

**Geotechnical Investigation Report
BIA Project N12 (12-2)(19-2)2&4
Navajo, New Mexico to N64 Junction, Arizona (near Tsaile)
Five Bridge Sites: N505, Tsaile Creek; N504, Wheatfield Creek; N503, Whiskey Creek;
N614, Coyote Wash; N613, Tohdildonih Wash
BIA Order No. A13PD00246
BIA Requisition No. 0040100785
Architect – Engineer IDIQ Contract No. A12PC00121**

Submitted to:

**Bureau of Indian Affairs, Navajo Regional Office
Gallup, New Mexico**

Submitted by:

**AMEC Environment & Infrastructure, Inc.
Phoenix, Arizona**

September 22, 2014

**AMEC Project No. 17-2013-4030
Revision No. 1**



September 22, 2014
AMEC Project No. 17-2013-4030.0001
Revision No. 1

Bureau of Indian Affairs, Navajo Regional Office
Division of Acquisition
PO Box 1060
301 West Hill, Room 346
Gallup, New Mexico 87305-1060

Attn: Corwyn Henry

**Re: Geotechnical Investigation Report
BIA Project N12 (12-2)(19-2)2&4
Navajo, New Mexico to N64 Junction, Arizona (near Tsaille)
Five Bridge Sites: N505, Tsaille Creek; N504, Wheatfield Creek; N503, Whiskey
Creek; N614, Coyote Wash; N613, Tohdildonih Wash
BIA Order No. A13PD00246
BIA Requisition No. 0040100785
Architect – Engineer IDIQ Contract No. A12PC00121**

AMEC Environment & Infrastructure, Inc. (AMEC) has revised our Preliminary Geotechnical Investigation of the subsurface conditions at five bridge sites on Bureau of Indian Affairs (BIA) Route N12 based on comments received on August 29, 2014. The bridge sites consist of bridges N505 at Tsaille Creek, N504 at Wheatfield Creek, N503 at Whiskey Creek, N614 at Coyote Wash, and N613 at Tohdildonih Wash. The bridge sites are contained between Navajo, New Mexico and N64 Junction near Tsaille, Arizona. This work was performed in general accordance with BIA Order No. A13PD00246 dated July 13, 2013. The results of our investigation along with the boring location plans and boring logs are attached.

We at AMEC are committed to providing quality engineering services combined with client satisfaction in order to achieve a continuing relationship with our clients. We appreciate the opportunity to provide these services for you. If you have any questions regarding any of the other engineering and testing services AMEC provides, please do not hesitate to contact us.

Respectfully submitted,

AMEC Environment & Infrastructure, Inc.

Reviewed by:



Mark Hartig, PE Expires 3/31/2017
Geotechnical Operations Manager



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c: Addressee (3)

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1.0 PROJECT INFORMATION AND PURPOSE

Included in this report are the results of our subsurface investigation at five bridge sites along Bureau of Indian Affairs (BIA) Route N12 from Navajo, New Mexico north to N64 Junction near Tsaile, Arizona. The five bridge sites consist of bridges N505 at Tsaile Creek, N504 at Wheatfield Creek, N503 at Whiskey Creek, N614 at Coyote Wash, and N613 at Tohdildonih Wash. At the request of the BIA, our investigation was in general accordance with IDIQ Contract No. A12PC00121, Section D, Bridges and Other Major Structural Element Soils Investigations, Sampling, & Testing, along with the following exceptions:

- Per e-mail from Ms. Ella Dempsey on June 6, 2013
 - References to "recommended structure" or "recommended replacement structure" shall be changed to say "structure to be recommended in the future".
 - Boring Plan development shall be based on existing foundation elements of the existing bridges currently in place.
 - Section D. 1. (a). (1). (C). does not apply since the approach roadway investigation will fall under the roadway portion of this RFP.
 - The Section D. 1. (a). (2). (B). reference to the prohibition of the Modified California sampler can be revised to say, "The Modified California sampler shall only be used to obtain samples but shall not be used to determine blow counts of the soil being sampled. Blow counts shall be determined by a standard, non-modified sampler."
 - A "structure specific" foundation design is not required since a specific recommended structure is not available. However, the consultant shall provided a recommended structure type (system) based on the subsurface characteristics encountered that will best support a standard highway bridge structure. The data gathered from the investigation and laboratory analyses shall be sufficient to design a foundation for a structure to be determined in the future.
- Per direction from Mr. Harold Riley on August 1, 2013, via telephone call
 - Proposed borings at the midpoints (upstream and downstream) of the single span bridges (N503, N504, N505, and N614), and the proposed borings at each pier of Bridge N613 (4 span bridge) are not to be performed.

This report does not address any environmental issues related to the site or the project. If you have any questions concerning environmental aspects of this project please contact us and we can discuss additional services with you.

Our professional services have been performed using that degree of care and skill ordinarily exercised, under similar circumstances, by reputable geotechnical consultants practicing in this or similar localities. No other warranty, expressed or implied, is made as to the professional advice included in this report. This report has been prepared for BIA, Navajo Regional Office for the purpose of providing the information described above. This report has not been prepared for any other parties, and may not contain sufficient information for purposes of other parties. If

any of the project information described in Section 2.0 of this report has changed, we should be notified so that we may amend our recommendations, as necessary.

2.0 FIELD EXPLORATION AND LABORATORY TESTING

2.1 Field Exploration

AMEC Environment & Infrastructure, Inc. (AMEC) advanced one boring at each end of each existing bridge abutment between the dates of September 17 and October 27, 2013. The borings were performed under the direction of Reed Seamons, AMEC field geologist. The borings were performed by Cascade Drilling with a buggy-mounted CME 85 drill rig using 203 millimeter diameter hollow stem auger (HSA) and 96mm (HQ) outside diameter rock coring. The rock coring was advanced using a HWT casing advancer and HQ-sized, wireline, diamond-bit, rock coring system. The HQ core system produces 63.5millimeter-diameter core and a 96-millimeter-diameter borehole. All borings were drilled in a vertical orientation. Per the requirements of the contract, the borings were augered to approximately 30.5 meters in depth or until bedrock was encountered. If bedrock was encountered, rock coring was performed to a depth of approximately 6 meters or greater depending on percent recovery. Standard penetration testing and open-end drive sampling were generally performed every 1.5 meters within the soil section of the borings. Below is a summary of the auger and core drilling performed at the bridge locations:

- Bridge N505: Augered to bedrock encountered at depths between 2.7 and 4.4 meters below ground surface (bgs). Cored to depths between 9.3 to 15.4 meters bgs.
- Bridge N504: Augered to depths between 28.2 to 30.5 meters bgs. No rock coring. *Note: Boring N504 B-2 stopped at 28.2 meters due to auger/mechanical difficulties.*
- Bridge N503: Augered to bedrock encountered at depths between 8.8 and 11.9 meters bgs. Cored to depths between 15.4 and 18.3 meters bgs.
- Bridge N614: Augered to bedrock encountered at depths between 7.6 and 11.6 meters bgs. Cored to depths between 13.7 and 17.7 meters bgs.
- Bridge N613: Augered to bedrock encountered at depths between 7.6 and 16.2 meters bgs. Cored to depths between 14.0 and 22.3 meters bgs.

Borings performed were backfilled with soil cuttings and grout in the upper 6 meters. Excess soil cuttings were spread nearby. In some locations, the borings were performed through the existing asphalt pavement. These locations were backfilled as described above; however the surfaces were patched with cold patch asphalt, tamped down with a mallet, and were left slightly mounded to allow for some settlement. Soil borings were numbered B-1 through B-4 at each bridge location, with B-1 at the northwest abutment, B-2 at the northeast abutment, B-3 at the southwest abutment, and B-4 at the southeast abutment.

The approximate locations of the soil borings are shown on Figures 1 through 6 – Project Overview and Boring Locations Map. The GPS NAD 83 – UTM Zone 12 coordinates for each location were established using a handheld survey grade GPS unit and are shown on the attached boring logs along with elevations. The soils and bedrock encountered at each location were visually classified and recorded on a field log. After completion of the laboratory tests on

the samples retrieved, the field logs were reviewed and modified where necessary to produce the final boring logs presented in Appendix A. Additionally, descriptions of the drilling techniques used, a summary of the Unified Soil Classification System (ASTM D2487) and an explanation of the terminology used in describing rock core can be found in Appendix A. Our field and final classifications were based on the Unified Soil Classification System (USCS) and AMEC guidelines.

2.2 Laboratory Testing

Laboratory tests were performed on the representative bulk, split spoon, and undisturbed samples obtained during our field exploration for the purpose of evaluating the pertinent engineering properties of the site soils. The following tests were performed in general accordance with the applicable American Association of State Highway and Transportation Officials (AASHTO) test methods:

- Plasticity Index (AASHTO T89, T90)
- Sieve Analysis (Gradation and Minus #200 wash) (AASHTO T11, T27)
- Direct Shear (AASHTO T236) 3-point in-situ
- Unconfined Compression of Cohesive Soil or Rock Core (AASHTO T208)
- Consolidation (AASHTO T216)

The laboratory results are summarized in Table C-1 of Appendix C and are followed by copies of the laboratory reports.

2.3 Geologic Setting

The project area is located in the Colorado Plateau geologic province along the western base of the Chuska Mountains in northeastern Arizona and northwestern New Mexico. The geologic units underlying the project corridor typically consist of recent unconsolidated deposits of varying thickness underlain by Triassic-age rock formations: the Chinle and Wingate Formations (Byers 1980, O'Sullivan and Beikman 1963 and Thaden 1990).

The Chinle Formation is the geologic formation present throughout most of the corridor. It is subdivided into several Members, three of which are present along the project corridor: Red Member, Owl Rock Member, and the Petrified Forest Member. The Red Member of the Chinle Formation is present in the northernmost portion of the corridor and typically consists of dark reddish-brown bentonitic siltstone, sandstone and lime-pellet conglomerate. The Owl Rock Member of the Chinle formation is present along much of the corridor and typically consists of interbedded limestone and reddish-brown, clayey siltstone. The Petrified Forest Member of the Chinle Formation periodically occurs throughout the corridor and typically consists of blue to gray to red to white bentonitic claystone, siltstone and sandstone (Byers 1980, O'Sullivan and Beikman 1963 and Thaden 1990).

The Red Member of the Chinle Formation occurs at the bridge at Tsaille Creek (N505). In this area the Red Member typically consists of reddish-brown sandstone.

The Petrified Forest Member of the Chinle Formation is present at the bridge at Wheatfield Creek (N504). The Petrified Forest Member of the Chinle Formation typically consists of blue to gray to red to white bentonitic claystone, siltstone and sandstone.

The Petrified Forest Member of the Chinle Formation occurs in the area of the Whiskey Creek Bridge (N503). In this area the Petrified Forest Member of the Chinle Formation typically consists of reddish-brown calcareous siltstone.

The Owl Rock Member of the Chinle Formation is present at the bridge at Coyote Wash (N614). In this area the Owl Rock Member typically consists of reddish-brown to purplish siltstone and claystone.

Both the Owl Rock and Petrified Forest Members of the Chinle Formation occur in the area of the Navajo Bridge (N613) and it is difficult to tell for certain how the rock in this area is best categorized. The Chinle Formation typically consists of reddish-brown to purplish siltstone, claystone and mudstone.

2.4 Geotechnical Profile

N505 at Tsaille Creek

Native subgrade soils consisted of clayey sands and sandy clays with traces of fine gravel to depths ranging from 1.5 to 4.4 meters bgs, overlaying approximately 1 meter thick layer of clayey gravels and silty sands in Borings B-1 and B-4, respectively. Plasticities range from low to medium. The soil profiles generally ranged from firm to hard. Groundwater was not encountered. Sandstone bedrock was encountered at depths between 2.7 and 4.4 meters bgs. The sandstone was generally slightly to moderately weathered, with some unweathered sandstone encountered in Boring B-4. Boring B-2 had poor recovery of the rock core, and therefore several extra runs of core were performed for a total of approximately 11 meters. See the N505 boring logs for full descriptions of the soil and rock encountered.

N504 at Wheatfield Creek

Native subgrade soils consisted of silty sands, silty sandy clays, sands, sandy silts, and gravelly sands to depths of approximately 10.7 to 12.5 meters bgs. These materials were overlaying clays, clayey silts, and silty clays (possibly claystones or siltstones) to the full depths of exploration, 30.5 meters bgs. Plasticity ranged from low to medium for the silty sandy clays, clayey silts, and silty clays, and was generally nonplastic for the silty sands and sands. The soil profiles generally ranged from moderately firm to hard to depths of approximately 10.7 to 12.5 meters bgs, and hard below that to the full depth of exploration. Groundwater (possibly perched on the claystone/siltstone type material) was encountered at depths ranging from 6.4 to 7.6 meters bgs in the soil borings performed. See the N504 boring logs for full descriptions of the soils encountered.

N503 at Whiskey Creek

Native subgrade soils consisted of sandy clays and clayey sands with occasional to some gravel overlaying silty sands, sandy silts, and sandy clays with occasional fine-grained gravels. These were generally overlaying a silty gravel layer, followed by more silty sands, sands, and sandy silts with varying amounts of gravels. Plasticity ranged from low to medium for the clayey sands, sandy clays, and sandy silts, and was generally nonplastic for the silty sands, sands, and gravels. The soil profiles generally ranged from moderately firm to hard. Groundwater (possibly perched on the bedrock) was encountered at depths ranging from 4.6 to 5.6 meters bgs in the soil borings performed. Calcareous siltstone bedrock was encountered at depths between 8.8 and 11.9 meters bgs. The siltstone was generally slightly to moderately weathered, with some highly weathered siltstone encountered in Boring B-1 near 12 meters bgs. See the N503 boring logs for full descriptions of the soil and rock encountered.

N614 at Coyote Wash

Native subgrade soils consisted of clayey sands with some to considerable gravels ranging from approximately 3 to 7.75 meters in all four borings. The clayey sands were underlain by silty sands, sandy clays, sands, and sandy silt and clay with varying amounts of gravel. Plasticity ranged from low to medium for the clayey sands, sandy clays, and sandy silt and clays, and was generally nonplastic for the silty sands and sands. The soil profiles generally ranged from moderately firm to hard, with some soft layers encountered in Boring B-1 between approximately 4.5 and 6 meters, and 9.2 and 10.7 meters. Groundwater was not encountered. Siltstone/claystone bedrock was encountered at depths between 7.6 and 11.6 meters bgs. The siltstone/claystone was generally slightly to moderately weathered, with some highly weathered siltstone/claystone encountered in Boring B-2 near 13 meters bgs. See the N614 boring logs for full descriptions of the soil and rock encountered.

N613 at Tohdildonih Wash

Native subgrade soils generally consisted of clayey sands and silty sands with varying amounts of gravel overlaying sandy clays and sandy silts. Boring B-3 encountered a 0.5 meter thick sandy gravel layer at the surface. Plasticity ranged from low to medium for the clayey sands, sandy clays, and sandy silts, and was generally nonplastic for the silty sands and gravels. The soil profiles generally ranged from very soft to hard, with blow counts as low as 2 encountered at varying depths. Groundwater (possibly perched on the bedrock) was encountered at depths ranging from 4.3 to 5.2 meters bgs in the soil borings performed. Borings B-1, B-2, and B-4 encountered siltstone bedrock at depths between 7.8 and 10.7 meters bgs. Boring B-3 encountered a calcareous mudstone bedrock at a depth of 16.2 meters bgs. The siltstone was generally slightly to moderately weathered, with some highly weathered siltstone encountered in Boring B-4 near 10.5 meters bgs. The mudstone was generally slightly to moderately weathered. See the N613 boring logs for full descriptions of the soil and rock encountered.

2.5 Foundation Type Recommendations

AMEC understands that the BIA plans to widen Bridge 613 at Tohdildonih Wash. The existing bridge structure and superstructure will remain and the abutments and piers will be extended laterally to provide a wider deck. The four other bridges, N505, N504, N503, and N614; are planned to be removed and replaced. There is potential that these structures will be replaced with precast concrete arch structures, such as ConSpan arch structure. AMEC reviewed preliminary details for the ConSpan arch structures and identified the following items that need to be considered further if these structures are used:

1. The maximum span available for a ConSpan arch structure is 48 feet. The estimated spans for these four bridges are between 80 and 100 feet resulting in the need for a two-span structure.
2. A two-span structure will require a pier in the middle of each wash or creek, which will impact the hydrology and the potential scour.
3. The current investigation only investigated the abutment locations for these structures. Additional geotechnical investigation would be required to identify the conditions at the pier locations.
4. The use of a ConSpan arch structure does not dictate the foundation type required. These structures only require a surface large enough to allow a keyway to be constructed where the ConSpan arch leg is placed. Either spread footings or pile/pier caps would be suitable.

The preliminary foundation type recommendations in this report were based on the soils/bedrock encountered in the test borings performed. It has been assumed that conditions between abutment borings are representative of the soil/bedrock conditions encountered in the abutment borings.

N505 at Tsaille Creek

Sandstone bedrock was encountered at relatively shallow depths at this location (2.7 to 4.4 meters bgs). If desired, a new bridge structure could be supported on spread footings keyed into the sandstone bedrock or by appropriately sized drilled shafts (also known as cast-in-drilled hole [CIDH] piles, caissons, and cast-in-situ piles). Drilled shafts, if used, should be socketed into the sandstone bedrock.

N504 at Wheatfield Creek

The varying soil profile and consistency doesn't lend itself to shallow foundations. Lightly to moderately loaded structures could be founded on spread footings below a depth of 3 meters. Moderately to heavily loaded structures should be supported by appropriately sized drilled shafts (also known as cast-in-drilled hole [CIDH] piles, caissons, and cast-in-situ piles). Groundwater was encountered at depths ranging from 6.4 to 7.6 meters bgs, and should be accounted for when planning construction of the foundations.

N503 at Whiskey Creek

The varying soil profile and consistency doesn't lend itself to spread footing foundations without considerable mitigation of the native soils. Therefore, we recommend a new bridge structure be supported by appropriately sized drilled shafts (also known as cast-in-drilled hole [CIDH] piles, caissons, and cast-in-situ piles). Groundwater was encountered at depths ranging from 4.6 to 5.6 meters bgs, and should be accounted for when planning construction of the foundations. To increase the end bearing capacity, the drilled shafts could be socketed into the siltstone bedrock encountered between 8.8 and 11.9 meters bgs.

N614 at Coyote Wash

The soil profile consists of considerable soft to moderately firm zones in the upper 10 meters ruling out the use of spread footing foundations. Therefore, we recommend a new bridge structure be supported by appropriately sized drilled shafts (also known as cast-in-drilled hole [CIDH] piles, caissons, and cast-in-situ piles). To increase the end bearing capacity, the drilled shafts could be socketed into the siltstone/claystone bedrock encountered between 7.6 and 11.6 meters bgs.

N613 at Tohdildonih Wash

The soft to very soft soils in the upper 8 to 13 meters at the north and south abutments respectively, preclude the use of spread footing foundations. Furthermore, the use of spread footing foundations would result in increased differential settlement between the existing structure and the proposed widened structure. Therefore, AMEC recommends that the widened portion of the bridge be supported on drilled shafts (also known as cast-in-drilled hole [CIDH] piles, caissons, and cast-in-situ piles). The use of drilled shafts will allow adequate capacity to be obtained while reducing the potential differential settlement between the existing structure and the proposed widened structure. There is potential that the drilled shafts will need to be socketed into the siltstone bedrock encountered at approximately 8 to 16.2 meters bgs at the north and south abutments, respectively. Groundwater was encountered at depths ranging from 4.3 to 5.2 meters bgs, and should be accounted for when planning construction of the foundations.

2.6 Preliminary Foundation Design Recommendations

At the request of the BIA, AMEC has developed preliminary recommendations for unit side resistance and unit end bearing resistance for drilled shafts socketed into rock for all bridge locations. In addition, preliminary unit side resistance and unit end bearing resistance for driven steel H piles has been developed for bridge N613 since this bridge is currently founded on driven steel H piles. The recommendations are preliminary due to no borings being done at the bridge pier locations and due to the unknown scour depth at each bridge location. This additional information would be required prior to finalization of these recommendations.

Preliminary Nominal Resistance

Bridge	Drilled Shaft		H-Pile	
	Unit Side Resistance, kPa	Unit End Bearing Resistance, kPa	Unit Side Resistance, kPa	Unit End Bearing Resistance, kPa
N505	500	1,300	---	---
N504	80	150	---	---
N503	370	510	---	---
N614	280	290	---	---
N613	250	240	---	2,100

Note: Appropriate resistance factors need to be applied to the nominal unit side resistance and end bearing resistance presented.

3.0 DRILLED, CAST-IN-PLACE, CONCRETE SHAFTS

3.1 General

Recommendations are presented herein for rock socket drilled shafts for support of the proposed bridge structure foundations. A minimum 762-mm-diameter drilled shaft is recommended. The recommended design criteria are based on the AASHTO Load and Resistance Factor Design (LRFD) as presented in *AASHTO LRFD Bridge Design Specifications* (American Association of State Highway and Transportation Officials [AASHTO] 2010).

3.2 Vertical Capacity

The axial compression capacity of the bridge drilled-shaft foundations was determined using the AASHTO LRFD rock socket design criteria, which determines the unit side resistance as a function of the unconfined compressive strength (UCS) of the rock and reduces it by an empirical amount to account for rock jointing. The unit side resistance determined cannot exceed the strength of the drilled-shaft concrete in shear, which is determined as a function of the UCS of the concrete.

Resistance to loads is developed by shear between the concrete of the drilled shaft and the wall of the drilled-shaft excavation. If tip resistance is considered in the analyses specialized cleaning of the bottom of the drilled-shaft foundation excavations will be necessary. Furthermore, the use of the maximum unit side resistance and the unit end bearing resistance is not recommended due to strain incompatibility of the two resistances. AMEC recommends unit side resistance or unit end bearing resistance be considered in the design, not both.

The maximum tip elevation of the rock sockets is the top of suitable rock elevation identified in Section 2.5, minus two drilled-shaft diameters.

3.2.1 Strength and the Limit State

The drilled-shaft foundations were designed using side-wall shear in accordance with the AASHTO LRFD procedure developed by Horvath and Kenney (1979), as presented in equation

10.8.3.5.4b-1. This procedure considers the uniaxial UCS of the rock and a reduction factor to account for rock jointing. A resistance factor of 0.55 will need to be applied, per Table 10.5.5.2.4-1, for the Horvath and Kenney analytical procedure for side resistance. A resistance factor of 0.50 will need to be applied, per Table 10.5.5.2.4-1, for the O'Neill and Resse (1999) analytical procedure for end bearing.

3.2.2 Service Limit State

The vertical resistance provided by the rock is a function of the movement between the drilled shaft and the surrounding rock mass. The elastic solutions of Carter and Kulhawy (1988) were used to compute the load-displacement behavior of the rock socket. The results of the analysis reveals that the full factored strength limit capacity of the rock socket will be achieved at a displacement of less than ½ inch. Therefore, a breakdown of service load capacities was not necessary.

3.2.3 Redundancy of Foundations

The resistance factors used for calculating the vertical drilled-shaft capacity may need to be modified depending upon the number of drilled shafts used at each foundation element or the redundancy of the foundations. Section 10.5.5.2.4 of AASHTO (2010) states "Where the resistance factors provided in [Table 10.5.5.2.4-1] are applied to a single shaft supporting a bridge pier, the resistance factor values in the Table should be reduced by 20 percent.

3.2.4 Group Effect - Axial

The minimum recommended center-to-center (CTC) pier spacing is 3.5 diameters. No axial capacity group reduction is recommended for drilled shafts founded in rock with this minimum spacing.

4.0 DRIVEN PILES

4.1 General

Recommendations are presented herein for driven piles founded on rock for support of the proposed bridge structure foundations at Bridge N613. The recommended design criteria are based on the AASHTO Load and Resistance Factor Design (LRFD) as presented in *AASHTO LRFD Bridge Design Specifications* (American Association of State Highway and Transportation Officials [AASHTO] 2010).

4.2 Vertical Capacity

The axial compression capacity of the bridge pile foundations was determined using the AASHTO LRFD end bearing on rock design criteria as outlined in the Canadian Geotechnical Society (1985), which determines the unit end bearing as a function of the UCS of the rock and reduces it by an empirical amount to account for rock jointing. Given the strong nature of the rock, the pile is not expected to penetrate into the rock sufficiently to develop side resistance and is therefore neglected.

Nominal pile bearing resistance should be verified in the field during pile installation using one of the methods outlined in AASHTO.

4.2.1 Strength and the Limit State

The pile foundations were designed using end bearing on rock design criteria as outlined in the Canadian Geotechnical Society (CGS) (1985), which determines the unit end bearing as a function of the UCS of the rock and reduces it by an empirical amount to account for rock jointing. A resistance factor of 0.50 will need to be applied, per Table 10.5.5.2.3-1, for the CGS analytical procedure for end bearing.

4.2.2 Service Limit State

The settlement of the driven piles should be determined by the equivalent footing analogy as outlined in AASHTO. This should be completed once the pile group geometry and loading are determined.

4.2.3 Redundancy of Foundations

The resistance factors used for calculating the vertical pile capacity may need to be modified depending upon the number of piles used at each foundation element or the redundancy of the foundations. Section 10.5.5.2.3 of AASHTO (2010) states "Where the resistance factors provided in [Table 10.5.5.2.3-1] are applied to a pile group of three or less supporting a bridge pier, the resistance factor values in the Table should be reduced by 20 percent.

4.2.4 Group Effect - Axial

The minimum recommended center-to-center (CTC) pile spacing is 762 mm or 2.5 pile diameters. No axial capacity group reduction is recommended for piles founded in rock with this minimum spacing.

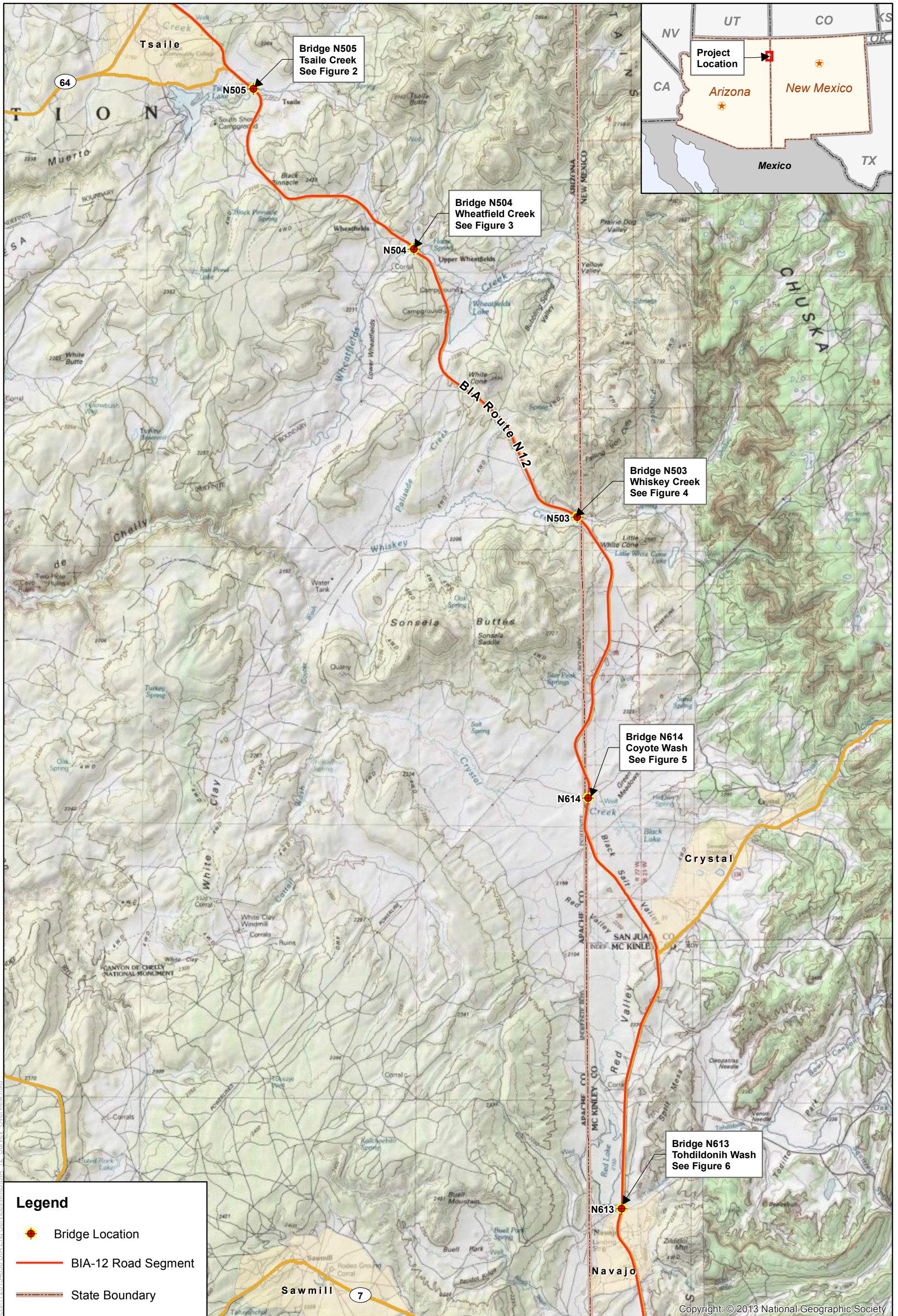
5.0 REFERENCES

Byers, V.P., 1980. Geologic Map and Sections of the Sonsela Butte 4 SE Quadrangle, Apache County, Arizona and San Juan and McKinley Counties, New Mexico. U.S. Geological Survey Open-File Report 80-788.

O'Sullivan, R.B. and Beikman, H.M., 1963. Geology, Structure, and Uranium Deposits of the Shiprock Quadrangle, New Mexico and Arizona. U.S. Geological Survey Miscellaneous Geologic Investigations, Map I-345.

Thaden, R.E., 1990. Geologic Map of the Buell Park Quadrangle, Apache County, Arizona and McKinley County, New Mexico. U.S. Geological Survey Geologic Quadrangle Map GQ-1649.

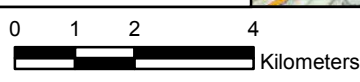
FIGURES



Path: X:\Projects\2013\Projects\172013-4030\BIA_12_Survey_Overview.mxd

Legend

- Bridge Location
- BIA-12 Road Segment
- State Boundary



Job No. 17-2013-4030
 PM: MH
 Date: 2/18/2014
 Scale: 1 cm = 1 km



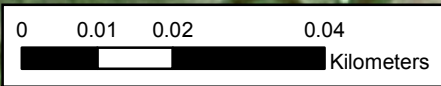
The map shown here has been created with all due and reasonable care and is strictly for use with AMEC Project Number 17-2013-4030. This map has not been certified by a licensed land surveyor, and any third party use of this map comes without warranties of any kind. AMEC assumes no liability, direct or indirect, whatsoever for any such third party or unintended use.

BIA Project N12 (12-2) (19-2) 2&4
 Navajo, New Mexico to N64 Junction, Arizona


Project Overview **FIGURE 1**



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Legend

 Boring Location

Imagery Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Job No.	1720134030
PM:	MH
Date:	2/18/2014
Scale:	1 cm = .01 km



**BIA Project N12 (12-2) (19-2) 2&4
Navajo, New Mexico to N64 Junction, Arizona
Bridge N505**



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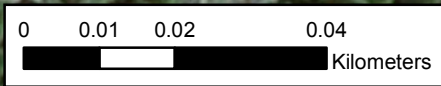
Boring Locations Map

**FIGURE
2**


Path: X:\Projects\2013\Projects\1720134030 BIA Eng Services\MXD\BIA_12_Bridge_Locations.mxd



Path: X:\Projects\2013\Projects\1720134030\BIA Eng Services\MXD\BIA_12_Bridge_Locations.mxd



Legend

 Boring Location

Imagery Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Job No.	1720134030
PM:	MH
Date:	2/18/2014
Scale:	1 cm = .01 km



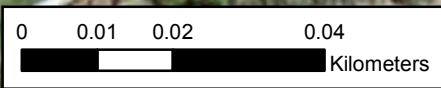
**BIA Project N12 (12-2) (19-2) 2&4
Navajo, New Mexico to N64 Junction, Arizona
Bridge N504**




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Boring Locations Map

**FIGURE
3**



Legend

 Boring Location

Imagery Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Job No.	1720134030
PM:	MH
Date:	2/18/2014
Scale:	1 cm = .01 km



**BIA Project N12 (12-2) (19-2) 2&4
Navajo, New Mexico to N64 Junction, Arizona
Bridge N503**



Boring Locations Map


**FIGURE
4**

Path: X:\Projects\2013\Projects\1720134030 BIA Engr Services\MXD\BIA_12_Bridge_Locations.mxd

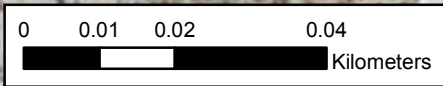
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Legend

 Boring Location

Imagery Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



Job No.	1720134030
PM:	MH
Date:	2/18/2014
Scale:	1 cm = .01 km



BIA Project N12 (12-2) (19-2) 2&4
 Navajo, New Mexico to N64 Junction, Arizona
 Bridge N614



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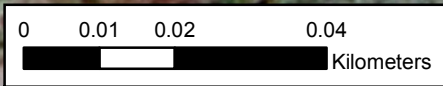
Boring Locations Map

FIGURE
5


Path: X:\Projects\2013\Projects\1720134030 BIA Engr Services\MXD\BIA_12_Bridge_Locations.mxd



Path: X:\Projects\2013\Projects\1720134030 BIA Eng Services\MXD\BIA_12_Bridge_Locations.mxd



Legend

 Boring Location

Imagery Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Job No.	1720134030
PM:	MH
Date:	2/18/2014
Scale:	1 cm = .01 km



BIA Project N12 (12-2) (19-2) 2&4
Navajo, New Mexico to N64 Junction, Arizona
Bridge N613



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Boring Locations Map

FIGURE
6

APPENDIX A

FIELD INVESTIGATION & BORING LOGS

TEST DRILLING EQUIPMENT AND PROCEDURES

Description of Subsurface Exploration Methods

Auger Boring Drilling through overburden soils is performed with 6 5/8-inch O.D., 3 1/4-inch I.D. hollow stem auger or 4 1/2-inch solid stem continuous flight auger. Carbide insert teeth are normally used on bits so they can penetrate soft rock or very strongly cemented soils. A CME-75 truck-mounted drill rig is used to advance the auger. The drill rigs are powered with six-cylinder Cummins diesel engines capable of delivering about 11.4 kN-m torque to the drill spindle. The spindle is advanced with twin hydraulic rams capable of exerting 90 kN (20,000 pounds) downward force.

Generally, refusal to penetration of the auger is adopted as top of the SGC or "river-run" material or harder bedrock, which require other techniques for penetration. Grab samples or auger cuttings may be taken as necessary. Standard penetration tests or 2.42-inch diameter ring samples are taken in conjunction with the auger borings as needed, with the sampling interval and type being indicated on the boring logs.

Hammer Drill Drilling with the Hammer drill is accomplished with a Drill Systems AP-1000 drill rig advancing a double-walled drive casing with a link-belt 180 diesel pile driving hammer, having a rated energy of 8,100 foot-pounds per blow. Where noted on the boring log, the hammer is equipped with a supercharger which can boost the energy to approximately 12,000 foot-pounds per blow. The supercharger is used only in portions of the boring where blow counts are relatively high. Cuttings are removed with compressed air by a reverse circulation process, and are collected in a cyclone from which grab samples are obtained. The drive casing is either 9-inch O.D. by 6-inch I.D. or 6 5/8-inch O.D. by 4-inch I.D. and employs an expendable bit of slightly larger diameter than the O.D. of the casing. Hammer blows required to advance the drive casing are recorded in 1-foot increments, as noted on the boring logs. Standard penetration tests or 2.42-inch diameter ring samples taken are noted on the boring logs.

Core Boring Rock core samples are retrieved using a CME-75 drill rig, SAITECH GH 3 rig or Burley 2500, 4500 or 4000. The GH 3 is a portable hydraulic core drill. The GH 3 is powered by a Kohler two-cylinder 25-horsepower engine. The hydraulics motor which feeds a two-speed transmission and powers the BW spindle. This unit has a 3-foot stroke and is hand-fed with a 2,000 pound push-pull capability. The GH 3 has the capability of drilling with either B- or N-size core steel using standard or wireline systems. N-size core is the preferred size and it has a nominal O.D. of about 2 inches. The Burley 2500 and 4500 series are portable hydraulic core drills. The 4500 series is capable of a track-mounted or skid-type chassis. The Burley 2500 and 4500 series are powered by 44 and 75 HP power units, respectively, provide up to 2,000 foot-pounds (ft.-lbs.) of torque and in excess of 1,000 revolutions per minute (RPM) of spindle speed. Both rigs are capable of retrieving either N- or H-sized core using wireline systems. The N-size core has a nominal O.D. of about 2 inches and the H-size of about 2.4 inches. The Burley 4000 is a track-mounted core drill.

The CME-75 utilizes a wireline core drilling system that takes N-size cores. Using the NQ wireline system, core is recovered quickly by retrieving the core-laden inner tube through the drill string.

TEST DRILLING EQUIPMENT AND PROCEDURES (Cont.)

Sampling Procedures Dynamically driven tube samples are usually obtained at selected intervals in the borings by the ASTM D1586 test procedure. In many cases, 2-inch O.D., 1 3/8-inch I.D. samples are used to obtain the standard penetration resistance. "Undisturbed" samples of firmer soils are often obtained with 3-inch O.D. samples lined with 2.42-inch I.D. brass rings. The driving energy is generally recorded as the number of blows of a 140-pound, 30-inch free fall drop hammer required to advance the samples in 6-inch increments. However, in stratified soils, driving resistance is sometimes recorded in 2- or 3-inch increments so that soil changes and the presence of scattered gravel or cemented layers can be readily detected and the realistic penetration values obtained for consideration in design. These values are expressed in blows per 6 inches on the boring logs. "Undisturbed" sampling of softer soils is sometimes performed with thin walled Shelby tubes (ASTM D1587), pitcher samplers, Denison samplers or continuous CME samplers. Where samples of rock are required, they are obtained by NQ diamond core drilling (ASTM D2113). Tube samples are labeled and placed in watertight containers to maintain field moisture contents for testing. When necessary for testing, larger bulk samples are taken from auger cuttings. Also, representative samples are obtained from the cuttings from the hammer and Schramm drill rig.

Boring Records Drilling operations are directed by our field engineer or geologist who examines soil recovery and prepares the boring logs. Soils are visually classified in accordance with the Unified Soil Classification System (ASTM D2487), with appropriate group symbols being shown on the boring logs.

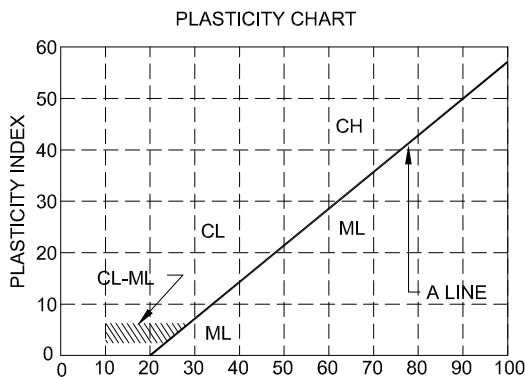
UNIFIED CLASSIFICATION SYSTEM FOR SOILS



Soils are visually classified by the United Soil Classification System on the boring logs presents Grain-size analysis and Atterberg Limits Tests are often performed on selected samples to aid in classification. The classification system is briefly outlined on this chart. For a more detailed description of the system, see " The Unified Soil Classification System " ASTM Designation: D2487

MAJOR DIVISION		GRAPH SYMBOL	GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE-GRAINED SOILS (Less than 50% passes No. 200 sieve)	GRAVELS (50% or less of coarse fraction passes No. 4 sieve)	CLEAN GRAVELS (Less than 5% passes No. 200 sieve)	GW	Well graded gravels, gravel-sized mixtures or sand-gravel-cobble mixture.
		GRAVELS WITH FINES (More than 12% passes No. 200 sieve)	GP	Poorly graded gravels, gravel-sized mixtures or sand-gravel-cobble mixture.
		Limits plot below "A" line & hatched zone on plasticity chart	GM	Silty gravels, gravel-sand-silt mixture.
		Limits plot below "A" line & hatched zone on plasticity chart	GC	Clayey gravels, gravel-sand-clay mixture.
	SANDS (More than 50% of coarse fraction passes No. 4 sieve)	CLEAN SANDS (Less than 5% passes No. 200 sieve)	SW	Well graded sands, gravelly sands.
		SANDS WITH FINES (More than 12% passes No. 200 sieve)	SP	Poorly graded sands, gravelly sands.
		Limits plot below "A" line & hatched zone on plasticity chart	SM	Silty sands, sand-silt mixtures.
		Limits plot below "A" line & hatched zone on plasticity chart	SC	Clayey sands, sand-clay mixtures.
FINE-GRAINED SOILS (50% or more passes No. 200 sieve)	SILTS OF LOW PLASTICITY (Liquid limit less than 50)	ML	Inorganic silts, clayey silts with slight plasticity.	
	SILTS OF HIGH PLASTICITY (Liquid limit more than 50)	MH	Inorganic silts of high plasticity, silty soils, elastic silts.	
	CLAYS OF LOW PLASTICITY (Liquid limit less than 50)	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	
	CLAYS OF HIGH PLASTICITY (Liquid limit more than 50)	CH	Inorganic clays of high plasticity, fat clays, silty and sandy clays of high plasticity.	

NOTE: Coarse-grained soils with between 5% to 12% passing the No. 200 sieve and fine-grained soils with limits plotting in the hatched zone on the plasticity chart to have dual symbol.



DEFINITIONS OF SOIL FRACTIONS

SOIL COMPONENT	PARTICLE SIZE RANGE
Boulders	Above 300mm (12in.)
Cobbles	300mm to 75mm (12in. to 3in.)
Gravel	75mm (3in.) to No. 4 sieve
Coarse gravel	75mm to 19mm (3in to 3/4in.)
Fine gravel	19mm (3/4in.) to No. 4 sieve
Sand	No. 4 to No. 200
Coarse	No. 4 to No. 10
Medium	No. 10 to No. 40
Fine	No. 40 to No. 200
Fines (silt or clay)	Below No. 200 sieve

**TERMINOLOGY USED TO DESCRIBE THE RELATIVE DENSITY,
CONSISTENCY OR FIRMNESS OF SOILS**

The terminology used on the boring logs to describe the relative density, consistency or firmness of soils relative to the standard penetration resistance is presented below. The standard penetration resistance (N) in blows per foot is obtained by the ASTM D1586 procedure using 2" O.D., 1 3/8" I.D. samplers.

1. **Relative Density.** Terms for description of relative density of cohesionless, uncemented sands and sand-gravel mixtures.

<u>N</u>	<u>Relative Density</u>
0-4	Very loose
5-10	Loose
11-30	Medium dense
31-50	Dense
50+	Very dense

2. **Relative Consistency.** Terms for description of clays which are saturated or near saturation.

<u>N</u>	<u>Relative Consistency</u>	<u>Remarks</u>
0-2	Very soft	Easily penetrated several inches with fist.
3-4	Soft	Easily penetrated several inches with thumb.
5-8	Medium stiff	Can be penetrated several inches with thumb with moderate effort.
9-15	Stiff	Readily indented with thumb, but penetrated only with great effort.
16-30	Very stiff	Readily indented with thumbnail.
30+	Hard	Indented only with difficulty by thumbnail.

3. **Relative Firmness.** Terms for description of partially saturated and/or cemented soils which commonly occur in the Southwest including clays, cemented granular materials, silts and silty and clayey granular soils.

<u>N</u>	<u>Relative Firmness</u>
0-4	Very soft
5-8	Soft
9-15	Moderately firm
16-30	Firm
31-50	Very firm
50+	Hard

**EXPLANATION OF CORE LOG PRESENTATION
AND TERMINOLOGY FOR THE DESCRIPTION OF ROCK**

I. **ROCK QUALITY DESIGNATION (RQD).** Percentage of rock core per core run which is relatively sound and unfractured and which is longer than 0.33 feet in length. Rock which is soft or weathered, closely jointed, or rock from which the core recovery is low, will have poor to fair RQD.

II. **DISCONTINUITIES**

A. **Spacing of Joints**

<u>Code</u>	<u>Spacing of Joints</u>	<u>Descriptive Term</u>
1	Greater than 10 ft.	Very wide
2	3 ft. - 10 ft.	Wide
3	1 ft. - 3 ft.	Moderately close
4	0.2 ft. - 1 ft.	Close
5	Less than 0.2 ft.	Very close

B. **Orientation of Joints**

Measurements presented represent dip angles from horizontal.

<u>Symbol</u>	<u>Description</u>
Rdm	Random - preferred orientation cannot be determined.

C. **Condition of Joints**

1. **Roughness**

<u>Symbol</u>	<u>Descriptive Term</u>	<u>Properties</u>
Smth	Smooth	Appears smooth and is essentially smooth to the touch. May be slickensided.
Srgh	Slightly rough	Asperities on the fracture surfaces are visible and can be distinctly felt.
Mrgh	Medium rough	Asperities are clearly visible and fracture surface feels abrasive.
Rgh	Rough	Large angular asperities can be seen. Some ridge and high side angle steps evident.
VRgh	Very rough	Near-vertical steps and ridges occur on the fracture surface.

**EXPLANATION OF CORE LOG PRESENTATION
AND TERMINOLOGY FOR THE DESCRIPTION OF ROCK**

C. Condition of Joints (cont.)

2. Presence or Absence of Fracture Filling Material

<u>Symbol</u>	<u>Descriptive Term</u>	<u>Definition</u>
Cln	Clean	No fracture filling material.
Stn	Stained	Coloration of rock only. No recognizable filling material.
Fld	Filled	Fracture filled with recognizable filling material.

III. BEDDING

<u>Symbol</u>	<u>Descriptive Term</u>	<u>Definition</u>
TL	Thinly laminated	Less than 0.01 ft.
L	Laminated	0.01 ft. to 0.04 ft.
ThB	Thinly bedded	0.04 ft. to 0.20 ft.
MB	Medium bedded	0.20 ft. to 2.00 ft.
TkB	Thickly bedded	More than 2.00 ft.

IV. DEGREE OF WEATHERING

<u>Symbol</u>	<u>Descriptive Term</u>	<u>Properties</u>
Dec	<u>Decomposed</u>	generally soil-like, can be crumbled by hand pressure.
HiW	<u>Highly weathered</u>	generally rock-like, can be broken easily, but crumbles with difficulty by hand.
MdW	<u>Moderately weathered</u>	fabric stained rusty brown, can be indented by steel nail, breaks only with difficulty.
SIW	<u>Slightly weathered</u>	open discontinuities are weathered, coated, but only slight weathering of rock mass, generally not indented by steel nail.
UnW Ex Jts	<u>Unweathered except joints</u>	weathering limited to the surface of discontinuities; fabric is fresh throughout but most joints show rusty stain and/or soil filling material.
UnW Inc Jts	<u>Unweathered including joints</u>	rock mass and discontinuities are unweathered; only occasional joints show rusty stain, practically no soil filling.
UnW	<u>Unweathered</u>	rock mass unweathered; no staining or infilling.

**EXPLANATION OF CORE LOG PRESENTATION
AND TERMINOLOGY FOR THE DESCRIPTION OF ROCK**

V. HARDNESS

<u>Descriptive Term</u>	<u>Properties</u>
Very hard	Cannot be scratched with knife or sharp pick. Breaking of hand specimens requires several hard blows of geologist's pick.
Hard	Can be scratched with knife or pick only with difficulty. Hard blow of hammer required to detach hand specimen.
Moderately hard	Can be scratched with knife or pick. Gouges or grooves to 3 inch deep can be excavated by hard blow of point of a geologist's pick. Hand specimens can be detached by moderate blow.
Moderately soft	Can be grooved or gouged 1/16 inch deep by firm pressure on knife or pick point. Can be excavated in small chips to pieces about 1 inch maximum size by hard blows of the point of a geologist's pick.
Soft	Can be gouged or grooved readily with knife or pick point. Can be excavated in chips to pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.
Very soft	Can be carved with knife. Can be excavated readily with point of pick. Pieces 1 inch or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.

VI. MISCELLANEOUS ABBREVIATIONS

<u>Symbol</u>	<u>Description</u>	<u>Symbol</u>	<u>Description</u>
Bkn	Broken	Incl	Inclusions
Brc	Brecciated	Mgd	Medium-Grained
Band	Banded	Mod	Moderately
Qtz	Quartz	Wkly	Weakly
Calc	Calcite	Slicks	Slickensides
Cem	Cemented	Strong	Strongly
Frct	Fractured	SZ	Shear Zone
Fgd	Fine-Grained	Gog	Gouge



JOB NO. 17-2013-4030 DATE 10/6/13

LOCATION N. 4001370.138
E. 675659.5221
RIG TYPE CME-85 Buggy Mounted
BORING TYPE 203mm Hollow Stem Auger
SURFACE ELEV. 2231.1m
DATUM GPS NAD 83 - UTM Zone 12

Depth in Meters	Blows per 152 mm	Graphical Log	Sample	Sample Type	Blow Counts	Dry Density Kg. per Cubic meter	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				A				SC-SM	moist	SILTY CLAYEY SAND , some fine grained, subangular gravel, predominantly fine to medium grained sand, low plasticity, calcareous mix of green, gray, black & reddish-brown note: reacts to HCl
1								firm		
2										
3				S 12-13-18				CL	moist	SANDY CLAY WITH GRAVEL , some coarse grained gravel, calcareous sandstone cobble, medium plasticity, brown with green spots note: reacts to HCl
4								firm		
5				U 28-35-50/ S 152mm 16-19-25				CL-ML	moist	SILTY CLAY WITH SAND , trace gravel, some fine grained sand, low plasticity, brown note: does not react with HCl
6								very firm		
7				S 6-11-13				ML	wet	SANDY SILT , trace fine grained sand, calcareous, nonplastic note: reacts to HCl
8								firm		
9				S 28-33-44				GM	wet	SILTY GRAVEL WITH SAND , some silt, considerable fine grained, subangular gravel, predominantly fine to medium grained sand, nonplastic, green & black note: does not react with HCl
10				U 50/ 76mm				hard		
11										Stopped Auger at 8.8m Began HQ Coring at 8.8m
12										
13										
14										
15										

GROUNDWATER

DEPTH (m)	HOUR	DATE
5.5		10-6-13

SAMPLE TYPE

A - Auger cuttings; NR-No Recovery
S - 51mm O.D. 35mm I.D. tube sample.
U - 76mm O.D. 61mm I.D. tube sample.
T - 25mm O.D. thin-walled tube sample

PROJECT

BIA Project N12 (12-2) (19-2) 2 & 4
 Navajo, New Mexico to N64 Junction, Arizona



JOB NO.

17-2013-4030

DATE

10-6-13

RIG TYPE

CME-85 Buggy Mounted

METHOD

HQ Wireline

OPERATOR

CasCade Drilling

LOGGED BY

Reed Seamons

LOCATION

N. 4001370.138

E. 675659.5221

ELEVATION

2231.1m

DATUM

GPS NAD 83 - UTM Zone 12

INCLINATION

Vertical

Boring Operation and Drill Rate (min/meter)	Depth in Meter	Sample	Sample Type	Unconfined Compression of Point Load Index Test (KPa)	% Core Recovery	% Drilling Fluid/Air Rec.	Rock Quality Designation (RQD)	DISCONTINUITIES							Condition	Bedding and/or Fabric	Weathering or USCS (Soils)	Rock Type & Remarks
								Spacing					Orientation					
								Wide - Close					Horiz - Vert					
								1	2	3	4	5	H	45				
																	Began HQ Coring at 8.8m	
10/6 HQ4.0	9	HQ			20	95	0										CHINLE FORMATION CALCAREOUS SILTSTONE , moderately soft to moderately hard, reddish-brown with grayish-green reduction spots (2mm to 13mm) note: some irregularly-shaped healed fractures note: calcareous nodular zones	
8.4		HQ			95		35											
	9.0	HQ		25249	85		75										note: increase in nodules & reduction spots below 11.3m	
	8.8	HQ			100		70										note: majority of breaks/discontinuities occur on bedding planes (near horizontal)	
	22.6	HQ	30100		100	100	75										note: slight color change, more pinkish, numerous nodules at 13.7m	
	16.8	HQ			100		65										note: low RQD values in zones due to mechanical breaks	
																	note: discontinuity spacing resultant from mechanical breaks & relatively soft rock mass in some zones	
	16																Stopped HQ Coring at 15.4m	

GROUNDWATER

DEPTH (m)	HOUR	DATE

BORING OPERATION

B - BDBGM 51mm O.D. Wireline Rock Coring
 BWC - B-size casing
 HQ - 96mm O.D. Wireline Rock Coring
 NQ - 71mm O.D. Wireline Rock Coring
 S - 51mm O.D./35mm I.D. Tube Sample
 D - Disturbed Bulk Sample



JOB NO. 17-2013-4030 DATE 10/4/13

LOCATION N. 4001377.29
E. 675666.1267
RIG TYPE CME-85 Buggy Mounted
BORING TYPE 203mm Hollow Stem Auger
SURFACE ELEV. 2232.6m
DATUM GPS NAD 83 - UTM Zone 12

Depth in Meters	Blows per 152 mm	Graphical Log	Sample	Sample Type	Blow Counts	Dry Density Kg. per Cubic meter	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				A				SC	slightly moist	Asphalt CLAYEY SAND , trace silt, predominantly fine grained sand, calcareous, low to medium plasticity, brown
1									firm	
2				S	12-12-12			CL-ML	slightly moist	note: reacts to HCl SILTY CLAY , occasional fine grained gravel, predominantly medium to fine grained, subangular sand, low to medium plasticity, reddish-brown
3				S	10-15-20			CL		note: does not react with HCl
4									very firm	SANDY CLAY , trace silt, trace predominantly fine grained gravel, considerable fine to medium grained sand, medium plasticity, reddish-brown
5				U	24-50/152mm	1855	10			note: does not react with HCl
6				S	35-50/152mm			GM	wet	SILTY GRAVEL WITH SAND , some to considerable predominantly fine to medium grained sand, fine to coarse grained gravel, nonplastic, red & green
7									hard	
8				S	9-10-30			SM	wet	note: does not react with HCl SILTY SAND , some clay, predominantly fine grained sand, nonplastic
9									very firm	note: does not react with HCl
10				S	50/51mm			ML	slightly moist	SANDY SILT , trace clay, some fine grained sand, low plasticity, reddish-orange
11				S	50/76mm			CL-ML	slightly moist	SILTY CLAY , some clay, considerable silt, calcareous, medium plasticity, light reddish-brown
12				U	50/102mm				hard	note: reacts to HCl
13										Stopped Auger 11.9m Sampler refused at 12.0m Began HQ Coring at 11.9m
14										
15										

GROUNDWATER

DEPTH (m)	HOUR	DATE
4.6	09:30	10-4-13

SAMPLE TYPE

A - Auger cuttings; NR-No Recovery
S - 51mm O.D. 35mm I.D. tube sample.
U - 76mm O.D. 61mm I.D. tube sample.
T - 25mm O.D. thin-walled tube sample

PROJECT

BIA Project N12 (12-2) (19-2) 2 & 4
Navajo, New Mexico to N64 Junction, Arizona



JOB NO.

17-2013-4030

DATE

10-4-13

RIG TYPE CME-85 Buggy Mounted

METHOD HQ Wireline

OPERATOR CasCade Drilling

LOGGED BY Reed Seamons

LOCATION N. 4001377.29

E. 675666.1267

ELEVATION 2232.6m

DATUM GPS NAD 83 - UTM Zone 12

INCLINATION Vertical

Boring Operation and Drill Rate (min/meter)	Depth in Meter	Sample	Sample Type	Unconfined Compression of Point Load Index Test (KPa)	% Core Recovery	% Drilling Fluid/Air Rec.	Rock Quality Designation (RQD)	DISCONTINUITIES							Condition	Bedding and/or Fabric	Weathering or USCS (Soils)	Rock Type & Remarks
								Spacing					Orientation					
								Wide - Close					Horiz - Vert					
								1	2	3	4	5	H	45				
10/4	12	HQ			50	100	0								N/A	TL to L	SIW to MdW	Began HQ Coring at 11.9m
HQ22.0	21.0	HQ			100		20											CHINLE FORMATION CALCAREOUS SILTSTONE , moderately soft to moderately hard, reddish-brown with greenish-gray note: nodules are lighter & gray color of the brown silt note: some turbidites in zones below 15.2m note: clay-rich zones
	8.2	HQ			100		90											
	8.2	HQ			100		45											
	7.8	HQ		12844	90		80											
	9.3	HQ			100		95											
	19																	Stopped HQ Coring at 18.3m note: low RQD values in zones due to mechanical breaks note: discontinuity spacing resultant from mechanical breaks & relatively soft rock mass in some zones

GROUNDWATER

DEPTH (m)	HOUR	DATE

BORING OPERATION

B - BDBGM 51mm O.D. Wireline Rock Coring
 BWC - B-size casing
 HQ - 96mm O.D. Wireline Rock Coring
 NQ - 71mm O.D. Wireline Rock Coring
 S - 51mm O.D./35mm I.D. Tube Sample
 D - Disturbed Bulk Sample



JOB NO. 17-2013-4030 DATE 10/16/13

LOCATION N. 4001347.19
E. 675688.7639
RIG TYPE CME-85 Buggy Mounted
BORING TYPE 203mm Hollow Stem Auger
SURFACE ELEV. 2233.0m
DATUM GPS NAD 83 - UTM Zone 12

Depth in Meters	Blows per 152 mm	Graphical Log	Sample	Sample Type	Blow Counts	Dry Density Kg. per Cubic meter	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				A				CL-ML	moist	SANDY SILTY CLAY , occasional fine grained, subangular gravel, considerable predominantly fine grained sand, low plasticity, brown note: does not react with HCl
1									moderately firm	
2				S 3-5-7						
3				S 4-6-8				ML	slightly moist	SANDY SILT , trace clay, considerable predominantly fine grained sand, low plasticity, reddish-brown note: does not react with HCl
4									moderately firm	
5				U 51						
6				S 10-18-22				GP-GM	wet	SANDY GRAVEL WITH SILT , considerable predominantly fine grained sand, angular to subangular gravel, nonplastic, grayish-brown note: does not react with HCl
7									very firm	
8				S 4-6-9				SP-SM	wet	SAND WITH SILT & GRAVEL , some fine grained, subangular to subrounded gravel, predominantly medium to fine grained sand, nonplastic, gray note: does not react with HCl
9									firm	
10				S 24-50/102mm				SM	hard	SILTY SAND WITH GRAVEL , considerable predominantly fine grained gravel, considerable predominantly fine to medium grained sand, nonplastic, brown
11				S 25-50/102mm				SC-SM	slightly moist	SILTY CLAYEY SAND WITH GRAVEL , considerable predominantly fine grained gravel, predominantly fine to coarse grained sand, low plasticity, brown note: does not react with HCl
12									hard	
13										
14										Stopped Auger at 10.7m Sampler refused at 10.9m Began HQ Coring at 10.7m
15										

GROUNDWATER

DEPTH (m)	HOUR	DATE
5.6	16:20	10-16-13

SAMPLE TYPE

A - Auger cuttings; NR-No Recovery
S - 51mm O.D. 35mm I.D. tube sample.
U - 76mm O.D. 61mm I.D. tube sample.
T - 25mm O.D. thin-walled tube sample

PROJECT

BIA Project N12 (12-2) (19-2) 2 & 4
 Navajo, New Mexico to N64 Junction, Arizona



JOB NO. 17-2013-4030 **DATE** 10-17-13

RIG TYPE CME-85 Buggy Mounted
METHOD HQ Wireline
OPERATOR CasCade Drilling
LOGGED BY Reed Seamons
LOCATION N. 4001347.19
 E. 675688.7639
ELEVATION 2233.0m
DATUM GPS NAD 83 - UTM Zone 12
INCLINATION Vertical

Boring Operation and Drill Rate (min/meter)	Depth in Meter	Sample	Sample Type	Unconfined Compression of Point Load Index Test (KPa)	% Core Recovery	% Drilling Fluid/Air Rec.	Rock Quality Designation (RQD)	DISCONTINUITIES									Condition	Bedding and/or Fabric	Weathering or USCS (Soils)	Rock Type & Remarks
								Spacing					Orientation							
								Wide - Close					Horiz - Vert							
								1	2	3	4	5	H	45	V					
																	Began HQ Coring at 10.7m			
10/17 HQ 5.8	11	HQ			0	100	0	NO RECOVERY	NO RECOVERY					Smth Stn	L to LT	MdW	CHINLE FORMANTION CALCAREOUS SILTSTONE , moderately soft to moderately hard, brown to dark brown note: chemical reduction spots, some clay in zones, brown to reddish-brown note: small 76mm to 127mm thick zones of calcified nodules from 11.7m to 15.4m			
	15.5	HQ			75		0	BROKEN									note: occasional near-vertical calcite-healed fracture at 13.7m note: fracture surfaces calcite filled or stained at 14.0m note: soft (decomposed zone to clay) from 15.1m to 15.2m note: hard to very hard silicified zone from 15.5m to 16.0m note: occasional thin turbidite zone 16.0m			
	11.6	HQ	18623		75	80	20									SIW to MdW				
	12.0	HQ			50		15	BROKEN						SRgh						
	24.1	HQ			70		30	BROKEN						Smth Stn		Dec SIW				
	16		40142																	
	17																Stopped HQ Coring at 16.8m note: low RQD values in zones due to mechanical breaks note: discontinuity spacing resultant from mechanical breaks & relatively soft rock mass in some zones			

GROUNDWATER		
DEPTH (m)	HOUR	DATE

BORING OPERATION
 B - BDBGM 51mm O.D. Wireline Rock Coring
 BWC - B-size casing
 HQ - 96mm O.D. Wireline Rock Coring
 NQ - 71mm O.D. Wireline Rock Coring
 S - 51mm O.D./35mm I.D. Tube Sample
 D - Disturbed Bulk Sample

LOG OF TEST BORING NO. N503-B-3



JOB NO. 17-2013-4030 DATE 10/18/13

LOCATION N. 4001355.992
E. 675692.5248
RIG TYPE CME-85 Buggy Mounted
BORING TYPE 203mm Hollow Stem Auger
SURFACE ELEV. 2231.7m
DATUM GPS NAD 83 - UTM Zone 12

Depth in Meters	Blows per 152 mm	Graphical Log	Sample	Sample Type	Blow Counts	Dry Density Kg. per Cubic meter	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				A				SC	slightly moist	Asphalt CLAYEY SAND , predominantly fine grained sand, low plasticity, brown note: does not react with HCl
1										
2				S	4-8-10			SM	slightly moist firm	SILTY SAND , rare cobbles, considerable silt, predominantly fine grained sand, trace predominantly fine grained gravel, nonplastic, brown note: strong reaction with HCl
3				U	55	1885	10			
4										
5				S	3-3-6			GM	moist moderately firm	SILTY SANDY GRAVEL , considerable predominantly fine to medium grained sand, predominantly fine grained gravel, nonplastic, brown note: does not react with HCl
6				S	12-7-7			SM	wet moderately firm	SILTY SAND , considerable silt, predominantly fine grained sand, nonplastic, brown note: does not react with HCl
7										
8				S	4-9-10			SP	wet very stiff	SAND WITH GRAVEL , considerable predominantly fine to coarse grained, angular to subangular gravel, predominantly fine to medium grained sand, nonplastic, dark gray note: does not react with HCl
9				U	41			SM	wet hard	SILTY SAND WITH GRAVEL , some to considerable angular to subangular gravel, predominantly medium grained sand, nonplastic, light brown note: does not react with HCl
10										
11										Stopped Auger at 10.5m Began HQ Coring at 10.5m
12										
13										
14										
15										

GROUNDWATER

DEPTH (m)	HOUR	DATE
5.5	12:30	10-18-13

SAMPLE TYPE

A - Auger cuttings; NR-No Recovery
S - 51mm O.D. 35mm I.D. tube sample.
U - 76mm O.D. 61mm I.D. tube sample.
T - 25mm O.D. thin-walled tube sample

PROJECT

BIA Project N12 (12-2) (19-2) 2 & 4
Navajo, New Mexico to N64 Junction, Arizona



JOB NO.

