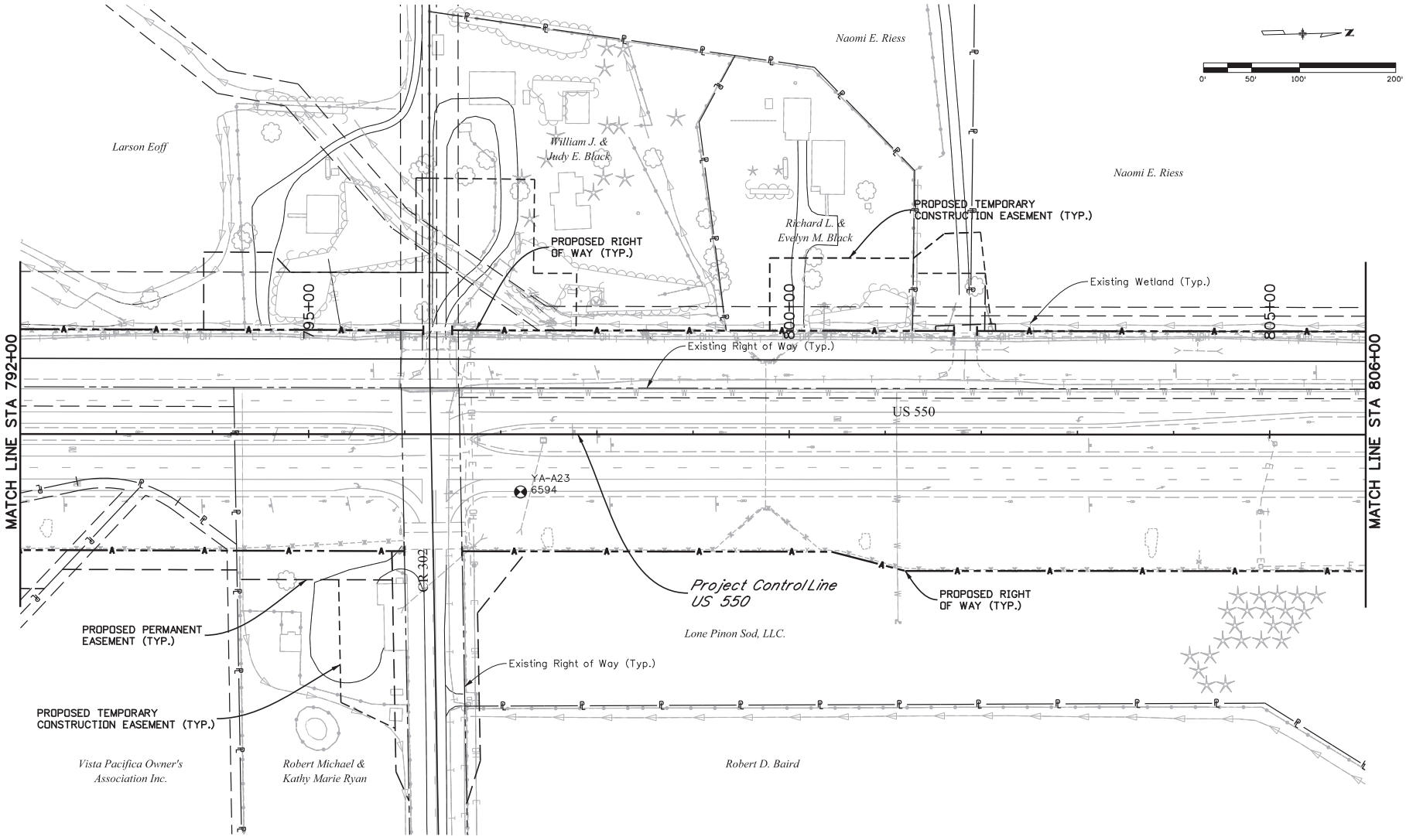
Appendix B.2 – Boring Log Plan Sheets



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