GEOTECHNICAL INVESTIGATION AND FOUNDATION RECOMMENDATION REPORT BIA ROUTE N11 BIA PROJECT N11(1A)1,2&4 NEAR CROWNPOINT, NEW MEXICO KLEINFELDER PROJECT NO. 105884

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Subject: **Geotechnical Investigation and Foundation Recommendation Report**
BIA Route N11, BIA Project N11(1A)1,2&4
Crownpoint, New Mexico

Dear Ms. LeVee:

Kleinfelder West, Inc. (Kleinfelder) is pleased to present our geotechnical evaluation report for the proposed design and construction of new asphalt pavement and a new bridge structure on the southern portion of Route N11 on the Navajo Nation near Crownpoint, New Mexico. This report presents the results of our observations and analyses, and our recommendations for subgrade preparation and earthwork, pavement sections, drainage and bridge foundations. Additionally, our report presents a short discussion regarding construction considerations related to the geotechnical conditions disclosed by the borings.

We appreciate the opportunity to be of service to you. Should any questions arise concerning this report or if you require any additional information regarding this project, please contact us.

Respectfully submitted,
KLEINFELDER WEST, INC.

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APPENDICES

1. INTRODUCTION

1.1 GENERAL

This report presents the results of the geotechnical exploration by Kleinfelder West, Inc. (Kleinfelder) for the proposed design and construction of the southern portion of BIA Route N11, BIA Project N11(1A)1,2&4, on the Navajo Nation near Crownpoint, New Mexico. The general location of the project site is shown on Figure 1, Sheet 1 in Appendix A of this report.

The purpose of this investigation was to characterize the subsurface soil and evaluate its engineering properties for use in the design of the proposed construction of the southern portion of Route N11. The investigation included a site reconnaissance, subsurface exploration, selected soil sampling, field and laboratory testing, engineering design and analyses, and preparation of this report. The recommendations contained in this report are subject to the limitations presented herein.

The recommendations and conclusions of this report are based on the subsurface conditions found at the locations of our exploratory borings at the time our exploration was performed. They also are subject to the provisions stated in the following specific sections of this report: "Additional Services" and "Limitations". Our findings, conclusions, and recommendations for this evaluation may not be extrapolated to other adjacent sites or used for other projects without our written approval.

1.2 PROJECT DESCRIPTION

The current alignment of the southern portion of Route N11 consists of a two-lane compacted dirt road approximately 10.6 kilometers (6.6 miles) long; the road primarily carries local traffic. The beginning of project (BOP) is located at station 0+002.298 at the intersection of Route N11 and Route N49. The end of project (EOP) is located at station 10+620 approximately 8.8 kilometers (5.5 miles) miles from at the intersection of Route N11 and Route N9. The roadway crosses the Puerco River at approximate station 3+965. The Site Location Map is presented as Figure 1, Sheet 1 of Appendix A.

The purpose of the project is to reconstruct Route N11, which will include grading, drainage improvements, and asphalt paving. The proposed project also includes a new bridge structure over the Puerco River. We understand that the structure will be a single span bridge with a span length of 27.4 m (90 ft). We understand that the current phase of the project will consist of all pre-construction tasks including design, survey and environmental assessment.

We understand that the majority of the new road will be close to the horizontal alignment of the existing roadway as shown in Figure 1, Sheets 2 through 17 of Appendix A. However, the horizontal alignment will be located northwest of the existing alignment near the crossing of the Puerco River. At the time of this report, we

understand that the vertical alignment of the proposed road will be modified from the existing roadway as shown in Figure 1, Sheets 2 through 17.

1.3 Purpose And Scope

The purpose of our investigation was to explore and evaluate subsurface conditions at Route N11 and develop recommendations relating to the geotechnical aspects of project design and construction. The conclusions and recommendations in this report are based on analysis of the data from our field exploration and laboratory tests. Specifically, our scope included:

- Drilling of fifty-eight (58) exploratory borings and sampling of subsurface materials.
- Geotechnical and analytical laboratory testing of selected samples obtained during the field exploration to evaluate relevant physical and engineering properties of the soil.
- Evaluation and engineering analysis of the field and laboratory data to develop our geotechnical conclusions and recommendations.
- Preparation of this report.

2. EVALUATION PROCEDURES

2.1 FIELD EXPLORATION

The subsurface conditions on Route N11 were explored by drilling fifty-eight (58) total borings at the subject site. The boring locations are shown in Figure 1, Sheets 2 through 17, of Appendix A of this report. Logs of the borings are presented in Appendix B. The borings were advanced by hollow stem auger drilling using a truck-mounted drill rig.

Kleinfelder performed traffic control during subsurface exploration drilling conducted along the existing Route N11. Traffic control consisted of "Road Work Ahead" signs placed near the beginning and end of the work zone and an exclusion zone formed from orange traffic cones placed around the drill rig and Kleinfelder field vehicle.

For all borings drilled during the exploratory boring program, the soil and rock encountered was continuously examined, visually classified, and logged. Logs of the borings are presented in Appendix B. Visual classifications of the soil and rock encountered in our exploratory borings were made in general accordance with the Unified Soil Classification System (ASTM: D2487). A key for the classification of the soil is presented in Appendix B.

A total of 305 lineal meters (1000 lineal feet) of hollow stem auger drilling was performed utilizing a truck-mounted drill rig. Hollow stem auger drilling was accomplished using a truck-mounted CME-75 drill rig equipped with 3¼ in, 83 mm I.D. hollow-stem auger. Soil samples were obtained using a modified California (ring) sampler (2.5 in, 64 mm I.D.) and a standard split-spoon sampler (1.375 in, 35 mm I.D.). The sampler was driven with a 140-pound, 63.5-kilogram CME automatic hammer free-falling through a distance of 30 inches, 0.76 m. The sampler driving resistance was recorded as the number of blows per one foot (305 mm) of penetration (referred to as blow counts or N-values), the results of which are presented on the boring logs in Appendix B.

Due to the relatively hard nature of the subsoils, Shelby tube samples were not practical at this site and modified California samples were therefore substituted in lieu of Shelby tubes. This sampler consists of a series of brass rings placed inside a steel tube that is lowered to the bottom of the borehole and driven through the soil by means of hammer blows at the top of the drilling rod. Because the rings are encased inside a steel tube, they do not crumple when driven through hard materials. This substitution was necessary to obtain in-situ densities in order to fulfill the objectives of the Statement of Work (SOW) per contract requirements. The density values that we obtained from soils sampled by the ring sampler compared well with published textbook values and additional sampling would not change any of Kleinfelder's recommendations provided in our geotechnical report.

Rock samples were obtained using an HQ core barrel sampler (2.5-inch, 64 mm I.D.) typically advanced in 1.5-meter (5-foot) runs. Kleinfelder calculated the percent recovery and Rock Quality Designation (RQD) for each run and noted these on the boring logs. The RQD is a modified core recovery percentage in which all of the pieces of sound core greater than 4 inches, 100 mm long are summed and divided by the length of the core run. RQD is expressed as a percentage and categorized according to Table 2.1.

TABLE 2.1 – Classification of Rock by RQD Value

RQD	Rock Quality
less than 25	Very poor
25 - 50	Poor
50 - 75	Fair
75 - 90	Good
90 - 100	Excellent

The individual boring logs and a legend to the logs (including a summary of the Unified Soil Classification System used to describe the soil and the rock classification key sheet) are included in Appendix B of this report. The lines defining boundaries between soil strata are approximate and are based on the observations of the field engineer or geologist and interpolation between samples. Samples obtained during the field exploration were transported to our laboratory for further examination and testing.

2.2 LABORATORY TESTING

2.2.1 Geotechnical Laboratory Testing

The laboratory testing program consisted of performing visual soil classifications and index property testing on the recovered samples. Soil classification was aided with laboratory tests performed in general accordance of ASTM and AASHTO specifications. As shown in Table 2.2, the following tests were performed according to the corresponding ASTM methods and comparable AASHTO methods:

TABLE 2.2 – Summary of Geotechnical Laboratory Tests

Test	ASTM Method	Comparable AASHTO Method
Moisture Content	D 2216	T 265
Particle Size Analysis	D 422	T 88
Atterberg Limits	D 4318	T 89 and T 90
Direct Shear	D 3080	T236

The results of these tests are presented in Appendix C of this report.

3. GENERAL SITE CONDITIONS

3.1 SURFACE CONDITIONS

The overall Route N11 alignment is shown in Figure 1, Sheet 1, with detailed plan and profile drawings shown on Sheets 2 through 17 of Appendix A. Photographs showing the surface conditions of Route N11 are shown in Appendix D of this report. Surface soils on the unpaved roadway consist of very stiff to hard sandy clay and clayey sand with occasional outcrops of moderately weathered to highly weathered shale and sandstone and sandstone boulders. Vegetation in the area primarily consists of sagebrush and high grasses with areas of juniper and piñon trees. Erosion of soils along the alignment was generally observed approximately 6 to 15 m (20 to 50 ft) away from the roadway, with occasional washboarding on the roadway.

The Puerco River crosses the existing Route N11 alignment approximately 65 m (213 ft) south of station 3+965. Water generated from the wash is channeled through a drainage culvert passing under the roadway at this station. The majority of the wash was dry during our site reconnaissance in February of 2009 and follow-up visits during the fall of 2009. However, a small amount of standing water was observed on either side of the drainage culvert in August of 2009, which was likely caused by rains in the area.

3.2 GEOLOGIC SETTING

Prior to drilling, site geology was evaluated by reviewing the Geologic Map of New Mexico (New Mexico Bureau of Geology and Mineral Resources, 2003). The surface geology of the proposed Route N11 realignment consists of five Cretaceous age geologic units as shown in the geologic map in Figure 3.1 below. The northern end of the N-11 (1A) realignment is comprised of the Mulatto Tongue of Mancos Shale (Kmm) and the Crevasse Canyon Formation (Kcc), which contains various sandstone and coal-bearing (lignite) units. The Gallup Sandstone (Kg) unit is also present in the northern portion of the alignment. The majority of the southern portion of the N-11(1A) alignment is comprised of Lower Mancos Shale (Kml) materials, with the southernmost tip of the alignment consisting of combined Mancos Shale and Dakota Sandstone (Kmd). During our field activities, sandstones, shales, siltstones and occasional coal seams were observed along the project site.

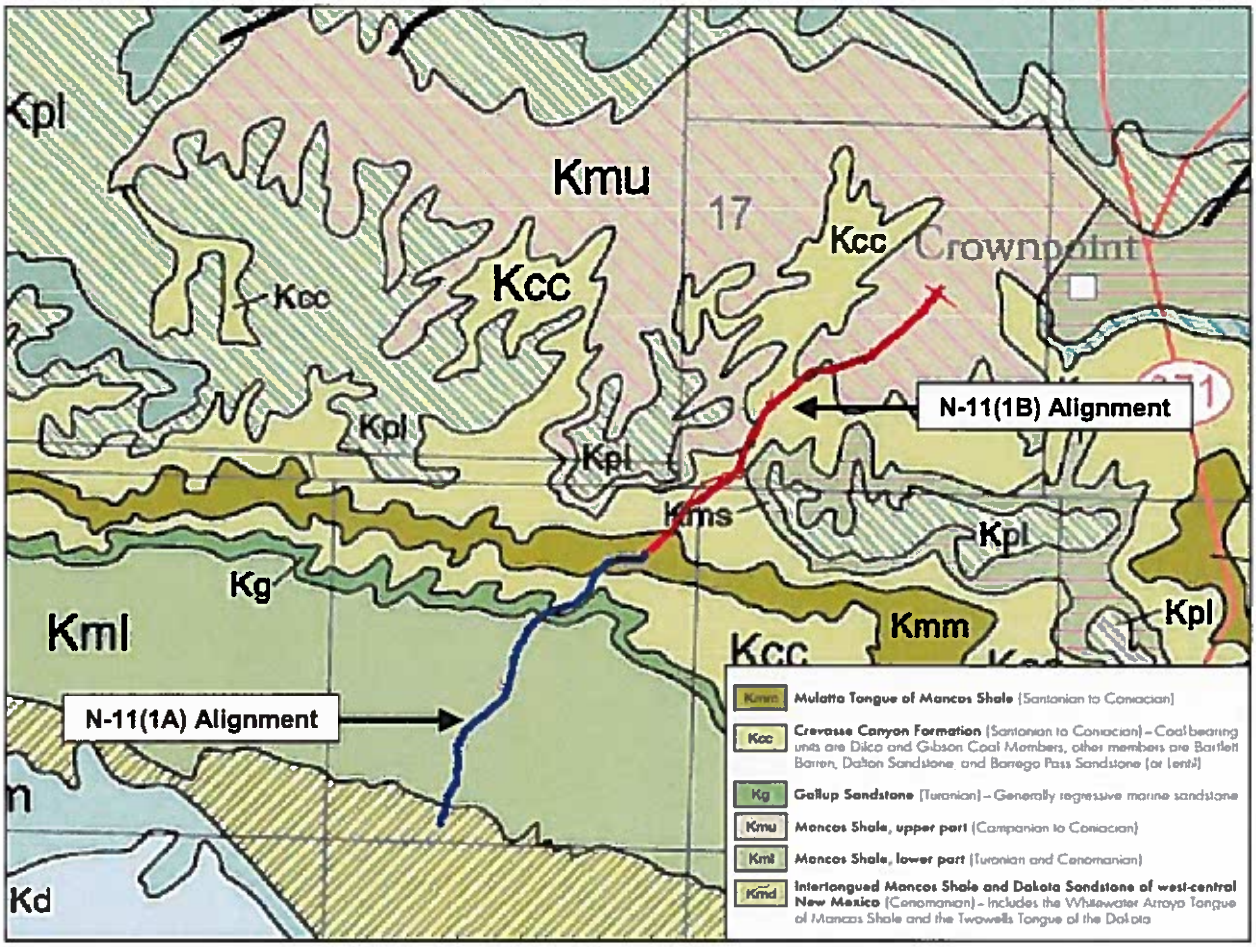

Figure 3.1 – Project Vicinity Geologic Map

3.3 ROADWAY CONDITIONS

Subsurface conditions encountered at the boring locations are described using general conditions below. For specific information at each soil boring location, please refer to the actual soil boring logs presented in Appendix B.

3.3.1 Subsurface Conditions

3.3.1.1 Road Alignment

BOP to Approximate Station 2+000 (borings GR-1 to GR-11)

Stratum 1: Alluvium – Stratum 1 (as described in the following sections), was not observed in our geotechnical borings from BOP to approximate station 2+000.

Stratum 2: Claystone and Siltstone (Kml and Kcc geologic units) – Stratum 2 consisted of highly weathered to decomposed claystone and siltstone with intermittent clay and silt

layers. This layer was light brown to gray in color, moist with occasional gypsum crystals and iron oxide staining. This stratum was encountered to the total depth of borings GR-1 through GR-11, approximately 3.5 m, 11.5 ft below ground surface (bgs). Blow counts for this stratum ranged from 9 blows per foot (305 mm) to 50 blows for 4 inches (100 mm) with an average blow count of 39 blows per foot. The plasticity of the material was low to high. Liquid limit values ranged from 29 to 54, and plasticity indices ranged from 9 to 23.

Stratum 3: Shale – Stratum 3 (as described in the following sections), was not observed in our geotechnical borings from BOP to approximate station 2+000.

Stratum 4: Sandstone (Kg geologic unit) – A layer of weathered sandstone with siltstone was encountered in borings GR-8 and GR-9. The layer was encountered at ground surface in boring GR-8 and 1.1 m (3.5 ft) below ground surface in boring GR-9. This layer was approximately 0.6 m (2 ft) to 1.2 m (4 ft) thick and contained silt and clay seams.

Approximate Station 2+000 to 3+980 (borings GR-12 to GR-20)

Stratum 1: Alluvium – Stratum 1 consisted of a thin soil layer approximately 0.2 m to 1 m (0.5 to 3.5 ft) thick consisting of sandy lean clay (CL) to high plasticity clay (CH). This clay layer exhibited a stiff to hard consistency and was brown in color. The moisture content in this layer ranged from 9.6% to 11.6%. N-values ranged from 11 to 40.

Stratum 2: Claystone and Siltstone (Kml geologic unit) – Stratum 2 consisted of highly weathered to decomposed claystone and siltstone to the total depth of the general roadway borings (generally 3.5 m, 11.5 ft bgs, ranging to 6.6 m, 21.5 ft bgs in boring GR-17). This stratum was generally brown to gray, moist with iron oxide staining and occasional gypsum crystals and calcite. Plasticity was low to high, with liquid limits values ranging from 47 to 54 and plasticity indices ranging from 19 to 23. Occasional clay or silt layers were observed in Stratum 2. Occasional sandy layers were also observed. Thin sandstone layers were observed in boring GR-20 at 2.3 m, 7.5 ft bgs and GR-17 at 4.9 m, 16 ft bgs.

Approximate Station 3+980 to 5+700 (borings GR-21 to GR-29)

Stratum 1: Alluvium – This soil layer consisted of silty sand (SM) to sandy silt (ML). This layer was usually encountered at the ground surface and generally ranged from 1.2 to 3.5 m (4 to 11.5 ft) thick. Intermittent layers of poorly-graded sand (SP) with varying silt content were also observed in the borings. N-values in this soil layer ranged from 5 to 27 with an average value of 13. Moisture contents ranged from 3.6% to 8.5% with an average moisture content of 6%. Loose zones were encountered in borings GR-28 and GR-29 at a depth of 0.8 to 3.5 m (2.5 to 11.5 ft) with N-values ranging from 5 to 7. Moisture contents in this loose zone ranged from 5.1% to 7.2%.

A layer of sandy lean clay (CL) was also encountered in Stratum 1 in borings GR-21, GR-22, GR-24, GR-27, and GR-28. This soil layer was usually encountered below Stratum 1 at a depth of 1.2 to 3.4 m (4 to 11 ft) bgs. However, this soil layer was encountered at the ground surface at borings GR-27 and GR-28 and was 1.4 to 2.1 m (4.5 to 7 ft) thick. N-values in this soil layer ranged from 9 to 22 with an average value of 22. Moisture contents ranged from 7.1% to 12.8% with an average moisture content of 10.4%. The layer had an average liquid limit of 44 and an average plasticity index of 19.

Approximate Station 5+700 to EOP (borings GR-30 to GR-54)

Stratum 1: Alluvium – A layer of silty sand (SM) to clayey sand (SC) was encountered at the ground surface and ranged from 0.3 to 3.7 m (1 to 12 ft thick). N-values in this soil layer ranged from 2 to 37 with an average value of 13. Moisture contents ranged from 7.2% to 16.3% with an average moisture content of 11.2%.

Approximately 7 m (23 ft) of clayey sand (SC) was encountered in boring GR-46. N-values ranged from 2 to 25 with an average value of 8. Moisture contents ranged from 10.7% to 14.8% with an average moisture content of 13%. Clayey sand (SC) was also encountered in borings GR-31 and GR-32 from 1.5 to 3.5 m (5 to 11.5 ft) bgs. N-values in this layer ranged from 3 to 19 with a moisture content of 16.1%. Average liquid limit and plasticity index values were 30 and 10, respectively.

A layer of sandy lean clay (CL) was encountered in boring GR-31 from 0.6 to 1.7 m (2 to 5.5 ft) bgs. This clay layer had an N-value of 18 with a moisture content of 13%. This clay layer was also encountered in boring GR-33 from 0 to 1.8 m (6 ft) bgs with N-values ranging from 15 to 46 and moisture contents ranging from 9.4% to 11.2%. The layer had a liquid limit of 32 and a plasticity index of 14.

Lose Soil Zones: Intermittent zones of very loose to loose soil (N-values less than 10) were encountered in silt (ML) and sand (SM to SC) layers in borings GR-35 to GR-51. These zones were located at depths ranging from ground surface to 7 m (23 ft) bgs.

Stratum 2: Claystone and Siltstone (Kcc and Kmm geologic units) – Highly weathered to decomposed claystone and siltstone were encountered below Stratum 1. This stratum was generally brown to gray, moist, with ferric staining and occasional gypsum crystals and calcite. Occasional clay, silt and sand layers were observed in Stratum 2. Slightly weathered claystone and siltstone were observed in borings GR-40, GR-41, GR-42, GR-44, and GR-53. Liquid limit values ranged from 24 to 43 and plasticity index values ranged from 5 to 19 in this layer.

Stratum 3: Shale (Kml geologic unit) – Shale was encountered in borings GR-37 and GR-38. The shale layer exhibited high blow counts (50 for 125 mm, 5 in), was gray and brown in color, exhibited iron oxide staining and was in a moist condition. The liquid limit and plasticity index values were 33 and 12, respectively. In addition, intermittent seams of weathered shale were encountered in our exploratory borings from approximate station 8+000 to 9+600.

Stratum 4: Sandstone (Kg and Kcc geologic units) – Intermittent sandstone layers were observed in the borings at depths ranging from ground surface to 3.2 m (10.5 ft) below ground surface. The layer ranged from 0.3 m (1 ft) thick to greater than 8.2 m (27 ft) in boring GR-42. The sandstone was fine grained, poorly to moderately cemented and very weathered to slightly weathered. A coal (lignite) seam was encountered within this layer in boring GR-38.

Approximate Station 8+600 (Cut Area, boring GR-45)

According to the vertical road profile provided by WHPacific, a cut section is planned near station 8+600. The subsurface conditions at this cut area were explored by advancing boring GR-45 to a depth of 21.9 m (72 ft). The subsurface conditions encountered in this boring are described below.

Stratum 1: Alluvium – Stratum 1 was not observed in boring GR-45.

Stratum 2: Claystone and Siltstone (Kcc and Kmm geologic units) – Thin beds of alternating claystone, siltstone and sandstone layers were encountered through hollow stem auger drilling in boring GR-45 to a depth of 3 m (10 ft) bgs. These beds were light brown to light gray with blow counts ranging from 32 to 50 blows per 3 inches (75 mm). Practical auger refusal was met at a depth of 3 m (10 ft) bgs. Rock coring was used to explore below this depth in boring GR-45.

Stratum 3: Shale – Stratum 3 was not observed in boring GR-45. However, intermittent, thin seams of shale were observed in Stratum 4 as described below.

Stratum 4: Sandstone (Kcc geologic unit) – Stratum 4 consisted of slightly weathered sandstone. This stratum was weak to medium strong, light gray in color, fine grained and slightly fractured. Intermittent shale and coal (lignite) seams were encountered in this layer. The rock core recovery in this stratum ranged from 56% to 100% with an average recovery of 63%. Rock quality designation (RQD) values ranged from 87% to 100% with an average RQD value of 98%.

3.3.1.2 Proposed Bridge Location

Approximate Station 3+950 to 3+980 (bridge borings BR-1 to BR-4)

Stratum 1: Alluvium – A sandy lean clay (CL) layer was encountered in the bridge borings from 0 to 5.3 m (17.5 ft) bgs. This soil layer exhibited an increased plasticity in borings BR-1 and BR-3 from 1.2 to 1.5 m (4 to 5 ft) bgs and 3.8 to 5.3 m (12.5 to 17.5 ft) bgs, respectively. Stratum 1 also contained gravel in boring BR-3 from 4.4 to 4.9 m (14.5 to 16 ft) bgs. N-values in this soil layer ranged from 18 to 71 with an average value of 39 and an average moisture content of 16.5%.

A layer of silty sand (SM) to sandy silt (ML) was encountered in the bridge borings with the exception of boring BR-2. This layer was 1.4 to 1.8 m (4.5 to 6 ft) thick and located at the approximate mid-point of Stratum 1 in borings BR-1 and BR-3. Stratum 2 was

located below Stratum 1 in boring BR-4 from 3.7 to 4.9 m (12 to 16 ft) bgs. N-values in this soil layer ranged from 14 to 43 with an average value of 26 and an average moisture content of 12.8%.

Stratum 2: Claystone (Kml geologic unit) – Stratum 2 consisted of highly weathered to decomposed claystone of a hard clay consistency. This claystone layer was encountered in the bridge borings at an average depth of 4.4 m (14.5 ft) and had an average thickness of 4.1 m (13.5 ft). This stratum was generally brown with gray brown iron oxide staining, thickly bedded, moderately fractured, with calcite fracture infilling and occasional fine to medium gravel inclusions. Occasional thin sandstone layers and clay layers were also encountered in Stratum 3. N-values in this decomposed rock layer ranged from 21 to 54 with an average value of 39.

Stratum 3: Shale (Kml geologic unit) – Stratum 3 consisted of slightly weathered, weak shale. Rock coring was used to explore this stratum in borings BR-1 to BR-4. Stratum 4 was encountered in the bridge borings at an average depth of 8.5 m (28 ft) and extended to the total depth of each boring (approximately 16.8 m, 55 ft). This stratum was generally gray to light yellow brown in color, laminated, with calcite infilling the bedding planes. The rock core recovery in this stratum ranged from 18% to 95% with an average recovery of 67%. Rock quality designation (RQD) values ranged from 9% to 92% with an average RQD value of 62%.

A layer of weathered to decomposed shale and claystone was observed along the eroded western bank of the Puerco River. This profile is shown in log EB-1 in Appendix B. The layer was highly weathered to decomposed, extremely weak to weak with thin sandstone and clay lenses.

Stratum 4: Sandstone (Kml geologic unit) – A thin layer of extremely weak and fractured sandstone was encountered in all of the bridge borings within Stratum 3. This layer was encountered at depths ranging from 11.1 m (36.5 ft) to 13.0 m (42.5 ft) in borings BR-1 through BR-4. The thickness of this layer ranged from 25 mm (1 inch) to 0.6 m (2 ft).

3.3.2 Groundwater Conditions

Groundwater was encountered in all exploratory borings located at the bridge abutment locations (borings BR-1 through BR-4) during our geotechnical exploration. Detailed groundwater readings are shown on the borehole logs in Appendix B. A summary of the groundwater readings are shown in the following table.

TABLE 3.1 – Depth to Groundwater Summary

Borehole	Approximate Borehole Surface Elevation		Approximate Depth to Groundwater		Approximate Groundwater Elevation	
	(m)	(ft)	(m)	(ft)	(m)	(ft)
BR-1	2165.5	7104.7	7.6	25.0	2157.9	7079.7
BR-2	2165.5	7104.7	6.9	22.5	2158.6	7082.2
BR-3	2162.0	7093.2	7.6	25.0	2154.4	7068.2
BR-4	2163.0	7096.5	9.3	30.5	2153.7	7066.0

The groundwater levels recorded in the borings and presented in this section represent conditions at the time the borings were drilled. The groundwater conditions at the time of construction may vary. In addition, surface runoff may vary throughout the year. The depth to groundwater in the Puerco River wash area may fluctuate depending on the amount of water generated by surface runoff.

3.3.3 Collapse Potential of Soils

Hydro-collapse potential is the potential for vertical settlement caused by inundation of the foundation bearing soils after construction. Soils with possible hydro-collapse potential were identified for the N-11(1A) alignment based on unit weight values obtained from laboratory test results and consideration of SPT blow counts. Soils with collapse-potential were identified in borings GR-21, GR-25, GR-29, GR-35, GR-41, GR-46 and GR-49 in silty sand (SM), clayey sand (SC) and sandy silt (ML) soils at depths ranging from 0.8 m to 1.8 m (2.5 ft to 6 ft) below ground surface. In addition, soils with possible collapse potential were identified in bridge boring BR-4 where poorly-graded sand with silt (SP-SM) soils were encountered at an approximate depth of 3.8 m (12.5 ft) below ground surface.

If the potentially collapsible soils in these areas are subjected to concentrated moisture, differential settlements can occur, resulting in premature pavement distress. In this regard, positive subgrade drainage and avoiding ponding conditions along the road alignment will be essential in these areas to avoid the risk of premature pavement distress due to hydro-collapsible conditions.

Isolated areas of hydro-collapsible soils located in the top few meters of the soil profile are a common occurrence in the desert southwest and could be present in other areas of the alignment. These soils become mildly cemented by calcium minerals. When the soils become wetted the cementation breaks down and the soils can experience sudden large settlements. In this regard, adequate subsurface drainage in the final design and protection from possible surface water ponding and/or infiltration during construction is very important to the structural performance of the pavement.

4. CONCLUSIONS AND RECOMMENDATIONS

4.1 GENERAL

Based on the information presented herein, it is Kleinfelder's opinion that the site may be developed as proposed and described in this report, provided that the recommendations presented in this report are incorporated into design and construction. These opinions, conclusions, and recommendations are based on our field investigation and review of the logs, engineering analysis, the properties of the soil encountered in our borings, the results of the laboratory testing program, and our understanding of the proposed development of the site.

Kleinfelder's borehole depths and locations were determined based on the vertical and horizontal alignment shown in Figure 1 of this report. If the alignment is significantly changed from that presented in Figure 1, a representative of the geotechnical engineer should review the new alignment to ensure that the recommendations presented in this report still apply. We have been notified about the reduction of the cut area at station 8+600 that resulted in a change in the vertical alignment; this alignment change does not affect our recommendations.

4.2 GEOTECHNICAL CONSIDERATIONS

4.2.1 General Considerations

One of the principal geotechnical concerns for pavement subgrade support is the significant variation of geologic materials and their corresponding stiffness values along the project alignment as indicated by the borings logs, geologic reconnaissance and test data. The variation of subgrade support between the different soil types encountered in our geotechnical investigation is further discussed in Section 4.4.1. While alternate pavement sections are often used to provide thicker pavement sections in poorer subgrade support areas, it was possible to utilize the same pavement design section for this project due primarily to the projected low traffic volume. As discussed in Section 4.4.4, a BIA minimum pavement section of 76 mm (3.0 inches) of asphalt over 150 mm (6 inches) of aggregate base course is recommended for the pavement design.

Another geotechnical concern associated with the site is loose and/or hydro-collapsible soil zones encountered in our exploratory borings as discussed in Sections 3.3.1 and 3.3.3, respectively. Intermittent zones of very loose to loose soil (N-values less than 10) were encountered in our borings from approximate stations 5+600 to 5+750 and stations 6+600 to 9+800. While the majority of the loose soil zones are located in proposed cut or fill areas, several areas may have loose soil zones located near the existing vertical alignment. These locations include approximate station 5+720, stations 7+300 to 7+600 and stations 8+950 to 9+700. Zones of potentially hydro-collapsible soils are discussed in Section 3.3.3. It is important to note that Kleinfelder's

geotechnical borings sampled a small portion of the subsurface conditions at the site and that additional loose soil zones may be encountered at other locations along the N11(1A) alignment during construction.

Layers of strong sandstone were encountered in borings GR-42 and GR-45, which are located in the proposed cut sections between approximate stations 7+600 to 9+000. While much of the sandstone material may be rippable using conventional equipment, some zones may be strong enough and sufficiently widely-jointed so as to resist ripping and removal may require heavy-duty excavation equipment such as rock saws or hoe-rams. It may be necessary to perform ripping tests or seismic tests to evaluate the required method of removal for the sandstone material.

4.2.2 Use of Mancos Shale during Construction

As discussed in Section 3.3.1, intermittent layers of claystone, siltstone and soft, fissile shale (referred to herein as the Mancos Shale unit) were encountered in the alignment profile.

The challenge of using shale as structural fill centers around the potential for excessive post construction settlement and for large slope instabilities. The root cause of this poor performance is generally attributable to infiltration of water after construction causing either a degradation of the shale material properties or causing water induced settlements. Shales, such as Mancos shale, that are nondurable and that are placed as rock fill are particularly susceptible to post construction settlement and large slope instabilities. In addition, shales that are mixed with harder rock that prevents adequate compaction can experience post construction settlement. In terms of the use of shales in embankments, the most conservative approach is to break them down into small fragments and place them in thin lifts as soil.

A secondary concern for the use of shale in embankments is the potential for surface erosion that can form shallow slides on outer slopes that can progress over time into deeper slides and eventually lead to large slope instabilities.

Based upon our previous experiences with this material it is the opinion of Kleinfelder that Mancos Shale in the vicinity of the project can be successfully used in roadway embankment construction provided that it is treated as a soil and broken down and compacted in thin lifts to eliminate the potential for large voids. In addition, the shale should be placed in the embankment away from exposed surfaces and the slopes should be covered with soil or crushed sandstone so that the shale is not subjected to surface runoff erosion.

The primary concern for the design engineer when using Mancos Shale as a compacted soil is to prevent the shale from having access to water that can further degrade its properties or create excessive settlements. While post construction swelling/settlement

potential may exist (due to the moisture conditioning during placement), the majority of these movements should take place over relatively short periods of time and should be essentially completed within 1 to 3 months after placement.

Mancos Shale should be broken down into pieces no larger than 5 cm (2 in) in diameter prior to placement as soil. A bulldozer with a disk and a sheepsfoot roller working on lifts with a maximum thickness of 15 cm (6 in) should be able to break down the intact Mancos Shale. Road embankment construction could proceed as follows:

1) Following excavation of the shale and other overburden soils, the shale and/or overburden soils should be transported to the embankment area to be placed in the bottom 20 percent of the fill height and at least 2.4 m (8 ft) from the final surface of the embankment slope.

2) The excavated Mancos Shale should be laid out in a lift of not more than 15 cm (6 in) thick and broken down using a bulldozer or sheepsfoot roller. The material should be broken down into pieces not greater than 5 cm (2 in) in diameter. The Mancos Shale will then be moisture conditioned, and compacted with a sheepsfoot roller to the target compactive effort as developed by the laboratory experimental results.

3) The process should be repeated for each additional lift.

4.3 Bridge Foundations

4.3.1 Foundation Type and Loading

Based on information provided by Mr. Mike Zwolinski, P.E. of WHPacific, the new bridge structure over the Puerco River will consist of a single span bridge with a span length of 27.4 m (90 ft) and two abutments. It is our understanding that driven piles are the preferred foundation system, with driven steel H-piles oriented with the X-X (strong) axis of the pile oriented in the direction perpendicular to the bridge (i.e. the direction of river flow). The planned design with the weak axis in the longitudinal direction will accommodate thermal expansion and contraction without the use of expansion joints at the abutments. Passive earth pressure against the abutment backwalls will be relied upon to resist the longitudinal tractive and seismic loads parallel to the longitudinal axis of the bridge.

It is our understanding that five (5) HP360X152 (HP14X102, imperial units) piles will be utilized at each abutment. Foundation reactions for four different loading cases were provided by Mr. Mike Zwolinski as shown in Table 4.1.

TABLE 4.1 – Pile Foundation Reactions
(reactions for single HP360X152 pile)

Loading Case	Maximum Axial Load		Shear Force about x-x axis		Shear Force about y-y axis		Moment about y-y axis	
	(kN)	(kips)	(kN)	(kips)	(kN)	(kips)	(kN-m)	(kip-ft)
Case 1, Str Ia	1233.0	277.2	0.0	0.0	32.9	7.4	22.4	16.5
Case 2, Str V	1159.7	260.7	11.6	2.6	27.1	6.1	17.4	12.8
Case 3, Ext Event	926.6	208.3	48.0	10.8	13.3	3.0	8.4	6.2
Case 4, Str Ib	970.2	218.1	0.0	0.0	33.4	7.5	15.9	11.7

4.3.2 Pile Casing

It is our understanding that piles in the upper 3 m (10 ft) may be sleeved (unsupported laterally), with a corrugated metal pipe (CMP) casing for additional flexibility and in order to better distribute bending moments along the pile length. The results of our lateral analysis presented in the following sections account for this scenario. Based on conversations with Mr. Mike Zwolinski, the annular space between the casing and the piles must be filled to prevent concrete from leaking into the annulus. We recommend that annular backfill in the upper 3 m (10 ft) consist of a loose foam (such as Styrofoam packaging "peanuts" or similar) to provide backfill while still maintaining flexibility. The top of the annular space may then be capped to prevent concrete from flowing into the backfill material.

4.3.3 Pre-Boring

As discussed in Section 3.3.1, the stratum encountered in our exploratory borings (BR-1 through BR-4) at the bridge abutment locations consisted of a layer of slightly weathered shale overlain by highly weathered to decomposed claystone and alluvial material (sands, silts and clays). During our exploratory drilling, auger or SPT refusal was not encountered in the soils and weak claystone overlying the shale bedrock layer. Based on the information obtained from the borings, pre-boring should not be required in the weak claystone layer. However, zones of boulders or resistant shale are possible in the bridge area and may require pre-boring in some cases.

4.3.4 Scour Potential

In order to indentify the potential for scour on the bridge foundations, Kleinfelder performed gradation tests on select soil samples from the borings located in the proposed bridge location (borings BR-1 through BR-4). These test results are presented in Appendix C of this report. The results from the gradation tests were

provided to WHPacific and a maximum scour depth of 4.2 m (13.8 ft) was subsequently determined by WHPacific. Based on preliminary design drawings provided by Mr. Mike Zwolinski, the river slopes are designed to be protected with wire enclosed riprap. At the request of WHPacific, Kleinfelder's lateral and axial pile capacity calculations considered no scour for normal conditions and 4.2 m (13.8 ft) of scour potential for the Q500 event.

4.3.5 Axial Capacity of Piles

Kleinfelder evaluated the axial capacity of the piles at the bridge abutments using the AASHTO computer program Driven. Based on the borehole logs from our geotechnical evaluation, a generalized subsurface profile was compiled for the bridge location. Axial capacity of the piles was calculated assuming support from skin friction in the upper alluvium and weathered claystone layers and end-bearing in the shale material located below these layers; a friction component of axial capacity was not considered in the shale material.

Due to the relatively softer nature of the materials overlying the bearing strata, steel piles should be checked for compact section (buckling). Estimated axial pile capacities for use in LRFD strength design, as a function of depth, are shown in Figure 4.1. Results are presented for no scour and 4.2 m (13.8 ft) of scour.

Piles driven into shale materials, as shown on the boring logs, should be driven to capacity as determined by final blow counts per foot. Based on our borings at the proposed bridge location, the depth to shale material on the north bridge abutment (at boring locations BR-03 and BR-04) ranged from approximately 8.5 m to 10.1 m (28 ft to 33 ft) bgs. This depth corresponds to approximate elevations of 2,153.5 m (7,065 ft) to 2153 m (7064 ft). The depth to shale on the south bridge abutment (at boring locations BR-01 and BR-02) was approximately 7.8 m (25.5 ft) bgs. These depths correspond to an approximate elevation of 2,154.7 m (7,069 ft).

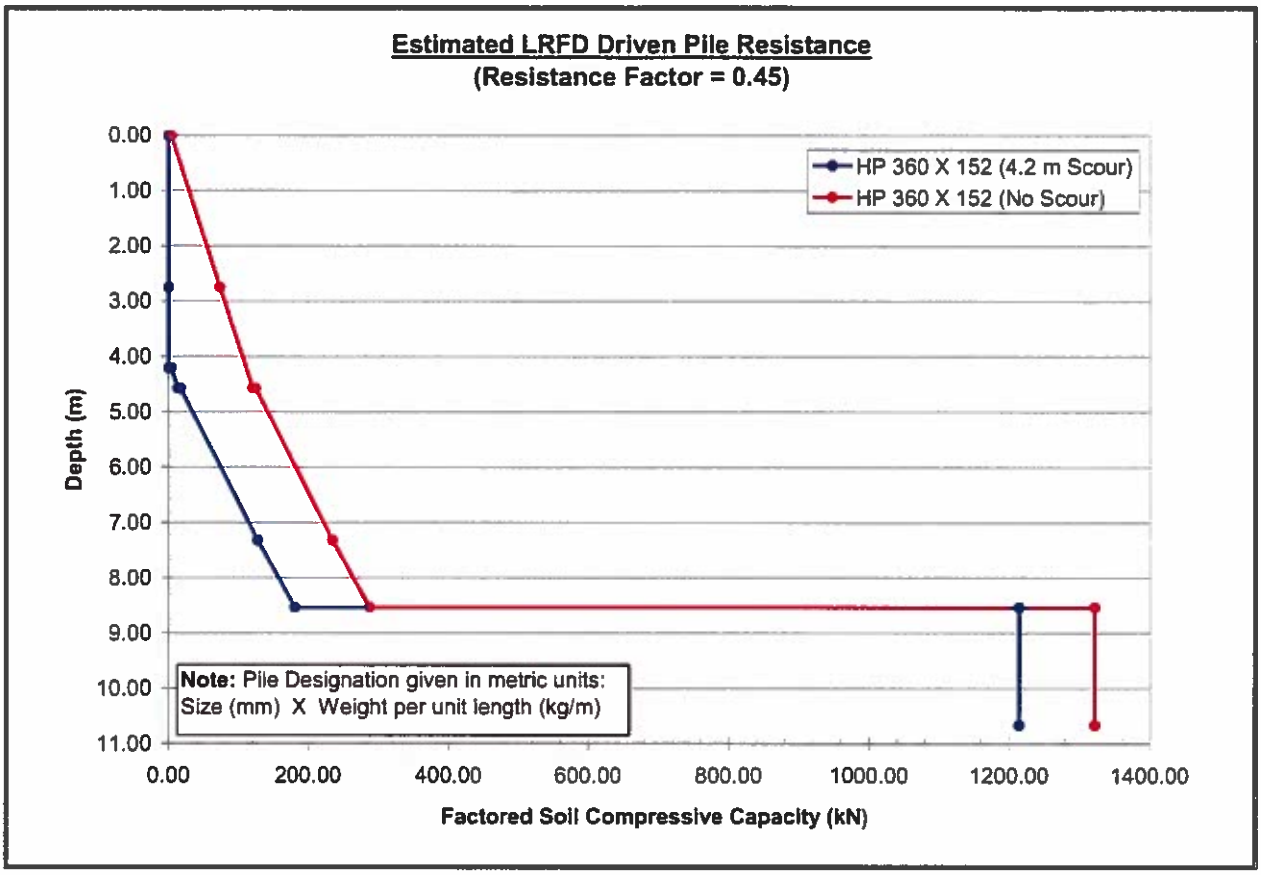

Figure 4.1 – Axial Capacity of Piles

4.3.6 Lateral Capacity of Piles

Kleinfelder evaluated the lateral capacity of the piles at the bridge abutments using the computer program LPILE PLUS 5.0. The LPILE calculations were made using soil and rock properties obtained or estimated from the test borings and laboratory tests. Based on information received from the WHPacific bridge design engineers, LPILE calculations for the piles were made using the assumption that the X-X axis of the piles (the stiffer direction in bending) would be oriented in the direction perpendicular to the bridge (i.e. the direction resisting river flows). Analyses were performed to determine *ultimate* lateral load capacity. *Allowable* lateral pile capacities should be reduced based on allowable lateral deflection at the pile head.