17-2013-4030

DATE

10-18-13

RIG TYPE

CME-85 Buggy Mounted

METHOD

HQ Wireline

OPERATOR

CasCade Drilling

LOGGED BY

Reed Seamons

LOCATION

N. 4001355.992

E. 675692.5248

ELEVATION

2231.7m

DATUM

GPS NAD 83 - UTM Zone 12

INCLINATION

Vertical

Boring Operation and Drill Rate (min/meter)	Depth in Meter	Sample	Sample Type	Unconfined Compression of Point Load Index Test (KPa)	% Core Recovery	% Drilling Fluid/Air Rec.	Rock Quality Designation (RQD)	DISCONTINUITIES									Condition	Bedding and/or Fabric	Weathering or USCS (Soils)	Rock Type & Remarks
								Spacing					Orientation							
								Wide - Close					Horiz - Vert							
								1	2	3	4	5	H	45	V					
10/18																		Bagan HQ Coring at 10.5m		
NQ14.0	12.6	HQ	HQ		0	100	0	NO RECOVERY					NO RECOVERY			SRgh Cln	L to TL	SIW	CHINLE FORMATION CALCAREOUS SILTSTONE , moderately hard, reddish-brown note: greenish-gray reduction spots note: clay-rich zones note: calcium carbonate nodules up to 2.5mm long below 11.0m	
	17.4	HQ			65		25													
	17.4	HQ			90		80													
	17.4			31202																
10/19	20.1	HQ			100	95	95													
	22.2	HQ			90		85												note: very hard silicified zone & turbidite with angular clasts from 16.0m to 16.3m	
	22.2			32531																
	17																		Stopped HQ Coring at 16.8m note: low RQD values in zones due to mechanical breaks note: discontinuity spacing resultant from mechanical breaks & relatively soft rock mass in some zones	

GROUNDWATER

DEPTH (m)	HOUR	DATE

BORING OPERATION

B - BDBGM 51mm O.D. Wireline Rock Coring
BWC - B-size casing
HQ - 96mm O.D. Wireline Rock Coring
NQ - 71mm O.D. Wireline Rock Coring
S - 51mm O.D./35mm I.D. Tube Sample
D - Disturbed Bulk Sample



JOB NO. 17-2013-4030 DATE 9-18-13 & 9-19-13

LOCATION N. 4011025.16
E. 669669.0039
RIG TYPE CME-85 Buggy Mounted
BORING TYPE 203mm Hollow Stem Auger
SURFACE ELEV. 2219.3m
DATUM GPS NAD 83 - UTM Zone 12

Depth in Meters	Blows per 152 mm	Graphical Log	Sample	Sample Type	Blow Counts	Dry Density Kg. per Cubic meter	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				A				SM	moist firm to hard	152mm Asphalt SILTY SAND , rare predominantly fine grained gravel, considerable predominantly fine grained sand, nonplastic, grayish-brown
1										
2										
3				U	41	1912	11			note: brown, reacts with HCl at 2.3m
4										
5				S	15-18-3					note: color change to dark grayish-brown at 4.6m, end gravel
6				S	15-38-43					
7										
8				U	23			ML	wet firm	SANDY SILT , some fine grained sand, nonplastic, light brown note: reacts with HCl
9				U	NR					
10								SP	slightly moist hard	GRAVELLY SAND , trace silt, light brown note: does not react with HCl
11										
12										
13				S	23-50/76mm			CL	moist hard	CLAY , some silt, trace fine grained sand, medium plasticity, reddish-brown note: mild reaction with HCl note: possible siltstone beginning at 12.2m
14				S	24-50/76mm					
15				S	47-50/76mm			CL		CLAY WITH SAND

GROUNDWATER

DEPTH (m)	HOUR	DATE
6.4		9-18-13

SAMPLE TYPE

A - Auger cuttings; NR-No Recovery
S - 51mm O.D. 35mm I.D. tube sample.
U - 76mm O.D. 61mm I.D. tube sample.
T - 25mm O.D. thin-walled tube sample



JOB NO. 17-2013-4030 **DATE** 9-18-13 & 9-19-13

LOCATION N. 4011025.16
E. 669669.0039
RIG TYPE CME-85 Buggy Mounted
BORING TYPE 203mm Hollow Stem Auger
SURFACE ELEV. 2219.3m
DATUM GPS NAD 83 - UTM Zone 12

Depth in Meters	Blows per 152 mm	Graphical Log	Sample	Sample Type	Blow Counts	Dry Density Kg. per Cubic meter	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
16								CL		CLAY WITH SAND , some to considerable predominantly fine to medium grained sand, medium plasticity, reddish-brown note: does not react with HCl
17			U	28-50/ 76mm						
18										
19			S	50/ 140mm				MH	moist hard	CLAYEY SILT , considerable clay, medium plasticity, reddish-brown note: no reaction to HCl note: color change to brown at 19.8m note: color change to brown to reddish-brown at 21.3m note: color change to brown at 24.4m
20										
21			S	50/ 140mm						
22			U	38-50/ 152mm						
23			S	50/ 102mm						
24										
25			S	50/ 140mm				CH	moist hard	SILTY CLAY , high plasticity, brown note: does not react with HCl
26			U	50/ 140mm						
27										
28			S	50/ 140mm				MH	slightly moist hard	CLAYEY SILT , high plasticity, reddish-brown note: does not react with HCl
29			S	50/ 140mm						
30										
31			S	50/ 140mm						Stopped Auger at 30.5m Sampler refused at 30.6m

GROUNDWATER

DEPTH (m)	HOUR	DATE
6.4		9-18-13

SAMPLE TYPE

A - Auger cuttings; NR-No Recovery
S - 51mm O.D. 35mm I.D. tube sample.
U - 76mm O.D. 61mm I.D. tube sample.
T - 25mm O.D. thin-walled tube sample



JOB NO. 17-2013-4030 DATE 9/21/13

LOCATION N. 4011028.254
E. 669673.9659
RIG TYPE CME-85 Buggy Mounted
BORING TYPE 203mm Hollow Stem Auger
SURFACE ELEV. 2218.6m
DATUM GPS NAD 83 - UTM Zone 12

Depth in Meters	Blows per 152 mm	Graphical Log	Sample	Sample Type	Blow Counts	Dry Density Kg. per Cubic meter	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				A				SM	slightly moist firm to hard	152mm Asphalt SILTY SAND , predominantly medium grained sand, nonplastic, dark grayish-brown note: no reaction with HCl
1										
2			X	S	6-11-11					note: mild reaction with HCl, color change to black to brown at 1.5m
3				U	60					note: little to no reaction with HCl at 3.0m note: predominantly fine grained sand
4										
5			X	S	11-22-25					note: mild to moderate reaction with HCl at 4.6m
6			X	S	13-13-14					note: mild reaction with HCl, color change to dark brown at 6.1m
7										
8			X	S	11-14-11					note: color change brown at 7.6m
9				U	33					note: considerable subrounded gravel, predominantly medium grained sand, light brown, no reaction with HCL at 9.1m
10										
11			X	S	22-50/140mm					note: some rounded gravel, predominantly medium to fine grained sand, trace micaceous siltstone at 10.7m
12			X	S	50/140mm					
13								ML		CLAYEY SILT , nonplastic, purple to reddish-brown note: very mild reaction with HCl
14			X	S	50/127mm					note: possible siltstone beginning at 12.5m
15			X	S	50/127mm					

GROUNDWATER

SAMPLE TYPE

DEPTH (m)	HOUR	DATE
7.6		9-21-13

A - Auger cuttings; NR-No Recovery
S - 51mm O.D. 35mm I.D. tube sample.
U - 76mm O.D. 61mm I.D. tube sample.
T - 25mm O.D. thin-walled tube sample



JOB NO. 17-2013-4030 **DATE** 9/21/13

LOCATION N. 4011028.254
 E. 669673.9659
RIG TYPE CME-85 Buggy Mounted
BORING TYPE 203mm Hollow Stem Auger
SURFACE ELEV. 2218.6m
DATUM GPS NAD 83 - UTM Zone 12

Depth in Meters	Blows per 152 mm	Graphical Log	Sample	Sample Type	Blow Counts	Dry Density Kg. per Cubic meter	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
16								ML		CLAYEY SILT, continued
17			S	50/140mm						
18			U	50/127mm						note: color change to brown at 18.3m
19										
20			S	50/140mm				CH	moist	SILTY CLAY, high plasticity, brown note: no reaction with HCl
21									hard	
22			U	50/140mm				MH	moist	CLAYEY SILT, brown to reddish-brown note: mild reaction with HCl
23			S	50/152mm					hard	
24										note: no reaction with HCl, color change to brown at 22.9m
25			S	50/140mm						
26			U	50/127mm						
27										
28			S	50/127mm						Stopped Auger at 28.2m
29										
30										
31										

GROUNDWATER

DEPTH (m)	HOUR	DATE
7.6		9-21-13

SAMPLE TYPE

- A - Auger cuttings; NR-No Recovery
- S - 51mm O.D. 35mm I.D. tube sample.
- U - 76mm O.D. 61mm I.D. tube sample.
- T - 25mm O.D. thin-walled tube sample



JOB NO. 17-2013-4030 **DATE** 9-17-13 & 9-18-13

LOCATION N. 4010994.663
E. 669688.928
RIG TYPE CME-85 Buggy Mounted
BORING TYPE 203mm Hollow Stem Auger
SURFACE ELEV. 2219.0m
DATUM GPS NAD 83 - UTM Zone 12

Depth in Meters	Blows per 152 mm	Graphical Log	Sample	Sample Type	Blow Counts	Dry Density Kg. per Cubic meter	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				A				CL-ML	slightly moist hard	SANDY SILTY CLAY , occasional fine grained gravel, considerable predominantly fine grained sand, low plasticity, brown note: moderate reaction with HCl note: almost no reaction with HCL at 1.5m
1				U	12-22-20/ 127mm					
2				S	12-29-50/ 127mm					
3				S	12-26-50			SC	moist hard	CLAYEY SAND WITH GRAVEL , some coarse grained gravel, predominantly fine grained sand, medium plasticity, purple note: does not react with HCl
4				S	12-36-50/ 76mm					
5				S	15-15-23			SM	moist very firm	SILTY SAND , predominantly fine grained sand, considerable silt, nonplastic, brown note: well graded, fine grained sand note: does not react with HCl
6				U	31					
7				S	12-15-23					
8				S	31-50/ 127mm			ML	moist hard	CLAYEY SILT , low plasticity, reddish-brown note: slight reaction with HCl note: no reaction with HCl, color change to red at 12.2m note: possible siltstone beginning at 10.7m
9				S	42-50/ 127mm					
10				U	30-50/ 76mm					
11				S						

GROUNDWATER

SAMPLE TYPE

DEPTH (m)	HOUR	DATE
7.6		9-17-13

A - Auger cuttings; NR-No Recovery
S - 51mm O.D. 35mm I.D. tube sample.
U - 76mm O.D. 61mm I.D. tube sample.
T - 25mm O.D. thin-walled tube sample



JOB NO. 17-2013-4030 **DATE** 9-17-13 & 9-18-13

LOCATION N. 4010994.663
E. 669688.928
RIG TYPE CME-85 Buggy Mounted
BORING TYPE 203mm Hollow Stem Auger
SURFACE ELEV. 2219.0m
DATUM GPS NAD 83 - UTM Zone 12

Depth in Meters	Blows per 152 mm	Graphical Log	Sample	Sample Type	Blow Counts	Dry Density Kg. per Cubic meter	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
16								ML	moist hard	CLAYEY SILT , continued, dark brown note: medium plasticity, reddish-brown at 16.8m note: some medium to fine grained sand, color change to red at 18.3m
17			X	S	23-50/ 102mm					
18				U	24-50/ 127mm					
19										
20			X	S	24-50/ 127mm			MH	wet hard	CLAYEY SILT , high plasticity, reddish-brown note: does not react with HCl
21			X	S	50/ 140mm					
22										
23			X	S	40-50/ 76mm			ML	wet hard	CLAYEY SILT WITH SAND , some fine grained sand, low plasticity, red note: does not react with HCl
24				U	30-50/ 127mm			MH	moist hard	
25										
26			X	S	40-50/ 127mm			CH	wet hard	SILTY CLAY , high plasticity, brown to light red note: does not react with HCl
27										
28			X	S	38-50/ 127mm					
29			X	S	48-50/ 127mm					
30				U	28-50/ 102mm					
31										Stopped Auger at 30.5m Sampler refused at 30.6m

GROUNDWATER

SAMPLE TYPE

DEPTH (m)	HOUR	DATE
7.6		9-17-13

A - Auger cuttings; NR-No Recovery
S - 51mm O.D. 35mm I.D. tube sample.
U - 76mm O.D. 61mm I.D. tube sample.
T - 25mm O.D. thin-walled tube sample



JOB NO. 17-2013-4030 DATE 9/20/13

LOCATION N. 4010998.746
E. 669695.8424
RIG TYPE CME-85 Buggy Mounted
BORING TYPE 203mm Hollow Stem Auger
SURFACE ELEV. 2217.5m
DATUM GPS NAD 83 - UTM Zone 12

Depth in Meters	Blows per 152 mm	Graphical Log	Sample	Sample Type	Blow Counts	Dry Density Kg. per Cubic meter	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				A				SM	slightly moist	152mm Asphalt SILTY SAND , some calcium carbonate, nonplastic, dark grayish-brown
1										
2				S	5-9-6			CL	slightly moist moderately firm	SANDY CLAY , trace silt, considerable predominantly fine grained sand, medium plasticity, brown note: moderate reaction with HCl
3				S	5-19-29			SM	moist very firm	SILTY SAND , trace clay & gravel, predominantly fine grained sand, nonplastic note: no reaction with HCl at 4.6m
4										
5				U	59	1962	8			
6				S	5-29-28				hard	note: predominantly fine grained sand, moderate reaction with HCl at 6.1m
7										
8				S	12-22-29			SP-SM	wet hard to firm	SAND WITH SILT & GRAVEL , considerable predominantly fine grained gravel, predominantly fine grained sand, nonplastic, light brown to brown note: predominantly medium to fine grained sand, dark brown at 9.1m note: does not react with HCl
9				U	26					
10										
11				S	9-22-30					
12										
13				S	12-50/ 152mm			ML	moist hard	CLAYEY SILT , medium plasticity, reddish-brown note: mild reaction with HCl note: possible siltstone beginning at 12.2m
14				S	24-50/ 140mm					
15				S	50/					

GROUNDWATER

DEPTH (m)	HOUR	DATE
7.6		9-20-13

SAMPLE TYPE

A - Auger cuttings; NR-No Recovery
S - 51mm O.D. 35mm I.D. tube sample.
U - 76mm O.D. 61mm I.D. tube sample.
T - 25mm O.D. thin-walled tube sample



JOB NO. 17-2013-4030 **DATE** 9/20/13

LOCATION N. 4010998.746
 E. 669695.8424
RIG TYPE CME-85 Buggy Mounted
BORING TYPE 203mm Hollow Stem Auger
SURFACE ELEV. 2217.5m
DATUM GPS NAD 83 - UTM Zone 12

Depth in Meters	Blows per 152 mm	Graphical Log	Sample	Sample Type	Blow Counts	Dry Density Kg. per Cubic meter	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
16					152mm			ML	moist	CLAYEY SILT , continued note: reddish-brown note: marbled brown colors at 18.3m note: moderate reaction with HCl at 19.8m note: little to no reaction with HCl, color change to brown at 21.3m note: no reaction with HCl at 22.9m
17			U	50/	140mm				hard	
18										
19			S	50/	152mm					
20			S	50/	152mm					
21			S	50/	140mm					
22										
23			U	13-28-50/	102mm					
24										
25			S	50/	127mm					
26			S	50/	102mm					
27										
28			U	28-50/	127mm					
29			S	50/	152mm					
30			S	50/	152mm					
31										Stopped Auger at 30.5m Sampler refused at 30.6m

GROUNDWATER

SAMPLE TYPE

DEPTH (m)	HOUR	DATE
7.6		9-20-13

A - Auger cuttings; NR-No Recovery
 S - 51mm O.D. 35mm I.D. tube sample.
 U - 76mm O.D. 61mm I.D. tube sample.
 T - 25mm O.D. thin-walled tube sample



JOB NO. 17-2013-4030 **DATE** 10/3/13

LOCATION N. 4016770.864
E. 663792.2072
RIG TYPE CME-85 Buggy Mounted
BORING TYPE 203mm Hollow Stem Auger
SURFACE ELEV. 2168.9m
DATUM GPS NAD 83 - UTM Zone 12

Depth in Meters	Blows per 152 mm	Graphical Log	Sample	Sample Type	Blow Counts	Dry Density Kg. per Cubic meter	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				A				SC	slightly moist	CLAYEY SAND WITH GRAVEL , predominantly fine grained sand, calcareous, low to medium plasticity, grayish-brown note: moderate reaction with HCl note: considerable silt
1									hard	
2				U 25-50/140mm						
3				S 50/102mm				GC	slightly moist	CLAYEY GRAVEL WITH SAND , trace silt, considerable fine grained sand, predominantly coarse grained gravel note: does not react with HCl
4									hard	
5										Stopped Auger at 4.3m Began HQ Coring at 4.3m
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										

GROUNDWATER

DEPTH (m)	HOUR	DATE
▽	none	
▼		

SAMPLE TYPE

- A - Auger cuttings; NR-No Recovery
- S - 51mm O.D. 35mm I.D. tube sample.
- U - 76mm O.D. 61mm I.D. tube sample.
- T - 25mm O.D. thin-walled tube sample

PROJECT

BIA Project N12 (12-2) (19-2) 2 & 4
Navajo, New Mexico to N64 Junction, Arizona



JOB NO.

17-2013-4030

DATE

10-3-13

RIG TYPE

CME-85 Buggy Mounted

METHOD

HQ Wireline

OPERATOR

CasCade Drilling

LOGGED BY

Reed Seamons

LOCATION

N. 4016770.864

E. 663792.2072

ELEVATION

2168.9m

DATUM

GPS NAD 83 - UTM Zone 12

INCLINATION

Vertical

Boring Operation and Drill Rate (min/meter)	Depth in Meter	Sample	Sample Type	Unconfined Compression of Point Load Index Test (KPa)	% Core Recovery	% Drilling Fluid/Air Rec.	Rock Quality Designation (RQD)	DISCONTINUITIES									Condition	Bedding and/or Fabric	Weathering or USCS (Soils)	Rock Type & Remarks
								Spacing					Orientation							
								Wide - Close					Horiz - Vert							
								1	2	3	4	5	H	45	V					
	4																	Began HQ Coring at 4.3m		
10/3 HQ 0.3		HQ			75	100	25								SRgh	VTb Fgn	SIW	CHINLE FORMATION SANDSTONE , fine grained, well sorted, moderately hard to hard, friable note: quartz arenite, fine grained (colorless & tan) clear quartz, slight SiO2 overgrowths, light tan to medium tan, gray tan		
	5																			
4.2		HQ			65		30								SRgh Stn	TL to L occ Mgn to Cgn zones		note: bedding dips range from 7° to 15° note: some clay filled worm burroughs note: some fracture surfaces stained with iron-oxide		
	6																			
4.2		HQ		43733	100		0								MRgh to SRgh Stn	TL to L		note: some fabric stained in zones with iron-oxide		
	7																			
	8																			
4.0		HQ			100		25								SRgh Cln step-like features		SIW	note: some worm burroughs below 9.0m note: occasional medium to coarse grained zones throughout		
	9																			
	10																			
3.5		HQ			80		30								SRgh Cln step-like features	TL to L		note: low to zero RQD values due to mechanical breaks along bedding planes note: water used while coring, therefore unknown if groundwater encountered		
	11																	Stopped HQ Coring at 10.7m note: low RQD values in zones due to mechanical breaks note: discontinuity spacing resultant from mechanical breaks & relatively soft rock mass in some zones		

GROUNDWATER

DEPTH (m)	HOUR	DATE
	none	

BORING OPERATION

B - BDBGM 51mm O.D. Wireline Rock Coring
BWC - B-size casing
HQ - 96mm O.D. Wireline Rock Coring
NQ - 71mm O.D. Wireline Rock Coring
S - 51mm O.D./35mm I.D. Tube Sample
D - Disturbed Bulk Sample



JOB NO. 17-2013-4030 DATE 10/3/13

LOCATION N. 4016778.682
E. 663798.5613
RIG TYPE CME-85 Buggy Mounted
BORING TYPE 203mm Hollow Stem Auger
SURFACE ELEV. 2168.7m
DATUM GPS NAD 83 - UTM Zone 12

Depth in Meters	Blows per 152 mm	Graphical Log	Sample	Sample Type	Blow Counts	Dry Density Kg. per Cubic meter	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				A				SC	slightly moist very firm to hard	CLAYEY SAND WITH GRAVEL , trace subangular to subrounded gravel, predominantly fine grained sand, low to medium plasticity, light grayish-tan note: moderate reaction with HCl note: increase plasticity & increase in clay note: little to no reaction with HCl, color change to light green
1										
2				S 17-17-14						
3				U 60						
4				S 50/76mm						
5									Stopped Auger at 4.3m Began HQ Coring at 4.3m	
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										

GROUNDWATER

DEPTH (m)	HOUR	DATE
▽	none	
▼		

SAMPLE TYPE

- A - Auger cuttings; NR-No Recovery
- S - 51mm O.D. 35mm I.D. tube sample.
- U - 76mm O.D. 61mm I.D. tube sample.
- T - 25mm O.D. thin-walled tube sample

PROJECT

BIA Project N12 (12-2) (19-2) 2 & 4
Navajo, New Mexico to N64 Junction, Arizona



JOB NO. 17-2013-4030 **DATE** 10-3-13

RIG TYPE CME-85 Buggy Mounted
METHOD HQ Wireline
OPERATOR CasCade Drilling
LOGGED BY Reed Seamons
LOCATION N. 4016778.682
E. 663798.5613
ELEVATION 2168.7m
DATUM GPS NAD 83 - UTM Zone 12
INCLINATION Vertical

Boring Operation and Drill Rate (min/meter)	Depth in Meter	Sample	Sample Type	Unconfined Compression of Point Load Index Test (KPa)	% Core Recovery	% Drilling Fluid/Air Rec.	Rock Quality Designation (RQD)	DISCONTINUITIES									Condition	Bedding and/or Fabric	Weathering or USCS (Soils)	Rock Type & Remarks
								Spacing					Orientation							
								Wide - Close					Horiz - Vert							
								1	2	3	4	5	H	45	V					
	4																Began HQ Coring at 4.3m			
10/3 HQ 5.3		HQ			80	100	45							None	L to ThB Fgn to Mgn	SIW to MdW	CHINLE FORMATION SANDSTONE , quartz arenite, well sorted, medium to fine grained, moderately hard to hard, trace red & black (opaque) grains, predominate colorless & yellow clear quartz, grayish-tan to tan note: cross-bedded in zones			
2.4		HQ			0		0	NO RECOVERY												
	5																			
4.0		HQ			5		0								Fgn		note: predominantly fine grained sandstone at 6.2m			
	6																			
	7																note: some variably-oriented partially open fractures at 7.3m			
1.6		HQ			25		70								MB in zones		note: some small diameter roots along fracture bedding surfaces 8.8m			
	8																			
3.0		HQ			5		0	NO RECOVERY						ThB to L with MB zones		note: low to no RQD values due to poor recovery percentages and/or mechanical breaks along bedding planes at 9.4m				
	9																			
4.0		HQ			90		20							SRgh Stn	L to TL	SIW to MdW	note: occasional black manganese & brown, iron-oxide staining on fabric & fracture surfaces below 9.1m			
	10																			
	11																			

GROUNDWATER		
DEPTH (m)	HOUR	DATE
	none	

BORING OPERATION
 B - BDBGM 51mm O.D. Wireline Rock Coring
 BWC - B-size casing
 HQ - 96mm O.D. Wireline Rock Coring
 NQ - 71mm O.D. Wireline Rock Coring
 S - 51mm O.D./35mm I.D. Tube Sample
 D - Disturbed Bulk Sample

LOG OF TEST BORING NO. N505-B-2



JOB NO. 17-2013-4030 DATE 9/24/13

LOCATION N. 4016751.141
E. 663816.675
RIG TYPE CME-85 Buggy Mounted
BORING TYPE 203mm Hollow Stem Auger
SURFACE ELEV. 2169.5m
DATUM GPS NAD 83 - UTM Zone 12

Depth in Meters	Blows per 152 mm	Graphical Log	Sample	Sample Type	Blow Counts	Dry Density Kg. per Cubic meter	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION	
0				A				CL	slightly moist firm to hard	SANDY CLAY WITH GRAVEL , some fine grained gravel to rare moderately calcareous, considerable predominantly fine grained sand, medium plasticity, light grayish-tan note: decrease gravel, brown, medium plasticity note: does not react with HCl	
1				S	6-8-12						
2											
3					U	50/ 127mm					
4											
5										Stopped Auger at 4.4m Began HQ Coring at 4.4m	
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											

GROUNDWATER

DEPTH (m)	HOUR	DATE
▽	none	
▼		

SAMPLE TYPE

- A - Auger cuttings; NR-No Recovery
- S - 51mm O.D. 35mm I.D. tube sample.
- U - 76mm O.D. 61mm I.D. tube sample.
- T - 25mm O.D. thin-walled tube sample

PROJECT

BIA Project N12 (12-2) (19-2) 2 & 4
Navajo, New Mexico to N64 Junction, Arizona



JOB NO. 17-2013-4030 **DATE** 9-24-13

RIG TYPE CME-85 Buggy Mounted
METHOD HQ Wireline
OPERATOR CasCade Drilling
LOGGED BY Reed Seamons
LOCATION N. 4016751.141
E. 663816.675
ELEVATION 2168.5m
DATUM GPS NAD 83 - UTM Zone 12
INCLINATION Vertical

Boring Operation and Drill Rate (min/meter)	Depth in Meter	Sample	Sample Type	Unconfined Compression of Point Load Index Test (KPa)	% Core Recovery	% Drilling Fluid/Air Rec.	Rock Quality Designation (RQD)	DISCONTINUITIES							Condition	Bedding and/or Fabric	Weathering or USCS (Soils)	Rock Type & Remarks
								Spacing					Orientation					
								Wide - Close					Horiz - Vert					
								1	2	3	4	5	H	45				
																Began HQ Coring at 4.4m		
9/24 HQ 4.5	5	HQ			50	100	0						SRgh Stn	ThB to L Fgn	MdW	CHINLE FORMATION SANDSTONE , quartz arenite, well sorted, medium to fine grained, moderately hard to hard, trace red & black grains note: worm burroughs & clay fill to 5.5m note: considerable micaceous laminae		
4.0	5	HQ			70		25								SIW	note: some predominantly high-angle partially open fractures at 6.1m note: bedding dips variable from subhorizontal up to 15° at 6.9m		
				42314														
4.0	7	HQ			100		20						MRgh Step-like Features to Partially Stn	L		note: considerable brown, iron-oxide staining along some fracture surfaces & in fabric in zones at 7.6m		
3.8	8	HQ			95		50							MB		note: clay-rich laminae from 9.0m to 9.3m note: considerable black, manganese-oxide staining on trace surfaces from 9.6m to 10.2m note: some worm burroughs below 10.2m		
4.0	10	HQ			100		20									note: low RQD values in zones due to mechanical breaks note: discontinuity spacing resultant from mechanical breaks & relatively soft rock mass in some zones note: water used while coring, therefore unknown if groundwater encountered		
	11			24694												Stopped HQ Coring at 11.1m		

GROUNDWATER		
DEPTH (m)	HOUR	DATE
	none	

BORING OPERATION
B - BDBGM 51mm O.D. Wireline Rock Coring
BWC - B-size casing
HQ - 96mm O.D. Wireline Rock Coring
NQ - 71mm O.D. Wireline Rock Coring
S - 51mm O.D./35mm I.D. Tube Sample
D - Disturbed Bulk Sample

LOG OF TEST BORING NO. N505-B-3



JOB NO. 17-2013-4030 **DATE** 9/22/13

LOCATION N. 4016759.232
 E. 663822.9862
RIG TYPE CME-85 Buggy Mounted
BORING TYPE 203mm Hollow Stem Auger
SURFACE ELEV. 2168.1m
DATUM GPS NAD 83 - UTM Zone 12

Depth in Meters	Blows per 152 mm	Graphical Log	Sample	Sample Type	Blow Counts	Dry Density Kg. per Cubic meter	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				A				CL		SANDY CLAY , trace fine grained, rounded gravel, predominantly medium to fine grained sand, medium plasticity, dark brown note: moderate reaction with HCl
1										
2				U	36			SM		SILTY SAND , trace subrounded gravel, considerable silt, predominantly fine grained sand, nonplastic, tan note: strong effervesence with HCl
3									firm	
4										Stopped Auger at 2.7m Began HQ Coring at 2.7m
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										

GROUNDWATER

DEPTH (m)	HOUR	DATE
▽	none	
▼		

SAMPLE TYPE

- A - Auger cuttings; NR-No Recovery
- S - 51mm O.D. 35mm I.D. tube sample.
- U - 76mm O.D. 61mm I.D. tube sample.
- T - 25mm O.D. thin-walled tube sample

PROJECT

BIA Project N12 (12-2) (19-2) 2 & 4
Navajo, New Mexico to N64 Junction, Arizona



JOB NO. 17-2013-4030 **DATE** 9-23-13

RIG TYPE CME-85 Buggy Mounted
METHOD HQ Wireline
OPERATOR CasCade Drilling
LOGGED BY Reed Seamons
LOCATION N. 4016759.232
E. 663822.9862
ELEVATION 2168.1m
DATUM GPS NAD 83 - UTM Zone 12
INCLINATION Vertical

Boring Operation and Drill Rate (min/meter)	Depth in Meter	Sample	Sample Type	Unconfined Compression of Point Load Index Test (KPa)	% Core Recovery	% Drilling Fluid/Air Rec.	Rock Quality Designation (RQD)	DISCONTINUITIES							Condition	Bedding and/or Fabric	Weathering or USCS (Soils)	Rock Type & Remarks
								Spacing					Orientation					
								Wide - Close					Horiz - Vert					
								1	2	3	4	5	H	45				
																Began HQ Coring at 2.7m		
9/23 HQ 4.7	3	HQ			95	100	0						SRgh Stn	L	SIW	CHINLE FORMATION SANDSTONE , quartz arenite, well sorted, medium grained, moderately hard to hard, clear white gray & tan stained grains, light gray to tan note: darker tan to light brown hematite stain 13mm to 25mm thick from 3.5m to 5.6m note: clay infilling along bedding planes from 4.3m to 4.6m note: bedding planes generally dipping at 10° to 15° at 5.2m note: 1.6mm to 3.2mm pinkish-brown to green laminae at 6.0m note: brown zones & micaceous-rich bedding planes from 6.3m to 6.7m note: low to no RQD values due to mechanical breaks along bedding planes 7.6m note: some predominate high-angle partially open fractures 8.2m note: clay infilling along bedding planes from 8.7m to 9.0m note: water used while coring, therefore unknown if groundwater encountered		
3.8		HQ		100		0						Fgn						
	4												Smth Stn					
	4												SRgh Stn	TL	UnW Jts			
4.0	5	HQ			80		0						MRgh Stn		SIW			
	6												Mgn					
9/24 HQ 4.2	7	HQ			90		35						Smth	TL	UnW Jts			
	7																	
3.8	8	HQ			100		25						Rgh Clin		SIW			
	8																	
	9			37604									Mgn					
	9												Fgn					
	10															Stopped HQ Coring at 9.3m note: low RQD values in zones due to mechanical breaks note: discontinuity spacing resultant from mechanical breaks & relatively soft rock mass in some zones		

GROUNDWATER		
DEPTH (m)	HOUR	DATE
	none	

BORING OPERATION
 B - BDBGM 51mm O.D. Wireline Rock Coring
 BWC - B-size casing
 HQ - 96mm O.D. Wireline Rock Coring
 NQ - 71mm O.D. Wireline Rock Coring
 S - 51mm O.D./35mm I.D. Tube Sample
 D - Disturbed Bulk Sample

LOG OF TEST BORING NO. N505-B-4



JOB NO. 17-2013-4030 DATE 10/19/13

LOCATION N. 3976367.143
 E. 677493.1838
 RIG TYPE CME-85 Buggy Mounted
 BORING TYPE 203mm Hollow Stem Auger
 SURFACE ELEV. 2162.2m
 DATUM GPS NAD 83 - UTM Zone 12

Depth in Meters	Blows per 152 mm	Graphical Log	Sample	Sample Type	Blow Counts	Dry Density Kg. per Cubic meter	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				A				SC	slightly moist	Asphalt CLAYEY SAND WITH GRAVEL , occasional subrounded gravel, low to medium plasticity, brown note: calcareous, reacts with HCl
1										
2			X	S 11-8-5				SM	slightly moist	SILTY SAND , some silt, trace clay, medium to fine grained, well rounded sand, nonplastic, light brown note: calcareous, reacts with HCl
3									moderately firm to soft	
4										
5			X	S 1-1-3						
6			X	S 4-6-10						
7										
8									slightly moist	SANDY SILT , trace clay, some to considerable fine grained sand, considerable silt, medium plasticity, light purplish-brown note: highly calcareous, reacts with HCl
9									hard	
10										Stopped Auger 7.6m Sampler retracted at 7.8m Began HQ Coring at 7.8m
11										
12										
13										
14										
15										

GROUNDWATER

DEPTH (m)	HOUR	DATE
4.3	14:45	10-19-13

SAMPLE TYPE

- A - Auger cuttings; NR-No Recovery
- S - 51mm O.D. 35mm I.D. tube sample.
- U - 76mm O.D. 61mm I.D. tube sample.
- T - 25mm O.D. thin-walled tube sample

PROJECT

BIA Project N12 (12-2) (19-2) 2 & 4
Navajo, New Mexico to N64 Junction, Arizona



JOB NO. 17-2013-4030 **DATE** 10-19-13

RIG TYPE CME-85 Buggy Mounted
METHOD HQ Wireline
OPERATOR CasCade Drilling
LOGGED BY Reed Seamons
LOCATION N. 3976367.143
E. 677493.1838
ELEVATION 2162.2m
DATUM GPS NAD 83 - UTM Zone 12
INCLINATION Vertical

Boring Operation and Drill Rate (min/meter)	Depth in Meter	Sample	Sample Type	Unconfined Compression of Point Load Index Test (KPa)	% Core Recovery	% Drilling Fluid/Air Rec.	Rock Quality Designation (RQD)	DISCONTINUITIES									Condition	Bedding and/or Fabric	Weathering or USCS (Soils)	Rock Type & Remarks
								Spacing					Orientation							
								Wide - Close					Horiz - Vert							
								1	2	3	4	5	H	45	V					
																	Began HQ Coring at 7.8m			
10/19 HQ 7.8	8	HQ			35	100	N/A							N/A	N/A	SM/GM	CHINLE FORMATION SILTSTONE , clayey in zones, calcareous, moderately soft to moderately hard, brown to reddish-brown note: chemical reduction spots (1.6mm to 13mm) note: bedding planes range from 0° to 15° at 8.5m note: abundant calcite nodules (white/gray) from 10.0m to 14.0m note: lenticular to cylindrical calcareous nodules about 13mm are abundant from 11.6m to 13.7m note: healed fractures with brown (clayey & slight calcareous) infilling below 12.2m note: clay & calcite fracture infilling along fracture surfaces 13.0m note: occasional bedding planes dipping up to 45° below 13.4m			
	11.6	HQ			100		75													
	10	HQ		6921	100	95	85													
10/20 15.8	13.4	HQ			100		90													
	11.3	HQ		16986	70		50										MRgh curved			
	14																Stopped HQ Coring at 14.0m			
	15																note: low RQD values in zones due to mechanical breaks note: discontinuity spacing resultant from mechanical breaks & relatively soft rock mass in some zones			

GROUNDWATER		
DEPTH (m)	HOUR	DATE
4.3	14:45	10-19-13

BORING OPERATION
 B - BDBGM 51mm O.D. Wireline Rock Coring
 BWC - B-size casing
 HQ - 96mm O.D. Wireline Rock Coring
 NQ - 71mm O.D. Wireline Rock Coring
 S - 51mm O.D./35mm I.D. Tube Sample
 D - Disturbed Bulk Sample

LOG OF TEST BORING NO. N613-B-1



JOB NO. 17-2013-4030 DATE 10/20/13

LOCATION N. 3976371.754
E. 677508.1141
RIG TYPE CME-85 Buggy Mounted
BORING TYPE 203mm Hollow Stem Auger
SURFACE ELEV. 2163.5m
DATUM GPS NAD 83 - UTM Zone 12

Depth in Meters	Blows per 152 mm	Graphical Log	Sample	Sample Type	Blow Counts	Dry Density Kg. per Cubic meter	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				A				SC	slightly moist	Asphalt CLAYEY SAND , trace fine grained, subangular gravel, low plasticity, brown note: calcareous, reacts with HCl
1										
2			X	S 2-4-8				SM	slightly moist	SILTY SAND , predominantly fine grained sand, nonplastic, brown note: calcareous
3			X	S 2-2-3					soft to moderately firm	
4										
5				U 8						
6			X	S 1-1-8						note: medium grained sand
7										
8			X	S 8-10-20				SP-SM	slightly moist	SAND WITH SILT , trace coarse grained gravel, nonplastic, brown note: does not react with HCl
9									firm	SILTSTONE note: augered through weathered siltstone to 9.8m
10										
11										Stopped Auger at 9.8m Began HQ Coring at 9.8m
12										
13										
14										
15										

GROUNDWATER

DEPTH (m)	HOUR	DATE
5.2	14:20	10-20-13

SAMPLE TYPE

A - Auger cuttings; NR-No Recovery
S - 51mm O.D. 35mm I.D. tube sample.
U - 76mm O.D. 61mm I.D. tube sample.
T - 25mm O.D. thin-walled tube sample

PROJECT

BIA Project N12 (12-2) (19-2) 2 & 4
Navajo, New Mexico to N64 Junction, Arizona



JOB NO. 17-2013-4030 **DATE** 10-21-13

RIG TYPE CME-85 Buggy Mounted
METHOD HQ Wireline
OPERATOR CasCade Drilling
LOGGED BY Reed Seamons
LOCATION N. 3976371.754
E. 677508.1141
ELEVATION 2163.5m
DATUM GPS NAD 83 - UTM Zone 12
INCLINATION Vertical

Boring Operation and Drill Rate (min/meter)	Depth in Meter	Sample	Sample Type	Unconfined Compression of Point Load Index Test (KPa)	% Core Recovery	% Drilling Fluid/Air Rec.	Rock Quality Designation (RQD)	DISCONTINUITIES							Condition	Bedding and/or Fabric	Weathering or USCS (Soils)	Rock Type & Remarks
								Spacing					Orientation					
								Wide - Close					Horiz - Vert					
								1	2	3	4	5	H	45				
																Began HQ Coring at 8.8m		
10/21 HQ 11.4	9	HQ			90	100	40						Rgh part Fld	TL	SIW	CHINLE FORMATION SILTSTONE WITH ZONES OF SILTY SANDSTONE TO SANDY SILTSTONE , moderately hard to moderately soft, light gray to light greenish-gray, spotted purplish-red note: reduction spots 1.6mm to 6.4mm note: some predominate high-angle healed fractures below 10.5m filled with brown clay/silt mixture note: purplish-brown from 10.7m to 13.1m note: calcareous nodules below 10.7m up to 1.6mm in diameter note: some partially calcite-filled fracture surfaces		
15.2	10	HQ			90		60											
				6040														
15.8	11	HQ			100		70											
13.4	13	HQ	15997		100		90											
	14												Smth					
12.4	15	HQ			100		100											
	16																	
	15															Stopped HQ Coring at 14.9m note: low RQD values in zones due to mechanical breaks note: discontinuity spacing resultant from mechanical breaks & relatively soft rock mass in some zones		

GROUNDWATER		
DEPTH (m)	HOUR	DATE
5.2	14:20	10-20-13

BORING OPERATION
B - BDBGM 51mm O.D. Wireline Rock Coring
BWC - B-size casing
HQ - 96mm O.D. Wireline Rock Coring
NQ - 71mm O.D. Wireline Rock Coring
S - 51mm O.D./35mm I.D. Tube Sample
D - Disturbed Bulk Sample

LOG OF TEST BORING NO. N613-B-2



JOB NO. 17-2013-4030 DATE 10/22/13

LOCATION N. 3976285.707
E. 677486.7648
RIG TYPE CME-85 Buggy Mounted
BORING TYPE 203mm Hollow Stem Auger
SURFACE ELEV. 2162.6m
DATUM GPS NAD 83 - UTM Zone 12

Depth in Meters	Blows per 152 mm	Graphical Log	Sample	Sample Type	Blow Counts	Dry Density Kg. per Cubic meter	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				A				GP	slightly moist	Asphalt SANDY GRAVEL , some medium to fine grained sand, predominantly subangular to subrounded gravel, dark gray note: does not react with HCl
1								SC		
2			X	S 2-6-6				SM	slightly moist	CLAYEY SAND , trace silt, predominantly fine grained sand, calcareous, low to medium plasticity, brown note: calcareous, reacts with HCl
3					11	1797	9	U		
4									slightly moist	SILTY SAND , predominantly fine grained, nonplastic, brown
5			X	S 2-2-4					soft to moderately firm	note: not calcareous below 4.7m
6										
7			X	S 1-1-2				SC	wet very soft to firm	CLAYEY SAND , predominantly fine grained sand, low to medium plasticity, brown note: occasional gravel note: does not react with HCl
8					38			U		
9										
10			X	S 2-2-4				CL	moist soft	SANDY CLAY , some fine grained sand, considerable clay, slightly calcareous, medium plasticity, reddish-gray note: does not react with HCl
11			X	S 2-3-4						
12										
13					5			SM	wet soft to firm	SILTY SAND , occasional fine grained gravel, predominantly fine to medium grained, nonplastic, brown note: reacts to HCl
14			X	S 4-9-10						
15			X	S 3-8-11						note: cemented/flaky

GROUNDWATER

DEPTH (m)	HOUR	DATE
4.4		10-22-13

SAMPLE TYPE

A - Auger cuttings; NR-No Recovery
S - 51mm O.D. 35mm I.D. tube sample.
U - 76mm O.D. 61mm I.D. tube sample.
T - 25mm O.D. thin-walled tube sample



JOB NO. 17-2013-4030 **DATE** 10/22/13

LOCATION N. 3976285.707
E. 677486.7648
RIG TYPE CME-85 Buggy Mounted
BORING TYPE 203mm Hollow Stem Auger
SURFACE ELEV. 2162.6m
DATUM GPS NAD 83 - UTM Zone 12

Depth in Meters	Blows per 152 mm	Graphical Log	Sample	Sample Type	Blow Counts	Dry Density Kg. per Cubic meter	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
16										SILTY SAND , continued
17										Stopped Auger at 16.2m Began HQ Coring at 16.2m
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										

GROUNDWATER

SAMPLE TYPE

DEPTH (m)	HOUR	DATE
4.4		10-22-13

A - Auger cuttings; NR-No Recovery
S - 51mm O.D. 35mm I.D. tube sample.
U - 76mm O.D. 61mm I.D. tube sample.
T - 25mm O.D. thin-walled tube sample

PROJECT

BIA Project N12 (12-2) (19-2) 2 & 4
 Navajo, New Mexico to N64 Junction, Arizona



JOB NO. 17-2013-4030 **DATE** 10-23-13

RIG TYPE CME-85 Buggy Mounted
METHOD HQ Wireline
OPERATOR CasCade Drilling
LOGGED BY Reed Seamons
LOCATION N. 3976285.707
 E. 677486.7648
ELEVATION 2162.6m
DATUM GPS NAD 83 - UTM Zone 12
INCLINATION Vertical

Boring Operation and Drill Rate (min/meter)	Depth in Meter	Sample	Sample Type	Unconfined Compression of Point Load Index Test (KPa)	% Core Recovery	% Drilling Fluid/Air Rec.	Rock Quality Designation (RQD)	DISCONTINUITIES									Condition	Bedding and/or Fabric	Weathering or USCS (Soils)	Rock Type & Remarks
								Spacing					Orientation							
								Wide - Close					Horiz - Vert							
								1	2	3	4	5	H	45	V					
	16																Began HQ Coring at 16.2m			
10/23 HQ 6.2		HQ			50	100	0	BROKEN		BROKEN				N/A	Massive	MdW	CHINLE FORMATION CALCAREOUS SILTSTONE , soft, reddish-brown with occasional green spots note: greenish-gray to gray reduction spots note: considerable clay content throughout note: lamination = <0.8mm to 1.6mm			
	17																			
	18		HQ		80		10													
	19							BROKEN						MRgh Cln	TL in zones		note: healed fracture filled with clay at 18.6m note: soft with very soft zones below 18.7m			
	20		HQ	6049	90		85									SIW to MdW				
	21		HQ		100		85													
	22																note: decrease in reduction spots below 21.8m			
	23																Stopped HQ Coring at 22.3m note: low RQD values in zones due to mechanical breaks & soft rockmass note: discontinuity spacing resultant from mechanical breaks & relatively soft rockmass in some zones			

GROUNDWATER		
DEPTH (m)	HOURL	DATE
4.4		10-22-13

BORING OPERATION
 B - BDBGM 51mm O.D. Wireline Rock Coring
 BWC - B-size casing
 HQ - 96mm O.D. Wireline Rock Coring
 NQ - 71mm O.D. Wireline Rock Coring
 S - 51mm O.D./35mm I.D. Tube Sample
 D - Disturbed Bulk Sample

LOG OF TEST BORING NO. N613-B-3



JOB NO. 17-2013-4030 DATE 10/21/13

LOCATION N. 3976286.21
E. 677497.3724
RIG TYPE CME-85 Buggy Mounted
BORING TYPE 203mm Hollow Stem Auger
SURFACE ELEV. 2158.9m
DATUM GPS NAD 83 - UTM Zone 12

Depth in Meters	Blows per 152 mm	Graphical Log	Sample	Sample Type	Blow Counts	Dry Density Kg. per Cubic meter	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				A				SM	slightly moist	Asphalt SILTY SAND , trace subrounded gravel, predominantly fine grained sand, nonplastic, pinkish-brown note: calcareous, reacts with HCl
1									very soft to soft	
2			X	S	6-6-8					
3				U	16	1763	13			
4										
5			X	S	1-1-1					
6				U	14					
8			X	S	2-2-4			SP-SM	wet soft	SAND WITH SILT , predominantly medium grained sand, nonplastic, brown note: does not react with HCl
10			X	S	3-3-6			CL	moist stiff	SANDY CLAY , predominantly fine grained sand, medium to high plasticity, dark gray & brown note: does not react with HCl
11			X	S	25-30-40			ML	slightly moist hard	SANDY SILT , trace medium to coarse grained sand, some fine grained sand, calcareous, pinkish-brown note: calcareous, reacts with HCL
13										Stopped Auger at 10.7m Stopped Sampler at 11.1m Began HQ Coring at 11.1m

GROUNDWATER

DEPTH (m)	HOUR	DATE
4.4		10-21-13

SAMPLE TYPE

- A - Auger cuttings; NR-No Recovery
- S - 51mm O.D. 35mm I.D. tube sample.
- U - 76mm O.D. 61mm I.D. tube sample.
- T - 25mm O.D. thin-walled tube sample

PROJECT

BIA Project N12 (12-2) (19-2) 2 & 4
Navajo, New Mexico to N64 Junction, Arizona



JOB NO. 17-2013-4030 **DATE** 10-21-13

RIG TYPE CME-85 Buggy Mounted
METHOD HQ Wireline
OPERATOR CasCade Drilling
LOGGED BY Reed Seamons
LOCATION N. 3976286.21
E. 677497.3724
ELEVATION 2158.9m
DATUM GPS NAD 83 - UTM Zone 12
INCLINATION Vertical

Boring Operation and Drill Rate (min/meter)	Depth in Meter	Sample	Sample Type	Unconfined Compression of Point Load Index Test (KPa)	% Core Recovery	% Drilling Fluid/Air Rec.	Rock Quality Designation (RQD)	DISCONTINUITIES									Condition	Bedding and/or Fabric	Weathering or USCS (Soils)	Rock Type & Remarks
								Spacing					Orientation							
								Wide - Close					Horiz - Vert							
								1	2	3	4	5	H	45	V					
																	Began HQ Coring at 10.7m			
10/21 HQ 3.3	11	HQ			65	95	0							Smith to SRgh Stn	Massive	HiW	CHINLE FORMATION SILTSTONE , clayey in zones, soft to moderately soft, reddish-brown with green spots note: greenish-gray to gray reduction spots up to 13mm in diameter, calcareous, some clear nodules 0.8mm to 1.6mm			
	12.4	HQ			100	90	25	BROKEN							MdW to SIW	note: clayey from 10.7m to 11.9m				
	13			18325													SILTSTONE , calcareous in parts, dark brown with greenish-gray nodules note: moderately soft to moderately hard below 11.9m			
10/22 13.2	13.2	HQ			100		55							some curved Fld Rgh			note: numerous predominantly high-angle healed fractures, clay filled (6mm), dark brown			
	14																note: increase in predominantly high-angle clay-healed fractures below 14.6m			
	15	HQ			100		35							Rgh Fld			note: some iron-oxide staining on fracture surfaces at 15.1m			
	16			12018										SRgh clay Fld						
	16.5	HQ			100		90							Sicks w/step-like features			note: some calcareous infilling			
	17																Stopped HQ Coring at 16.8m note: low RQD values in zones due to mechanical breaks & soft rockmass note: discontinuity spacing resultant from mechanical breaks & relatively soft rockmass in some zones			
	18																			

GROUNDWATER		
DEPTH (m)	HOUR	DATE
4.4		10-21-13

BORING OPERATION
B - BDBGM 51mm O.D. Wireline Rock Coring
BWC - B-size casing
HQ - 96mm O.D. Wireline Rock Coring
NQ - 71mm O.D. Wireline Rock Coring
S - 51mm O.D./35mm I.D. Tube Sample
D - Disturbed Bulk Sample

LOG OF TEST BORING NO. N613-B-4



JOB NO. 17-2013-4030 DATE 10/24/13

LOCATION N. 3991204.956
E. 676150.9859
RIG TYPE CME-85 Buggy Mounted
BORING TYPE 203mm Hollow Stem Auger
SURFACE ELEV. 2218.8m
DATUM GPS NAD 83 - UTM Zone 12

Depth in Meters	Blows per 152 mm	Graphical Log	Sample	Sample Type	Blow Counts	Dry Density Kg. per Cubic meter	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				A				SC	slightly moist	152mm Asphalt CLAYEY SAND & GRAVEL , considerable subrounded gravel, calcareous, low plasticity note: reacts to HCl
1										
2				U	33	1901	12			
3				S	4-10-10			SM	moist	SILTY SAND , predominantly fine grained sand, moderately calcareous, yellow to tan grading to black note: reacts to HCl
4									firm	
5				S	2-2-3			CL-ML		note: increased clay, low plasticity
6									moist	SANDY SILTY CLAY , considerable predominantly fine grained sand, low plasticity, tan
7				U	15			SM	soft	note: does not react with HCl
8				S	3-3-6			SP-SM	moderately firm	SILTY SAND , predominantly fine grained sand, nonplastic, gray note: does not react with HCl
9									wet	SAND WITH SILT , considerable predominantly fine to medium grained, subrounded sand, nonplastic, tan
10				S	2-2-3			SM	stiff	note: does not react with HCl
11				S	6-8-12			SP-SM	wet	SILTY SAND , predominantly fine to medium grained, subrounded sand, some subrounded gravel, brown
12									soft	note: does not react with HCl
13									very stiff	SAND WITH SILT , occasional subrounded gravel, trace silt, medium grained, subrounded sand, brown
14										note: does not react with HCl
15										Stopped Auger at 11.6m Began HQ Coring at 11.6m

GROUNDWATER

DEPTH (m)	HOUR	DATE
▽	none	
▼		

SAMPLE TYPE

A - Auger cuttings; NR-No Recovery
S - 51mm O.D. 35mm I.D. tube sample.
U - 76mm O.D. 61mm I.D. tube sample.
T - 25mm O.D. thin-walled tube sample

PROJECT

BIA Project N12 (12-2) (19-2) 2 & 4
 Navajo, New Mexico to N64 Junction, Arizona



JOB NO.