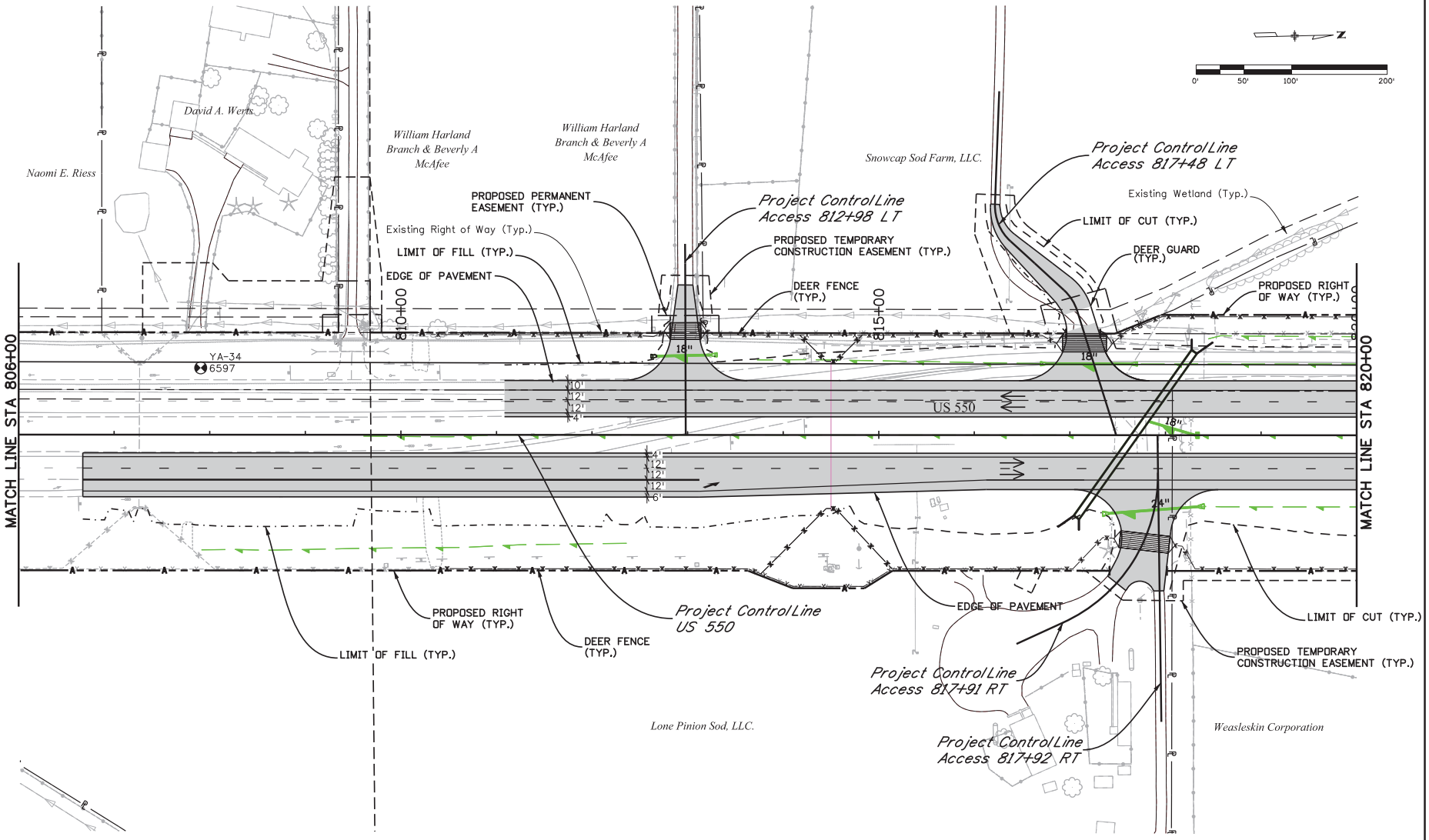

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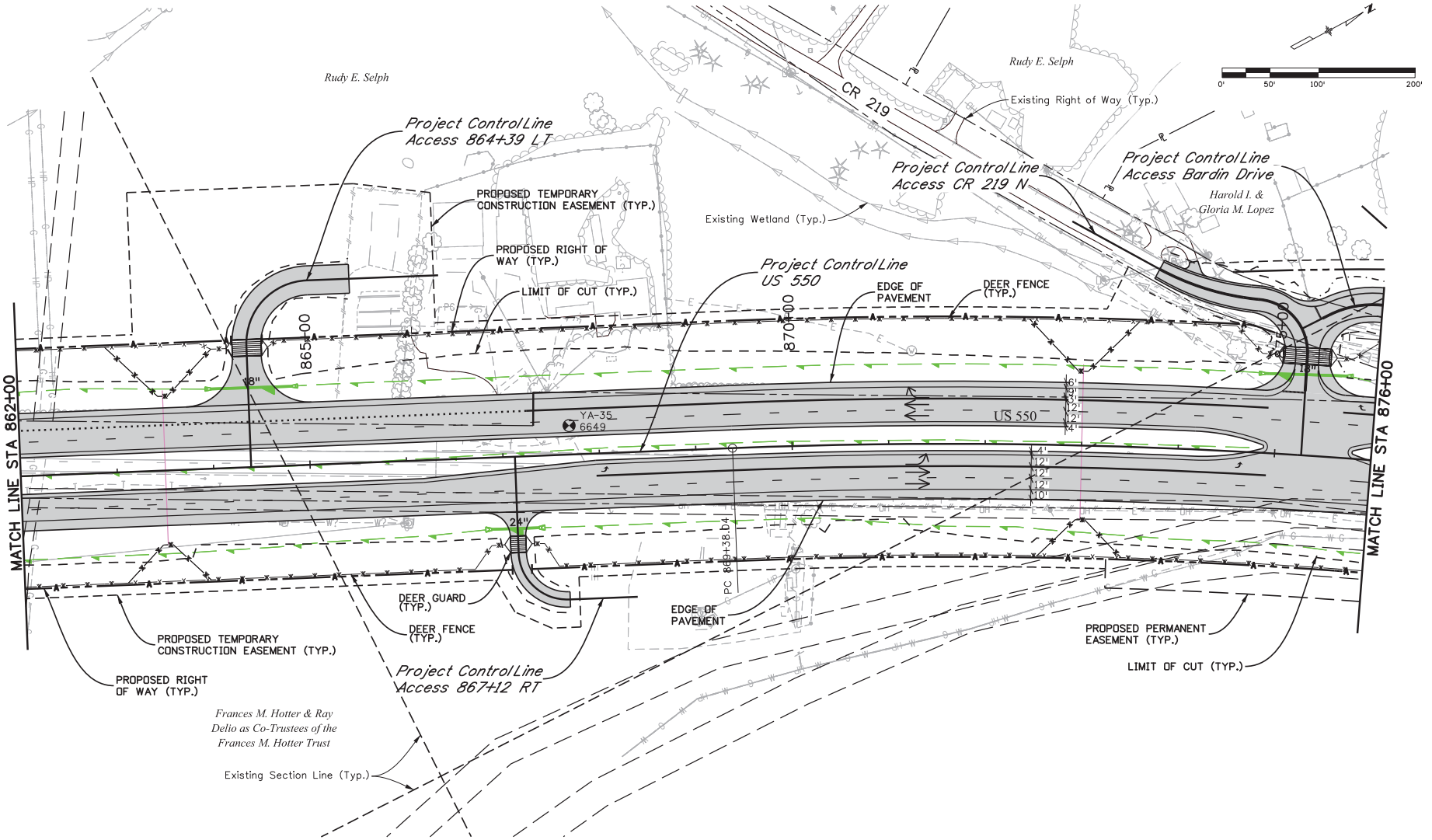