The LPILE analyses were performed for a total of 8 cases in which the lateral and axial loads for the four loading cases were applied. As discussed above, pile loads were provided for a single, HP360X152 (HP14X102, imperial units) pile based on five piles per abutment. All analyses were performed assuming a laterally-unsupported length in the upper 3 m (10 ft) of the pile to account for the CMP casing. Analyses were performed for no scour and a 4.2 m (13.8 ft) scour depth. A typical soil profile as was found at borings BR-01 through BR-04 was utilized in our analysis. Results for the lateral capacity of piles for the bridge foundation are presented in Appendix E. The

results of the lateral analysis do not account for passive earth resistance. The equivalent fluid pressure for passive earth resistance presented in Section 4.3.7 may be applied to the pile cap.

4.3.7 Bridge Abutments

Lateral earth pressures acting against abutments, columns, and wing walls can be estimated using the earth pressures presented in Table 4.2. The earth pressures are based on engineered fill material modeled with a friction angle (Φ) of 32 degrees and a moist unit weight (γ) of 2,000 kg/m^3 (125 pounds lb/ft^3)

TABLE 4.2 – Earth Pressures

Lateral Earth Pressure Case	Equivalent Fluid Pressure	
	(kg/m^3)	(lb/ft^3)
Active Earth Pressure	560	35
Passive Earth Pressure	4,805	300

The earth pressures provided above were calculated assuming vertical walls backfilled with materials that meet the specifications for structural fill and engineered fill as described in Section 704.04 of the FP-03 Specifications. Proper drainage should be designed behind the walls to allow for drained conditions in the backfill soils and to prevent hydrostatic pressure behind the abutments and walls.

4.4 PAVEMENTS

Kleinfelder performed the pavement design calculations in accordance with the BIA Requirements specified in the design analysis report for Route N11. Detailed pavement design calculations are provided in Appendix F of this report. General pavement design recommendations for the proposed project are provided in the following sections.

4.4.1 Anticipated Pavement Subgrade Material

The subsurface soils encountered at the proposed pavement subgrade depth in the borings generally ranged from lean clay to low plasticity silt (CL to ML) to clayey and silty sands (SC to SM). Weathered rock (sandstone, siltstone, claystone and shale) with occasional layers of fat clay (CH) were also encountered throughout the alignment profile. In addition, lignite seams were observed in borings GR-38 and GR-45. Based on the range of geologic materials encountered and the highly variable N values from Standard Penetration Tests (SPT), variable subgrade support is anticipated. Therefore, our calculations were performed utilizing a conservative composite CBR estimate to account for weaker materials such as the clay and silt materials encountered in our borings. For specific information at each soil boring location, please refer to the actual soil boring logs presented in Appendix B.

CBR values were estimated based on the general soil types encountered in our field exploration as shown in Table 4.3. As previously discussed, there is significant lateral variation of soil types along the project section.

TABLE 4.3 – Estimated CBR Values Based on Material Type

Soil Type	Estimated CBR
Lean Clay (CL) to Fat Clay (CH) and Low Plasticity Silt (ML)	8
Clayey Sand (SC) and Silty Sand (SM)	17
Sandstone, Siltstone Claystone and Shale	50+

Because the overall performance of this road section will be more affected by the poorer subgrade soil sections, we recommend a composite CBR value of 8 be utilized for the design section of Route N11. The selected value represents a lower-end value that will govern the overall behavior of the pavement section. Using this value, a correlated subgrade resilient modulus of 65.5 MPa (9,500 psi) was used in our calculations.

4.4.2 Drainage Coefficient

A drainage coefficient of 1.0 for the asphalt crushed base course was used in our calculations. These values assume that positive drainage controls will be designed and constructed.

4.4.3 Design Traffic Loadings

Based on traffic count data in a BIA design analysis report for Route N11 (dated 06/27/05, revised 10/11/05) provided by WHPacific, it is our understanding that the average daily traffic (ADT) value was 371 vehicles per day (vpd) in 2002, with a projected ADT of 453 vpd for 2022. Based on a growth factor of 1.0% (provided in the BIA design analysis report), Kleinfelder calculated a 2009 ADT value of 398 vpd for 2-way traffic.

Based on information provided by Ms. Rachel LeVee of WHPacific, the anticipated percentage of heavy vehicles is 2%. The total ADT value was subdivided based on anticipated vehicle type as shown in Table 4.4. Using the ADT values for each vehicle type as shown in Table 4.4, a design period of 20 years, a growth factor of 1.0%, a direction factor of 1, and a lane distribution factor of 0.5, a total of 103,524 18-kip ESALs were estimated.

Table 4.4– Percent Annual Daily Traffic Values (ADT)

Vehicle Type	Percent of Total ADT	ADT Value (vpd)
Light Duty	93 %	370
Medium Duty	5 %	20
Heavy Duty	2 %	8
	Total ADT:	398

4.4.4 Design Sections

A hot mix asphalt and base course pavement section will involve treatment of the exposed subgrade soils as described in Section 4.5.1 "Site Preparation" of this report. An imported aggregate base course as described in Section 4.5.3.4 of this report is then placed over the treated subgrade soils. A hot mix asphalt pavement is then placed over the aggregate base course material.

The asphaltic concrete pavement sections were calculated using the 1993 AASHTO method. Based on our calculations a pavement section consisting of 76 mm (3 inches) asphalt over 150 mm (6 inches) of aggregate base would be sufficient for the anticipated traffic loads. This pavement section corresponds to the minimum required section specified in the BIA design analysis report. We therefore recommend the minimum BIA pavement section for Route N11 presented in the following table.

Table 4.5– Design Pavement Section

Traffic Loading	Asphaltic Concrete Pavement (ACP)	Aggregate Base
103,524 18-kip ESAL	76 mm (3 in) ACP	150 mm (6 in) Base

4.5 Construction Considerations

The following sections summarize the recommendations relating to construction. The recommendations are based on the subsurface conditions encountered and are in general accordance with the design guides presented in FP-03, the Standard Specifications for the Construction of Roads and Bridges on Federal Highway Projects. Specific recommendations for use of Mancos Shale during construction are provided in Section 4.2.2.

4.5.1 Site Preparation

All site preparation and earthwork operations should be performed in accordance with applicable codes, safety regulations and other local, State or Federal guidelines. In general, all the subgrade preparation work and earth moving should be performed

according the specifications in Section 204 "Excavation and Embankment", of the FP-03 Specifications.

Once the subgrade is exposed, we recommend it be tested and observed and all surface debris, trees, stumps, roots, organic matter and other objectionable protruding obstructions be cleared or removed as required. The subgrade should be cleared of unsuitable soils or debris, including coal (lignite) layers. Where lignite is exposed at the proposed final subgrade elevation, it should be undercut a minimum of 30 cm (12 in) to reduce the potential for future pavement distress. Any voids or holes in the subgrade resulting from the removal of unsuitable soils or lignite shall be backfilled and compacted in accordance with the recommendations in this report.

The subgrade should be graded to slope a minimum of 2% from the center to the edge. The subgrade should then be scarified to a minimum depth of 30 cm (12 in) and recompacted to a density not less than 95% of the maximum dry density and within 2% of the optimum moisture content as determined by AASHTO T 99, Method C or AASHTO T 180. Next a proof-roll test should be performed on the prepared subgrade to identify any soft areas in the subgrade that need additional compaction or stabilization.

Subgrade compaction shall be verified by field density tests taken at locations in accordance with the FP-03 minimum testing standards. The densities should be determined in accordance with AASHTO T 310, by nuclear methods or by other approved methods. In addition to the density tests, a proof-roll test should be performed once each layer has been placed.

Strong sandstone rock layers were encountered in the borings performed during our geotechnical exploration between approximate stations 7+600 to 9+000. Since these areas are located in proposed cut sections, it may be necessary to perform ripping tests or seismic tests to determine the required method of removal for the sandstone material.

4.5.2 Drainage

Long-term performance of pavement will require that the subgrade soils and engineered fill be protected against excessive water infiltration and/or saturation. We recommend the civil engineering design include measures to keep the subgrade dry and to include measures to divert water generated by drainage channels crossing the roadway, which could fluctuate throughout the year.

4.5.3 Engineered Fill

4.5.3.1 Acceptable Materials

The definition of "Engineered fill" is soil that is placed; moisture conditioned, compacted to a specified minimum density, and tested by the geotechnical engineer. The material

selected for engineered fill should be free of frozen soil, root mat material, organic and deleterious matter. In addition, some blending of soils and removal of debris may be required to achieve a uniform soil consistency.

Based on our visual identification of the soils, supplemented with laboratory testing, it is our opinion much of the on-site soils are acceptable for re-use as engineered fill provided they are suitably moisture conditioned prior to compaction and provided the soils meet the previously described criteria. Lignite layers (encountered in borings GR-38 and GR-45) should NOT be re-used as fill material due to its organic content and high potential for future pavement distress.

Lean to high-plasticity clay (CL to CH) and silty soils (ML to MH) observed at the boring locations were not confined to a single area of the alignment; rather, these soils were encountered throughout the alignment. While these soils are less desirable as a subgrade support layer and should not be imported from an off-site location, they may be used for engineered fill or blended with imported fill meeting the criteria specified in Table 4.6.

Table 4.6– Engineered Fill Requirements
From FP-03 Section 704.06, Unclassified Borrow

Soil Classification, AASHTO M 145	Approximate Equivalent USCS Soil Classification
A-1	GP, GW, GM, GC
A-3	SP,SW, SP-SM
A-2-4	SC, SM

The weathered shale, siltstone and claystone of the Mancos Shale Unit encountered in our borings along the southern portion of the alignment are generally not preferred material for engineered fill and may result in lowered subgrade performance over the design life of the road. The owner should consider this lowered performance versus the cost for using imported fill. Although it will be more labor intensive and require engineering support to successfully construct, a methodology to utilize a portion of Mancos Shale material in deep fill locations is presented in Section 4.2.2., "Use of Mancos Shale during Construction" of this report

If additional fill soils must be imported to the site, we recommend that the material for fill should consist of soils that meet the gradation requirements shown in Table 4.6.

4.5.3.2 Engineered Fill Placement and Compaction

If Mancos shale is used as engineered fill, the requirements described in section 4.2.2 "Use of Mancos Shale during Construction" of this report should be followed. Placement and compaction requirements for other fill material are as follows.

Any fill placed for the subbase where fill is required to raise the grade of the roadbed should be placed in horizontal layers not exceeding 300 mm (12 in), compacted measurement, and shall be compacted in accordance with the recommendations presented in this section and in Section 204 of the FP-03 Specifications. As discussed in Section 204.10 of the FP-03 Specifications, oversized boulders or rock fragments too large for a 30 cm (12 in) layer should be reduced in size or placed individually as discussed in Part (c) to prevent nested zones. Any subgrade areas disturbed by the construction activities should be repaired prior to placement of the next lift of fill. If lean to high-plasticity clay (CL to CH) and silty (ML to MH) soils are utilized for engineered fill, they should be used as lower fill layers placed near the soil subgrade. Fill materials conforming to the soils shown in Table 4.6 should be utilized for subsequent upper fill layers in contact with the base course layer.

Each lift of engineered fill should be compacted to not less than 95% of maximum density. The moisture content of the soil at the time of compaction should not exceed the optimum or be less than the optimum minus two percentage points as determined by AASHTO T 99, Method C or AASHTO T 180. If the moisture content at the time of compaction is not within the specified range, the material shall be either moistened or dried and thoroughly mixed by reprocessing, to the full depth of the lift, before re-compaction.

Maximum densities should be determined by AASHTO T 99, Method C or AASHTO T 180, and field densities should be determined by AASHTO T 310 or other approved methods. Densities shall be taken at each lift just prior to placing fill on the succeeding lift.

We recommend that a representative of the geotechnical engineer provide continuous on-site observation and testing during over-excavation, subgrade preparation, and placement of engineered fill to document compliance with the recommendations contained herein.

4.5.3.3 Shrinkage Factor

A shrinkage factor relates the decrease in volume of soils once they are compacted. Laboratory testing to determine the shrinkage factors of the onsite soils was not part of the scope of this project. A general shrinkage factor of 10 to 15 percent as described in the NAVFAC Design Manual 7.02 may be used for estimating purposes.

4.5.3.4 Aggregate Base Course

The aggregate base course should conform to Section 703.05 of the FP-03 Specifications. The base course should be composed of crushed stone material meeting the requirements specified in Table 703-2 of the FP-03 Specifications for Grading D Base as shown in the following table.

Table 4.7– Base Course Requirements From FP-03 Table 703-2

Standard Sieve Size	Percent Passing by Mass
25 mm (1.0 in)	100
19 mm (3/4 in)	86 (±6) – 100 (±6)
9.5 mm (3/8 in)	51 (±6) – 82 (±6)
4.75 mm (No. 4 sieve)	36 (±6) – 64 (±6)
425 µm (No. 40 sieve)	12 (±4) – 26 (±4)
75 µm (No. 200 sieve)	4 (±3) – 7 (±3)
Plasticity Requirements	
Liquid Limit	25 or less

The base course should be placed and compacted in accordance with Sections 301.05 of the FP-03 Specifications. The aggregate base course should be compacted to a minimum of 95 percent of the maximum dry density as determined in accordance with AASHTO T-99 or T-180 Method D. Moisture content, at the time of compaction, should be within 2 percent of the optimum moisture content.

4.5.3.5 Drainage Pipe Bedding and Backfill

Pipe bedding material shall conform to Section 704.02 of the FP-03 Specifications. Gradation requirements for pipe bedding are given in Table 4.8. Pipe backfill material shall conform to Section 704.03 of the FP-03 Specifications. Gradation requirements for pipe bedding are provided in Table 4.9. Pipe bedding and backfill should be placed and compacted in accordance with Section 209.09 and 209.10, respectively of the FP-03 Specifications.

Table 4.8– Bedding Material Requirements
From FP-03 Section 704.02, Bedding Material

Soil Classification, AASHTO M 145	Approximate Equivalent USCS Soil Classification
A-1	GP, GW, GM, GC
A-2-4	SC, SM
A-2-5	GM, SM
A-3	SP, SW
Max Particle Size	12.5 mm or half the corrugation depth, whichever is smaller

Table 4.9– Backfill Material Requirements for Structures and Pipes
From FP-03 Section 704.03, Backfill Material

Soil Classification, AASHTO M 145	Approximate Equivalent USCS Soil Classification
A-1	GP, GW, GM, GC
A-2	GM, GC, SM, SC
A-3	SP, SW
Max Particle Size	75 mm

Geo-chemical soil testing for corrosion potential was not part of this investigation's scope. Therefore, geo-chemical testing will need to be done prior to construction to determine the appropriate culvert type or thickness of galvanization.

4.5.3.6 Hot Mix Asphalt Concrete

Asphalt concrete materials quality and construction requirements should conform to Section 403 of the FP-03 Specifications. Asphalt binder should conform to Sections 702.01 and 702.04 of FP-03. Asphalt aggregate should conform to Section 703.07 of

FP-03 Specifications. Recommended asphalt aggregate gradation is summarized in the Table 4.10.

Table 4.10– Asphalt Aggregate Gradation Requirements From FP-03 Table 703-4

Standard Sieve Size	Percent Passing by Mass
25 mm (1.0 in)	100
19 mm (3/4 in)	97 – 100
12.5 mm (1/2 in)	76 (±5) – 88 (±5)
4.75 mm (No. 4 sieve)	49 (±7) – 59 (±7)
2.36 mm (No. 8 sieve)	36 (±5) – 45 (±5)
600 µm (No. 30 sieve)	20 (±4) – 28 (±4)
300 µm (No. 50 sieve)	13 (±3) – 21 (±3)
75 µm (No. 200 sieve)	3 (±2) – 7 (±2)

According to the New Mexico Department of Transportation Pavement Design Directive (IDD-2008-05) Table A-6, an asphalt binder grade of PG 58-28 is applicable for roads in McKinley County, New Mexico near the Thoreau, New Mexico station. As described in the NMDOT IDD-2008-05 Table A-7, an adjustment to the asphalt binder grade is then made to account for the traffic loading and traffic speed of the roadway. Using a traffic loading of 103,524 18-kip ESALs as described in Section 4.4.3 of this report and a traffic speed range of greater than 15 mph, no adjustment is necessary. Thus, an asphalt binder grade of PG 58-28 may be used for this project.

4.5.4 Construction in Wet or Cold Weather

Grading fill, structural fill or other fill should not be placed on frosted or frozen ground, nor should frozen material be placed as fill. Frozen ground should be allowed to thaw or be completely removed prior to placement of fill. If earthwork is performed during the winter months when freezing is a factor, a good practice is to cover the compacted fill with a "blanket" of loose fill each evening to help prevent the compacted fill from freezing. Prior to commencement of fill placement operations the next morning, the loose fill blanket must be entirely removed and allowed to thaw before incorporating it into the fill.

During construction, grade the site so that surface water can drain readily away from the pavement areas. Ponding of water in or near excavations should be avoided. Promptly pump out or otherwise remove water that accumulates in excavations or on subgrades, and allow these areas to dry out before resuming construction. Use berms, ditches, and similar means to prevent storm water from entering work areas and to convey it off-site efficiently.

4.5.5 Construction Testing and Observation

Field testing and construction observation should take place under the observation of Kleinfelder to support our engineer's professional opinion as to whether the earthwork does or does not substantially conform to the recommendations in this report.

Furthermore, the opinions and conclusions of a geotechnical report are based on interpretation of a limited amount of information obtained from the field exploration. It is therefore common to find that actual site conditions differ somewhat from those indicated in the report. Kleinfelder should remain involved throughout the project to evaluate such differing conditions as they appear, and to modify or add to the geotechnical recommendations as necessary.

5. CLOSURE

5.1 LIMITATIONS

This work was performed in a manner consistent with that level of care and skill ordinarily exercised by other members of Kleinfelder's profession practicing in the same locality, under similar conditions and at the date the services are provided. Our conclusions, opinions and recommendations are based on a limited number of observations and data. It is possible that conditions could vary between or beyond the data evaluated. Kleinfelder makes no other representation, guarantee or warranty, expression or implication, regarding the services, communication (oral or written), report, opinion, or instrument of service provided.

The scope of our services does not include services related to construction safety precautions and our recommendations are not intended to direct the contractor's methods, techniques, sequences, or procedures except as specifically described in our report for consideration in design. The scope of our services for this report did not include any environmental assessment or evaluation regarding the presence or absence of wetlands or hazardous or toxic materials in the soil, surface water, groundwater, air, or below or around the site.

This report may be used only by the Client and the registered design professional in charge and only for the purposes stated for this specific engagement within a reasonable time from its issuance, but in no event later than two (2) years from the date of the report.

The work performed was based on project information provided by the Client. If the Client does not retain Kleinfelder to review any plans and specifications, including any revisions or modifications to the plans and specifications, Kleinfelder assumes no responsibility for the suitability of our recommendations. In addition, if there are any changes in the field to the plans and specifications, the Client must obtain written approval from Kleinfelder's engineer that such changes do not affect our recommendations. Failure to do so will vitiate Kleinfelder's recommendations.

5.2 ADDITIONAL SERVICES

The recommendations provided in this report are based on the assumption that an adequate program of tests and observations will be performed during the construction to verify compliance with these recommendations. These tests and observations should include, but not necessarily be limited to, the following:

- Observations and testing during site preparation and earthwork operations.
- Slope stability of proposed soil and rock cuts
- Consultation as may be required during construction.

It is also recommended that the project plans and specifications be reviewed by Kleinfelder to verify compatibility with the conclusions and recommendations presented in this report. Additional information concerning the scope and cost of these services can be provided by this office upon request.

6. REFERENCES

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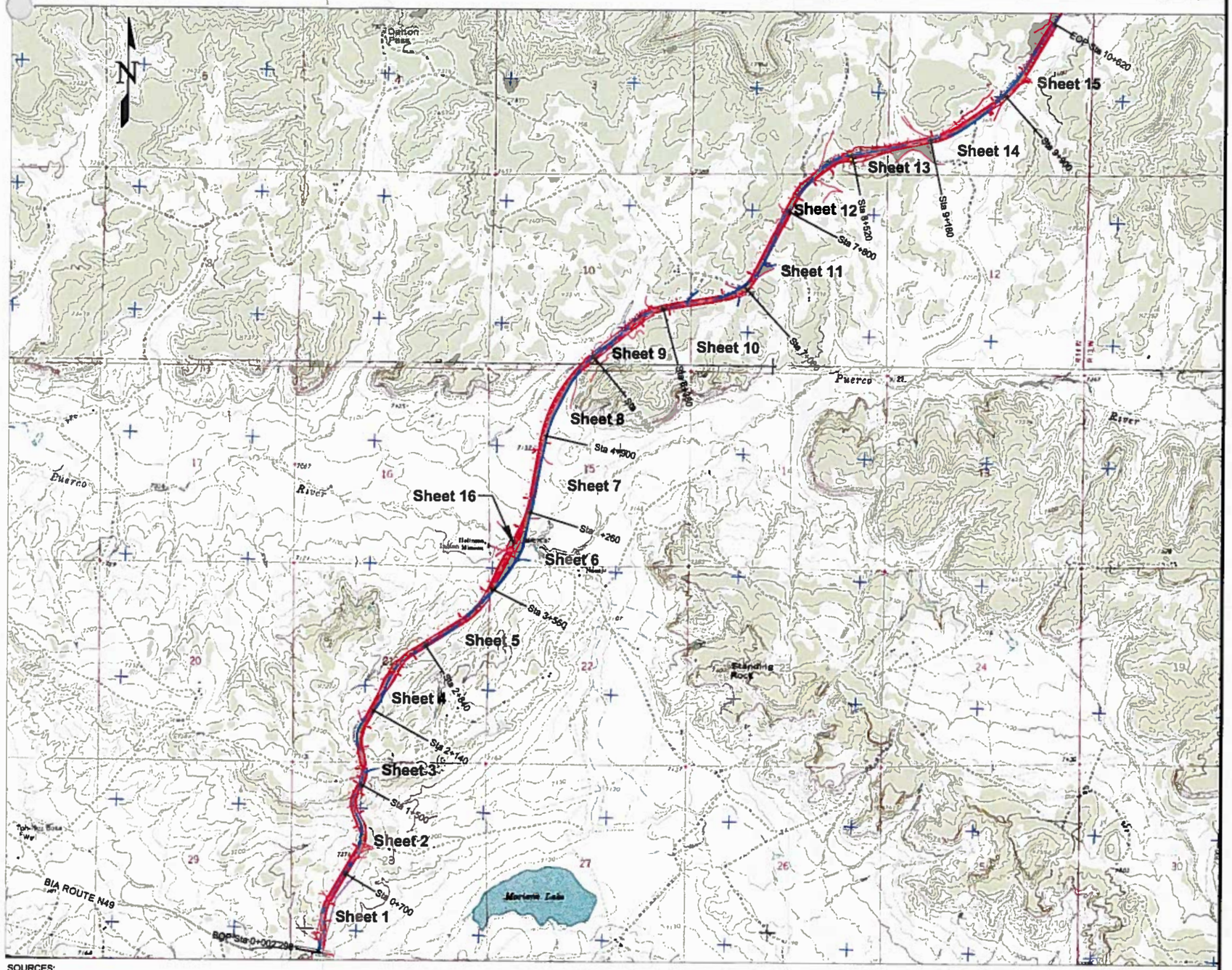
APPENDIX A

Figure 1 – Borehole Location Map (Sheets 1 through 17)

SOURCE: Base map provided my nationalatlas.gov.

LEGEND

- APPROXIMATE SITE LOCATION
- APPROXIMATE N11(1A) PROPOSED ALIGNMENT
- CURRENT APPROXIMATE N11 EXISTING ROADWAY



SOURCES:
1) N11(1A) ALIGNMENT PROVIDED BY WHPACIFIC ON CAD FILES:
A) N11(1A)-Base-09.30.09.dwg
2) TOPO MAP CREATED FROM MAPCARD.COM, 1:35000 SCALE.

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PROJECT NO.	105884
DRAWN:	JAN 2010
DRAWN BY:	PD
CHECKED BY:	MV
FILE NAME:	105884_SL_01.dwg

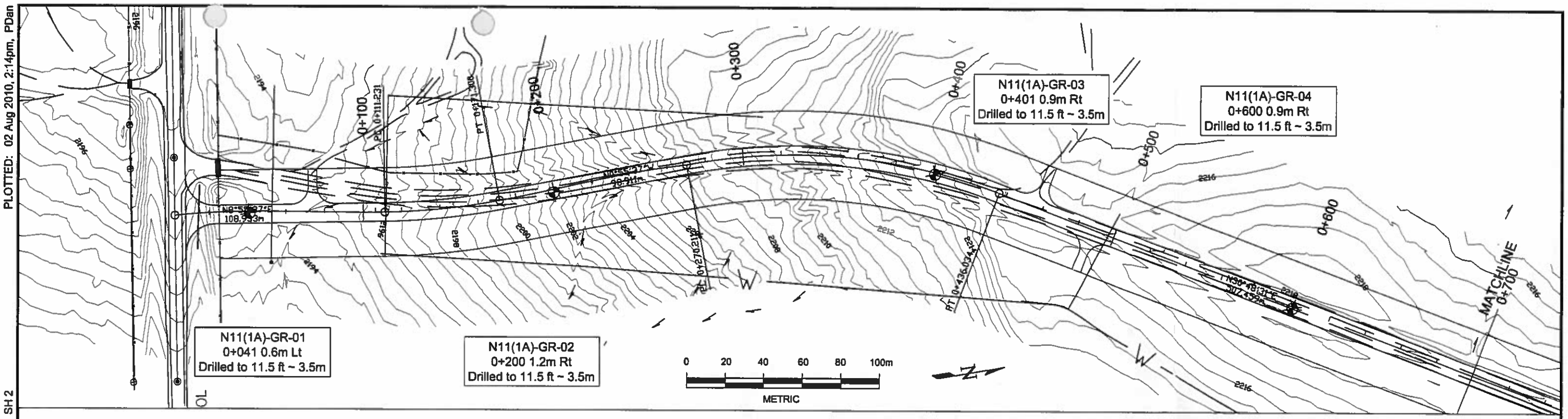
SITE LOCATION MAP

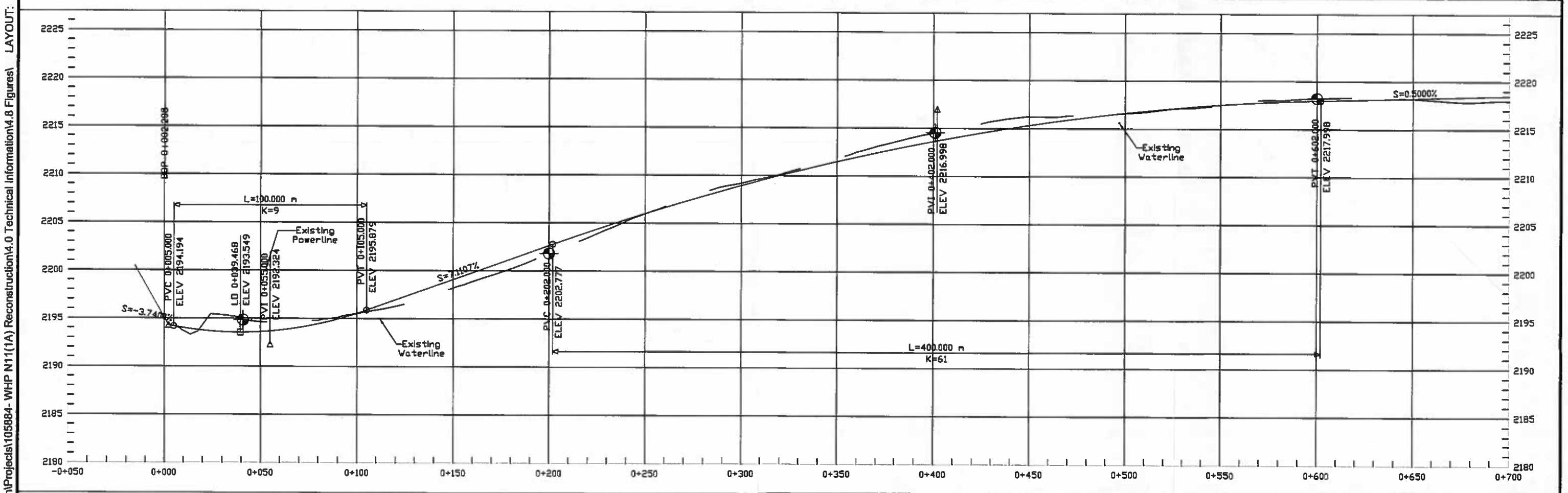
N11(1A)1, 2, & 4
BIA ROUTE - N11
NEAR CROWNPOINT, NM

ORIGINATOR:	M. VALLEJO
APPROVED BY:	
DRAWING CATEGORY:	1

FIGURE 1

SHEET 1 of 17





SOURCE:
1) BASE MAP PROVIDED BY WHPACIFIC ON CAD FILE: N11(1A)-BASE.DWG

LEGEND

⊕ APPROXIMATE BOREHOLE LOCATION

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PROJECT NO.	105884
DRAWN:	JAN 2010
REVISED BY:	PD
CHECKED BY:	CV
FILE NAME:	105884_01_05.dwg

BOREHOLE LOCATION MAP
BOP STA. 0+000 TO STA. 0+700

N11(1A)1, 2, & 4
BIA ROUTE - N11
NEAR CROWNPOINT, NEW MEXICO

ORIGINATOR: M. VALLEJO
APPROVED BY:
DRAWING CATEGORY: 2

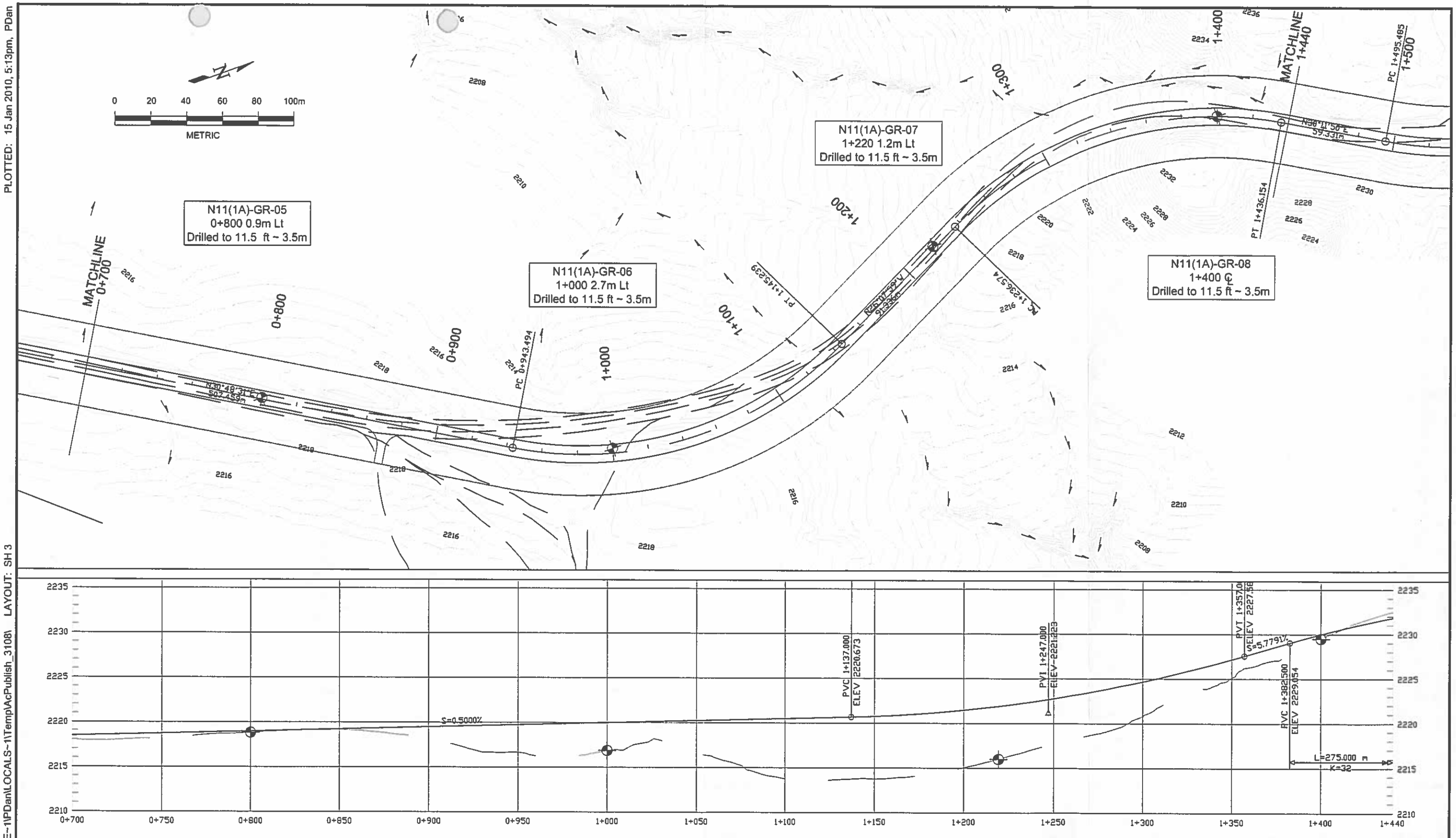
FIGURE 1
SHEET 2 of 17

PLOTTED: 15 Jan 2010, 5:13pm, PDan

CAD FILE: C:\DOCUME~1\PDan\LOCALS~1\Temp\AcPublish_3108\ LAYOUT: SH 3

ATTACHED XREFS:

ATTACHED IMAGES: Images: J. Laird.JPG



SOURCE.
1) BASE MAP PROVIDED BY WHPACIFIC ON CAD FILE:
N11(1A)-BASE.DWG

LEGEND

APPROXIMATE BOREHOLE LOCATION

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PROJECT NO.	105884
DRAWN:	JAN 2010
REVISED BY:	PD
CHECKED BY:	CV
FILE NAME:	105884_01_05.dwg

BOREHOLE LOCATION MAP
STA. 0+700 TO STA. 1+440

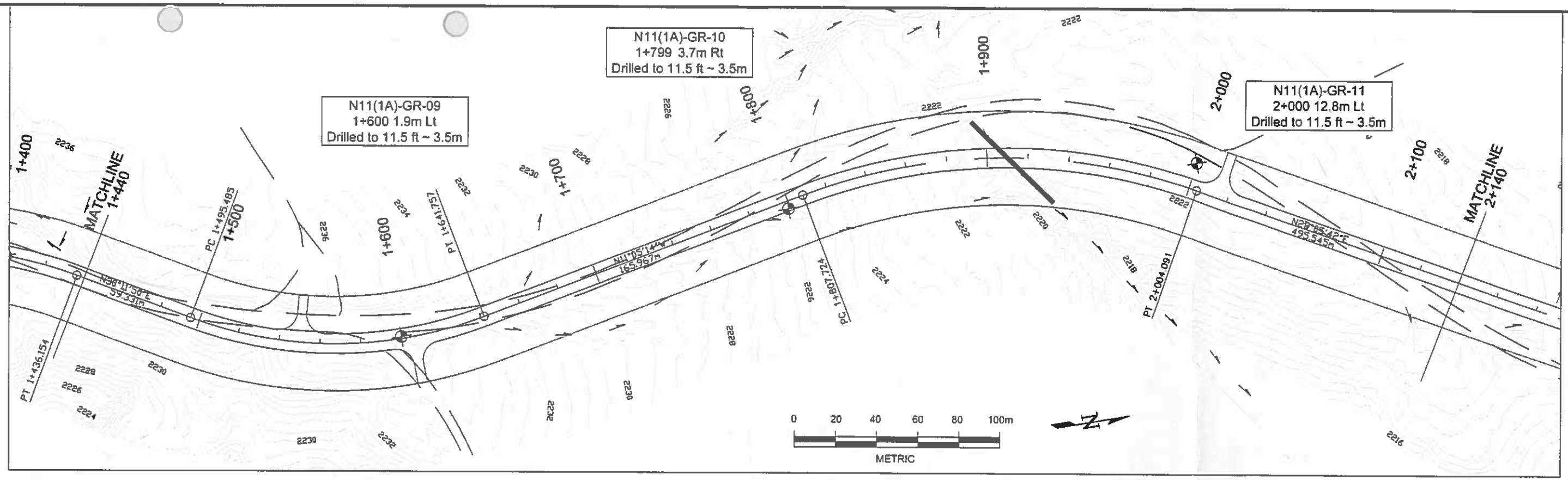
N11(1A)1, 2, & 4
BIA ROUTE - N11
NEAR CROWNPOINT, NEW MEXICO

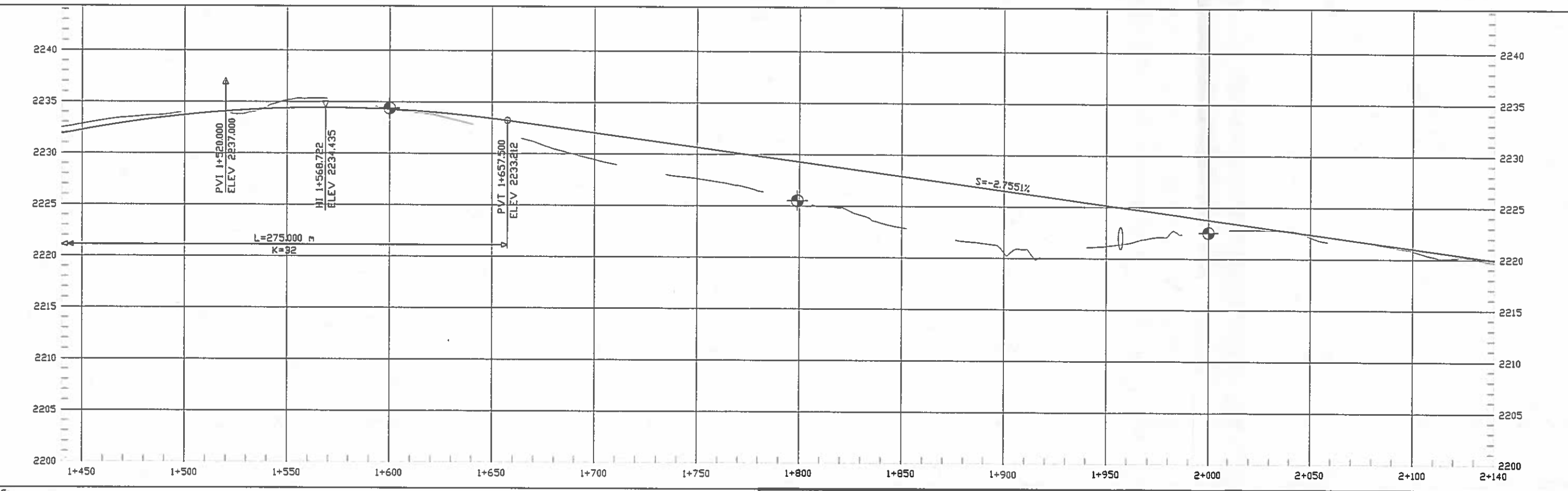
ORIGINATOR: M. VALLEJO
APPROVED BY:

DRAWING CATEGORY: 2

FIGURE 1

SHEET 3 of 17





SOURCE:
1) BASE MAP PROVIDED BY WHPACIFIC ON CAD FILE:
N11(1A)-BASE.DWG

LEGEND

APPROXIMATE BOREHOLE LOCATION

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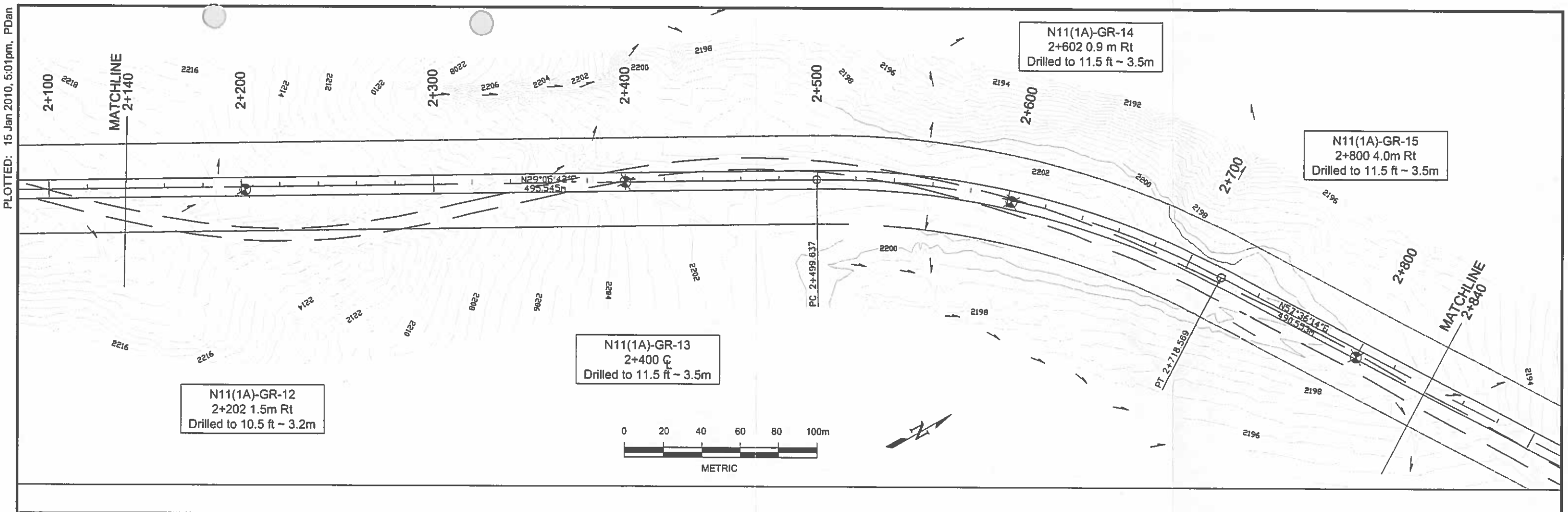
PROJECT NO.	105884
DRAWN:	JAN 2010
REVISED BY:	PD
CHECKED BY:	CV
FILE NAME:	105884_01_05.dwg