17-2013-4030

DATE

10-26-13

RIG TYPE

CME-85 Buggy Mounted

METHOD

HQ Wireline

OPERATOR

CasCade Drilling

LOGGED BY

Reed Seamons

LOCATION

N. 3991204.956

E. 676150.9859

ELEVATION

2218.8m

DATUM

GPS NAD 83 - UTM Zone 12

INCLINATION

Vertical

Boring Operation and Drill Rate (min/meter)	Depth in Meter	Sample	Sample Type	Unconfined Compression of Point Load Index Test (KPa)	% Core Recovery	% Drilling Fluid/Air Rec.	Rock Quality Designation (RQD)	DISCONTINUITIES							Condition	Bedding and/or Fabric	Weathering or USCS (Soils)	Rock Type & Remarks
								Spacing					Orientation					
								Wide - Close					Horiz - Vert					
								1	2	3	4	5	H	45				
																Began HQ Coring at 11.6m		
10/26 HQ 7.4	12	HQ			90	100	35						Rgh Cln	TL	MdW	CHINLE FORMATION SILTSTONE/CLAYSTONE , calcareous in zones, moderately soft to soft, reddish-brown note: grayish-green chemical reduction (0.8mm to 1.6mm) note: clayey in zones note: calcareous nodules from 11.9m to 12.8m		
10.8	13	HQ			75		25									note: moderately soft to moderately hard sandy siltstone, abundant calcite, clayey zones dark red to brown from 14.3m to 16.2m note: dark green spots 1.5mm to 3.0mm from 15.5m to 15.8m		
	14			7445														
	15	HQ			55		25											
8.6	16	HQ			85		60							SIW		note: moderately hard below 16.2m		
	17			18795														
9.0	17	HQ			100		80											
	18															Stopped HQ Coring at 17.7m note: low RQD values in zones due to mechanical breaks note: discontinuity spacing resultant from mechanical breaks & relatively soft rock mass in some zones note: water used while coring, therefore unknown if groundwater encountered		
	19																	

GROUNDWATER

DEPTH (m)	HOUR	DATE
	none	

BORING OPERATION

B - BDBGM 51mm O.D. Wireline Rock Coring
 BWC - B-size casing
 HQ - 96mm O.D. Wireline Rock Coring
 NQ - 71mm O.D. Wireline Rock Coring
 S - 51mm O.D./35mm I.D. Tube Sample
 D - Disturbed Bulk Sample

LOG OF TEST BORING NO. N614-B-1



JOB NO. 17-2013-4030 DATE 10/26/13

LOCATION N. 3991202.526
E. 676158.2223
RIG TYPE CME-85 Buggy Mounted
BORING TYPE 203mm Hollow Stem Auger
SURFACE ELEV. 2218.9m
DATUM GPS NAD 83 - UTM Zone 12

Depth in Meters	Blows per 152 mm	Graphical Log	Sample	Sample Type	Blow Counts	Dry Density Kg. per Cubic meter	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				A				SC	slightly moist	152mm Asphalt CLAYEY SAND & GRAVEL , some clay, considerable subangular gravel, predominantly fine grained sand, calcareous, low to medium plasticity, pinkish-brown note: decrease in gravel at 2.0m note: reacts to HCl
1								moderately firm		
2			X	S 4-6-7						
3			X	S 6-12-15						
4										
5			U	U 15	1819	16				
6								SM	moist	SILTY SAND , trace clay, considerable predominantly fine grained sand, highly calcareous, nonplastic, tan note: grayish-tan note: hair roots note: reacts to HCl
7			X	S 2-3-6					moderately firm	
8			U	U 18						
9										
10			X	S 3-4-6				SP-SM	wet	SAND WITH SILT , predominantly fine to medium grained sand, nonplastic, tan note: does not react with HCl
11			U	U 47				CL-ML	stiff	
12									moist	SANDY SILTY CLAY , low to medium plasticity, pinkish-reddish-brown note: does not react with HCl
13									hard	
14										
15										Stopped Auger at 10.7m Stopped Sampler at 11.0m Began HQ Coring at 10.7m

GROUNDWATER

DEPTH (m)	HOUR	DATE
▽	none	
▼		

SAMPLE TYPE

- A - Auger cuttings; NR-No Recovery
- S - 51mm O.D. 35mm I.D. tube sample.
- U - 76mm O.D. 61mm I.D. tube sample.
- T - 25mm O.D. thin-walled tube sample

PROJECT

BIA Project N12 (12-2) (19-2) 2 & 4
Navajo, New Mexico to N64 Junction, Arizona



JOB NO. 17-2013-4030 **DATE** 10-27-13

RIG TYPE CME-85 Buggy Mounted
METHOD HQ Wireline
OPERATOR CasCade Drilling
LOGGED BY Reed Seamons
LOCATION N. 3991202.526
E. 676158.2223
ELEVATION 2218.9m
DATUM GPS NAD 83 - UTM Zone 12
INCLINATION Vertical

Boring Operation and Drill Rate (min/meter)	Depth in Meter	Sample	Sample Type	Unconfined Compression of Point Load Index Test (KPa)	% Core Recovery	% Drilling Fluid/Air Rec.	Rock Quality Designation (RQD)	DISCONTINUITIES									Condition	Bedding and/or Fabric	Weathering or USCS (Soils)	Rock Type & Remarks
								Spacing					Orientation							
								Wide - Close					Horiz - Vert							
								1	2	3	4	5	H	45	V					
																	Began HQ Coring at 10.7m			
10/27 HQ 3.7	11	HQ			0	100	0	NO RECOVERY	NO RECOVERY				None	TL	MdW	CHINLE FORMATION SILTSTONE/CLAYSTONE , moderately soft to moderately hard, calcareous, reddish-brown note: grayish-green chemical reduction spots (0.8mm to 13mm) note: abundant grayish-green clay seams, moderately soft to soft note: soft brecciated & green zone from 13.7m to 13.8m				
7.6	12	HQ			95		10							Rgh Stn						
7.6	13	HQ 10887			95		15	BROKEN							HiW					
7.4	14	HQ			80		40							Smth Stn			note: some calcite-filled fracture surfaces at 14.5m			
5.0	15	HQ			60		20	BROKEN						SRgh Gouge			note: sandy siltstone, calcareous, moderately hard to moderately soft from 14.6m to 16.2m note: thin gouge zone from 15.1m to 15.2m			
	16	HQ 14321			60		20	BROKEN												
	17																Stopped HQ Coring at 16.8m note: low RQD values in zones due to mechanical breaks note: discontinuity spacing resultant from mechanical breaks & relatively soft rock mass in some zones			
	18																note: water used while coring, therefore unknown if groundwater encountered			

GROUNDWATER		
DEPTH (m)	HOUR	DATE

BORING OPERATION
B - BDBGM 51mm O.D. Wireline Rock Coring
BWC - B-size casing
HQ - 96mm O.D. Wireline Rock Coring
NQ - 71mm O.D. Wireline Rock Coring
S - 51mm O.D./35mm I.D. Tube Sample
D - Disturbed Bulk Sample

LOG OF TEST BORING NO. N614-B-2



JOB NO. 17-2013-4030 DATE 10/24/13

LOCATION N. 3991161.265
E. 676147.8781
RIG TYPE CME-85 Buggy Mounted
BORING TYPE 203mm Hollow Stem Auger
SURFACE ELEV. 2218.0m
DATUM GPS NAD 83 - UTM Zone 12

Depth in Meters	Blows per 152 mm	Graphical Log	Sample	Sample Type	Blow Counts	Dry Density Kg. per Cubic meter	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				A				SC	slightly moist	152mm Asphalt
1									moderately firm	CLAYEY SAND WITH GRAVEL , considerable gravel, 10% rare crystalline red & green mottled limestone cobbles, low to medium plasticity, light pinkish-brown
2				S 10-9-6				GC		note: does not react with HCl note: unweathered core stones of same composition
3				S 17-9-8				CL		CLAYEY GRAVEL WITH SAND , considerable fine to coarse grained sand, fine to coarse grained gravel, medium plasticity, light brown
4									slightly moist	SANDY CLAY , occasional gravel, trace silt, highly calcareous, medium plasticity, brownish-pink
5				U 39					firm	note: reacts to HCl
6				S 5-5-26				SM	moist	SILTY SAND , nonplastic, light brown
7									very firm to hard	note: reddish-brown, increase in clay at 6.9m note: does not react with HCl
8				U 50/76mm						Stopped Auger at 7.6m Sampler refused at 7.7m Began HQ Coring at 7.7m
9										
10										
11										
12										
13										
14										
15										

GROUNDWATER

DEPTH (m)	HOUR	DATE
▽	none	
▼		

SAMPLE TYPE

- A - Auger cuttings; NR-No Recovery
- S - 51mm O.D. 35mm I.D. tube sample.
- U - 76mm O.D. 61mm I.D. tube sample.
- T - 25mm O.D. thin-walled tube sample

PROJECT

BIA Project N12 (12-2) (19-2) 2 & 4
Navajo, New Mexico to N64 Junction, Arizona



JOB NO. 17-2013-4030 **DATE** 10-24-13

RIG TYPE CME-85 Buggy Mounted
METHOD HQ Wireline
OPERATOR CasCade Drilling
LOGGED BY Reed Seamons
LOCATION N. 3991161.265
E. 676147.8781
ELEVATION 2218.0m
DATUM GPS NAD 83 - UTM Zone 12
INCLINATION Vertical

Boring Operation and Drill Rate (min/meter)	Depth in Meter	Sample	Sample Type	Unconfined Compression of Point Load Index Test (KPa)	% Core Recovery	% Drilling Fluid/Air Rec.	Rock Quality Designation (RQD)	DISCONTINUITIES							Condition	Bedding and/or Fabric	Weathering or USCS (Soils)	Rock Type & Remarks
								Spacing					Orientation					
								Wide - Close					Horiz - Vert					
								1	2	3	4	5	H	45				
																Began HQ Coring at 7.6m		
10/24 HQ 5.0	8	HQ			10	100	0						MRgh Stn	TL	MdW	CHINLE FORMATION SILTSTONE/CLAYSTONE , calcareous, moderately soft to moderately hard, clayey in parts, purplish-brown note: purplish-brown & brown reduction spots (green) dispersed throughout		
10.5	9	HQ			80		10									note: green reduction zones healed fractures at 9m		
								BROKEN										
								BROKEN										
9.5	10	HQ		12149	90		30						SRgh Fld			note: some variably-oriented calcite healed fractures at 10.2m		
													Smth Stn	SIW to MdW				
12.6	12	HQ		15093	85		10						Smth			note: alternating green, softer zones up to 51mm to 76mm thick at 12.2m		
								BROKEN										
6.7	13	HQ			85		0								SIW			
15.0	13	HQ			100		65						Smth slcks					
	14															Stopped HQ Coring at 13.7m note: low to zero RQD values in zones due to mechanical breaks note: discontinuity spacing resultant from mechanical breaks & relatively soft rock mass in some zones note: water used while coring, therefore unknown if groundwater encountered		
	15																	

GROUNDWATER		
DEPTH (m)	HOUR	DATE
	none	

BORING OPERATION
B - BDBGM 51mm O.D. Wireline Rock Coring
BWC - B-size casing
HQ - 96mm O.D. Wireline Rock Coring
NQ - 71mm O.D. Wireline Rock Coring
S - 51mm O.D./35mm I.D. Tube Sample
D - Disturbed Bulk Sample

LOG OF TEST BORING NO. N614-B-3



JOB NO. 17-2013-4030 DATE 10/24/13

LOCATION N. 3991162.872
E. 676153.8745
RIG TYPE CME-85 Buggy Mounted
BORING TYPE 203mm Hollow Stem Auger
SURFACE ELEV. 2220.3m
DATUM GPS NAD 83 - UTM Zone 12

Depth in Meters	Blows per 152 mm	Graphical Log	Sample	Sample Type	Blow Counts	Dry Density Kg. per Cubic meter	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				A				SC	slightly moist moderately firm 152mm Asphalt CLAYEY SAND WITH GRAVEL , trace silt, some fine grained gravel, predominantly fine grained sand, low to medium plasticity, reddish-brown note: does not react with HCl note: increase clay, decrease silt, increase medium grained sand, medium plasticity at 4.6m	
1										
2				S	5-6-6					
3					U	16				
4										
5				S	6-12-13					
6				S	6-12-24					
7										
8			S	12-24-36			SC-SM	slightly moist hard	SILTY CLAYEY SAND WITH GRAVEL , some fine grained gravel, predominantly medium grained sand, low to medium plasticity, reddish-brown, calcareous	
9			S	29-50/127mm			SM	slightly moist hard	note: reacts to HCl SILTY SAND WITH GRAVEL , considerable fine grained gravel, calcareous, nonplastic, reddish-brown note: reacts to HCl	
10									Stopped Auger at 9.1m Sampler refused at 9.4m Began HQ Coring at 9.4m	
11										
12										
13										
14										
15										
15										

GROUNDWATER

DEPTH (m)	HOUR	DATE
▽	none	
▼		

SAMPLE TYPE

- A - Auger cuttings; NR-No Recovery
- S - 51mm O.D. 35mm I.D. tube sample.
- U - 76mm O.D. 61mm I.D. tube sample.
- T - 25mm O.D. thin-walled tube sample

PROJECT

BIA Project N12 (12-2) (19-2) 2 & 4
Navajo, New Mexico to N64 Junction, Arizona



JOB NO.

17-2013-4030

DATE

10-26-13

RIG TYPE

CME-85 Buggy Mounted

METHOD

HQ Wireline

OPERATOR

CasCade Drilling

LOGGED BY

Reed Seamons

LOCATION

N. 3991162.872

E. 676153.8745

ELEVATION

2220.3m

DATUM

GPS NAD 83 - UTM Zone 12

INCLINATION

Vertical

Boring Operation and Drill Rate (min/meter)	Depth in Meter	Sample	Sample Type	Unconfined Compression of Point Load Index Test (KPa)	% Core Recovery	% Drilling Fluid/Air Rec.	Rock Quality Designation (RQD)	DISCONTINUITIES							Condition	Bedding and/or Fabric	Weathering or USCS (Soils)	Rock Type & Remarks
								Spacing					Orientation					
								Wide - Close					Horiz - Vert					
								1	2	3	4	5	H	45				
	9																Began HQ Coring at 9.1m	
10/26 HQ 4.3		HQ			40	100	10							Smth Sicks	TL	SIW to MdW	CHINLE FORMATION SILTSTONE/CLAYSTONE , calcareous in parts, moderately soft to moderately hard, clayey in parts, reddish-brown	
	10				75		60										note: grayish-green reduction spots up to 0.8mm to 1.6mm	
	11																note: mechanical fractures along bedding plans dipping from 5° to 15°	
	12				90		30							Sicks Smth Fld Stn				
	13				100		30	BROKEN						Gouge TL		note: thin gouge zone from 13.0m to 13.1m		
	14			9758														
	15				90		60							Smth SRgh Stn				
	16																Stopped HQ Coring at 15.2m note: low to zero RQD values in zones due to mechanical breaks note: discontinuity spacing resultant from mechanical breaks & relatively soft rock mass in some zones note: water used while coring, therefore unknown if groundwater encountered	

GROUNDWATER

DEPTH (m)	HOUR	DATE
	none	

BORING OPERATION

B - BDBGM 51mm O.D. Wireline Rock Coring
BWC - B-size casing
HQ - 96mm O.D. Wireline Rock Coring
NQ - 71mm O.D. Wireline Rock Coring
S - 51mm O.D./35mm I.D. Tube Sample
D - Disturbed Bulk Sample

APPENDIX B

CORE PHOTOS

BIA PROJECT N12(12-2)(19-2)2&4
NAVAJO, NEW MEXICO TO N64 JUNCTION, ARIZONA (NEAR TSAILE)
Bridge Sites: N505, Tsaile Creek; N504, Wheatfield Creek; N503, Whiskey Creek;
N614, Coyote Wash; N613, Tohdildonih Wash
PHOTOGRAPHIC LOG OF ROCK CORE



Photograph No. 1

Bridge N503, Boring No. 1, 8.84 meters to 12.04 meters



Photograph No. 2

Bridge N503, Boring No. 1, 12.04 meters to 14.63 meters

AMEC Job No.
17-2013-4030

Photographed By:
Alex Yiannakakis

Prepared By:
Mark Hartig



BIA PROJECT N12(12-2)(19-2)2&4
NAVAJO, NEW MEXICO TO N64 JUNCTION, ARIZONA (NEAR TSAILE)
Bridge Sites: N505, Tsaille Creek; N504, Wheatfield Creek; N503, Whiskey Creek;
N614, Coyote Wash; N613, Tohdildonih Wash
PHOTOGRAPHIC LOG OF ROCK CORE



Photograph No. 3

Bridge N503, Boring No. 1, 14.63 meters to 15.39 meters



Photograph No. 4

Bridge N503, Boring No. 2, 11.89 meters to 14.63 meters

AMEC Job No.
17-2013-4030

Photographed By:
Alex Yiannakakis

Prepared By:
Mark Hartig



BIA PROJECT N12(12-2)(19-2)2&4
NAVAJO, NEW MEXICO TO N64 JUNCTION, ARIZONA (NEAR TSAILE)
Bridge Sites: N505, Tsaille Creek; N504, Wheatfield Creek; N503, Whiskey Creek;
N614, Coyote Wash; N613, Tohdildonih Wash
PHOTOGRAPHIC LOG OF ROCK CORE



Photograph No. 5

Bridge N503, Boring No. 2, 14.63 meters to 17.47 meters



Photograph No. 6

Bridge N503, Boring No. 2, 17.47 meters to 18.29 meters

AMEC Job No.
17-2013-4030

Photographed By:
Alex Yiannakakis

Prepared By:
Mark Hartig



BIA PROJECT N12(12-2)(19-2)2&4
NAVAJO, NEW MEXICO TO N64 JUNCTION, ARIZONA (NEAR TSAILE)
Bridge Sites: N505, Tsaille Creek; N504, Wheatfield Creek; N503, Whiskey Creek;
N614, Coyote Wash; N613, Tohdildonih Wash
PHOTOGRAPHIC LOG OF ROCK CORE



Photograph No. 7

Bridge N503, Boring No. 3, 10.67 meters to 15.58 meters



Photograph No. 8

Bridge N503, Boring No. 3, 15.58 meters to 16.76 meters

AMEC Job No.
17-2013-4030

Photographed By:
Alex Yiannakakis

Prepared By:
Mark Hartig



BIA PROJECT N12(12-2)(19-2)2&4
NAVAJO, NEW MEXICO TO N64 JUNCTION, ARIZONA (NEAR TSAILE)
Bridge Sites: N505, Tsaille Creek; N504, Wheatfield Creek; N503, Whiskey Creek;
N614, Coyote Wash; N613, Tohdildonih Wash
PHOTOGRAPHIC LOG OF ROCK CORE



Photograph No. 9

Bridge N503, Boring No. 4, 10.51 meters to 13.93 meters



Photograph No. 10

Bridge N503, Boring No. 4, 13.93 meters to 16.76 meters

AMEC Job No.
17-2013-4030

Photographed By:
Alex Yiannakakis

Prepared By:
Mark Hartig



BIA PROJECT N12(12-2)(19-2)2&4
NAVAJO, NEW MEXICO TO N64 JUNCTION, ARIZONA (NEAR TSAILE)
Bridge Sites: N505, Tsaile Creek; N504, Wheatfield Creek; N503, Whiskey Creek;
N614, Coyote Wash; N613, Tohdildonih Wash
PHOTOGRAPHIC LOG OF ROCK CORE



Photograph No. 11

Bridge N505, Boring No. 1, 4.27 meters to 7.86 meters



Photograph No. 12

Bridge N505, Boring No. 1, 7.86 meters to 10.67 meters

AMEC Job No.
17-2013-4030

Photographed By:
Alex Yiannakakis

Prepared By:
Mark Hartig



BIA PROJECT N12(12-2)(19-2)2&4
NAVAJO, NEW MEXICO TO N64 JUNCTION, ARIZONA (NEAR TSAILE)
Bridge Sites: N505, Tsaille Creek; N504, Wheatfield Creek; N503, Whiskey Creek;
N614, Coyote Wash; N613, Tohdildonih Wash
PHOTOGRAPHIC LOG OF ROCK CORE



Photograph No. 13

Bridge N505, Boring No. 2, 4.42 meters to 12.34 meters



Photograph No. 14

Bridge N505, Boring No. 2, 12.34 meters to 15.24 meters

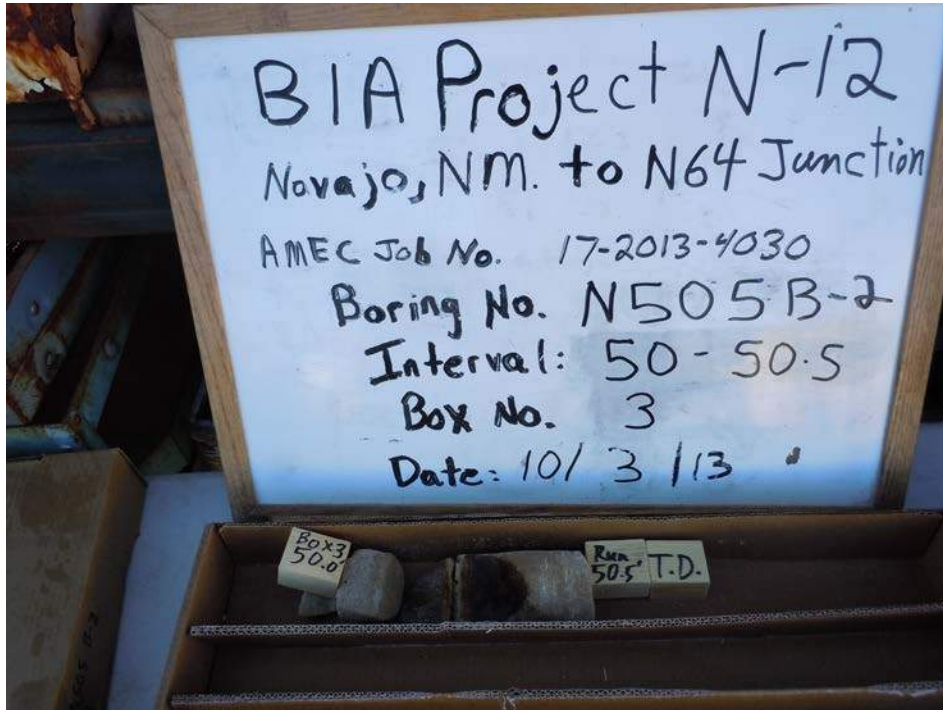
AMEC Job No.
17-2013-4030

Photographed By:
Alex Yiannakakis

Prepared By:
Mark Hartig



BIA PROJECT N12(12-2)(19-2)2&4
NAVAJO, NEW MEXICO TO N64 JUNCTION, ARIZONA (NEAR TSAILE)
Bridge Sites: N505, Tsaille Creek; N504, Wheatfield Creek; N503, Whiskey Creek;
N614, Coyote Wash; N613, Tohdildonih Wash
PHOTOGRAPHIC LOG OF ROCK CORE



Photograph No. 15

Bridge N505, Boring No. 2, 15.24 meters to 15.39 meters



Photograph No. 16

Bridge N505, Boring No. 3, 4.42 meters to 7.83 meters

AMEC Job No.
17-2013-4030

Photographed By:
Alex Yiannakakis

Prepared By:
Mark Hartig



BIA PROJECT N12(12-2)(19-2)2&4
NAVAJO, NEW MEXICO TO N64 JUNCTION, ARIZONA (NEAR TSAILE)
Bridge Sites: N505, Tsaile Creek; N504, Wheatfield Creek; N503, Whiskey Creek;
N614, Coyote Wash; N613, Tohdildonih Wash
PHOTOGRAPHIC LOG OF ROCK CORE



Photograph No. 17

Bridge N505, Boring No. 3, 7.83 meters to 10.64 meters



Photograph No. 18

Bridge N505, Boring No. 3, 10.64 meters to 11.13 meters

AMEC Job No.
17-2013-4030

Photographed By:
Alex Yiannakakis

Prepared By:
Mark Hartig



BIA PROJECT N12(12-2)(19-2)2&4
NAVAJO, NEW MEXICO TO N64 JUNCTION, ARIZONA (NEAR TSAILE)
Bridge Sites: N505, Tsaille Creek; N504, Wheatfield Creek; N503, Whiskey Creek;
N614, Coyote Wash; N613, Tohdildonih Wash
PHOTOGRAPHIC LOG OF ROCK CORE



Photograph No. 19
Bridge N505, Boring No. 4, 2.74 meters to 6.25 meters



Photograph No. 20
Bridge N505, Boring No. 4, 6.25 meters to 9.02 meters

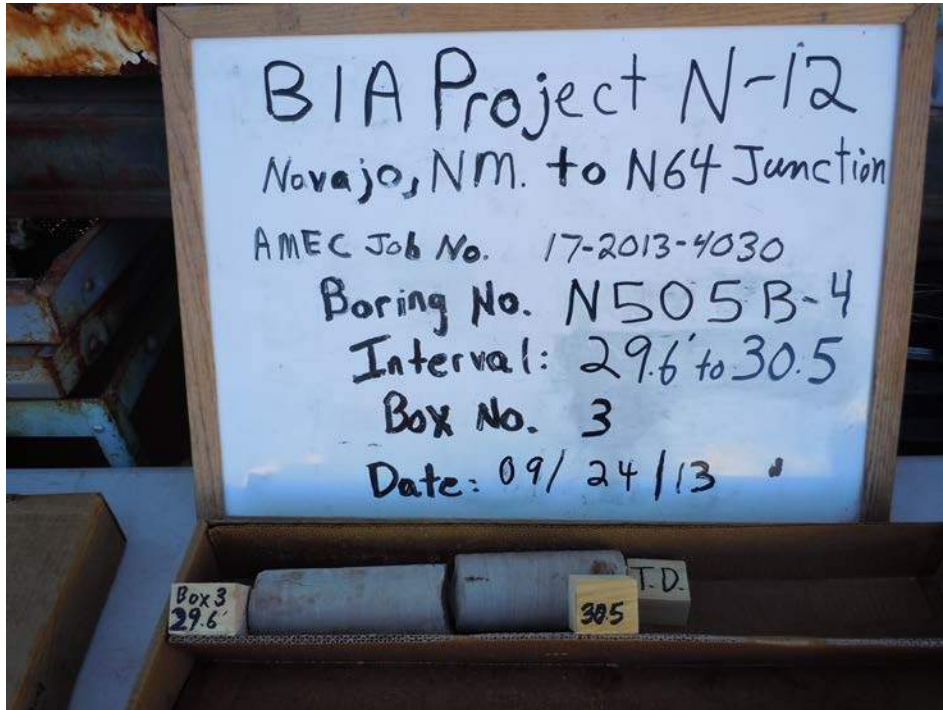
AMEC Job No.
17-2013-4030

Photographed By:
Alex Yiannakakis

Prepared By:
Mark Hartig



BIA PROJECT N12(12-2)(19-2)2&4
NAVAJO, NEW MEXICO TO N64 JUNCTION, ARIZONA (NEAR TSAILE)
Bridge Sites: N505, Tsaile Creek; N504, Wheatfield Creek; N503, Whiskey Creek;
N614, Coyote Wash; N613, Tohdildonih Wash
PHOTOGRAPHIC LOG OF ROCK CORE



Photograph No. 21

Bridge N505, Boring No. 4, 9.02 meters to 9.30 meters



Photograph No. 22

Bridge N613, Boring No. 1, 7.92 meters to 11.16 meters

AMEC Job No.
17-2013-4030

Photographed By:
Alex Yiannakakis

Prepared By:
Mark Hartig



BIA PROJECT N12(12-2)(19-2)2&4
NAVAJO, NEW MEXICO TO N64 JUNCTION, ARIZONA (NEAR TSAILE)
Bridge Sites: N505, Tsaille Creek; N504, Wheatfield Creek; N503, Whiskey Creek;
N614, Coyote Wash; N613, Tohdildonih Wash
PHOTOGRAPHIC LOG OF ROCK CORE



Photograph No. 23

Bridge N613, Boring No. 1, 11.16 meters to 13.72 meters



Photograph No. 24

Bridge N613, Boring No. 1, 13.72 meters to 14.02 meters

AMEC Job No.
17-2013-4030

Photographed By:
Alex Yiannakakis

Prepared By:
Mark Hartig



BIA PROJECT N12(12-2)(19-2)2&4
NAVAJO, NEW MEXICO TO N64 JUNCTION, ARIZONA (NEAR TSAILE)
 Bridge Sites: N505, Tsaille Creek; N504, Wheatfield Creek; N503, Whiskey Creek;
 N614, Coyote Wash; N613, Tohdildonih Wash
PHOTOGRAPHIC LOG OF ROCK CORE



Photograph No. 25
 Bridge N613, Boring No. 2, 8.84 meters to 11.64 meters



Photograph No. 27
 Bridge N613, Boring No. 2, 11.64 meters to 14.23 meters

AMEC Job No.
17-2013-4030

Photographed By:
Alex Yiannakakis

Prepared By:
Mark Hartig



BIA PROJECT N12(12-2)(19-2)2&4
NAVAJO, NEW MEXICO TO N64 JUNCTION, ARIZONA (NEAR TSAILE)
 Bridge Sites: N505, Tsaille Creek; N504, Wheatfield Creek; N503, Whiskey Creek;
 N614, Coyote Wash; N613, Tohdildonih Wash
PHOTOGRAPHIC LOG OF ROCK CORE



Photograph No. 27

Bridge N613, Boring No. 2, 14.23 meters to 14.94 meters



Photograph No. 28

Bridge N613, Boring No. 3, 16.15 meters to 19.57 meters

<p>AMEC Job No. 17-2013-4030</p>	<p>Photographed By: Alex Yiannakakis</p>	<p>Prepared By: Mark Hartig</p>	
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BIA PROJECT N12(12-2)(19-2)2&4
NAVAJO, NEW MEXICO TO N64 JUNCTION, ARIZONA (NEAR TSAILE)
Bridge Sites: N505, Tsaille Creek; N504, Wheatfield Creek; N503, Whiskey Creek;
N614, Coyote Wash; N613, Tohdildonih Wash
PHOTOGRAPHIC LOG OF ROCK CORE



Photograph No. 29

Bridge N613, Boring No. 3, 19.57 meters to 22.25 meters



Photograph No. 30

Bridge N613, Boring No. 4, 10.67 meters to 13.53 meters

AMEC Job No.
17-2013-4030

Photographed By:
Alex Yiannakakis

Prepared By:
Mark Hartig



BIA PROJECT N12(12-2)(19-2)2&4
NAVAJO, NEW MEXICO TO N64 JUNCTION, ARIZONA (NEAR TSAILE)
Bridge Sites: N505, Tsaille Creek; N504, Wheatfield Creek; N503, Whiskey Creek;
N614, Coyote Wash; N613, Tohdildonih Wash
PHOTOGRAPHIC LOG OF ROCK CORE



Photograph No. 31

Bridge N613, Boring No. 4, 13.53 meters to 16.15 meters



Photograph 32

Bridge N613, Boring No. 4, 16.15 meters to 16.76 meters

AMEC Job No.
17-2013-4030

Photographed By:
Alex Yiannakakis

Prepared By:
Mark Hartig



BIA PROJECT N12(12-2)(19-2)2&4
NAVAJO, NEW MEXICO TO N64 JUNCTION, ARIZONA (NEAR TSAILE)
Bridge Sites: N505, Tsaille Creek; N504, Wheatfield Creek; N503, Whiskey Creek;
N614, Coyote Wash; N613, Tohdildonih Wash
PHOTOGRAPHIC LOG OF ROCK CORE



Photograph No. 33

Bridge N614, Boring No. 1, 11.58 meters to 14.63 meters



Photograph No. 34

Bridge N614, Boring No. 1, 14.63 meters to 17.68 meters

AMEC Job No.
17-2013-4030

Photographed By:
Alex Yiannakakis

Prepared By:
Mark Hartig



BIA PROJECT N12(12-2)(19-2)2&4
NAVAJO, NEW MEXICO TO N64 JUNCTION, ARIZONA (NEAR TSAILE)
Bridge Sites: N505, Tsaille Creek; N504, Wheatfield Creek; N503, Whiskey Creek;
N614, Coyote Wash; N613, Tohdildonih Wash
PHOTOGRAPHIC LOG OF ROCK CORE



Photograph No. 35

Bridge N614, Boring No. 2, 10.67 meters to 13.90 meters



Photograph No. 36

A Bridge N614, Boring No. 2, 13.90 meters to 16.76 meters

AMEC Job No.
17-2013-4030

Photographed By:
Alex Yiannakakis

Prepared By:
Mark Hartig



BIA PROJECT N12(12-2)(19-2)2&4
NAVAJO, NEW MEXICO TO N64 JUNCTION, ARIZONA (NEAR TSAILE)
Bridge Sites: N505, Tsaille Creek; N504, Wheatfield Creek; N503, Whiskey Creek;
N614, Coyote Wash; N613, Tohdildonih Wash
PHOTOGRAPHIC LOG OF ROCK CORE



Photograph No. 37

Bridge N614, Boring No. 3, 7.62 meters to 11.43 meters



Photograph No. 38

Bridge N614, Boring No. 3, 11.43 meters to 13.72 meters

AMEC Job No.
17-2013-4030

Photographed By:
Alex Yiannakakis

Prepared By:
Mark Hartig



BIA PROJECT N12(12-2)(19-2)2&4
NAVAJO, NEW MEXICO TO N64 JUNCTION, ARIZONA (NEAR TSAILE)
Bridge Sites: N505, Tsaille Creek; N504, Wheatfield Creek; N503, Whiskey Creek;
N614, Coyote Wash; N613, Tohdildonih Wash
PHOTOGRAPHIC LOG OF ROCK CORE



Photograph No. 39

Bridge N614, Boring No. 4, 9.14 meters to 12.37 meters



Photograph No. 40

Bridge N614, Boring No. 4, 12.37 meters to 15.24 meters

AMEC Job No.
17-2013-4030

Photographed By:
Alex Yiannakakis

Prepared By:
Mark Hartig



APPENDIX C

LABORATORY TEST RESULTS

LABORATORY TESTING PROCEDURES

Consolidation Tests Soiltest or Clockhouse apparatus of the "floating-ring" type are employed for the one-dimensional consolidation tests. They are designed to receive 1-inch high 2.5-inch O.D. brass liner rings with soil specimens as secured in the field. Procedures for the tests generally are those outlined in ASTM D2435. Loads are applied in several increments to the upper surface of the test specimen and the resulting deformations are recorded at selected time intervals for each increment. For soils which are essentially saturated, each increment of load is maintained until the deformation versus log of time curve indicates completion of primary consolidation. For partially saturated soils, each increment of load is maintained until the rate of deformation is equal or less than 1/10,000 inch per hour. Applied loads are such that each new increment is equal to the total previously applied loading. Porous stones are placed in contact with the top and bottom of the specimens to permit free addition or expulsion of water. For partially saturated soils, the tests are normally performed at in situ moisture conditions until consolidation is complete under stresses approximately equal to those which will be imposed by the combined overburden and foundation loads. The samples are then submerged to show the effect of moisture increase and the tests continued under higher loadings. Generally, the tests are continued to about twice the anticipated curve due to overburden and structural loads with a rebound curve then being established by releasing loads.

Expansion Tests The same type of consolidometer apparatus described above is used in expansion testing. Undisturbed samples contained in brass liner rings are placed in the consolidometers, subjected to appropriate surcharge loads and submerged. The loads are maintained until the expansion versus log of time curve indicates the completion of "primary swell".

Direct Shear Tests Direct shear tests are run using a Clockhouse or Soiltest apparatus of the strain-control of approximately 0.05 inch per minute. The machine is designed to receive one of the 1-inch high 2.42-inch diameter specimens obtained by tube sampling. Generally, each sample is sheared under a normal load equivalent to the effective overburden pressure at the point of sampling. In some instances, samples are sheared at several normal loads to obtain the cohesion and angle of internal friction. When necessary, samples are saturated and/or consolidated before shearing in order to approximate the anticipated controlling field loading conditions.

**TABLE C-1
SUMMARY OF LABORATORY TEST RESULTS**

Boring Number	Depth (meters)		USCS/Group Symbol or Rock Type	Percent Fines (minus 200)	Liquid Limit	Plasticity Index	Direct Shear Performed	Collapse (%) ¹ [Swell (+) / Collapse (-)]	Unconfined Compressive Strength of Soil (Kpa) ²	Unconfined Compressive Strength of Rock (Kpa) ²
	Begin	End								
N503 B-1	0.00	1.52	SC-SM	30	21	7				
N503 B-1	2.44	2.90	CL	51	30	11				
N503 B-1	3.81	4.27	³ CL-ML				✓			
N503 B-1	5.49	5.94	ML	67	NV	NP				
N503 B-1	7.01	7.47	GM	18	NV	NP				
N503 B-1	10.52	10.67	³ Siltstone							25,249
N503 B-1	13.72	13.94	³ Siltstone							30,100
N503 B-2	1.52	1.98	CL-ML	63	26	7				
N503 B-2	3.05	3.51	CL	52	30	8				
N503 B-2	4.57	4.88	³ CL					-1.2		
N503 B-2	6.10	6.40	GM	13	NV	NP				
N503 B-2	7.62	7.92	³ SM				✓			
N503 B-2	15.39	15.58	³ Siltstone							12,844
N503 B-3	0.00	1.52	CL-ML	50	22	6				
N503 B-3	3.05	3.51	ML	51	19	3				
N503 B-3	4.57	4.88	³ ML						18	
N503 B-3	6.10	6.55	GP-GM	11	NV	NP				
N503 B-3	7.62	8.08	SP-SM	9.1	NV	NP				
N503 B-3	9.14	9.45	SM	12	NV	NP				
N503 B-3	10.67	10.97	SC-SM	22	23	6				
N503 B-3	12.53	12.65	³ Siltstone							18,623
N503 B-3	16.49	16.64	³ Siltstone							40,142
N503 B-4	1.52	1.98	SM	41	NV	NP				
N503 B-4	3.05	3.35	³ SM					-0.3		
N503 B-4	4.57	5.03	GM	16	NV	NP				
N503 B-4	6.10	6.55	SM	40	NV	NP				
N503 B-4	7.62	8.08	SP	1.6	NV	NP				
N503 B-4	9.14	9.45	³ SM				✓			
N503 B-4	13.38	13.53	³ Siltstone							31,202
N503 B-4	15.79	15.85	³ Siltstone							32,531
N504 B-1	0.00	1.52	SM	27	NV	NP				
N504 B-1	2.44	2.74	³ SM					0		
N504 B-1	4.57	5.03	SM	30	18	2				
N504 B-1	12.19	12.50	CL	92	40	20				
N504 B-1	13.72	14.02	CL	89	37	23				
N504 B-1	15.24	15.48	CL	72	42	25				
N504 B-1	16.76	17.07	³ CL				✓			
N504 B-2	3.20	3.35	³ SM				✓			
N504 B-2	4.57	5.03	SM	25	NV	NP				
N504 B-2	9.30	9.60	³ SM						41	
N504 B-3	0.00	1.52	SC	37	30	16				
N504 B-3	3.05	3.51	SC	45	35	22				
N504 B-3	7.01	7.32	³ SM				✓			
N504 B-3	14.48	14.78	³ ML						6	
N504 B-4	1.52	1.98	CL	58	37	23				
N504 B-4	4.72	5.03	³ SM					-0.2		
N504 B-4	7.62	8.08	SP-SM	7.6	NV	NP				
N505 B-1	1.52	1.83	³ SC				✓			
N505 B-1	3.05	3.20	GC	19	25	12				
N505 B-1	6.54	6.71	³ Sandstone							43,733
N505 B-1	10.36	10.55	³ Sandstone							40,539
N505 B-2	1.52	1.98	SC	39	26	13				

**TABLE C-1
SUMMARY OF LABORATORY TEST RESULTS**

Boring Number	Depth (meters)		USCS/Group Symbol or Rock Type	Percent Fines (minus 200)	Liquid Limit	Plasticity Index	Direct Shear Performed	Collapse (%) ¹ [Swell (+) / Collapse (-)]	Unconfined Compressive Strength of Soil (Kpa) ²	Unconfined Compressive Strength of Rock (Kpa) ²
	Begin	End								
N505 B-2	2.29	2.59	³ SC				✓			
N505 B-2	3.81	3.96	SC	43	34	14				
N505 B-2	11.70	11.90	³ Sandstone							39,061
N505 B-2	13.38	13.53	³ Sandstone							33,827
N505 B-3	1.22	1.68	CL	75	36	20				
N505 B-3	6.22	6.43	³ Sandstone							42,314
N505 B-3	10.47	10.61	³ Sandstone							24,694
N505 B-4	0.00	1.52	CL	54	29	14				
N505 B-4	1.52	1.83	³ SM				✓			
N505 B-4	9.02	9.17	³ Sandstone							37,604
N613 B-1	1.52	1.98	SM	30	NV	NP				
N613 B-1	3.05	3.35	³ SM				✓			
N613 B-1	4.57	5.03	SM	30	NV	NP				
N613 B-1	6.10	6.25	SM	20	NV	NP				
N613 B-1	10.45	10.61	³ Siltstone							6,921
N613 B-1	13.20	13.35	³ Siltstone							16,986
N613 B-2	0.00	1.52	SC	48	28	14				
N613 B-2	3.05	3.51	SM	31	NV	NP				
N613 B-2	6.10	6.55	SM	37	NV	NP				
N613 B-2	7.62	8.08	SP-SM	8.8	NV	NP				
N613 B-2	10.70	10.82	³ Siltstone							6,040
N613 B-2	12.98	13.20	³ Siltstone							15,997
N613 B-3	1.52	1.98	SM	27	NV	NP				
N613 B-3	3.05	3.35	³ SM					-0.1		
N613 B-3	4.57	5.03	SM	17	NV	NP				
N613 B-3	6.10	6.55	SC	37	27	9				
N613 B-3	7.62	7.92	³ SC				✓			
N613 B-3	9.14	9.60	CL	75	44	27				
N613 B-3	10.67	11.13	CL	77	37	23				
N613 B-3	12.19	12.50	³ SM				✓			
N613 B-3	13.72	14.17	SM	33	NV	NP				
N613 B-3	15.24	15.70	SM	34	NV	NP				
N613 B-3	19.78	19.93	³ Siltstone							6,049
N613 B-4	1.52	1.98	SM	36	NV	NP				
N613 B-4	3.05	3.35	³ SM					-0.1		
N613 B-4	6.10	6.40	³ SM				✓			
N613 B-4	7.62	8.08	SP-SM	5.3	NV	NP				
N613 B-4	9.14	9.60	CL	70	46	32				
N613 B-4	10.67	11.13	ML	71	NV	NP				
N613 B-4	12.86	13.01	³ Siltstone							18,325
N613 B-4	15.15	15.32	³ Siltstone							12,018
N614 B-1	1.68	1.98	³ SC					-0.1		
N614 B-1	3.05	3.51	SM	39	NV	NP				
N614 B-1	4.57	5.03	CL-ML	50	24	7				
N614 B-1	6.25	6.55	³ SM				✓			
N614 B-1	7.62	8.08	SP-SM	5.6	NV	NP				
N614 B-1	9.14	9.60	SM	13	NV	NP				
N614 B-1	10.67	11.13	SP-SM	5.6	NV	NP				
N614 B-1	13.90	14.02	³ Siltstone/Claystone							7,445
N614 B-1	17.10	17.22	³ Siltstone/Claystone							18,795
N614 B-2	3.05	3.51	SC	38	28	12				
N614 B-2	4.57	4.88	³ SC					-0.7		

**TABLE C-1
SUMMARY OF LABORATORY TEST RESULTS**

Boring Number	Depth (meters)		USCS/Group Symbol or Rock Type	Percent Fines (minus 200)	Liquid Limit	Plasticity Index	Direct Shear Performed	Collapse (%) ¹ [Swell (+) / Collapse (-)]	Unconfined Compressive Strength of Soil (Kpa) ²	Unconfined Compressive Strength of Rock (Kpa) ²
	Begin	End								
N614 B-2	6.10	6.55	SM	34	NV	NP				
N614 B-2	9.14	9.60	SP-SM	6.3	NV	NP				
N614 B-2	10.67	10.97	³ CL-ML				✓			
N614 B-2	13.11	13.26	³ Siltstone/Claystone							10,887
N614 B-2	16.22	16.34	³ Siltstone/Claystone							14,321
N614 B-3	0.00	1.52	SC	32	27	13				
N614 B-3	1.52	1.98	GC	33	30	15				
N614 B-3	3.05	3.51	CL	53	32	16				
N614 B-3	6.10	6.55	SM	41	NV	NP				
N614 B-3	9.85	10.00	³ Siltstone/Claystone							12,149
N614 B-3	11.89	12.01	³ Siltstone/Claystone							15,093
N614 B-4	1.52	1.98	SC	36	29	13				
N614 B-4	3.05	3.35	³ SC				✓			
N614 B-4	4.57	5.03	SC	26	41	24				
N614 B-4	6.10	6.55	SC	43	28	11				
N614 B-4	7.62	8.08	SC-SM	38	25	7				
N614 B-4	9.14	9.45	SM	23	NV	NP				
N614 B-4	13.44	13.66	³ Siltstone/Claystone							9,758
Average				36.8				-0.3	21.7	22,259
Standard Deviation				21.5				0.4	17.8	12,494
Maximum				92				0	41	43,733
Minimum				2				-1.2	6.0	6,040
Count				67	67	67	16	8	3	28



PROJECT: BIA project N12(12-2)(19-2)2+4
 LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
 SAMPLE SOURCE: SEE BELOW

JOB NO: 1720134030.0002
 WORK ORDER NO: 3
 DATE ASSIGNED: 10/2/13

Liquid Limit, Plastic Limit & Plasticity Index (AASHTO T89-10 & T90-00)
 Sieve Analysis of Fine and Coarse Aggregates (AASHTO T27-11 & T11-05)
 GROUP SYMBOL, USCS (ASTM D-2487)

SIEVE SIZES

Location & Depth	USCS	LL	PI	Silt or Clay	SAND								GRAVEL						COBBLES	
					Fine			Medium			Coarse		Fine			Coarse			152mm	Lab #
					75um	150um	300um	425um	600um	1.18mm	2.00mm	2.36mm	4.75mm	6.3mm	9.5mm	12.5mm	19mm	25mm		

PERCENT PASSING BY WEIGHT

N504 B-1; 4.57 m - 5.03 m	SM	18	2	30	54	84	95	98	99	100	100	100	100	100	100	100	100	100	100	100	100	100	247
N504 B-1; 12.19 m - 12.50 m	CL	40	20	92	95	97	99	99	100	100	100	100	100	100	100	100	100	100	100	100	100	100	249
N504 B-1; 13.72 m - 14.02 m	CL	37	23	89	93	96	97	98	98	99	99	100	100	100	100	100	100	100	100	100	100	100	250
N504 B-1; 15.24 m - 15.48 m	CL	42	25	72	77	80	82	84	88	91	93	97	98	99	100	100	100	100	100	100	100	100	251
N504 B-2; 4.57 m - 5.03 m	SM	NV	NP	25	52	84	95	98	99	100	100	100	100	100	100	100	100	100	100	100	100	100	260
N504 B-3; 3.05 m - 3.51 m	SC	35	22	45	52	70	78	81	82	82	83	84	84	84	84	86	86	100	100	100	100	100	272
N504 B-4; 1.52 m - 1.98 m	CL	37	23	58	68	88	95	98	99	99	99	100	100	100	100	100	100	100	100	100	100	100	285
N504 B-4; 7.62 m - 8.08 m	SP-SM	NV	NP	7.6	18	39	47	51	53	54	55	60	63	69	73	86	90	100	100	100	100	100	288
N504 B-1; 0.00 m - 1.52 m	SM	NV	NP	27	48	75	86	90	92	93	93	95	95	97	98	99	99	99	100	100	100	100	300
N504 B-3; 0.00 m - 1.52 m	SC	30	16	37	51	75	85	90	93	94	95	97	98	99	99	100	100	100	100	100	100	100	302



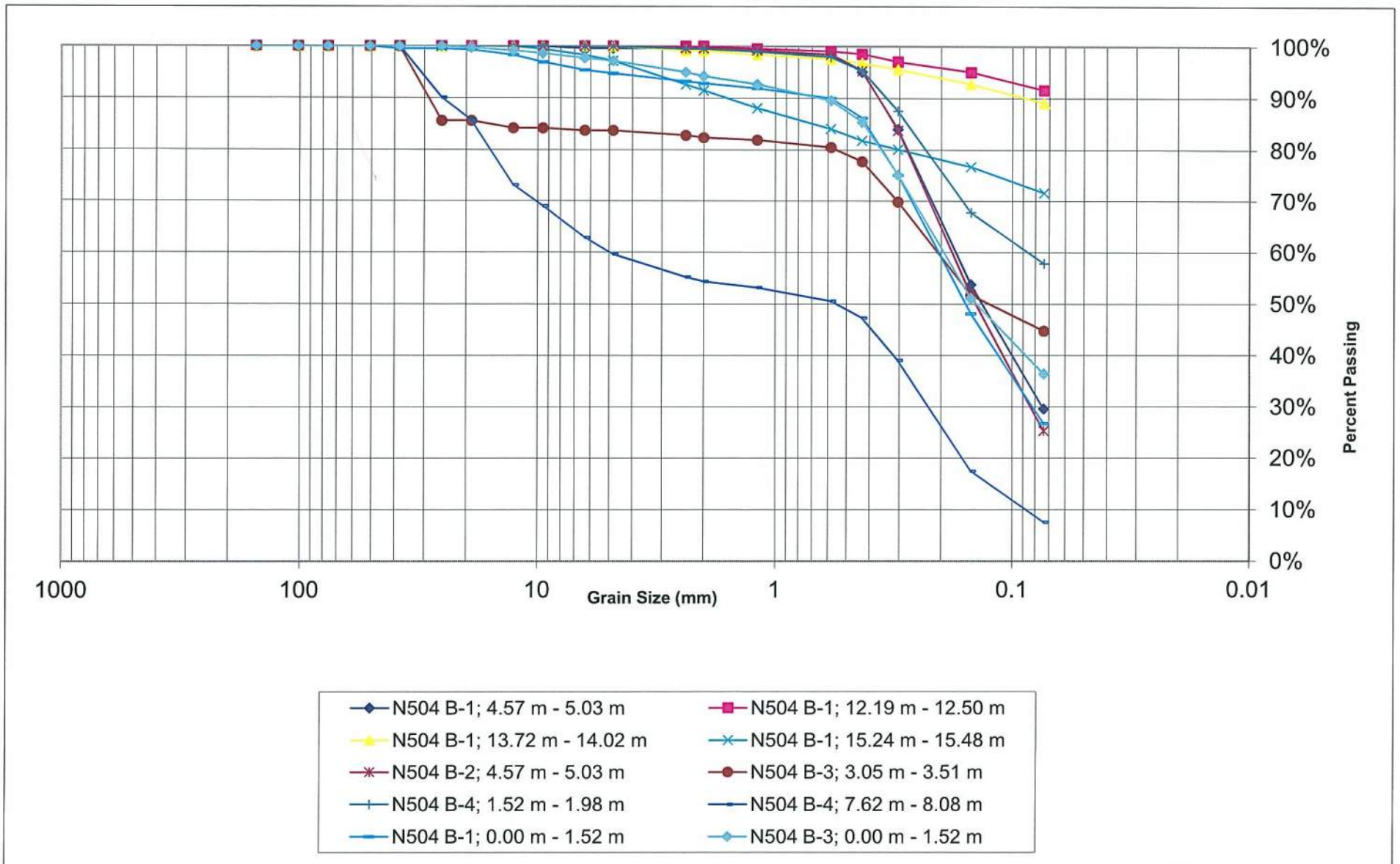
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[Signature]

PROJECT: BIA project N12(12-2)(19-2)2+4
 LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
 SAMPLE SOURCE: SEE BELOW

JOB NO: 1720134030.0002
 WORK ORDER NO: 3
 DATE ASSIGNED: 10/2/13

MECHANICAL SIEVE ANALYSIS



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PROJECT: BIA project N12(12-2)(19-2)2+4
 LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
 SAMPLE SOURCE: SEE BELOW

JOB NO: 1720134030.0002
 WORK ORDER NO: 4
 DATE ASSIGNED: 11/4/13

Liquid Limit, Plastic Limit & Plasticity Index (AASHTO T89-10 & T90-00)
 Sieve Analysis of Fine and Coarse Aggregates (AASHTO T27-11 & T11-05)
 GROUP SYMBOL, USCS (ASTM D-2487)

SIEVE SIZES

Location & Depth	USCS	LL	PI	Silt or Clay	SAND								GRAVEL						COBBLES	Lab #
					75um	150um	300um	425um	600um	1.18um	2.00mm	2.36mm	4.75mm	6.3mm	9.5mm	12.5mm	19mm	25mm		

PERCENT PASSING BY WEIGHT

N503 B-1 @ 0.00 m - 1.52 m	SC-SM	21	7	30	40	54	60	63	68	72	74	82	85	90	94	97	98	99	100	100	100	100	372
N503 B-3 @ 0.00 m - 1.52 m	CL-ML	22	6	50	65	80	86	89	91	93	94	96	97	98	99	100	100	100	100	100	100	100	374
N613 B-2 @ 0.00 m - 1.52 m	SC	28	14	48	62	70	73	75	78	81	82	87	90	94	96	98	99	100	100	100	100	100	377
N614 B-3 @ 0.00 m - 1.52 m	SC	27	13	32	37	42	44	47	52	57	60	69	73	80	85	90	94	96	97	100	100	100	382
N505 B-4 @ 0.00 m - 1.52 m	CL	29	14	54	70	80	84	86	88	89	89	91	93	96	98	100	100	100	100	100	100	100	386
N503 B-1 @ 2.44 m - 2.90 m	CL	30	11	51	58	64	66	68	71	74	75	81	83	84	85	85	85	100	100	100	100	100	387
N503 B-1 @ 5.49 m - 5.94 m	ML	NV	NP	67	89	95	96	97	98	99	99	100	100	100	100	100	100	100	100	100	100	100	389
N503 B-1 @ 7.01 m - 7.47 m	GM	NV	NP	18	26	33	38	43	47	49	50	56	59	65	71	90	95	100	100	100	100	100	390
N503 B-2 @ 1.52 m - 1.98 m	CL-ML	26	7	63	71	78	82	84	88	90	92	96	98	100	100	100	100	100	100	100	100	100	391
N503 B-2 @ 3.05 m - 3.51 m	CL	30	8	52	59	67	71	74	79	83	85	90	92	94	95	100	100	100	100	100	100	100	392

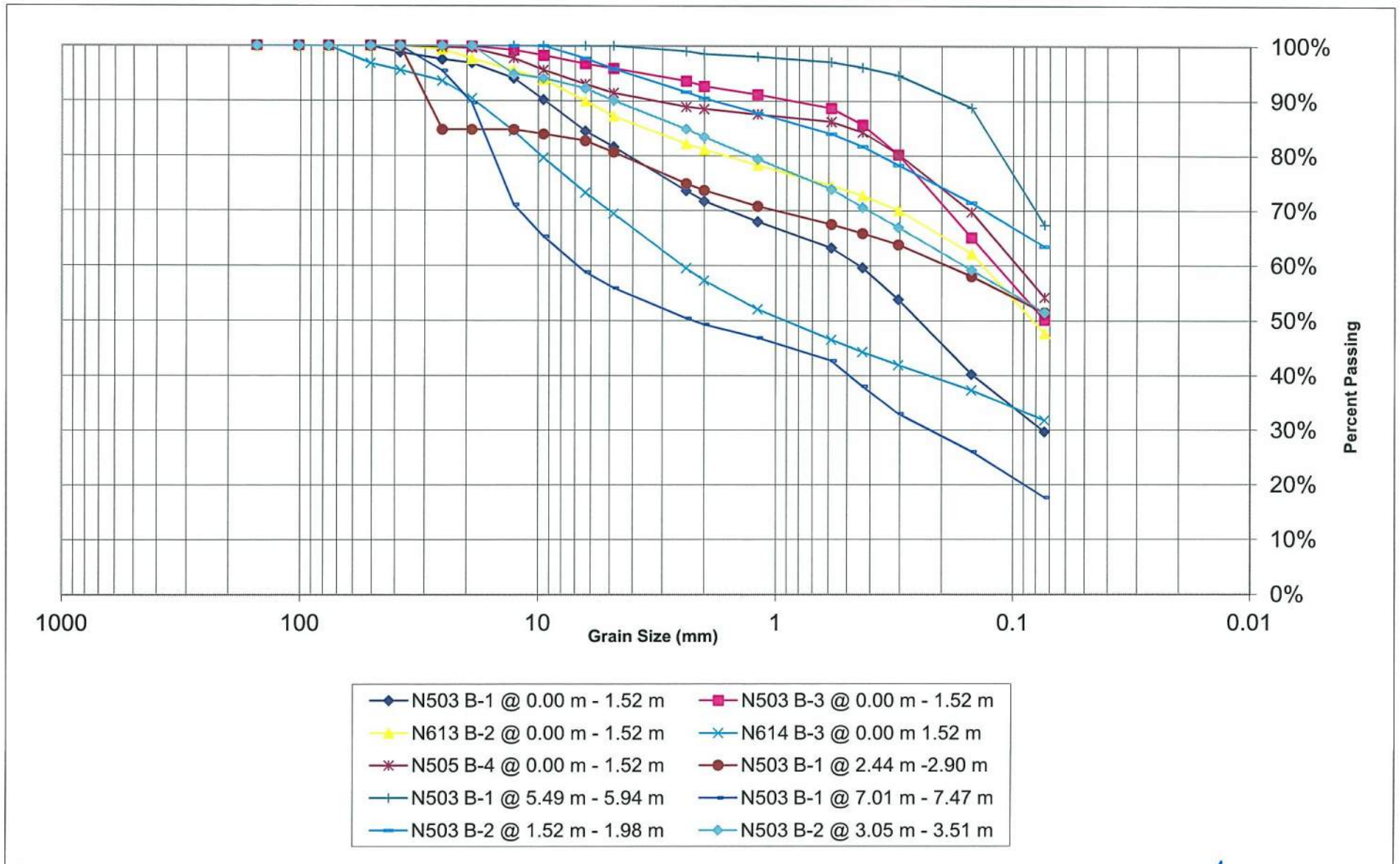


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PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
SAMPLE SOURCE: SEE BELOW

JOB NO: 1720134030.0002
WORK ORDER NO: 4
DATE ASSIGNED: 11/4/13

MECHANICAL SIEVE ANALYSIS



REVIEWED BY _____



PROJECT: BIA project N12(12-2)(19-2)2+4
 LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
 SAMPLE SOURCE: SEE BELOW

JOB NO: 1720134030.0002
 WORK ORDER NO: 4
 DATE ASSIGNED: 11/4/13

Liquid Limit, Plastic Limit & Plasticity Index (AASHTO T89-10 & T90-00)
 Sieve Analysis of Fine and Coarse Aggregates (AASHTO T27-11 & T11-05)
 GROUP SYMBOL, USCS (ASTM D-2487)

SIEVE SIZES

Location & Depth	USCS	LL	PI	Silt or Clay	SAND								GRAVEL								COBBLES	Lab #
					Fine			Medium			Coarse		Fine				Coarse					
					75um	150um	300um	425um	600um	1.18um	2.00mm	2.36mm	4.75mm	6.3mm	9.5mm	12.5mm	19mm	25mm	31.2mm	37.5mm		

PERCENT PASSING BY WEIGHT

N503 B-2 @ 6.10 m - 6.40 m	GM	NV	NP	13	18	25	30	34	39	42	43	50	53	61	64	78	93	100	100	100	100	100	393
N503 B-3 @ 3.05 m - 3.51 m	ML	19	3	51	68	84	89	92	95	96	96	98	98	99	100	100	100	100	100	100	100	100	397
N503 B-3 @ 6.10 m - 6.55 m	GP-GM	NV	NP	11	17	25	30	34	37	39	41	47	51	61	67	82	89	100	100	100	100	100	398
N503 B-3 @ 7.62 m - 8.08 m	SP-SM	NV	NP	9.1	15	25	32	37	42	45	47	55	59	69	77	90	100	100	100	100	100	100	399
N503 B-3 @ 9.14 m - 9.45 m	SM	NV	NP	12	16	23	27	32	38	41	44	57	62	72	80	84	100	100	100	100	100	100	400
N503 B-3 @ 10.67 m - 10.97 m	SC-SM	23	6	22	25	31	34	38	44	51	55	69	76	88	91	100	100	100	100	100	100	100	401
N503 B-4 @ 1.52 m - 1.98 m	SM	NV	NP	41	57	74	80	83	86	88	88	89	90	93	96	100	100	100	100	100	100	100	402
N503 B-4 @ 4.57 m - 5.03 m	GM	NV	NP	16	21	28	32	34	38	40	42	47	49	57	61	74	100	100	100	100	100	100	403
N503 B-4 @ 6.10 m - 6.55 m	SM	NV	NP	40	62	83	91	95	97	98	98	99	100	100	100	100	100	100	100	100	100	100	404
N503 B-4 @ 7.62 m - 8.08 m	SP	NV	NP	1.6	7	27	44	52	57	58	59	63	66	71	77	87	100	100	100	100	100	100	405