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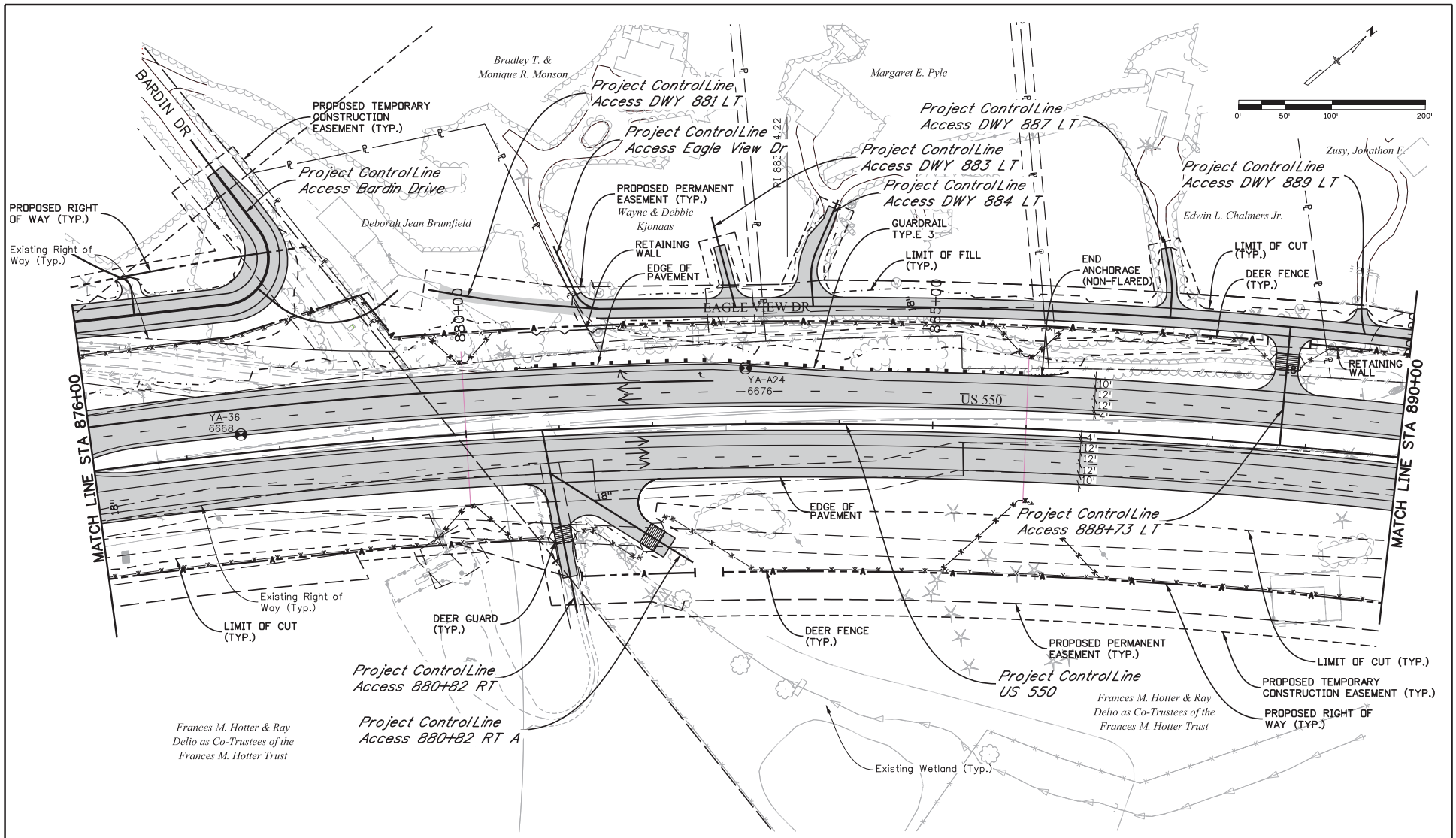