BOREHOLE LOCATION MAP
STA. 1+440 TO STA. 2+140
N11(1A)1, 2, & 4
BIA ROUTE - N11
NEAR CROWNPOINT, NEW MEXICO

ORIGINATOR: M. VALLEJO
APPROVED BY:
DRAWING CATEGORY: 2

FIGURE 1
SHEET 4 of 17



SOURCE:
1) BASE MAP PROVIDED BY WHPACIFIC ON CAD FILE:
N11(1A)-BASE.DWG

LEGEND

APPROXIMATE BOREHOLE LOCATION

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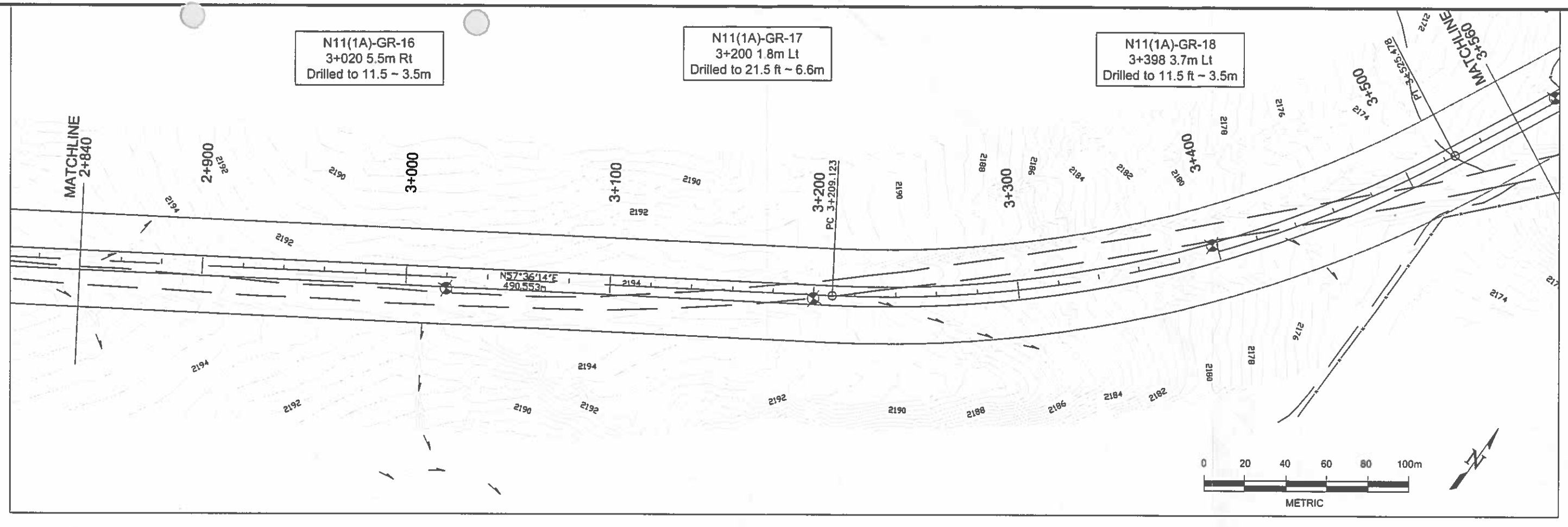
PROJECT NO.	105884
DRAWN:	JAN 2010
REVISED BY:	PD
CHECKED BY:	CV
FILE NAME:	105884_01_05.dwg

BOREHOLE LOCATION MAP
STA. 2+140 TO STA. 2+840

N11(1A)1, 2, & 4
BIA ROUTE - N11
NEAR CROWNPOINT, NEW MEXICO

ORIGINATOR: M. VALLEJO
APPROVED BY: Dwight Laird
DRAWING CATEGORY: 2

FIGURE 1
SHEET 5 of 17



SOURCE.
1) BASE MAP PROVIDED BY WHPACIFIC ON CAD FILE: N11(1A)-BASE.DWG

LEGEND

APPROXIMATE BOREHOLE LOCATION

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PROJECT NO.	105884
DRAWN:	JAN 2010
REVISED BY:	PD
CHECKED BY:	CV
FILE NAME:	105884_01_05.dwg

BORE HOLE LOCATION MAP
STA. 2+840 TO STA. 3+560
N11(1A)1, 2, & 4
BIA ROUTE - N11
NEAR CROWNPOINT, NEW MEXICO

ORIGINATOR: M. VALLEJO
APPROVED BY: Dwight Laird
DRAWING CATEGORY: 2

FIGURE 1
SHEET 6 of 17

PLOTTED: 15 Jan 2010, 4:46pm, PDan

N11(1A)-GR-19
3+582 1.8m Lt
Drilled to 11.5 ft ~ 3.5m

N11(1A)-GR-20
3+801 1.8 m Lt
Drilled to 11.5 ft ~ 3.5m

N11(1A)-GR-21
4+198 1.8m Lt
Drilled to 11 ft ~ 3m

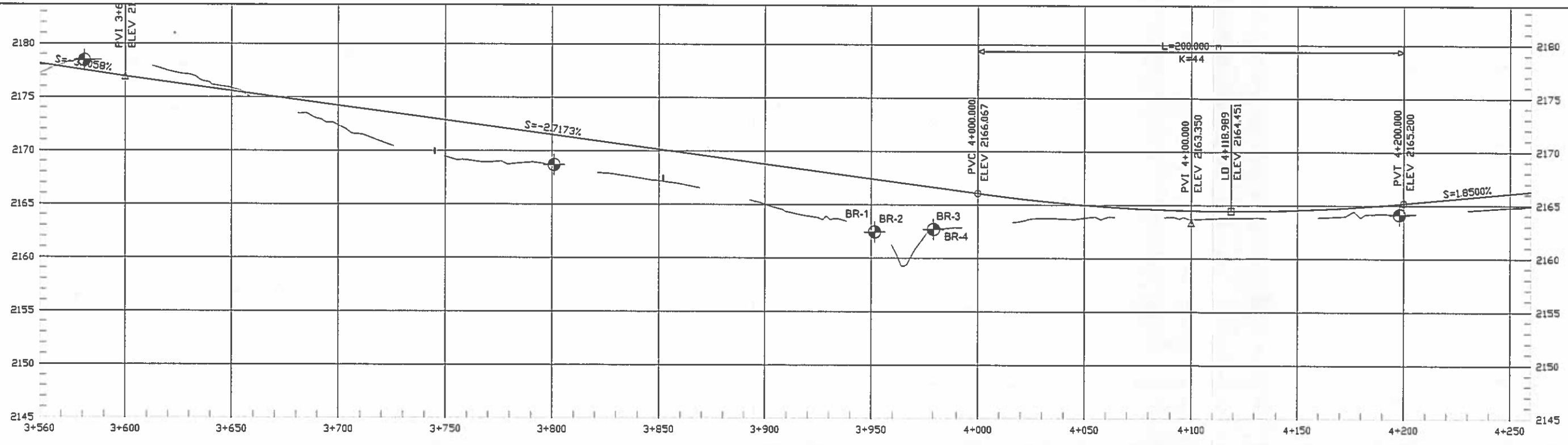
PT 3+525.478
MATCHLINE 3+560
3+600
3+700
3+800
3+900
4+000
4+100
4+200
MATCHLINE 4+260
4+300

N26°37'10"E
589.802m

BR-1
BR-2
BR-3
BR-4

*NOTE: SEE SHEET 17 FOR BRIDGE DETAILS

0 20 40 60 80 100m
METRIC



ATTACHED IMAGES: Images: J. Laird.JPG
ATTACHED XREFS:
ALBUQUERQUE, NM
CAD FILE: C:\DOCUME~1\PDan\LOCALS~1\Temp\AcPublish_3108\ LAYOUT: SH 7

SOURCE:
1) BASE MAP PROVIDED BY WHPACIFIC ON CAD FILE: N11(1A)-BASE.DWG

LEGEND

APPROXIMATE BOREHOLE LOCATION

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PROJECT NO.	105884
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CHECKED BY:	CV
FILE NAME:	105884_01_05.dwg

BOREHOLE LOCATION MAP
STA. 3+560 TO STA. 4+260

N11(1A)1, 2, & 4
BIA ROUTE - N11
NEAR CROWNPOINT, NEW MEXICO

ORIGINATOR: M. VALLEJO
APPROVED BY:
DRAWING CATEGORY: 2

FIGURE 1
SHEET 7 of 17

PLOTTED: 15 Jan 2010, 4:38pm, PDan

CAD FILE: C:\DOCUME~1\PDan\LOCALS~1\Temp\AcPublish_3108\ LAYOUT: SH 8

ATTACHED IMAGES: Images: J. Laird.JPG

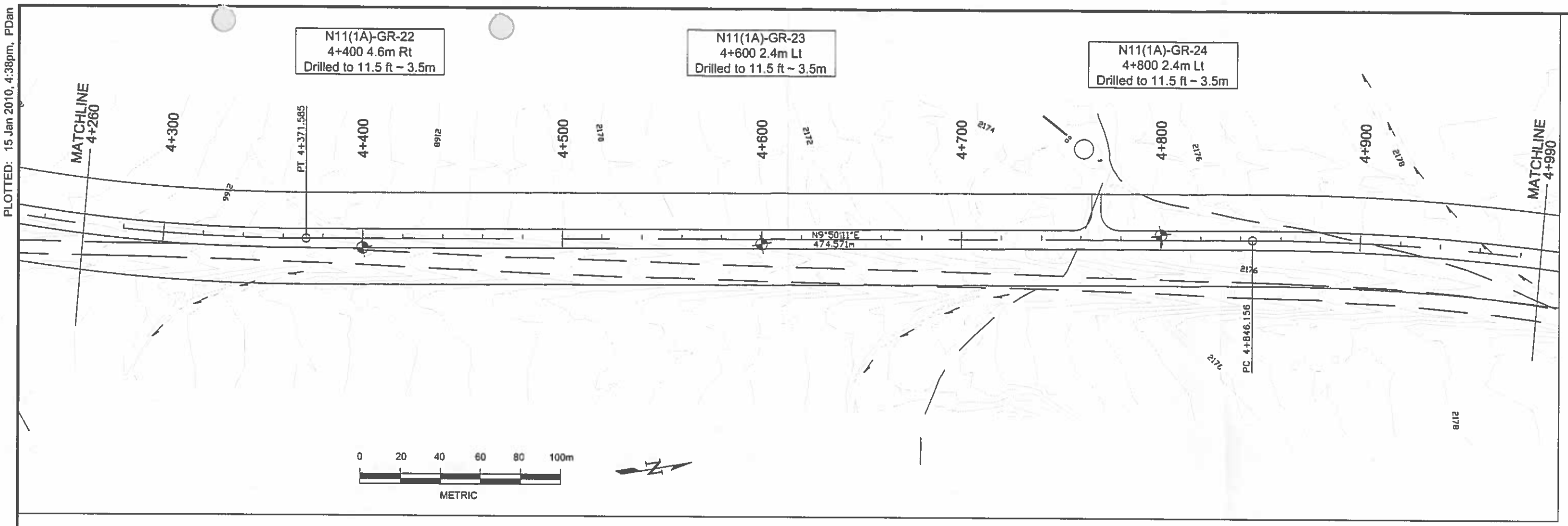
ATTACHED XREFS:

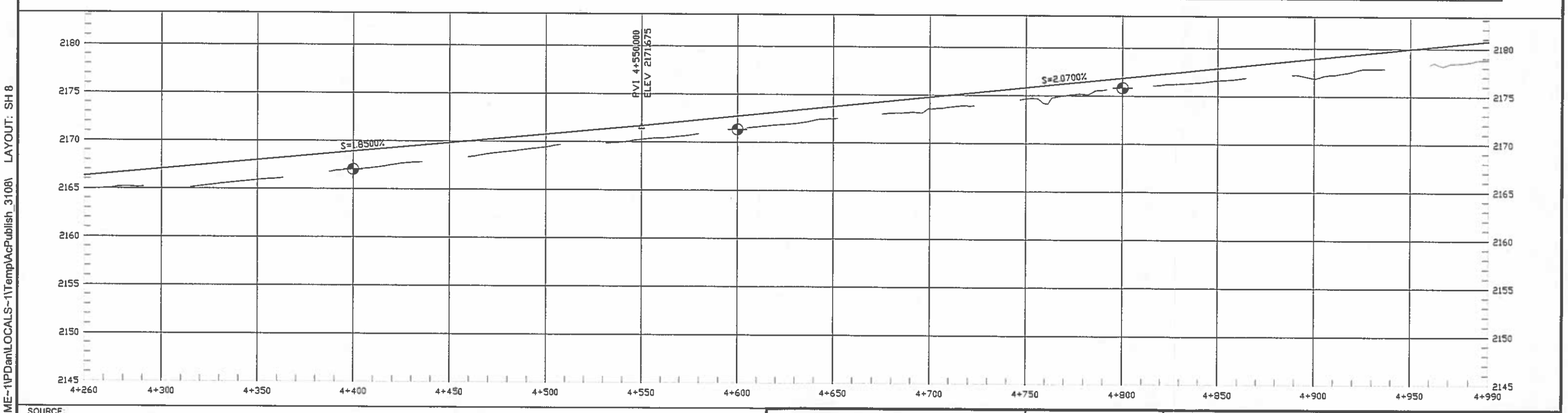
ALBUQUERQUE, NM

N11(1A)-GR-22
4+400 4.6m Rt
Drilled to 11.5 ft ~ 3.5m

N11(1A)-GR-23
4+600 2.4m Lt
Drilled to 11.5 ft ~ 3.5m

N11(1A)-GR-24
4+800 2.4m Lt
Drilled to 11.5 ft ~ 3.5m





SOURCE:
1) BASE MAP PROVIDED BY WHPACIFIC ON CAD FILE:
N11(1A)-BASE.DWG

LEGEND

APPROXIMATE BOREHOLE LOCATION

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PROJECT NO.	105884
DRAWN:	JAN 2010
REVISED BY:	PD
CHECKED BY:	CV
FILE NAME:	105884_01_05.dwg

BOREHOLE LOCATION MAP
STA. 4+260 TO STA. 4+990

N11(1A)1, 2, & 4
BIA ROUTE - N11
NEAR CROWNPOINT, NEW MEXICO

ORIGINATOR: M. VALLEJO
APPROVED BY:
DRAWING CATEGORY: 2

FIGURE 1

SHEET 8 of 17

PLOTTED: 15 Jan 2010, 4:33pm, PDan

N11(1A)-GR-25
5+004 0.9m Rt
Drilled to 11.5 ft ~ 3.5m

N11(1A)-GR-26
5+201 2.7m Lt
Drilled to 11.5 ft ~ 3.5m

N11(1A)-GR-27
5+400 2.1m Lt
Drilled to 11.5 ft ~ 3.5m

N11(1A)-GR-28
5+600 1.2m Lt
Drilled to 11.5 ft ~ 3.5m

MATCHLINE 4+990

5+000

5+100

5+200

5+300

5+400

5+500

5+600

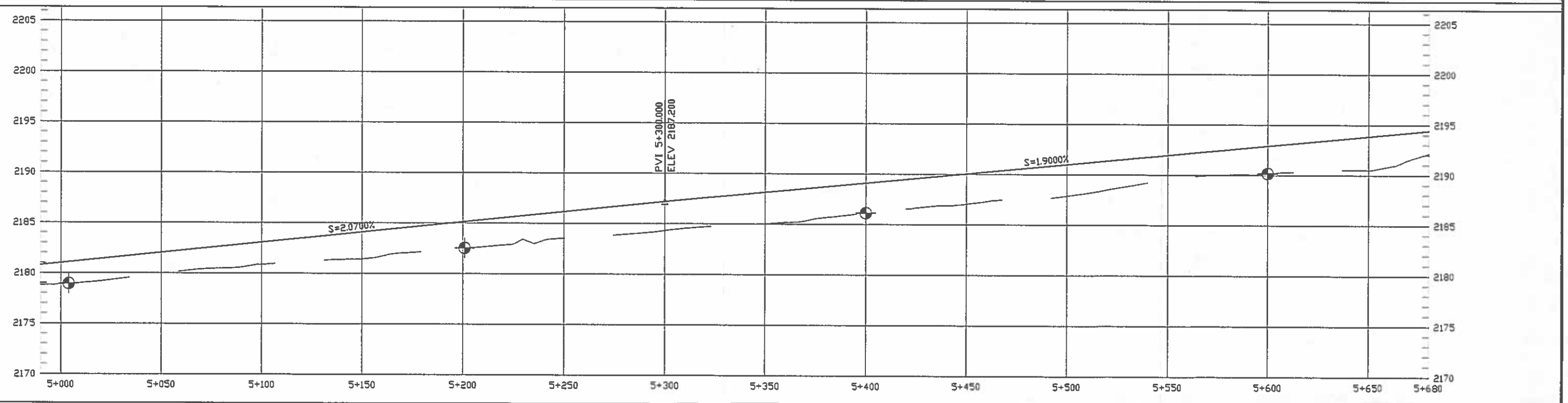
MATCHLINE 5+680

5+700

BASE ROCK OUTCROP

PT 5+669.628

0 20 40 60 80 100m
METRIC



SOURCE:
1) BASE MAP PROVIDED BY WHPACIFIC ON CAD FILE:
N11(1A)-BASE.DWG

LEGEND

APPROXIMATE BOREHOLE LOCATION

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PROJECT NO.	105884
DRAWN:	OCT 2009
REVISED BY:	PD
CHECKED BY:	CV
FILE NAME:	105884_01_05.dwg

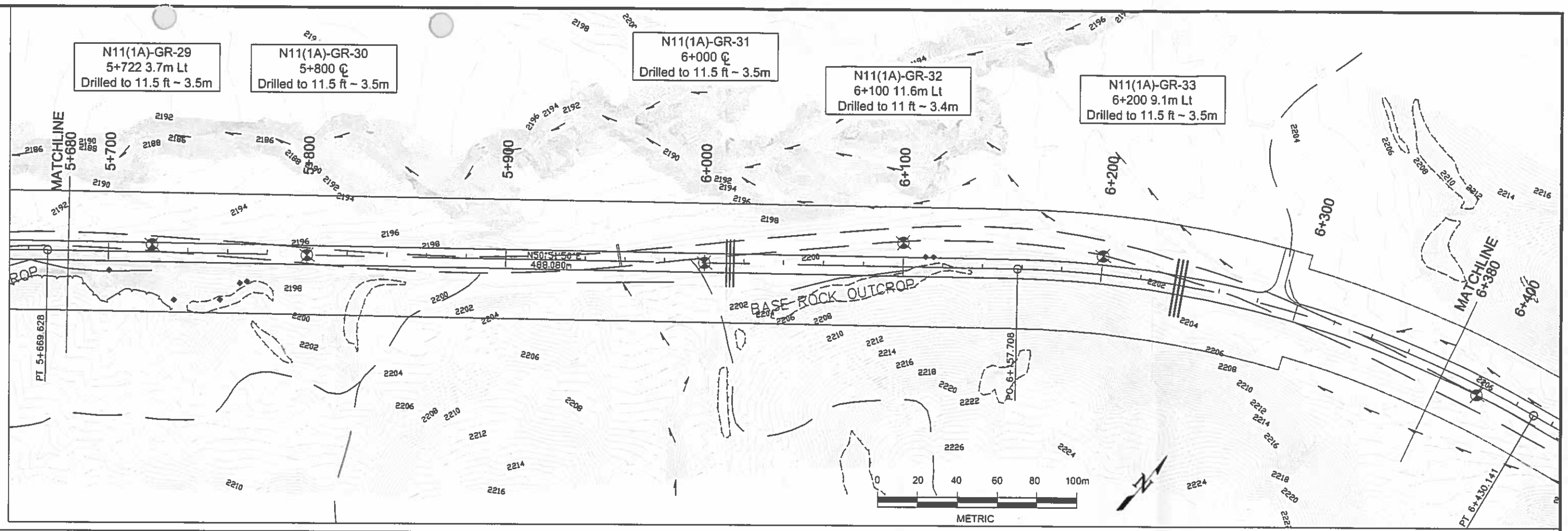
BOREHOLE LOCATION MAP
STA. 4+990 TO STA. 5+680

N11(1A)1, 2, & 4
BIA ROUTE - N11
NEAR CROWNPOINT, NEW MEXICO

ORIGINATOR: JAN 2010
APPROVED BY:
DRAWING CATEGORY: 2

FIGURE 1
SHEET 9 of 17

ATTACHED IMAGES: Images: J. Laird.JPG
ATTACHED XREFS:
ALBUQUERQUE, NM
CAD FILE: C:\DOCUME~1\PDan\LOCALS~1\Temp\AcPublish_3108\ LAYOUT: SH 9



SOURCE:
1) BASE MAP PROVIDED BY WHPACIFIC ON CAD FILE: N11(1A)-BASE.DWG

LEGEND

APPROXIMATE BOREHOLE LOCATION

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PROJECT NO.	105884
DRAWN:	JAN 2010
REVISED BY:	PD
CHECKED BY:	CV
FILE NAME:	105884_01_05.dwg

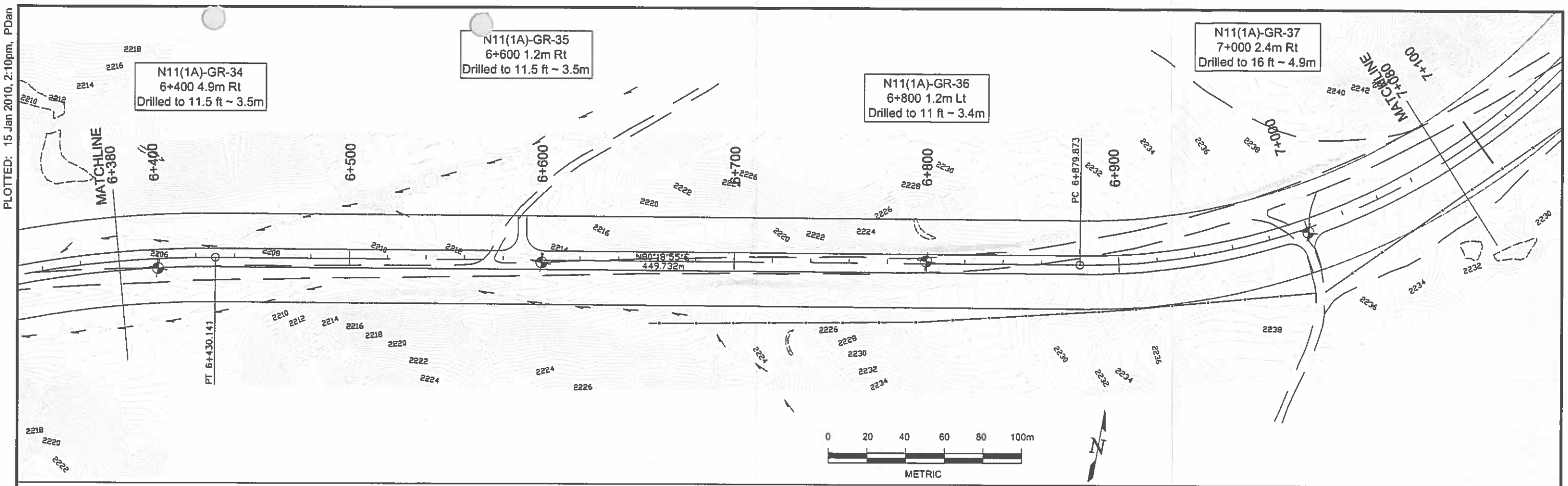
BOREHOLE LOCATION MAP
STA. 5+680 TO STA. 6+380

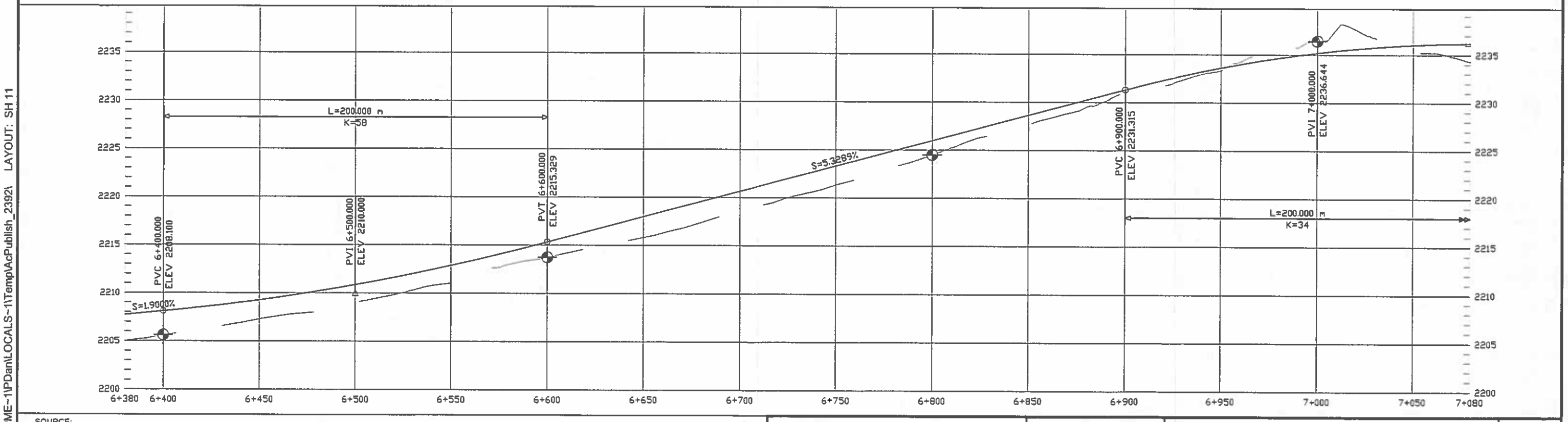
N11(1A)1, 2, & 4
BIA ROUTE - N11
NEAR CROWNPOINT, NEW MEXICO

ORIGINATOR: M. VALLEJO
APPROVED BY: Dwight Laird
DRAWING CATEGORY: 2

FIGURE 1

SHEET 10 of 17





SOURCE:
1) BASE MAP PROVIDED BY WHPACIFIC ON CAD FILE: N11(1A)-BASE.DWG

LEGEND

APPROXIMATE BOREHOLE LOCATION

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PROJECT NO.	105884
DRAWN:	JAN 2010
REVISED BY:	PD
CHECKED BY:	CV
FILE NAME:	105884_01_05.dwg

BOREHOLE LOCATION MAP
STA. 6+380 TO STA. 7+080

N11(1A)1, 2, & 4
BIA ROUTE - N11
NEAR CROWNPOINT, NEW MEXICO

ORIGINATOR: M. VALLEJO
APPROVED BY: Dwight Laird
DRAWING CATEGORY: 2

FIGURE 1
SHEET 11 of 17

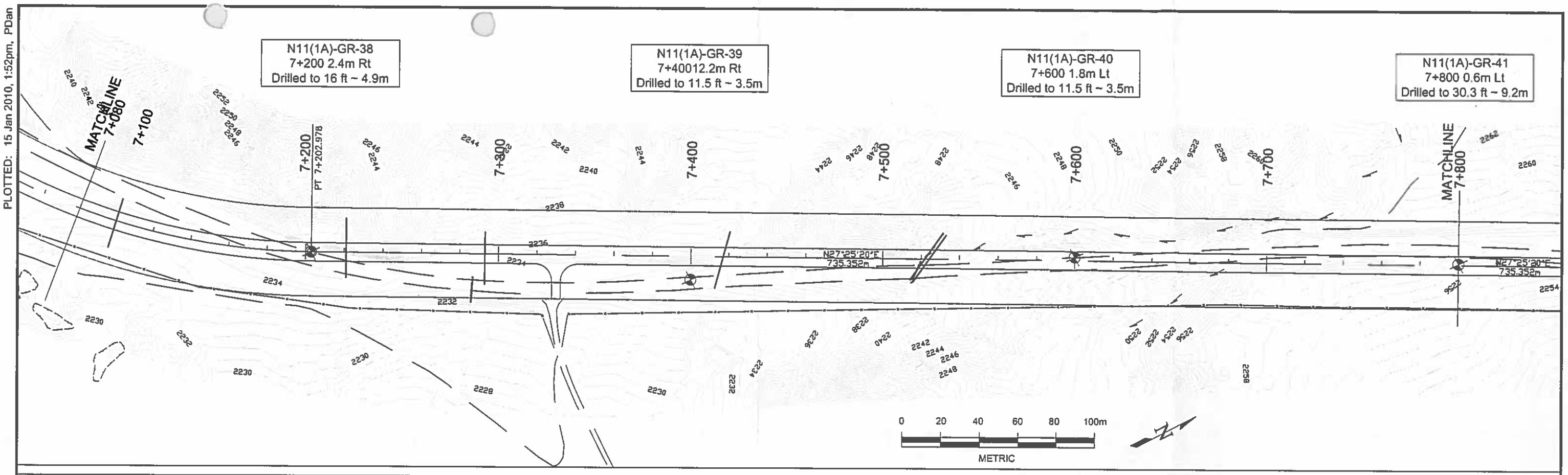
PLOTTED: 15 Jan 2010, 1:52pm, PDan

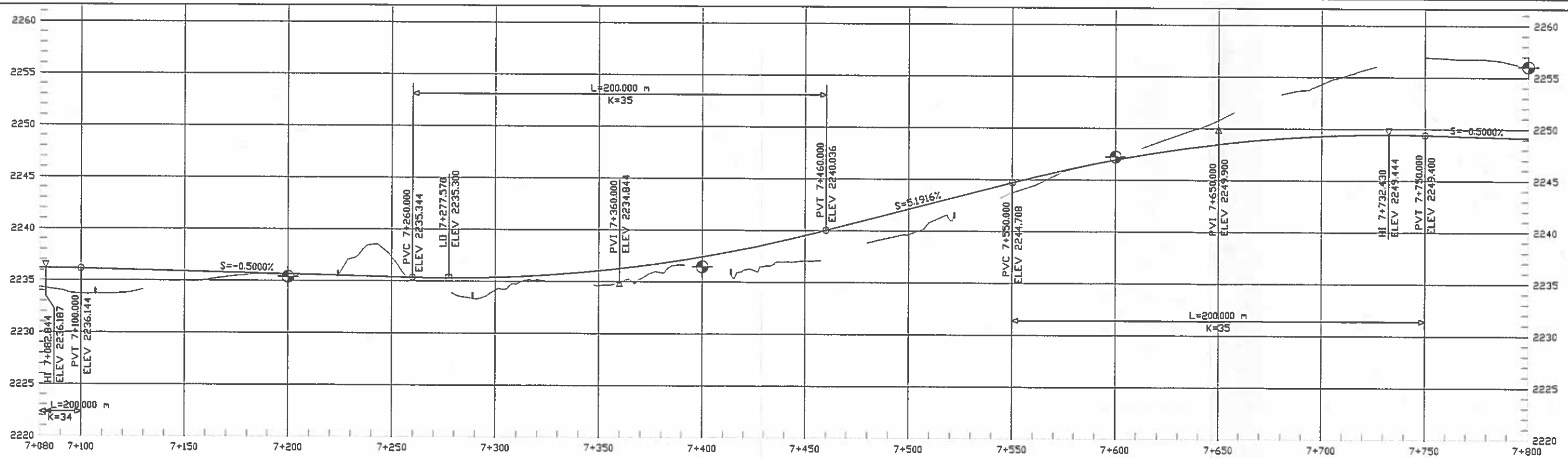
N11(1A)-GR-38
7+200 2.4m Rt
Drilled to 16 ft ~ 4.9m

N11(1A)-GR-39
7+40012.2m Rt
Drilled to 11.5 ft ~ 3.5m

N11(1A)-GR-40
7+600 1.8m Lt
Drilled to 11.5 ft ~ 3.5m

N11(1A)-GR-41
7+800 0.6m Lt
Drilled to 30.3 ft ~ 9.2m





SOURCE:
1) BASE MAP PROVIDED BY WHPACIFIC ON CAD FILE:
N11(1A)-BASE.DWG

LEGEND

APPROXIMATE BOREHOLE LOCATION

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PROJECT NO.	105884
DRAWN:	JAN 2010
REVISED BY:	PD
CHECKED BY:	CV
FILE NAME:	105884_01_05.dwg

BOREHOLE LOCATION MAP
STA. 7+080 TO STA. 7+800

N11(1A)1, 2, & 4
BIA ROUTE - N11
NEAR CROWNPOINT, NEW MEXICO

ORIGINATOR: M. VALLEJO
APPROVED BY:
DRAWING CATEGORY: 2

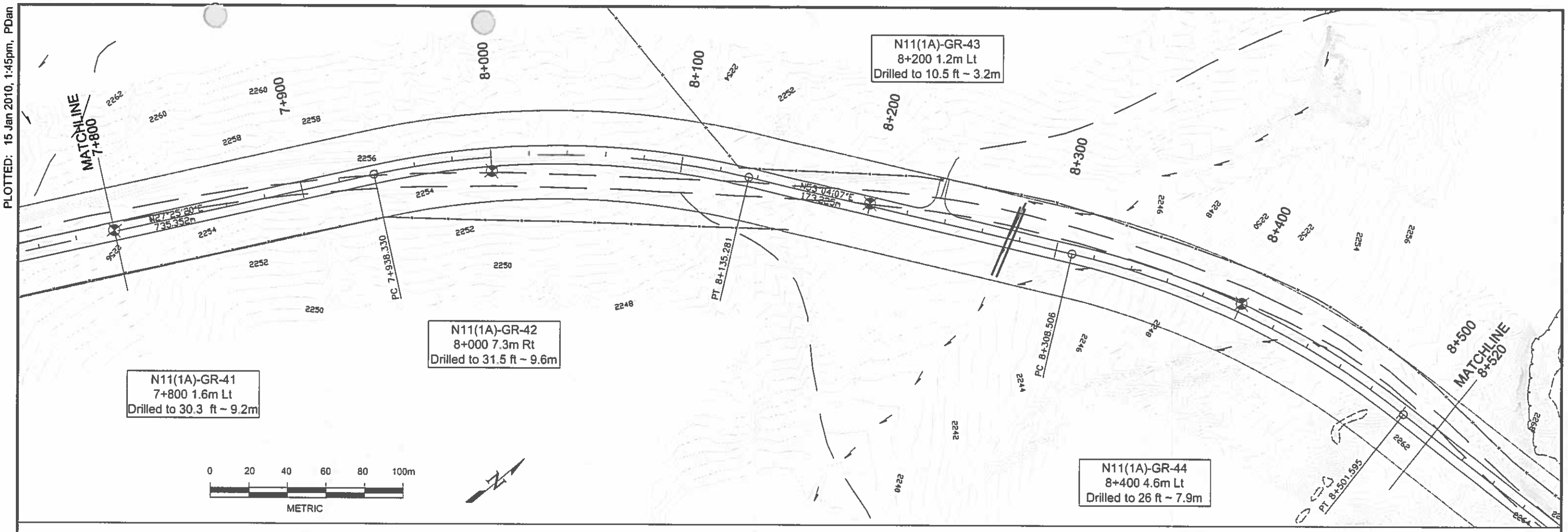
FIGURE 1
SHEET 12 of 17

ATTACHED IMAGES: Images: J. Laird.JPG
ATTACHED XREFS:
ALBUQUERQUE, NM
CAD FILE: C:\DOCUME~1\PDan\LOCALS~1\Temp\AcPublish_2392\ LAYOUT: SH 12

PLOTTED: 15 Jan 2010, 1:45pm, PDan

LAYOUT: SH 13

ATTACHED IMAGES: Images: J. Laird.JPG
ATTACHED XREFS:
ALBUQUERQUE, NM
CAD FILE: C:\DOCUME~1\PDan\LOCALS~1\Temp\AcPublish_2392\



SOURCE:
1) BASE MAP PROVIDED BY WHPACIFIC ON CAD FILE: N11(1A)-BASE.DWG

LEGEND

APPROXIMATE BOREHOLE LOCATION

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PROJECT NO.	105884
DRAWN:	JAN 2010
REVISED BY:	PD
CHECKED BY:	CV
FILE NAME:	105884_01_05.dwg

BORHOLE LOCATION MAP
STA. 7+800 TO STA. 8+520

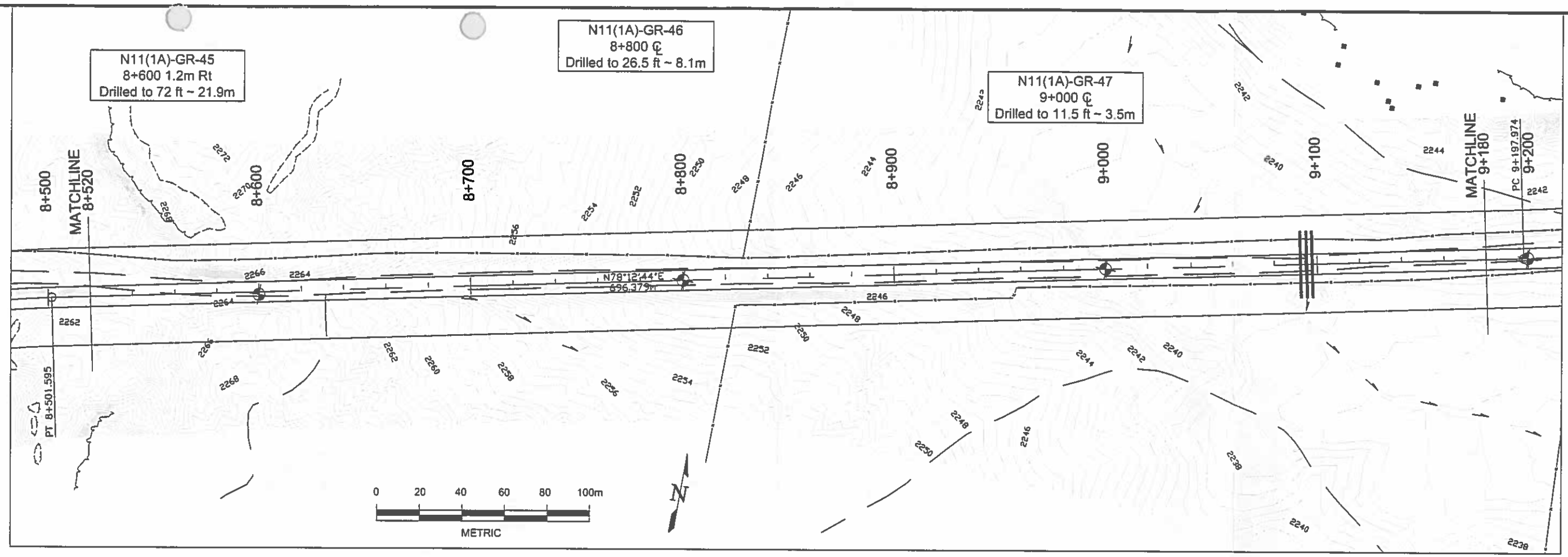
N11(1A)1, 2, & 4
BIA ROUTE - N11
NEAR CROWNPOINT, NEW MEXICO

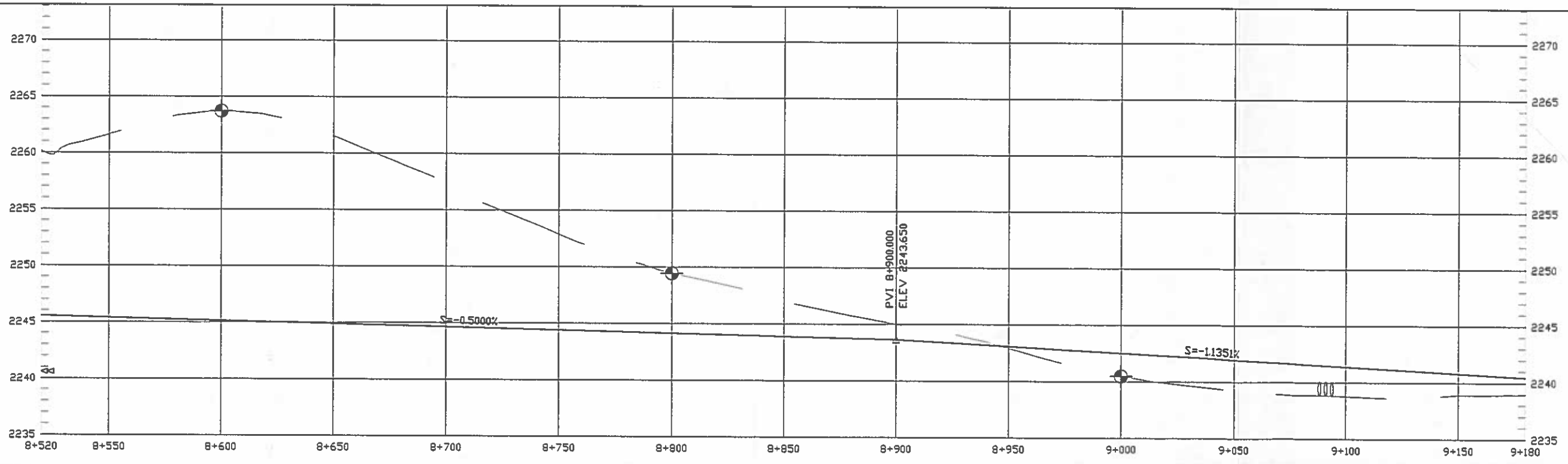
ORIGINATOR: M. VALLEJO
APPROVED BY:

DRAWING CATEGORY: 2

FIGURE 1

SHEET 13 of 17





SOURCE:
1) BASE MAP PROVIDED BY WHPACIFIC ON CAD FILE: N11(1A)-BASE.DWG

LEGEND

APPROXIMATE BOREHOLE LOCATION

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PROJECT NO.	105884
DRAWN:	JAN 2010
REVISED BY:	PD
CHECKED BY:	CV
FILE NAME:	105884_01_05.dwg

BOREHOLE LOCATION MAP
STA. 8+520 TO STA. 9+180

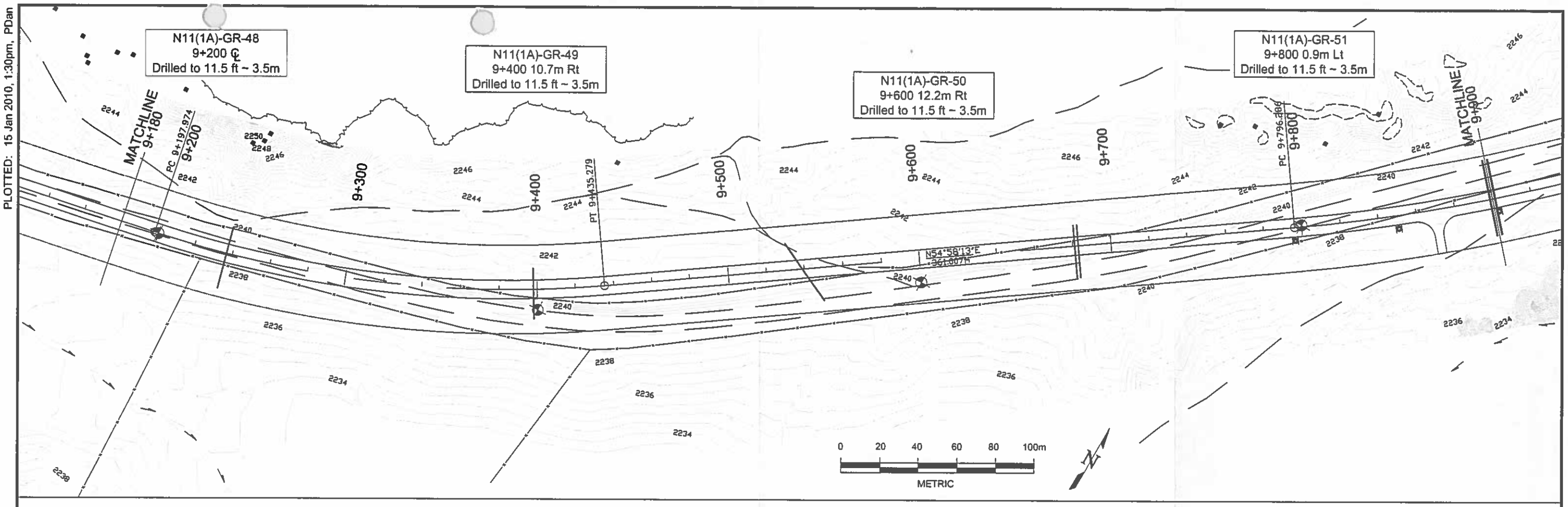
N11(1A)1, 2, & 4
BIA ROUTE - N11
NEAR CROWNPOINT, NEW MEXICO

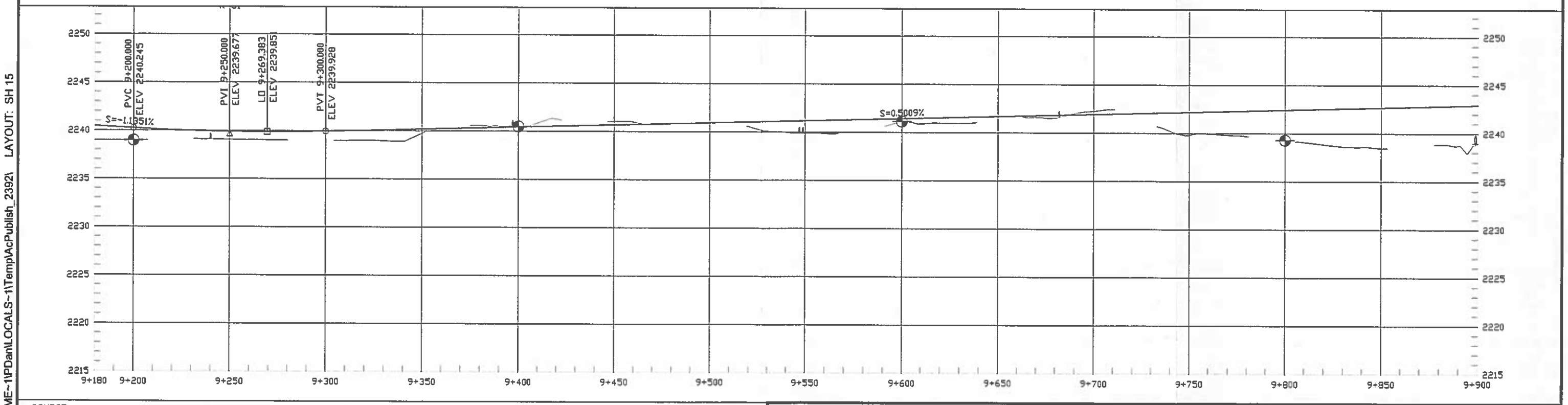
ORIGINATOR: M. VALLEJO
APPROVED BY: Dwight Laird

DRAWING CATEGORY: 2

FIGURE 1

SHEET 14 of 17





SOURCE:
1) BASE MAP PROVIDED BY WHPACIFIC ON CAD FILE:
N11(1A)-BASE.DWG

LEGEND

APPROXIMATE BOREHOLE LOCATION

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PROJECT NO.	105884
DRAWN:	JAN 2010
REVISED BY:	PD
CHECKED BY:	CV
FILE NAME:	105884_01_05.dwg

BOREHOLE LOCATION MAP
STA. 9+180 TO STA. 9+900

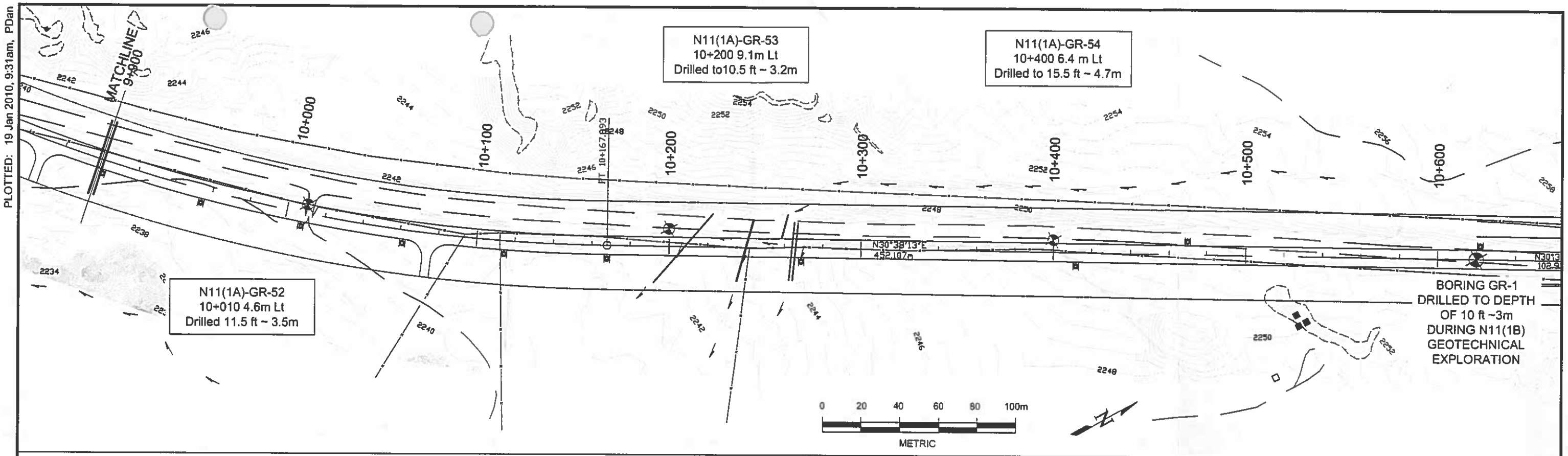
N11(1A)1, 2, & 4
BIA ROUTE - N11
NEAR CROWNPOINT, NEW MEXICO

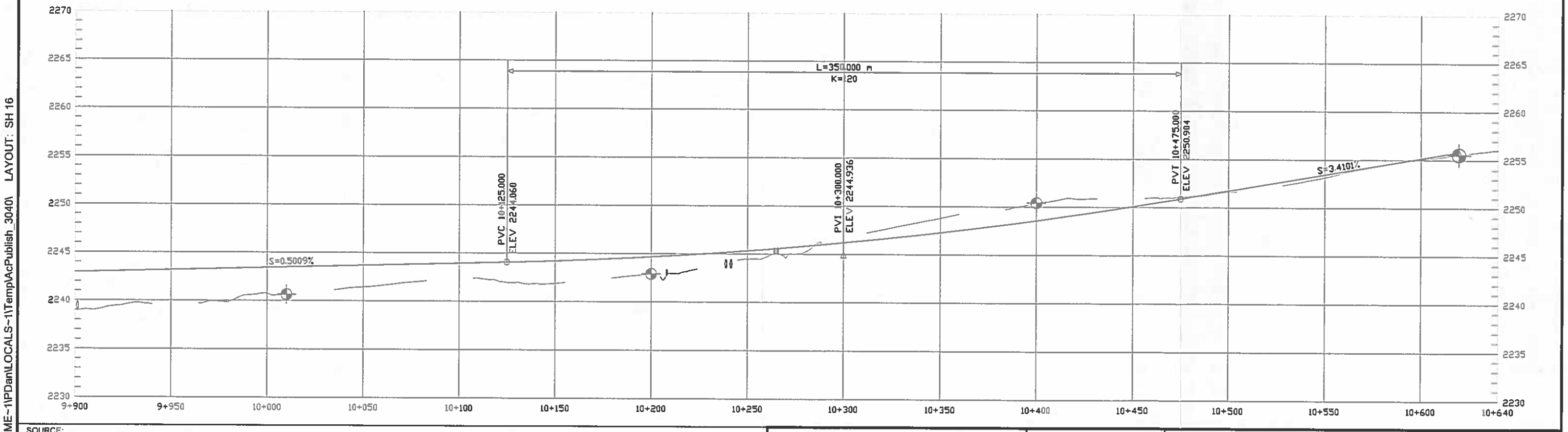
ORIGINATOR: M. VALLEJO
APPROVED BY:
DRAWING CATEGORY: 2

FIGURE 1

SHEET 15 of 17

PLOTTED: 19 Jan 2010, 9:31am, PDan





SOURCE:
1) BASE MAP PROVIDED BY WHPACIFIC ON CAD FILE:
N11(1A)-BASE.DWG

LEGEND

APPROXIMATE BOREHOLE LOCATION

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PROJECT NO.	105884
DRAWN:	JAN 2010
REVISED BY:	PD
CHECKED BY:	CV
FILE NAME:	105884_01_05.dwg

BORE HOLE LOCATION MAP
STA. 9+900 TO EOP

N11(1A)1, 2, & 4
BIA ROUTE - N11
NEAR CROWNPOINT, NEW MEXICO

ORIGINATOR: M. VALLEJO
APPROVED BY: Wright Land

DRAWING CATEGORY: 2

FIGURE 1

SHEET 16 of 17

ATTACHED IMAGES: Images: J. Laird.JPG
ATTACHED XREFS:
ALBUQUERQUE, NM
CAD FILE: C:\DOCUME~1\PDan\LOCALS~1\Temp\AcPublish_3040\ LAYOUT: SH 16

N11(1A)-EB-1
OBSERVED
LOCATION OF
ERODED ARROYO
EMBANKMENT

EB-1

BRIDGE ABUTMENT NO. 1
3+951.7

BRIDGE ABUTMENT NO. 2
3+979.2

3+900

4+000

4+100

PC 4+115.280

N11(1A)-BR-1
STA 3+952 4.8m Lt
Drilled to 55.5 ft ~ 16.9m

N11(1A)-BR-3
STA 3+979 4.8m Lt
Drilled to 53.6 ft ~ 16.3m

2162

2160

N11(1A)-BR-2
STA 3+952 4.8 m Rt
Drilled to 55.5 ft ~ 16.9m

N11(1A)-BR-4
STA 3+979 4.8 m Rt
Drilled to 55 ft ~ 16.8m

0 10 20 30 40m
METRIC

PVC 4+000.00
ELEV 2166.067

PVI 4+100.000
ELEV 2163.350

LD 4+118.989
ELEV 2164.45

BR-1
BR-2
BR-3
BR-4

SOURCE:
1) BASE MAP PROVIDED BY WHPACIFIC ON CAD FILE:
N11(1A)-BASE.DWG

LEGEND

- APPROXIMATE BOREHOLE LOCATION
- APPROXIMATE OSERVED LOCATION OF ARROYO BANK

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PROJECT NO.	105884
DRAWN:	JAN 2010
REVISED BY:	PD
CHECKED BY:	CV
FILE NAME:	105884_01_05.dwg

PROPOSED BOREHOLE LOCATION MAP
BRIDGE LOCATION SITE

N11(1A)1, 2, & 4
BIA ROUTE - N11
NEAR CROWNPOINT, NEW MEXICO

ORIGINATOR: M. VALLEJO
APPROVED BY:
DRAWING CATEGORY: 2

FIGURE 1
SHEET 17 of 17

APPENDIX B

Unified Soil Classification System
Logs of Exploratory Borings

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			USCS SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS (More than half of material is larger than the #200 sieve)	GRAVELS (More than half of coarse fraction is larger than the #4 sieve)	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
			GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
		GRAVELS WITH OVER 12% FINES	GM	SILTY GRAVELS, GRAVEL-SILT-SAND MIXTURES
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SANDS (More than half of coarse fraction is smaller than the #4 sieve)	CLEAN SANDS WITH LITTLE OR NO FINES	SW	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
			SP	POORLY-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
		SANDS WITH OVER 12% FINES	SM	SILTY SANDS, SAND-GRAVEL-SILT MIXTURES
			SC	CLAYEY SANDS, SAND-GRAVEL-CLAY MIXTURES
FINE GRAINED SOILS (More than half of material is smaller than the #200 sieve)	SILTS AND CLAYS (Liquid limit less than 50)		ML	INORGANIC SILTS & VERY FINE SANDS, SILTY OR CLAYEY FINE SANDS, CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC SILTS & ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS (Liquid limit greater than 50)		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILT
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS & ORGANIC SILTS OF MEDIUM-TO-HIGH PLASTICITY
LOAMS				UNDER USDA SOIL CLASSIFICATION SYSTEM, SOIL OF APPROXIMATELY EQUAL SAND/SILT/CLAY

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UNIFIED SOIL CLASSIFICATION SYSTEM

Project: N11(1A)1,2,4

Location: Near Crownpoint, New Mexico

Project Number: 105884

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Boring Log

Boring # BR-1
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/14/2009	105884	N11(1A)1,2,4
Completed: 12/14/2009		
Backfilled: 12/14/2009	Rig Type: CME 75	Surface Elevation: 2162.5 m (7094.8') Logged By: R. Stump
Latitude: 35°36.7048'	Longitude: 108°18.9408'	Location: N11(1A) Sta. 3+952 4.8m Lt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
7.6 (25)	12/14/2009

Groundwater Depth (m)	Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
	0			SPT	18								SANDY LEAN CLAY (CL)- firm to hard, with silty, sandy lenses, brown
	1			SPT	42								1.2 m (4.0') El. 2161.3 m (7090.8')
				MC	30								1.5 m (5.0') FAT CLAY (CH)- hard, brown, dry El. 2161.0 m (7089.8')
	2												SILTY SAND (SM)- fine grained, medium dense, slightly moist
				SPT	14								2.9 m (9.5') El. 2159.6 m (7085.3')
	3			MC	50								3.4 m (11.0') SANDY LEAN CLAY (CL)- hard, with fine subrounded gravel, brown, moist El. 2159.1 m (7083.8')
	4			SPT	39								WEATHERED CLAYSTONE - with clay layers, with thin sandstone lenses, brown with gray brown ferric staining, highly weathered to decomposed, tight calcite infilling (calcite crystals to calcite staining), with fine to medium subrounded gravel, inclusions to 6.7m (22 ft) bgs
				MC	54								
	5			SPT	36								
	6			MC	43								
				SPT	24								
▽	7			MC	27								7.8 m (25.5') El. 2154.7 m (7069.3') Moist to wet in joints at 7.6m (25 ft) bgs, possible perched water. Practical auger refusal at 7.8m (25.5 ft) bgs
	8			CORE		78	47						SHALE - light yellow brown, slightly weathered, weak, very thinly bedded to laminated, aphanitic, slightly fractured, bedding joints horizontal, open to wide joints, ferric staining at some joints, mottled white zones
	9			CORE		92	67						
	10			CORE		100	93						
	11			CORE		100	80						11.6 m (38.0') El. 2150.9 m (7056.8')
				CORE		100	77						11.7 m (38.5') El. 2150.8 m (7056.3') SANDSTONE - light gray, weak to extremely weak, intensely fractured, with carbonate material
	12												SHALE - light yellow brown, slightly weathered, weak, very thinly bedded to laminated, aphanitic, slightly fractured, bedding joints horizontal, open to wide joints, ferric staining at some joints, mottled white zones
	13			CORE		100	83						
	14			CORE		98	92						
	15												Fossiliferous at 15.2m (50 ft) bgs
	16			CORE		100	88						16.9 m (55.5') El. 2145.6 m (7039.3')

Total Depth 16.9 m (55.5')

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Boring # BR-2
Sheet 1 of 1
Revision: 0

Date		Project Number	Project
Started: 12/15/2009		105884	N11(1A)1,2,4
Completed: 12/15/2009			
Backfilled: 12/15/2009	Rig Type: CME 75	Surface Elevation: 2162.5 m (7094.8')	Logged By: R. Stump
Latitude: 35°36.7025'	Longitude: 108°18.9351'	Location: N11(1A) Sta. 3+952 4.8m Rt	

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
6.9 (22.5)	12/15/2009

Groundwater Depth (m)	Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
	0			SPT	28								LEAN CLAY WITH SAND (CL)- fine to coarse sand, firm to hard, some sandstone fragments, brown, moist
	1			MC	58								
				SPT	38							76	Zones of silty sand lenses from 1.1m (3.5 ft) bgs
	2			MC	38								
	3			SPT	18					41	18		
	4			MC	31								4.1 m (13.5') El. 2158.4 m (7081.3')
	5			SPT	40								WEATHERED CLAYSTONE - with thin sandstone lenses, with clay layers, yellow brown to gray brown, moist, highly weathered to decomposed, with ferric staining and calcite infilling
				MC	36								
	6			SPT	30								
▽	7			MC	54								Wet in some joints at 6.9m (22.5 ft) bgs, possible perched water
				SPT	53								7.8 m (25.5') El. 2154.7 m (7069.3')
	8			CORE		75	33						SHALE - light yellow brown, slightly weathered, weak, very thinly bedded to laminated, aphanitic, slightly fractured, tight to open joints, very wide with spotty and filled calcite, slightly moist to dry
	9			CORE		92	79						
	10			CORE		100	90						
	11			CORE		100	67						11.1 m (36.5') El. 2151.4 m (7058.3')
	12												SANDSTONE - light gray, weak to extremely weak, intensely fractured, with carbonate material 11.7 m (38.5') 11.8 m (7056.3')
	13			CORE		100	93						SHALE - light yellow brown, slightly weathered, weak, very thinly bedded to laminated, aphanitic, slightly fractured, tight to open joints, very wide with calcite infilling, slightly moist to dry
	14			CORE		98	95						
	15												
	16			CORE		100	92						16.9 m (55.5') El. 2145.6 m (7039.3')

Total Depth 16.9 m (55.5')

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Boring Log

Boring # BR-3
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/18/2009	105884	N11(1A)1,2,4
Completed: 12/18/2009		
Backfilled: 12/18/2009	Rig Type: CME 75	Surface Elevation: 2162.0 m (7093.2') | Logged By: R. Stump
Latitude: 35°36.7176'	Longitude: 108°18.9314'	Location: N11(1A) Sta. 3+979 4.8m Lt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
7.6 (25)	12/18/2009

Groundwater Depth (m) / Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
0			SPT	23								SILTY TO SAND LEAN CLAY (CL)- firm to hard, light brown, moist
1			MC	71								
			SPT	23								
2												2.0 m (6.5') El. 2160.0 m (7086.7')
			MC	43								2.3 m (7.5') SILTY SAND (SM)- fine grained, medium dense, light brown, moist El. 2159.7 m (7085.7')
3			SPT	28								SANDY SILT (ML)- hard, with fine to coarse, angular to subangular gravel, with coarse sand, brown and red brown, moist
4			MC	45			17.9	17.6	45	16		3.8 m (12.5') El. 2158.2 m (7080.7')
												FAT CLAY (CH)- firm, gray with ferric staining in layers, moist
												4.4 m (14.5') El. 2157.6 m (7078.7')
5			SPT	66								4.9 m (16.0') CLAYEY GRAVEL (GC)- fine to coarse, dense, angular to subangular, red brown, dry El. 2157.1 m (7077.2')
												5.3 m (17.5') El. 2156.7 m (7075.7')
			MC	38								SILTY FAT CLAY (CH)- firm, olive brown, moist
6			SPT	25								WEATHERED CLAYSTONE - with clay layers, light yellow brown and gray, highly weathered to decomposed, iron staining and spotting in bedding joints, very tight joints
7			MC	36								
▽												Very moist a 7.6m (25 ft) bgs, possible perched water
8			SPT	32								
			SPT	82/9"								8.5 m (28.0') El. 2153.5 m (7065.2')
9			CORE		100	69						SHALE - light gray, moderately weathered to slightly weathered, weak, very thinly bedded to laminated, aphanitic, laminated, slightly fractured to unfractured, fractures widely spaced, tight to moderately open joints, slightly rough, calcite infilling and staining
10												
11			CORE		100	82						
												11.6 m (38.0') El. 2150.4 m (7055.2')
12												11.9 m (39.0') SANDSTONE - light gray, weak to extremely weak, intensely fractured, with carbonate material El. 2150.1 m (7054.2')
			CORE		97	75						
13												SHALE - light gray, slightly weathered, weak, very thinly bedded to laminated, aphanitic, laminated, slightly fractured to unfractured, fractures widely spaced, tight to moderately open, slightly rough, calcite infilling and staining
14			CORE		100	92						
15												
			CORE		95	87						
16												16.3 m (53.6') El. 2145.7 m (7039.6')

Total Depth 16.3 m (53.6')

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Boring Log

Boring # BR-4
Sheet 1 of 1
Revision: 0

Date		Project Number	Project
Started: 12/15/2009		105884	N11(1A)1,2,4
Completed: 12/17/2009			
Backfilled: 12/17/2009	Rig Type: CME 75	Surface Elevation: 2163.0 m (7096.5')	Logged By: R. Stump
Latitude: 35°36.7153'	Longitude: 108°18.9249'	Location: N11(1A) Sta. 3+979 4.8m Rt	

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
9.3 (30.5)	12/15/2009

Groundwater Depth (m)	Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
	0			SPT	60								SILTY TO SANDY LEAN CLAY (CL)- hard, light brown, dry to moist
	1			MC	30			7.3	15.0	NV	NP		With sand lenses from 1.1m (2.5 ft) bgs
	2			SPT	27								With occasional calcite stringers at 1.5m (5 ft) bgs
				MC	47								
	3			SPT	18								
													3.7 m (12.0') El. 2159.3 m (7084.5')
	4			MC	16			12.8	13.9			90	POORLY GRADED SAND WITH SILT (SP-SM)- fine grained, medium dense, light brown, moist
				SPT	22								4.9 m (16.0') El. 2158.1 m (7080.5')
	5			MC	52								WEATHERED CLAYSTONE - with thin sandstone lenses, with clay layers
	6			SPT	36								
	7			MC	42								
	8			SPT	21								
				SPT	30								
▽	9			SPT	48								Perched water at 9.3m (30.5) bgs
	10			SPT	50/5"								10.1 m (33.0') El. 2152.9 m (7063.5')
	11			CORE		95	86						SHALE - gray with variated white, slightly weathered, weak, very thinly bedded to laminated, aphanitic, bedding joints horizontal, slightly fractured to unfractured, tight to moderately open joints, calcite infilling, fracture staining, moist to dry
	12			CORE		88	62						0.03m (1 in) of sandstone layer, white, moist, extremely weak at 12.2m (40 ft) bgs
	13												13.0 m (42.5') El. 2150.0 m (7054.0')
													13.1 m (43.0') El. 2149.9 m (7053.5') SANDSTONE - light gray, moist, weak to extremely weak, intensely fractured, with carbonate material
	14			CORE		98	82						SHALE - gray with variated white, slightly weathered, weak, very thinly bedded to laminated, aphanitic, bedding joints horizontal, slightly fractured to unfractured, tight to moderately open joints, calcite infilling, fracture staining, moist to dry
	15			CORE		100	91						
	16			CORE		100	78						
				CORE		72	55						16.8 m (55.0') El. 2146.2 m (7041.5')

Total Depth 16.8 m (55.0')

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Boring Log

Boring # EB-1
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/14/2009	105884	N11(1A)1,2,4
Completed: 12/14/2009		
Backfilled: 12/14/2009	Rig Type: NA	Surface Elevation: 2163.0 m (7096.5') Logged By: R. Stump
Latitude: 35°36.7249'	Longitude: 108°18.9617'	Location: N11(1A) Sta. 3+972 48m Lt

Groundwater Depth (m) / Depth (m) | Graphical Log | Sample Taken | Sample Type | Penetration Resistance (Blows / 0.3 m) | % Recovery (Rock) | RQD | Moisture Content (%) | Dry Density (kN/cu. m) | Liquid Limit | Plasticity Index | Percent Passing No. 200 Sieve

Sample Type:
AUGER - Auger Cuttings
G - Grab Sample
MC - 2.5" O.D. 2.46" I.D. Modified California Sample
SPT - 2" O.D. 1.38" I.D. Tube Sample
U - 3 " O.D. 2.42" I.D. Ring Sample
ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
(Not encountered)	

Visual Classification

0

LEAN CLAY (CL)- with silty and sandy lenses, brown, dry to slightly moist

1.4 m (4.5') El. 2161.6 m (7092.0')

1

2

SILTY SAND (SM)- brown, dry to slightly moist

3.7 m (12.0') El. 2159.3 m (7084.5')

3

SILTY LEAN CLAY (SL-ML)- firm, brown, dry

4.1 m (13.5') El. 2158.9 m (7083.0')

4

WEATHERED MANCOS SHALE AND CLAYSTONE - with thin sandstone lenses, with clay layers, highly weathered to decomposed, brown and gray brown, dry

5.2 m (17.0') El. 2157.8 m (7079.5')

5

WEATHERED CLAYSTONE - with clay layers, brown to gray brown, slightly moist

5.8 m (19.0') El. 2157.2 m (7077.5')

Total Depth 5.8 m (19.0')

Note: Log created from observation of eroded arroyo bank west of BR-1. No drilling was performed at this location. Bank was approximately 5.8m (19 ft) high.

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Boring Log

Boring #	GR-01
Sheet	1 of 1
Revision:	0

Date		Project Number	Project
Started:	12/7/2009	105884	N11(1A)1,2,4
Completed:	12/7/2009		
Backfilled:	12/7/2009	Rig Type: CME 75	Surface Elevation: 2195.0 m (7201.4') Logged By: R. Stump
Latitude: 35°34.9153'		Longitude: 108°19.9493'	Location: N11(1A) Sta. 0+041 0.6m Lt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater

Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m)	Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
	0			SPT	18					47	23		WEATHERED CLAYSTONE - with clay layers, light brown, moist
	1			MC	69			15.2				66	
				SPT	50			12.0					
	2			MC	50/5"								White sulfate in partings and joints at 2.3m (7.5 ft) bgs
	3			SPT	22								Dark brown and gray at 2.9m (9.5 ft) bgs
													3.5 m (11.5') El. 2191.5 m (7189.9')

Total Depth 3.5 m (11.5')

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Boring Log

Boring # GR-02
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/7/2009	105884	N11(1A)1,2,4
Completed: 12/7/2009		
Backfilled: 12/7/2009	Rig Type: CME 75	Surface Elevation: 2202.0 m (7224.4') Logged By: R. Stump
Latitude: 35°35.007'	Longitude: 108°19.9387'	Location: N11(1A) Sta. 0+200 1.2m Rt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3 " O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater

Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m) / Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
0			SPT	59								WEATHERED SILTSTONE - with silt layers, light brown, moist
1			MC	50/5"								
												Gray with ferric staining, gypsum in partings and joints at 1.4m (4.5 ft) bgs
2			SPT	29								
			MC	40								
3			SPT	40								3.5 m (11.5') El. 2198.5 m (7212.9')

Total Depth 3.5 m (11.5')

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Boring Log

Boring # GR-03
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/7/2009	105884	N11(1A)1,2,4
Completed: 12/7/2009		
Backfilled: 12/7/2009	Rig Type: CME 75	Surface Elevation: 2214.5 m (7265.4') | Logged By: R. Stump
Latitude: 35°35.1077'	Longitude: 108°19.9263'	Location: N11(1A) Sta. 0+401 0.9m Rt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3 " O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m)	Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
	0			SPT	40			9.1					WEATHERED SILTSTONE - with silt layers, gray with ferric staining, moist
	1			MC	51			14.6		54	24		
				SPT	61			17.8				98	With yellow mineral deposits in partings and joints at 1.8m (6 ft) bgs
	2			MC	50/5"								
	3			SPT	82/11"								3.5 m (11.5') El. 2211.0 m (7253.9')

Total Depth 3.5 m (11.5')

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Boring Log

Boring # GR-04
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/7/2009	105884	N11(1A)1,2,4
Completed: 12/7/2009		
Backfilled: 12/7/2009	Rig Type: CME 75	Surface Elevation: 2218.0 m (7276.9') | Logged By: R. Stump
Latitude: 35°35.2008'	Longitude: 108°19.8568'	Location: N11(1A) Sta. 0+600 0.9m Rt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m) / Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
0			SPT	27								WEATHERED CLAYSTONE - with clay layers, light brown, moist
1			MC	36								
			SPT	32								
2			MC	34								
3			SPT	28								3.5 m (11.5') El. 2214.5 m (7265.4')

Total Depth 3.5 m (11.5')

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Boring Log

Boring # GR-05
Sheet 1 of 1
Revision: 0

Date		Project Number	Project
Started: 12/7/2009		105884	N11(1A)1,2,4
Completed: 12/7/2009			
Backfilled: 12/7/2009	Rig Type: CME 75	Surface Elevation: 2218.5 m (7278.5')	Logged By: R. Stump
Latitude: 35°35.2941'	Longitude: 108°19.7913'	Location: N11(1A) Sta. 0+800 0.9m Lt	

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3 " O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m) / Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
0			SPT	15								WEATHERED CLAYSTONE - with clay layers, brown and gray with white, moist
1			MC	15			20.7	14.4			84	
			SPT	9			18.9					
2			MC	27								
3			SPT	23								
												3.5 m (11.5') El. 2215.0 m (7267.0')

Total Depth 3.5 m (11.5')

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Boring Log

Boring # GR-06
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/7/2009	105884	N11(1A)1,2,4
Completed: 12/7/2009		
Backfilled: 12/7/2009	Rig Type: CME 75	Surface Elevation: 2216.5 m (7272.0') Logged By: R. Stump
Latitude: 35°35.3890'	Longitude: 108°19.7310'	Location: N11(1A) Sta. 1+000 2.7m Lt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m)	Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
	0			SPT	20								WEATHERED CLAYSTONE - with clay layers, brown and gray, moist
	1			MC	53								With ferric staining at 0.9m (3 ft) bgs
	2			SPT	29								
				MC	50/5"								
	3			SPT	39								3.5 m (11.5') El. 2213.0 m (7260.5')

Total Depth 3.5 m (11.5')

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Boring Log

Boring # GR-07
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/7/2009	105884	N11(1A)1,2,4
Completed: 12/7/2009		
Backfilled: 12/7/2009	Rig Type: CME 75	Surface Elevation: 2216.0 m (7270.3') Logged By: R. Stump
Latitude: 35°35.4906'	Longitude: 108°19.7550'	Location: N11(1A) Sta. 1+220 1.2m Lt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater

Depth. m (ft.)	Date
(Not encountered)	

Groundwater Depth (m) Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
0			SPT	42			10.2					WEATHERED SILTSTONE - medium strong, with silt layers, brown and dark gray, moist
1			MC	71			13.7		49	18		
			SPT	35			15.9				94	
2			MC	66			16.1	18.3				
3			SPT	41								

3.5 m (11.5') El. 2212.5 m (7258.8')

Total Depth 3.5 m (11.5')

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Boring Log

Boring # GR-08
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/7/2009	105884	N11(1A)1,2,4
Completed: 12/7/2009		
Backfilled: 12/7/2009	Rig Type: CME 75	Surface Elevation: 2229.5 m (7314.6') Logged By: R. Stump
Latitude: 35°35.5945	Longitude: 108°19.7719'	Location: N11(1A) Sta. 1+400 CL

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater

Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m) Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
0			SPT	32								WEATHERED SANDSTONE AND WEATHERED SILTSTONE - moderately hard, with silt layers, tan and red brown, moist
0.6 m (2.0')												El. 2228.9 m (7312.6')
1			MC	30								WEATHERED CLAYSTONE - moderately hard, with clay layers, brown and gray and ferric staining, moist
2			SPT	19								
			MC	41								
3			SPT	33								
3.5 m (11.5')												El. 2226.0 m (7303.1')

Total Depth 3.5 m (11.5')

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Boring Log

Boring # GR-09
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/7/2009	105884	N11(1A)1,2,4
Completed: 12/7/2009		
Backfilled: 12/7/2009	Rig Type: CME 75	Surface Elevation: 2234.5 m (7331.0') | Logged By: R. Stump
Latitude: 35°35.6944'	Longitude: 108°19.7241'	Location: N11(1A) Sta. 1+600 0.9m Lt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.45" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m)	Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
	0			SPT	21			15.2					WEATHERED SILTSTONE AND WEATHERED CLAYSTONE - with silt and clay layers, brown and tan, moist
	1			MC	40			9.1	18.5			60	1.1 m (3.5') El. 2233.4 m (7327.5')
													WEATHERED SANDSTONE AND WEATHERED SILTSTONE - fine, medium strong, with silt layers, brown and red brown, moist
	2			SPT	50			13.9		50	20		2.3 m (7.5') El. 2232.2 m (7323.5')
				MC	50/4"								SANDY CLAYSTONE - medium strong, brown and gray, moist
	3			SPT	63								3.5 m (11.5') El. 2231.0 m (7319.5')

Total Depth 3.5 m (11.5')

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Boring Log

Boring #	GR-10
Sheet	1 of 1
Revision:	0

Date		Project Number	Project
Started:	12/7/2009	105884	N11(1A)1,2,4
Completed:	12/7/2009		
Backfilled:	12/7/2009	Rig Type: CME 75	Surface Elevation: 2226.0 m (7303.1') Logged By: R. Stump
Latitude: 35°35.7975'		Longitude: 108°19.7491'	Location: N11(1A) Sta. 1+799 3.7m Rt

Groundwater Depth (m) / Depth (m) | Graphical Log | Sample Taken | Sample Type | Penetration Resistance (Blows / 0.3 m) | % Recovery (Rock) | RQD | Moisture Content (%) | Dry Density (kN/cu. m) | Liquid Limit | Plasticity Index | Percent Passing No. 200 Sieve

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
(Not encountered)	

Visual Classification

Depth	Sample Type	Penetration Resistance	Visual Classification
0	SPT	33	WEATHERED SILTSTONE - medium strong, with thin sandstone, with silt layers, light brown, moist
1	MC	76	
			1.4 m (4.5') El. 2224.6 m (7298.6')
	SPT	26	WEATHERED CLAYSTONE WITH SILTSTONE LENSES - medium strong, with clay layers, gray, moist, ferric staining
2	SPT	30	
3	SPT	25	
			3.5 m (11.5') El. 2222.5 m (7291.6')

Total Depth 3.5 m (11.5')

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Boring Log

Boring # GR-11
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/7/2009	105884	N11(1A)1,2,4
Completed: 12/7/2009		
Backfilled: 12/7/2009	Rig Type: CME 75	Surface Elevation: 2223.0 m (7293.3') | Logged By: R. Stump
Latitude: 35°35.9085'	Longitude: 108°19.7368'	Location: N11(1A) Sta. 2+000 12.8m Lt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater

Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m)	Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
	0			MC	38								WEATHERED SILTSTONE WITH CLAYSTONE LENSES - medium strong, with silt and clay layers, tan and brown, moist
	1			SPT	22			5.4		29	8		1.2 m (4.0') El. 2221.8 m (7289.3')
	2			SPT	39								WEATHERED CLAYSTONE - medium strong, with clay layers, gray and dark brown with ferric staining and gypsum in partings and joints, highly weathered to decomposed No recovery in split spoon sample at 1.5m (5 ft) bgs
				SPT	34			15.5				89	
	3			SPT	38								3.5 m (11.5') El. 2219.5 m (7281.8')

Total Depth 3.5 m (11.5')

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Boring Log

Boring # GR-12
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/11/2009	105884	N11(1A)1,2,4
Completed: 12/11/2009		
Backfilled: 12/11/2009	Rig Type: CME 75	Surface Elevation: 2217.0 m (7273.6') Logged By: R. Stump
Latitude: 35°35.9998'	Longitude: 108°19.6653'	Location: N11(1A) Sta. 2+202 1.5m Rt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater

Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m) / Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
0			SPT	15								LEAN CLAY WITH SAND (CL)- hard, brown, moist
0.3 m (1.0')												El. 2216.7 m (7272.6')
1			MC	36								WEATHERED CLAYSTONE - soft to hard, with clay layers, brown to gray, moist, with sandy zones (fine sand)
2			SPT	37								
			SPT	25								
3			SPT	10/5"								
3.2 m (10.5')												El. 2213.8 m (7263.1')

Total Depth 3.2 m (10.5')

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Boring Log

Boring # GR-13
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/8/2009	105884	N11(1A)1,2,4
Completed: 12/8/2009		
Backfilled: 12/8/2009	Rig Type: CME 75	Surface Elevation: 2203.5 m (7229.3') | Logged By: R. Stump
Latitude: 35°36.0971'	Longitude: 108°19.6033'	Location: N11(1A) Sta. 2+400 CL

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m) / Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
0			SPT	40			9.6				73	FAT CLAY WITH SAND (CH)- medium to coarse sand, some fine gravel, hard, light brown, moist
1			SPT	22			14.1		51	23		1.1 m (3.5') El. 2202.4 m (7225.8')
												WEATHERED CLAYSTONE - medium strong, with clay layers, brown and gray with yellow and ferric staining, moist
2			SPT	26								
			SPT	41			11.3					
3			SPT	23								With gypsum crystals in partings and joints at 3m (10 ft) bgs
												3.5 m (11.5') El. 2200.0 m (7217.8')

Total Depth 3.5 m (11.5')

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Boring Log

Boring # GR-14
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/9/2009	105884	N11(1A)1,2,4
Completed: 12/9/2009		
Backfilled: 12/9/2009	Rig Type: CME 75	Surface Elevation: 2202.0 m (7224.4') Logged By: R. Stump
Latitude: 35°36.1873'	Longitude: 108°19.5325'	Location: N11(1A) Sta. 2+602 0.9m Rt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3 " O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m)	Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
	0			SPT	29								SANDY LEAN CLAY (CL)- hard, light brown, moist
													0.6 m (2.0') El. 2201.4 m (7222.4')
	1			MC	40								WEATHERED CLAYSTONE - with clay layers, brown and gray with ferric staining and yellow mineral deposits
	2			SPT	23								
				SPT	36								
	3			SPT	63/11"								With fine sandy zones at 3m (10 ft) bgs
													3.5 m (11.5') El. 2198.5 m (7212.9')

Total Depth 3.5 m (11.5')

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Boring Log

Boring # GR-15
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/9/2009	105884	N11(1A)1,2,4
Completed: 12/9/2009		
Backfilled: 12/9/2009	Rig Type: CME 75	Surface Elevation: 2199.0 m (7214.6') | Logged By: R. Stump
Latitude: 35°36.2507'	Longitude: 108°19.4275'	Location: N11(1A) Sta. 2+800 4.0m Rt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m) / Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
0			SPT	22								SANDY LEAN CLAY (CL)- hard, light brown, dry to moist
												0.5 m (1.5') El. 2198.5 m (7213.1')
1			MC	39			16.6	15.6			90	WEATHERED SILTSTONE - medium strong, with silt layers, brown and gray with ferric staining
2			SPT	30			13.5		47	18		
			SPT	30								
3			SPT	26								3.5 m (11.5') El. 2195.5 m (7203.1')

Total Depth 3.5 m (11.5')

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Boring Log

Boring # GR-16
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/9/2009	105884	N11(1A)1,2,4
Completed: 12/9/2009		
Backfilled: 12/9/2009	Rig Type: CME 75	Surface Elevation: 2193.0 m (7194.9') Logged By: R. Stump
Latitude: 35°36.3133'	Longitude: 108°19.3027'	Location: N11(1A) Sta. 3+020 5.5m Rt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D 2.46" I.D Modified California Sample; SPT - 2" O.D 1.38" I.D. Tube Sample; U - 3 " O.D 2.42" I.D Ring Sample; ST - 3" O.D Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m)	Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
	0			SPT	18								SANDY LEAN CLAY (CL)- stiff, light brown, moist
	0.3 m (1.0')												El. 2192.7 m (7193.9')
	1			MC	45								WEATHERED CLAYSTONE - medium strong, with clay layers, brown with calcite deposits, moist
	2			SPT	26								
	3			SPT	21								
				SPT	29								
	3.5 m (11.5')												El. 2189.5 m (7183.4')