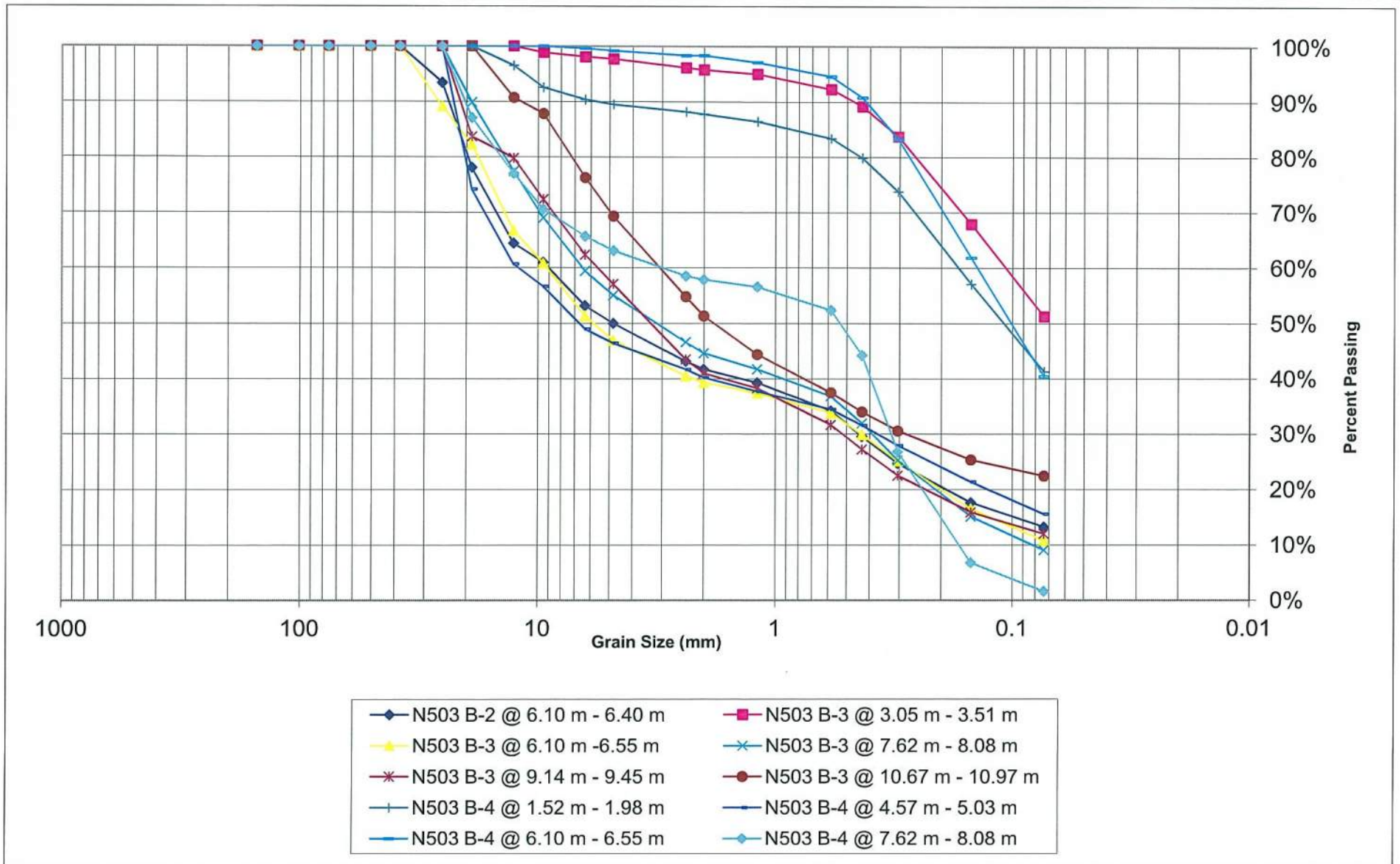


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PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
SAMPLE SOURCE: SEE BELOW

JOB NO: 1720134030.0002
WORK ORDER NO: 4
DATE ASSIGNED: 11/4/13

MECHANICAL SIEVE ANALYSIS



REVIEWED BY



PROJECT: BIA project N12(12-2)(19-2)2+4
 LOCATION: Navajo, NM to N64 junction AZ (near Tsaile, AZ)
 SAMPLE SOURCE: SEE BELOW

JOB NO: 1720134030.0002
 WORK ORDER NO: 4
 DATE ASSIGNED: 11/4/13

Liquid Limit, Plastic Limit & Plasticity Index (AASHTO T89-10 & T90-00)
 Sieve Analysis of Fine and Coarse Aggregates (AASHTO T27-11 & T11-05)
 GROUP SYMBOL, USCS (ASTM D-2487)

SIEVE SIZES

Location & Depth	USCS	LL	PI	Silt or Clay	SAND								GRAVEL						COBBLES	Lab #
					Fine			Medium			Coarse		Fine			Coarse				
					75um	150um	300um	425um	600um	1.18mm	2.00mm	2.36mm	4.75mm	6.3mm	9.5mm	12.5mm	19mm	25mm		

PERCENT PASSING BY WEIGHT

N613 B-1 @ 1.52 m - 1.98 m	SM	NV	NP	30	58	81	86	90	94	95	96	97	98	99	100	100	100	100	100	100	100	100	100	100	406
N613 B-1 @ 4.57 m - 5.03 m	SM	NV	NP	30	57	79	86	90	94	96	96	98	99	99	100	100	100	100	100	100	100	100	100	100	407
N613 B-1 @ 6.10 m - 6.25 m	SM	NV	NP	20	50	84	91	94	97	98	98	99	99	99	100	100	100	100	100	100	100	100	100	100	408
N613 B-2 @ 3.05 m - 3.51 m	SM	NV	NP	31	78	97	99	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	410
N613 B-2 @ 6.10 m - 6.55 m	SM	NV	NP	37	72	85	92	96	99	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	411
N613 B-2 @ 7.62 m - 8.08 m	SP-SM	NV	NP	8.8	24	58	72	79	83	85	85	86	87	88	88	88	88	100	100	100	100	100	100	100	412
N613 B-3 @ 1.52 m - 1.98 m	SM	NV	NP	27	66	93	97	98	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	413
N613 B-3 @ 4.57 m - 5.03 m	SM	NV	NP	17	54	85	93	97	99	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	414
N613 B-3 @ 6.10 m - 6.55 m	SC	27	9	37	73	93	95	96	97	98	98	99	100	100	100	100	100	100	100	100	100	100	100	100	415
N613 B-3 @ 9.14 m - 9.60 m	CL	44	27	75	92	98	99	99	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	416

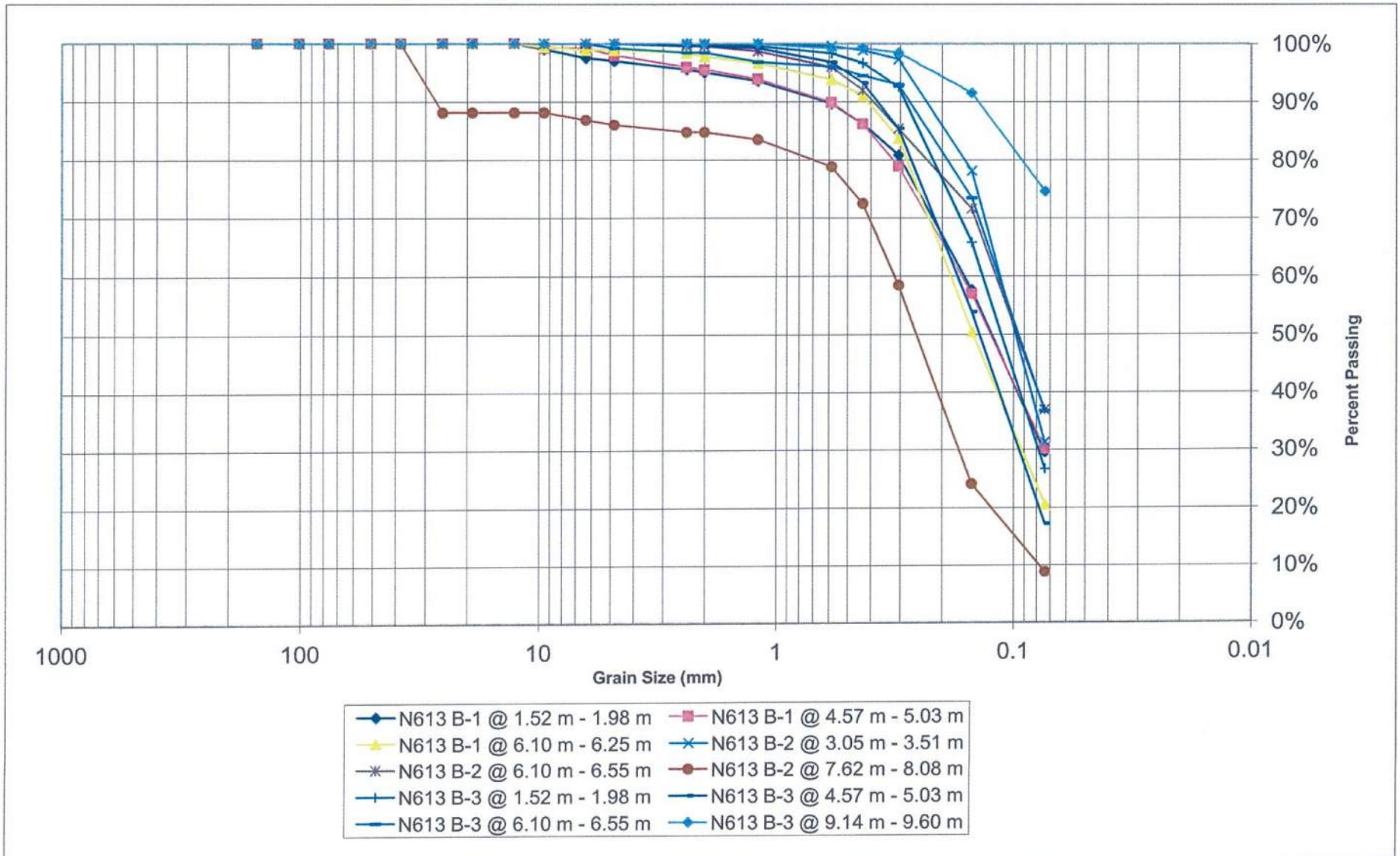


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PROJECT: BIA project N12(12-2)(19-2)2+4
 LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
 SAMPLE SOURCE: SEE BELOW

JOB NO: 1720134030.0002
 WORK ORDER NO: 4
 DATE ASSIGNED: 11/4/13

MECHANICAL SIEVE ANALYSIS



REVIEWED BY *cy*



PROJECT: BIA project N12(12-2)(19-2)2+4
 LOCATION: Navajo, NM to N64 junction AZ (near Tsalle, AZ)
 SAMPLE SOURCE: SEE BELOW

JOB NO: 1720134030.0002
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Liquid Limit, Plastic Limit & Plasticity Index (AASHTO T89-10 & T90-00)
 Sieve Analysis of Fine and Coarse Aggregates (AASHTO T27-11 & T11-05)
 GROUP SYMBOL, USCS (ASTM D-2487)

SIEVE SIZES

Location & Depth	USCS	LL	PI	Silt or Clay	SAND								GRAVEL								COBBLES	Lab #
					Fine			Medium			Coarse		Fine				Coarse					
					75um	150um	300um	425um	600um	1.18um	2.00mm	2.36mm	4.75mm	6.3mm	9.5mm	12.5mm	19mm	25mm	31.2mm	37.5mm		

PERCENT PASSING BY WEIGHT

N613 B-3 @ 10.67 m - 11.13 m	CL	37	23	77	90	95	97	98	98	99	99	100	100	100	100	100	100	100	100	100	100	100	100	417	
N613 B-3 @ 13.72 m - 14.17 m	SM	NV	NP	33	48	61	68	73	83	89	91	95	96	96	99	100	100	100	100	100	100	100	100	100	418
N613 B-3 @ 15.24 m - 15.70 m	SM	NV	NP	34	44	48	53	58	70	78	81	90	94	97	100	100	100	100	100	100	100	100	100	100	419
N613 B-4 @ 1.52 m - 1.98 m	SM	NV	NP	36	74	94	97	98	99	100	100	100	100	100	100	100	100	100	100	100	100	100	100	420	
N613 B-4 @ 7.62 m - 8.08 m	SP-SM	NV	NP	5.3	19	53	74	84	92	95	96	99	100	100	100	100	100	100	100	100	100	100	100	421	
N613 B-4 @ 9.14 m - 9.60 m	CL	46	32	70	80	90	94	96	98	99	99	100	100	100	100	100	100	100	100	100	100	100	100	422	
N613 B-4 @ 10.67 m - 11.13 m	ML	NV	NP	71	80	88	90	91	93	94	95	98	99	100	100	100	100	100	100	100	100	100	100	423	
N614 B-1 @ 3.05 m - 3.51 m	SM	NV	NP	39	70	95	99	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	424	
N614 B-1 @ 4.57 m - 5.03 m	CL-ML	24	7	50	79	95	98	99	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	425	
N614 B-1 @ 7.62 m - 8.08 m	SP-SM	NV	NP	5.6	18	49	67	86	99	100	100	100	100	100	100	100	100	100	100	100	100	100	100	426	

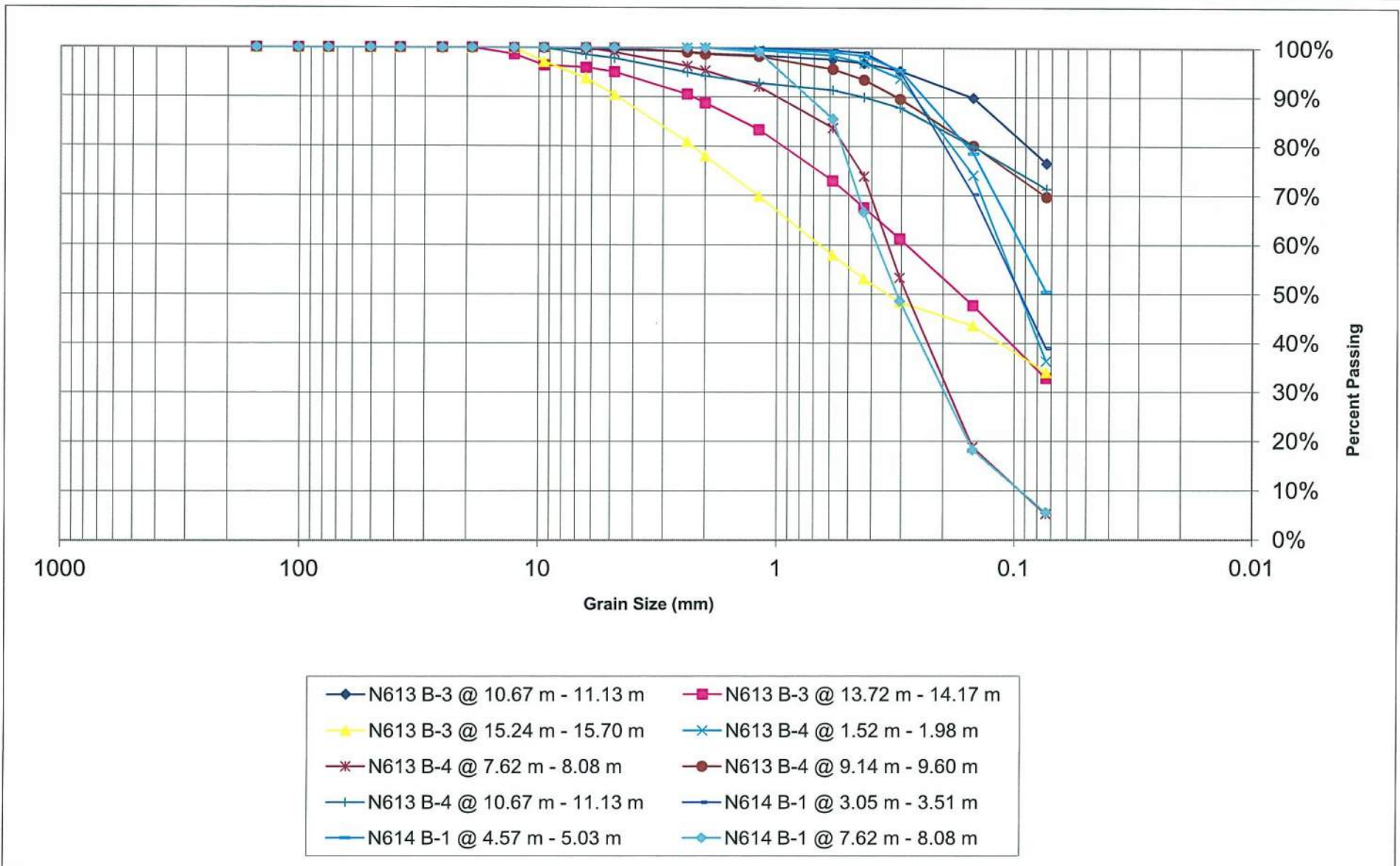


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PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsalle, AZ)
SAMPLE SOURCE: SEE BELOW

JOB NO: 1720134030.0002
WORK ORDER NO: 4
DATE ASSIGNED: 11/4/13

MECHANICAL SIEVE ANALYSIS



REVIEWED BY 



PROJECT: BIA project N12(12-2)(19-2)2+4
 LOCATION: Navajo, NM to N64 junction AZ (near Tsaile, AZ)
 SAMPLE SOURCE: SEE BELOW

JOB NO: 1720134030.0002
 WORK ORDER NO: 4
 DATE ASSIGNED: 11/4/13

Liquid Limit, Plastic Limit & Plasticity Index (AASHTO T89-10 & T90-00)
 Sieve Analysis of Fine and Coarse Aggregates (AASHTO T27-11 & T11-05)
 GROUP SYMBOL, USCS (ASTM D-2487)

SIEVE SIZES

Location & Depth	USCS	LL	PI	Silt or Clay	SAND								GRAVEL						COBBLES	Lab #
					75um	150um	300um	425um	600um	1.18um	2.00mm	2.36mm	4.75mm	6.3mm	9.5mm	12.5mm	19mm	25mm		

PERCENT PASSING BY WEIGHT

N614 B-1 @ 9.14 m - 9.60 m	SM	NV	NP	13	17	31	45	58	71	76	77	81	83	87	92	94	100	100	100	100	100	100	100	427
N614 B-1 @ 10.67 m - 11.13 m	SP-SM	NV	NP	5.6	12	60	82	91	95	97	97	98	98	100	100	100	100	100	100	100	100	100	100	428
N614 B-2 @ 3.05 m - 3.51 m	SC	28	12	38	45	54	58	63	70	73	74	80	83	88	93	100	100	100	100	100	100	100	100	430
N614 B-2 @ 6.1 m - 6.55 m	SM	NV	NP	34	68	97	99	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	431
N614 B-2 @ 9.14 m - 9.60 m	SP-SM	NV	NP	6.3	15	46	70	86	94	96	97	98	99	99	100	100	100	100	100	100	100	100	100	432
N614 B-3 @ 1.52 m - 1.98 m	GC	30	15	33	39	44	46	48	54	56	58	65	68	76	79	85	85	100	100	100	100	100	100	433
N614 B-3 @ 3.05 m - 3.51 m	CL	32	16	53	65	77	81	83	87	90	91	95	97	99	100	100	100	100	100	100	100	100	100	434
N614 B-3 @ 6.10 m - 6.55 m	SM	NV	NP	41	57	69	73	76	83	87	89	96	97	99	100	100	100	100	100	100	100	100	100	435
N614 B-4 @ 1.52 m - 1.98 m	SC	29	13	36	42	47	50	52	59	64	66	74	77	84	90	100	100	100	100	100	100	100	100	436
N614 B-4 @ 4.57 m - 5.03 m	SC	41	24	26	29	39	46	54	70	74	74	79	80	84	85	100	100	100	100	100	100	100	100	437

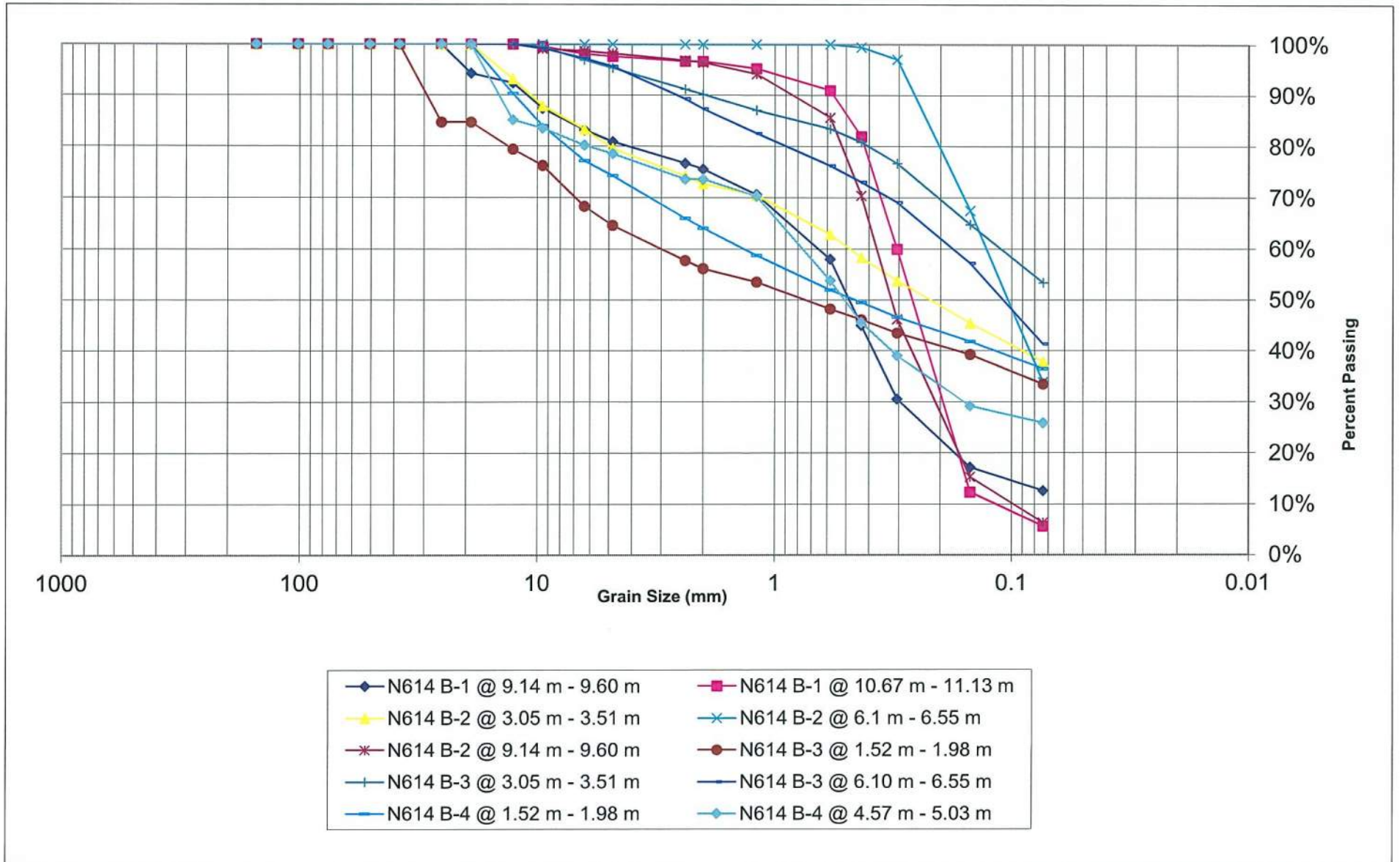


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PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
SAMPLE SOURCE: SEE BELOW

JOB NO: 1720134030.0002
WORK ORDER NO: 4
DATE ASSIGNED: 11/4/13

MECHANICAL SIEVE ANALYSIS



REVIEWED BY



PROJECT: BIA project N12(12-2)(19-2)2+4
 LOCATION: Navajo, NM to N64 junction AZ (near Tsaila, AZ)
 SAMPLE SOURCE: SEE BELOW

JOB NO: 1720134030.0002
 WORK ORDER NO: 4
 DATE ASSIGNED: 11/4/13

Liquid Limit, Plastic Limit & Plasticity Index (AASHTO T89-10 & T90-00)
 Sieve Analysis of Fine and Coarse Aggregates (AASHTO T27-11 & T11-05)
 GROUP SYMBOL, USCS (ASTM D-2487)

SIEVE SIZES

Location & Depth	USCS	LL	PI	Silt or Clay	SAND									GRAVEL						COBBLES	
					Fine			Medium			Coarse			Fine			Coarse			152mm	Lab #
					75um	150um	300um	425um	600um	1.18um	2.00mm	2.36mm	4.75mm	6.3mm	9.5mm	12.5mm	19mm	25mm	31.2mm		

PERCENT PASSING BY WEIGHT

N614 B-4 @ 6.10 m - 6.55 m	SC	28	11	43	50	54	57	59	65	70	72	80	82	85	86	86	86	100	100	100	100	100	438
N614 B-4 @ 7.62 m - 8.08 m	SC-SM	25	7	38	42	47	50	54	65	73	76	86	89	94	95	100	100	100	100	100	100	100	439
N614 B-4 @ 9.14 m - 9.45 m	SM	NV	NP	23	26	30	33	36	44	52	55	66	73	77	80	90	100	100	100	100	100	100	440
N505 B-1 3.05 m - 3.20 m	GC	25	12	19	33	45	48	49	50	51	51	53	55	58	61	65	78	100	100	100	100	100	441
N505 B-2 @ 1.52 m - 1.98 m	SC	26	13	39	60	69	72	74	80	84	86	92	94	97	97	100	100	100	100	100	100	100	442
N505 B-2 @ 3.81 m - 3.96 m	SC	34	14	43	56	69	75	80	92	97	99	100	100	100	100	100	100	100	100	100	100	100	443
N505 B-3 @ 1.22 m - 1.68 m	CL	36	20	75	89	95	97	97	98	98	99	99	99	100	100	100	100	100	100	100	100	100	444

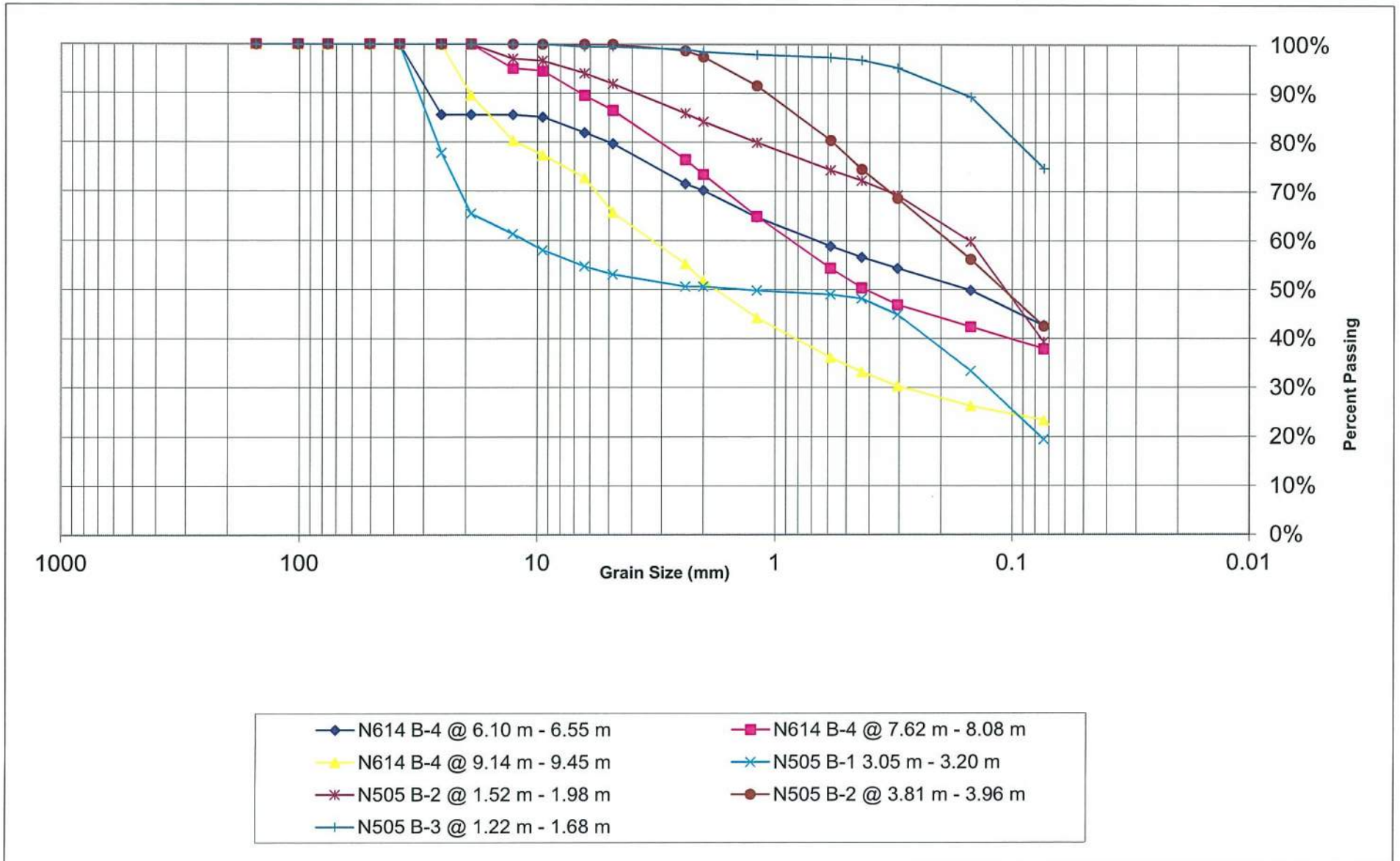


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PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
SAMPLE SOURCE: SEE BELOW

JOB NO: 1720134030.0002
WORK ORDER NO: 4
DATE ASSIGNED: 11/4/13

MECHANICAL SIEVE ANALYSIS



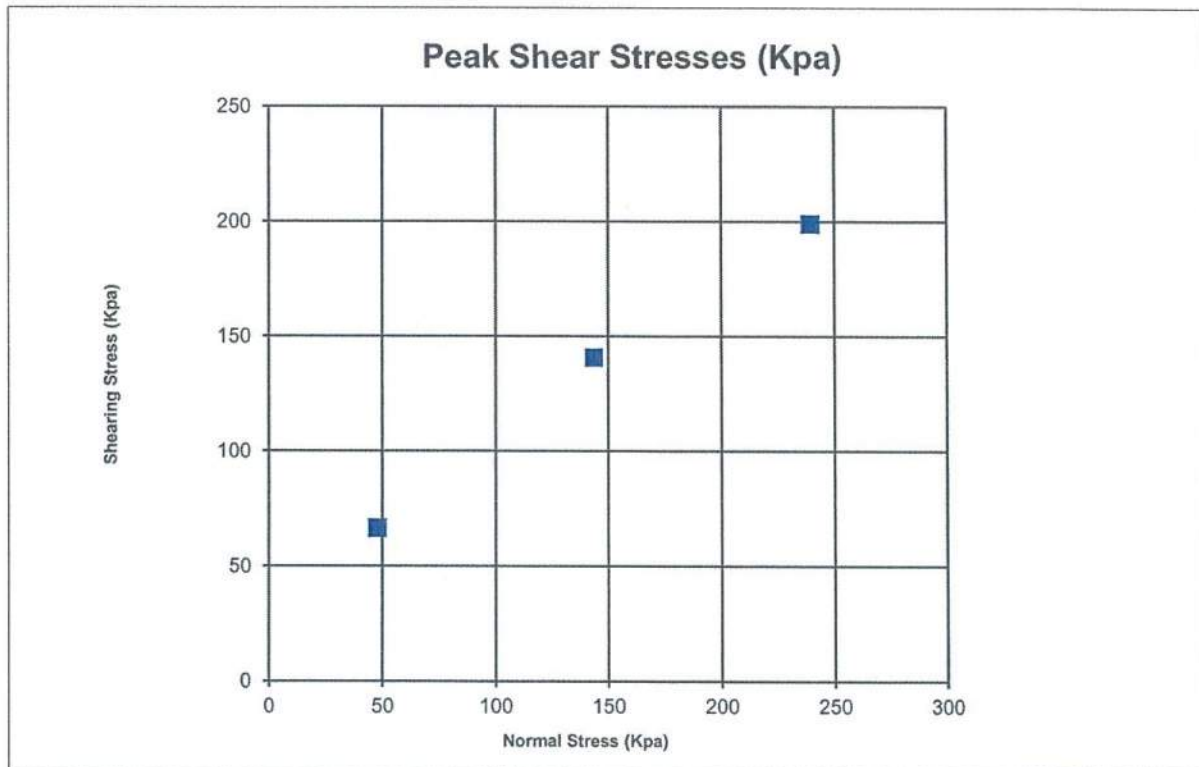
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PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N503 B-1 @ 3.81 m - 4.27 m
SAMPLE PREPARATION: Insitu-Saturate

JOB NO: 1720134030.0002
WORK ORDER NO: 4
LAB NO: 445
DATE ASSIGNED: 11/4/2013

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (AASHTO T-236)

Initial thickness of specimen (mm):	25.4		
Initial diameter of specimen (mm):	61.5		
Shearing device used:	DigiShear Automated Shear Test System by Trautwein Soil Testing Equipment		
Rate of deformation (mm/min):	0.4064		
Direct shear point (Kpa):	47.9	143.6	239.4
Dry mass of specimen (g):	124.0	124.7	122.9
Initial Moisture Content:	19.5%	16.9%	21.7%
Initial Wet Density (Kg per cu.m):	1965.4	1934.2	1984.1
Initial Dry Density (Kg per cu.m):	1645.0	1654.6	1631.0
Final Moisture Content:	31.0%	27.5%	30.6%
Final Wet Density (Kg per cu.m):	2153.3	2108.9	2128.8
Final Dry Density (Kg per cu.m):	1644.2	1653.9	1630.3
Normal Stress (kpa):	47.9	143.6	239.4
Maximum Shearing Stress (Kpa):	66.51	140.65	198.89
Vertical Deformation @ Max Shear (mm):	0.245	-0.004	-0.190
Horizontal Deformation @ Max Shear (mm):	2.892	3.422	12.628



REVIEWED BY _____

Deey

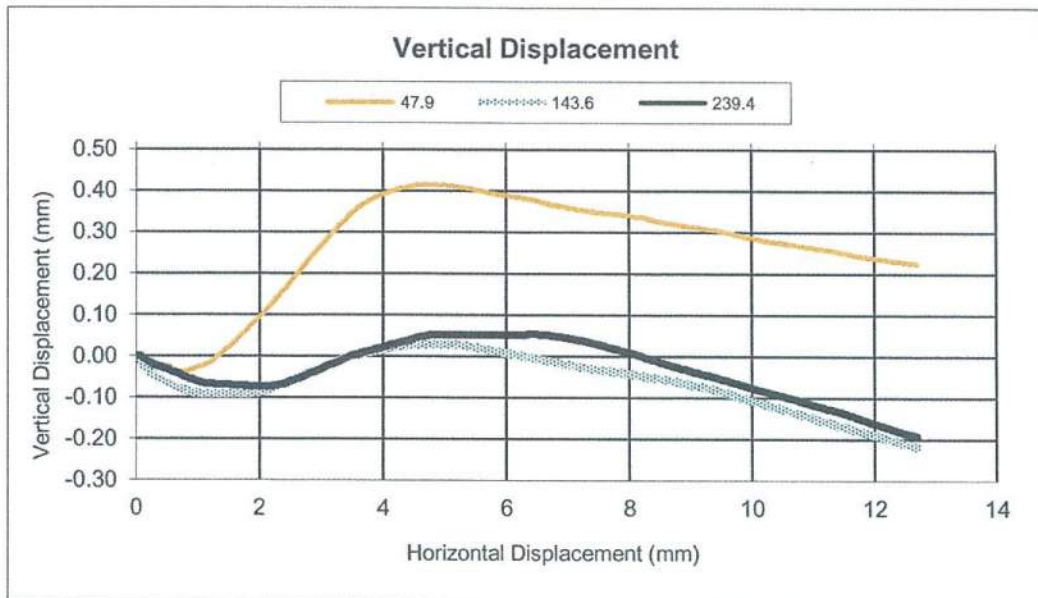
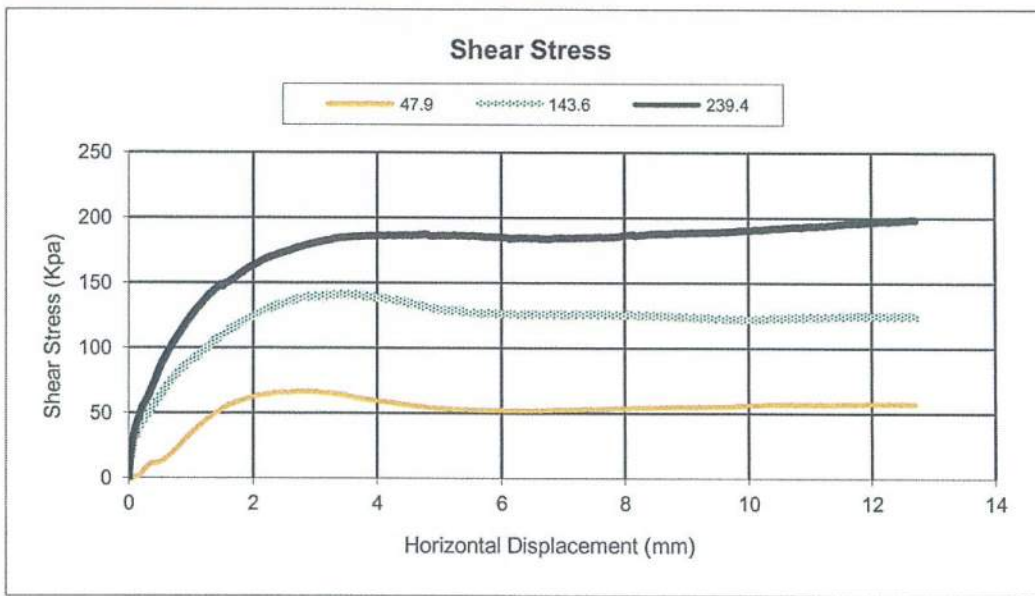


PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsalle, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N503 B-1 @ 3.81 m - 4.27 m
SAMPLE PREPARATION: Insitu-Saturate

JOB NO: 1720134030.0002
WORK ORDER NO: 4
LAB NO: 445
DATE ASSIGNED: 11/4/2013

NORMAL LOADS (Kpa): 47.9 143.6 239.4

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (AASHTO T-236)



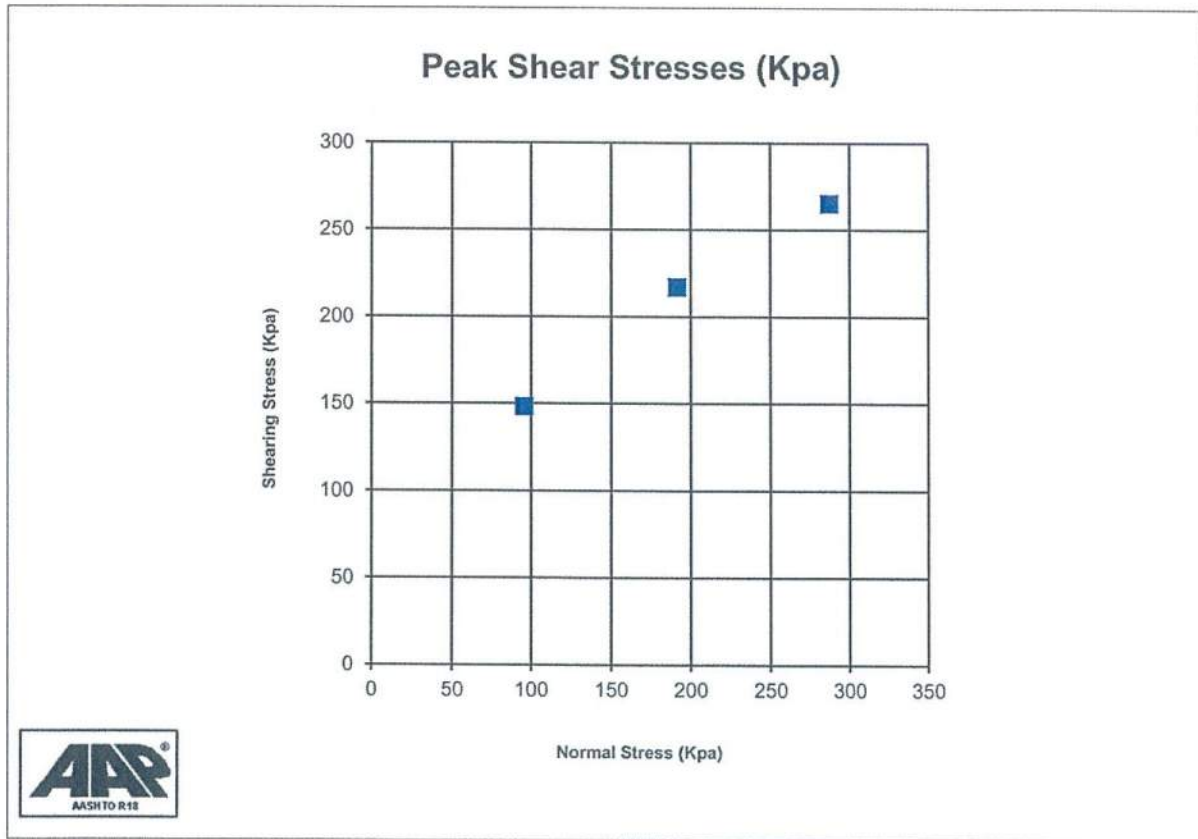
Blue

PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N503 B-2 @ 7.62 m - 7.92 m
SAMPLE PREPARATION: Insitu-Saturate

JOB NO: 1720134030.0002
WORK ORDER NO: 4
LAB NO: 447
DATE ASSIGNED: 11/4/2013

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (AASHTO T-236)

Initial thickness of specimen (mm):	25.4		
Initial diameter of specimen (mm):	61.5		
Shearing device used:	DigiShear Automated Shear Test System by Trautwein Soil Testing Equipment		
Rate of deformation (mm/min):	0.4064		
Direct shear point (Kpa):	95.8	191.5	287.3
Dry mass of specimen (g):	137.7	140.1	139.6
Initial Moisture Content:	18.1%	18.0%	17.4%
Initial Wet Density (Kg per cu.m):	2155.5	2191.1	2174.0
Initial Dry Density (Kg per cu.m):	1826.2	1858.0	1852.1
Final Moisture Content:	19.3%	20.1%	18.7%
Final Wet Density (Kg per cu.m):	2177.7	2229.9	2198.2
Final Dry Density (Kg per cu.m):	1825.4	1857.2	1851.2
Normal Stress (kpa):	95.8	191.5	287.3
Maximum Shearing Stress (Kpa):	148.38	217.14	265.42
Vertical Deformation @ Max Shear (mm):	0.124	-0.416	0.004
Horizontal Deformation @ Max Shear (mm):	12.626	12.696	11.437



REVIEWED BY _____

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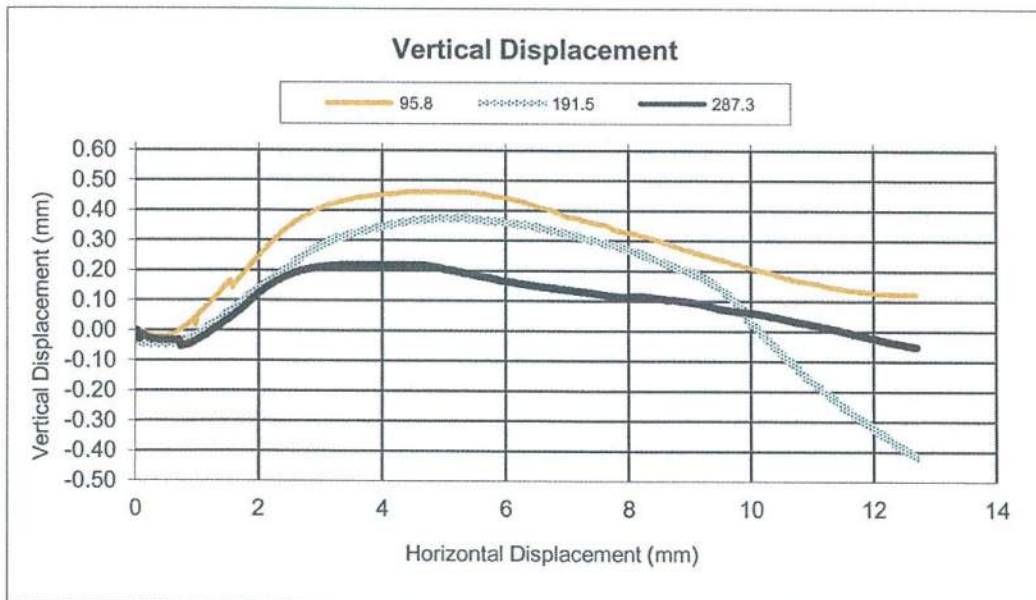
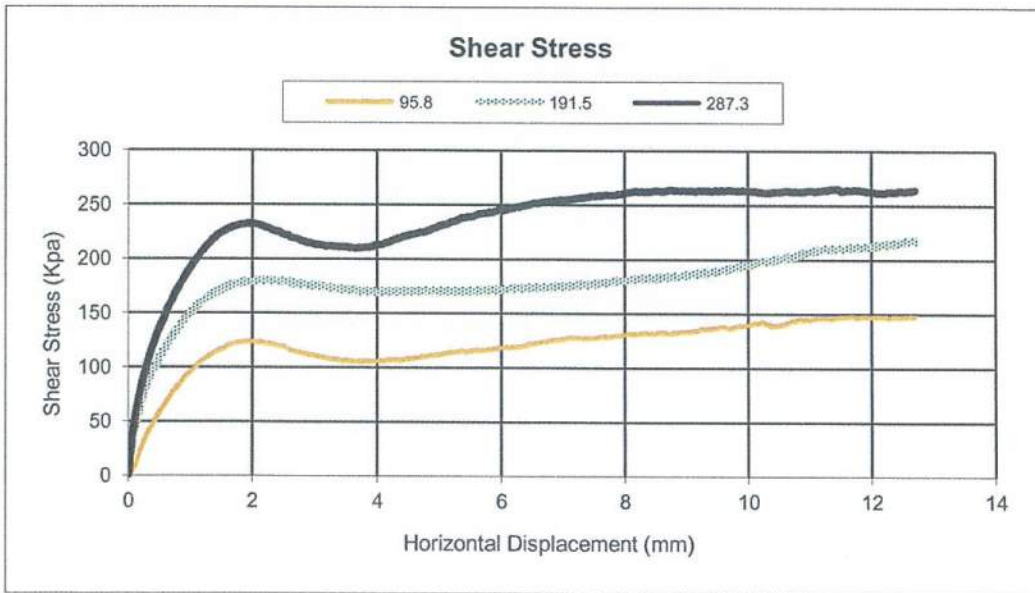


PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsalle, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N503 B-2 @ 7.62 m - 7.92 m
SAMPLE PREPARATION: Insitu-Saturate

JOB NO: 1720134030.0002
WORK ORDER NO: 4
LAB NO: 447
DATE ASSIGNED: 11/4/2013

NORMAL LOADS (Kpa): 95.8 191.5 287.3

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (AASHTO T-236)



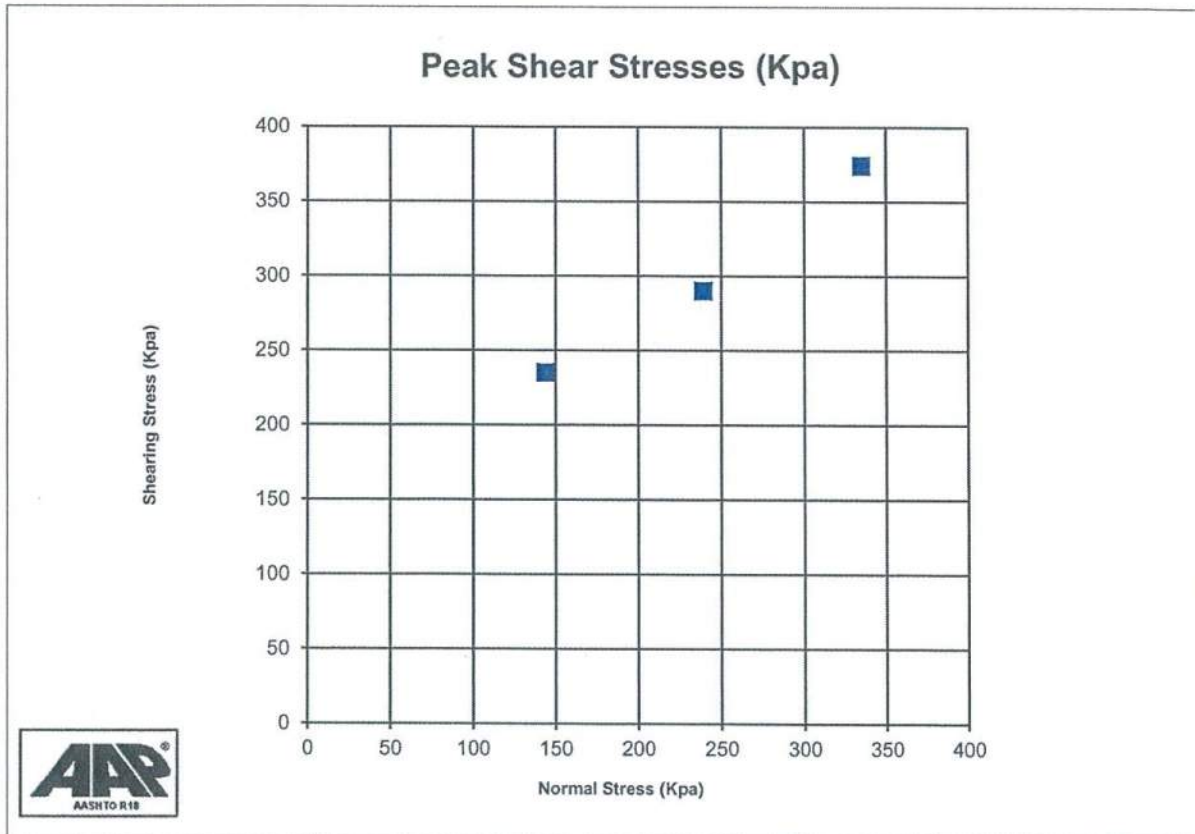
Sheep

PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N503 B-4 @ 9.14 m - 9.45 m
SAMPLE PREPARATION: Insitu-Saturate

JOB NO: 1720134030.0002
WORK ORDER NO: 4
LAB NO: 451
DATE ASSIGNED: 11/4/2013

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (AASHTO T-236)

Initial thickness of specimen (mm):	25.4		
Initial diameter of specimen (mm):	61.5		
Shearing device used:	DigiShear Automated Shear Test System by Trautwein Soil Testing Equipment		
Rate of deformation (mm/min):	0.4064		
Direct shear point (Kpa):	143.6	239.4	335.2
Dry mass of specimen (g):	153.2	154.7	152.4
Initial Moisture Content:	13.3%	12.0%	12.4%
Initial Wet Density (Kg per cu.m):	2300.5	2296.4	2270.3
Initial Dry Density (Kg per cu.m):	2032.2	2052.1	2021.5
Final Moisture Content:	15.6%	14.4%	14.8%
Final Wet Density (Kg per cu.m):	2349.2	2347.0	2320.5
Final Dry Density (Kg per cu.m):	2031.3	2051.2	2020.6
Normal Stress (kpa):	143.6	239.4	335.2
Maximum Shearing Stress (Kpa):	235.00	289.99	374.09
Vertical Deformation @ Max Shear (mm):	0.307	0.205	0.168
Horizontal Deformation @ Max Shear (mm):	2.084	2.273	2.408



REVIEWED BY _____

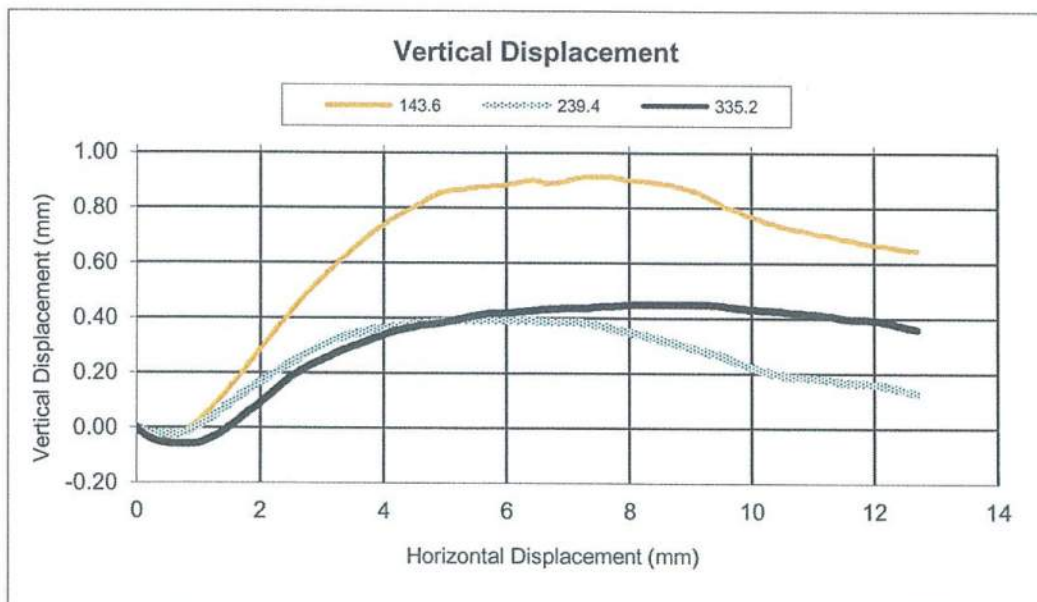
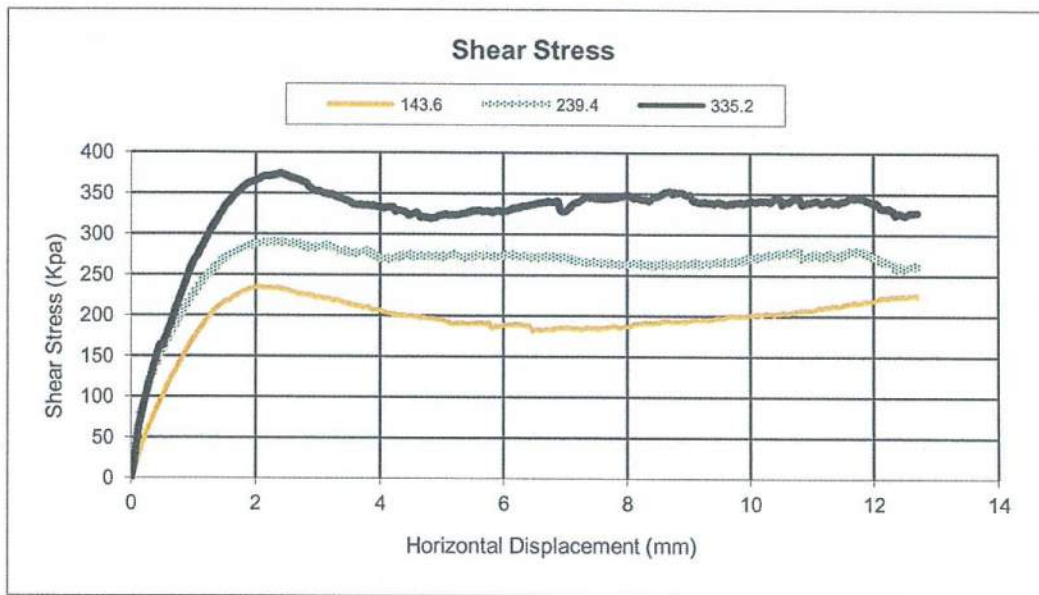


PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsalle, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N503 B-4 @ 9.14 m - 9.45 m
SAMPLE PREPARATION: Insitu-Saturate

JOB NO: 1720134030.0002
WORK ORDER NO: 4
LAB NO: 451
DATE ASSIGNED: 11/4/2013

NORMAL LOADS (Kpa): 143.6 239.4 335.2

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (AASHTO T-236)



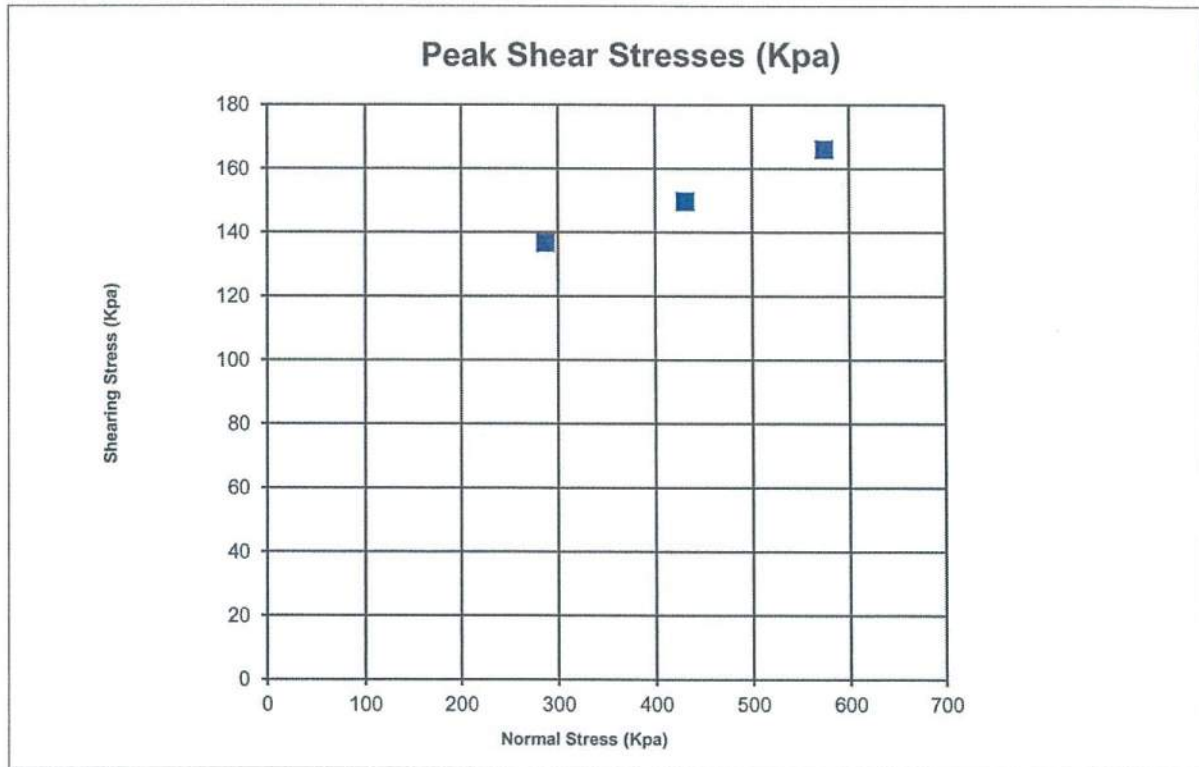
Deep

PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N504 B-1; 16.76 m -17.07 m
SAMPLE PREPARATION: Saturate

JOB NO: 1720134030.0002
WORK ORDER NO: 3
LAB NO: 313
DATE ASSIGNED: 10/2/2013

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (AASHTO T-236)

Initial thickness of specimen (mm):	25.4		
Initial diameter of specimen (mm):	61.5		
Shearing device used:	DigiShear Automated Shear Test System by Trautwein Soil Testing Equipment		
Rate of deformation (mm/min):	0.4064		
Direct shear point (Kpa):	287.3	430.9	574.6
Dry mass of specimen (g):	136.7	136.8	139.8
Initial Moisture Content:	18.3%	18.6%	16.7%
Initial Wet Density (Kg per cu.m):	2143.2	2153.0	2164.0
Initial Dry Density (Kg per cu.m):	1812.9	1815.4	1854.8
Final Moisture Content:	21.8%	19.1%	17.4%
Final Wet Density (Kg per cu.m):	2206.9	2161.0	2176.4
Final Dry Density (Kg per cu.m):	1812.1	1814.6	1854.0
Normal Stress (kpa):	287.3	430.9	574.6
Maximum Shearing Stress (Kpa):	136.64	149.59	165.95
Vertical Deformation @ Max Shear (mm):	-0.192	-0.300	-0.386
Horizontal Deformation @ Max Shear (mm):	6.686	12.355	12.514