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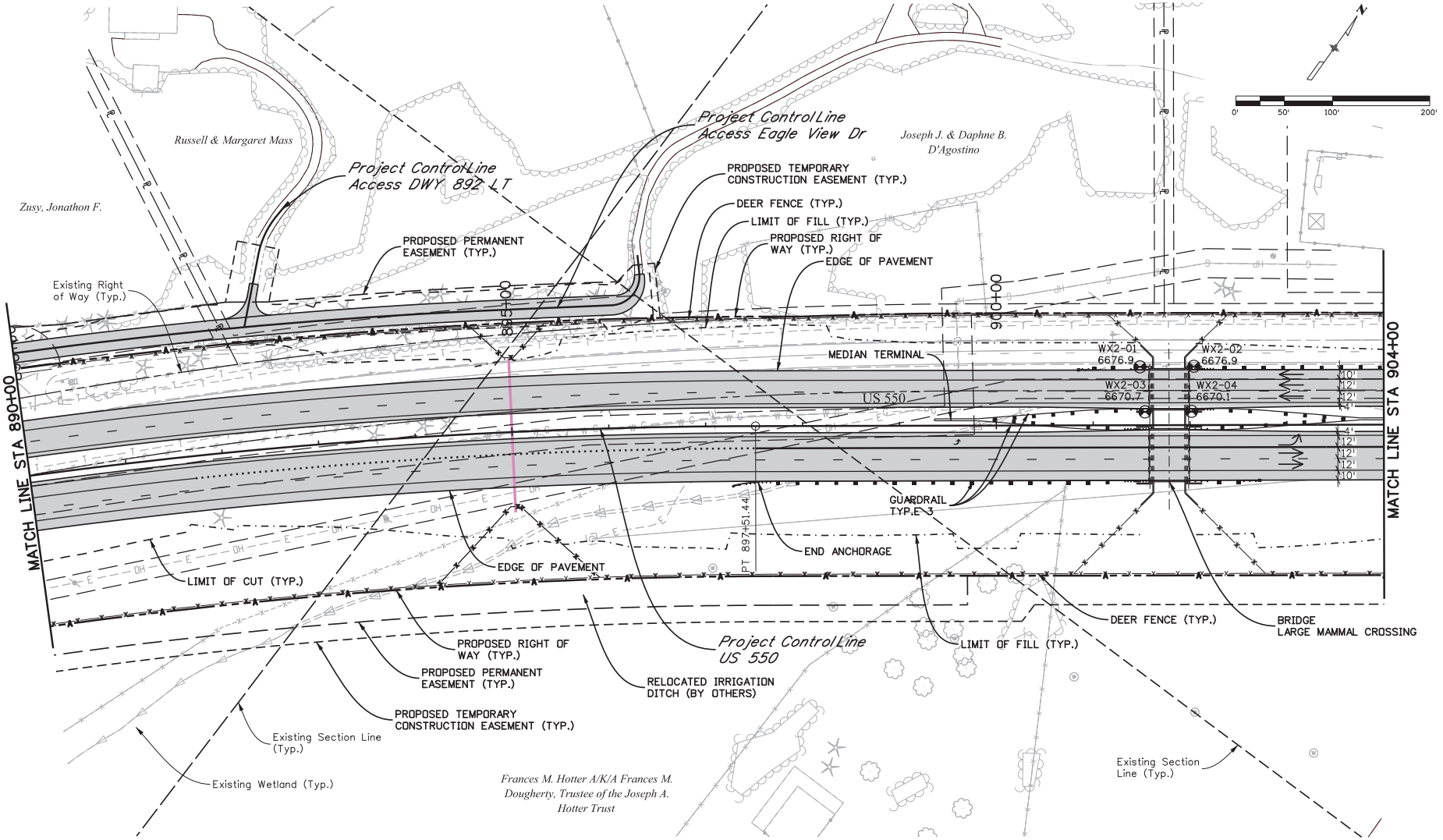

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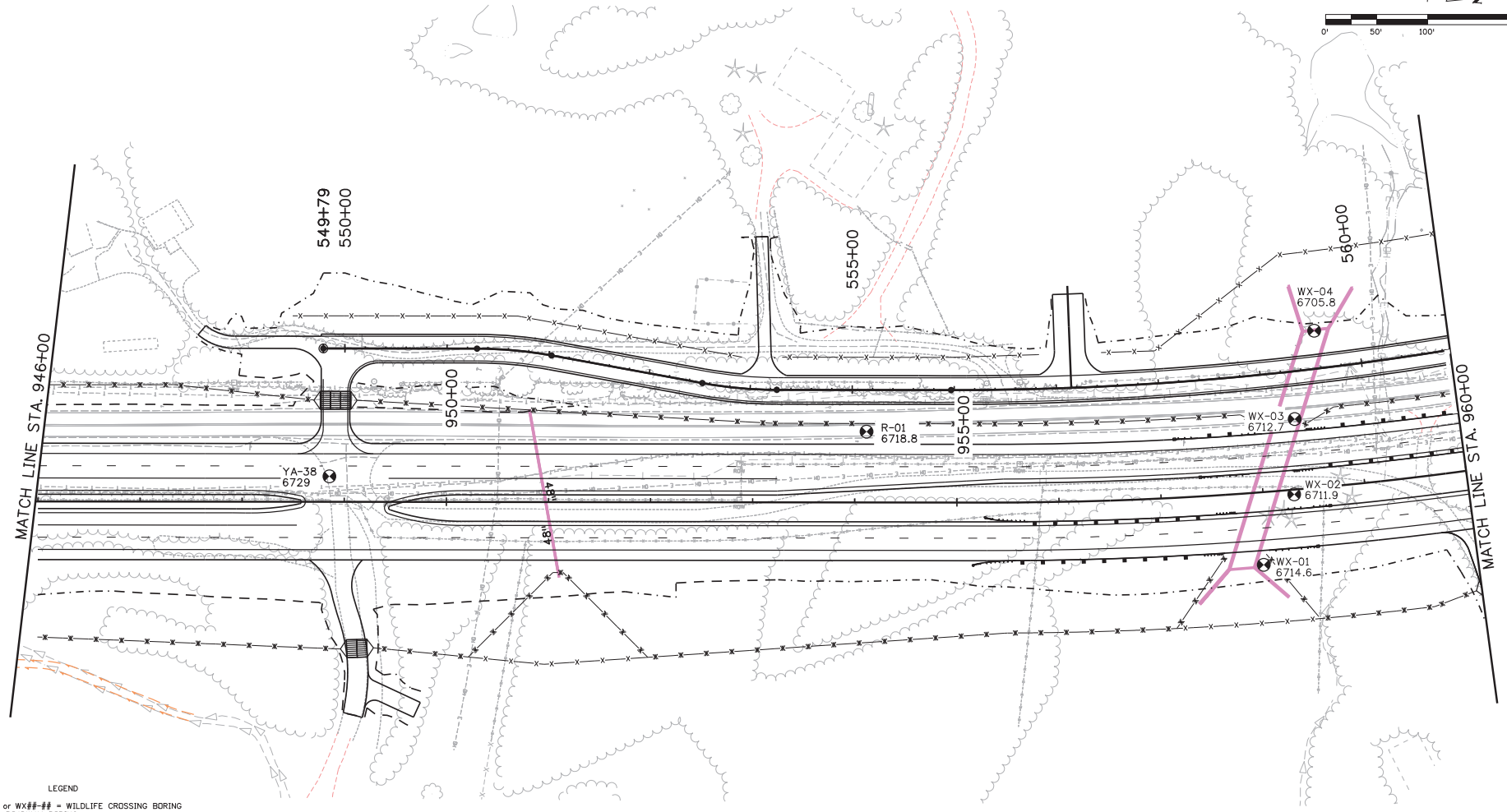