Total Depth 3.5 m (11.5')

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Boring Log

Boring # GR-17
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/9/2009	105884	N11(1A)1,2,4
Completed: 12/9/2009		
Backfilled: 12/9/2009	Rig Type: CME 75	Surface Elevation: 2191.5 m (7190.0') | Logged By: R. Stump
Latitude: 35°36.3641'	Longitude: 108°19.2182'	Location: N11(1A) Sta. 3+200 1.8m Lt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m)	Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
	0			MC	37			11.6	13.9			65	SANDY LEAN CLAY (CL)- firm, with calcite, light brown, moist
													0.6 m (2.0') El. 2190.9 m (7188.0')
	1			SPT	13								WEATHERED CLAYSTONE - with clay layers, highly weathered to decomposed
				SPT	13			12.6					
	2												2.1 m (7.0') El. 2189.4 m (7183.0')
				SPT	26								WEATHERED CLAYSTONE - medium strong, with clay layers, brown, moist
	3			SPT	32								With thin fine sand layers at 3m (10ft) bgs
	4			SPT	21			15.6		47	19		
				SPT	37								With thin sandstone layers at 4.9m (16 ft) bgs
	5			SPT	24								
	6			SPT	46								6.6 m (21.5') El. 2184.9 m (7168.5')

Total Depth 6.6 m (21.5')

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Boring Log

Boring # GR-18
Sheet 1 of 1
Revision: 0

Date		Project Number	Project
Started: 12/9/2009		105884	N11(1A)1,2,4
Completed: 12/9/2009			
Backfilled: 12/9/2009	Rig Type: CME 75	Surface Elevation: 2179.0 m (7149.0')	Logged By: R. Stump
Latitude: 35°36.4405'	Longitude: 108°19.1098'	Location: N11(1A) Sta. 3+398 3.7m Lt	

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m)	Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
	0			SPT	11								LEAN CLAY (CL)- brown, moist
													0.3 m (1.0') El. 2178.7 m (7148.0')
	1			MC	38								WEATHERED CLAYSTONE - with thin sandy layers, with clay layers, brown, moist
				SPT	38								
	2												
				SPT	29								
	3												
				SPT	31								3.5 m (11.5') El. 2175.5 m (7137.5')

Total Depth 3.5 m (11.5')

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Boring Log

Boring # GR-19
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/9/2009	105884	N11(1A)1,2,4
Completed: 12/9/2009		
Backfilled: 12/9/2009	Rig Type: CME 75	Surface Elevation: 2178.5 m (7147.3') | Logged By: R. Stump
Latitude: 35°36.5232'	Longitude: 108°19.0455'	Location: N11(1A) Sta. 3+582 1.8m Lt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3 " O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m)	Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
	0			SPT	22					54	21		WEATHERED SILTSTONE - with silt layers, light brown
	1			SPT	27			14.8				96	
				SPT	37								
	2			SPT	50			14.2					With ferric staining at 2.3m (7.5 ft) bgs
	3			SPT	38								
													3.5 m (11.5') El. 2175.0 m (7135.8')

Total Depth 3.5 m (11.5')

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Boring Log

Boring # GR-20
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/9/2009	105884	N11(1A)1,2,4
Completed: 12/9/2009		
Backfilled: 12/9/2009	Rig Type: CME 75	Surface Elevation: 2169.0 m (7116.1') Logged By: R. Stump
Latitude: 35°36.6293'	Longitude: 108°18.9802'	Location: N11(1A) Sta. 3+801 1.8m Rt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater

Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m) Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
0		SPT		14								0.2 m (0.5') LEAN CLAY (CL)- brown, moist El. 2168.8 m (7115.6')
												WEATHERED CLAYSTONE - with calcite, with clay layers, brown and tan, moist, highly weathered to decomposed
1		SPT		10								No split spoon sample recovery at 0.8m (2.5 ft) bgs
		MC		24								
2												With thin sandstone layers at 2.3m (7.5 ft) bgs
		SPT		59								
3		SPT		49								3.5 m (11.5') El. 2165.5 m (7104.6')

Total Depth 3.5 m (11.5')

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Boring Log

Boring #	GR-21
Sheet	1 of 1
Revision:	0

Date	Started: 12/9/2009	Project Number 105884	Project N11(1A)1,2,4
	Completed: 12/9/2009		
	Backfilled: 12/9/2009	Rig Type: CME 75	Surface Elevation: 2164.5 m (7101.4') | Logged By: R. Stump
Latitude: 35°36.8231'		Longitude: 108°18.8641'	Location: N11(1A) Sta. 4+198 1.8m Lt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater

Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m)	Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
	0			MC	13								POORLY GRADED SAND (SP)- fine grained, loose, light brown, dry
													0.6 m (2.0') El. 2163.9 m (7099.4')
	1			MC	24			4.4	13.7			46	SILTY SAND (SM)- fine, medium dense, brown, dry
													1.2 m (4.0') El. 2163.3 m (7097.4')
				MC	42			12.8	15.1	49	23		LEAN CLAY WITH SAND (CL)- firm, brown, dry
	2												2.1 m (7.0') El. 2162.4 m (7094.4')
				SPT	13								SILTY SAND (SM)- fine, loose, brown, dry, porous
													2.9 m (9.5') El. 2161.6 m (7091.9')
	3			MC	37								SILTY LEAN CLAY (CL-ML)- hard, brown, dry
													3.4 m (11.0') El. 2161.1 m (7090.4')

Total Depth 3.4 m (11.0')

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Boring Log

Boring # GR-22
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/9/2009	105884	N11(1A)1,2,4
Completed: 12/9/2009		
Backfilled: 12/9/2009	Rig Type: CME 75	Surface Elevation: 2167.0 m (7109.6') Logged By: R. Stump
Latitude: 35°36.9281'	Longitude: 108°18.8287'	Location: N11(1A) Sta. 4+400 4.6m Rt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m)	Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
	0			SPT	15								SILTY SAND (SM)- fine grained, loose to medium dense, brown, dry
	1			MC	16			8.5					
	2			MC	25								
				SPT	12								2.7 m (9.0') El. 2164.3 m (7100.6')
	3			SPT	20								LEAN CLAY (CL)- firm, brown, moist
													3.5 m (11.5') El. 2163.5 m (7098.1')

Total Depth 3.5 m (11.5')

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Boring Log

Boring # GR-23
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/9/2009	105884	N11(1A)1,2,4
Completed: 12/9/2009		
Backfilled: 12/9/2009	Rig Type: CME 75	Surface Elevation: 2171.0 m (7122.7') Logged By: R. Stump
Latitude: 35°37.0350'	Longitude: 108°18.8161'	Location: N11(1A) Sta. 4+600 2.4m Lt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m)	Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
	0			SPT	8			4.7					SILT WITH SAND (ML)- fine grained, loose, brown, dry
	1			MC	19			3.6					
				SPT	13			7.5				71	
	2			SPT	21								
													2.6 m (8.5') El. 2168.4 m (7114.2')
													CLAYEY SAND (SC)- fine grained, medium dense, brown, dry
	3			SPT	8								2.9 m (9.5') El. 2168.1 m (7113.2')
													SILTY SAND (SM)- fine grained, loose, brown, dry
													3.5 m (11.5') El. 2167.5 m (7111.2')

Total Depth 3.5 m (11.5')

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Boring Log

Boring # GR-24
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/9/2009	105884	N11(1A)1,2,4
Completed: 12/9/2009		
Backfilled: 12/9/2009	Rig Type: CME 75	Surface Elevation: 2176.0 m (7139.1') Logged By: R. Stump
Latitude: 35°37.1411'	Longitude: 108°18.7913'	Location: N11(1A) Sta. 4+800 2.4m Lt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater

Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m) / Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
0			SPT	6								SILTY SAND (SM)- fine grained, loose, brown, dry
1			SPT	9								
			SPT	8								
2			SH									
3			SPT	16								3.4 m (11.0') El. 2172.6 m (7128.1')
												3.5 m (11.5') SANDY LEAN CLAY (CL)- hard, brown, dry El. 2172.5 m (7127.6')

Total Depth 3.5 m (11.5')

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Boring Log

Boring #	GR-25
Sheet	1 of 1
Revision:	0

Date		Project Number	Project
Started:	12/9/2009	105884	N11(1A)1,2,4
Completed:	12/9/2009		
Backfilled:	12/9/2009	Rig Type: CME 75	Surface Elevation: 2179.0 m (7149.0') Logged By: R. Stump
Latitude: 35°37.2547'		Longitude: 108°18.7589'	Location: N11(1A) Sta. 5+004 0.9m Rt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater

Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m)	Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
	0			SPT	9			5.2					SANDY SILT (ML)- loose to medium dense, light brown, dry
	1			MC	22								
				MC	18			7.8	14.3			64	
	2												2.1 m (7.0') El. 2176.9 m (7142.0')
				MC	27								POORLY GRADED SAND WITH SILT (SP-SM)- loose, light brown, dry
	3			SPT	11								3.5 m (11.5') El. 2175.5 m (7137.5')

Total Depth 3.5 m (11.5')

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Boring Log

Boring #	GR-26
Sheet	1 of 1
Revision:	0

Date		Project Number	Project
Started:	12/9/2009	105884	N11(1A)1,2,4
Completed:	12/9/2009		
Backfilled:	12/9/2009	Rig Type: CME 75	Surface Elevation: 2172.5 m (7127.6') Logged By: R. Stump
Latitude: 35°37.3497'		Longitude: 108°18.7127'	Location: N11(1A) Sta. 5+201 2.7m Lt

Groundwater Depth (m) / Depth (m) | Graphical Log | Sample Taken | Sample Type | Penetration Resistance (Blows / 0.3 m) | % Recovery (Rock) | RQD | Moisture Content (%) | Dry Density (kN/cu. m) | Liquid Limit | Plasticity Index | Percent Passing No. 200 Sieve | Visual Classification

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater

Depth, m (ft.)	Date
(Not encountered)	

Depth (m)	Sample Type	Penetration Resistance	Visual Classification
0	MC	11	SILTY SAND (SM)- fine grained, loose, light brown, dry
0.6 m (2.0')			El. 2171.9 m (7125.6')
1	SPT	19	SILTY CLAYEY SAND (SC-SM)- fine grained, loose to medium dense, light brown, dry
	SPT	8	
2.1 m (7.0')			El. 2170.4 m (7120.6')
2	SPT	8	POORLY GRADED SAND (SP)- fine grained, loose, light brown, dry
3	SPT	10	
3.5 m (11.5')			El. 2169.0 m (7116.1')

Total Depth 3.5 m (11.5')

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Boring Log

Boring # GR-27
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/9/2009	105884	N11(1A)1,2,4
Completed: 12/9/2009		
Backfilled: 12/9/2009	Rig Type: CME 75	Surface Elevation: 2186.0 m (7171.9') Logged By: R. Stump
Latitude: 35°37.4393'	Longitude: 108°18.6409'	Location: N11(1A) Sta. 5+400 2.1m Lt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m)	Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
	0			SPT	26			11.4		39	16		SANDY LEAN CLAY (CL)- fine grained, hard to firm, light brown and brown, dry
	1			SPT	10			7.1				60	
				SPT	9								
	2												2.1 m (7.0') El. 2183.9 m (7164.9')
				SPT	9								POORLY GRADED SAND WITH SILT (SP-SM)- fine grained, loose, light brown, dry
	3			SPT	11								3.5 m (11.5') El. 2182.5 m (7160.4')

Total Depth 3.5 m (11.5')

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Boring Log

Boring # GR-28
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/9/2009	105884	N11(1A)1,2,4
Completed: 12/9/2009		
Backfilled: 12/9/2009	Rig Type: CME 75	Surface Elevation: 2190.0 m (7185.0') | Logged By: R. Stump
Latitude: 35°37.5189'	Longitude: 108°18.5525'	Location: N11(1A) Sta. 5+600 1.2m Lt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.45" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m) Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
0			SPT	19								SANDY LEAN CLAY (CL)- fine grained, firm, brown, dry
1			SPT	15								1.4 m (4.5') El. 2188.6 m (7180.5')
			SPT	7								SILTY SAND (SM)- fine grained, loose, light brown, dry
2			SPT	7								2.9 m (9.5') El. 2187.1 m (7175.5')
3			SPT	5								POORLY GRADED SAND WITH SILT (SP-SM)- fine grained, loose, light brown, moist
												3.5 m (11.5') El. 2186.5 m (7173.5')

Total Depth 3.5 m (11.5')

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Boring Log

Boring # GR-29
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/9/2009	105884	N11(1A)1,2,4
Completed: 12/9/2009		
Backfilled: 12/9/2009	Rig Type: CME 75	Surface Elevation: 2194.5 m (7199.8') Logged By: R. Stump
Latitude: 35°37.5635'	Longitude: 108°18.4907'	Location: N11(1A) Sta. 5+722 3.7m Lt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3 " O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater

Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m) Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
0			MC	23								SANDY SILT (ML)- fine grained, hard to soft, light brown, dry
1			MC	12			6.2	12.7			57	
			SPT	7			7.2		NV	NP		
2			SPT	6								
3			SPT	7			5.1					
												3.5 m (11.5') El. 2191.0 m (7188.3')

Total Depth 3.5 m (11.5')

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Boring Log

Boring #	GR-30
Sheet	1 of 1
Revision:	0

Date	Started: 12/9/2009	Project Number 105884	Project N11(1A)1,2,4
	Completed: 12/9/2009		
	Backfilled: 12/9/2009	Rig Type: CME 75	Surface Elevation: 2197.0 m (7208.0') Logged By: R. Stump
Latitude: 35°37.5886'		Longitude: 108°18.4509'	Location: N11(1A) Sta. 5+800 CL

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3 " O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater

Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m)	Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
	0			SPT	15								SILTY SAND (SM)- fine grained, loose to medium dense, light brown, dry
	1			MC	14								
				SPT	8								
	2			SPT	8								
	3			SPT	20								3.2 m (10.5') El. 2193.8 m (7197.5') WEATHERED SANDSTONE - weak, with sand layers, light brown and red brown, dry
													3.5 m (11.5') El. 2193.5 m (7196.5')

Total Depth 3.5 m (11.5')

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Boring Log

Boring # GR-31
Sheet 1 of 1
Revision: 0

Date		Project Number	Project
Started: 12/10/2009		105884	N11(1A)1,2,4
Completed: 12/10/2009			
Backfilled: 12/10/2009	Rig Type: CME 75	Surface Elevation: 2200.0 m (7217.8')	Logged By: R. Stump
Latitude: 35°37.6575'	Longitude: 108°18.3509'	Location: N11(1A) Sta. 6+000 CL	

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m)	Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
	0			SPT	9			8.2					SILTY SAND (SM)- fine grained, loose, brown, moist
													0.6 m (2.0') El. 2199.4 m (7215.8')
	1			MC	18			13.0	15.9			74	LEAN CLAY WITH SAND (CL)- fine grained, soft, brown, moist
													1.7 m (5.5') El. 2198.3 m (7212.3')
				SPT	13								WEATHERED SANDSTONE - with sand layers, red brown, highly weathered to
	2												2.1 m (7.0') decomposed El. 2197.9 m (7210.8')
				SPT	5			16.1		29	11		CLAYEY SAND (SC)- fine grained, very loose to loose, with silt, brown, moist to very moist
	3			SPT	12								3.5 m (11.5') El. 2196.5 m (7206.3')

Total Depth 3.5 m (11.5')

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Boring Log

Boring #	GR-32
Sheet	1 of 1
Revision:	0

Date	Started: 12/10/2009	Project Number 105884	Project N11(1A)1,2,4
	Completed: 12/10/2009		
	Backfilled: 12/10/2009	Rig Type: CME 75	Surface Elevation: 2200.5 m (7219.5') Logged By: R. Stump
Latitude: 35°37.6960'		Longitude: 108°18.3043'	Location: N11(1A) Sta. 6+100 11.6m Lt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater

Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m)	Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
	0			MC	31								SILTY SAND (SM)- fine grained, medium dense, brown, moist
	1			MC	20								1.2 m (4.0') El. 2199.3 m (7215.5')
													WEATHERED SANDSTONE - with sand layers, red brown, highly weathered to decomposed
													1.5 m (5.0') El. 2199.0 m (7214.5')
	2			SPT	3								CLAYEY SAND (SC)- fine grained, very loose to loose, dark brown, very moist
				MC	8								
	3			MC	19								3.4 m (11.0') El. 2197.1 m (7208.5')

Total Depth 3.4 m (11.0')

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Boring Log

Boring # GR-33
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/10/2009	105884	N11(1A)1,2,4
Completed: 12/10/2009		
Backfilled: 12/10/2009	Rig Type: CME 75	Surface Elevation: 2201.5 m (7222.8') Logged By: R. Stump
Latitude: 35°37.7288'	Longitude: 108°18.2502'	Location: N11(1A) Sta. 6+200 9.1m Lt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m)	Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
	0			SPT	41			9.4				61	SANDY LEAN CLAY (CL)- fine to medium grained, hard to firm, brown, moist
	1			SPT	15			11.2		32	14		
				SPT	46								
	1.8 m (6.0')												El. 2199.7 m (7216.8')
	2												WEATHERED SANDSTONE - fine grained, with sand layers, light brown, moist, highly weathered to decomposed
	2.4 m (8.0')												El. 2199.1 m (7214.8')
				SPT	20								WEATHERED CLAYSTONE - medium strong, with clay layers, gray
	3												
	3.0 m (10.0')												El. 2198.5 m (7212.8')
				SPT	48								WEATHERED CLAYSTONE - medium strong, with clay layers, light brown with iron staining
	3.5 m (11.5')												El. 2198.0 m (7211.3')

Total Depth 3.5 m (11.5')

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Boring Log

Boring # GR-34
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/10/2009	105884	N11(1A)1,2,4
Completed: 12/10/2009		
Backfilled: 12/10/2009	Rig Type: CME 75	Surface Elevation: 2206.0 m (7237.5') Logged By: R. Stump
Latitude: 35°37.7672'	Longitude: 108°18.1248'	Location: N11(1A) Sta. 6+400 4.9m Lt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3 " O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m)	Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
	0			SPT	13								SILTY SAND (SM)- fine to medium grained, medium dense, light brown, dry to moist
	1			SPT	9								With rootlets from 1.5m (5 ft) bgs
	2			SPT	10								
				SPT	27								
	3			SPT	22								
													3.5 m (11.5') El. 2202.5 m (7226.0')

Total Depth 3.5 m (11.5')

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Boring Log

Boring #	GR-35
Sheet	1 of 1
Revision:	0

Date		Project Number	Project
Started:	12/10/2009	105884	N11(1A)1,2,4
Completed:	12/10/2009		
Backfilled:	12/10/2009	Rig Type: CME 75	Surface Elevation: 2214.5 m (7265.4') Logged By: R. Stump
Latitude: 35°37.7888'		Longitude: 108°17.9940'	Location: N11(1A) Sta. 6+600 1.2m Rt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater

Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m) Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
0			SPT	24								SILT WITH SAND (ML)- fine to medium grained, soft to firm, light brown, moist
1			MC	13			13.6	12.6			80	With rootlets from 0.9m (3 ft) to 1.8m (6 ft) bgs
2			MC	19								
			SPT	8			15.8				84	
3			SPT	5			16.3					

3.5 m (11.5') El. 2211.0 m (7253.9')

Total Depth 3.5 m (11.5')

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Boring Log

Boring # GR-36
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/10/2009	105884	N11(1A)1,2,4
Completed: 12/10/2009		
Backfilled: 12/10/2009	Rig Type: CME 75	Surface Elevation: 2224.5 m (7298.2') Logged By: R. Stump
Latitude: 35°37.8081'	Longitude: 108°17.8639'	Location: N11(1A) Sta. 6+800 1.2m Lt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3 " O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m)	Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
	0			SPT	26								WEATHERED SANDY CLAYSTONE AND SILTSTONE - with clay and silt layers, light brown and yellow brown, highly fractured sandstone layers, with ferric staining,
	1			SPT	62								
				SPT	48								
	2			SPT	51								
	3			SPT	50/4"								

3.4 m (11.0') El. 2221.1 m (7287.2')

Total Depth 3.4 m (11.0')

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Boring Log

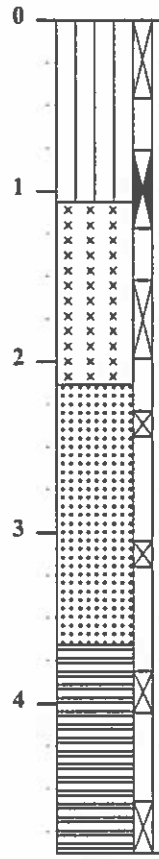
Boring # GR-37
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/10/2009	105884	N11(1A)1,2,4
Completed: 12/10/2009		
Backfilled: 12/10/2009	Rig Type: CME 75	Surface Elevation: 2236.5 m (7337.6') Logged By: R. Stump
Latitude: 35°37.8356'	Longitude: 108°17.7368'	Location: N11(1A) Sta. 7+000 2.4m Rt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater

Depth, m (ft.)	Date
(Not encountered)	



Groundwater Depth (m)	Depth (m)	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
	0		SPT	19			10.3				87	SILT (ML)- fine grained, firm, some sand, brown, dry
	1		MC	14								1.1 m (3.5') El. 2235.4 m (7334.1')
												WEATHERED SILTSTONE AND CLAYSTONE - with silt and clay layers, gray brown and light brown with iron staining, moist
			SPT	37			13.4		42	17		
	2											2.1 m (7.0') El. 2234.4 m (7330.6')
			SPT	50/5"								SANDSTONE - fine grained, with iron staining, weakly cemented, light tan, dry
	3		SPT	50/5"								3.7 m (12.0') El. 2232.8 m (7325.6')
												SHALE - gray and brown with iron staining, moist
	4		SPT	50/4"			10.6		33	12		
			SPT	50/5"								4.9 m (16.0') El. 2231.6 m (7321.6')

Total Depth 4.9 m (16.0')

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Boring Log

Boring # GR-38
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/10/2009	105884	N11(1A)1,2,4
Completed: 12/10/2009		
Backfilled: 12/10/2009	Rig Type: CME 75	Surface Elevation: 2235.5 m (7334.3') | Logged By: R. Stump
Latitude: 35°37.9147'	Longitude: 108°17.6461'	Location: N11(1A) Sta. 7+203 CL

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3 " O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater

Depth. m (ft.)	Date
(Not encountered)	

Groundwater Depth (m) Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
0			SPT	30								SILTY SAND (SM)- fine to medium grained, dense to medium dense, light brown, moist
1			SPT	12								
												1.2 m (4.0') El. 2234.3 m (7330.3')
												WEATHERED SANDSTONE - fine grained, with sand layers, dry
2			SPT	25								
												2.1 m (7.0') Thin lignite layer at 2m (6.5 ft) bgs El. 2233.4 m (7327.3')
			SPT	50/1"								SANDY SILTSTONE AND FINE SANDSTONE - with thin to laminate shale layers, light tan to red brown, ferric staining, yellowish deposits
3			SPT	50/5"								
												3.2 m (10.5') El. 2232.3 m (7323.8')

Total Depth 3.2 m (10.5')

Gray shale layer at 3.2m (10.5 ft) bgs

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Boring Log

Boring # GR-39
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/10/2009	105884	N11(1A)1,2,4
Completed: 12/10/2009		
Backfilled: 12/10/2009	Rig Type: CME 75	Surface Elevation: 2235.5 m (7334.3') Logged By: R. Stump
Latitude: 35°38.0068'	Longitude: 108°17.5801'	Location: N11(1A) Sta. 7+400 12.2m Rt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater

Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m) / Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
0			SPT	14								SANDY SILT (ML)- very loose to loose, tan, dry
1			MC	9			7.2	14.9				
			SPT	5			9.0				70	
2			MC	5								
3			SPT	3			7.8		NV	NP		
												3.5 m (11.5') El. 2232.0 m (7322.8')

Total Depth 3.5 m (11.5')

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Boring Log

Boring # GR-40
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/10/2009	105884	N11(1A)1,2,4
Completed: 12/10/2009		
Backfilled: 12/10/2009	Rig Type: CME 75	Surface Elevation: 2247.0 m (7372.0') | Logged By: R. Stump
Latitude: 35°38.1060'	Longitude: 108°17.5272'	Location: N11(1A) Sta. 7+600 1.8m Lt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m)	Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
	0			SPT	14								SILTY SAND (SM)- fine grained, loose to dense, tan, dry
	1			MC	9								
				SPT	31								1.8 m (6.0') El. 2245.2 m (7366.0')
	2			SPT	50/6"								SILTSTONE - with fine sand, moderately cemented, tan and light brown, with calcite
	3			SPT	60								3.5 m (11.5') El. 2243.5 m (7360.5')

Total Depth 3.5 m (11.5')

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Boring Log

Boring # GR-41
Sheet 1 of 2
Revision: 0

Date	Project Number	Project
Started: 12/10/2009	105884	N11(1A)1,2,4
Completed: 12/10/2009		
Backfilled: 12/10/2009	Rig Type: CME 75	Surface Elevation: 2256.0 m (7401.6') | Logged By: R. Stump
Latitude: 35°38.2002'	Longitude: 108°17.4664'	Location: N11(1A) Sta. 7+800 0.6m Lt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m)	Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
	0			SPT	7								SANDY SILT (ML)- fine grained, soft, light brown, moist
	1			MC	12			9.6	12.5			65	
	2			SPT	5								
				MC	27								2.4 m (8.0') El. 2253.6 m (7393.6')
	3			SPT	53			12.4		43	19		CLAYSTONE - with clayey zones, well cemented, light gray brown, moist, highly weathered to decomposed
	4			SPT	68								4.0 m (13.0') El. 2252.0 m (7388.6')
				SPT	50/3"								SILTSTONE/CLAYSTONE - fine grained, poorly to moderately cemented, dry
	5			SPT	50/3"			8.5				54	
	6			SPT	50/5"								
	7			SPT	50/3"								
	8			SPT	50/6"								
				SPT	50/4"			7.0		24	5		
	9												

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Boring Log

Boring # GR-41
Sheet 2 of 2
Revision: 0

Date	Project Number	Project
Started: 12/10/2009	105884	N11(1A)1,2,4
Completed: 12/10/2009		
Backfilled: 12/10/2009	Rig Type: CME 75	Surface Elevation: 2256.0 m (7401.6') | Logged By: R. Stump
Latitude: 35°38.2002'	Longitude: 108°17.4664'	Location: N11(1A) Sta. 7+800 0.6m Lt

Groundwater Depth (m) / Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
9		☒	SPT	50/3"								9.2 m (30.3') El. 2246.8 m (7371.3')

Total Depth 9.2 m (30.3')

Sample Type
AUGER - Auger Cuttings
G - Grab Sample
MC - 2.5" O.D. 2.46" I.D. Modified California Sample
SPT - 2" O.D. 1.38" I.D. Tube Sample
U - 3 " O.D. 2.42" I.D. Ring Sample
ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
(Not encountered)	

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Boring Log

Boring # GR-42
Sheet 1 of 2
Revision: 0

Date	Project Number	Project
Started: 12/10/2009	105884	N11(1A)1,2,4
Completed: 12/10/2009		
Backfilled: 12/10/2009	Rig Type: CME 75	Surface Elevation: 2254.0 m (7395.0') | Logged By: R. Stump
Latitude: 35°38.2916'	Longitude: 108°17.3985'	Location: N11(1A) Sta. 8+000 7.3m Rt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3 " O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m)	Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
	0			SPT	10								SILTY SAND (SM)- fine grained, loose to medium dense, light brown to tan, dry
	1			MC	12								
													1.4 m (4.5') El. 2252.6 m (7390.5')
	2			SPT	59								SANDSTONE - fine grained, poorly to moderately cemented, tan to light brown, dry, silty
				SPT	50/6"								
	3			SPT	50/4"								
	4			SPT	50/4"								Thin shale layers at 4m (13 ft) bgs
				SPT	50/6"								
	5			SPT	85/8"								
	6			SPT	50/4"								
	7			SPT	50/5"								
	8			SPT	60								
	9			SPT	72								

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Boring Log

Boring # GR-42
Sheet 2 of 2
Revision: 0

Date	Project Number	Project
Started: 12/10/2009	105884	N11(1A)1,2,4
Completed: 12/10/2009		
Backfilled: 12/10/2009	Rig Type: CME 75	Surface Elevation: 2254.0 m (7395.0') Logged By: R. Stump
Latitude: 35°38.2916'	Longitude: 108°17.3985'	Location: N11(1A) Sta. 8+000 7.3m Rt

Groundwater Depth (m)	Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
	9			SPT	58								SANDSTONE - fine grained, poorly to moderately cemented, tan to light brown, dry, silty
													9.6 m (31.5') El. 2244.4 m (7363.5')

Total Depth 9.6 m (31.5')

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
(Not encountered)	

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Boring Log

Boring # GR-43
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/10/2009	105884	N11(1A)1,2,4
Completed: 12/10/2009		
Backfilled: 12/10/2009	Rig Type: CME 75	Surface Elevation: 2246.5 m (7370.4') Logged By: R. Stump
Latitude: 35°38.3706'	Longitude: 108°17.3071'	Location: N11(1A) Sta. 8+200 1.2m Lt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater

Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m)	Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
	0		☒	SPT	50/4"								SANDSTONE - fine grained, light brown
													0.3 m (1.0') El. 2246.2 m (7369.4')
													SILTSTONE - with sandstone layers, light brown, dry to moist, some ferric staining
	1		☒	SPT	37			13.2				89	
				SPT	54			13.3					
	2			SPT	78/11"								
	3		☒	SPT	50/5"								3.2 m (10.5') El. 2243.3 m (7359.9')

Total Depth 3.2 m (10.5')

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Boring Log

Boring # GR-44
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/11/2009	105884	N11(1A)1,2,4
Completed: 12/11/2009		
Backfilled: 12/11/2009	Rig Type: CME 75	Surface Elevation: 2250.5 m (7383.5') Logged By: R. Stump
Latitude: 35°38.4326'	Longitude: 108°17.1975'	Location: N11(1A) Sta. 8+400 4.6m Lt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater

Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m)	Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
	0			SPT	6								SILTY SAND (SM)- fine grained, loose to very loose, light brown, moist
	1			MC	11								
	2			SPT	2								
				SPT	2								
	3			MC	8								
													3.7 m (12.0') El. 2246.8 m (7371.5')
	4			SPT	30								WEATHERED CLAYSTONE - with clay layers, gray brown, moist
													4.6 m (15.0') El. 2245.9 m (7368.5')
				SPT	73/11"								SILTSTONE - light brown, with sandstone layers
	5			SPT	77/10"								
	6			SPT	50/4"								
				SPT	50/6"								Gray shale with calcite layers from 6.9m (22.5 ft) to 7.3m (24 ft) bgs
	7			SPT	50/5"								
													7.9 m (26.0') El. 2242.6 m (7357.5')

Total Depth 7.9 m (26.0')

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Boring Log

Boring # GR-45
Sheet 1 of 3
Revision: 0

Date	Project Number	Project
Started: 12/11/2009	105884	N11(1A)1,2,4
Completed: 12/11/2009		
Backfilled: 12/11/2009	Rig Type: CME 75	Surface Elevation: 2263.5 m (7426.2') | Logged By: R. Stump
Latitude: 35°38.4591'	Longitude: 108°17.0690'	Location: N11(1A) Sta. 8+600 1.2m Rt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.45" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m)	Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
	0			SPT	48								CLAYSTONE - olive brown
													0.5 m (1.5') El. 2263.0 m (7424.7')
													SANDSTONE - light brown
	1			SPT	44								0.9 m (3.0') El. 2262.6 m (7423.2')
													CLAYSTONE - gray
													1.2 m (4.0') El. 2262.3 m (7422.2')
													SANDSTONE - light gray
													1.5 m (5.0') El. 2262.0 m (7421.2')
	2			SPT	32								SILTSTONE - light brown, slightly carboniferous
													2.1 m (7.0') El. 2261.4 m (7419.2')
				SPT	50/3"								SANDSTONE - brown
													2.4 m (8.0') El. 2261.1 m (7418.2')
	3												SANDSTONE - gray
													76 mm (3 in) shale/coal seam at 5.8 (19 ft) bgs
				SPT	50/6"								3.2 m (10.5') El. 2260.3 m (7415.7')
													Pratical auger refusal at 3m (10 ft) bgs
				CORE		100	100						SANDSTONE - light gray, fine grained, slightly weathered, weak to medium strong, slightly fractured, thinly bedded, bedding joints tight, moderately smooth, no infilling
	4												
													With thin shaly coal seams from 4.4m (14.5 ft) bgs
	5			CORE		100	100						
	6			CORE		98	87						
	7												Reduced coal seams from 7m (23 ft) bgs
	8			CORE		100	100						
	9			CORE		100	100						

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Boring Log

Boring # GR-45
Sheet 2 of 3
Revision: 0

Date	Project Number	Project
Started: 12/11/2009	105884	N11(1A)1,2,4
Completed: 12/11/2009		
Backfilled: 12/11/2009	Rig Type: CME 75	Surface Elevation: 2263.5 m (7426.2') Logged By: R. Stump
Latitude: 35°38.4591'	Longitude: 108°17.0690'	Location: N11(1A) Sta. 8+600 1.2m Rt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m) / Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
9												SANDSTONE - light gray, fine grained, slightly weathered, weak to medium strong, slightly fractured, thinly bedded, bedding joints tight, moderately smooth, no infilling
			CORE		100	100						
10												
11			CORE		98	98						
12												
			CORE		100	100						
13												
14			CORE		100	100						
15												Increasing coal seams from 14.8m (48.5 ft) bgs
			CORE		95	92						
16												
17			CORE		100	100						
18												

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Boring Log

Boring # GR-45
Sheet 3 of 3
Revision: 0

Date	Project Number	Project
Started: 12/11/2009	105884	N11(1A)1,2,4
Completed: 12/11/2009		
Backfilled: 12/11/2009	Rig Type: CME 75	Surface Elevation: 2263.5 m (7426.2') | Logged By: R. Stump
Latitude: 35°38.4591'	Longitude: 108°17.0690'	Location: N11(1A) Sta. 8+600 1.2m Rt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater

Depth. m (ft.)	Date
(Not encountered)	

Groundwater Depth (m)	Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
	18					100	100						SANDSTONE - light gray, fine grained, slightly weathered, weak to medium strong, slightly fractured, thinly bedded, bedding joints tight, moderately smooth, no infilling
				CORE		100	100						
	19												
	20			CORE		98	92						
	21												
				CORE		100	100						

21.9 m (72.0') El. 2241.6 m (7354.2')

Total Depth 21.9 m (72.0')

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Boring Log

Boring # GR-46
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/11/2009	105884	N11(1A)1,2,4
Completed: 12/11/2009		
Backfilled: 12/11/2009	Rig Type: CME 75	Surface Elevation: 2249.5 m (7380.2') | Logged By: R. Stump
Latitude: 35°38.4828'	Longitude: 108°16.9390'	Location: N11(1A) Sta. 8+800 CL

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater

Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m) / Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
0			SPT	25								CLAYEY SAND (SC)- fine grained, loose to very loose, brown to light brown, moist
1			MC	7			14.8	14.4			47	
			SPT	4								
2			SPT	4								
3			SPT	4			13.5		30	8		
4			MC	10								
			SPT	2			10.7				33	
5			SPT	6								
6			SPT	6								
7			MC	25			16.8	16.9	30	10		7.0 m (23.0') El. 2242.5 m (7357.2') WEATHERED CLAYSTONE - with thin lenses of fine sandstone and siltstone, with clay layers, gray to light brown, weathered
			SPT	37								8.1 m (26.5') El. 2241.4 m (7353.7')
8												

Total Depth 8.1 m (26.5')

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Boring Log

Boring # GR-47
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/11/2009	105884	N11(1A)1,2,4
Completed: 12/11/2009		
Backfilled: 12/11/2009	Rig Type: CME 75	Surface Elevation: 2240.5 m (7350.7') Logged By: R. Stump
Latitude: 35°38.5062'	Longitude: 108°16.8091'	Location: N11(1A) Sta. 9+000 CL

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3 " O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater

Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m)	Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
	0			SPT	18			11.8				50	SILTY SAND (SM)- fine grained, loose to medium dense, brown, moist
	1			MC	13			15.0	16.8	NV	NP		
				SPT	9								
	2			SPT	32								2.4 m (8.0') El. 2238.1 m (7342.7') WEATHERED CLAYSTONE - with shale and sandy layers, with clay layers, tan to light red brown, dry
	3			SPT	52			10.8		35	13		3.5 m (11.5') El. 2237.0 m (7339.2')

Total Depth 3.5 m (11.5')

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Boring Log

Boring # GR-48
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/11/2009	105884	N11(1A)1,2,4
Completed: 12/11/2009		
Backfilled: 12/11/2009	Rig Type: CME 75	Surface Elevation: 2239.0 m (7345.8') Logged By: R. Stump
Latitude: 35°38.5279'	Longitude: 108°16.6807'	Location: N11(1A) Sta. 9+200 CL

Groundwater Depth (m) / Depth (m) | Graphical Log | Sample Taken | Sample Type | Penetration Resistance (Blows / 0.3 m) | % Recovery (Rock) | RQD | Moisture Content (%) | Dry Density (kN/cu. m) | Liquid Limit | Plasticity Index | Percent Passing No. 200 Sieve

Sample Type:
AUGER - Auger Cuttings
G - Grab Sample
MC - 2.5" O.D 2.46" I.D. Modified California Sample
SPT - 2" O.D 1.38" I.D. Tube Sample
U - 3 " O.D. 2.42" I.D. Ring Sample
ST - 3" O.D Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
(Not encountered)	

Visual Classification

Depth	Sample Type	Penetration Resistance	Visual Classification
0	SPT	18	SILTY SAND (SM)- fine grained, loose to very loose, light brown, moist
1	SPT	3	
	SPT	2	
2	SPT	3	
3	SPT	3	
3.5 m (11.5')			El. 2235.5 m (7334.3')

Total Depth 3.5 m (11.5')

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Boring Log

Boring # GR-49
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/11/2009	105884	N11(1A)1,2,4
Completed: 12/11/2009		
Backfilled: 12/11/2009	Rig Type: CME 75	Surface Elevation: 2239.0 m (7345.8') | Logged By: R. Stump
Latitude: 35°38.5619'	Longitude: 108°16.5569'	Location: N11(1A) Sta. 9+400 10.7m Rt

AUGER - Auger Cuttings
G - Grab Sample
MC - 2.5" O.D. 2.46" I.D. Modified California Sample
SPT - 2" O.D. 1.38" I.D. Tube Sample
U - 3" O.D. 2.42" I.D. Ring Sample
ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m)	Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Sample Type	Visual Classification
	0			SPT	7			16.1				40		SILTY SAND (SM)- fine grained, loose, light brown, moist
	1			MC	20			7.2	14.7					1.1 m (3.5') El. 2237.9 m (7342.3')
														WEATHERED CLAYSTONE - with thin shale and clayey lenses, with clay layers, brown to dark brown, moist, highly weathered to decomposed
	2			SPT	36			12.5		28	8			
				SPT	36			12.6				61		
	3			SPT	33									3.5 m (11.5') El. 2235.5 m (7334.3')

Total Depth 3.5 m (11.5')

Note: Survey stake location inacessible behind fence line. Boring offset 10.7 m Rt of centerline.

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Boring Log

Boring # GR-50
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/11/2009	105884	N11(1A)1,2,4
Completed: 12/11/2009		
Backfilled: 12/11/2009	Rig Type: CME 75	Surface Elevation: 2239.5 m (7347.4') Logged By: R. Stump
Latitude: 35°38.6248'	Longitude: 108°16.4450'	Location: N11(1A) Sta. 9+600 12.2m Rt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m)	Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
	0			SPT	20								SILTY SAND WITH FINE GRAVEL (SM)- loose, brown, moist
													0.3 m (1.0') El. 2239.2 m (7346.4')
													WEATHERED SILTSTONE - with thin sandstone and shale layers, with silt layers, weakly cemented, brown
	1			SPT	53								
				SPT	32								
	2												
				SPT	41								
	3												
				SPT	55								3.5 m (11.5') El. 2236.0 m (7335.9')

Total Depth 3.5 m (11.5')

Note: Survey stake location inacessible behind fence line. Boring offset 12.2 m Rt of centerline.

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Boring Log

Boring # GR-51
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/11/2009	105884	N11(1A)1,2,4
Completed: 12/11/2009		
Backfilled: 12/11/2009	Rig Type: CME 75	Surface Elevation: 2239.0 m (7345.8') Logged By: R. Stump
Latitude: 35°38.6919'	Longitude: 108°16.3427'	Location: N11(1A) Sta. 9+800 0.9m Lt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater

Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m) / Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
0			SPT	37								SILTY SAND (SM)- fine grained, medium dense to very loose, light brown, moist
1			MC	10			8.3	14.8			35	
			SPT	5								
2			SPT	3			10.0				42	
3			SPT	8								

3.5 m (11.5') El. 2235.5 m (7334.3')

Total Depth 3.5 m (11.5')

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Boring Log

Boring # GR-52
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/11/2009	105884	N11(1A)1,2,4
Completed: 12/11/2009		
Backfilled: 12/11/2009	Rig Type: CME 75	Surface Elevation: 2241.0 m (7352.4') Logged By: R. Stump
Latitude: 35°38.7699'	Longitude: 108°16.2423'	Location: N11(1A) Sta. 10+010 4.6m Lt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m) / Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
0			SPT	19								SILTY SAND WITH FINE GRAVEL (SM)- fine to coarse grained, medium dense, brown, dry
1			MC	11								
												1.4 m (4.5') El. 2239.6 m (7347.9')
			SPT	10								SILTY SAND (SM)- fine grained, loose to medium dense, with some fine gravel, brown, dry
2			SPT	17								
3			SPT	9								
												3.5 m (11.5') El. 2237.5 m (7340.9')

Total Depth 3.5 m (11.5')

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Boring Log

Boring # GR-53
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/11/2009	105884	N11(1A)1,2,4
Completed: 12/11/2009		
Backfilled: 12/11/2009	Rig Type: CME 75	Surface Elevation: 2243.0 m (7358.9') Logged By: R. Stump
Latitude: 35°38.8556'	Longitude: 108°16.1721'	Location: N11(1A) Sta. 10+200 9.1m Lt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3 " O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater

Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m) / Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
0			SPT	20			7.8				34	SILTY SAND WITH FINE GRAVEL (SM)- fine to medium grained, medium dense, brown, moist
1			SPT	18								1.1 m (3.5') El. 2241.9 m (7355.4')
			SPT	60			10.3		35	11		SILTSTONE - with thin claystone and sandstone layers, weakly to moderately cemented, olive brown to light brown, dry
2			SPT	82/9"			9.9				36	
3			SPT	50/5"								3.2 m (10.5') El. 2239.8 m (7348.4')

Total Depth 3.2 m (10.5')

Note: Survey stake location inacessible behind fence line. Boring offset 9.1 m Lt of centerline.