REVIEWED BY _____

Ohj

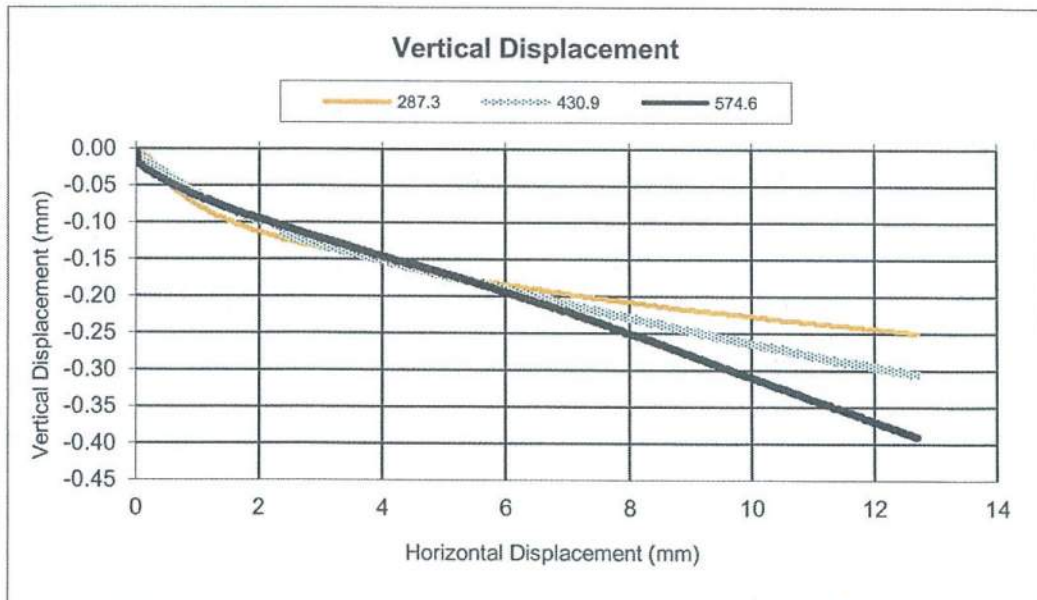
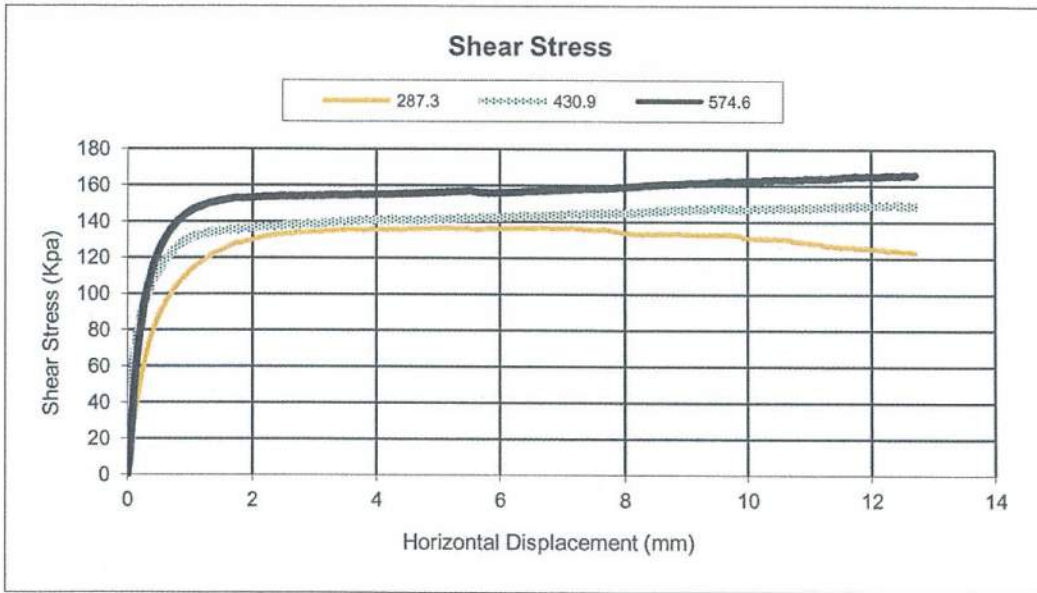


PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N504 B-1; 16.76 m -17.07 m
SAMPLE PREPARATION: Saturate

JOB NO: 1720134030.0002
WORK ORDER NO: 3
LAB NO: 313
DATE ASSIGNED: 10/2/2013

NORMAL LOADS (Kpa): 287.3 430.9 574.6

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (AASHTO T-236)



Any

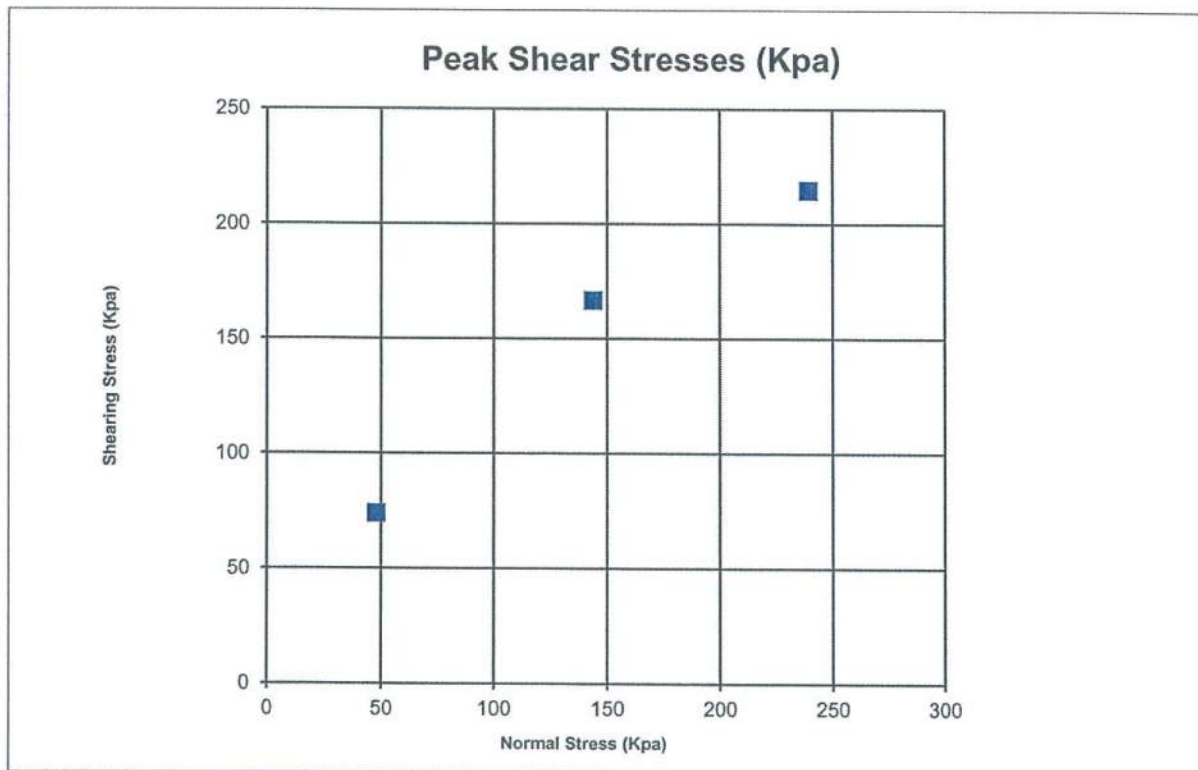


PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N504 B-2; 3.20 m - 3.35 m
SAMPLE PREPARATION: Saturate

JOB NO: 1720134030.0002
WORK ORDER NO: 3
LAB NO: 316
DATE ASSIGNED: 10/2/2013

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (AASHTO T-236)

Initial thickness of specimen (mm):	25.4		
Initial diameter of specimen (mm):	61.5		
Shearing device used:	DigiShear Automated Shear Test System by Trautwein Soil Testing Equipment		
Rate of deformation (mm/min):	0.4064		
Direct shear point (Kpa):	47.9	143.6	239.4
Dry mass of specimen (g):	139.8	143.2	141.1
Initial Moisture Content:	13.2%	12.3%	13.6%
Initial Wet Density (Kg per cu.m):	2097.7	2131.3	2126.1
Initial Dry Density (Kg per cu.m):	1854.2	1899.3	1872.1
Final Moisture Content:	16.5%	16.9%	18.9%
Final Wet Density (kg per cu.m):	2159.7	2219.5	2224.5
Final Dry Density (kg per cu.m):	1853.3	1898.4	1871.2
Normal Stress (kpa):	47.9	143.6	239.4
Maximum Shearing Stress (Kpa):	73.97	166.58	214.57
Vertical Deformation @ Max Shear (mm):	0.348	0.198	0.209
Horizontal Deformation @ Max Shear (mm):	1.928	1.679	2.424



REVIEWED BY Ohay

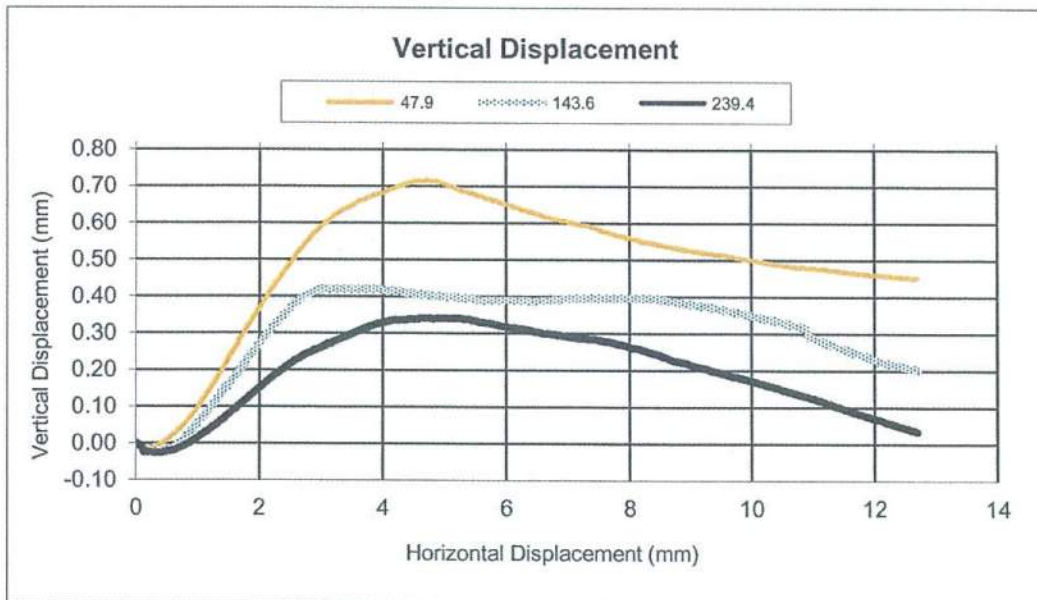
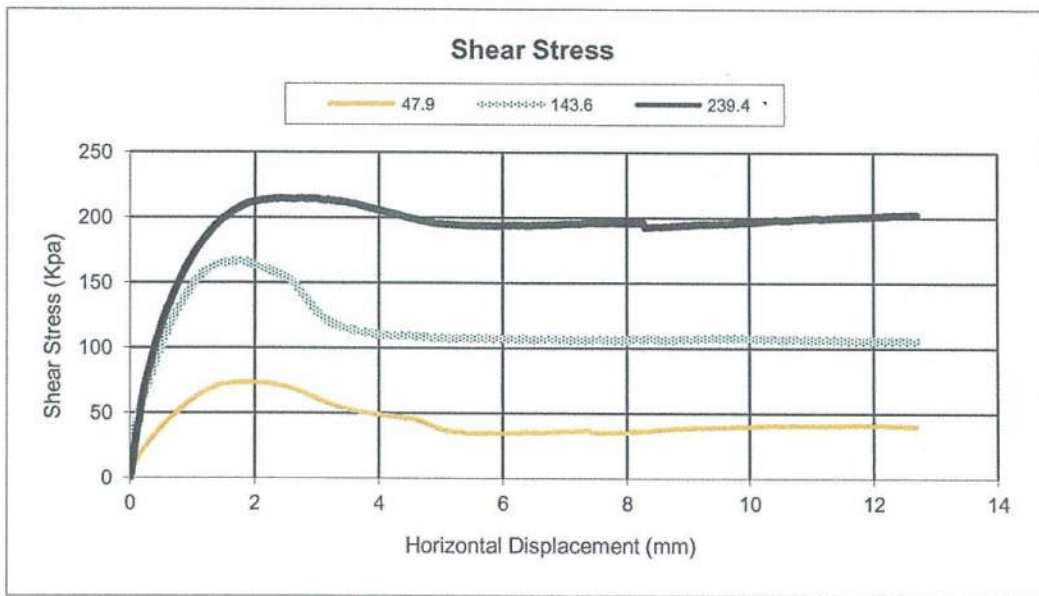


PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaile, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N504 B-2; 3.20 m - 3.35 m
SAMPLE PREPARATION: Saturate

JOB NO: 1720134030.0002
WORK ORDER NO: 3
LAB NO: 316
DATE ASSIGNED: 10/2/2013

NORMAL LOADS (Kpa): 47.9 143.6 239.4

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (AASHTO T-236)



Sheep

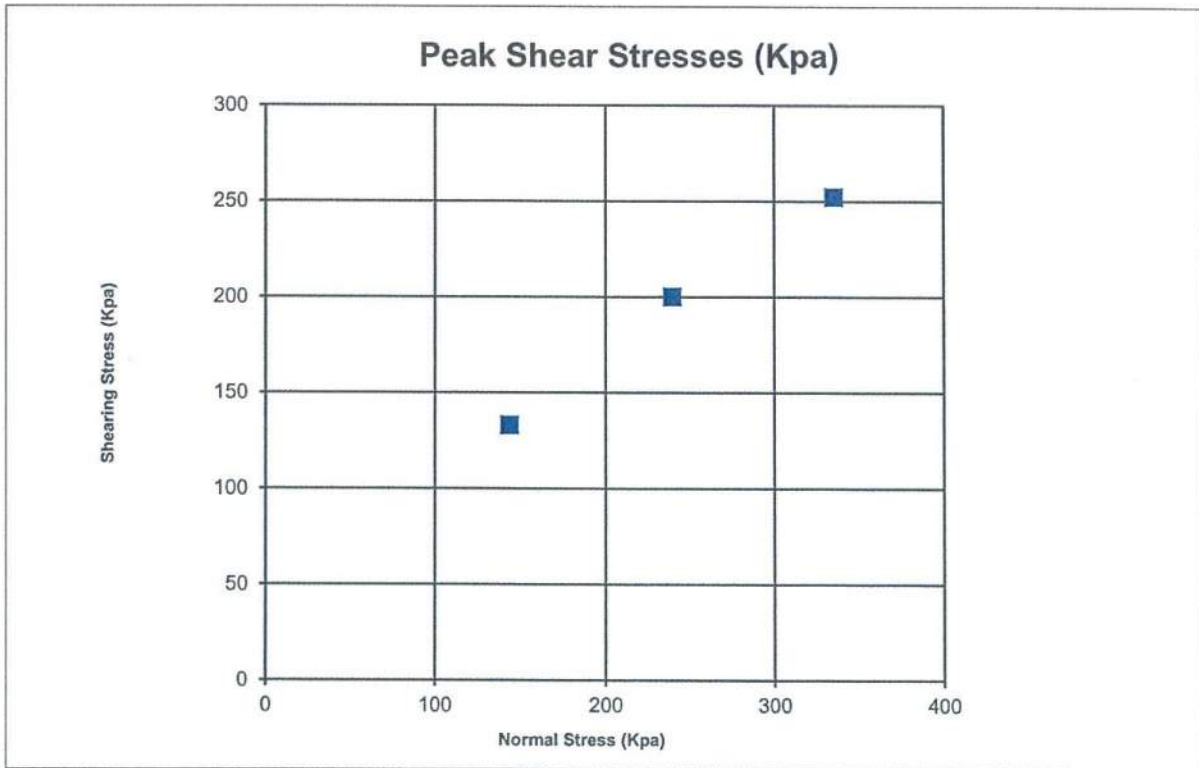


PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N504 B-3; 7.01 m - 7.32 m
SAMPLE PREPARATION: Insitu-Saturate

JOB NO: 1720134030.0002
WORK ORDER NO: 3
LAB NO: 323
DATE ASSIGNED: 10/2/2013

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (AASHTO T-236)

Initial thickness of specimen (mm):	25.4		
Initial diameter of specimen (mm):	61.5		
Shearing device used:	DigiShear Automated Shear Test System by Trautwein Soil Testing Equipment		
Rate of deformation (mm/min):	0.4064		
Direct shear point (Kpa):	143.6	239.4	335.2
Dry mass of specimen (g):	124.6	125.7	125.5
Initial Moisture Content:	23.0%	21.0%	22.4%
Initial Wet Density (Kg per cu.m):	2032.2	2016.6	2037.4
Initial Dry Density (Kg per cu.m):	1653.3	1667.1	1664.7
Final Moisture Content:	22.9%	22.8%	22.5%
Final Wet Density (kg per cu.m):	2030.9	2046.3	2038.5
Final Dry Density (kg per cu.m):	1652.6	1666.4	1664.0
Normal Stress (kpa):	143.6	239.4	335.2
Maximum Shearing Stress (Kpa):	132.91	200.01	252.17
Vertical Deformation @ Max Shear (mm):	0.169	0.113	0.039
Horizontal Deformation @ Max Shear (mm):	2.830	2.186	1.939



REVIEWED BY Deey

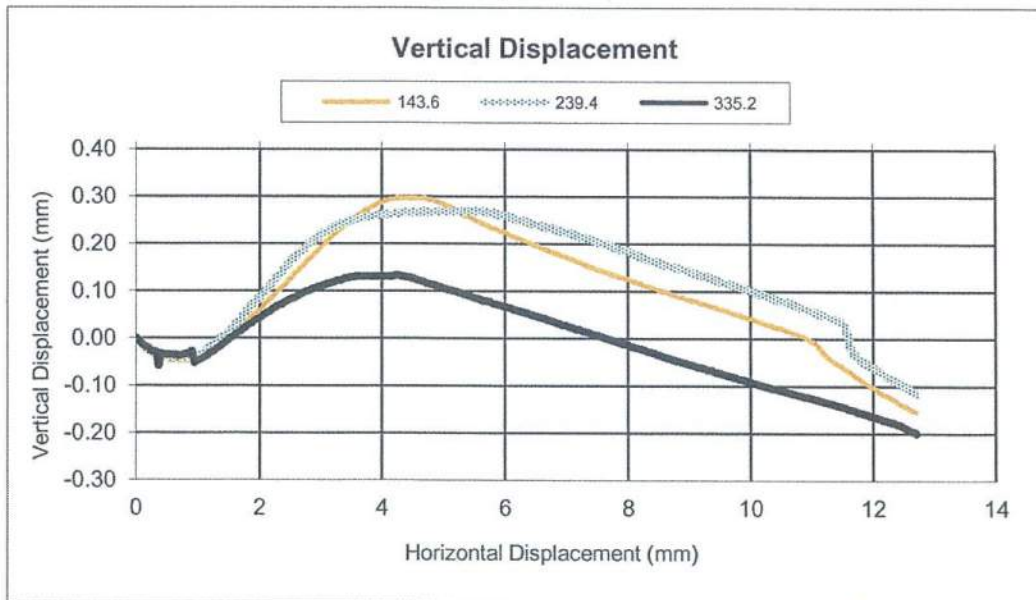
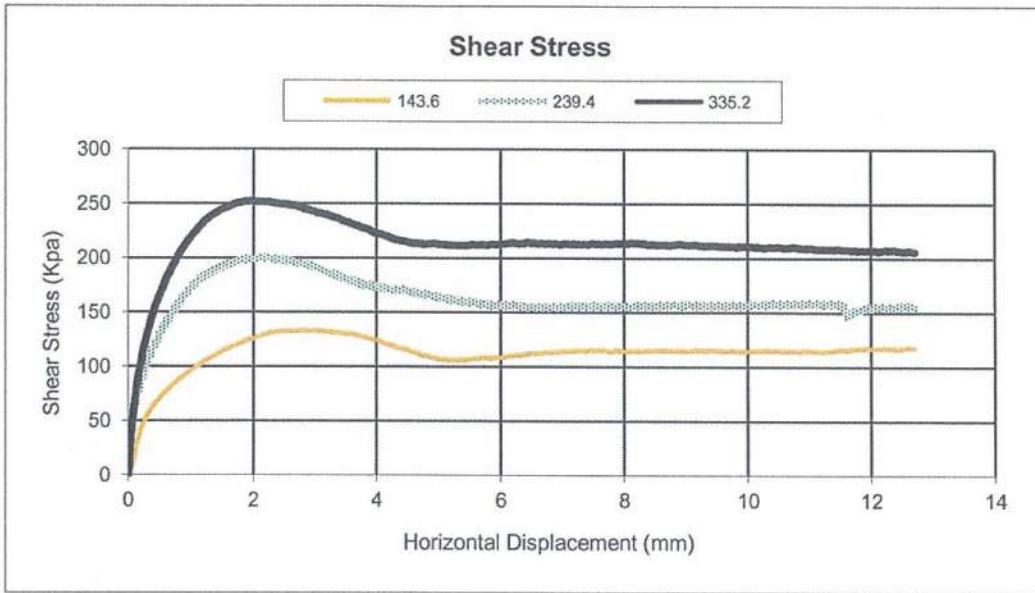


PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaile, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N504 B-3; 7.01 m - 7.32 m
SAMPLE PREPARATION: Insitu-Saturate

JOB NO: 1720134030.0002
WORK ORDER NO: 3
LAB NO: 323
DATE ASSIGNED: 10/2/2013

NORMAL LOADS (Kpa): 143.6 239.4 335.2

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (AASHTO T-236)



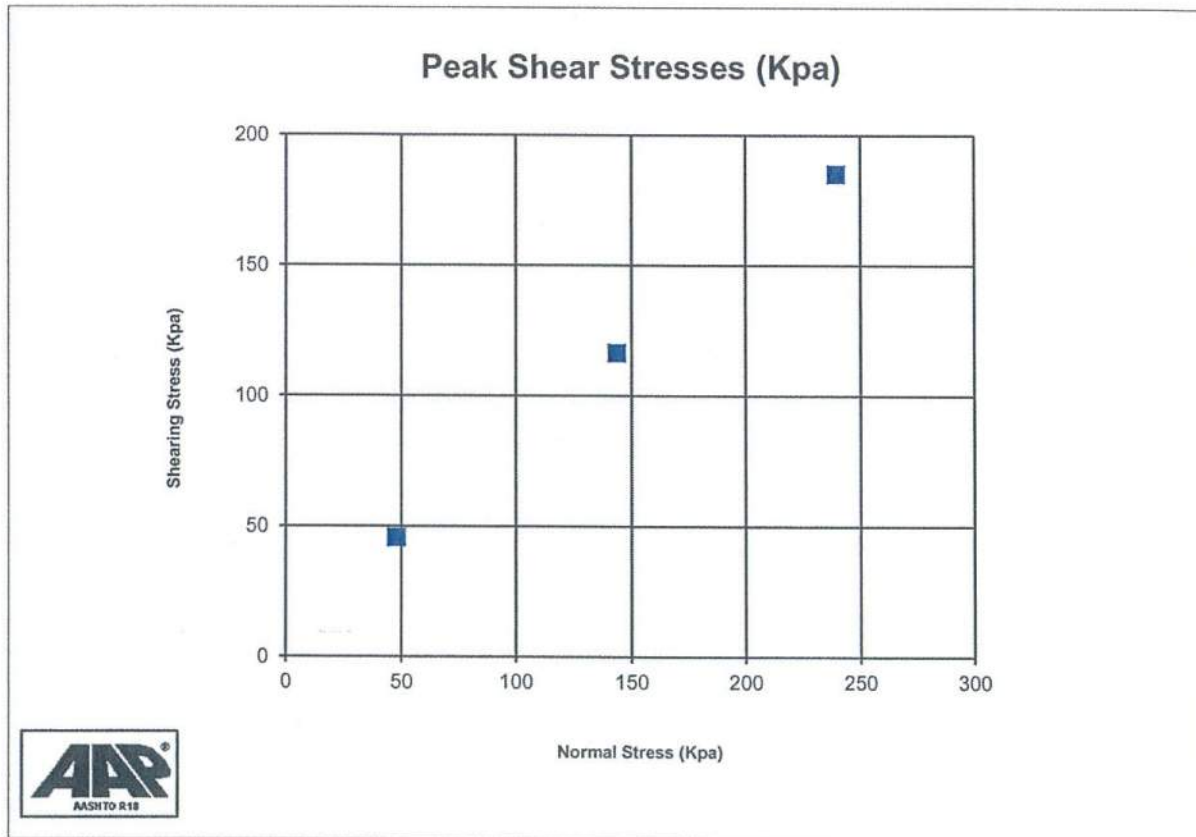
Sheep

PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N505 B-1 @ 1.52 m - 1.83 m
SAMPLE PREPARATION: Insitu-Saturate

JOB NO: 1720134030.0002
WORK ORDER NO: 4
LAB NO: 465
DATE ASSIGNED: 11/4/2013

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (AASHTO T-236)

Initial thickness of specimen (mm):	25.4		
Initial diameter of specimen (mm):	61.5		
Shearing device used:	DigiShear Automated Shear Test System by Trautwein Soil Testing Equipment		
Rate of deformation (mm/min):	0.4064		
Direct shear point (Kpa):	47.9	143.6	239.4
Dry mass of specimen (g):	134.1	133.0	137.7
Initial Moisture Content:	10.4%	11.2%	9.9%
Initial Wet Density (Kg per cu.m):	1963.7	1961.9	2006.1
Initial Dry Density (Kg per cu.m):	1779.5	1764.8	1826.6
Final Moisture Content:	23.6%	20.6%	22.1%
Final Wet Density (Kg per cu.m):	2199.3	2128.1	2228.4
Final Dry Density (Kg per cu.m):	1778.7	1764.0	1825.8
Normal Stress (kpa):	47.9	143.6	239.4
Maximum Shearing Stress (Kpa):	45.62	116.38	185.05
Vertical Deformation @ Max Shear (mm):	-0.183	-0.505	-0.362
Horizontal Deformation @ Max Shear (mm):	12.370	12.704	10.818



REVIEWED BY *Shef*

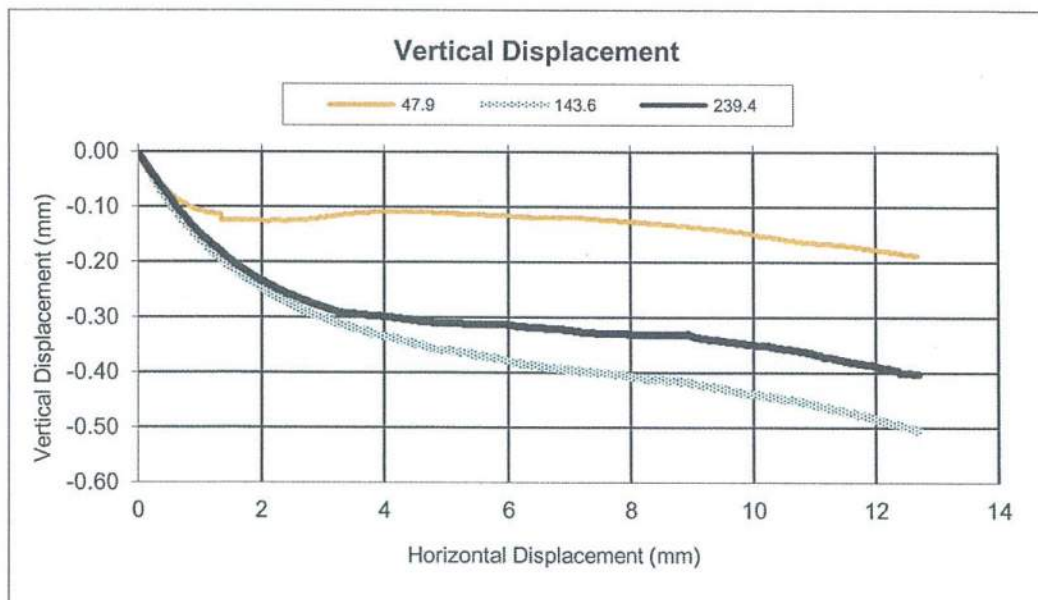
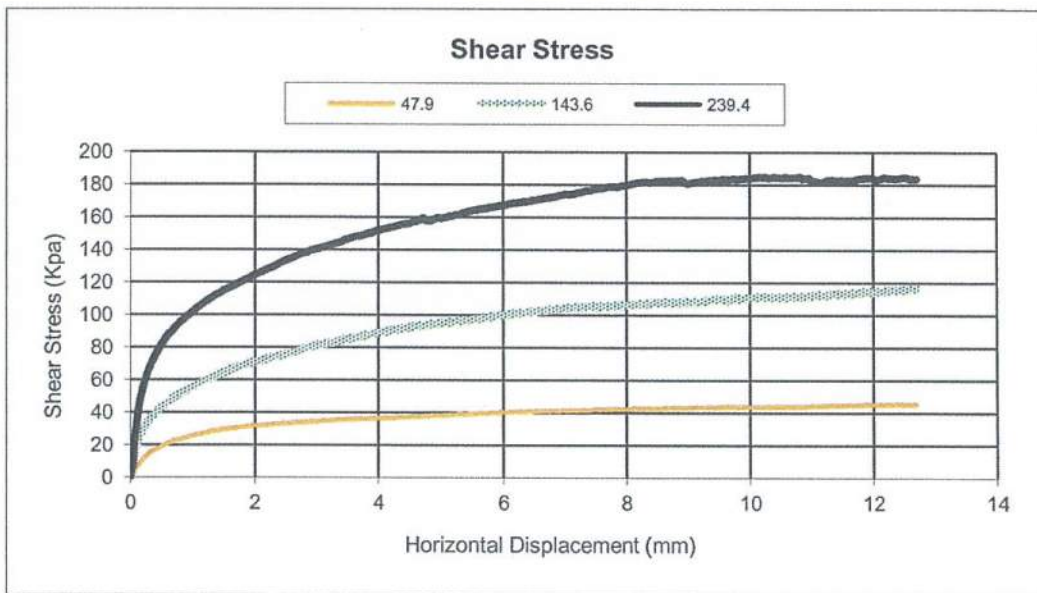


PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsalle, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N505 B-1 @ 1.52 m - 1.83 m
SAMPLE PREPARATION: Insitu-Saturate

JOB NO: 1720134030.0002
WORK ORDER NO: 4
LAB NO: 465
DATE ASSIGNED: 11/4/2013

NORMAL LOADS (Kpa): 47.9 143.6 239.4

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (AASHTO T-236)



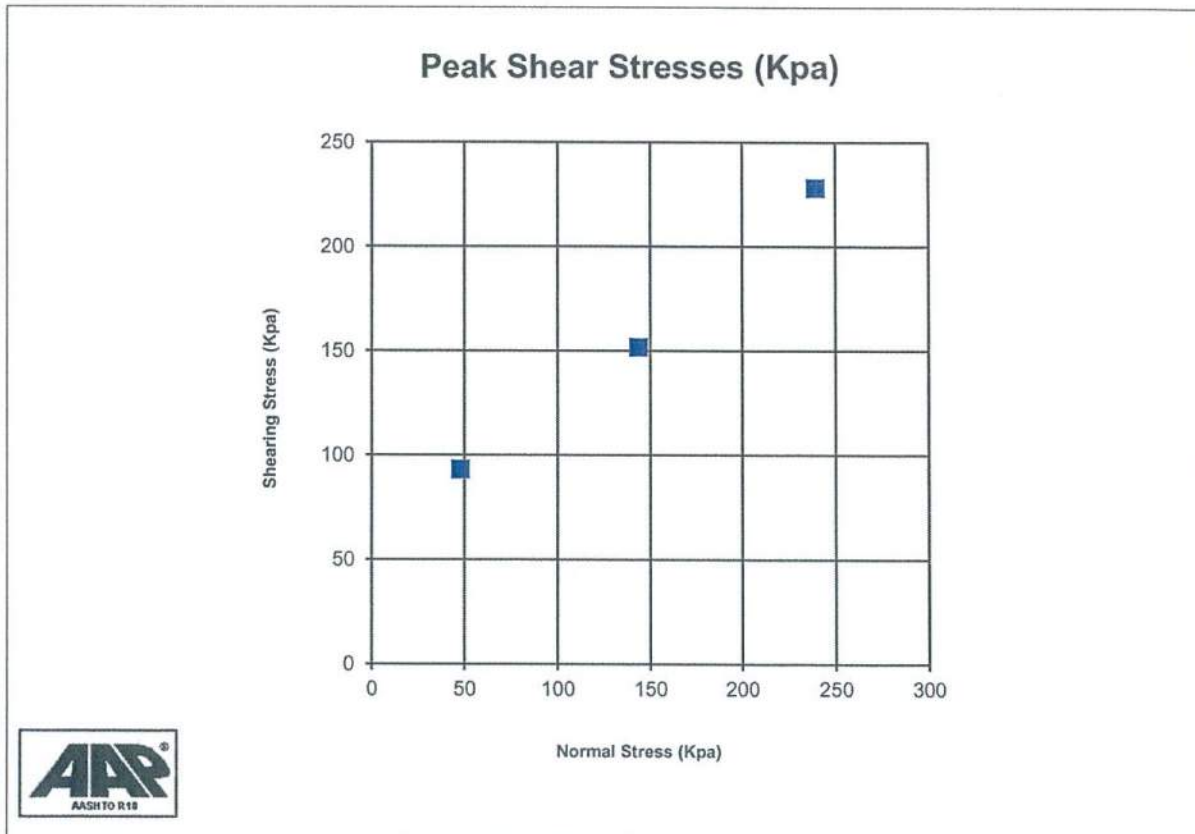
Deep

PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N505 B-2 @ 2.29 m - 2.59 m
SAMPLE PREPARATION: Insitu-Saturate

JOB NO: 1720134030.0002
WORK ORDER NO: 4
LAB NO: 466
DATE ASSIGNED: 11/4/2013

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (AASHTO T-236)

Initial thickness of specimen (mm):	25.4		
Initial diameter of specimen (mm):	61.5		
Shearing device used:	DigiShear Automated Shear Test System by Trautwein Soil Testing Equipment		
Rate of deformation (mm/min):	0.4064		
Direct shear point (Kpa):	47.9	143.6	239.4
Dry mass of specimen (g):	143.0	144.3	148.7
Initial Moisture Content:	10.5%	12.3%	12.1%
Initial Wet Density (Kg per cu.m):	2094.7	2148.8	2209.7
Initial Dry Density (Kg per cu.m):	1896.5	1914.4	1972.4
Final Moisture Content:	21.0%	18.0%	17.3%
Final Wet Density (Kg per cu.m):	2294.4	2258.1	2311.9
Final Dry Density (Kg per cu.m):	1895.6	1913.5	1971.5
Normal Stress (kpa):	47.9	143.6	239.4
Maximum Shearing Stress (Kpa):	93.05	151.71	228.04
Vertical Deformation @ Max Shear (mm):	0.896	-0.051	0.205
Horizontal Deformation @ Max Shear (mm):	12.704	12.672	8.752



REVIEWED BY *Duy*

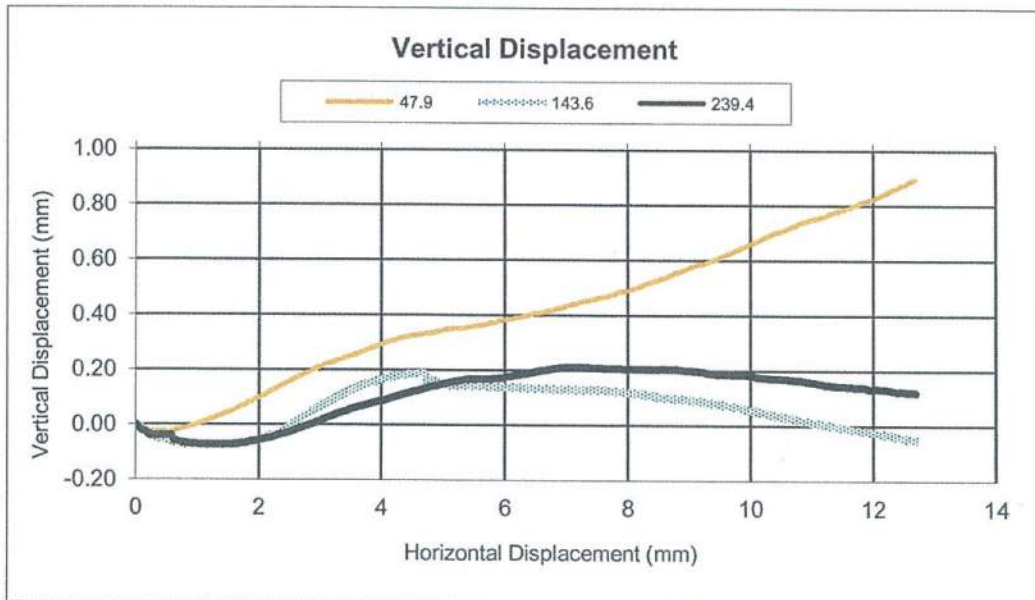
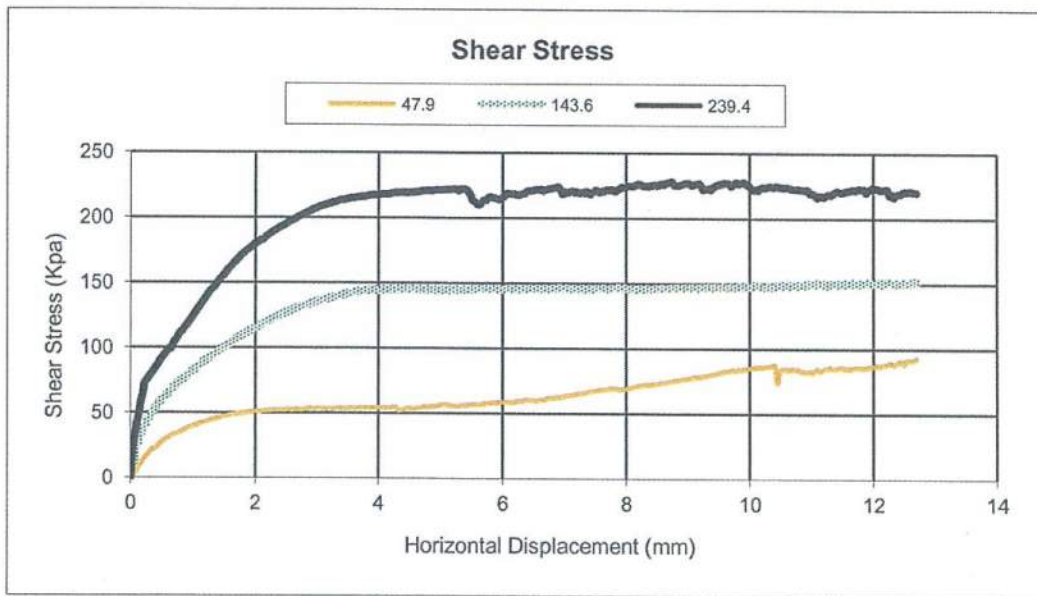


PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsatile, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N505 B-2 @ 2.29 m - 2.59 m
SAMPLE PREPARATION: Insitu-Saturate

JOB NO: 1720134030.0002
WORK ORDER NO: 4
LAB NO: 466
DATE ASSIGNED: 11/4/2013

NORMAL LOADS (Kpa): 47.9 143.6 239.4

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (AASHTO T-236)



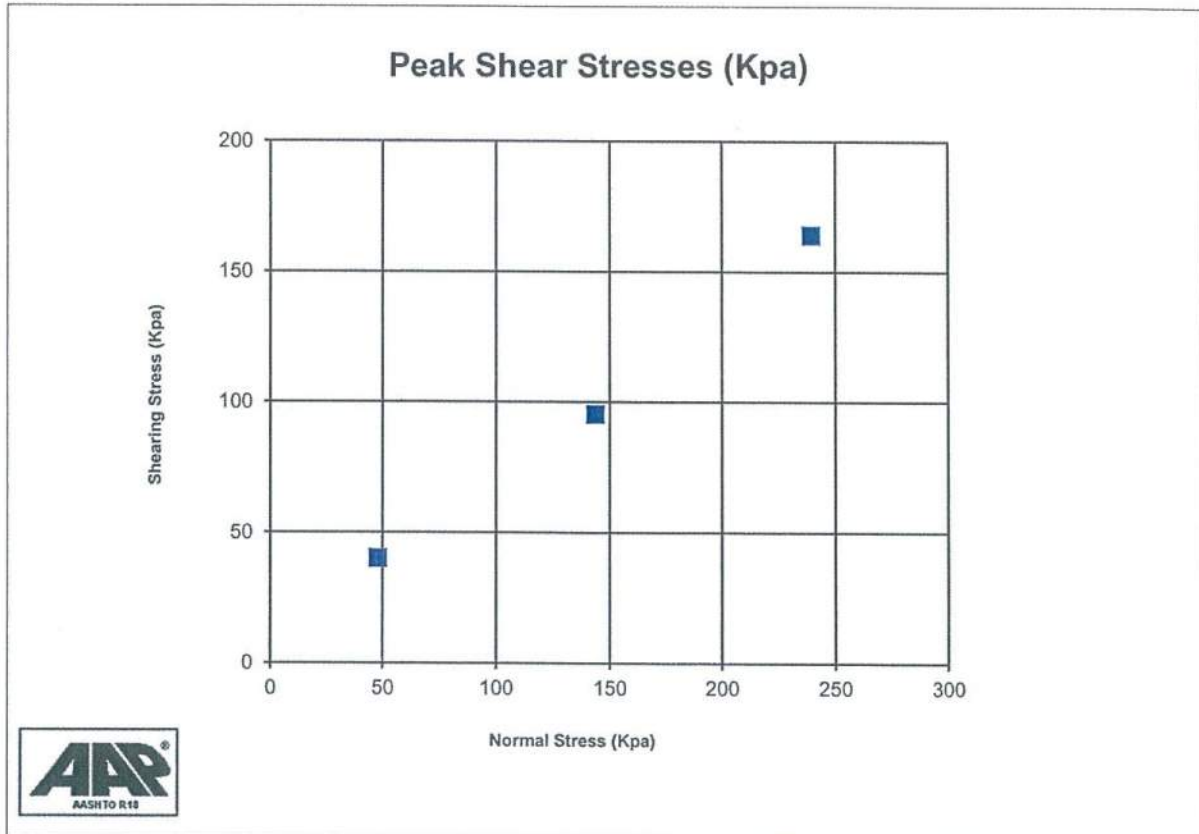
Aug

PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N505 B-4 @ 1.52 m - 1.83 m
SAMPLE PREPARATION: Insitu-Saturate

JOB NO: 1720134030.0002
WORK ORDER NO: 4
LAB NO: 467
DATE ASSIGNED: 11/4/2013

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (AASHTO T-236)

Initial thickness of specimen (mm):	25.4		
Initial diameter of specimen (mm):	61.5		
Shearing device used:	DigiShear Automated Shear Test System by Trautwein Soil Testing Equipment		
Rate of deformation (mm/min):	0.4064		
Direct shear point (Kpa):	47.9	143.6	239.4
Dry mass of specimen (g):	122.5	121.4	126.1
Initial Moisture Content:	10.8%	11.7%	12.1%
Initial Wet Density (Kg per cu.m):	1799.1	1797.6	1873.1
Initial Dry Density (Kg per cu.m):	1624.5	1610.2	1672.3
Final Moisture Content:	29.9%	30.5%	27.6%
Final Wet Density (Kg per cu.m):	2109.1	2100.7	2133.4
Final Dry Density (Kg per cu.m):	1623.8	1609.5	1671.5
Normal Stress (kpa):	47.9	143.6	239.4
Maximum Shearing Stress (Kpa):	40.09	95.25	163.99
Vertical Deformation @ Max Shear (mm):	-0.506	-0.680	-0.713
Horizontal Deformation @ Max Shear (mm):	11.444	8.649	12.696



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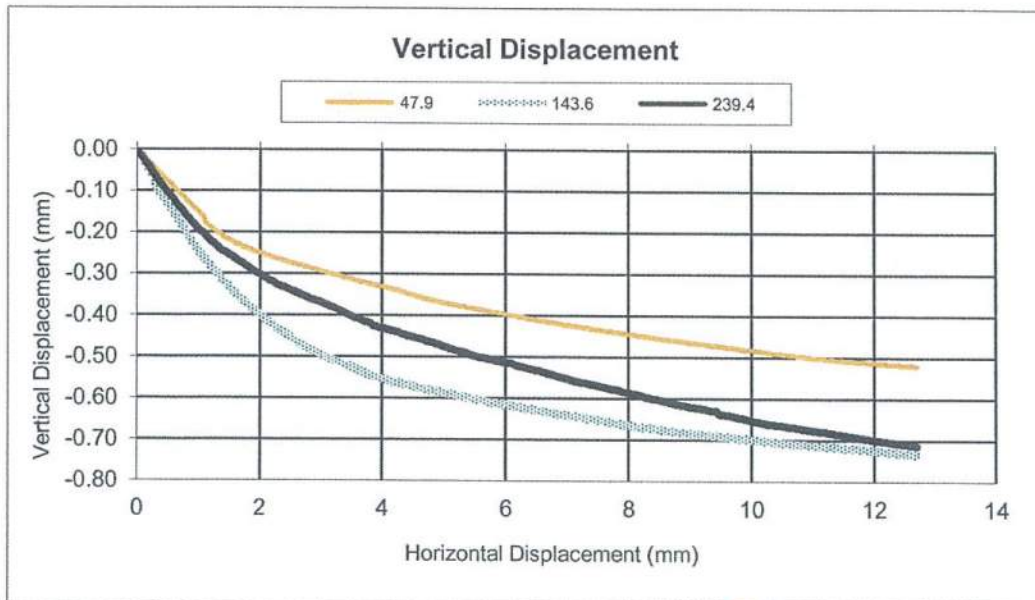
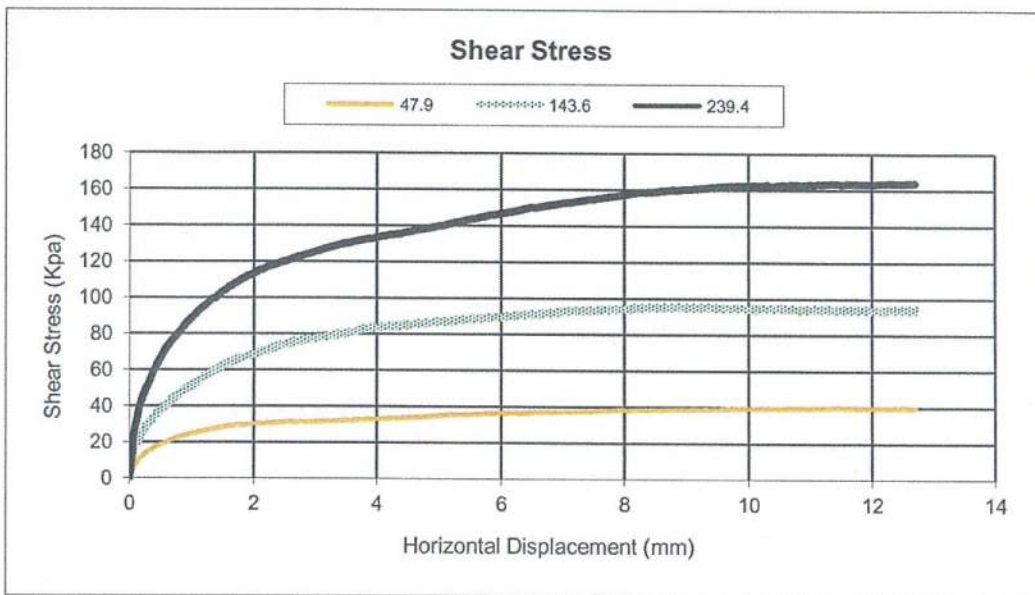


PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaile, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N505 B-4 @ 1.52 m - 1.83 m
SAMPLE PREPARATION: Insitu-Saturate

JOB NO: 1720134030.0002
WORK ORDER NO: 4
LAB NO: 467
DATE ASSIGNED: 11/4/2013

NORMAL LOADS (Kpa): 47.9 143.6 239.4

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (AASHTO T-236)



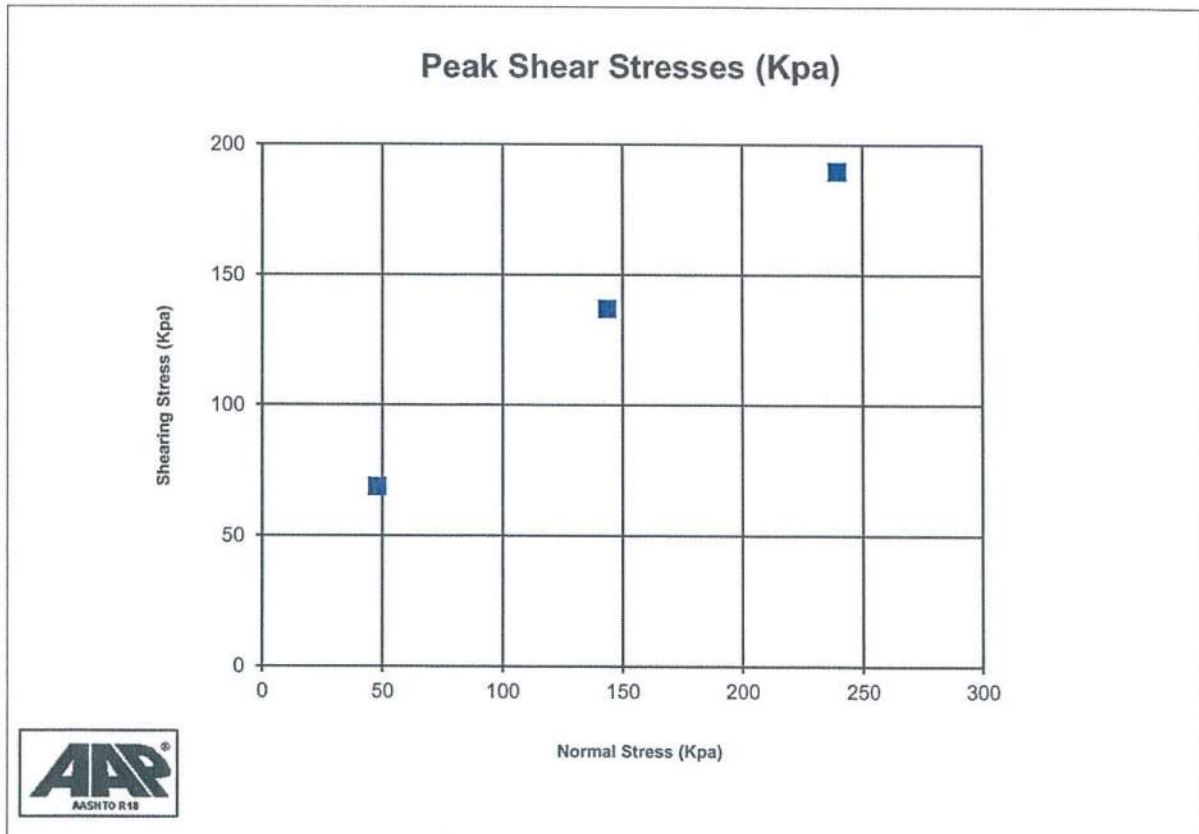
Key

PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N613 B-1 @ 3.05 m - 3.35 m
SAMPLE PREPARATION: Insitu-Saturate

JOB NO: 1720134030.0002
WORK ORDER NO: 4
LAB NO: 452
DATE ASSIGNED: 11/4/2013

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (AASHTO T-236)

Initial thickness of specimen (mm):	25.4		
Initial diameter of specimen (mm):	61.5		
Shearing device used:	DigiShear Automated Shear Test System by Trautwein Soil Testing Equipment		
Rate of deformation (mm/min):	0.4064		
Direct shear point (Kpa):	47.9	143.6	239.4
Dry mass of specimen (g):	125.8	127.7	133.4
Initial Moisture Content:	10.8%	10.6%	11.8%
Initial Wet Density (Kg per cu.m):	1849.0	1873.4	1978.3
Initial Dry Density (Kg per cu.m):	1669.2	1694.2	1769.8
Final Moisture Content:	26.7%	25.7%	24.6%
Final Wet Density (Kg per cu.m):	2114.7	2128.6	2204.0
Final Dry Density (Kg per cu.m):	1668.5	1693.4	1769.0
Normal Stress (kpa):	47.9	143.6	239.4
Maximum Shearing Stress (Kpa):	68.77	136.92	189.61
Vertical Deformation @ Max Shear (mm):	0.228	-0.438	-0.543
Horizontal Deformation @ Max Shear (mm):	12.688	12.696	12.514



REVIEWED BY *[Signature]*

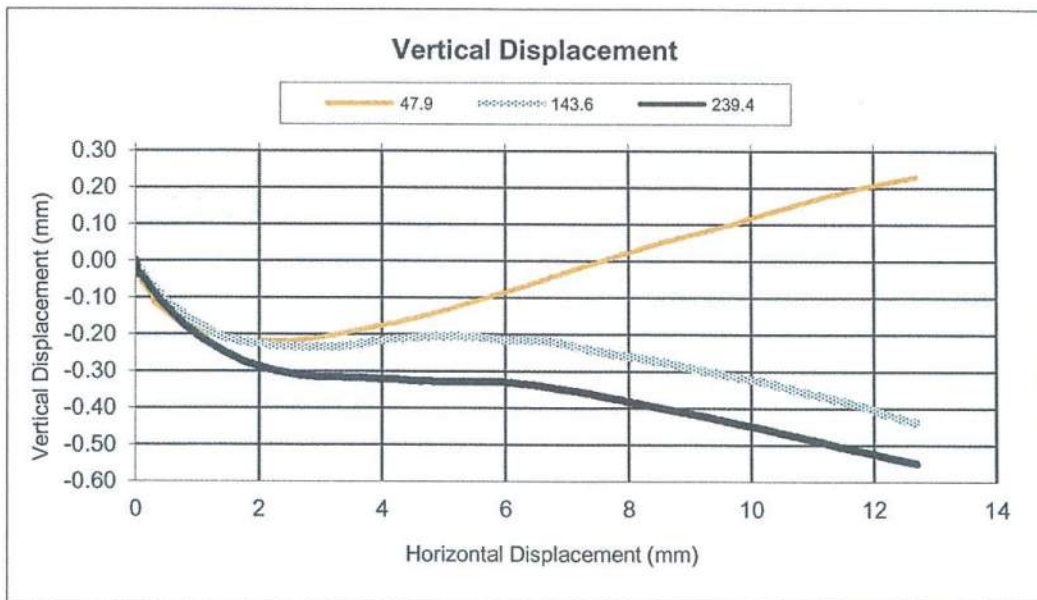
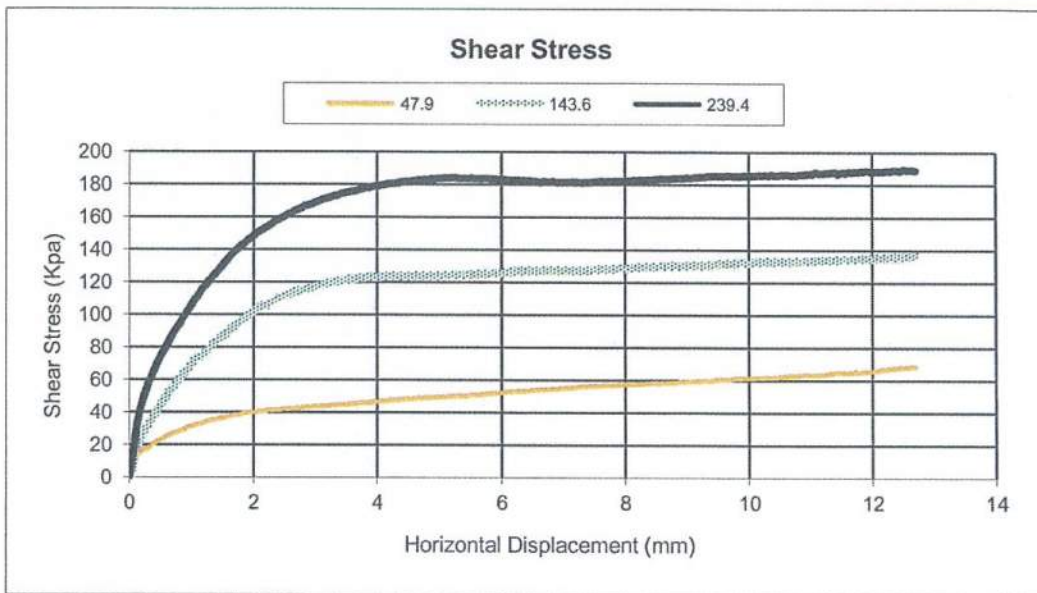


PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsalle, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N613 B-1 @ 3.05 m - 3.35 m
SAMPLE PREPARATION: Insitu-Saturate

JOB NO: 1720134030.0002
WORK ORDER NO: 4
LAB NO: 452
DATE ASSIGNED: 11/4/2013

NORMAL LOADS (Kpa): 47.9 143.6 239.4

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (AASHTO T-236)



Deep

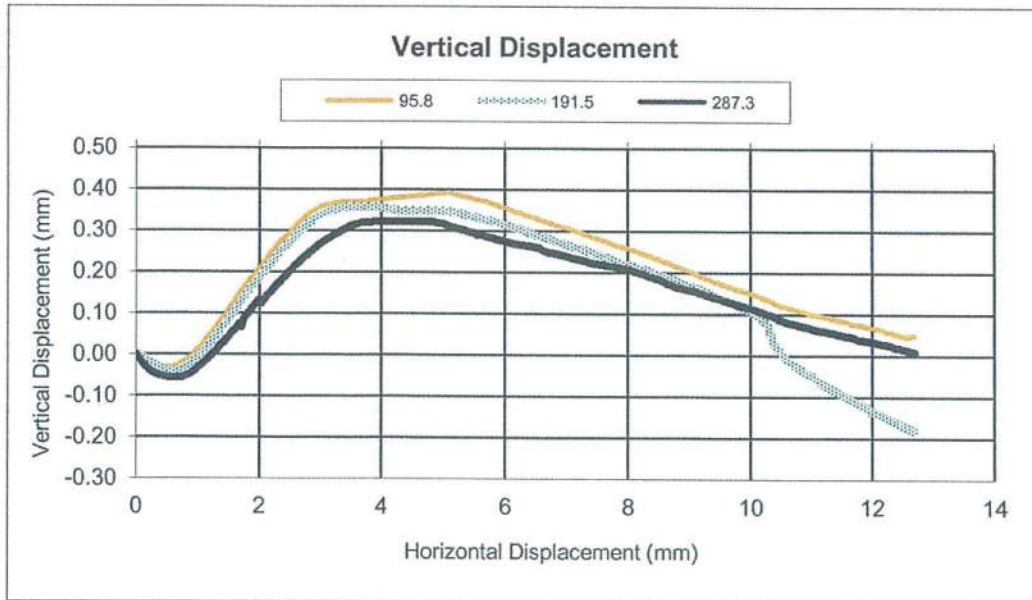
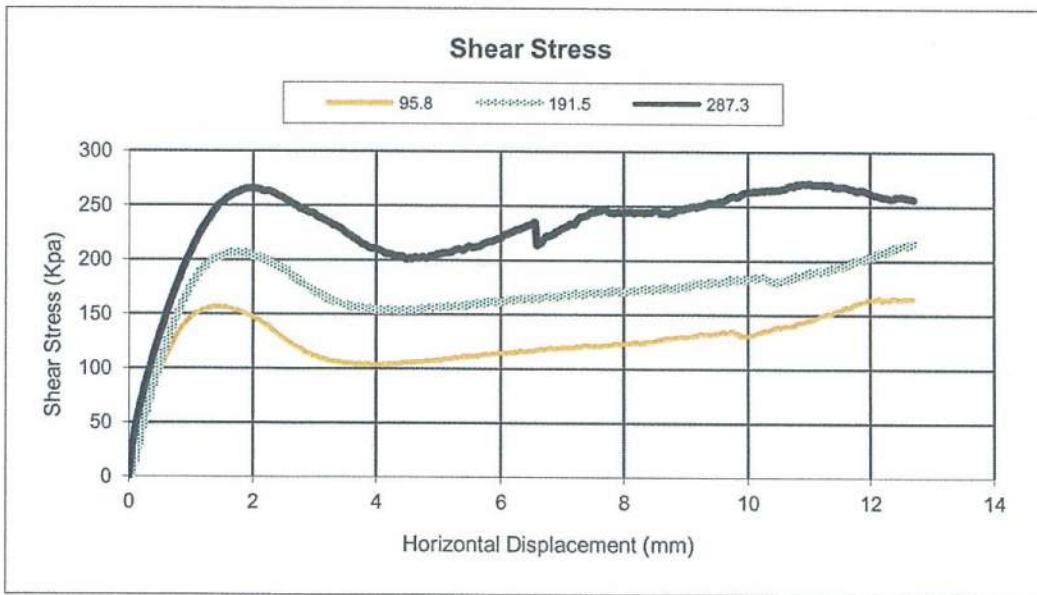


PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsalle, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N613 B-3 @ 7.62 m - 7.92 m
SAMPLE PREPARATION: Insitu-Saturate

JOB NO: 1720134030.0002
WORK ORDER NO: 4
LAB NO: 455
DATE ASSIGNED: 11/4/2013

NORMAL LOADS (Kpa): 95.8 191.5 287.3

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (AASHTO T-236)



Ok

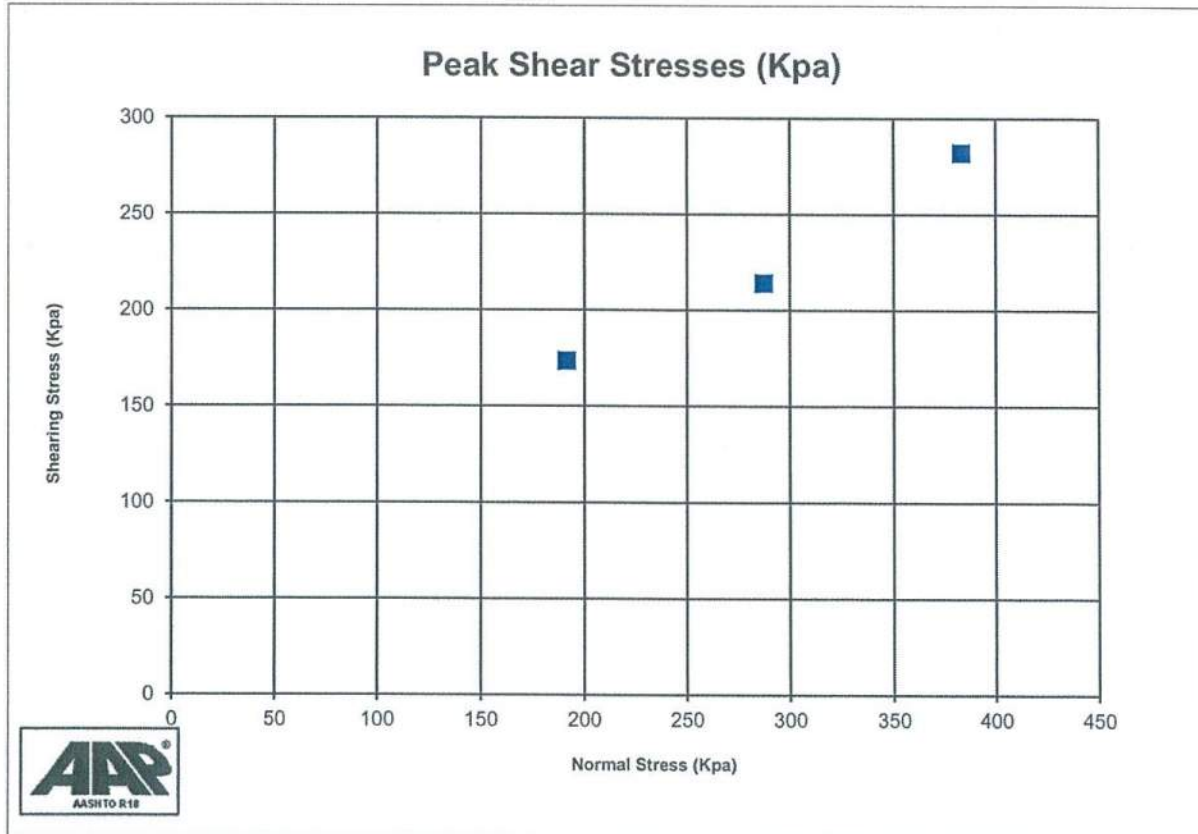


PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N613 B-3 @ 12.19 m - 12.50 m
SAMPLE PREPARATION: Insitu-Saturate

JOB NO: 1720134030.0002
WORK ORDER NO: 4
LAB NO: 456
DATE ASSIGNED: 11/4/2013

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (AASHTO T-236)

Initial thickness of specimen (mm):	25.4		
Initial diameter of specimen (mm):	61.5		
Shearing device used:	DigiShear Automated Shear Test System by Trautwein Soil Testing Equipment		
Rate of deformation (mm/min):	0.4064		
Direct shear point (Kpa):	191.5	287.3	383.1
Dry mass of specimen (g):	129.5	126.3	131.1
Initial Moisture Content:	21.1%	22.4%	20.9%
Initial Wet Density (Kg per cu.m):	2078.1	2050.7	2102.8
Initial Dry Density (Kg per cu.m):	1717.4	1675.7	1739.7
Final Moisture Content:	20.4%	21.2%	19.6%
Final Wet Density (Kg per cu.m):	2067.6	2029.7	2079.2
Final Dry Density (Kg per cu.m):	1716.6	1675.0	1738.9
Normal Stress (kpa):	191.5	287.3	383.1
Maximum Shearing Stress (Kpa):	173.57	214.08	282.07
Vertical Deformation @ Max Shear (mm):	-0.245	-0.196	-0.207
Horizontal Deformation @ Max Shear (mm):	8.024	3.697	3.675



REVIEWED BY

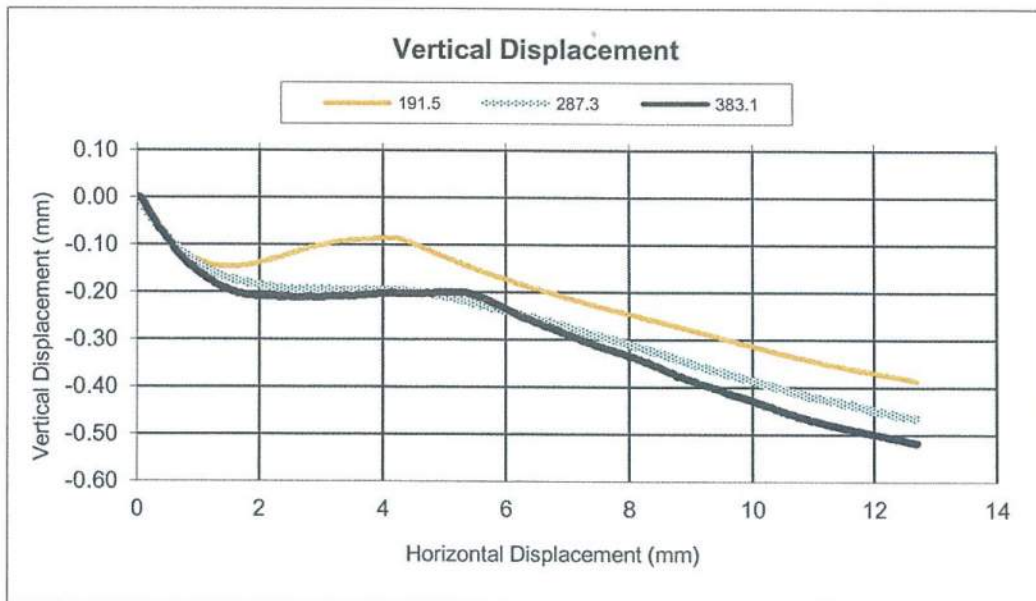
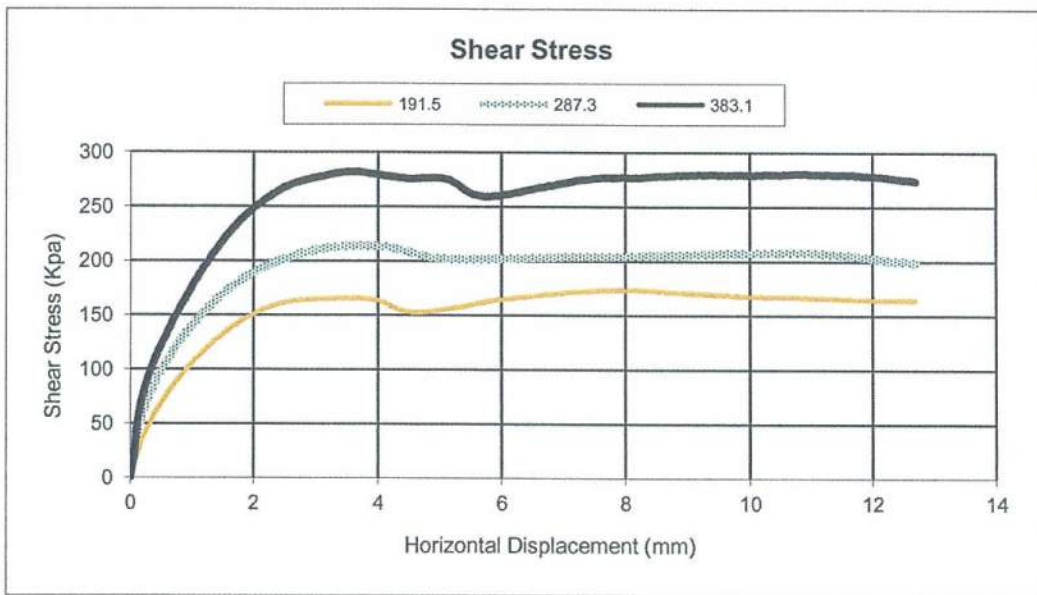


PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaile, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N613 B-3 @ 12.19 m - 12.50 m
SAMPLE PREPARATION: Insitu-Saturate

JOB NO: 1720134030.0002
WORK ORDER NO: 4
LAB NO: 456
DATE ASSIGNED: 11/4/2013

NORMAL LOADS (Kpa): 191.5 287.3 383.1

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (AASHTO T-236)



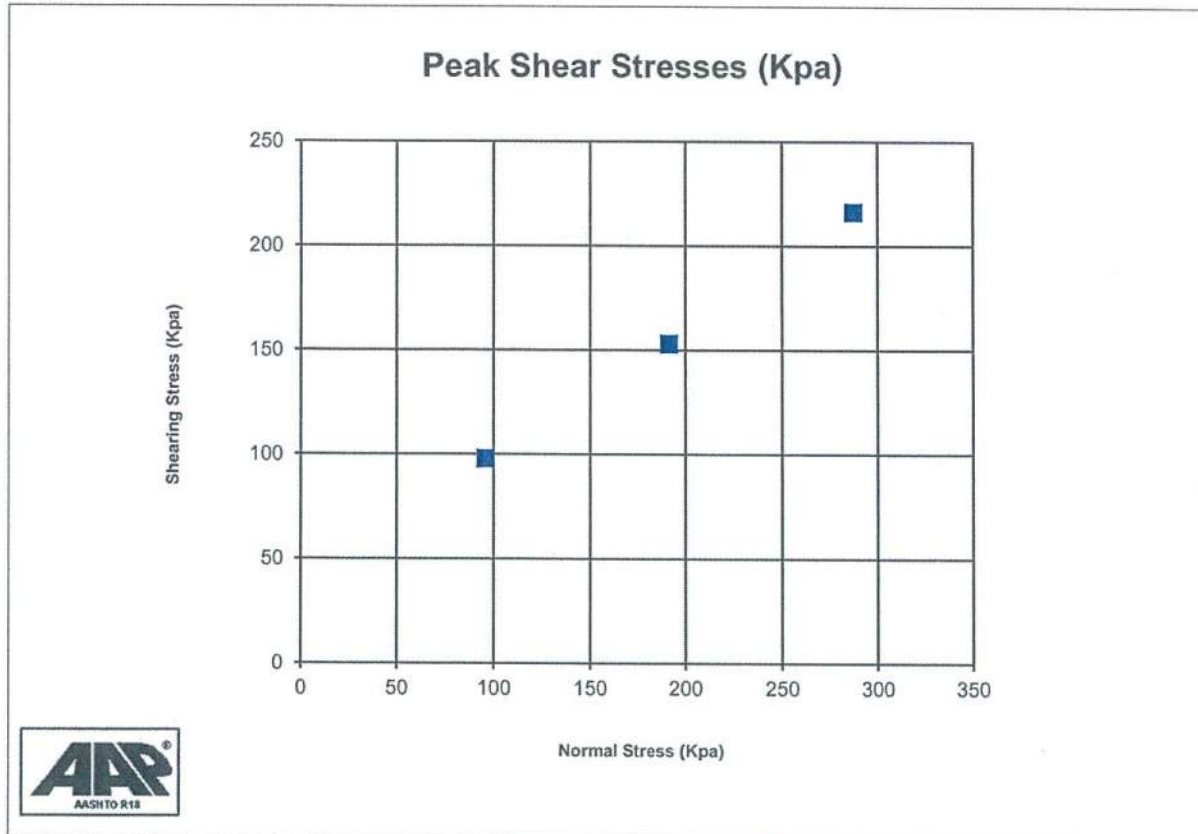
Sheep

PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N613 B-4 @ 6.10 m - 6.40 m
SAMPLE PREPARATION: Insitu-Saturate

JOB NO: 1720134030.0002
WORK ORDER NO: 4
LAB NO: 458
DATE ASSIGNED: 11/4/2013

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (AASHTO T-236)

Initial thickness of specimen (mm):	25.4		
Initial diameter of specimen (mm):	61.5		
Shearing device used:	DigiShear Automated Shear Test System by Trautwein Soil Testing Equipment		
Rate of deformation (mm/min):	0.4064		
Direct shear point (Kpa):	95.8	191.5	287.3
Dry mass of specimen (g):	129.4	130.5	127.4
Initial Moisture Content:	21.4%	21.0%	23.0%
Initial Wet Density (Kg per cu.m):	2083.5	2094.6	2078.5
Initial Dry Density (Kg per cu.m):	1717.0	1731.5	1690.1
Final Moisture Content:	21.2%	21.0%	22.5%
Final Wet Density (Kg per cu.m):	2079.4	2094.0	2068.7
Initial Dry Density (Kg per cu.m):	1716.2	1730.7	1689.3
Normal Stress (kpa):	95.8	191.5	287.3
Maximum Shearing Stress (Kpa):	97.79	152.94	216.16
Vertical Deformation @ Max Shear (mm):	-0.006	0.166	0.058
Horizontal Deformation @ Max Shear (mm):	12.564	1.933	1.879



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Deep

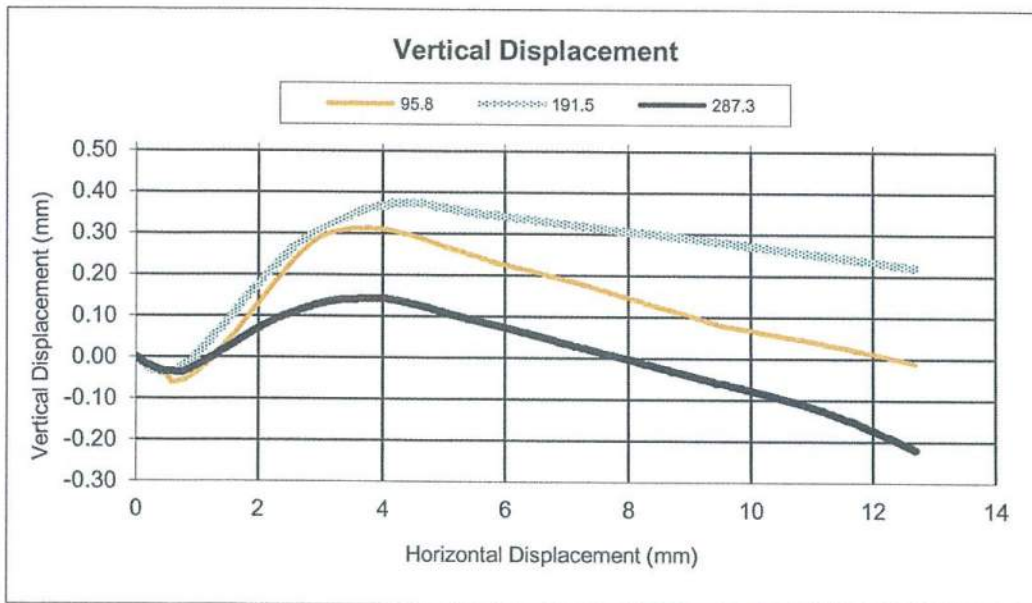
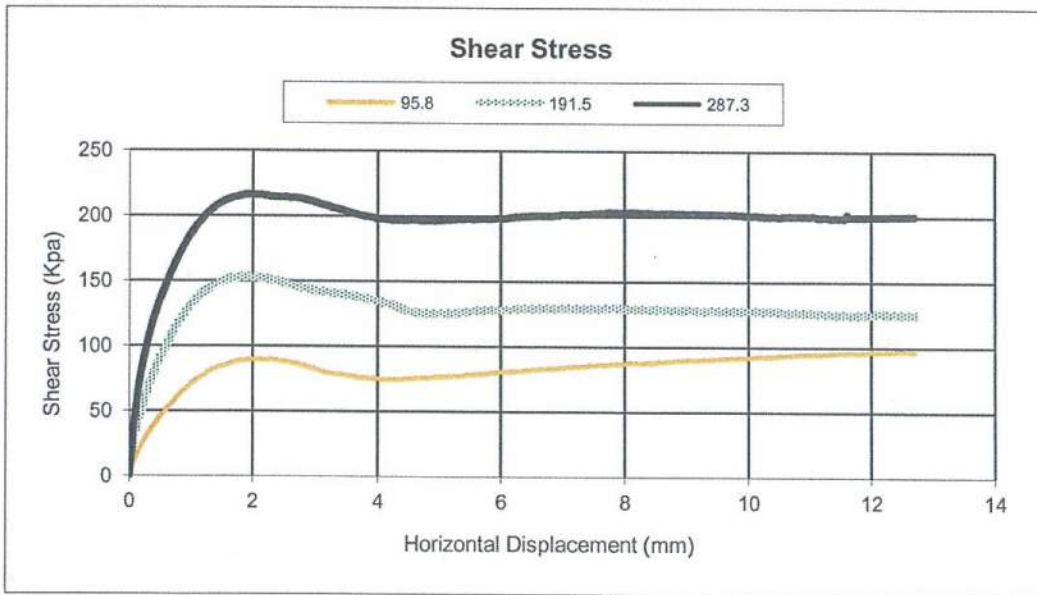


PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsalle, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N613 B-4 @ 6.10 m - 6.40 m
SAMPLE PREPARATION: Insitu-Saturate

JOB NO: 1720134030.0002
WORK ORDER NO: 4
LAB NO: 458
DATE ASSIGNED: 11/4/2013

NORMAL LOADS (Kpa): 95.8 191.5 287.3

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (AASHTO T-236)



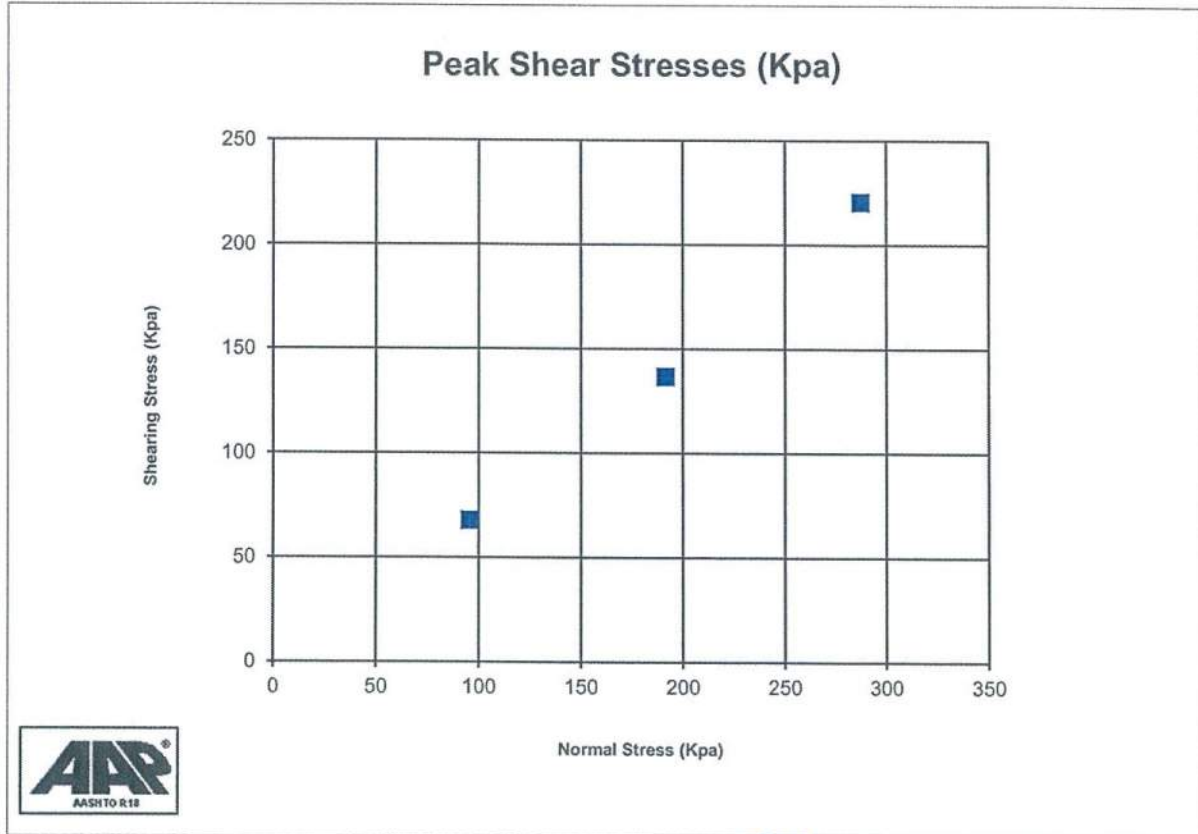
Sheep

PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N614 B-1 @ 6.25 m - 6.55 m
SAMPLE PREPARATION: Insitu-Saturate

JOB NO: 1720134030.0002
WORK ORDER NO: 4
LAB NO: 460
DATE ASSIGNED: 11/4/2013

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (AASHTO T-236)

Initial thickness of specimen (mm):	25.4		
Initial diameter of specimen (mm):	61.5		
Shearing device used:	DigiShear Automated Shear Test System by Trautwein Soil Testing Equipment		
Rate of deformation (mm/min):	0.4064		
Direct shear point (Kpa):	95.8	191.5	287.3
Dry mass of specimen (g):	123.4	128.0	127.8
Initial Moisture Content:	23.6%	21.9%	21.6%
Initial Wet Density (Kg per cu.m):	2023.1	2068.4	2060.1
Initial Dry Density (Kg per cu.m):	1637.5	1697.8	1695.5
Final Moisture Content:	28.2%	22.6%	21.7%
Final Wet Density (Kg per cu.m):	2098.5	2080.5	2062.5
Final Dry Density (Kg per cu.m):	1636.8	1697.0	1694.7
Normal Stress (kpa):	95.8	191.5	287.3
Maximum Shearing Stress (Kpa):	67.76	136.62	220.45
Vertical Deformation @ Max Shear (mm):	-0.049	-0.094	-0.058
Horizontal Deformation @ Max Shear (mm):	2.916	8.205	3.485



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Sheep

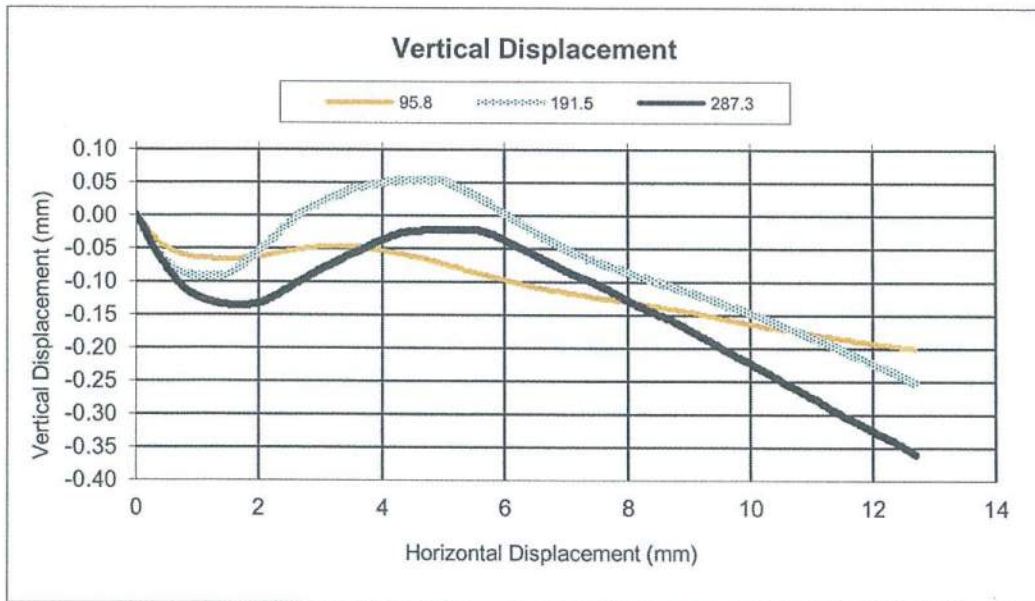
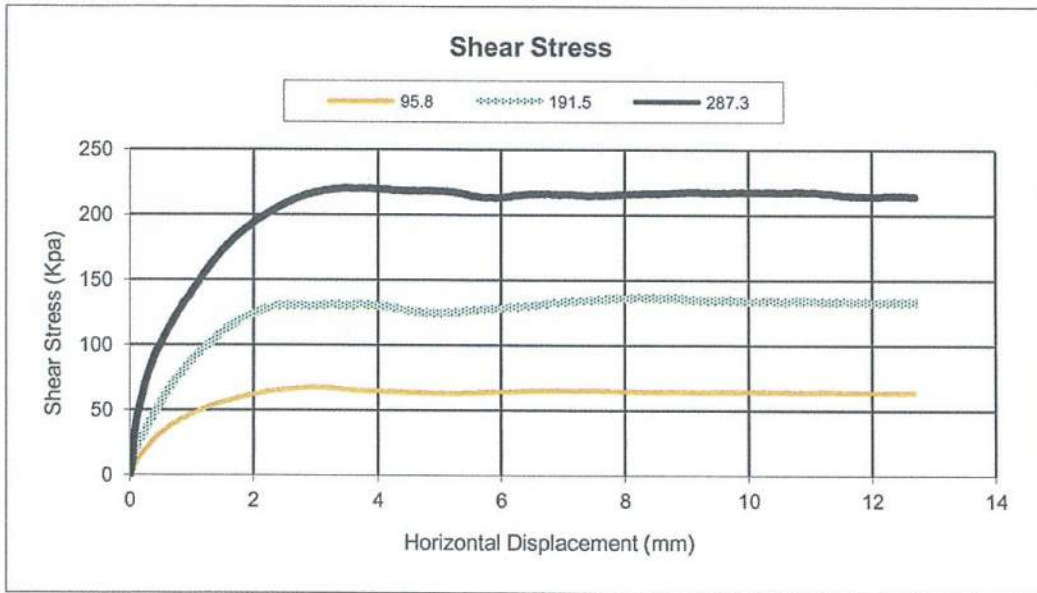


PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N614 B-1 @ 6.25 m - 6.55 m
SAMPLE PREPARATION: Insitu-Saturate

JOB NO: 1720134030.0002
WORK ORDER NO: 4
LAB NO: 460
DATE ASSIGNED: 11/4/2013

NORMAL LOADS (Kpa): 95.8 191.5 287.3

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (AASHTO T-236)



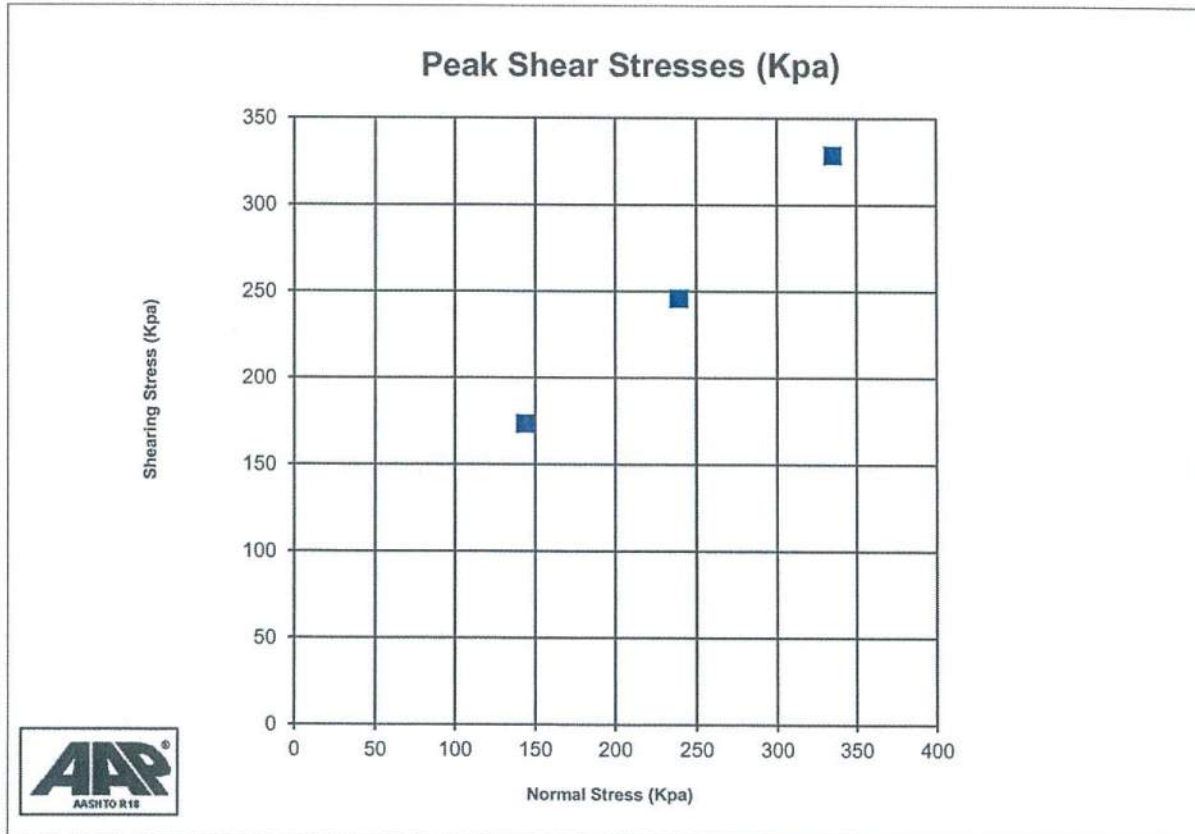
Sheep

PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N614 B-2 @ 10.67 m- 10.97 m
SAMPLE PREPARATION: Insitu-Saturate

JOB NO: 1720134030.0002
WORK ORDER NO: 4
LAB NO: 463
DATE ASSIGNED: 11/4/2013

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (AASHTO T-236)

Initial thickness of specimen (mm):	25.4		
Initial diameter of specimen (mm):	61.5		
Shearing device used:	DigiShear Automated Shear Test System by Trautwein Soil Testing Equipment		
Rate of deformation (mm/min):	0.4064		
Direct shear point (Kpa):	143.6	239.4	335.2
Dry mass of specimen (g):	145.1	144.2	145.9
Initial Moisture Content:	13.6%	14.1%	14.0%
Initial Wet Density (Kg per cu.m):	2187.1	2180.7	2205.0
Initial Dry Density (Kg per cu.m):	1925.6	1912.8	1935.4
Final Moisture Content:	15.5%	15.9%	15.6%
Final Wet Density (Kg per cu.m):	2223.2	2216.3	2236.4
Final Dry Density (Kg per cu.m):	1924.7	1911.9	1934.5
Normal Stress (kpa):	143.6	239.4	335.2
Maximum Shearing Stress (Kpa):	173.45	245.85	328.59
Vertical Deformation @ Max Shear (mm):	-0.036	-0.006	0.153
Horizontal Deformation @ Max Shear (mm):	11.600	12.704	6.909



REVIEWED BY _____

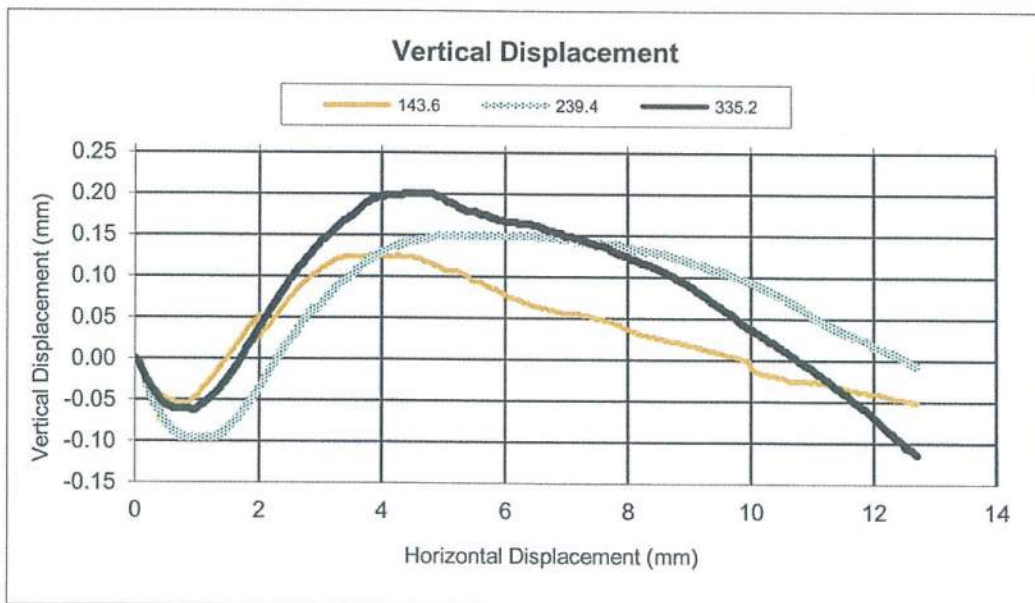
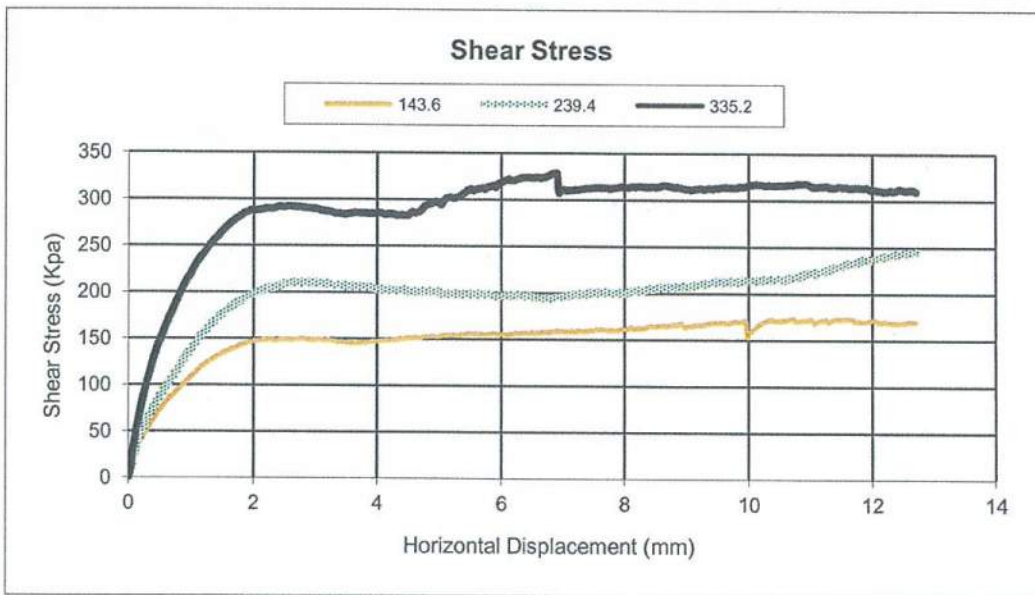


PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N614 B-2 @ 10.67 m- 10.97 m
SAMPLE PREPARATION: Insitu-Saturate

JOB NO: 1720134030.0002
WORK ORDER NO: 4
LAB NO: 463
DATE ASSIGNED: 11/4/2013

NORMAL LOADS (Kpa): 143.6 239.4 335.2

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (AASHTO T-236)



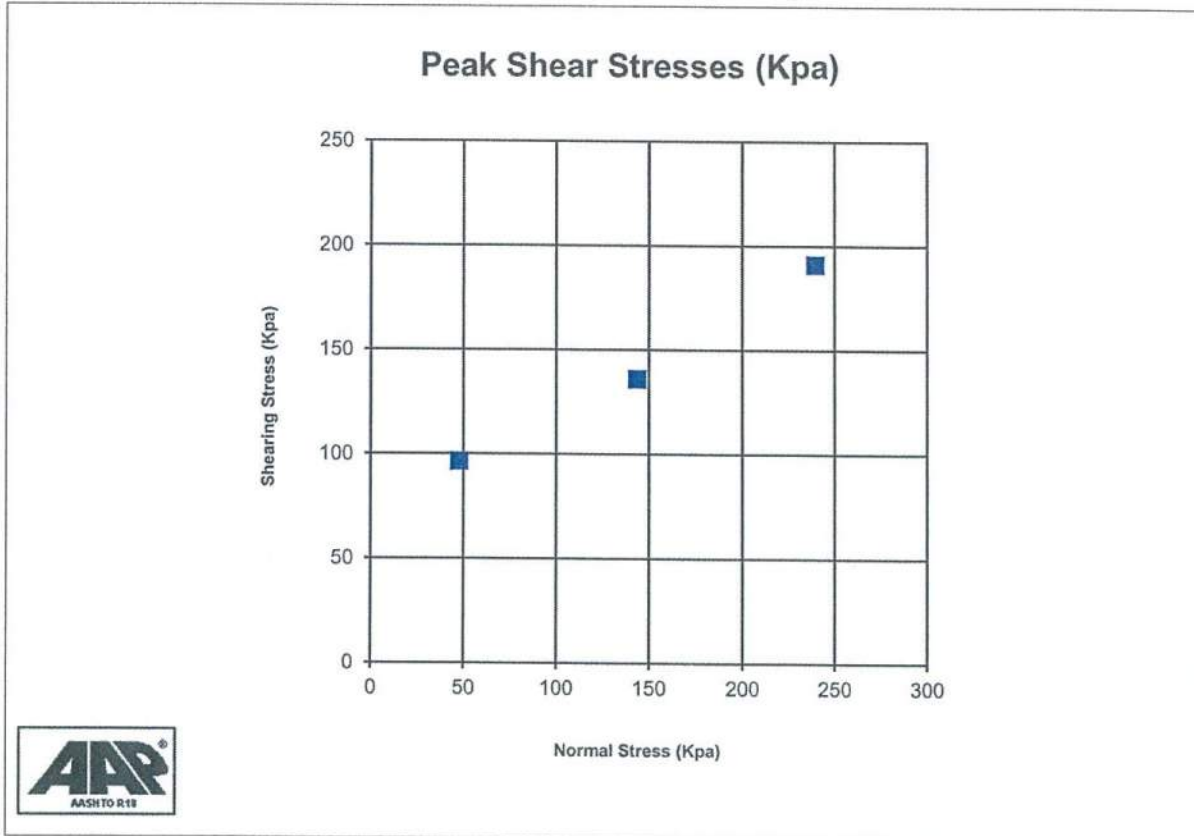
Okay

PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N614 B-4 @ 3.05 m - 3.35 m
SAMPLE PREPARATION: Insitu-Saturate

JOB NO: 1720134030.0002
WORK ORDER NO: 4
LAB NO: 464
DATE ASSIGNED: 11/4/2013

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (AASHTO T-236)

Initial thickness of specimen (mm):	25.4		
Initial diameter of specimen (mm):	61.5		
Shearing device used:	DigiShear Automated Shear Test System by Trautwein Soil Testing Equipment		
Rate of deformation (mm/min):	0.4064		
Direct shear point (Kpa):	47.9	143.6	239.4
Dry mass of specimen (g):	140.3	138.8	141.0
Initial Moisture Content:	8.8%	10.5%	10.3%
Initial Wet Density (Kg per cu.m):	2025.1	2033.9	2062.5
Initial Dry Density (Kg per cu.m):	1861.3	1841.0	1870.4
Final Moisture Content:	21.5%	21.5%	19.2%
Final Wet Density (Kg per cu.m):	2260.2	2236.7	2228.9
Final Dry Density (Kg per cu.m):	1860.5	1840.2	1869.5
Normal Stress (kpa):	47.9	143.6	239.4
Maximum Shearing Stress (Kpa):	96.33	135.95	190.93
Vertical Deformation @ Max Shear (mm):	0.335	-0.038	-0.621
Horizontal Deformation @ Max Shear (mm):	12.704	12.704	12.575



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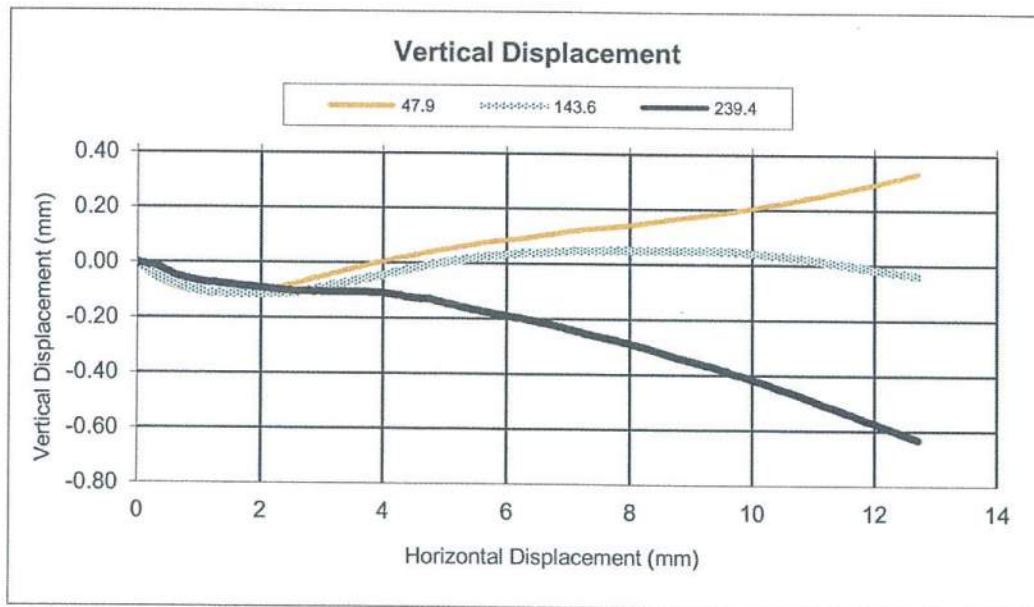
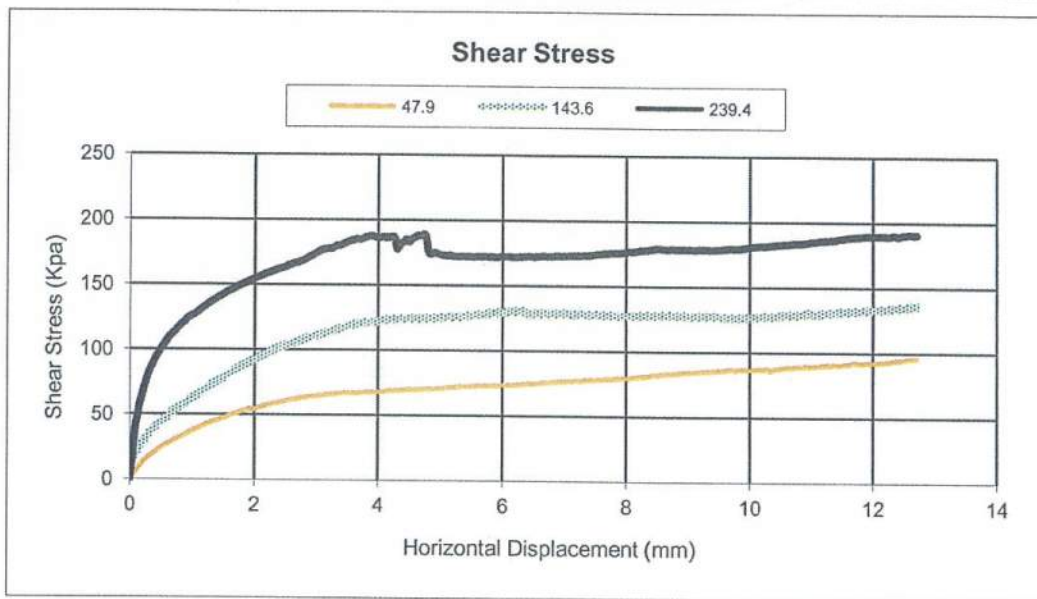


PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaile, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N614 B-4 @ 3.05 m - 3.35 m
SAMPLE PREPARATION: Insitu-Saturate

JOB NO: 1720134030.0002
WORK ORDER NO: 4
LAB NO: 464
DATE ASSIGNED: 11/4/2013

NORMAL LOADS (Kpa): 47.9 143.6 239.4

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (AASHTO T-236)



Day



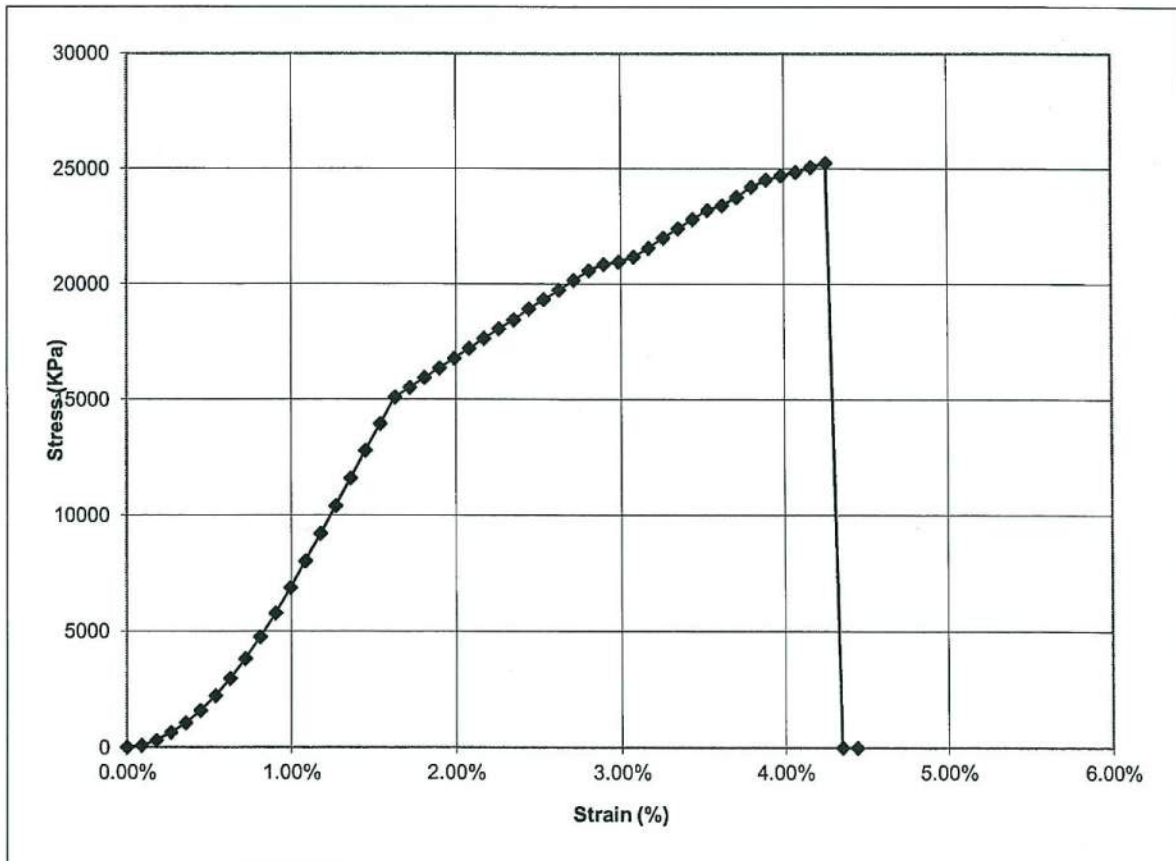
PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N503 B-1 10.52 m - 10.67 m
SAMPLE PREP: INSITU

JOB NO: 1720134030
WORK ORDER NO: 5
LAB NO: 463
DATE SAMPLED: 11/06/13

**UNCONFINED COMPRESSION STRENGTH OF COHESIVE SOIL
APPLICABLE PORTIONS OF (AASHTO T208-10)**

DIAMETER:	6.00 cm	MAXIMUM STRESS:	25,249 KPa
HEIGHT:	14.02 cm	AT STRAIN:	4.26%
STRAIN RATE:	5.1% cm/min.		
DRY DENSITY:	2,152.4 kg/cu.m		
L/D (2.0-2.5 REQ.):	2.34		

SPECIMEN CONTAINED IN A SEALED PLASTIC BAG UNTIL TIME OF TEST



REVIEWED BY: 



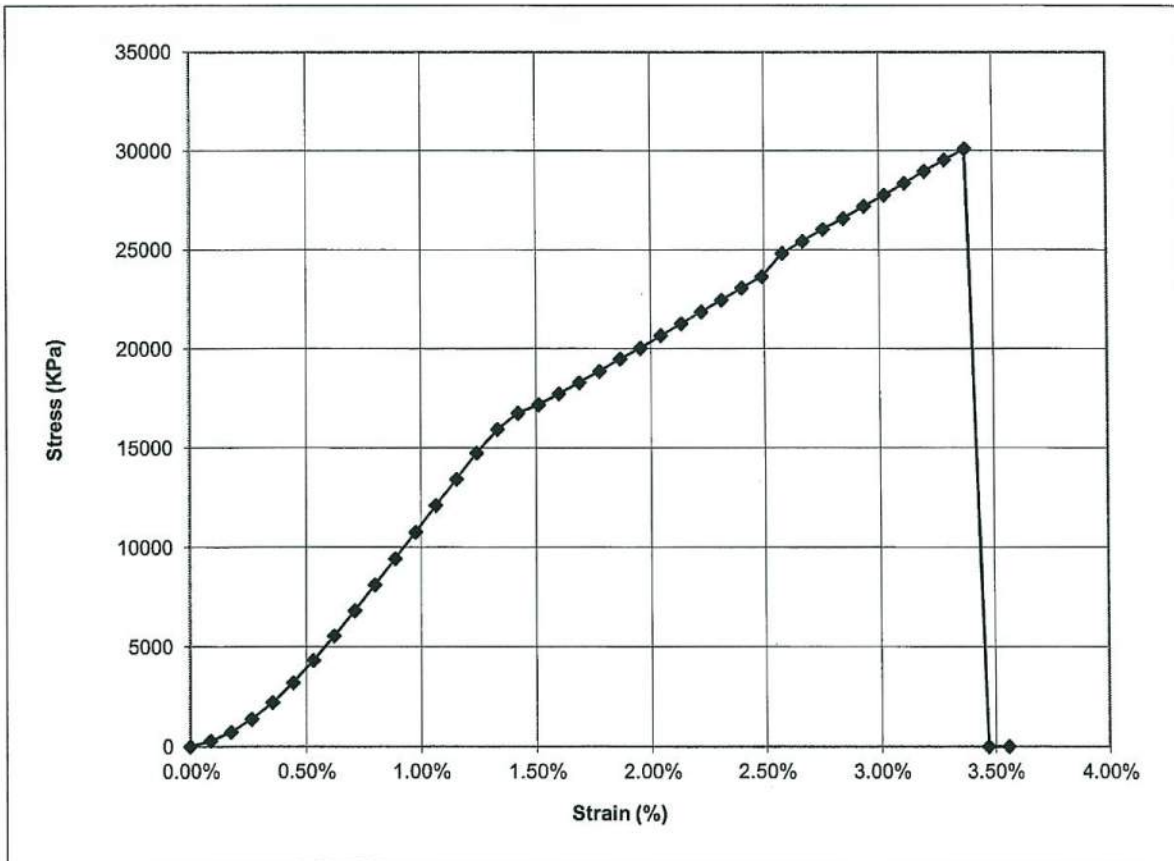
PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsalle, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N503 B-1 13.72 m - 13.94 m
SAMPLE PREP: INSITU

JOB NO: 1720134030
WORK ORDER NO: 5
LAB NO: 464
DATE SAMPLED: 11/06/13

**UNCONFINED COMPRESSION STRENGTH OF COHESIVE SOIL
APPLICABLE PORTIONS OF (AASHTO T208-10)**

DIAMETER:	6.00 cm	MAXIMUM STRESS:	30,100 KPa
HEIGHT:	14.27 cm	AT STRAIN:	3.38%
STRAIN RATE:	5.1% cm/min.		
DRY DENSITY:	2,470.5 kg/cu.m		
L/D (2.0-2.5 REQ.):	2.38		

SPECIMEN CONTAINED IN A SEALED PLASTIC BAG UNTIL TIME OF TEST



REVIEWED BY: 



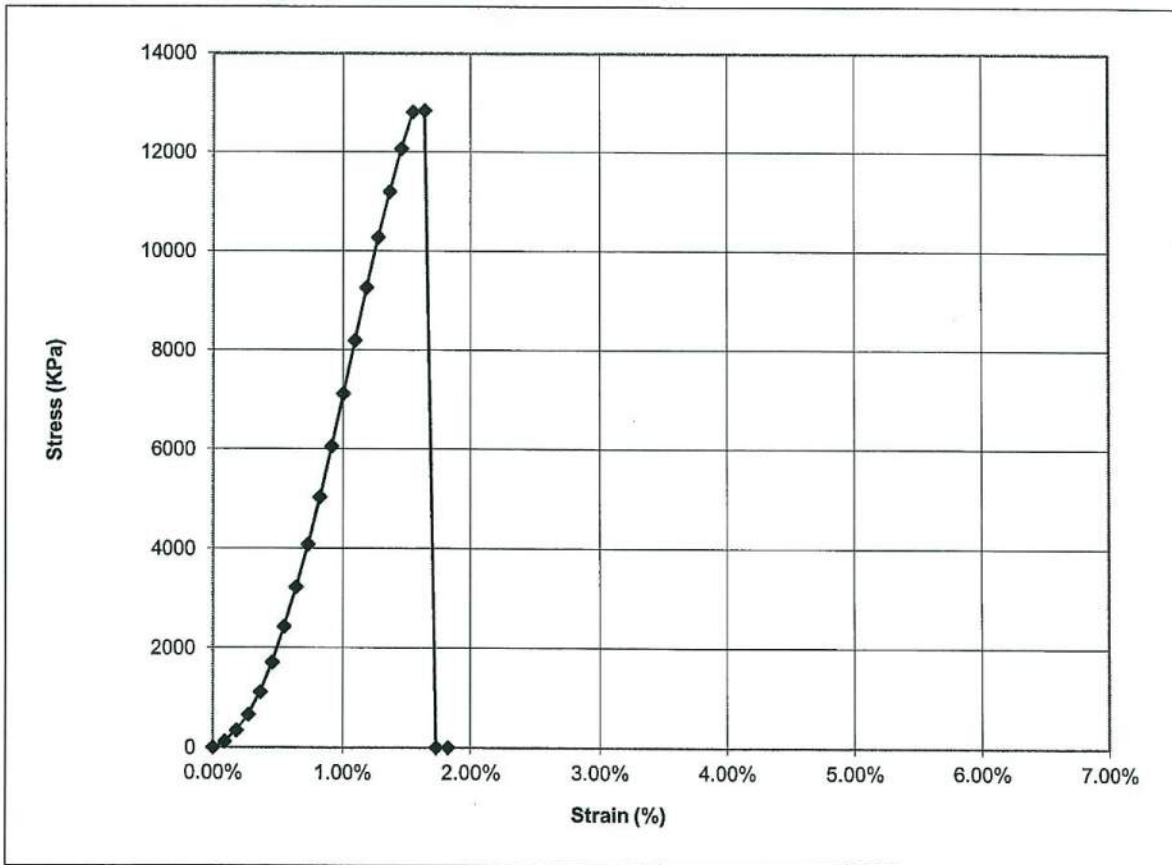
PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsalle, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N503 B-2 @ 15.39 m - 15.58 m
SAMPLE PREP: INSITU

JOB NO: 1720134030
WORK ORDER NO: 5
LAB NO: 466
DATE SAMPLED: 11/06/13

**UNCONFINED COMPRESSION STRENGTH OF COHESIVE SOIL
APPLICABLE PORTIONS OF (AASHTO T208-10)**

DIAMETER:	5.99 cm	MAXIMUM STRESS:	12,844 KPa
HEIGHT:	13.89 cm	AT STRAIN:	1.65%
STRAIN RATE:	5.1% cm/min.		
DRY DENSITY:	2,445.0 kg/cu.m		
L/D (2.0-2.5 REQ.):	2.32		

SPECIMEN CONTAINED IN A SEALED PLASTIC BAG UNTIL TIME OF TEST



REVIEWED BY: 



PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsalle, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N503 B-3 @ 4.57 m - 4.88 m
SAMPLE PREP: INSITU

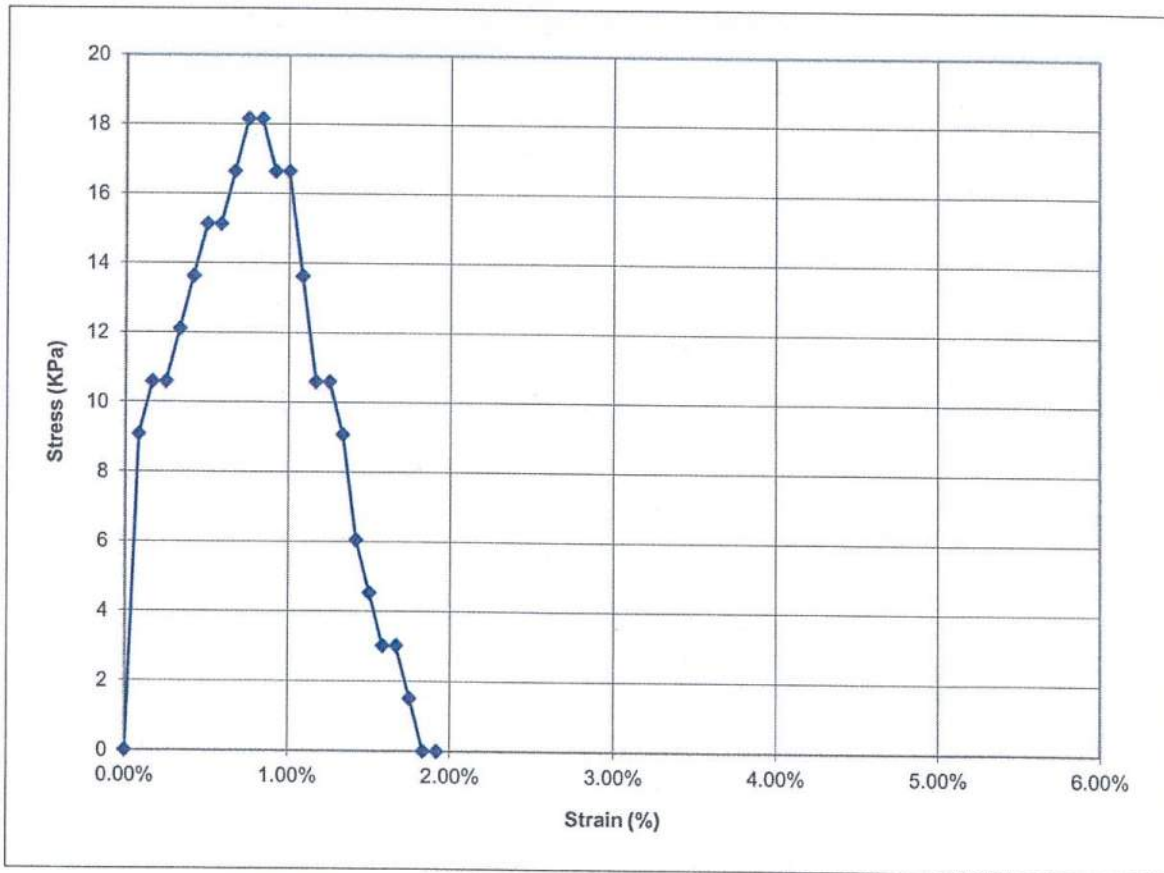
JOB NO: 1720134030
WORK ORDER NO: 4
LAB NO: 449
DATE SAMPLED: 11/04/13

UNCONFINED COMPRESSION STRENGTH OF COHESIVE SOIL
APPLICABLE PORTIONS OF (AASHTO T208-10)