LEGEND

WX-## or WX##-## = WILDLIFE CROSSING BORING
R-## = ROADWAY BORING
W*-## = WALL BORING
A-## = ANIMAL CROSSING BORING
B**-##? = BRIDGE BORING

* = WALLS A THROUGH F
** = BRIDGE NUMBER
= BORING NUMBER
? = SUPPLIMENTAL BORING

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Yeh and Associates, Inc. Consulting Engineers & Scientists					Region 5 DRV		Sheet Subset: EG_Plan / Subset Sheets: 6 of 12	Sheet Number

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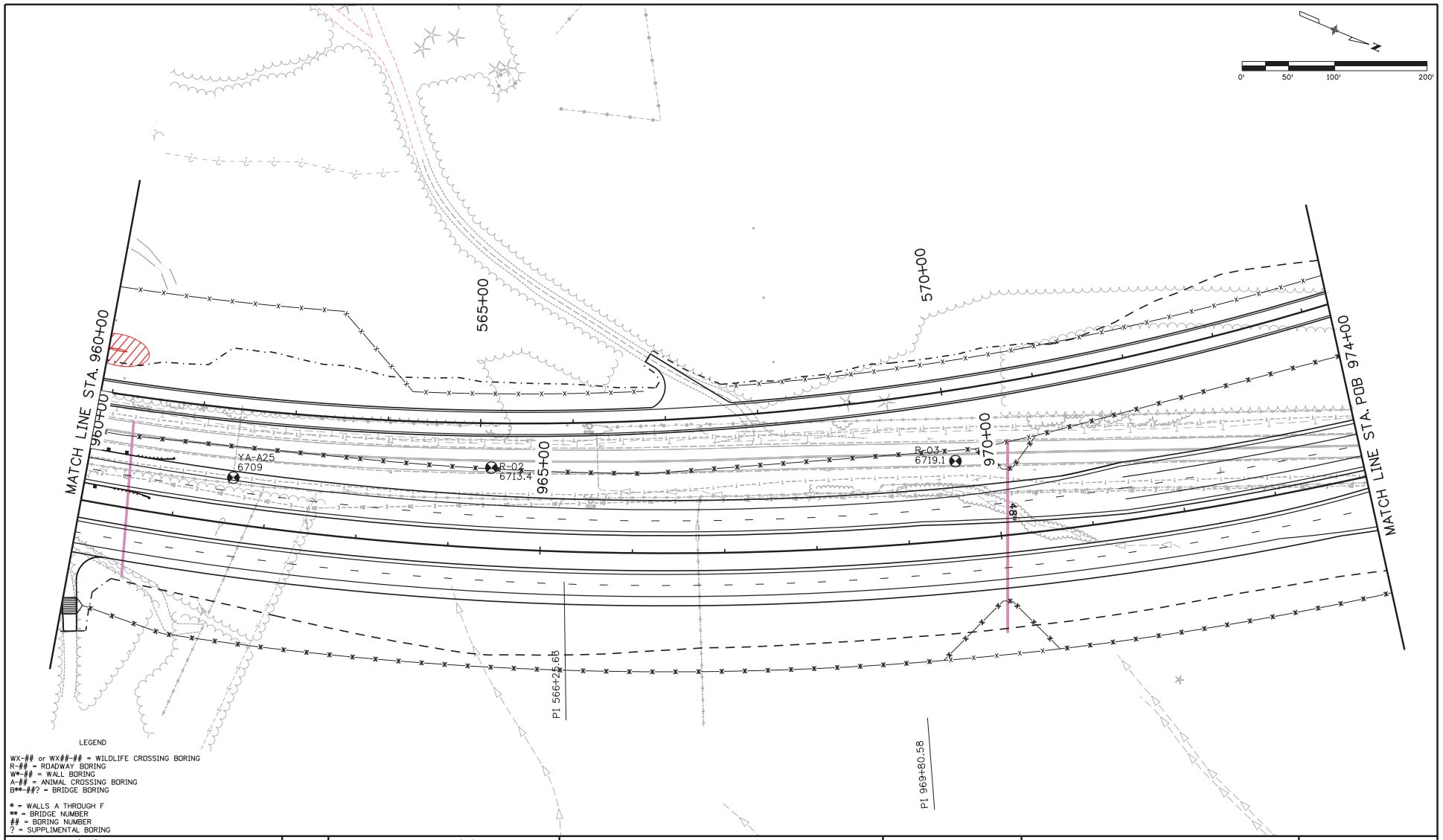

LEGEND

WX-## or WX##-## = WILDLIFE CROSSING BORING
R-## = ROADWAY BORING
W*-## = WALL BORING
A-## = ANIMAL CROSSING BORING
B**-##? = BRIDGE BORING