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Boring Log

Boring # GR-54
Sheet 1 of 1
Revision: 0

Date	Project Number	Project
Started: 12/11/2009	105884	N11(1A)1,2,4
Completed: 12/11/2009		
Backfilled: 12/11/2009	Rig Type: CME 75	Surface Elevation: 2249.5 m (7380.2') Logged By: R. Stump
Latitude: 35°38.9481'	Longitude: 108°16.1048'	Location: N11(1A) Sta. 10+400 6.4m Lt

Sample Type: AUGER - Auger Cuttings; G - Grab Sample; MC - 2.5" O.D. 2.46" I.D. Modified California Sample; SPT - 2" O.D. 1.38" I.D. Tube Sample; U - 3" O.D. 2.42" I.D. Ring Sample; ST - 3" O.D. Thin-Walled Shelby Tube

Groundwater	
Depth, m (ft.)	Date
(Not encountered)	

Groundwater Depth (m)	Depth (m)	Graphical Log	Sample Taken	Sample Type	Penetration Resistance (Blows / 0.3 m)	% Recovery (Rock)	RQD	Moisture Content (%)	Dry Density (kN/cu. m)	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve	Visual Classification
	0			SPT	20								POORLY GRADED SAND WITH SILT AND FINE TO COARSE GRAVEL (SP-SM)- fine to medium grained, medium dense, brown and red brown, dry
	1			SPT	10								
				SPT	10								
	2			SPT	17								
													2.7 m (9.0') El. 2246.8 m (7371.2')
	3			SPT	50/4"								SANDSTONE - fine grained, weakly to moderately cemented, tan to red brown, dry
				SPT	50/2.5"								
	4			SPT	50/5"								4.7 m (15.5') El. 2244.8 m (7364.7')

Total Depth 4.7 m (15.5')

Note: Survey stake location inacessible behind fence line. Boring offset 6.4 m Lt of centerline.

APPENDIX C

Geotechnical Laboratory Test Results

Summary of Laboratory Test Results

Particle Size Distribution Results

Atterberg Limits Test Results

Direct Shear Test Results

SUMMARY OF LABORATORY ANALYSIS

Project: **N11(1A)1,2,4**
Project Number: **105884**

Location: **Near Crownpoint, New Mexico**

Boring Number	Depth m (ft.)	Soil Classification		Atterberg Limits		Sieve Analysis - Accumulative % Passing										Moisture Content	Dry Density	Dry Density
		USCS	AASHTO	PI	LL	0.075 mm (No. 200)	0.150 mm (No. 100)	0.425 mm (No. 40)	2.000 mm (No. 10)	4.750 mm (No. 4)	9.525 mm (3/8 in)	12.7 mm (1/2 in)	19.05 mm (3/4 in)	25.4 mm (1 in)	38.1 mm (1 1/2 in)	(%)	(pcf)	(kg/m³)
BR-2	1.5 - 2.0 (5.0 - 6.5)			--	--	76	--	--	--	--	--	--	--	--	--	--	--	--
BR-2	3.0 - 3.5 (10.0 - 11.5)			18	41	--	--	--	--	--	--	--	--	--	--	--	--	--
BR-3	3.8 - 4.1 (12.5 - 13.5)			16	45	--	--	--	--	--	--	--	--	--	--	17.9	106.9	1713.1
BR-4	0.8 - 1.1 (2.5 - 3.5)			NP	NV	--	--	--	--	--	--	--	--	--	--	7.3	91.1	1459.5
BR-4	3.8 - 4.1 (12.5 - 13.5)			--	--	90	97	100	--	--	--	--	--	--	--	12.8	84.5	1353.4
GR-01	0.0 - 0.5 (0.0 - 1.5)			23	47	--	--	--	--	--	--	--	--	--	--	--	--	--
GR-01	0.8 - 1.1 (2.5 - 3.5)			--	--	66	67	73	93	99	100	--	--	--	--	15.2	--	--
GR-01	1.5 - 2.0 (5.0 - 6.5)			--	--	--	--	--	--	--	--	--	--	--	--	12.0	--	--
GR-03	0.0 - 0.5 (0.0 - 1.5)			--	--	--	--	--	--	--	--	--	--	--	--	9.1	--	--
GR-03	0.8 - 1.1 (2.5 - 3.5)			24	54	--	--	--	--	--	--	--	--	--	--	14.6	--	--
GR-03	1.5 - 2.0 (5.0 - 6.5)			--	--	98	--	--	--	--	--	--	--	--	--	17.8	--	--
GR-05	0.8 - 1.1 (2.5 - 3.5)			--	--	84	90	96	100	100	100	--	--	--	--	20.7	87.2	1396.1
GR-05	1.5 - 2.0 (5.0 - 6.5)			--	--	--	--	--	--	--	--	--	--	--	--	18.9	--	--
GR-07	0.0 - 0.5 (0.0 - 1.5)			--	--	--	--	--	--	--	--	--	--	--	--	10.2	--	--
GR-07	0.8 - 1.1 (2.5 - 3.5)			18	49	--	--	--	--	--	--	--	--	--	--	13.7	--	--
GR-07	1.5 - 2.0 (5.0 - 6.5)			--	--	94	--	--	--	--	--	--	--	--	--	15.9	--	--
GR-07	2.3 - 2.6 (7.5 - 8.5)			--	--	--	--	--	--	--	--	--	--	--	--	16.1	111.1	1779.0
GR-09	0.0 - 0.5 (0.0 - 1.5)			--	--	--	--	--	--	--	--	--	--	--	--	15.2	--	--
GR-09	0.8 - 1.1 (2.5 - 3.5)			--	--	60	62	67	75	77	80	80	80	80	100	9.1	112.3	1798.4
GR-09	1.5 - 2.0 (5.0 - 6.5)			20	50	--	--	--	--	--	--	--	--	--	--	13.9	--	--
GR-11	0.8 - 1.2 (2.5 - 4.0)			8	29	--	--	--	--	--	--	--	--	--	--	5.4	--	--

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SUMMARY OF LABORATORY ANALYSIS

Project: **N11(1A)1,2,4**
Project Number: **105884**

Location: **Near Crownpoint, New Mexico**

Boring Number	Depth m (ft.)	Soil Classification		Atterberg Limits		Sieve Analysis - Accumulative % Passing										Moisture Content	Dry Density	Dry Density
		USCS	AASHTO	PI	LL	0.075 mm (No. 200)	0.150 mm (No. 100)	0.425 mm (No. 40)	2.000 mm (No. 10)	4.750 mm (No. 4)	9.525 mm (3/8 in)	12.7 mm (1/2 in)	19.05 mm (3/4 in)	25.4 mm (1 in)	38.1 mm (1 1/2 in)	(%)	(pcf)	(kg/m³)
GR-11	2.3 - 2.7 (7.5 - 9.0)			--	--	89	--	--	--	--	--	--	--	--	--	15.5	--	--
GR-13	0.0 - 0.5 (0.0 - 1.5)			--	--	73	81	87	92	96	100	100	--	--	--	9.6	--	--
GR-13	0.8 - 1.2 (2.5 - 4.0)			23	51	--	--	--	--	--	--	--	--	--	--	14.1	--	--
GR-13	2.3 - 2.7 (7.5 - 9.0)			--	--	--	--	--	--	--	--	--	--	--	--	11.3	--	--
GR-15	0.8 - 1.1 (2.5 - 3.5)			--	--	90	91	93	98	99	100	100	--	--	--	16.6	94.7	1516.4
GR-15	1.5 - 2.0 (5.0 - 6.5)			18	47	--	--	--	--	--	--	--	--	--	--	13.5	--	--
GR-17	0.0 - 0.3 (0.0 - 1.0)			--	--	65	71	79	93	98	100	--	--	--	--	11.6	84.4	1352.1
GR-17	1.5 - 2.0 (5.0 - 6.5)			--	--	--	--	--	--	--	--	--	--	--	--	12.6	--	--
GR-17	3.8 - 4.2 (12.5 - 14.0)			19	47	--	--	--	--	--	--	--	--	--	--	15.6	--	--
GR-19	0.0 - 0.5 (0.0 - 1.5)			21	54	--	--	--	--	--	--	--	--	--	--	--	--	--
GR-19	0.8 - 1.2 (2.5 - 4.0)			--	--	96	--	--	--	--	--	--	--	--	--	14.8	--	--
GR-19	2.3 - 2.7 (7.5 - 9.0)			--	--	--	--	--	--	--	--	--	--	--	--	14.2	--	--
GR-21	0.8 - 1.1 (2.5 - 3.5)			--	--	46	72	94	97	99	100	--	--	--	--	4.4	82.9	1327.5
GR-21	1.5 - 1.8 (5.0 - 6.0)			23	49	--	--	--	--	--	--	--	--	--	--	12.8	91.7	1468.5
GR-22	0.8 - 1.1 (2.5 - 3.5)			--	--	--	--	--	--	--	--	--	--	--	--	8.5	--	--
GR-23	0.0 - 0.5 (0.0 - 1.5)			--	--	--	--	--	--	--	--	--	--	--	--	4.7	--	--
GR-23	0.8 - 1.1 (2.5 - 3.5)			--	--	--	--	--	--	--	--	--	--	--	--	3.6	--	--
GR-23	1.5 - 2.0 (5.0 - 6.5)			--	--	71	90	100	--	--	--	--	--	--	--	7.5	--	--
GR-25	0.0 - 0.5 (0.0 - 1.5)			--	--	--	--	--	--	--	--	--	--	--	--	5.2	--	--
GR-25	1.5 - 1.8 (5.0 - 6.0)			--	--	64	91	100	--	--	--	--	--	--	--	7.8	87.1	1394.8
GR-27	0.0 - 0.5 (0.0 - 1.5)			16	39	--	--	--	--	--	--	--	--	--	--	11.4	--	--

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SUMMARY OF LABORATORY ANALYSIS

Project: **N11(1A)1,2,4**
Project Number: **105884**

Location: **Near Crownpoint, New Mexico**

Boring Number	Depth m (ft.)	Soil Classification		Atterberg Limits		Sieve Analysis - Accumulative % Passing										Moisture Content	Dry Density	Dry Density
		USCS	AASHTO	PI	LL	0.075 mm (No. 200)	0.150 mm (No. 100)	0.425 mm (No. 40)	2.000 mm (No. 10)	4.750 mm (No. 4)	9.525 mm (3/8 in)	12.7 mm (1/2 in)	19.05 mm (3/4 in)	25.4 mm (1 in)	38.1 mm (1 1/2 in)	(%)	(pcf)	(kg/m³)
GR-27	0.8 - 1.2 (2.5 - 4.0)			--	--	60	83	99	100	100	--	--	--	--	--	7.1	--	--
GR-29	0.8 - 1.1 (2.5 - 3.5)			--	--	57	80	96	99	100	100	100	--	--	--	6.2	77.4	1239.5
GR-29	1.5 - 2.0 (5.0 - 6.5)			NP	NV	--	--	--	--	--	--	--	--	--	--	7.2	--	--
GR-29	3.0 - 3.5 (10.0 - 11.5)			--	--	--	--	--	--	--	--	--	--	--	--	5.1	--	--
GR-31	0.0 - 0.5 (0.0 - 1.5)			--	--	--	--	--	--	--	--	--	--	--	--	8.2	--	--
GR-31	0.8 - 1.1 (2.5 - 3.5)			--	--	74	91	96	98	99	99	100	--	--	--	13.0	96.7	1548.7
GR-31	2.3 - 2.7 (7.5 - 9.0)			11	29	--	--	--	--	--	--	--	--	--	--	16.1	--	--
GR-33	0.0 - 0.5 (0.0 - 1.5)			--	--	61	82	92	96	98	100	--	--	--	--	9.4	--	--
GR-33	0.8 - 1.2 (2.5 - 4.0)			14	32	--	--	--	--	--	--	--	--	--	--	11.2	--	--
GR-35	0.8 - 1.1 (2.5 - 3.5)			--	--	80	94	98	99	100	100	--	--	--	--	13.6	76.5	1225.3
GR-35	2.3 - 2.7 (7.5 - 9.0)			--	--	84	97	99	100	100	100	100	--	--	--	15.8	--	--
GR-35	3.0 - 3.5 (10.0 - 11.5)			--	--	--	--	--	--	--	--	--	--	--	--	16.3	--	--
GR-37	0.0 - 0.5 (0.0 - 1.5)			--	--	87	97	98	99	100	--	--	--	--	--	10.3	--	--
GR-37	1.5 - 2.0 (5.0 - 6.5)			17	42	--	--	--	--	--	--	--	--	--	--	13.4	--	--
GR-37	3.8 - 4.0 (12.5 - 13.3)			12	33	--	--	--	--	--	--	--	--	--	--	10.6	--	--
GR-39	0.8 - 1.1 (2.5 - 3.5)			--	--	--	--	--	--	--	--	--	--	--	--	7.2	90.3	1446.5
GR-39	1.5 - 2.0 (5.0 - 6.5)			--	--	70	97	99	100	100	100	--	--	--	--	9.0	--	--
GR-39	3.0 - 3.5 (10.0 - 11.5)			NP	NV	--	--	--	--	--	--	--	--	--	--	7.8	--	--
GR-41	0.8 - 1.1 (2.5 - 3.5)			--	--	65	90	96	99	100	100	--	--	--	--	9.6	75.7	1212.3
GR-41	3.0 - 3.5 (10.0 - 11.5)			19	43	--	--	--	--	--	--	--	--	--	--	12.4	--	--
GR-41	5.3 - 5.5 (17.5 - 18.3)			--	--	54	--	--	--	--	--	--	--	--	--	8.5	--	--

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SUMMARY OF LABORATORY ANALYSIS

Project: **N11(1A)1,2,4**
Project Number: **105884**

Location: **Near Crownpoint, New Mexico**

Boring Number	Depth m (ft.)	Soil Classification		Atterberg Limits		Sieve Analysis - Accumulative % Passing										Moisture Content	Dry Density	Dry Density
		USCS	AASHTO	PI	LL	0.075 mm (No. 200)	0.150 mm (No. 100)	0.425 mm (No. 40)	2.000 mm (No. 10)	4.750 mm (No. 4)	9.525 mm (3/8 in)	12.7 mm (1/2 in)	19.05 mm (3/4 in)	25.4 mm (1 in)	38.1 mm (1 1/2 in)	(%)	(pcf)	(kg/m³)
GR-41	8.3 - 8.4 (27.5 - 27.8)			5	24	--	--	--	--	--	--	--	--	--	--	7.0	--	--
GR-43	0.8 - 1.2 (2.5 - 4.0)			--	--	89	99	100	--	--	--	--	--	--	--	13.2	--	--
GR-43	1.5 - 2.0 (5.0 - 6.5)			--	--	--	--	--	--	--	--	--	--	--	--	13.3	--	--
GR-46	0.8 - 1.1 (2.5 - 3.5)			--	--	47	90	98	100	100	100	--	--	--	--	14.8	87.6	1403.8
GR-46	3.0 - 3.5 (10.0 - 11.5)			8	30	--	--	--	--	--	--	--	--	--	--	13.5	--	--
GR-46	4.5 - 5.0 (15.0 - 16.5)			--	--	33	80	97	100	100	--	--	--	--	--	10.7	--	--
GR-46	6.8 - 7.1 (22.5 - 23.5)			10	30	--	--	--	--	--	--	--	--	--	--	16.8	102.8	1647.1
GR-47	0.0 - 0.5 (0.0 - 1.5)			--	--	50	87	98	99	100	100	--	--	--	--	11.8	--	--
GR-47	0.8 - 1.1 (2.5 - 3.5)			NP	NV	--	--	--	--	--	--	--	--	--	--	15.0	102.2	1636.7
GR-47	3.0 - 3.5 (10.0 - 11.5)			13	35	--	--	--	--	--	--	--	--	--	--	10.8	--	--
GR-49	0.0 - 0.5 (0.0 - 1.5)			--	--	40	89	97	99	100	100	--	--	--	--	16.1	--	--
GR-49	0.8 - 1.1 (2.5 - 3.5)			--	--	--	--	--	--	--	--	--	--	--	--	7.2	89.3	1430.3
GR-49	1.5 - 2.0 (5.0 - 6.5)			8	28	--	--	--	--	--	--	--	--	--	--	12.5	--	--
GR-49	2.3 - 2.7 (7.5 - 9.0)			--	--	61	--	--	--	--	--	--	--	--	--	12.6	--	--
GR-51	0.8 - 1.1 (2.5 - 3.5)			--	--	35	77	95	98	99	99	100	--	--	--	8.3	90.0	1441.3
GR-51	2.3 - 2.7 (7.5 - 9.0)			--	--	42	88	96	98	99	100	--	--	--	--	10.0	--	--
GR-53	0.0 - 0.5 (0.0 - 1.5)			--	--	34	60	98	99	100	100	--	--	--	--	7.8	--	--
GR-53	1.5 - 2.0 (5.0 - 6.5)			11	35	--	--	--	--	--	--	--	--	--	--	10.3	--	--
GR-53	2.3 - 2.6 (7.5 - 8.8)			--	--	36	--	--	--	--	--	--	--	--	--	9.9	--	--

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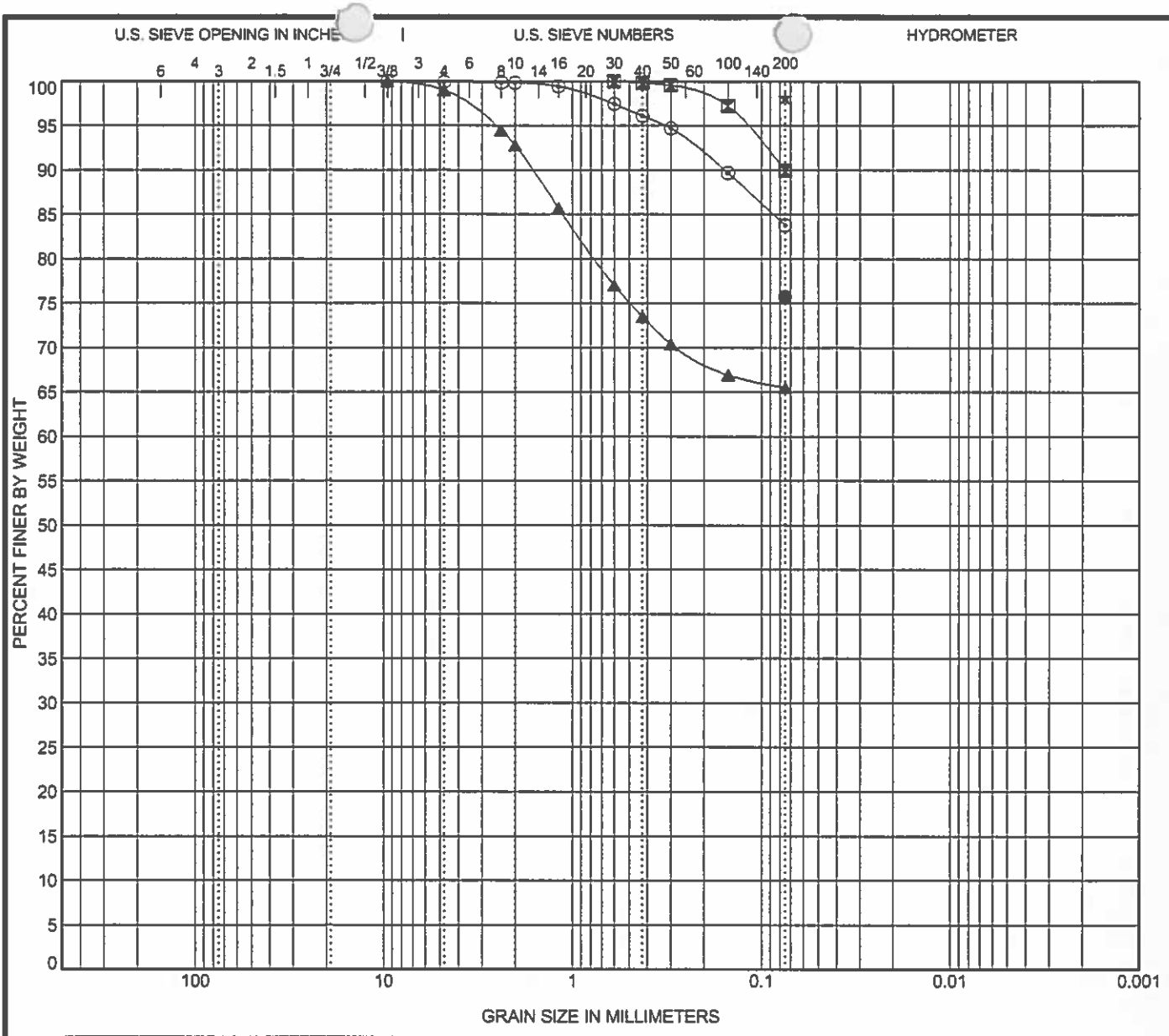

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BR-2	1.5 m (5.0')	0.075				0.0	0.0	75.7	
⊠	BR-4	3.8 m (12.5')	0.6				0.0	10.1	89.9	
▲	GR-01	0.8 m (2.5')	9.525				1.0	33.5	65.5	
★	GR-03	1.5 m (5.0')	0.075				0.0	0.0	98.2	
⊙	GR-05	0.8 m (2.5')	9.525				0.1	16.1	83.8	

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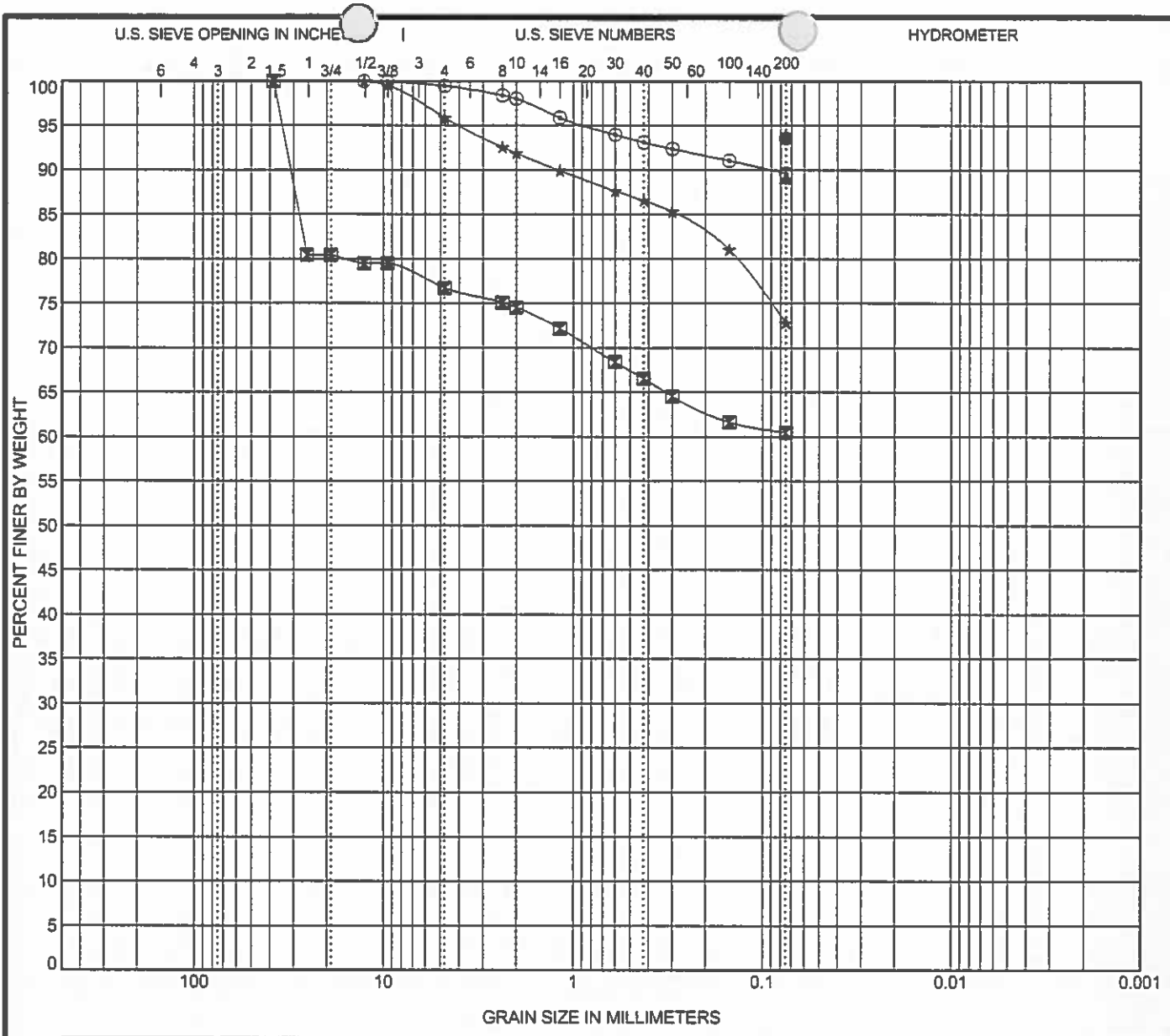
GRAIN SIZE DISTRIBUTION

Project: N11(1A)1,2,4

Location: Near Crownpoint, New Mexico

Project Number: 105884



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GR-07	1.5 m (5.0')	0.075				0.0	0.0	93.6	
⊠	GR-09	0.8 m (2.5')	38.1				23.2	16.3	60.5	
▲	GR-11	2.3 m (7.5')	0.075				0.0	0.0	89.1	
★	GR-13	0.0 m (0.0')	12.7				4.1	23.1	72.8	
⊙	GR-15	0.8 m (2.5')	12.7				0.5	9.9	89.6	

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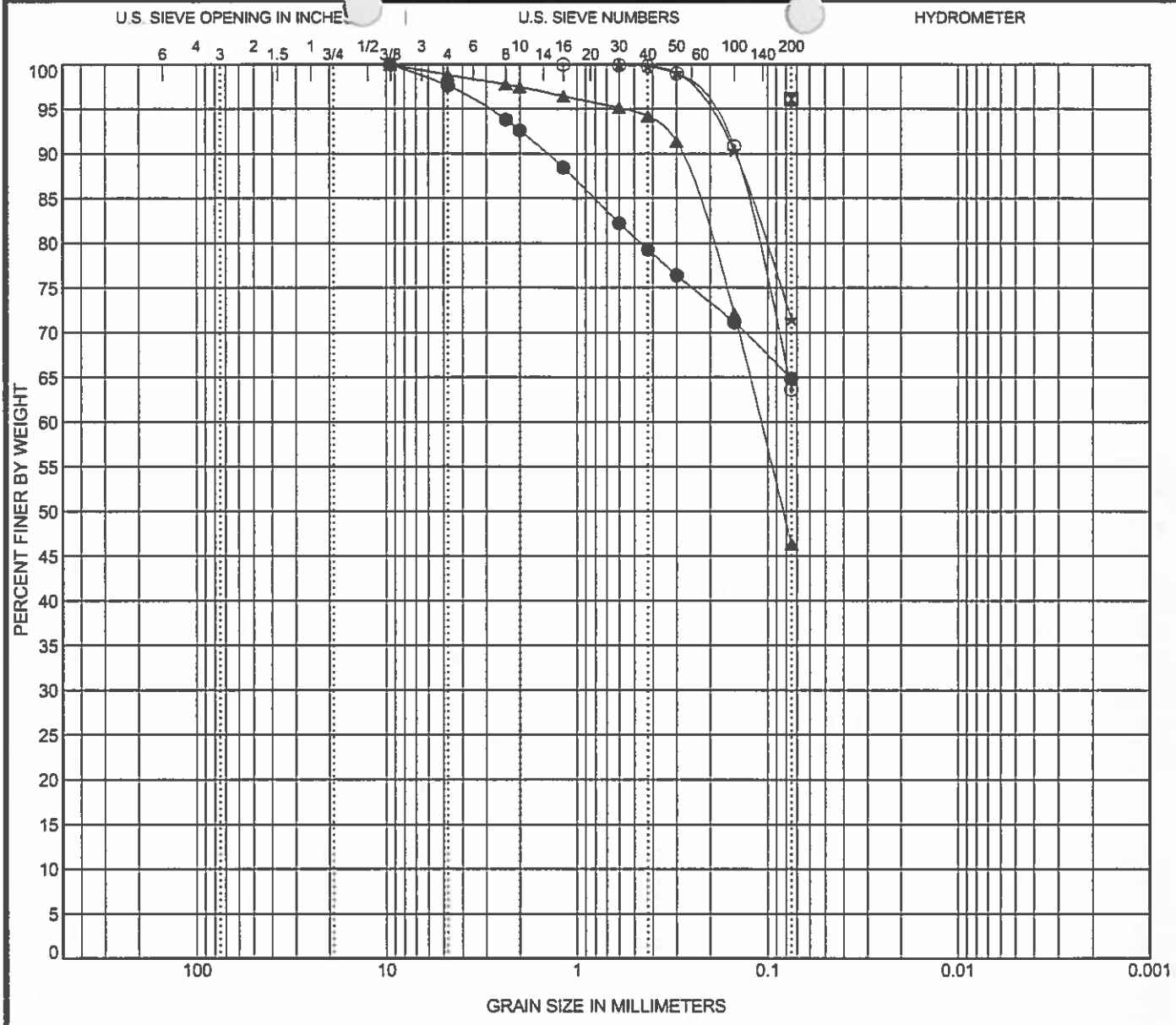
Project: N11(1A)1,2,4

Location: Near Crownpoint, New Mexico

Project Number: 105884



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GR-17	0.0 m (0.0')	9.525				2.4	32.8	64.9	
⊠	GR-19	0.8 m (2.5')	0.075				0.0	0.0	96.1	
▲	GR-21	0.8 m (2.5')	9.525	0.108			1.2	52.5	46.3	
★	GR-23	1.5 m (5.0')	0.6				0.0	28.5	71.5	
⊙	GR-25	1.5 m (5.0')	1.18				0.0	36.4	63.6	

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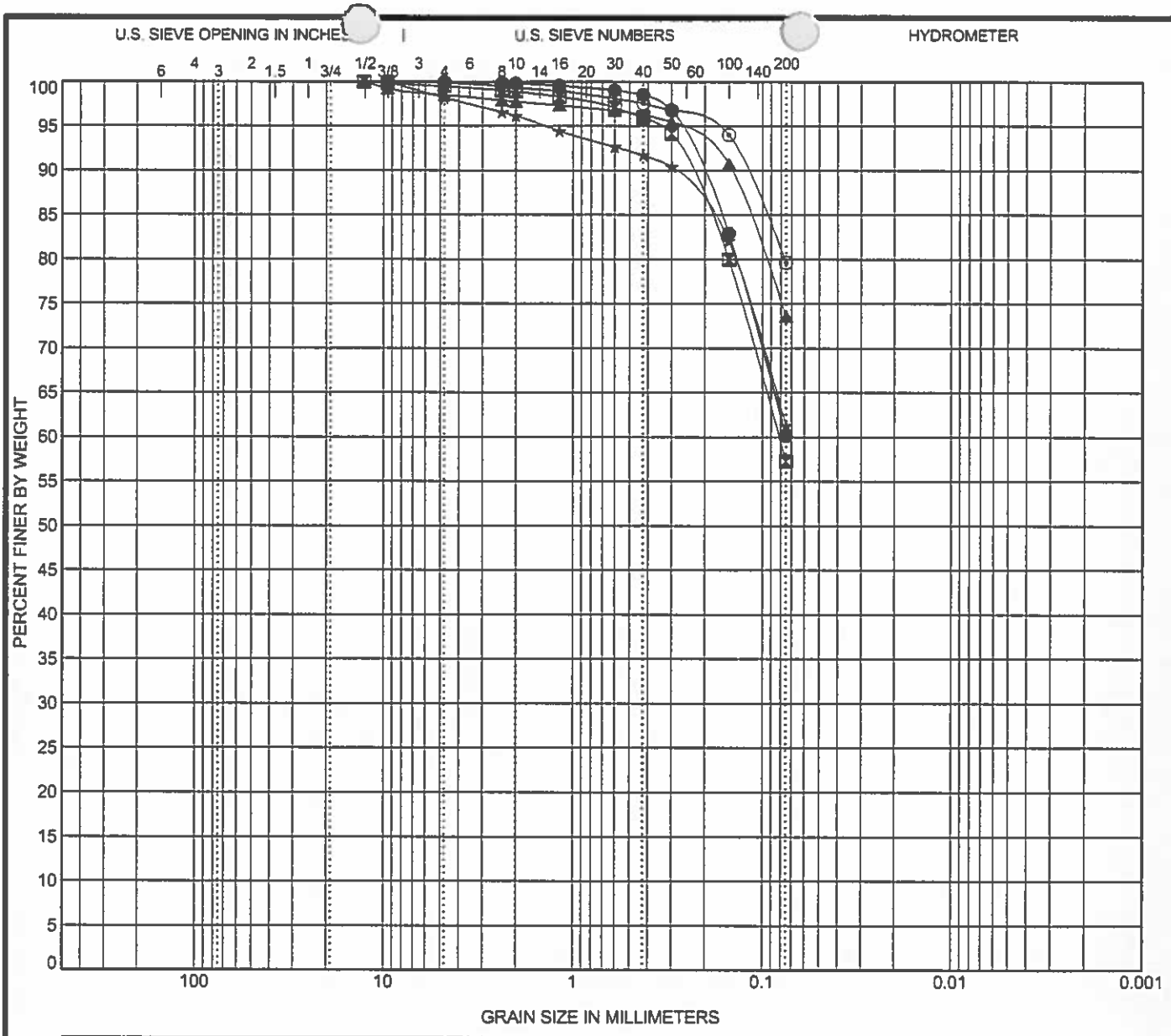
GRAIN SIZE DISTRIBUTION

Project: N11(1A)1,2,4

Location: Near Crownpoint, New Mexico

Project Number: 105884



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GR-27	0.8 m (2.5')	4.75				0.0	39.8	60.2	
⊠	GR-29	0.8 m (2.5')	12.7	0.081			0.5	42.2	57.3	
▲	GR-31	0.8 m (2.5')	12.7				1.5	25.0	73.6	
★	GR-33	0.0 m (0.0')	9.525				1.8	36.9	61.3	
⊙	GR-35	0.8 m (2.5')	9.525				0.2	20.2	79.6	

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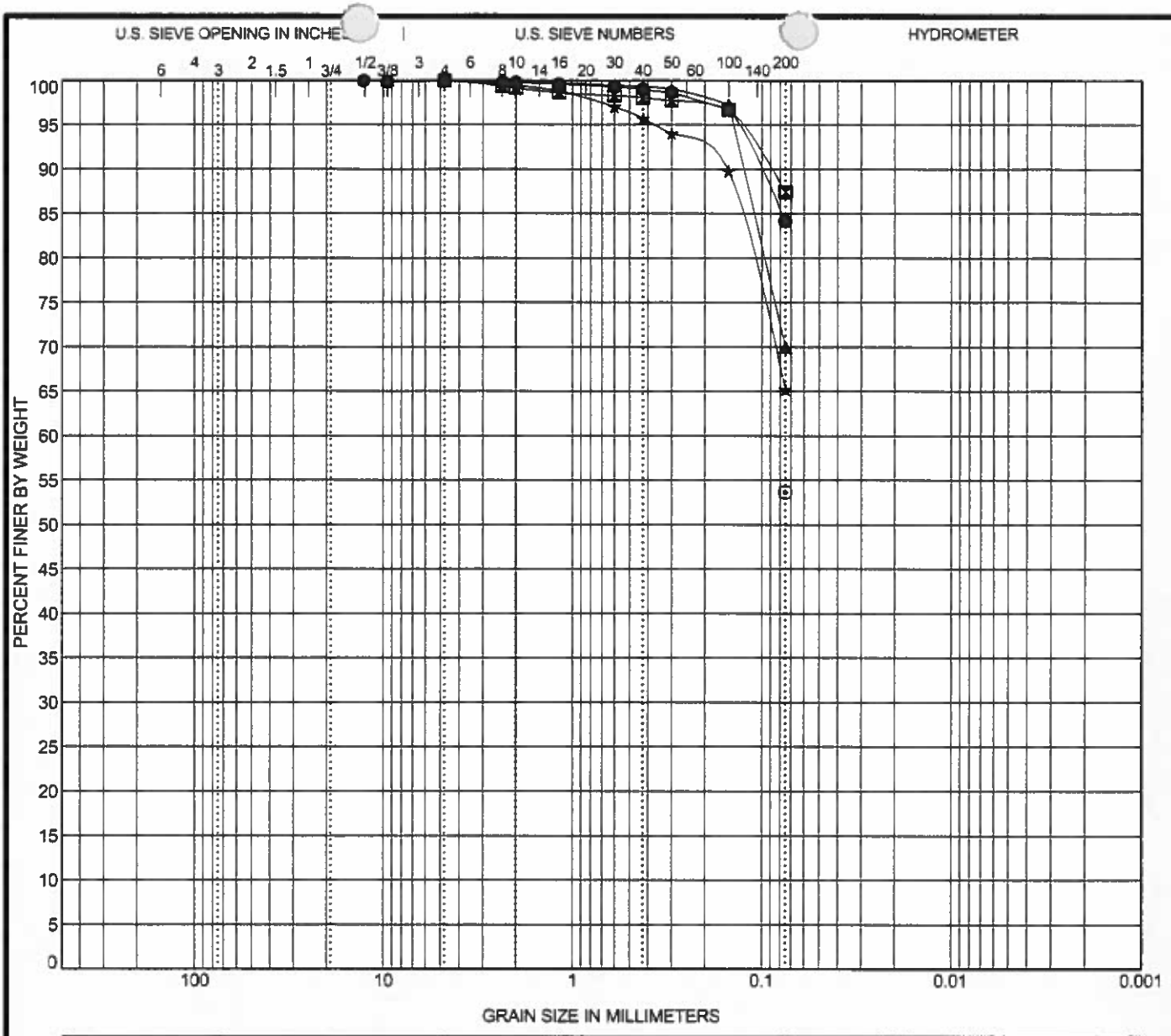
GRAIN SIZE DISTRIBUTION

Project: N11(1A)1,2,4

Location: Near Crownpoint, New Mexico

Project Number: 105884



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GR-35	2.3 m (7.5')	12.7				0.1	15.7	84.2	
⊠	GR-37	0.0 m (0.0')	4.75				0.0	12.5	87.5	
▲	GR-39	1.5 m (5.0')	9.525				0.1	30.0	70.0	
★	GR-41	0.8 m (2.5')	9.525				0.1	34.7	65.2	
⊙	GR-41	5.3 m (17.5')	0.075				0.0	0.0	53.7	

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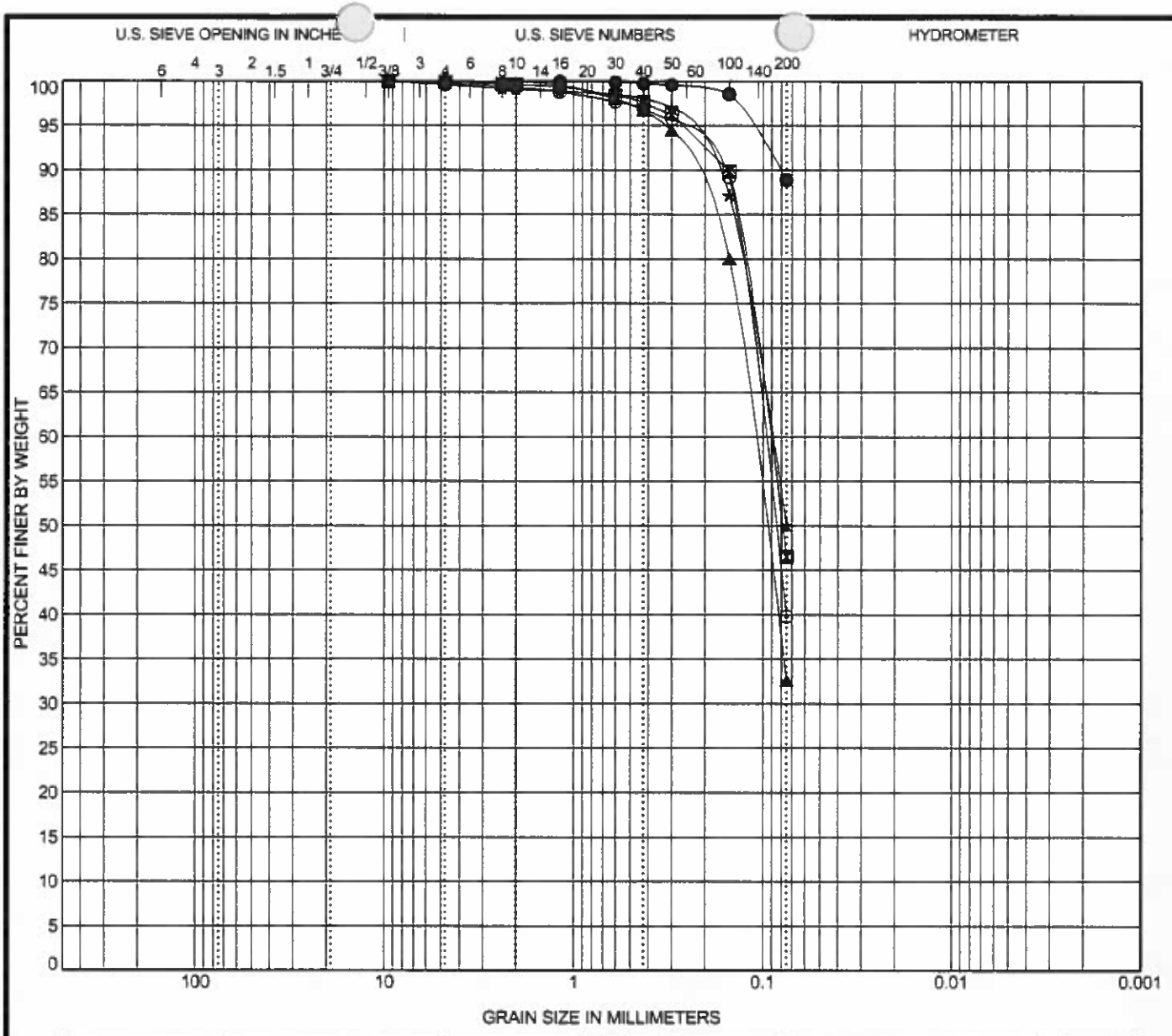
GRAIN SIZE DISTRIBUTION