DIAMETER: 6.12 cm
HEIGHT: 15.21 cm
STRAIN RATE: 5.1% cm/min.
DRY DENSITY: 1,927.7 kg/cu.m
L/D (2.0-2.5 REQ.): 2.49

MAXIMUM STRESS: 18 KPa
AT STRAIN: 0.75%

SPECIMEN CONTAINED IN A SEALED PLASTIC BAG UNTIL TIME OF TEST



REVIEWED BY: *aj*



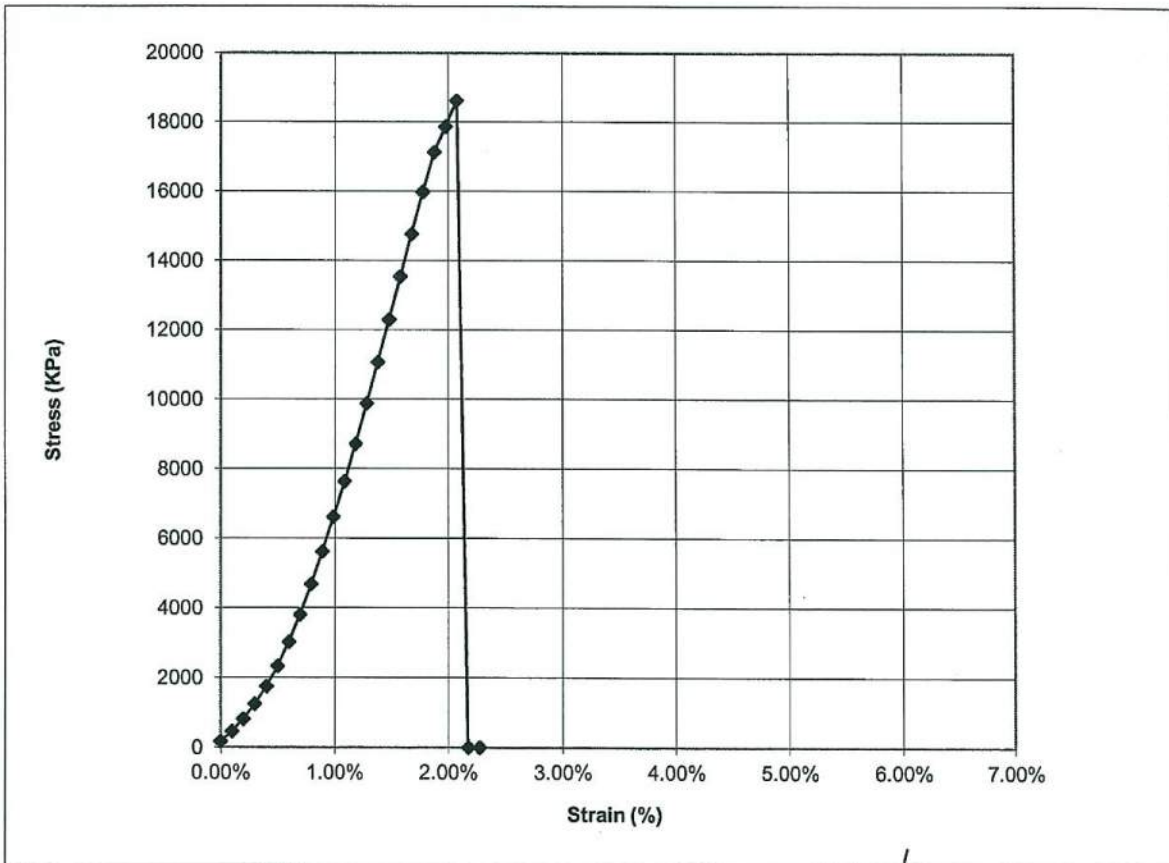
PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsalle, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N503 B-3 @ 12.53 m - 12.65 m
SAMPLE PREP: INSITU

JOB NO: 1720134030
WORK ORDER NO: 5
LAB NO: 467
DATE SAMPLED: 11/06/13

UNCONFINED COMPRESSION STRENGTH OF COHESIVE SOIL
APPLICABLE PORTIONS OF (AASHTO T208-10)

DIAMETER:	5.59 cm	MAXIMUM STRESS:	18,623 KPa
HEIGHT:	12.83 cm	AT STRAIN:	2.08%
STRAIN RATE:	5.1% cm/min.		
DRY DENSITY:	2,197.8 kg/cu.m		
L/D (2.0-2.5 REQ.):	2.29		

SPECIMEN CONTAINED IN A SEALED PLASTIC BAG UNTIL TIME OF TEST



REVIEWED BY: 



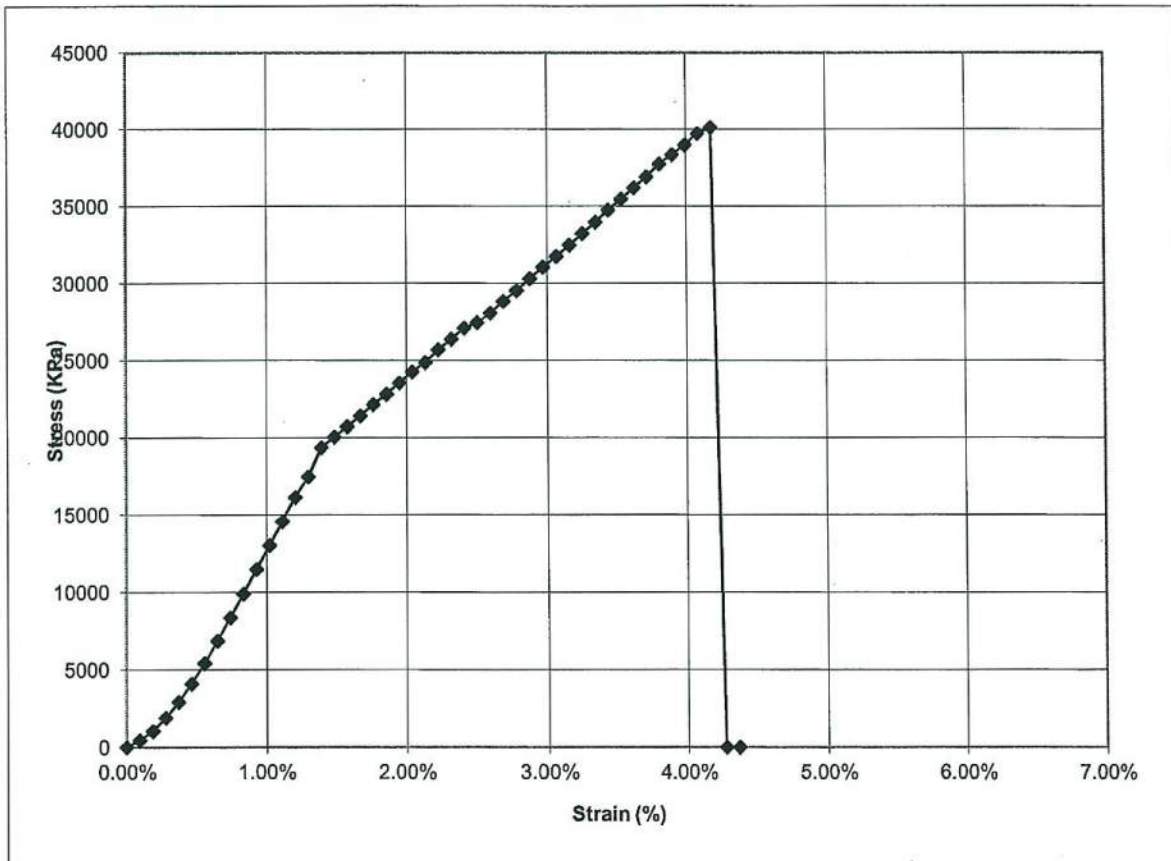
PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsalle, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N503 B-3 @ 16.49 m - 16.64 m
SAMPLE PREP: INSITU

JOB NO: 1720134030
WORK ORDER NO: 5
LAB NO: 468
DATE SAMPLED: 11/06/13

**UNCONFINED COMPRESSION STRENGTH OF COHESIVE SOIL
APPLICABLE PORTIONS OF (AASHTO T208-10)**

DIAMETER:	5.70 cm	MAXIMUM STRESS:	40,142 KPa
HEIGHT:	13.67 cm	AT STRAIN:	4.18%
STRAIN RATE:	5.1% cm/min.		
DRY DENSITY:	2,463.2 kg/cu.m		
L/D (2.0-2.5 REQ.):	2.40		

SPECIMEN CONTAINED IN A SEALED PLASTIC BAG UNTIL TIME OF TEST



REVIEWED BY: _____



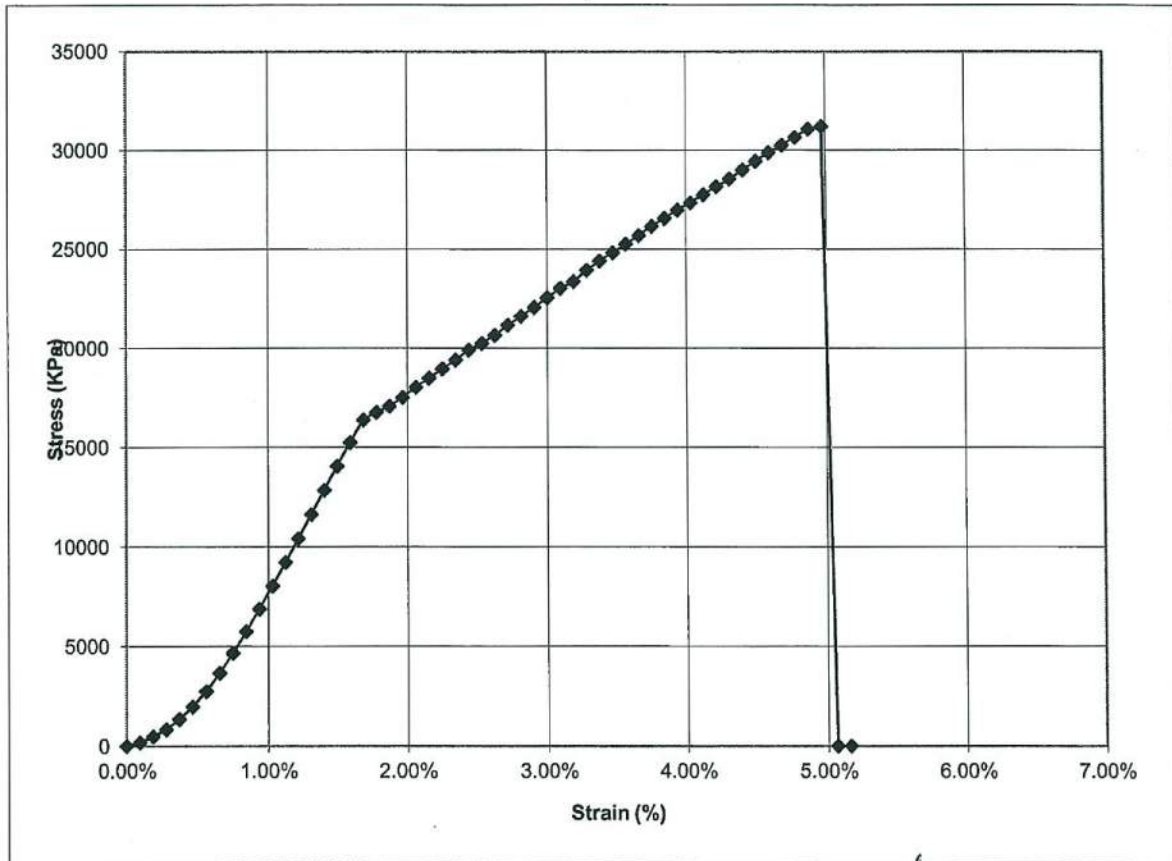
PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N503 B-4 @ 13.38 m - 13.53 m
SAMPLE PREP: INSITU

JOB NO: 1720134030
WORK ORDER NO: 5
LAB NO: 469
DATE SAMPLED: 11/06/13

**UNCONFINED COMPRESSION STRENGTH OF COHESIVE SOIL
APPLICABLE PORTIONS OF (AASHTO T208-10)**

DIAMETER:	5.96 cm	MAXIMUM STRESS:	31,202 KPa
HEIGHT:	13.53 cm	AT STRAIN:	4.97%
STRAIN RATE:	5.1% cm/min.		
DRY DENSITY:	2,411.5 kg/cu.m		
L/D (2.0-2.5 REQ.):	2.27		

SPECIMEN CONTAINED IN A SEALED PLASTIC BAG UNTIL TIME OF TEST



REVIEWED BY: 



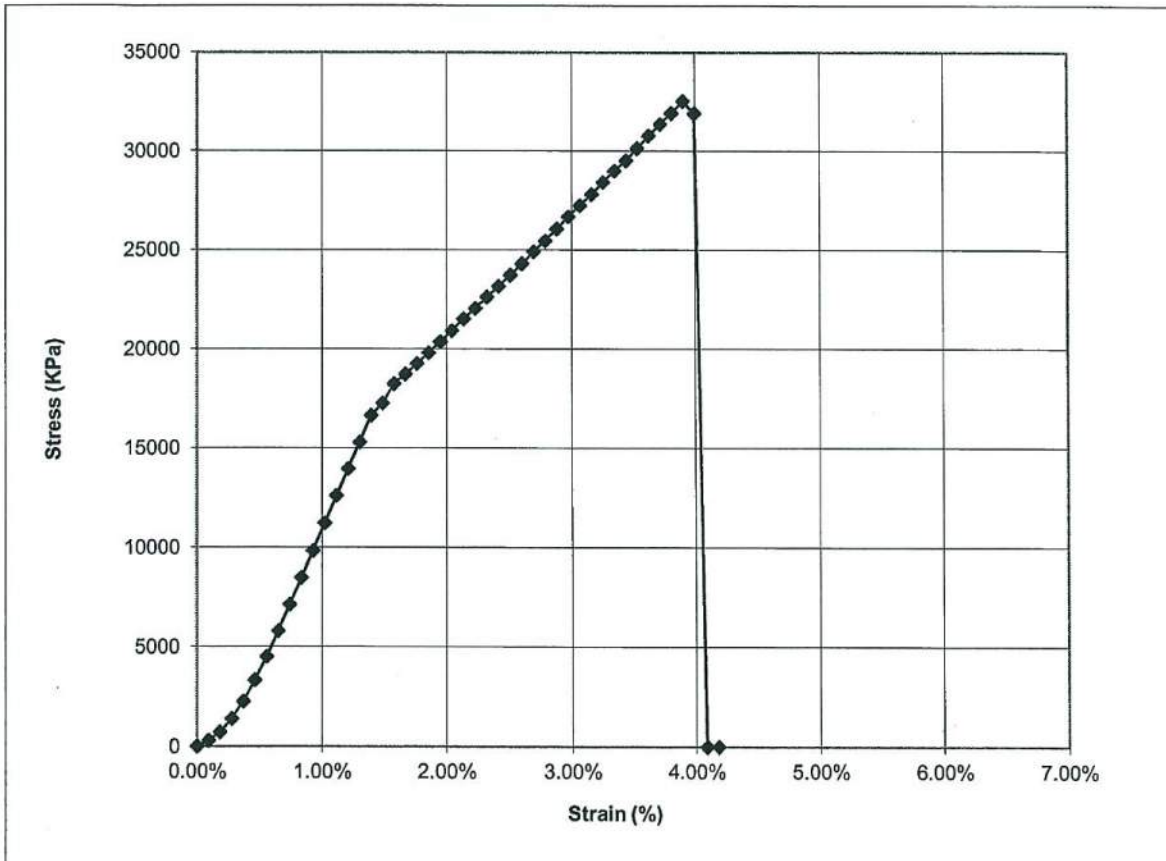
PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N503 B-4 @ 15.79 m - 15.85 m
SAMPLE PREP: INSITU

JOB NO: 1720134030
WORK ORDER NO: 5
LAB NO: 470
DATE SAMPLED: 11/06/13

**UNCONFINED COMPRESSION STRENGTH OF COHESIVE SOIL
APPLICABLE PORTIONS OF (AASHTO T208-10)**

DIAMETER:	6.04 cm	MAXIMUM STRESS:	32,531 KPa
HEIGHT:	13.66 cm	AT STRAIN:	3.90%
STRAIN RATE:	5.1% cm/min.		
DRY DENSITY:	2,441.5 kg/cu.m		
L/D (2.0-2.5 REQ.):	2.26		

SPECIMEN CONTAINED IN A SEALED PLASTIC BAG UNTIL TIME OF TEST



REVIEWED BY: _____



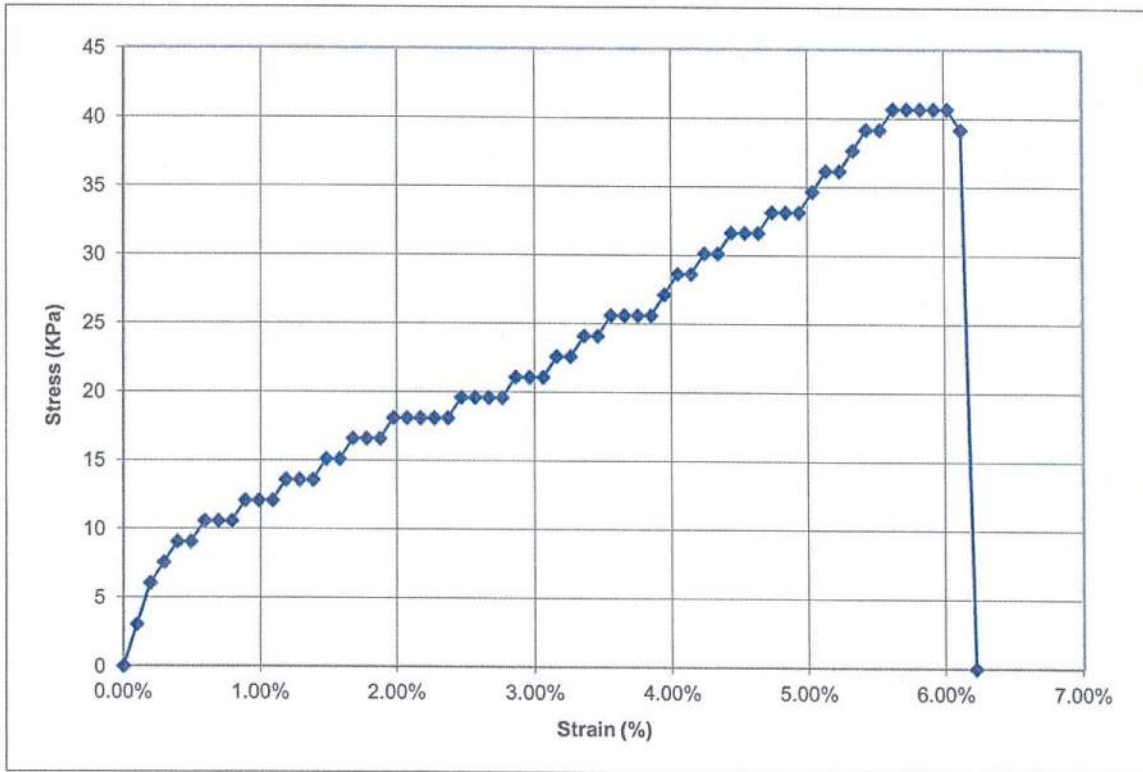
PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N504 B-2; 9.30 m - 9.60 m
SAMPLE PREP: INSITU

JOB NO: 1720134030.0002
WORK ORDER 3
LAB NO: 317
DATE SAMPLE 10/02/13

UNCONFINED COMPRESSION STRENGTH OF COHESIVE SOIL
APPLICABLE PORTIONS OF (AASHTO T208-10)

DIAMETER: 6.13 cm
HEIGHT: 12.87 cm
STRAIN RATE: 5.1% cm/min.
DRY DENSITY: 1,741.3 kg/cu.m

MAXIMUM STRESS: 41 KPa
AT STRAIN: 5.62%



REVIEWED BY: Oluf



PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N505 B-1 @ 6.54 m - 6.71 m
SAMPLE PREP: INSITU

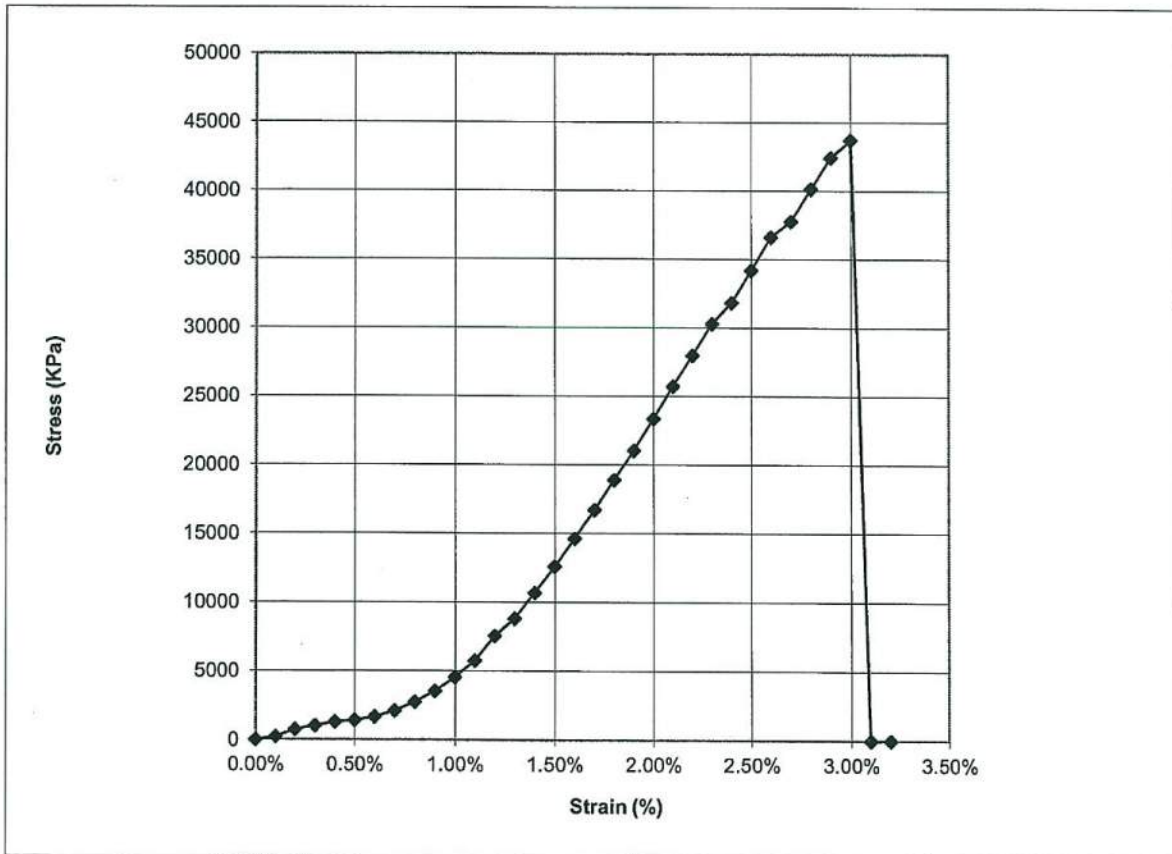
JOB NO: 1720134030
WORK ORDER NO: 5
LAB NO: 486
DATE SAMPLED: 11/06/13

UNCONFINED COMPRESSION STRENGTH OF COHESIVE SOIL
APPLICABLE PORTIONS OF (AASHTO T208-10)

DIAMETER: 5.92 cm
HEIGHT: 12.70 cm
STRAIN RATE: 5.1% cm/min.
DRY DENSITY: 2,082.2 kg/cu.m
L/D (2.0-2.5 REQ.): 2.15

MAXIMUM STRESS: 43,733 KPa
AT STRAIN: 3.00%

SPECIMEN CONTAINED IN A SEALED PLASTIC BAG UNTIL TIME OF TEST



REVIEWED BY: _____



PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N505 B-1 @ 10.36 m - 10.55 m
SAMPLE PREP: INSITU

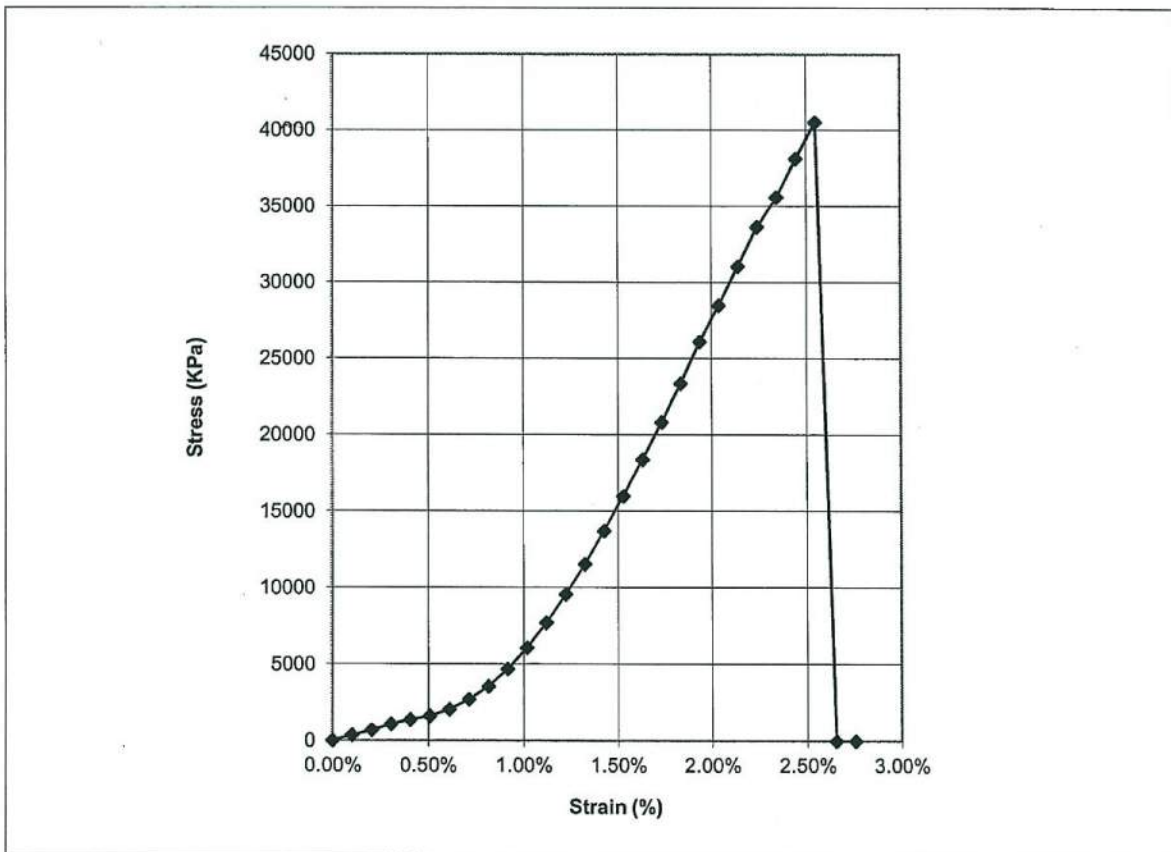
JOB NO: 1720134030
WORK ORDER NO: 5
LAB NO: 487
DATE SAMPLED: 11/06/13

UNCONFINED COMPRESSION STRENGTH OF COHESIVE SOIL
APPLICABLE PORTIONS OF (AASHTO T208-10)

DIAMETER: 6.00 cm
HEIGHT: 12.45 cm
STRAIN RATE: 5.1% cm/min.
DRY DENSITY: 2,114.1 kg/cu.m
L/D (2.0-2.5 REQ.): 2.07

MAXIMUM STRESS: 40,539 KPa
AT STRAIN: 2.55%

SPECIMEN CONTAINED IN A SEALED PLASTIC BAG UNTIL TIME OF TEST



REVIEWED BY:



PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N505 B-2 @ 11.70 m - 11.90 m
SAMPLE PREP: INSITU

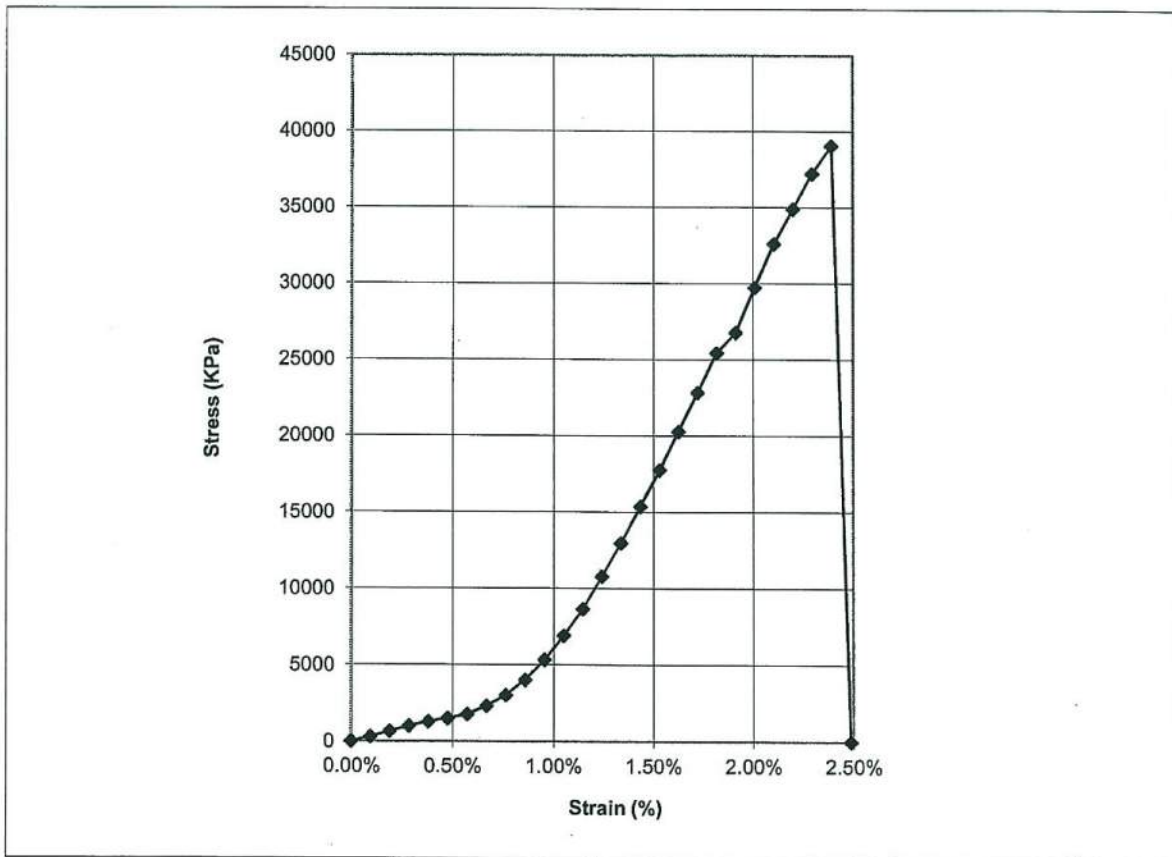
JOB NO: 1720134030
WORK ORDER NO: 5
LAB NO: 488
DATE SAMPLED: 11/06/13

UNCONFINED COMPRESSION STRENGTH OF COHESIVE SOIL
APPLICABLE PORTIONS OF (AASHTO T208-10)

DIAMETER: 6.00 cm
HEIGHT: 13.27 cm
STRAIN RATE: 5.1% cm/min.
DRY DENSITY: 2,098.1 kg/cu.m
L/D (2.0-2.5 REQ.): 2.21

MAXIMUM STRESS: 39,061 KPa
AT STRAIN: 2.39%

SPECIMEN CONTAINED IN A SEALED PLASTIC BAG UNTIL TIME OF TEST



REVIEWED BY: 



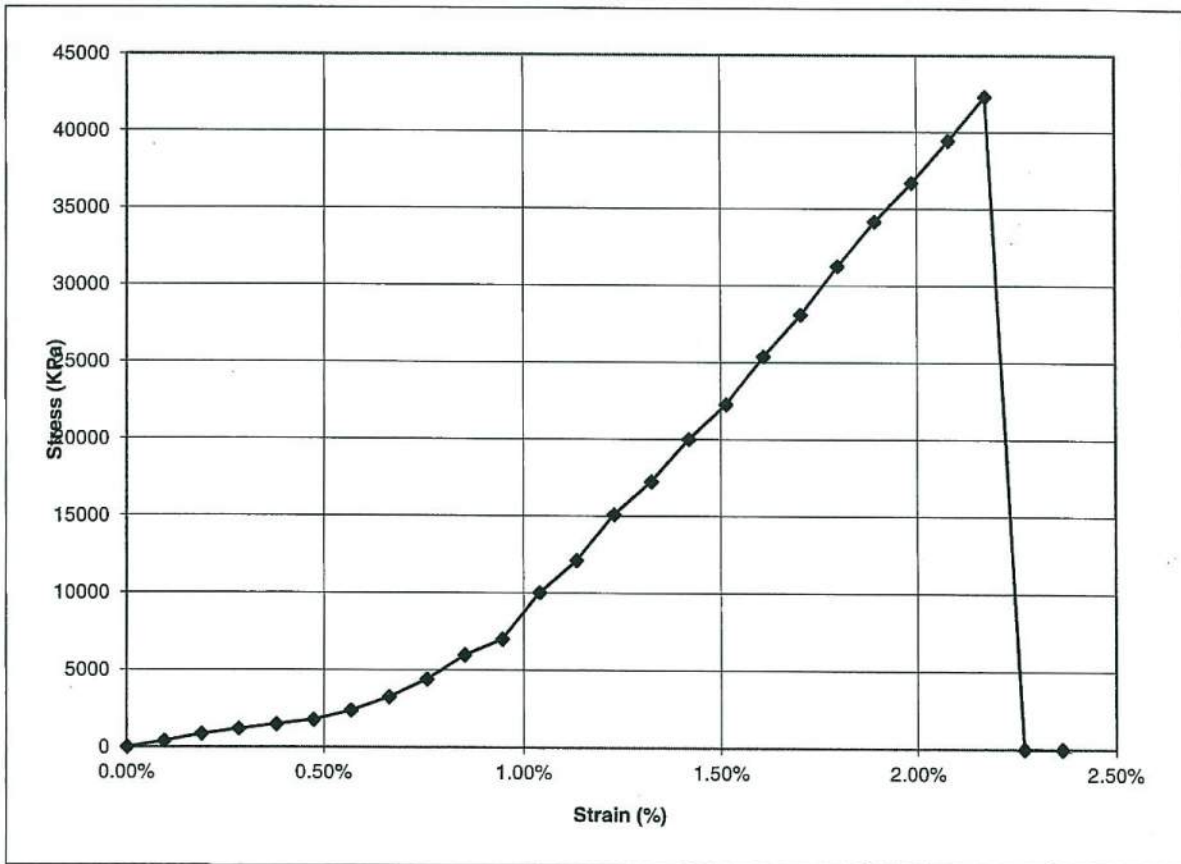
PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsalle, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N505 B-3 @ 6.22 m - 6.43 m
SAMPLE PREP: INSITU

JOB NO: 1720134030
WORK ORDER NO: 5
LAB NO: 490
DATE SAMPLED: 11/06/13

**UNCONFINED COMPRESSION STRENGTH OF COHESIVE SOIL
APPLICABLE PORTIONS OF (AASHTO T208-10)**

DIAMETER: 5.99 cm **MAXIMUM STRESS:** 42,314 KPa
HEIGHT: 13.43 cm **AT STRAIN:** 2.17%
STRAIN RATE: 5.1% cm/min.
DRY DENSITY: 2,117.3 kg/cu.m
L/D (2.0-2.5 REQ.): 2.24

SPECIMEN CONTAINED IN A SEALED PLASTIC BAG UNTIL TIME OF TEST



REVIEWED BY:



PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N505 B-3 @ 10.47 m - 10.61 m
SAMPLE PREP: INSITU

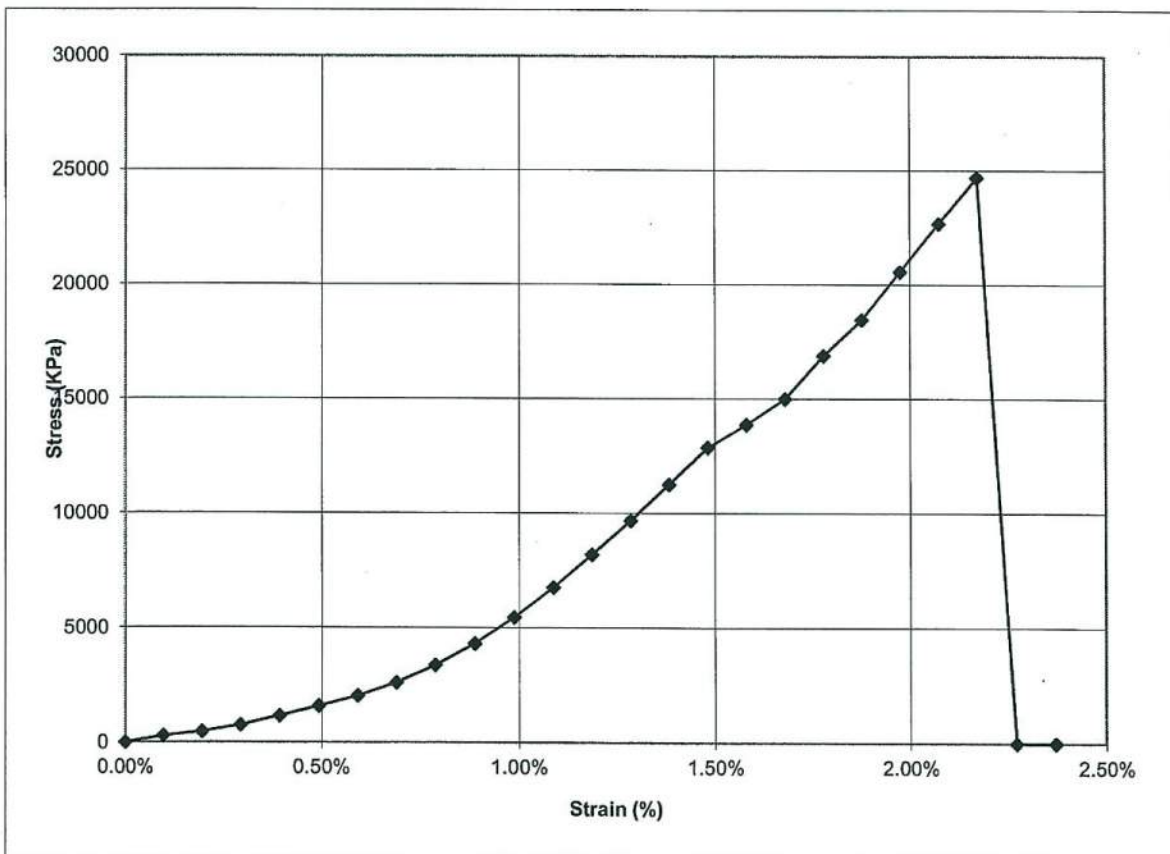
JOB NO: 1720134030
WORK ORDER NO: 5
LAB NO: 491
DATE SAMPLED: 11/06/13

UNCONFINED COMPRESSION STRENGTH OF COHESIVE SOIL
APPLICABLE PORTIONS OF (AASHTO T208-10)

DIAMETER: 6.04 cm
HEIGHT: 12.86 cm
STRAIN RATE: 5.1% cm/min.
DRY DENSITY: 2,057.7 kg/cu.m
L/D (2.0-2.5 REQ.): 2.13

MAXIMUM STRESS: 24,694 KPa
AT STRAIN: 2.17%

SPECIMEN CONTAINED IN A SEALED PLASTIC BAG UNTIL TIME OF TEST



REVIEWED BY: 



PROJECT: BIA-N12 Bridges Navajo, NM to Junction N64 AZ
LOCATION: NM to Junction N64 AZ
MATERIAL: Bore hole samples
SAMPLE SOURCE: N505 B-4 @ 9.02 m - 9.17 m
SAMPLE PREP: INSITU

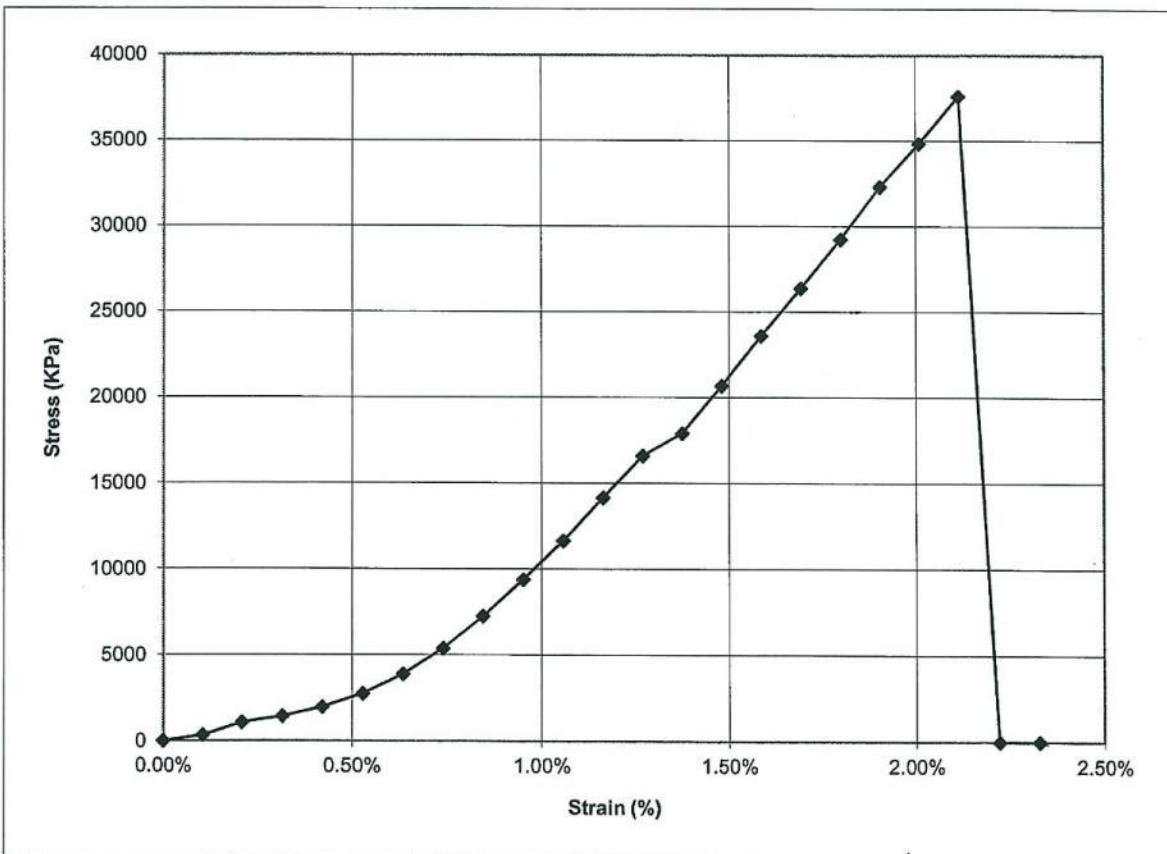
JOB NO: 1720134030
WORK ORDER NO: 5
LAB NO: 493
DATE SAMPLED: 11/06/13

**UNCONFINED COMPRESSION STRENGTH OF COHESIVE SOIL
APPLICABLE PORTIONS OF (AASHTO T208-10)**

DIAMETER: 6.08 cm
HEIGHT: 12.00 cm
STRAIN RATE: 5.1% cm/min.
DRY DENSITY: 2,069.6 kg/cu.m
L/D (2.0-2.5 REQ.): 1.97

MAXIMUM STRESS: 37,604 KPa
AT STRAIN: 2.12%

SPECIMEN CONTAINED IN A SEALED PLASTIC BAG UNTIL TIME OF TEST
Note: The L/D did not satisfy the 2.0 to 2.5 requirement.



REVIEWED BY: 



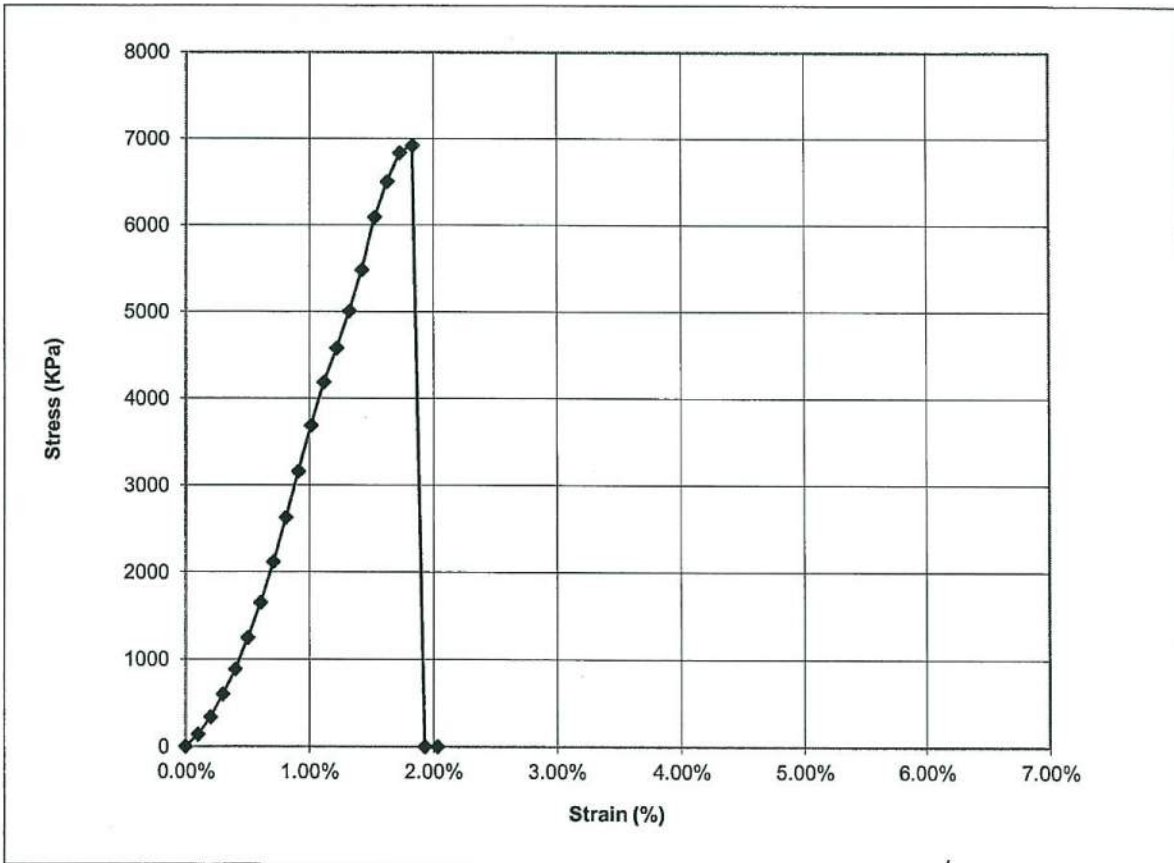
PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N613 B-1 @ 10.45 m - 10.61 m
SAMPLE PREP: INSITU

JOB NO: 1720134030
WORK ORDER NO: 5
LAB NO: 479
DATE SAMPLED: 11/06/13

UNCONFINED COMPRESSION STRENGTH OF COHESIVE SOIL
APPLICABLE PORTIONS OF (AASHTO T208-10)

DIAMETER:	6.01 cm	MAXIMUM STRESS:	6,921 KPa
HEIGHT:	12.48 cm	AT STRAIN:	1.83%
STRAIN RATE:	5.1% cm/min.		
DRY DENSITY:	2,395.5 kg/cu.m		
L/D (2.0-2.5 REQ.):	2.07		

SPECIMEN CONTAINED IN A SEALED PLASTIC BAG UNTIL TIME OF TEST



REVIEWED BY: 



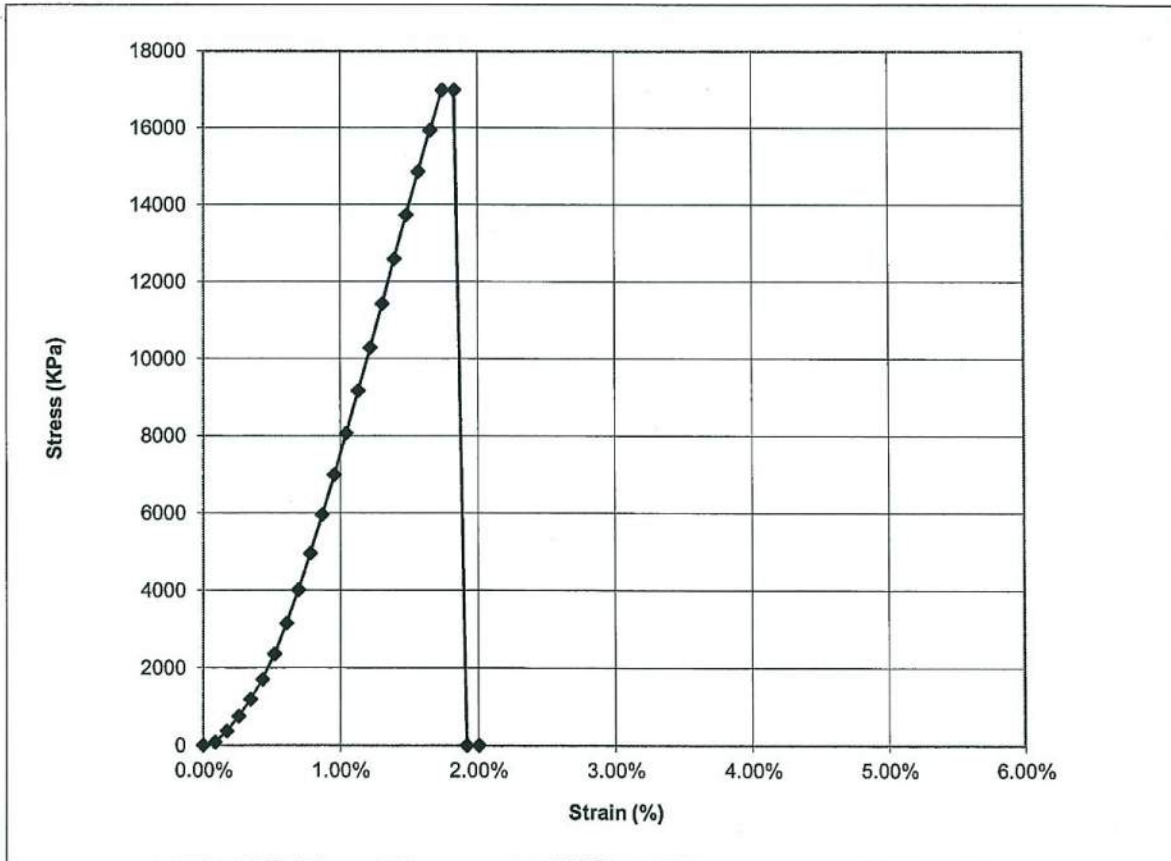
PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N613 B-1 @ 13.20 m - 13.35 m
SAMPLE PREP: INSITU

JOB NO: 1720134030
WORK ORDER NO 5
LAB NO: 480
DATE SAMPLED: 11/06/13

**UNCONFINED COMPRESSION STRENGTH OF COHESIVE SOIL
APPLICABLE PORTIONS OF (AASHTO T208-10)**

DIAMETER:	6.03 cm	MAXIMUM STRESS:	16,986 KPa
HEIGHT:	14.56 cm	AT STRAIN:	1.74%
STRAIN RATE:	5.1% cm/min.		
DRY DENSITY:	2,449.1 kg/cu.m		
L/D (2.0-2.5 REQ.):	2.42		

SPECIMEN CONTAINED IN A SEALED PLASTIC BAG UNTIL TIME OF TEST



REVIEWED BY: 



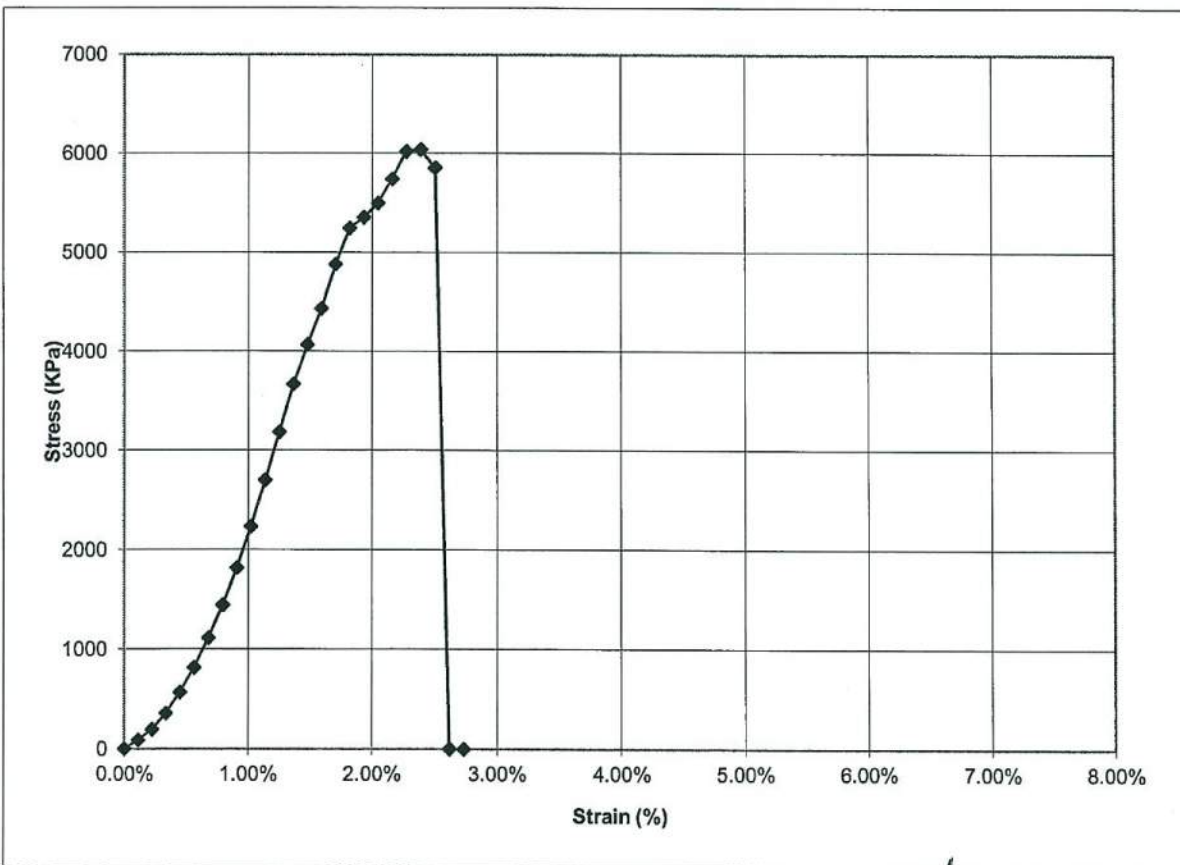
PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsalle, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N613 B-2 @ 10.70 m -10.82 m
SAMPLE PREP: INSITU

JOB NO: 1720134030
WORK ORDER NO: 5
LAB NO: 481
DATE SAMPLED: 11/06/13

UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE SPECIMENS
(AASHTO T208-10) as applicable

DIAMETER:	6.00 cm	MAXIMUM STRESS:	6,040 KPa
HEIGHT:	11.15 cm	AT STRAIN:	2.39%
STRAIN RATE:	5.1% cm/min.		
DRY DENSITY:	2,313.1 kg/cu.m		
L/D (2.0-2.5 REQ.):	1.86		

SPECIMEN CONTAINED IN A SEALED PLASTIC BAG UNTIL TIME OF TEST
Note: The L/D did not satisfy the 2.0 to 2.5 requirement.