* = WALLS A THROUGH F
** = BRIDGE NUMBER
= BORING NUMBER
? = SUPPLIMENTAL BORING

Print Date: 2/15/2019		Sheet Revisions			Colorado Department of Transportation	As Constructed	US 550 CONNECTION TO US 160 BORING LOCATION PLAN		Project No./Code
File Name: 007_22420_US 160-550-Plan Sheet 07.dgn		Date:	Comments	Init.	3803 North Main Avenue Durango, CO 81301 Phone: 970-385-1440 FAX: 970-385-8365	No Revisions:			NHPP 5501-029
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Unit Information Unit Leader Initials						Void:	Detailer:		
Yeh and Associates, Inc. Consulting Engineers & Scientists					Region 5 DRV		Sheet Subset: EG_Plan	Subset Sheets: 7 of 12	Sheet Number

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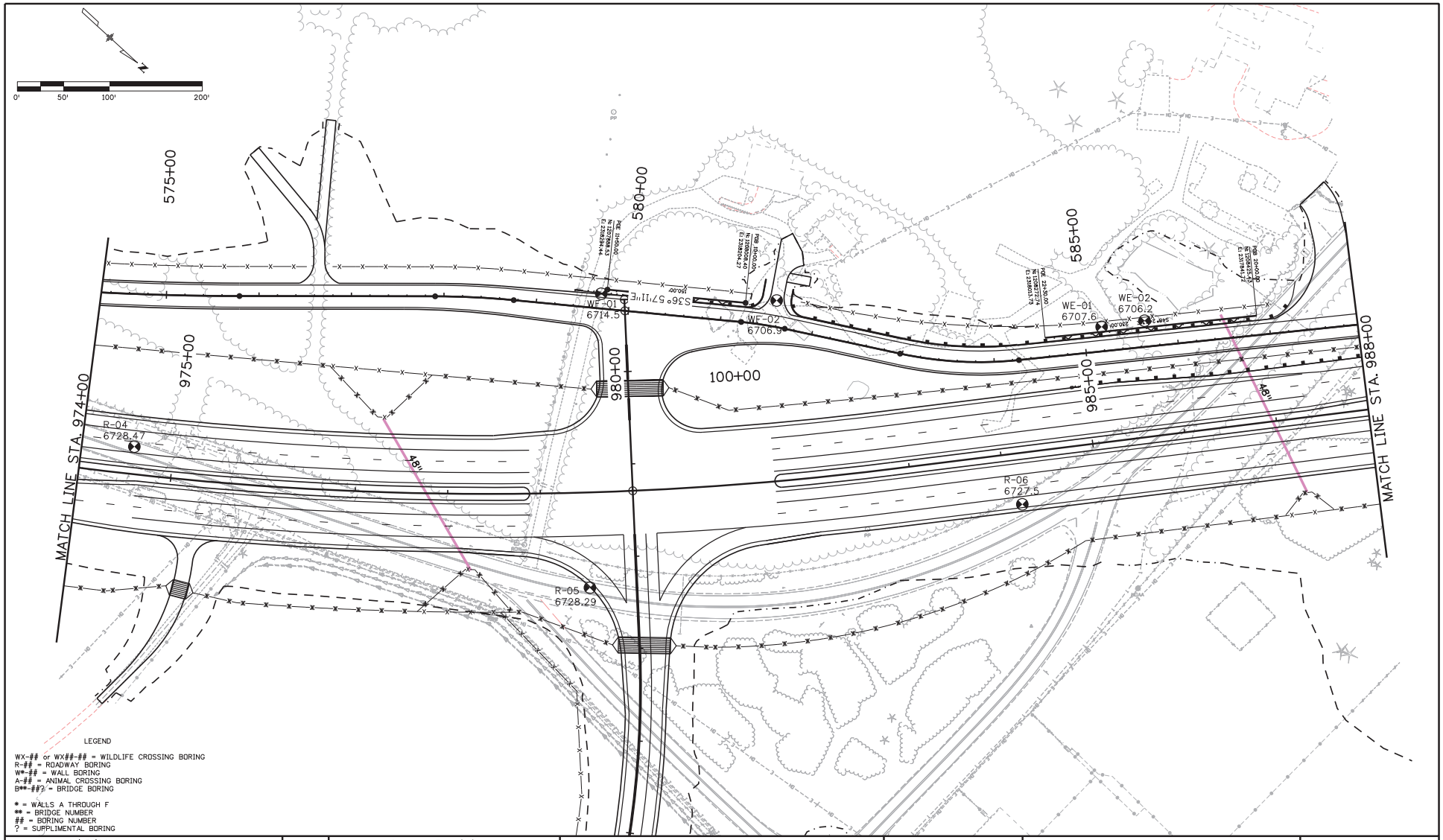

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Yeh and Associates, Inc. Consulting Engineers & Scientists					Region 5 DRV			