Project: N11(1A)1,2,4

Location: Near Crownpoint, New Mexico

Project Number: 105884



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GR-43	0.8 m (2.5')	1.18				0.0	11.1	88.9	
⊠	GR-46	0.8 m (2.5')	9.525	0.093			0.1	53.4	46.5	
▲	GR-46	4.5 m (15.0')	4.75	0.112			0.0	67.4	32.6	
★	GR-47	0.0 m (0.0')	9.525	0.09			0.4	49.6	50.0	
⊙	GR-49	0.0 m (0.0')	9.525	0.1			0.3	59.9	39.8	

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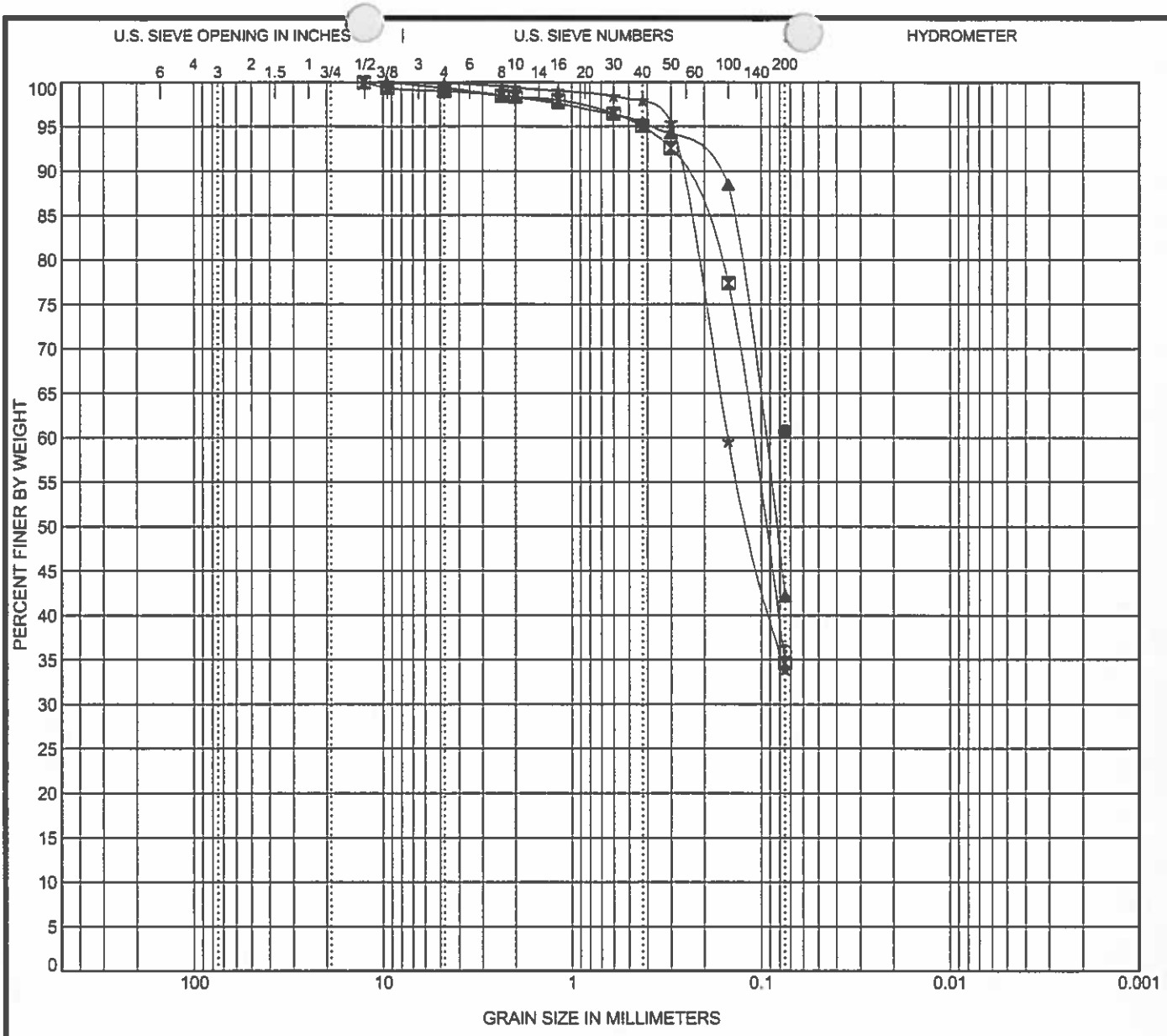
GRAIN SIZE DISTRIBUTION

Project: N11(1A)1,2,4

Location: Near Crownpoint, New Mexico

Project Number: 105884



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GR-49	2.3 m (7.5')	0.075				0.0	0.0	60.7	
⊠	GR-51	0.8 m (2.5')	12.7	0.113			1.0	64.4	34.6	
▲	GR-51	2.3 m (7.5')	9.525	0.098			0.6	57.1	42.2	
★	GR-53	0.0 m (0.0')	9.525	0.151			0.1	66.0	33.9	
⊙	GR-53	2.3 m (7.5')	0.075				0.0	0.0	35.9	

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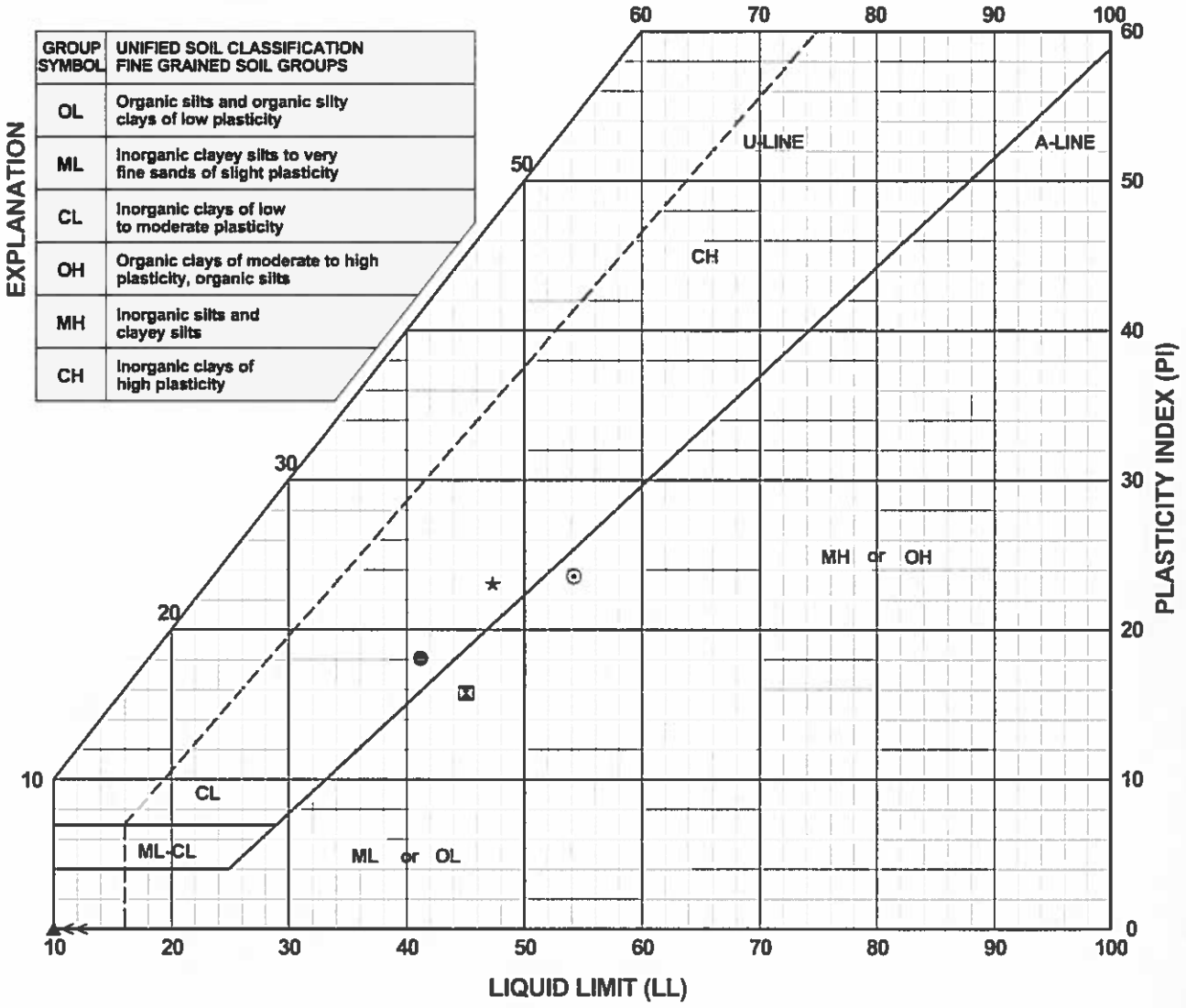

Specimen Identification			Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)
●	BR-2	3.0 m (10.0')	41	23	18
⊠	BR-3	3.8 m (12.5')	45	29	16
▲	BR-4	0.8 m (2.5')	NV	NV	NP
★	GR-01	0.0 m (0.0')	47	24	23
⊙	GR-03	0.8 m (2.5')	54	31	23

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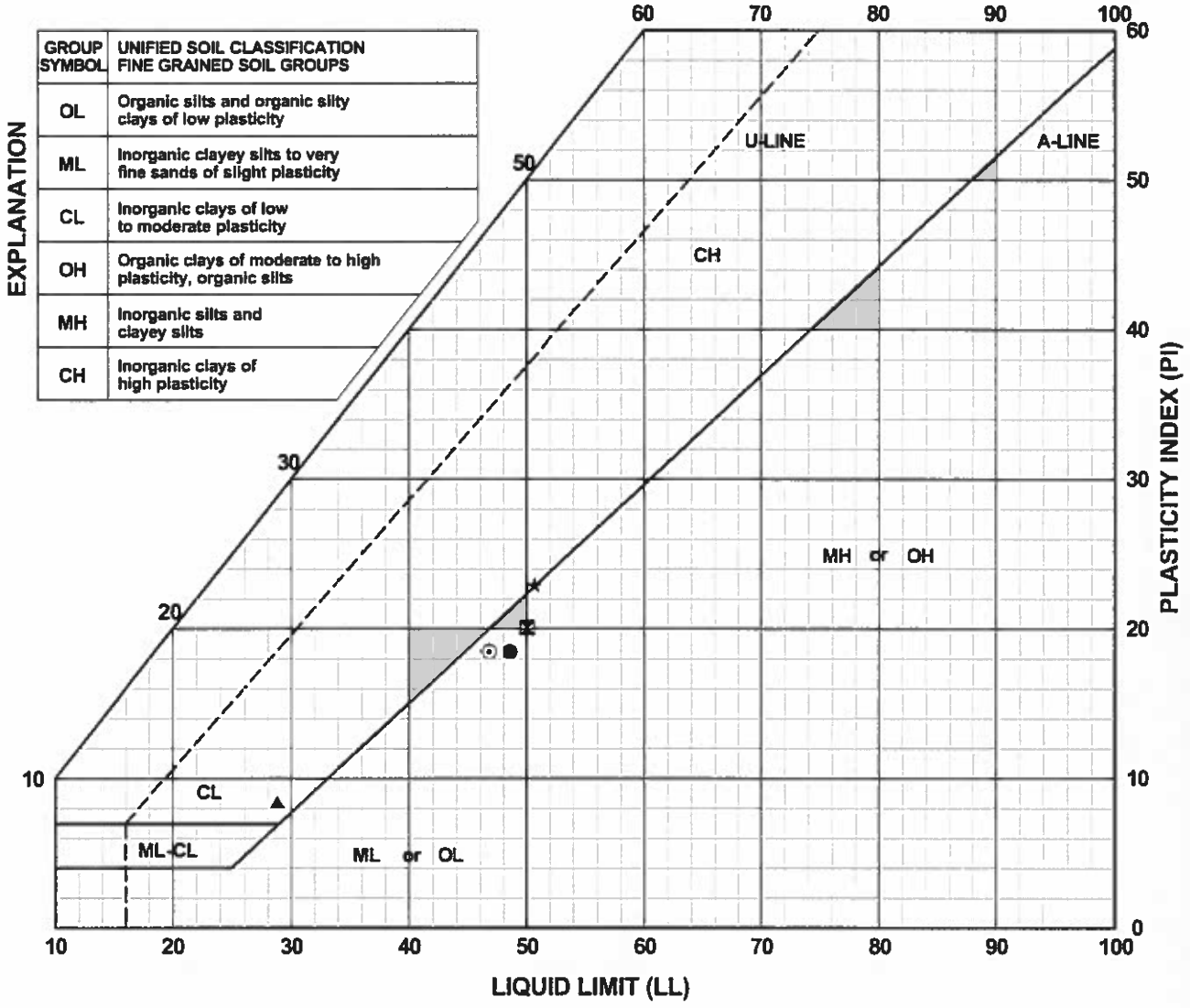
ATTERBERG LIMITS

Project: N11(1A)1,2,4

Location: Near Crownpoint, New Mexico

Project Number: 105884



Specimen Identification			Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)
●	GR-07	0.8 m (2.5')	49	30	19
⊠	GR-09	1.5 m (5.0')	50	30	20
▲	GR-11	0.8 m (2.5')	29	20	9
★	GR-13	0.8 m (2.5')	51	28	23
⊙	GR-15	1.5 m (5.0')	47	28	19

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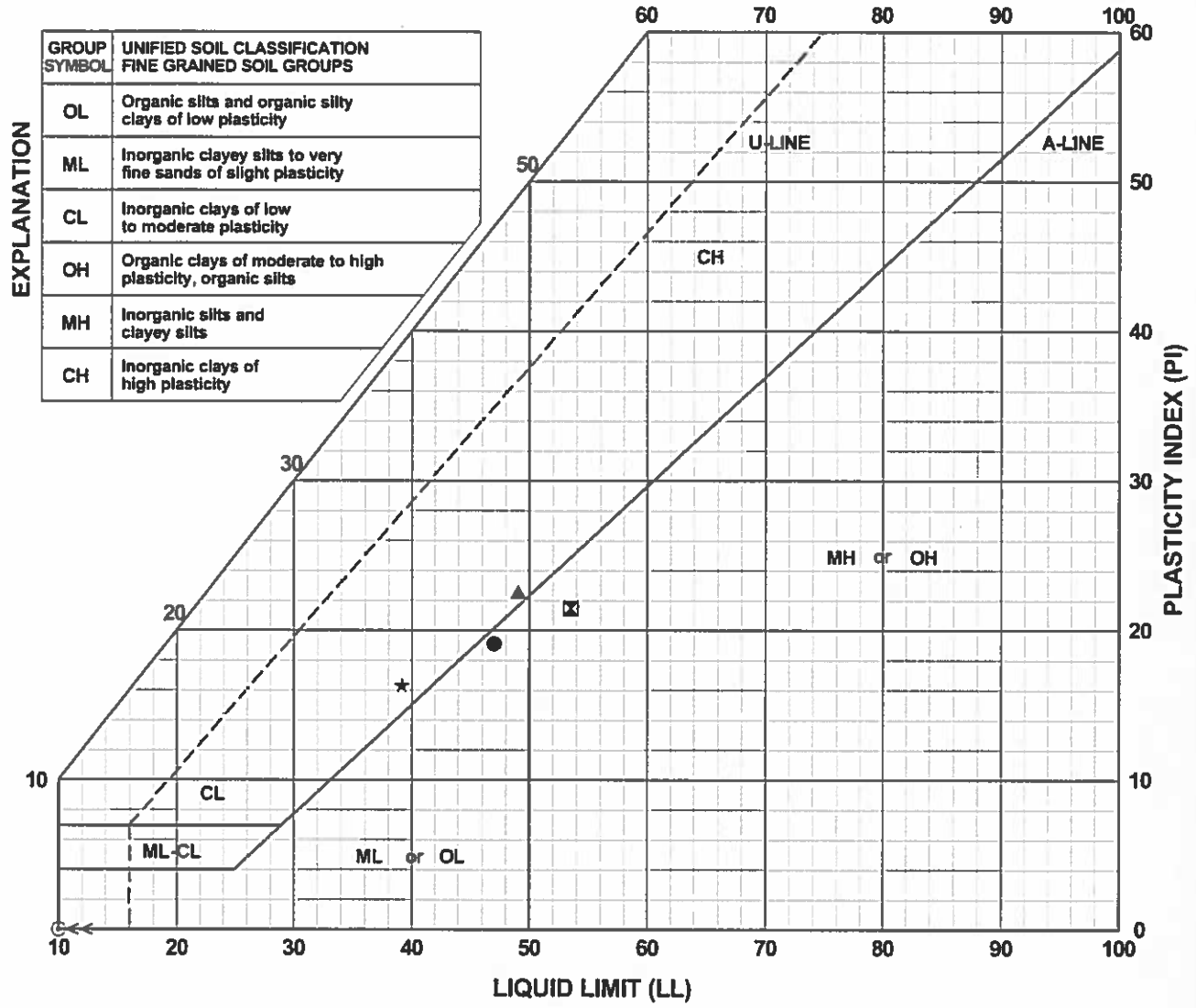
ATTERBERG LIMITS

Project: N11(1A)1,2,4

Location: Near Crownpoint, New Mexico

Project Number: 105884



Specimen Identification			Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)
●	GR-17	3.8 m (12.5')	47	28	19
⊠	GR-19	0.0 m (0.0')	54	32	22
▲	GR-21	1.5 m (5.0')	49	27	22
★	GR-27	0.0 m (0.0')	39	23	16
⊙	GR-29	1.5 m (5.0')	NV	NV	NP

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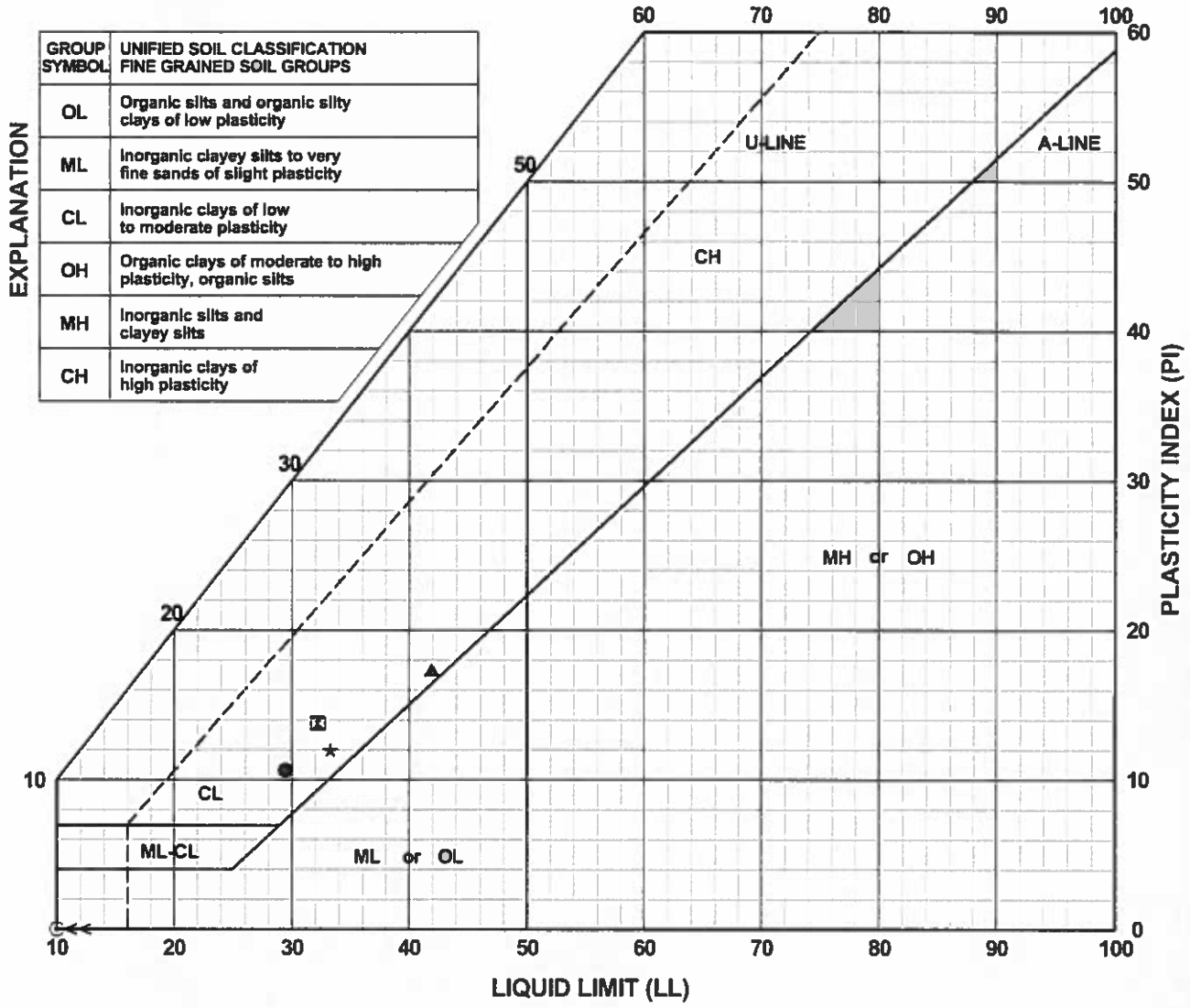
ATTERBERG LIMITS

Project: N11(1A)1,2,4

Location: Near Crownpoint, New Mexico

Project Number: 105884



Specimen Identification			Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)
●	GR-31	2.3 m (7.5')	29	19	10
⊠	GR-33	0.8 m (2.5')	32	18	14
▲	GR-37	1.5 m (5.0')	42	25	17
★	GR-37	3.8 m (12.5')	33	21	12
⊙	GR-39	3.0 m (10.0')	NV	NV	NP

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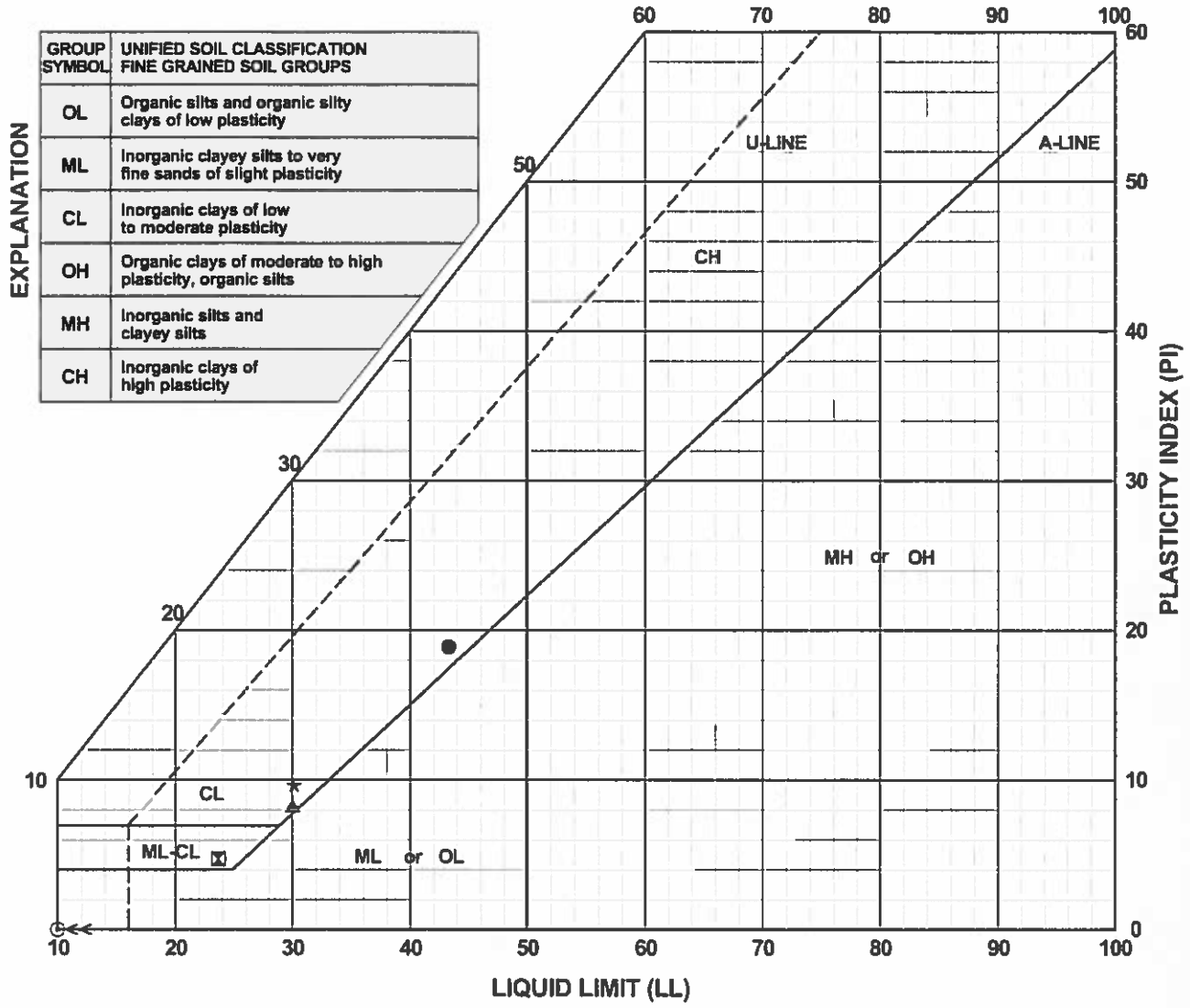
ATTERBERG LIMITS

Project: N11(1A)1,2,4

Location: Near Crownpoint, New Mexico

Project Number: 105884



Specimen Identification		Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)
●	GR-41 3.0 m (10.0')	43	24	19
⊠	GR-41 8.3 m (27.5')	24	19	5
▲	GR-46 3.0 m (10.0')	30	22	8
★	GR-46 6.8 m (22.5')	30	20	10
⊙	GR-47 0.8 m (2.5')	NV	NV	NP

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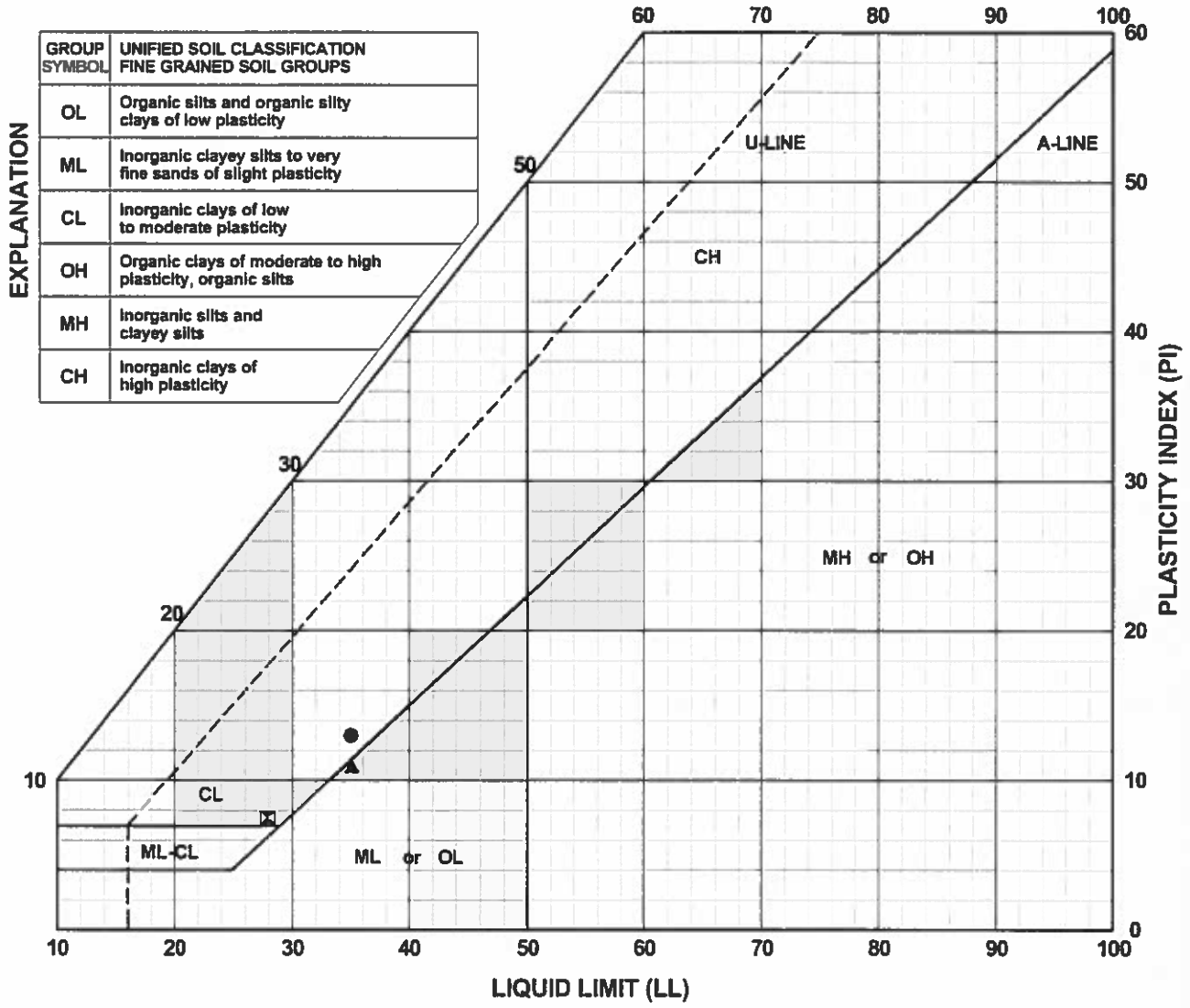
ATTERBERG LIMITS

Project: N11(1A)1,2,4

Location: Near Crownpoint, New Mexico

Project Number: 105884



Specimen Identification		Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)
●	GR-47 3.0 m (10.0')	35	22	13
⊠	GR-49 1.5 m (5.0')	28	20	8
▲	GR-53 1.5 m (5.0')	35	24	11

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ATTERBERG LIMITS

Project: N11(1A)1,2,4

Location: Near Crownpoint, New Mexico

Project Number: 105884

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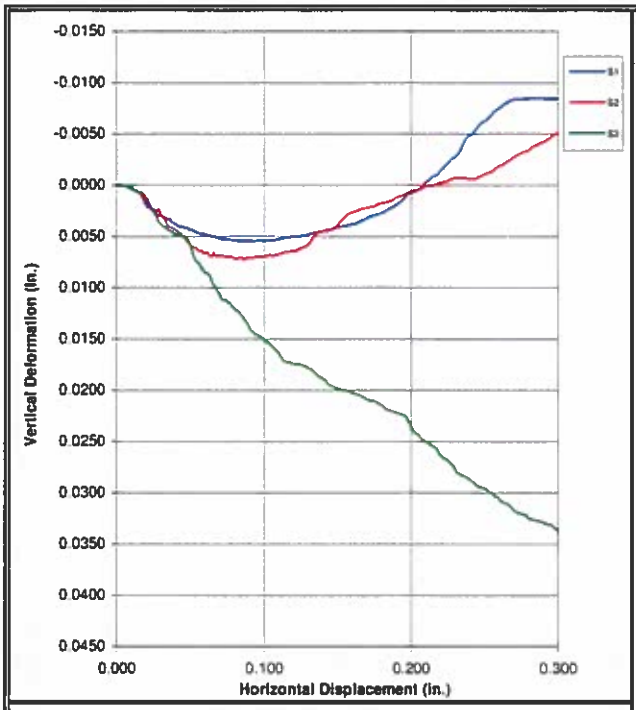
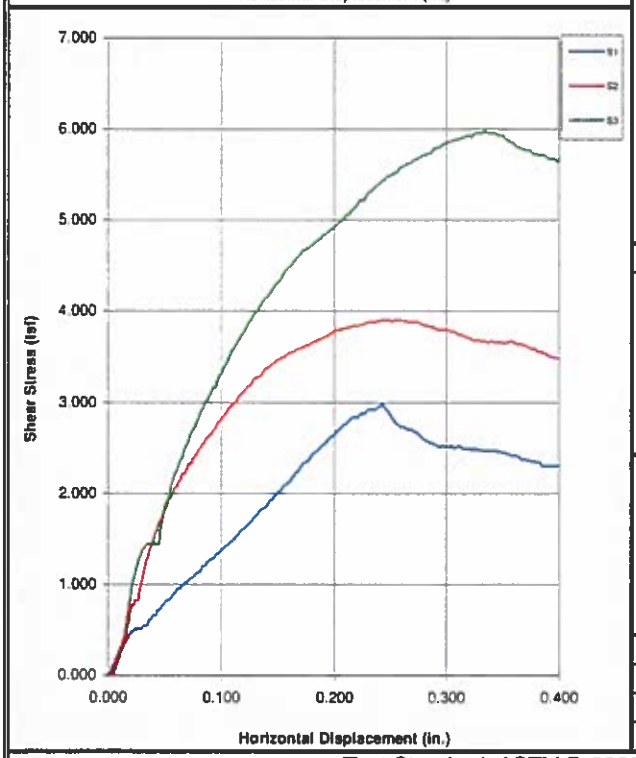
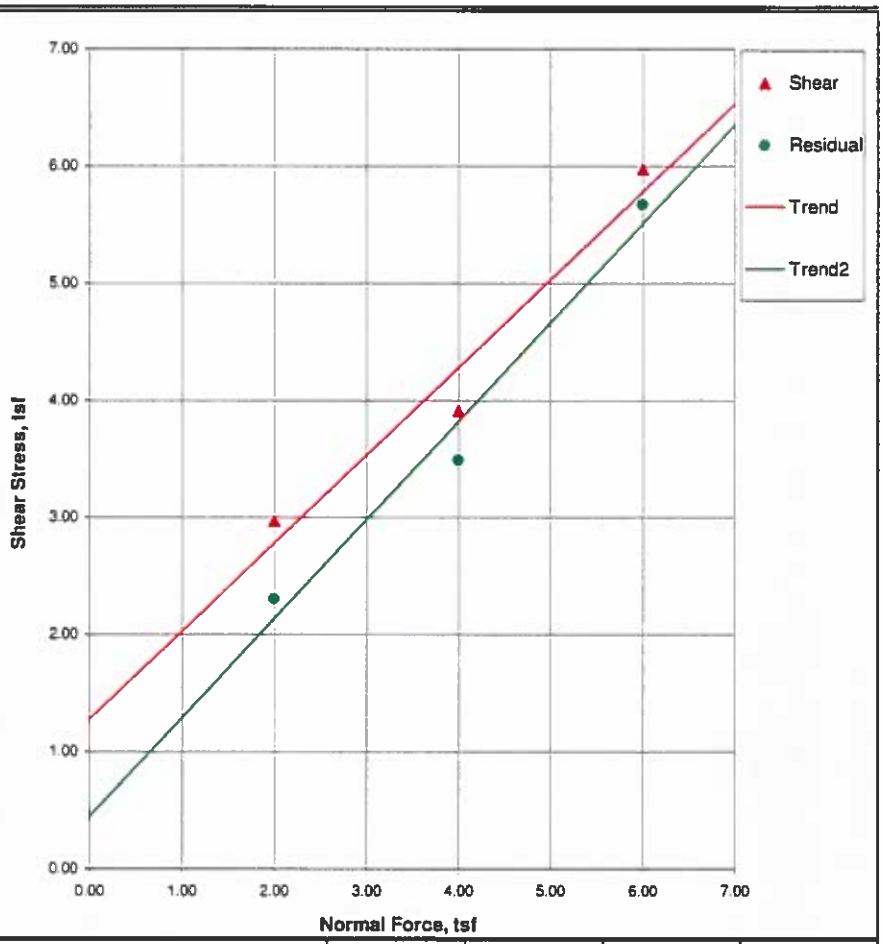
Direct Shear Test Report







Specimen Number			1	2	3	4
Initial	Water Content,	%	8.5	8.5	8.5	
	Dry Density,	pcf	90.7	92.5	91.5	
	Void Ratio		0.823	0.787	0.808	
	Saturation,	%	27.4	28.7	27.9	
	Area,	in^2	4.91	4.91	4.91	
	Height,	in	1.01	1.00	1.00	
At Test	Water Content,	%	8.5	8.5	8.5	
	Dry Density,	pcf	91.2	92.7	91.4	
	Void Ratio		0.813	0.785	0.810	
	Saturation,	%	27.8	28.8	27.9	
	Area,	in^2	4.91	4.91	4.91	
	Height,	in	1.01	1.00	1.00	
Maximum Shear Stress,		tsf	2.97	3.91	5.97	
Residual Shear Stress,		tsf	2.30	3.49	5.67	
Normal Force,		tsf	2.00	4.00	6.00	
Strain Rate,		in/min	0.0001	0.0001	0.0001	

Test Standard: ASTM D-3080

Results	C, tsf	ϕ, deg.	Tan ϕ, deg.
Failure	1.28	36.9	1.54
Residual	0.45	40.1	1.55

LL:	PL:	PI:	G_s: 2.65 Assumed

Description of Specimen 1: Silty sand (SM)
Description of Specimen 2: Silty sand (SM)
Description of Specimen 3: Silty sand (SM)

Test Conditions: Undisturbed / Natural moisture
Remarks:

Project:	N11(1A)		
Location:	Near Crownpoint, NM		
Client:	WHPacific		
Boring No.:	GR-22	Project No.:	105884
Depth:	2.5 '- 3.5' bgs	Test Date:	12/15/2009

APPENDIX D

Road Condition Photographs

Photo 1: General Condition of N11(1A) Roadway

Photo 2: Sandstone Outcrop with Boulders

Photos 3 and 4: Drainage Culvert Located approximately 65 m (213 ft) south of station 3+965 (note standing water)

APPENDIX E

Lateral Capacity of Piles for Bridge Foundations

TABLE E.1 – Pile Foundation Reactions (provided by WHPacific)
(reactions for single HP360X152 pile)

Loading Case	Maximum Axial Load		Shear Force about x-x axis		Shear Force about y-y axis		Moment about y-y axis	
	(kN)	(kips)	(kN)	(kips)	(kN)	(kips)	(kN-m)	(kip-ft)
Case 1, Str Ia	1233.0	277.2	0.0	0.0	32.9	7.4	22.4	16.5
Case 2, Str V	1159.7	260.7	11.6	2.6	27.1	6.1	17.4	12.8
Case 3, Ext Event	926.6	208.3	48.0	10.8	13.3	3.0	8.4	6.2
Case 4, Str Ib	970.2	218.1	0.0	0.0	33.4	7.5	15.9	11.7

Results for No Scour:

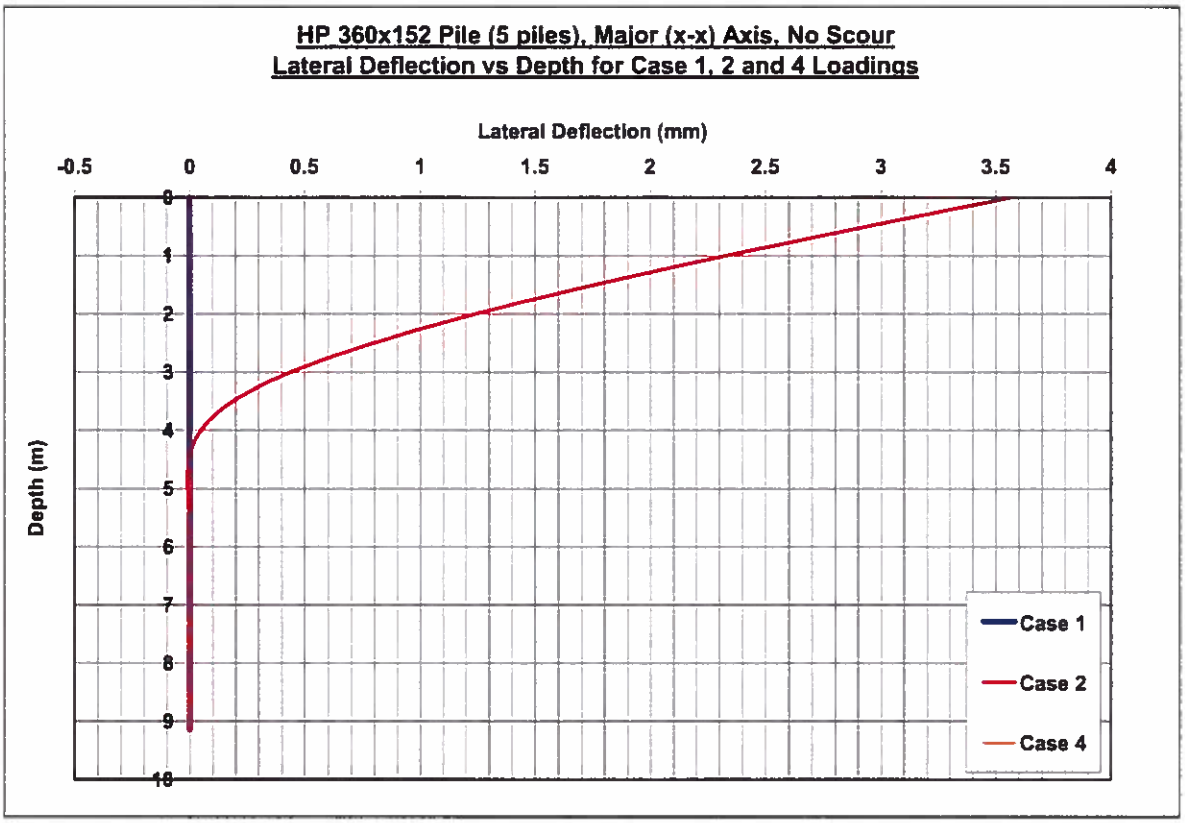


Figure E.1 – Lateral Deflection vs. Depth (x-x axis, no scour)