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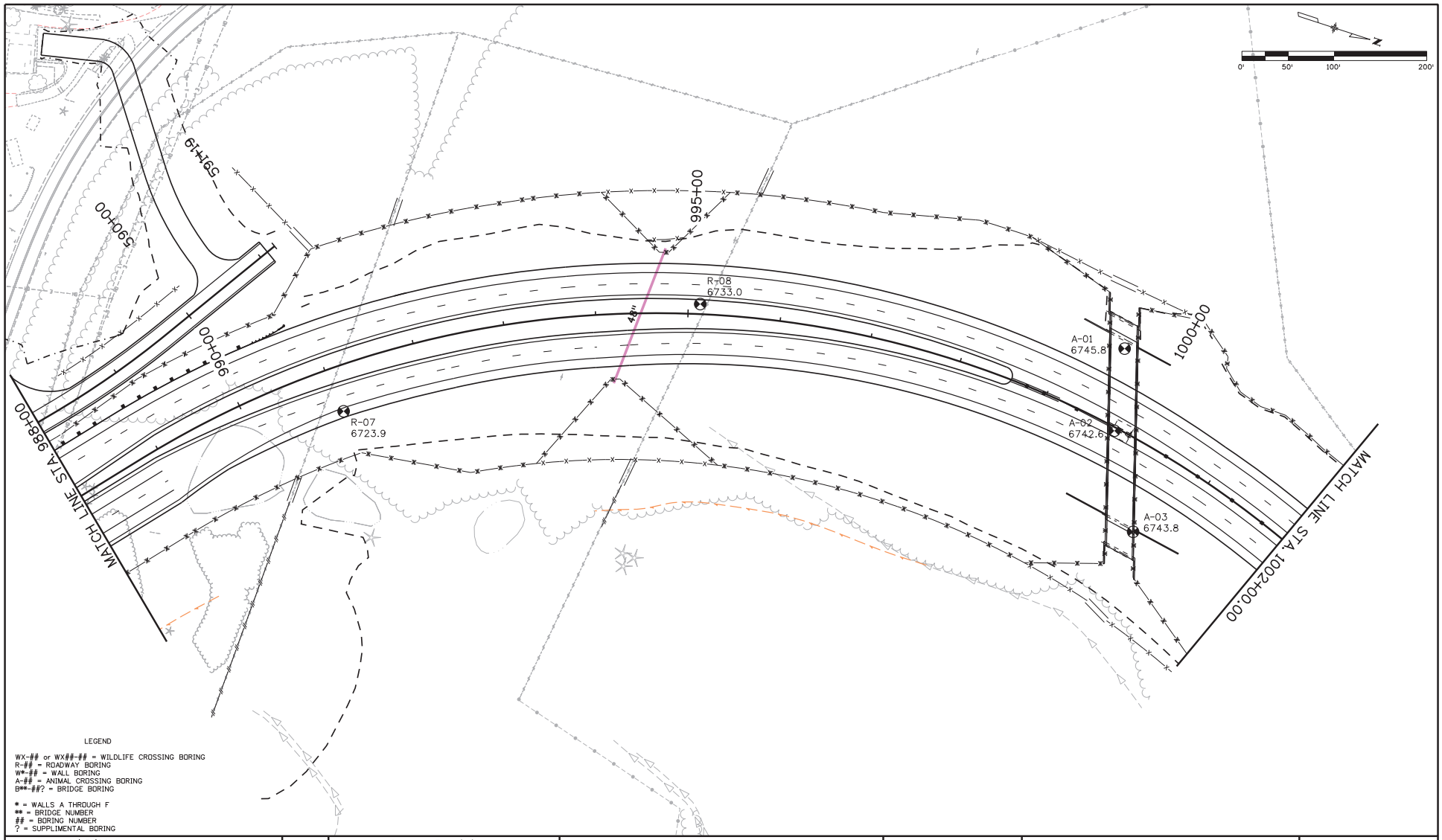

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Yeh and Associates, Inc. Consulting Engineers & Scientists					Region 5 DRV			

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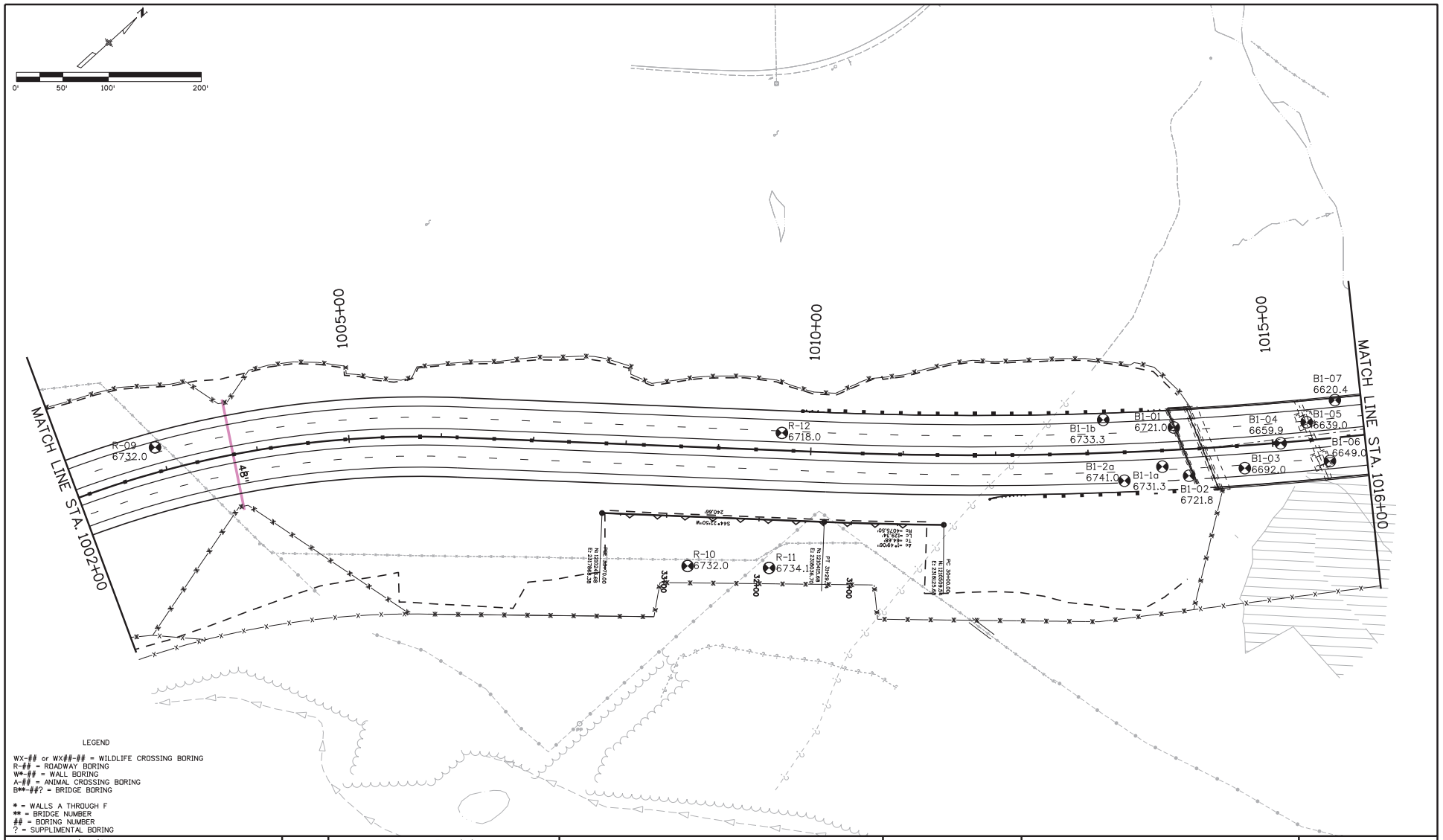