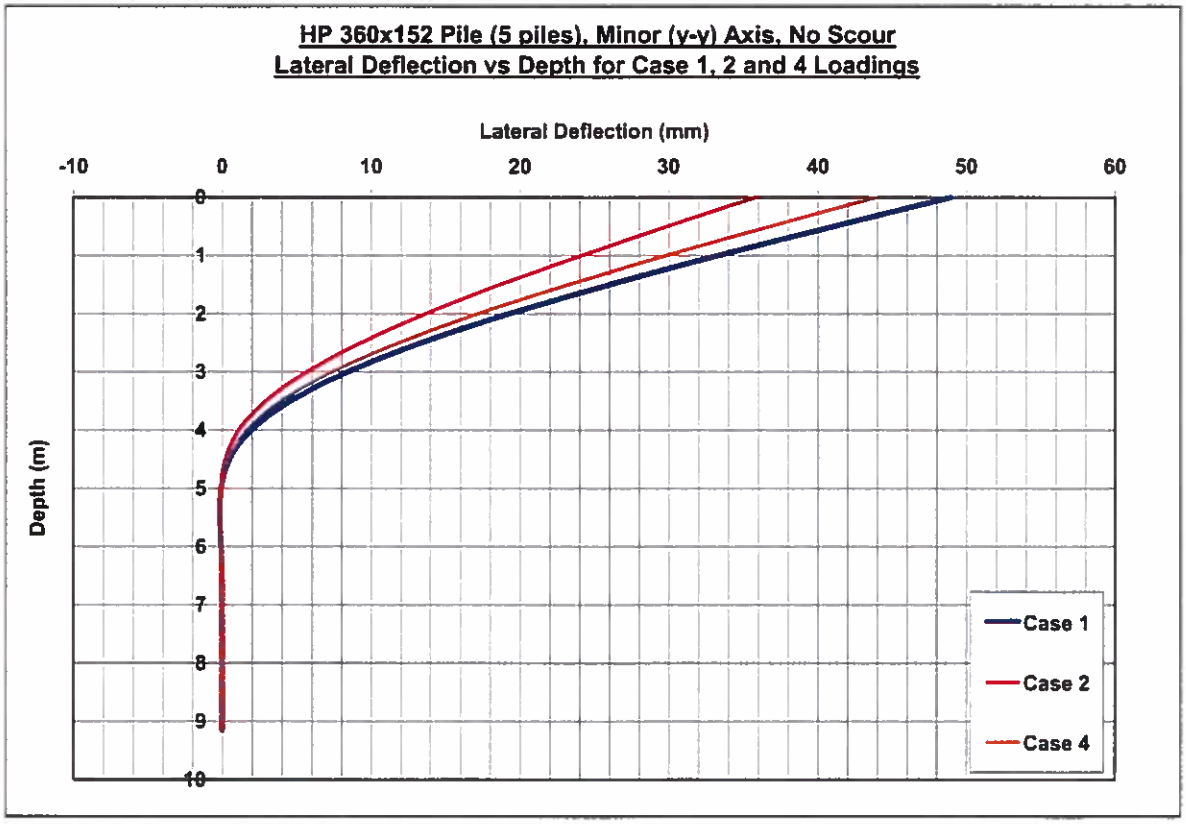


Figure E.2 – Lateral Deflection vs. Depth (y-y axis, no scour)

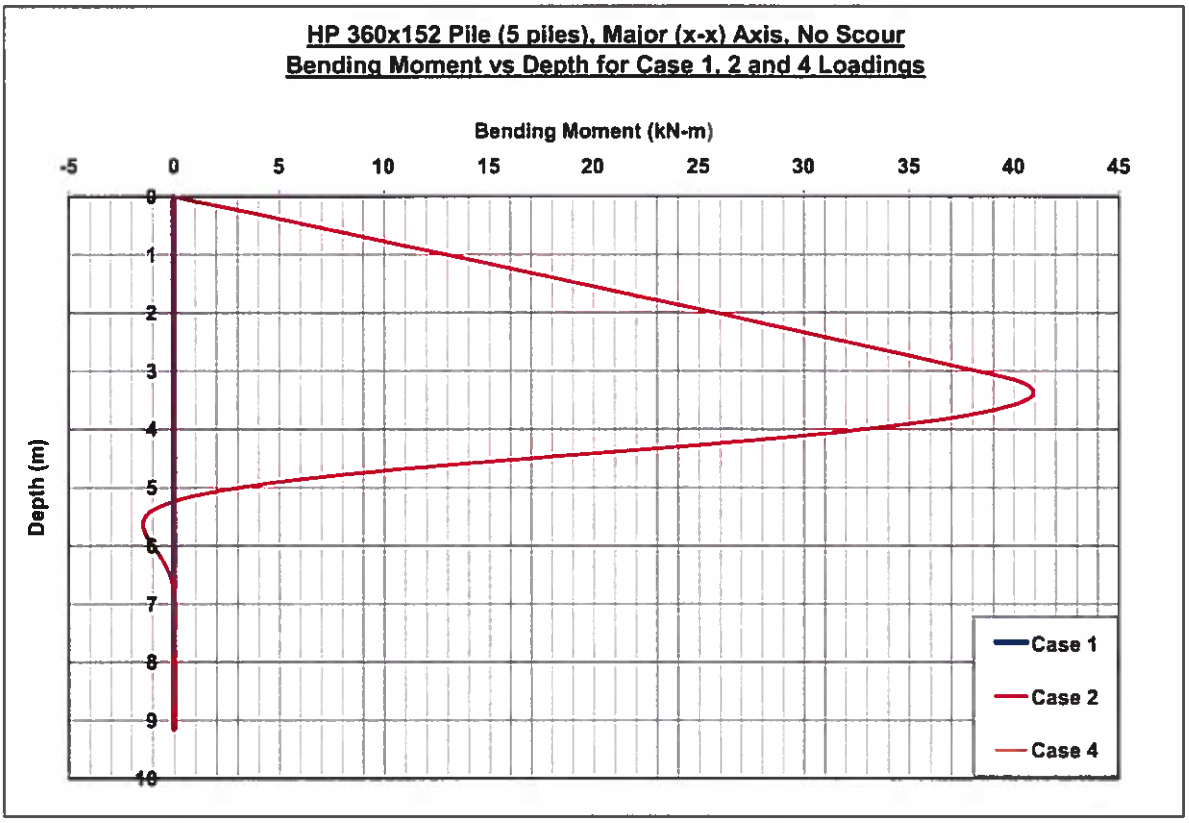


Figure E.3 – Bending Moment vs. Depth (x-x axis, no scour)

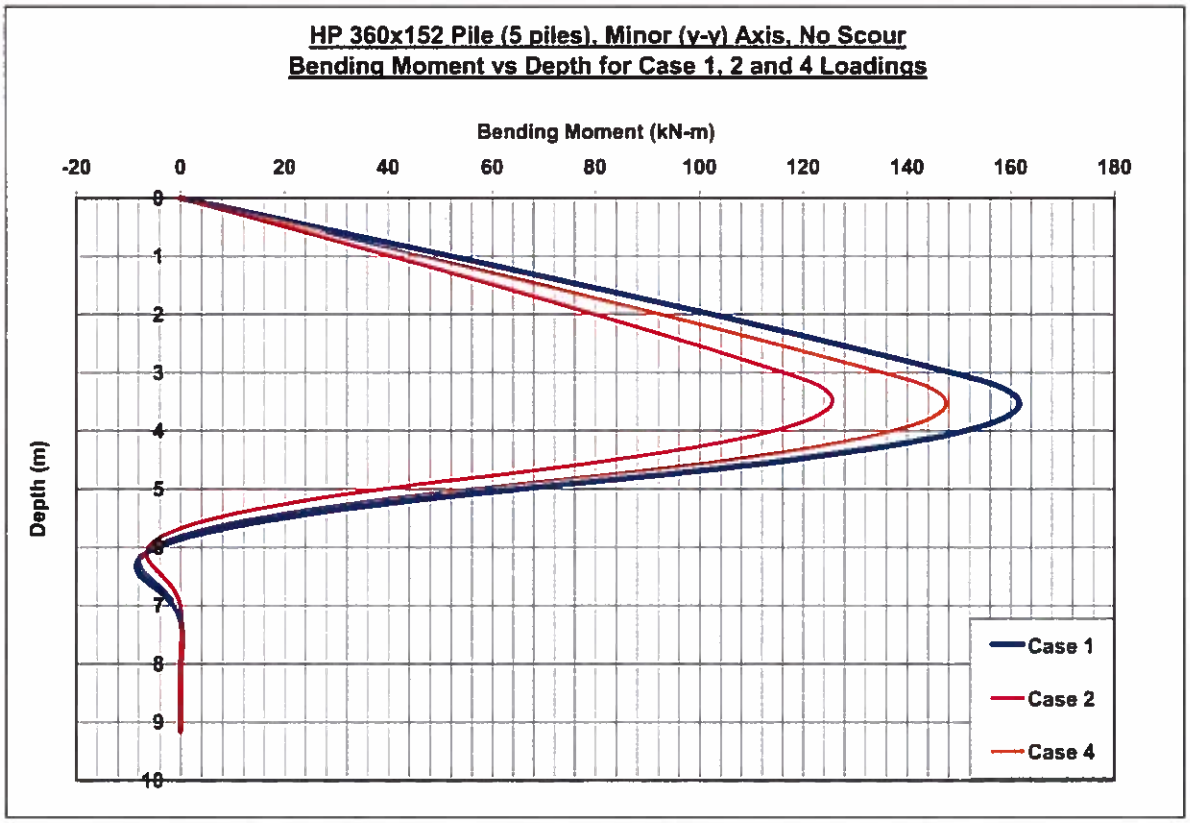


Figure E.4 – Bending Moment vs. Depth (y-y axis, no scour)

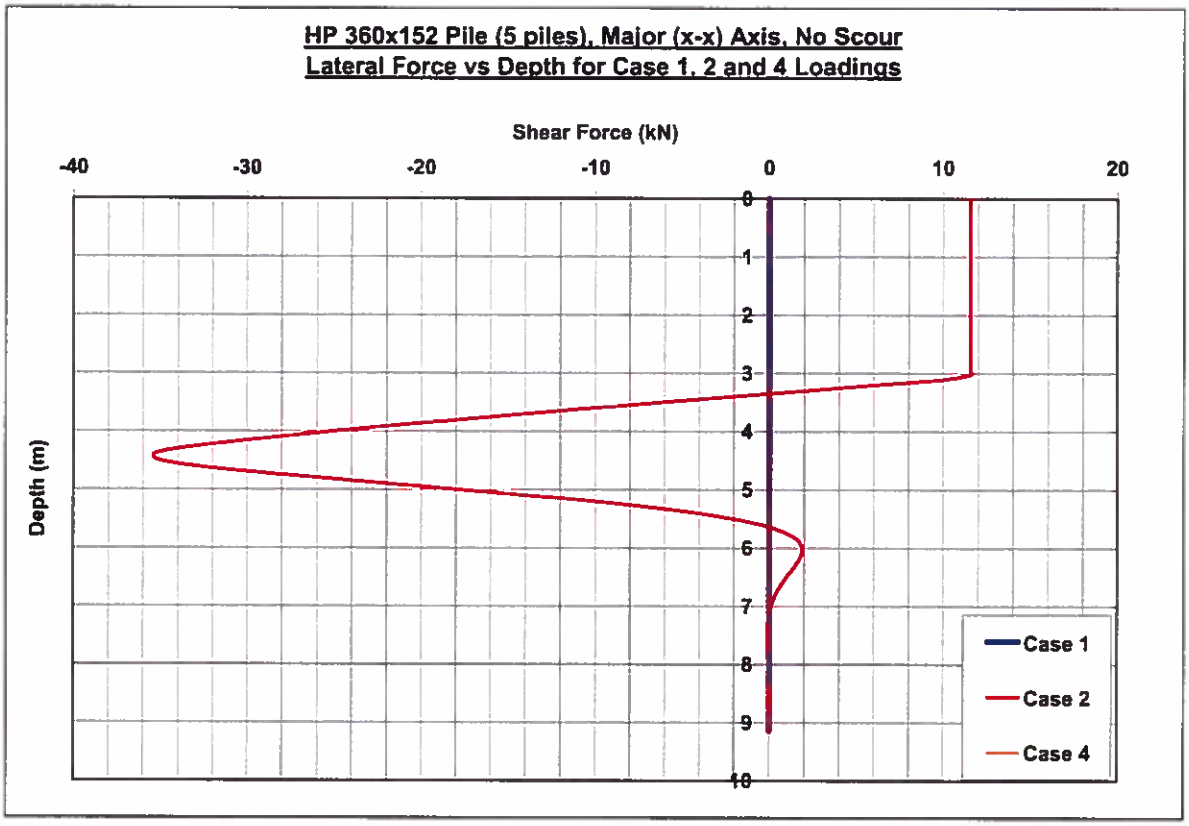


Figure E.5 – Lateral Force vs. Depth (x-x axis, no scour)

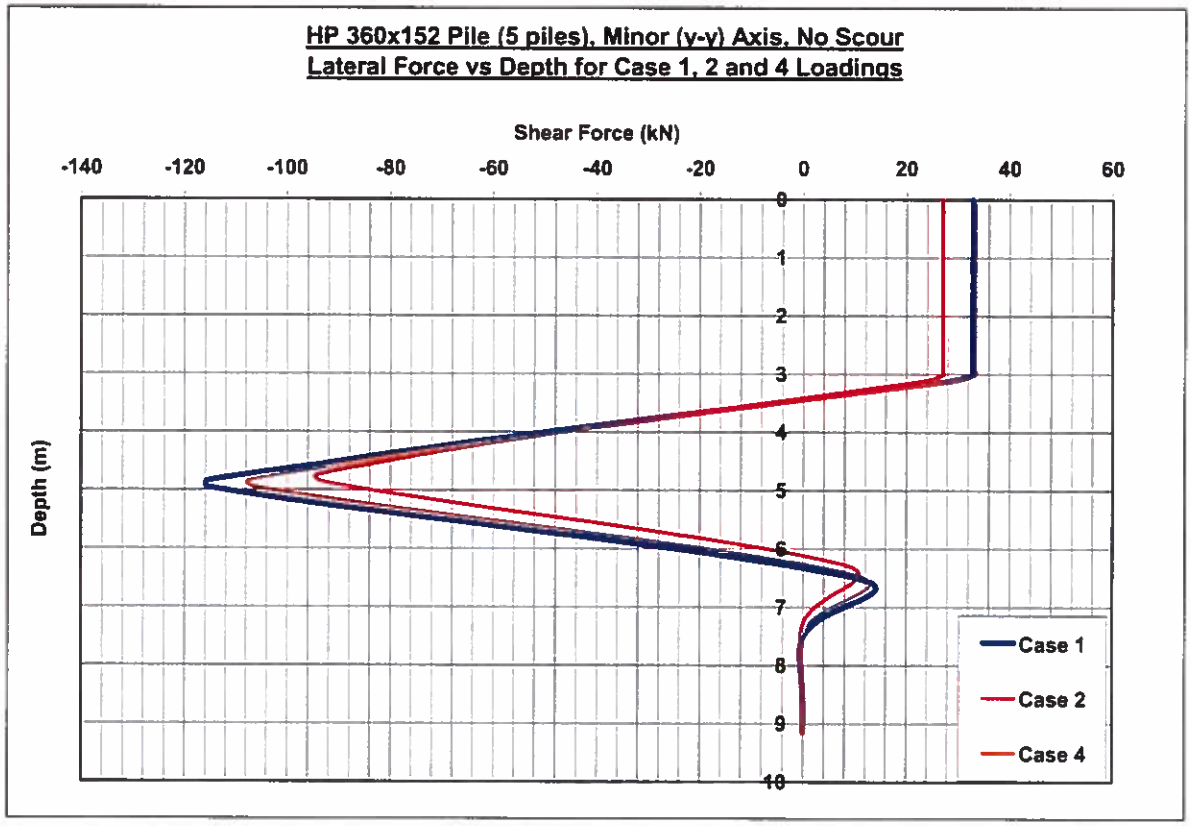


Figure E.6 – Lateral Force vs. Depth (y-y axis, no scour)

Results for 4.2 m (13.8 ft) Scour:

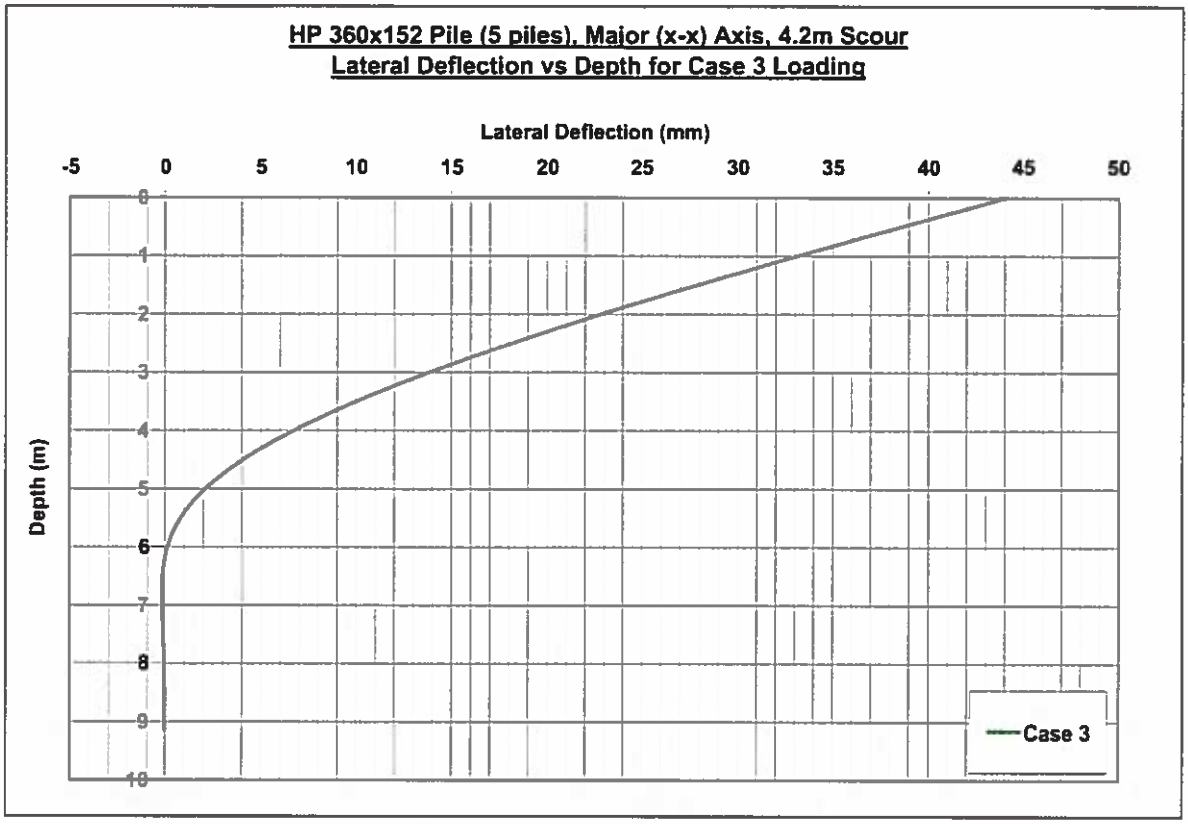


Figure E.7 – Lateral Deflection vs. Depth (x-x axis, 4.2m scour)

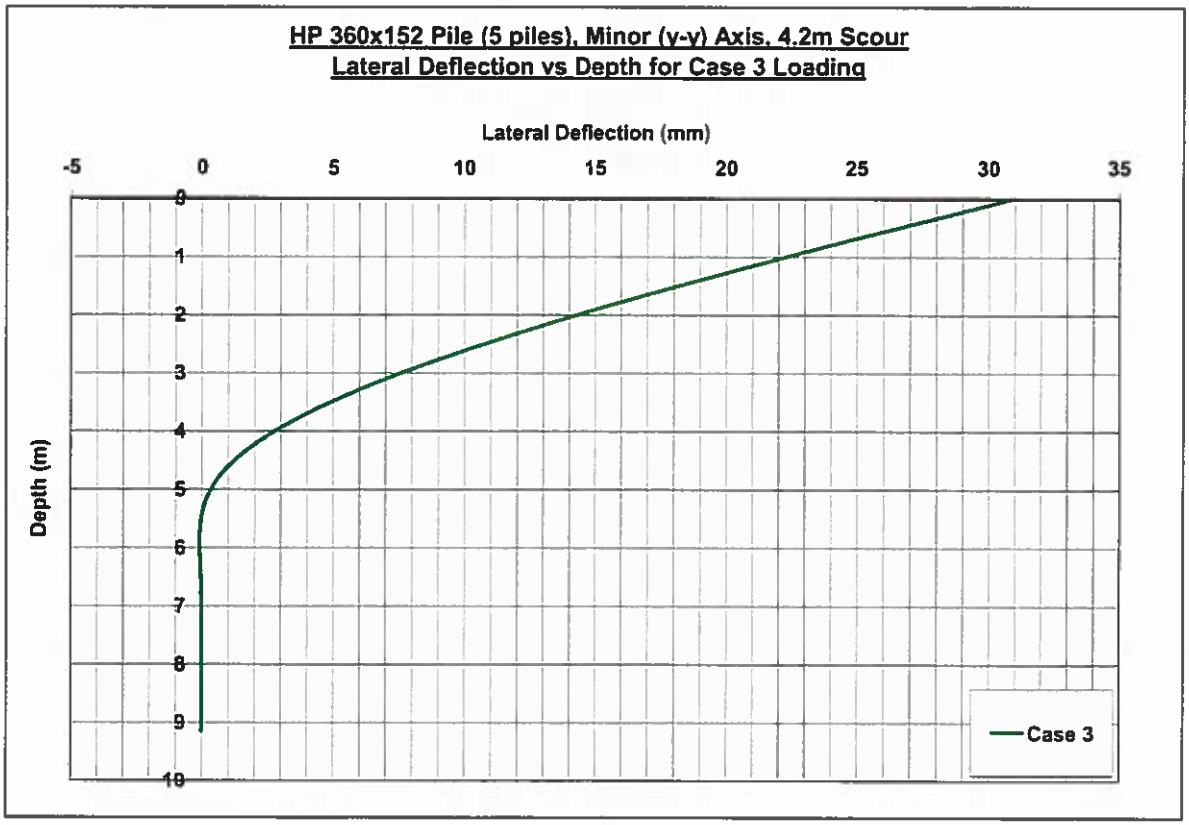


Figure E.8 – Lateral Deflection vs. Depth (y-y axis, 4.2m scour)

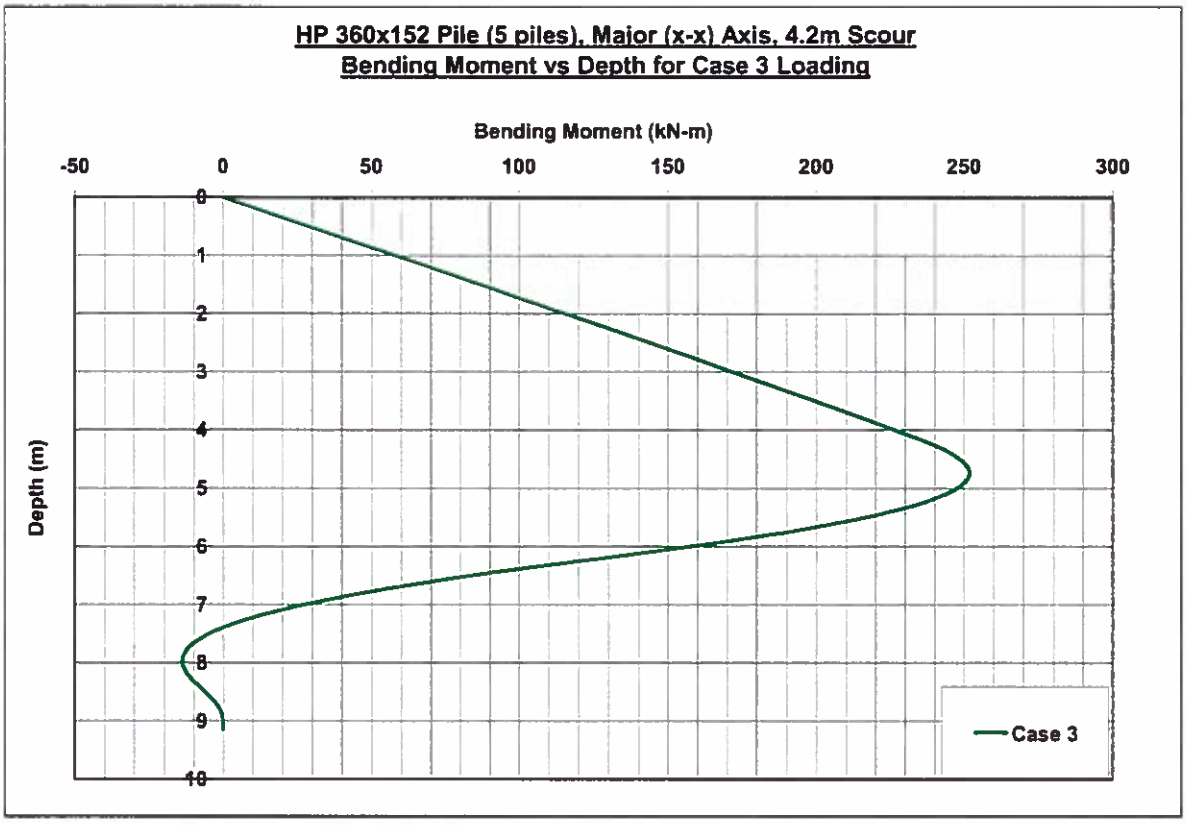


Figure E.9 – Bending Moment vs. Depth (x-x axis, 4.2m scour)

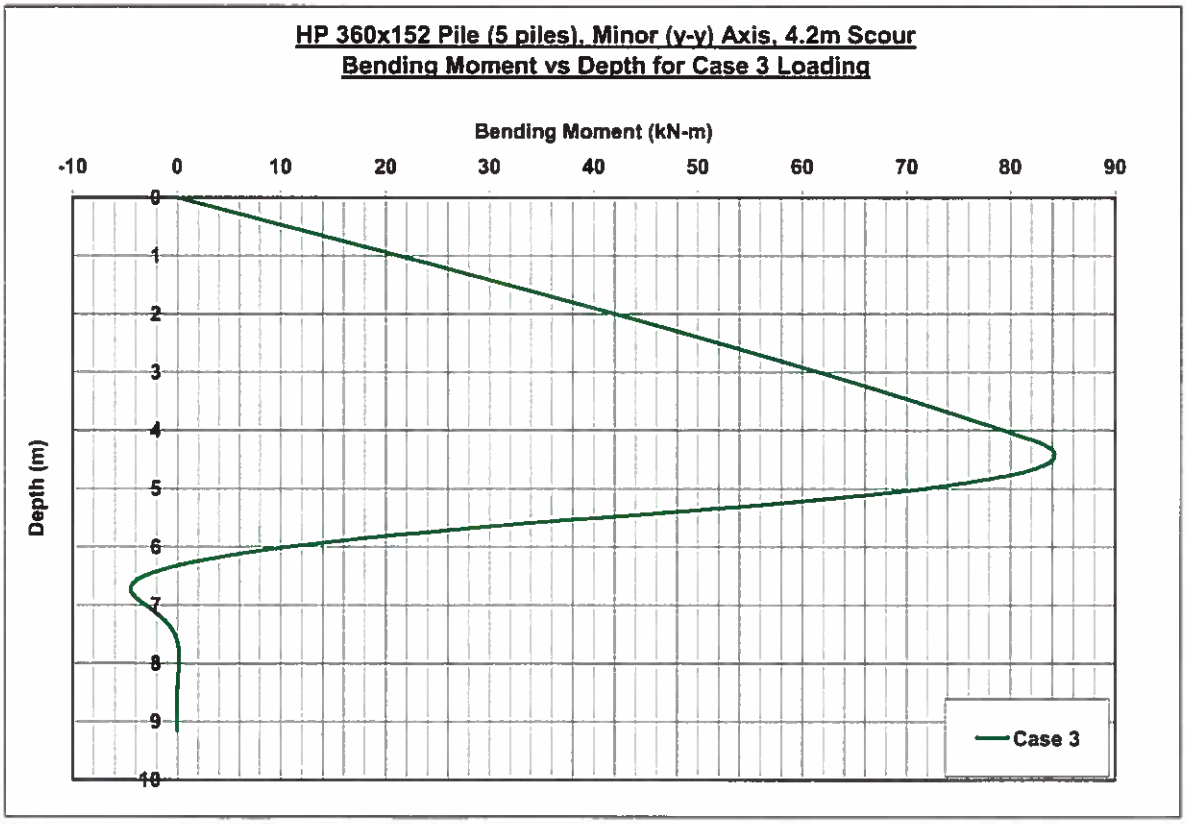


Figure E.10 – Bending Moment vs. Depth (y-y axis, 4.2m scour)

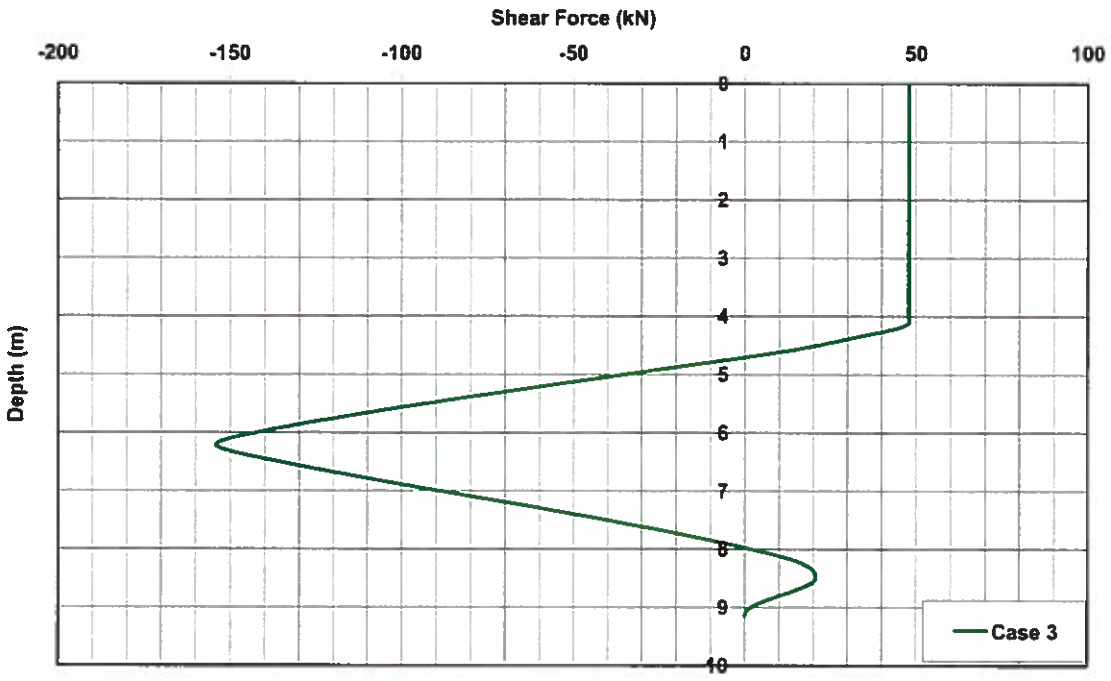


Figure E.11 – Lateral Force vs. Depth (x-x axis, 4.2m scour)

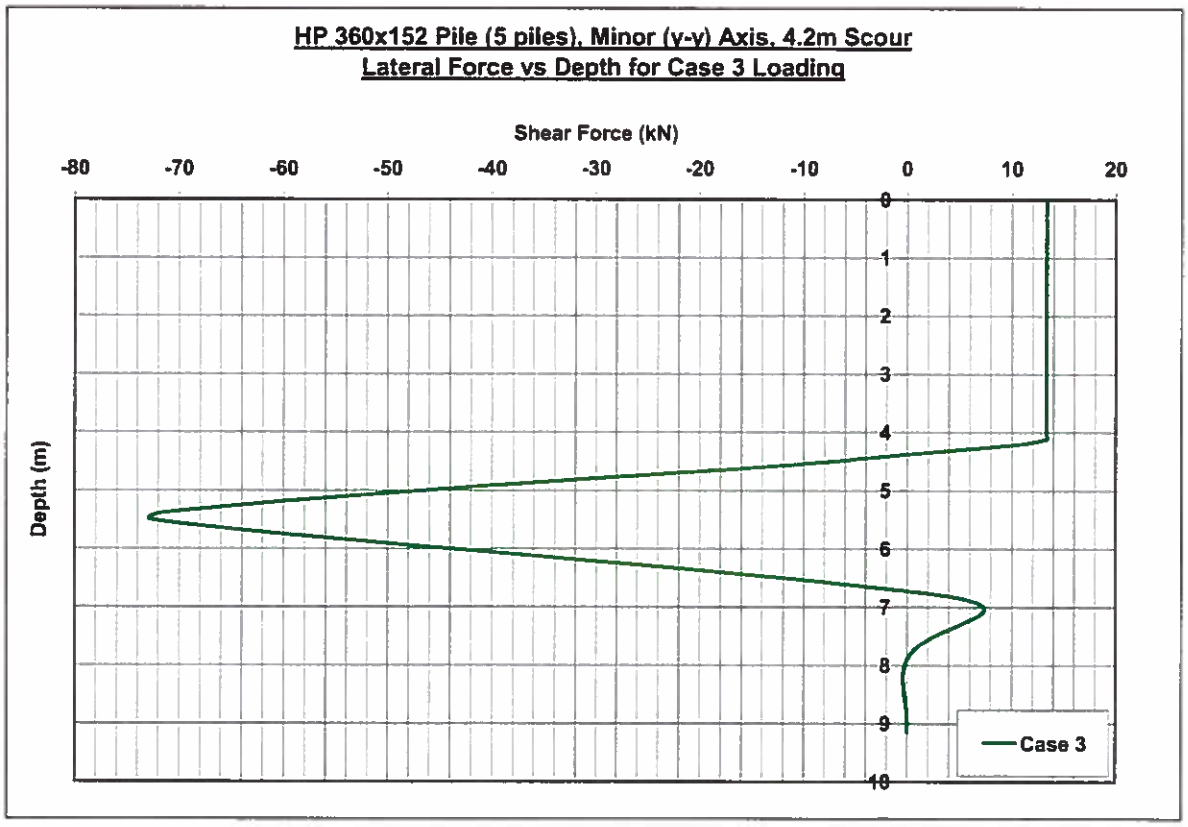


Figure E.12 – Lateral Force vs. Depth (y-y axis, 4.2m scour)

APPENDIX F

Pavement Design Calculations

105884 N11(1A)
Pavement Design Calculation
01/21/10

Originated By: CLV 7731 Date: 02/11/10
Reviewed By: [illegible] 1757 Date: 2/12/10

Objective

Calculate pavement design sections for the southern portion of Route N11 on the Navajo Nation in Crownpoint, NM.

References

1. Department of the Interior, Bureau of Indian Affairs, Navajo Region Office, Division of Transportation, Highway design Unit, "Design Analysis Report for Project: N11(1)1,2&4", June 27,2005, revised October 11, 2005.

2. Email from Ms. Rachel LeVee of WHPacific, subject "Re: N11 Traffic Counts," August 31, 2009.

3. New Mexico Department of Transportation, "Infrastructure Design Directive IDD-2008-05 (Pavement Design Guideline)", July 21, 2008.

Given

1. Borehole Logs from the Kleinfelder geotechnical and investigation of the site.

2. Traffic count data provided in Reference 1.

3. Anticipated percentage of heavy vehicles provided by Ms. Rachel LeVee of WHPacific (Reference 2).

Assumptions

1. Variable subgrade support is anticipated based on the range of geologic materials encountered in our geotechnical investigation and variable N values from Standard Penetration Tests (SPT). Therefore, a conservative composite CBR estimate of 8 was utilized in the calculations to account for weaker materials.

2. Drainage coefficients of 1.0 for the asphalt and crushed base course were assumed for the calculations. These values assume that positive drainage controls will be designed and constructed.

3. The total Average Daily Traffic (ADT) values for light duty and medium duty vehicles were subdivided based on anticipated vehicle type.

4. The following parameters were assumed for the pavement design calculations:

    - Direction factor = 1
    - Lane distribution factor = 0.5
    - Initial serviceability index = 4.2 (Reference 3)
    - Terminal Serviceability Index = 2.0 (Reference 3)

Originated By: CLD 7731 Date: 02/11/10
Reviewed By: KMA 4757 Date: 2/12/10

5. A design period of 20 years was assumed for calculations.

Calculations

Resilient Modulus

The resilient modulus (M_R) for the subgrade was calculated utilizing the composite CBR value for the roadway (based on AASHTO T193, "The California Bearing Ratio"):

$M_R = (2555)*CBR^{0.64} = (2555)*(8^{0.64}) \approx \underline{9,500}$

Growth Rate and 2009 ADT

The growth rate and 2009 ADT value was calculated utilizing the ADT estimates for a 20-year time period (n) from 2002 and 2022 provided in Reference 1:

ADT_{2002} = 371 vehicles per day (vpd), Reference 1
ADT_{2022} = 453 vpd, Reference 1

Growth rate (g) = $(ADT_{2022} / ADT_{2002})^{1/n} = (453 \text{ vpd}/ 371 \text{ vpd})^{1/20} = \underline{1\%}$

$ADT_{2009} = (ADT_{2002})*(1+g)^n = (371 \text{ vpd})*(1+0.01)^7 = \underline{398 \text{ vpd}}$

ESAL Applications

The 18 kip equivalent single axle load (ESAL) applications were calculated as shown below:

18 KIP EQUIVLENT SINGLE AXLE LOAD (ESAL) APPLICATIONS - AASHTO

Project Name: WHP N11 (1A) Reconstruction
Job Number: 105884
Date: 01/21/10

Location: Crownpoint, NM
Pavement Type: **Mainline - Flexible**
Monthly Traffic:
Avg. ADT: 398

Design Period: 20 Years
Growth Factor: 1.00%
Number of Lanes in Each Direction: 1
Present Serviceability Index (pt): 4.2
Estimated Structural Number:

Vehicle Types	Axle Load	Percent ADT	ADT	ADT x 365 x Design Period	Load Equivalent Factor	ESAL
Light Duty		93.00%	370	2,974,792	0.00002	59
Medium Duty		5.00%	20	159,935	0.617	98,680
Heavy Duty		2.00%	8	63,974	1.693	108,308
TOTAL			398			207,047

ESAL	Direction Factor	Lane Distribution Factor	DESIGN ESAL
207,047	1	0.50	103,524

20 YEAR DESIGN ESAL = **103,524**

DESIGN EDLA = **14**

Originated By: CLV 7731 Date: 02/11/10
Reviewed By: [illegible] Date: 2-12-10

The pavement design sections were calculated utilizing the information above in the PAS pavement analysis software, version 5.0, which utilizes the 1993 AASHTO method (AASHTO Guide for Design of Pavement Structures).

Results

The following pavement design section was calculated for the N11 (1A) Roadway:

76 mm (3 in) asphalt over 150 mm (6 in) aggregate base:

02-11-2010

State: NM
Agency: WHPacific
Company: Kleinfelder
Contractor: N/A
Engineer: C. Vallejo

Job Number: 105884
Location: Crownpoint, NM

========== Flexible Analysis ==========

Structural Number	=	1.94	
Design E 18's	=	103,524	
Reliability	=	75.00	percent
Overall Deviation	=	0.45	
Resilient Modulus	=	9,500.0	psi
Initial Serviceability	=	4.20	
Terminal Serviceablity	=	2.00	

Layer Number	Layer Coefficient == a (i) ==	Drainage Coefficient ==== Cd ===	Layer Thickness === t ===	a(i)*Cd*t =========
1	0.42	1.00	3.00	1.26
2	0.12	1.00	6.00	0.72
3				
4				
5				
6				
			Total SN =	1.98

Originated By: CLV 7731 Date: 02/11/10
Reviewed By: [illegible] 4757 Date: 2/12/10

Conclusions

Based on our calculations a pavement section consisting of 76 mm (3 inches) of asphalt over 150 mm (6 inches) of aggregate base course would be sufficient for the anticipated traffic loads. This pavement section corresponds to the minimum required section based on Reference 1. We therefore recommend the minimum BIA pavement section for Route N11 presented in the following table.

Table 1– Design Pavement Section

Traffic Loading	**Asphaltic Concrete Pavement (ACP)** (inches)	**Aggregate Base** (inches)
103,524 18-kip ESAL	76 mm (3 in) ACP	150 mm (6 in) Base