LEGEND

WX-## or WX##-## = WILDLIFE CROSSING BORING
R-## = ROADWAY BORING
W*-## = WALL BORING
A-## = ANIMAL CROSSING BORING
B**-##? = BRIDGE BORING

* = WALLS A THROUGH F
** = BRIDGE NUMBER
= BORING NUMBER
? = SUPPLIMENTAL BORING

Print Date: 2/20/2019		Sheet Revisions			Colorado Department of Transportation	As Constructed	US 550 CONNECTION TO US 160 BORING LOCATION PLAN	Project No./Code
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Yeh and Associates, Inc. Consulting Engineers & Scientists					Region 5 DRV		Sheet Subset: EG_Plan	Subset Sheets: 10 of 12	Sheet Number

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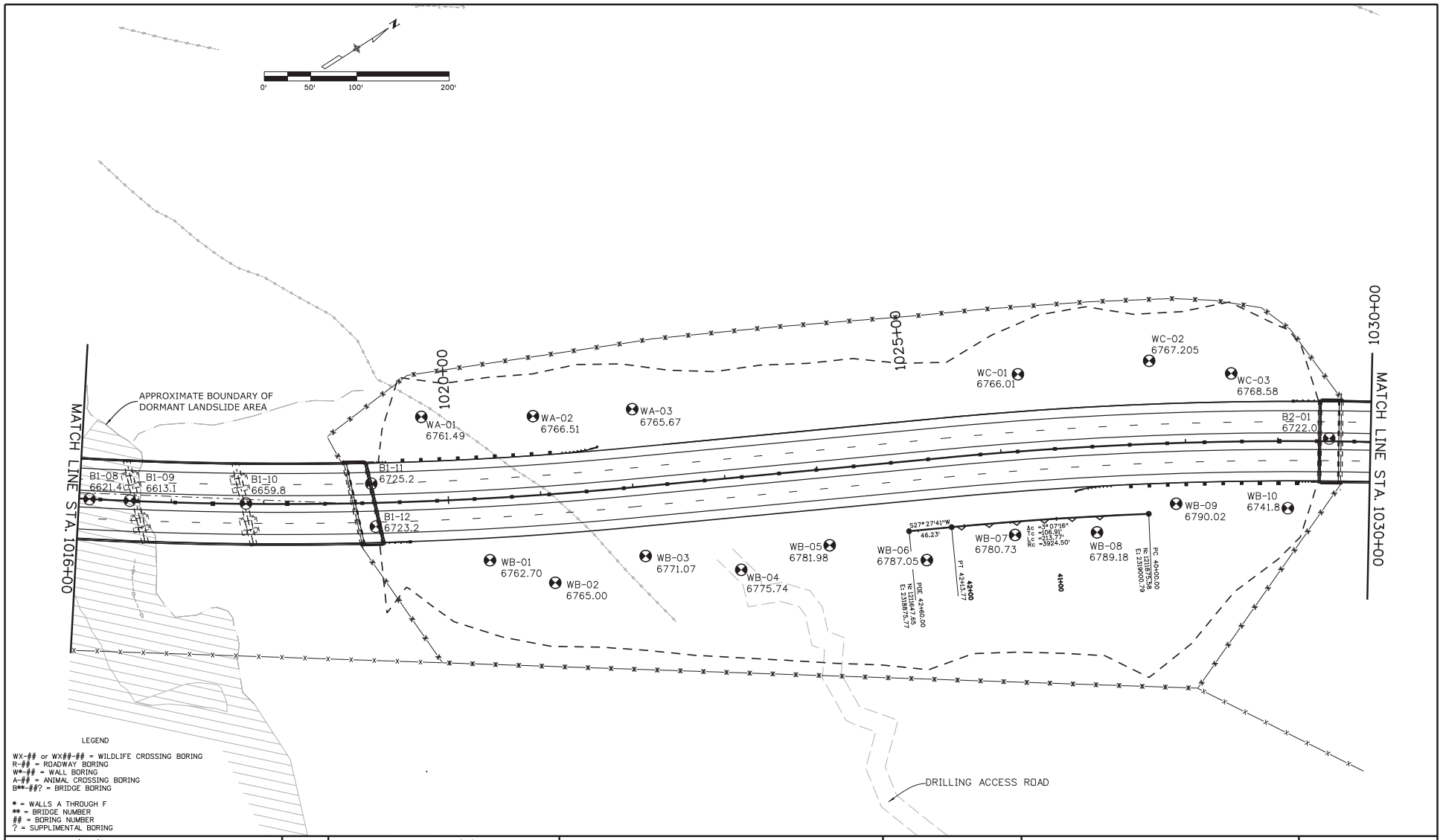

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Yeh and Associates, Inc. Consulting Engineers & Scientists								

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