REVIEWED BY: 



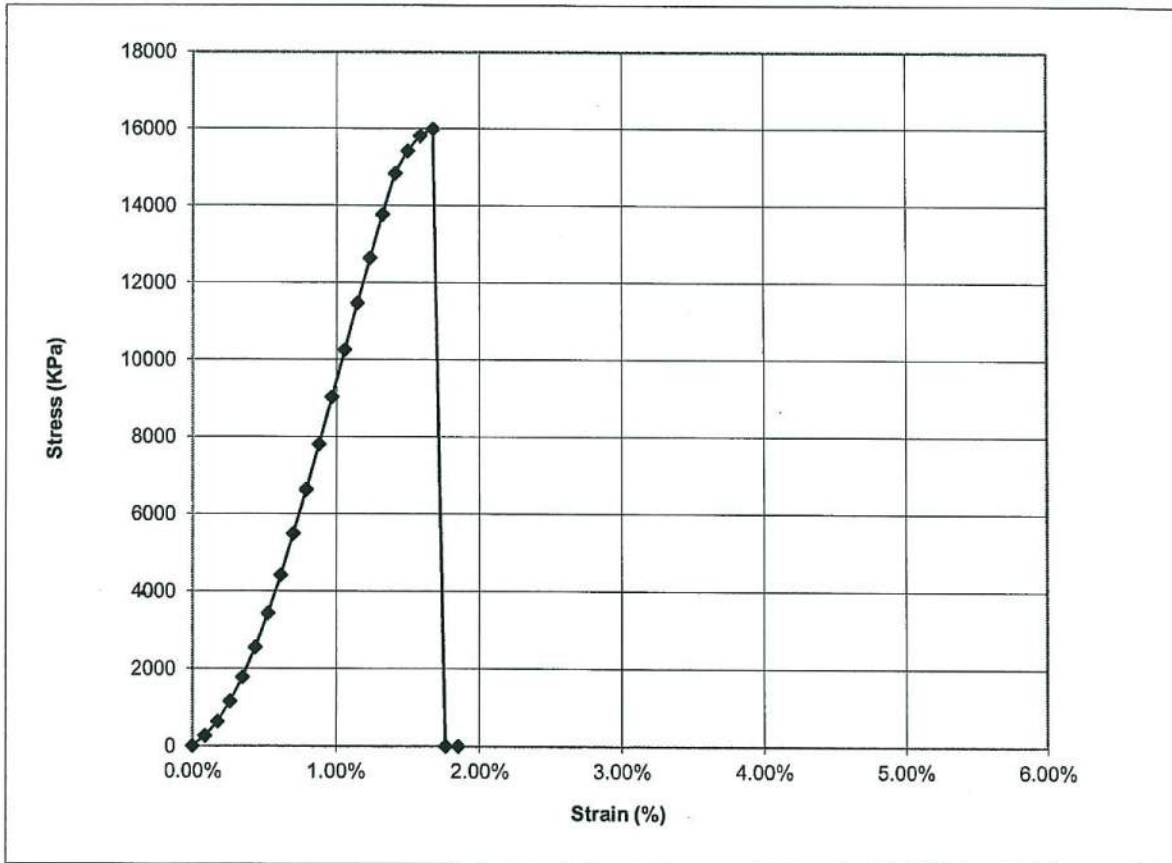
PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N613 B-2 @ 12.98 m -13.20 m
SAMPLE PREP: INSITU

JOB NO: 1720134030
WORK ORDER NO: 5
LAB NO: 482
DATE SAMPLED: 11/06/13

**UNCONFINED COMPRESSION STRENGTH OF COHESIVE SOIL
APPLICABLE PORTIONS OF (AASHTO T208-10)**

DIAMETER:	6.06 cm	MAXIMUM STRESS:	15,997 KPa
HEIGHT:	14.39 cm	AT STRAIN:	1.68%
STRAIN RATE:	5.1% cm/min.		
DRY DENSITY:	2,404.3 kg/cu.m		
L/D (2.0-2.5 REQ.):	2.37		

SPECIMEN CONTAINED IN A SEALED PLASTIC BAG UNTIL TIME OF TEST



REVIEWED BY: 



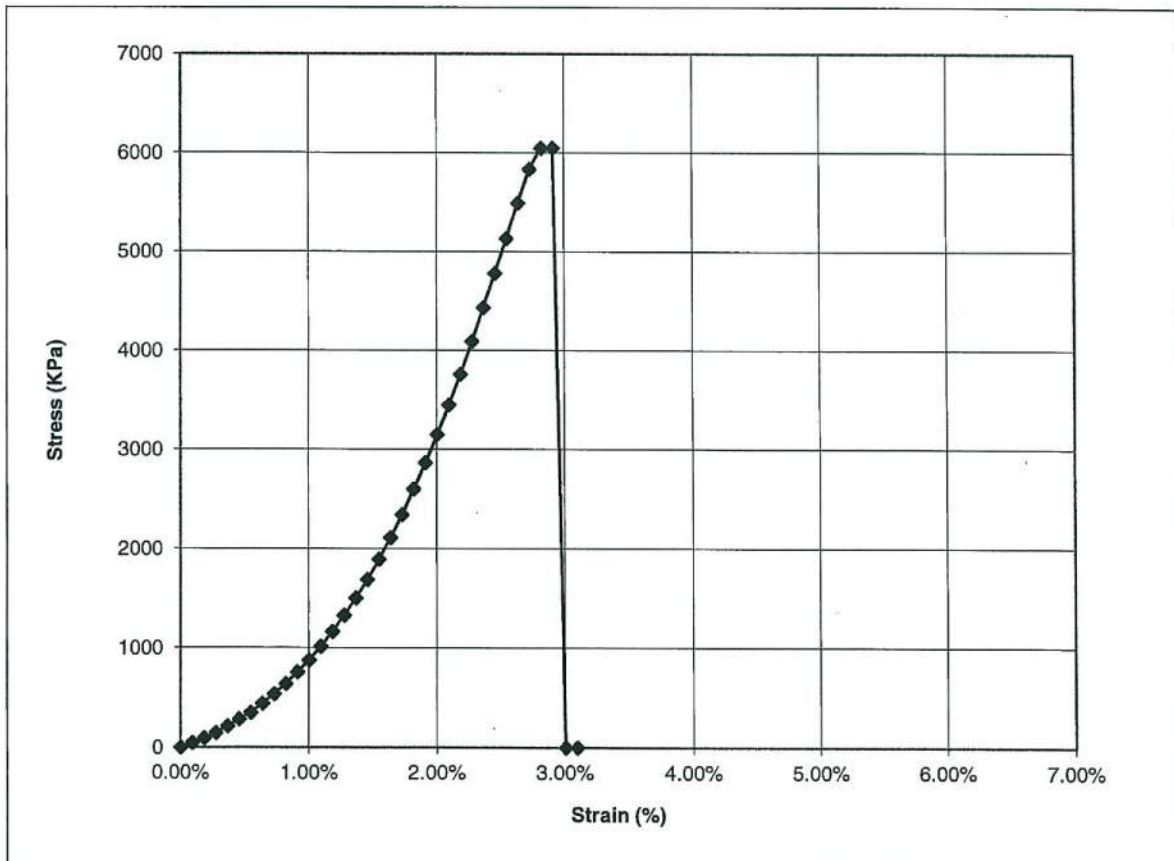
PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsalle, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N613 B-3 @ 19.78 m - 19.93 m
SAMPLE PREP: INSITU

JOB NO: 1720134030
WORK ORDER NO: 5
LAB NO: 483
DATE SAMPLED: 11/06/13

**UNCONFINED COMPRESSION STRENGTH OF COHESIVE SOIL
APPLICABLE PORTIONS OF (AASHTO T208-10)**

DIAMETER:	5.93 cm	MAXIMUM STRESS:	6,049 KPa
HEIGHT:	13.96 cm	AT STRAIN:	2.91%
STRAIN RATE:	5.1% cm/min.		
DRY DENSITY:	2,190.9 kg/cu.m		
L/D (2.0-2.5 REQ.):	2.35		

SPECIMEN CONTAINED IN A SEALED PLASTIC BAG UNTIL TIME OF TEST



REVIEWED BY: _____



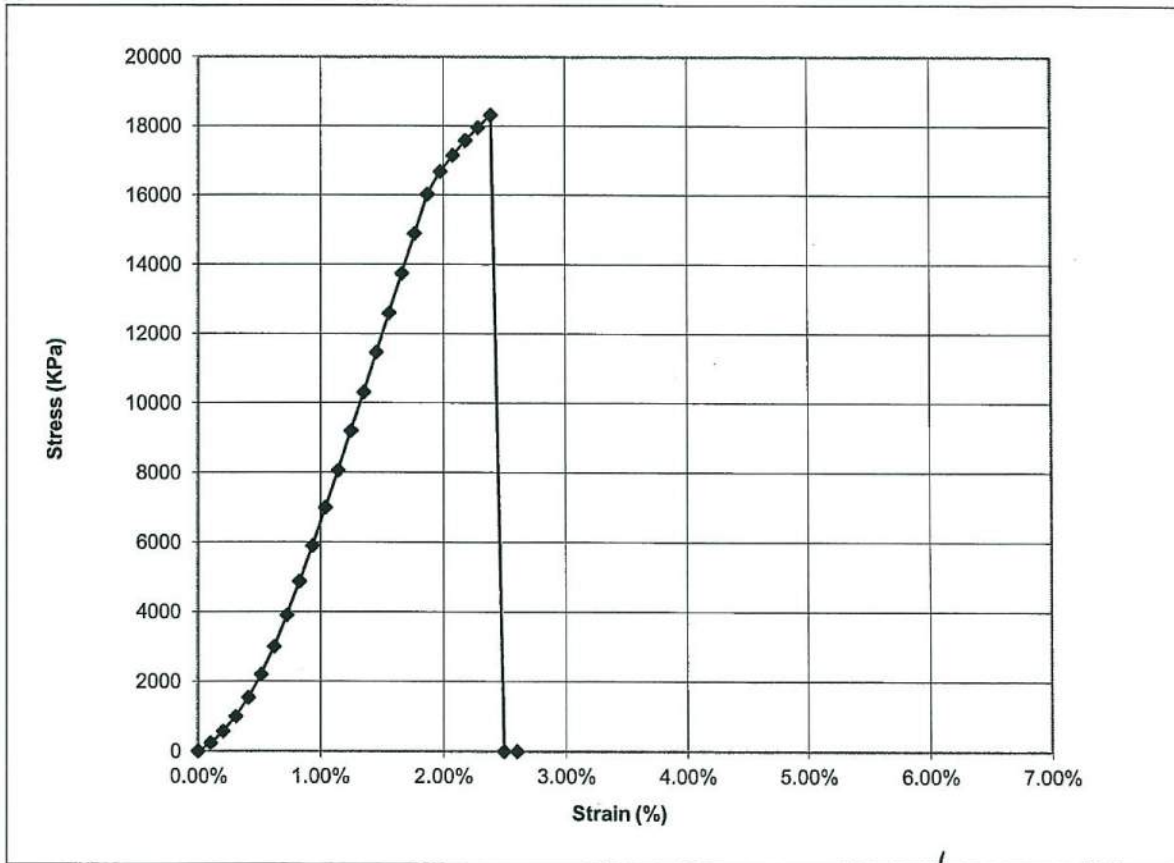
PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsalle, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N613 B-4 @ 12.86 m - 13.01 m
SAMPLE PREP: INSITU

JOB NO: 1720134030
WORK ORDER NO: 5
LAB NO: 484
DATE SAMPLED: 11/06/13

**UNCONFINED COMPRESSION STRENGTH OF COHESIVE SOIL
APPLICABLE PORTIONS OF (AASHTO T208-10)**

DIAMETER:	6.01 cm	MAXIMUM STRESS:	18,325 KPa
HEIGHT:	12.19 cm	AT STRAIN:	2.40%
STRAIN RATE:	5.1% cm/min.		
DRY DENSITY:	2,437.9 kg/cu.m		
L/D (2.0-2.5 REQ.):	2.03		

SPECIMEN CONTAINED IN A SEALED PLASTIC BAG UNTIL TIME OF TEST



REVIEWED BY: 



PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N613 B-4 @ 15.15 m - 15.32 m
SAMPLE PREP: INSITU

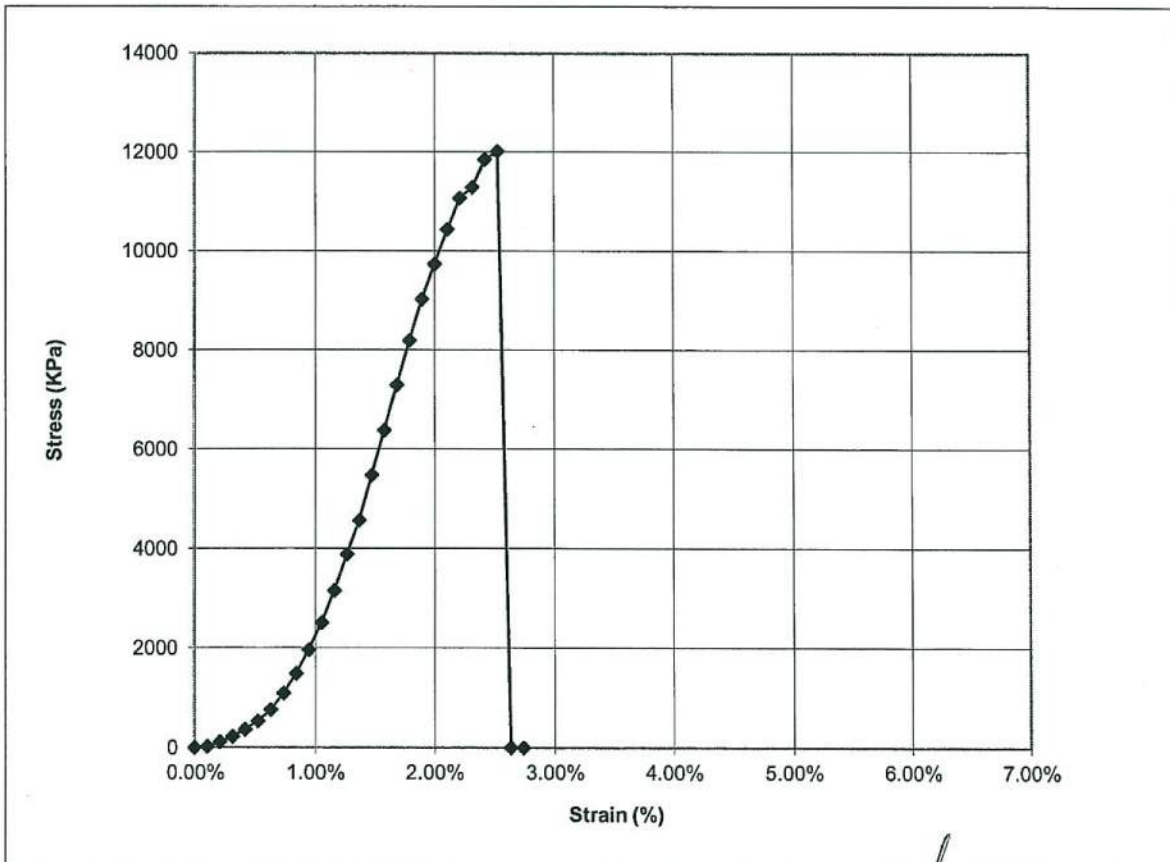
JOB NO: 1720134030
WORK ORDER NO: 5
LAB NO: 485
DATE SAMPLED: 11/06/13

UNCONFINED COMPRESSION STRENGTH OF COHESIVE SOIL
APPLICABLE PORTIONS OF (AASHTO T208-10)

DIAMETER: 6.01 cm
HEIGHT: 12.03 cm
STRAIN RATE: 5.1% cm/min.
DRY DENSITY: 2,398.6 kg/cu.m
L/D (2.0-2.5 REQ.): 2.00

MAXIMUM STRESS: 12,018 KPa
AT STRAIN: 2.53%

SPECIMEN CONTAINED IN A SEALED PLASTIC BAG UNTIL TIME OF TEST



REVIEWED BY: 



PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N614 B-1 @ 13.90 m - 14.02 m
SAMPLE PREP: INSITU

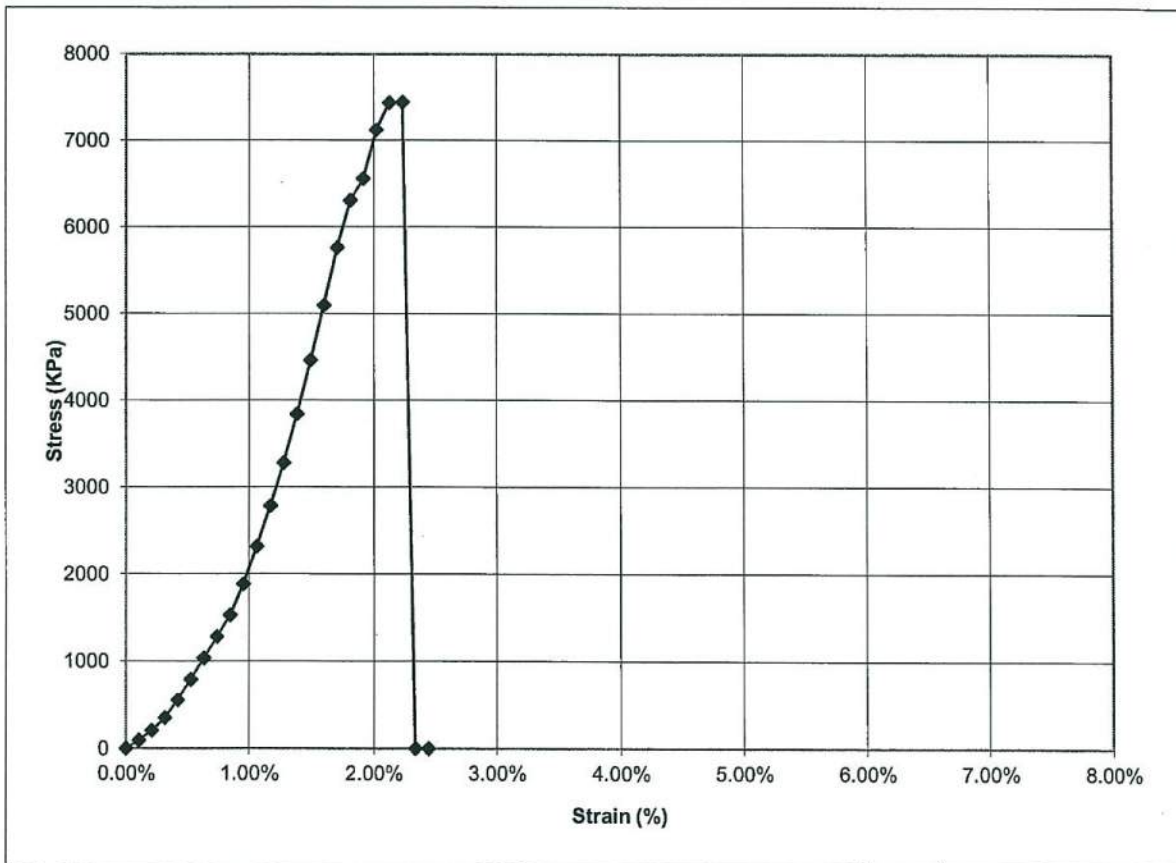
JOB NO: 1720134030
WORK ORDER NO: 5
LAB NO: 471
DATE SAMPLED: 11/06/13

UNCONFINED COMPRESSION STRENGTH OF COHESIVE SOIL
APPLICABLE PORTIONS OF (AASHTO T208-10)

DIAMETER: 6.05 cm
HEIGHT: 11.93 cm
STRAIN RATE: 5.1% cm/min.
DRY DENSITY: 2,142.1 kg/cu.m
L/D (2.0-2.5 REQ.): 1.97

MAXIMUM STRESS: 7,445 KPa
AT STRAIN: 2.24%

SPECIMEN CONTAINED IN A SEALED PLASTIC BAG UNTIL TIME OF TEST
Note: The L/D did not satisfy the 2.0 to 2.5 requirement.



REVIEWED BY: 



PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsalle, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N614 B-1 @ 17.10 m - 17.22 m
SAMPLE PREP: INSITU

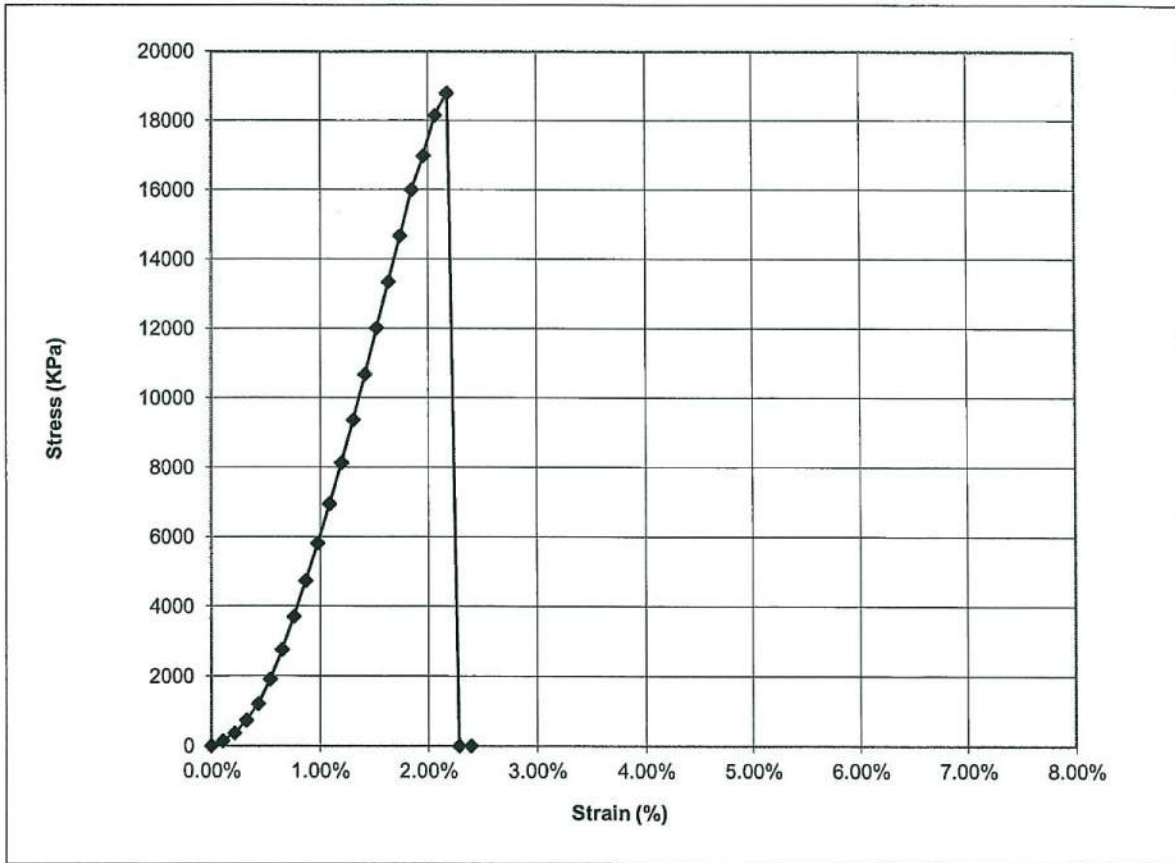
JOB NO: 1720134030
WORK ORDER NO: 5
LAB NO: 472
DATE SAMPLED: 11/06/13

UNCONFINED COMPRESSION STRENGTH OF COHESIVE SOIL
APPLICABLE PORTIONS OF (AASHTO T208-10)

DIAMETER: 6.08 cm
HEIGHT: 11.66 cm
STRAIN RATE: 5.1% cm/min.
DRY DENSITY: 2,491.1 kg/cu.m
L/D (2.0-2.5 REQ.): 1.92

MAXIMUM STRESS: 18,795 KPa
AT STRAIN: 2.18%

SPECIMEN CONTAINED IN A SEALED PLASTIC BAG UNTIL TIME OF TEST
Note: The L/D did not satisfy the 2.0 to 2.5 requirement.



REVIEWED BY: 



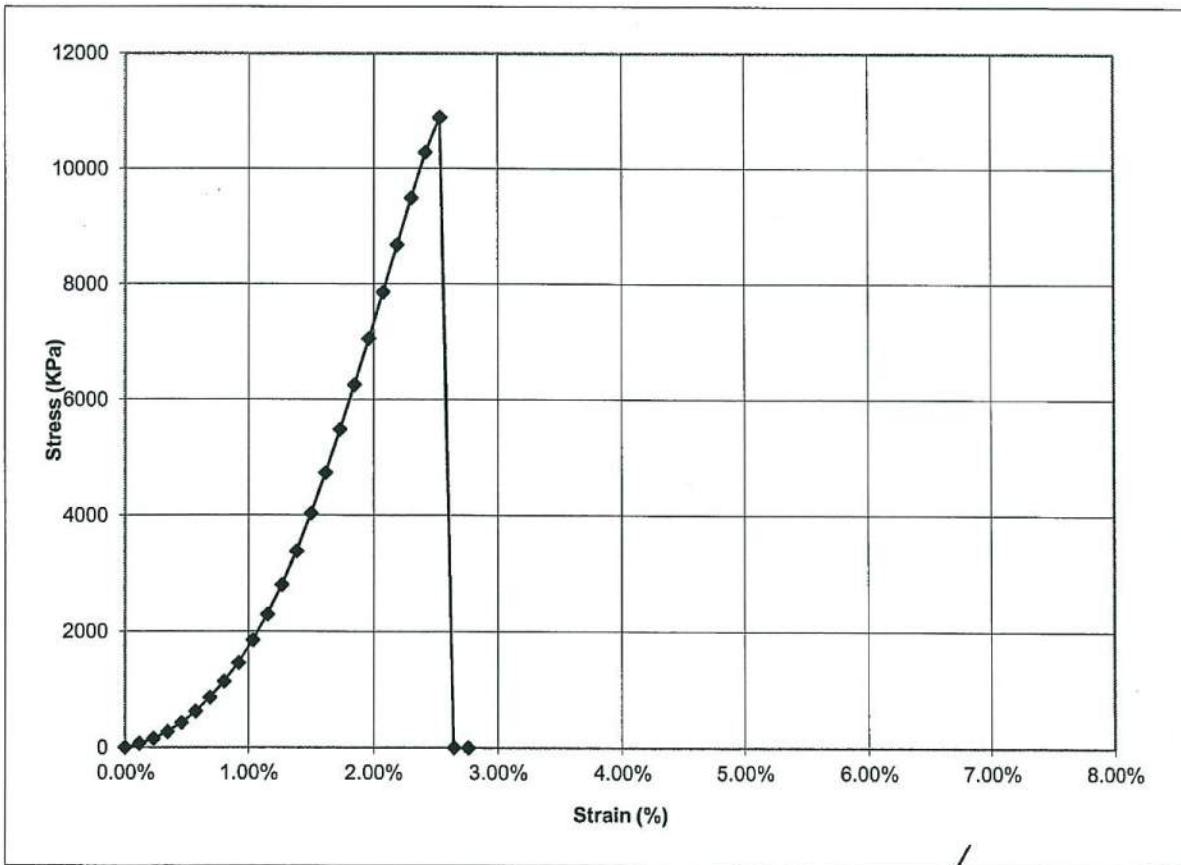
PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N614 B-2 @ 13.11 m - 13.26 m
SAMPLE PREP: INSITU

JOB NO: 1720134030
WORK ORDER NO: 5
LAB NO: 473
DATE SAMPLED: 11/06/13

UNCONFINED COMPRESSION STRENGTH OF COHESIVE SOIL
APPLICABLE PORTIONS OF (AASHTO T208-10)

DIAMETER:	6.07 cm	MAXIMUM STRESS:	10,887 KPa
HEIGHT:	11.01 cm	AT STRAIN:	2.54%
STRAIN RATE:	5.1% cm/min.		
DRY DENSITY:	2,187.4 kg/cu.m		
L/D (2.0-2.5 REQ.):	1.81		

SPECIMEN CONTAINED IN A SEALED PLASTIC BAG UNTIL TIME OF TEST
Note: The L/D did not satisfy the 2.0 to 2.5 requirement.



REVIEWED BY: 



PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N614 B-2 @ 16.22 m - 16.34 m
SAMPLE PREP: INSITU

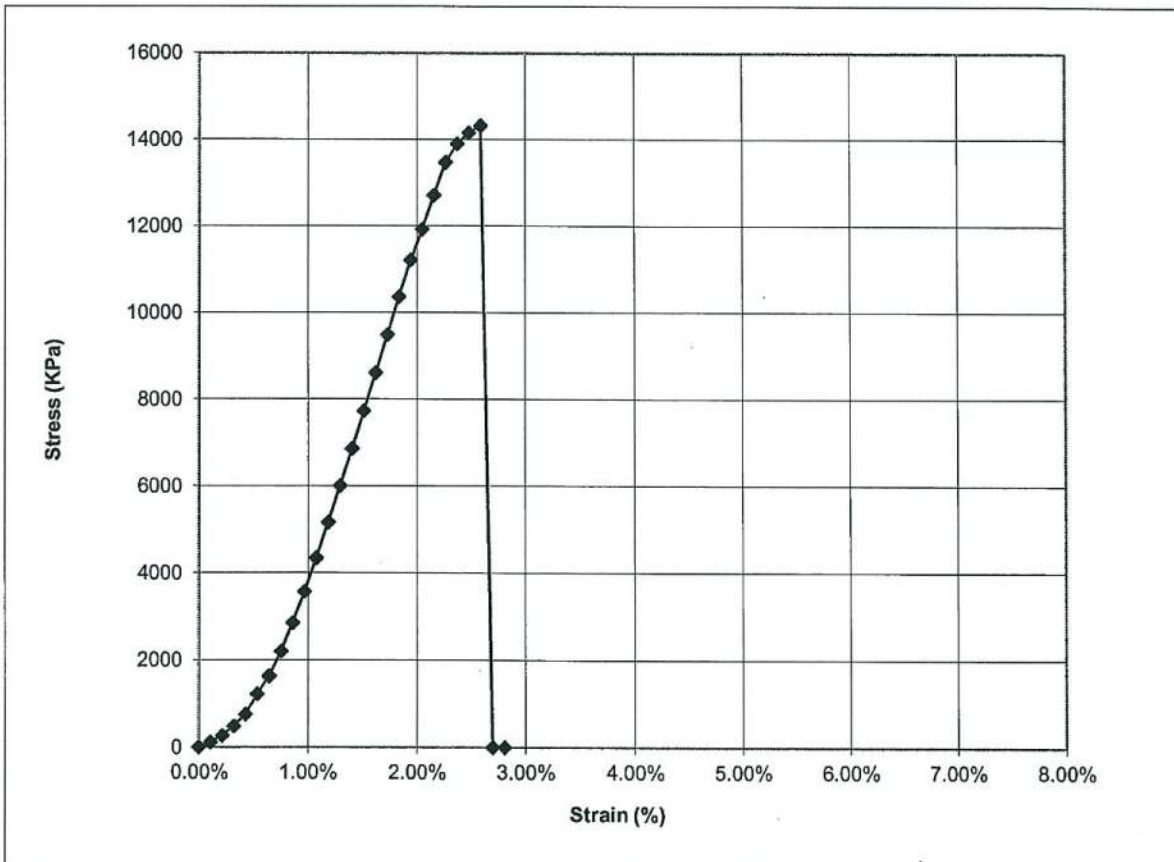
JOB NO: 1720134030
WORK ORDER NO: 5
LAB NO: 474
DATE SAMPLED: 11/06/13

**UNCONFINED COMPRESSION STRENGTH OF COHESIVE SOIL
APPLICABLE PORTIONS OF (AASHTO T208-10)**

DIAMETER: 6.09 cm
HEIGHT: 11.73 cm
STRAIN RATE: 5.1% cm/min.
DRY DENSITY: 2,266.4 kg/cu.m
L/D (2.0-2.5 REQ.): 1.93

MAXIMUM STRESS: 14,321 KPa
AT STRAIN: 2.60%

SPECIMEN CONTAINED IN A SEALED PLASTIC BAG UNTIL TIME OF TEST
Note: The L/D did not satisfy the 2.0 to 2.5 requirement.



REVIEWED BY: 



PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsalle, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N614 B-3 @ 9.85 m - 10.00 m
SAMPLE PREP: INSITU

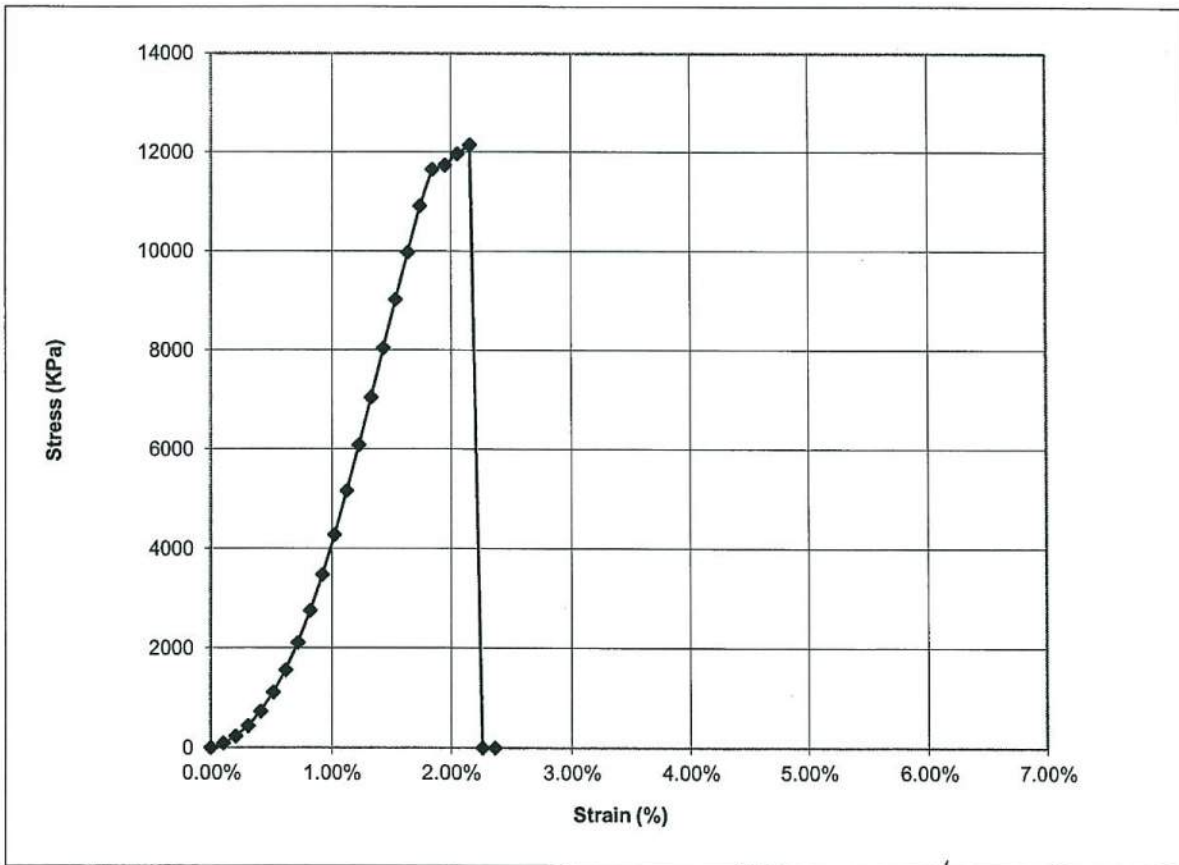
JOB NO: 1720134030
WORK ORDER NO: 5
LAB NO: 475
DATE SAMPLED: 11/06/13

UNCONFINED COMPRESSION STRENGTH OF COHESIVE SOIL
APPLICABLE PORTIONS OF (AASHTO T208-10)

DIAMETER: 6.09 cm
HEIGHT: 12.34 cm
STRAIN RATE: 5.1% cm/min.
DRY DENSITY: 2,157.1 kg/cu.m
L/D (2.0-2.5 REQ.): 2.03

MAXIMUM STRESS: 12,149 KPa
AT STRAIN: 2.16%

SPECIMEN CONTAINED IN A SEALED PLASTIC BAG UNTIL TIME OF TEST



REVIEWED BY: 



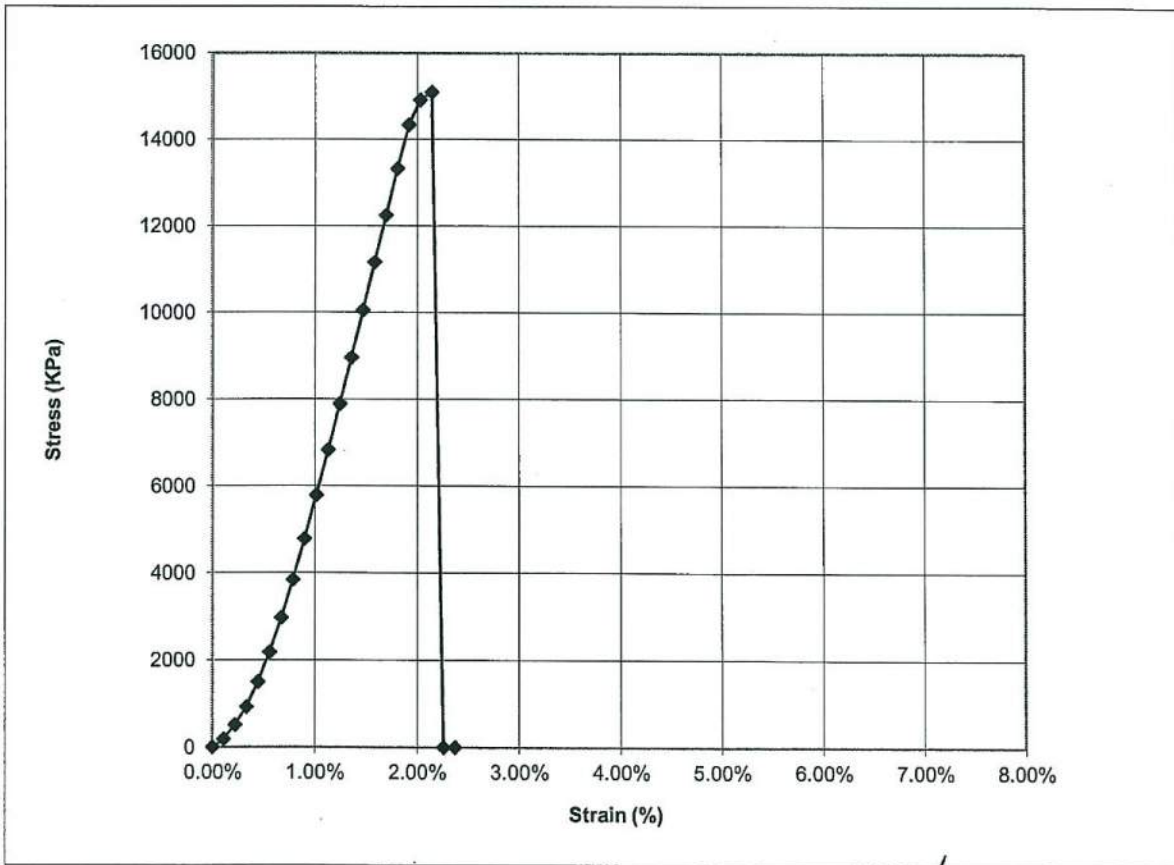
PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N614 B-3 @ 11.89 m - 12.01 m
SAMPLE PREP: INSITU

JOB NO: 1720134030
WORK ORDER NO 5
LAB NO: 476
DATE SAMPLED: 11/06/13

**UNCONFINED COMPRESSION STRENGTH OF COHESIVE SOIL
APPLICABLE PORTIONS OF (AASHTO T208-10)**

DIAMETER:	6.08 cm	MAXIMUM STRESS:	15,093 KPa
HEIGHT:	11.23 cm	AT STRAIN:	2.15%
STRAIN RATE:	5.1% cm/min.		
DRY DENSITY:	2,214.5 kg/cu.m		
L/D (2.0-2.5 REQ.):	1.85		

SPECIMEN CONTAINED IN A SEALED PLASTIC BAG UNTIL TIME OF TEST
Note: The L/D did not satisfy the 2.0 to 2.5 requirement.



REVIEWED BY: _____



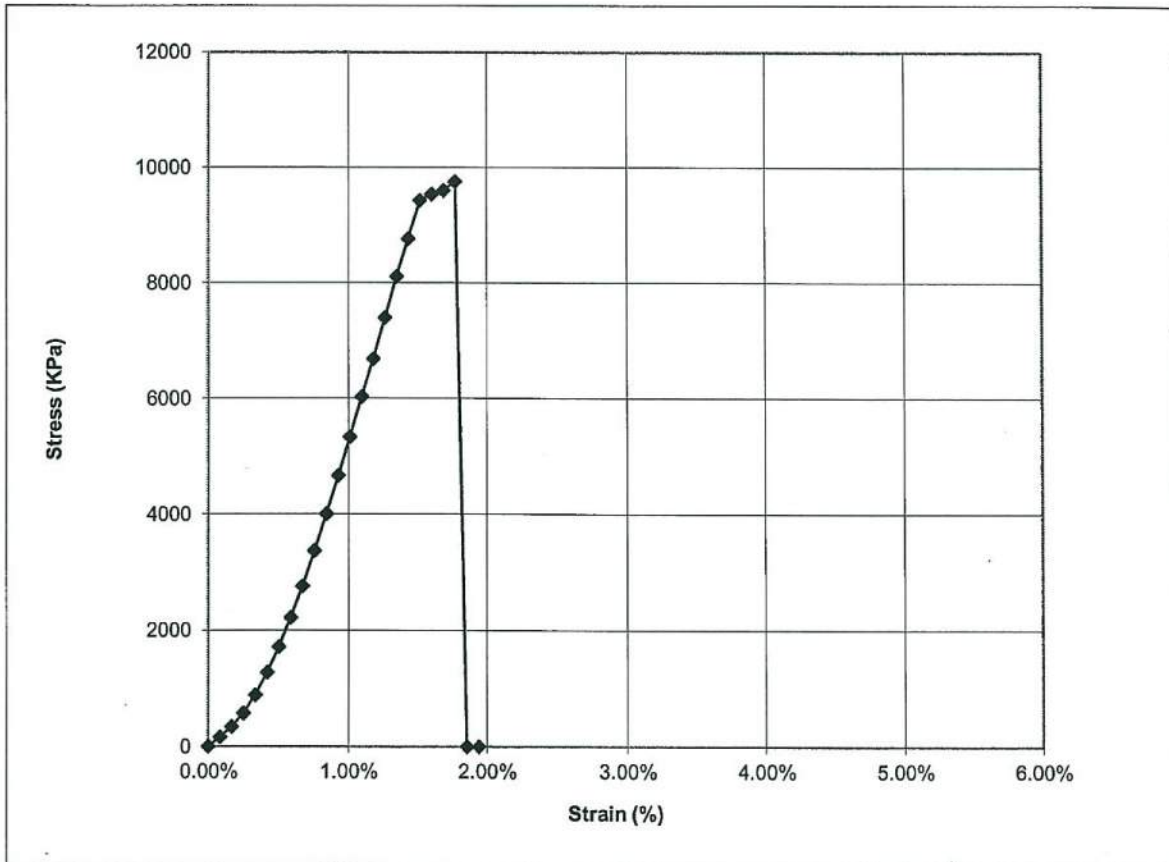
PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsalle, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N614 B-4 @ 13.44 m - 13.66 m
SAMPLE PREP: INSITU

JOB NO: 1720134030
WORK ORDER NO 5
LAB NO: 478
DATE SAMPLED: 11/06/13

UNCONFINED COMPRESSION STRENGTH OF COHESIVE SOIL
APPLICABLE PORTIONS OF (AASHTO T208-10)

DIAMETER:	6.08 cm	MAXIMUM STRESS:	9,758 KPa
HEIGHT:	15.04 cm	AT STRAIN:	1.77%
STRAIN RATE:	5.1% cm/min.		
DRY DENSITY:	2,205.1 kg/cu.m		
L/D (2.0-2.5 REQ.):	2.47		

SPECIMEN CONTAINED IN A SEALED PLASTIC BAG UNTIL TIME OF TEST



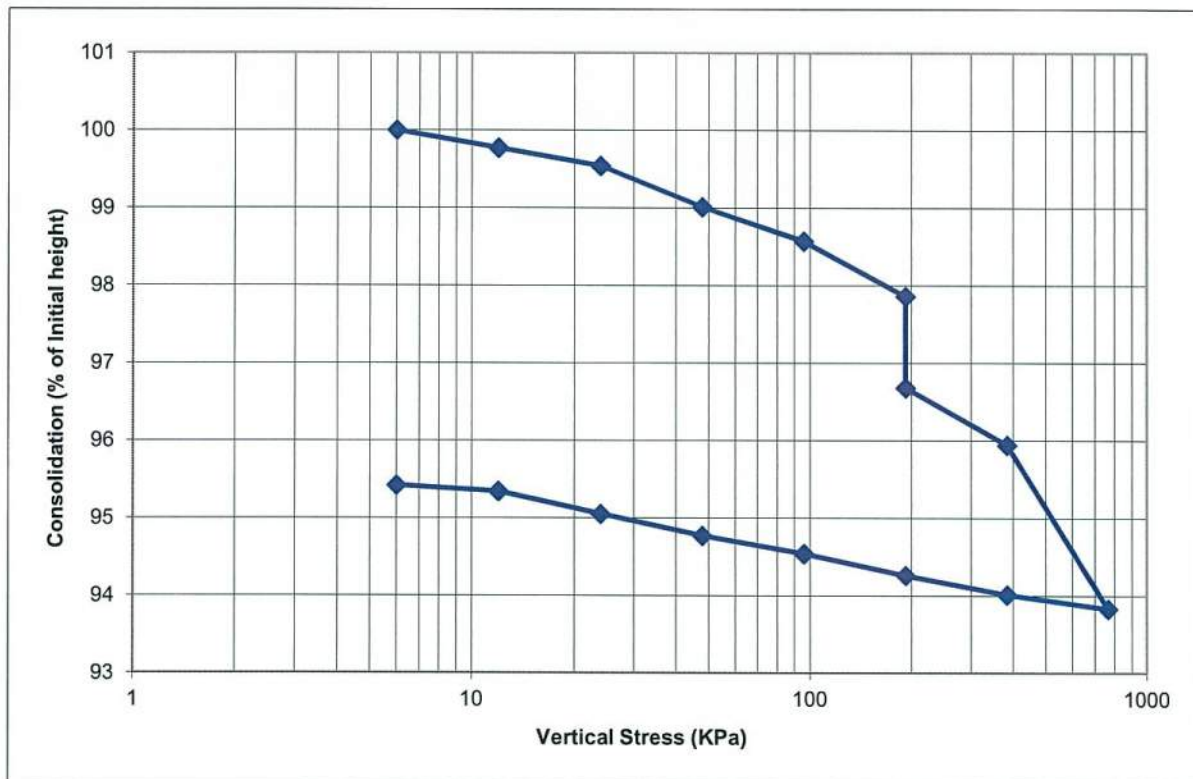
REVIEWED BY: 

PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N503 B-2 @ 4.57 m - 4.88 m
SAMPLE PREP: Undisturbed
 Saturate at 191 Kpa

JOB NO: 1720134030.0002
WORK ORDER NO: 4
LAB NO: 446
DATE SAMPLED: 11/4/13

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (AASHTO T216-07)

INITIAL VOLUME (cu.cm)	75.37	FINAL VOLUME (cu.cm)	70.72
INITIAL MOISTURE CONTENT	10.2%	FINAL MOISTURE CONTENT	13.1%
INITIAL DRY DENSITY (kg per cu.m)	1854.7	FINAL DRY DENSITY (kg per cu.m)	1969.3
INITIAL DEGREE OF SATURATION	62%	FINAL DEGREE OF SATURATION	100%
INITIAL VOID RATIO	0.44	FINAL VOID RATIO	0.35
ESTIMATED SPECIFIC GRAVITY	2.660	SATURATED AT	191.57 KPa



REVIEWED BY _____

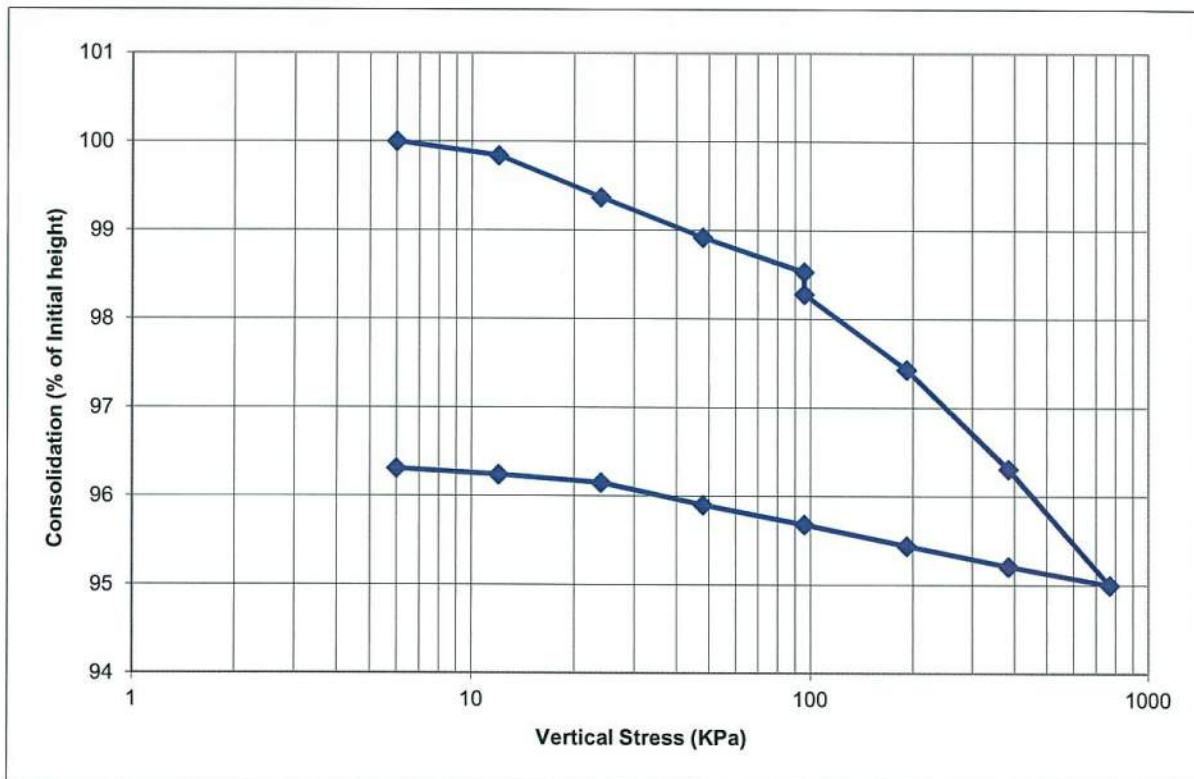


PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N503 B-4 @ 3.05 m - 3.35 m
SAMPLE PREP: Undisturbed
 Saturate at 96 Kpa

JOB NO: 1720134030.0002
WORK ORDER NO: 4
LAB NO: 450
DATE SAMPLED: 11/4/13

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (AASHTO T216-07)

INITIAL VOLUME (cu.cm)	75.37	FINAL VOLUME (cu.cm)	71.61
INITIAL MOISTURE CONTENT	10.4%	FINAL MOISTURE CONTENT	12.4%
INITIAL DRY DENSITY (kg per cu.m)	1884.8	FINAL DRY DENSITY (kg per cu.m)	1976.6
INITIAL DEGREE OF SATURATION	70%	FINAL DEGREE OF SATURATION	100%
INITIAL VOID RATIO	0.39	FINAL VOID RATIO	0.32
ESTIMATED SPECIFIC GRAVITY	2.620	SATURATED AT	95.785 KPa



REVIEWED BY _____

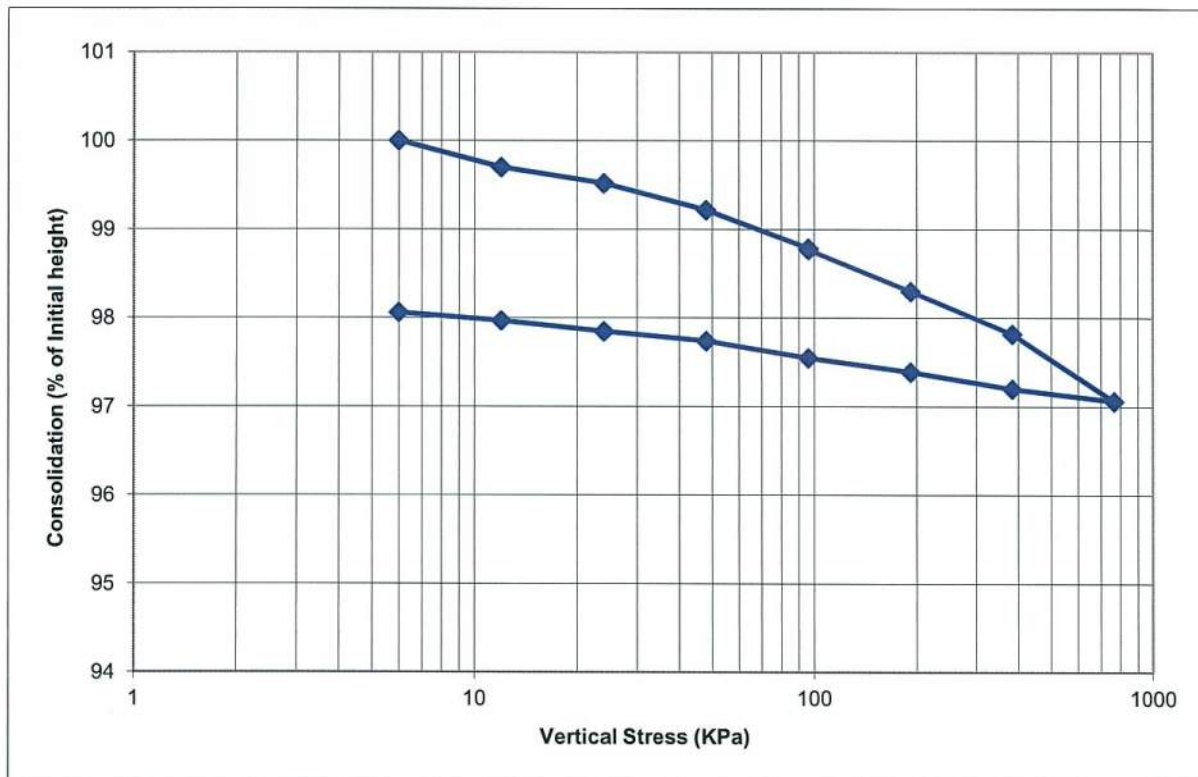


PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N504 B-1; 2.44 m - 2.74 m
SAMPLE PREP: Undisturbed
 Saturate at 96 Kpa

JOB NO: 1720134030.0002
WORK ORDER NO: 3
LAB NO: 310
DATE SAMPLED: 10/2/13

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (AASHTO T216-07)

INITIAL VOLUME (cu.cm)	75.38	FINAL VOLUME (cu.cm)	73.16
INITIAL MOISTURE CONTENT	10.9%	FINAL MOISTURE CONTENT	11.4%
INITIAL DRY DENSITY (kg per cu.m)	1911.5	FINAL DRY DENSITY (kg per cu.m)	1961.8
INITIAL DEGREE OF SATURATION	82%	FINAL DEGREE OF SATURATION	95%
INITIAL VOID RATIO	0.35	FINAL VOID RATIO	0.31
ESTIMATED SPECIFIC GRAVITY	2.570	SATURATED AT	95.785 KPa



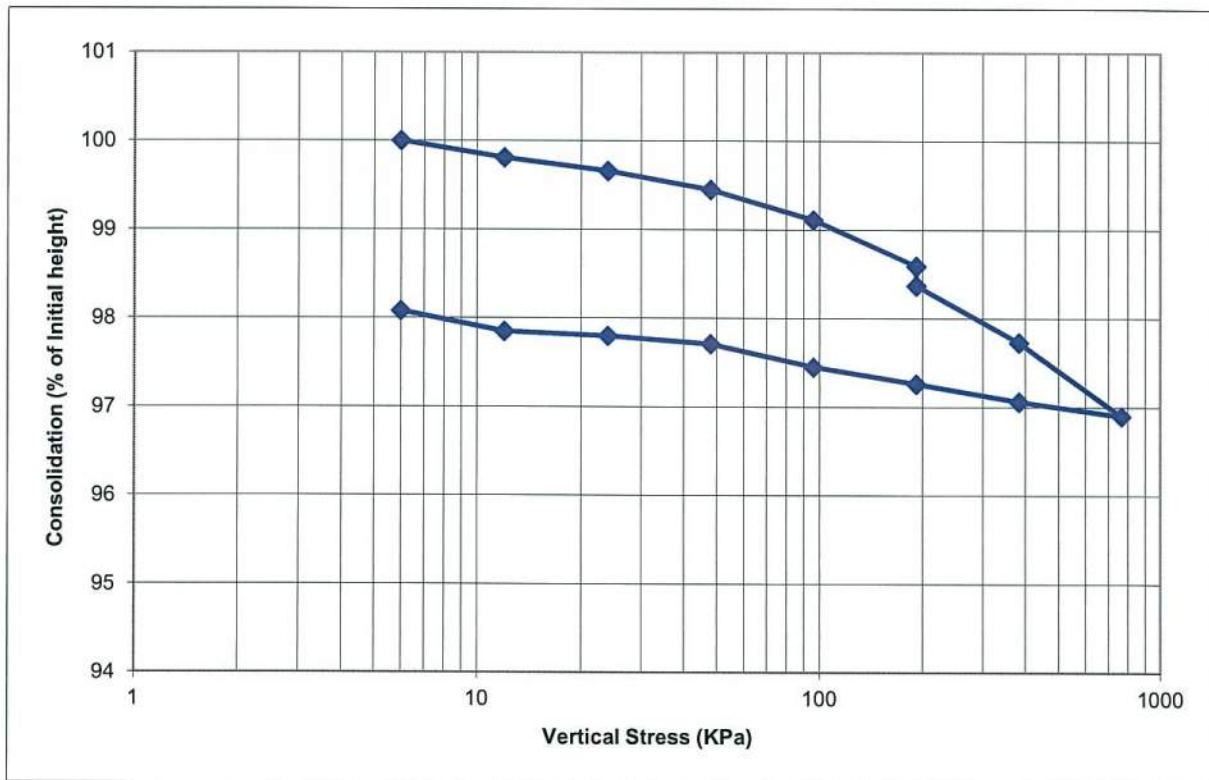
REVIEWED BY _____

PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N504 B-4; 4.72 m - 5.03 m
SAMPLE PREP: Undisturbed
 Saturate at 191 Kpa

JOB NO: 1720134030.0002
WORK ORDER NO 3
LAB NO: 328
DATE SAMPLED: 10/2/13

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (AASHTO T216-07)

INITIAL VOLUME (cu.cm)	75.38	FINAL VOLUME (cu.cm)	73.04
INITIAL MOISTURE CONTENT	8.4%	FINAL MOISTURE CONTENT	11.0%
INITIAL DRY DENSITY (kg per cu.m)	1961.5	FINAL DRY DENSITY (kg per cu.m)	2016.5
INITIAL DEGREE OF SATURATION	65%	FINAL DEGREE OF SATURATION	95%
INITIAL VOID RATIO	0.35	FINAL VOID RATIO	0.30
ESTIMATED SPECIFIC GRAVITY	2.630	SATURATED AT	191.57 KPa



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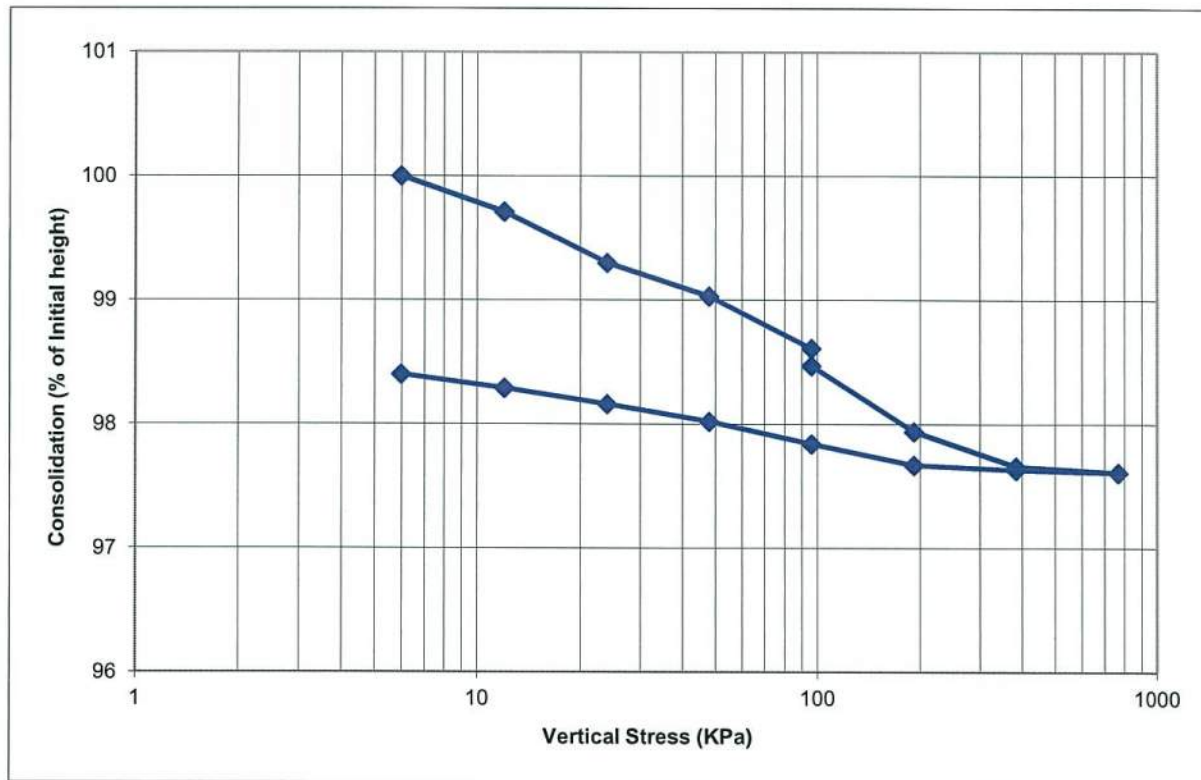


PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N613 B-3 @ 3.05 m - 3.35 m
SAMPLE PREP: Undisturbed
 Saturate at 96 Kpa

JOB NO: 1720134030.0002
WORK ORDER NO: 4
LAB NO: 454
DATE SAMPLED: 11/4/13

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (AASHTO T216-07)

INITIAL VOLUME (cu.cm)	75.37	FINAL VOLUME (cu.cm)	73.57
INITIAL MOISTURE CONTENT	9.1%	FINAL MOISTURE CONTENT	13.4%
INITIAL DRY DENSITY (kg per cu.m)	1797.0	FINAL DRY DENSITY (kg per cu.m)	1834.0
INITIAL DEGREE OF SATURATION	63%	FINAL DEGREE OF SATURATION	100%
INITIAL VOID RATIO	0.36	FINAL VOID RATIO	0.32
ESTIMATED SPECIFIC GRAVITY	2.429	SATURATED AT	95.785 KPa



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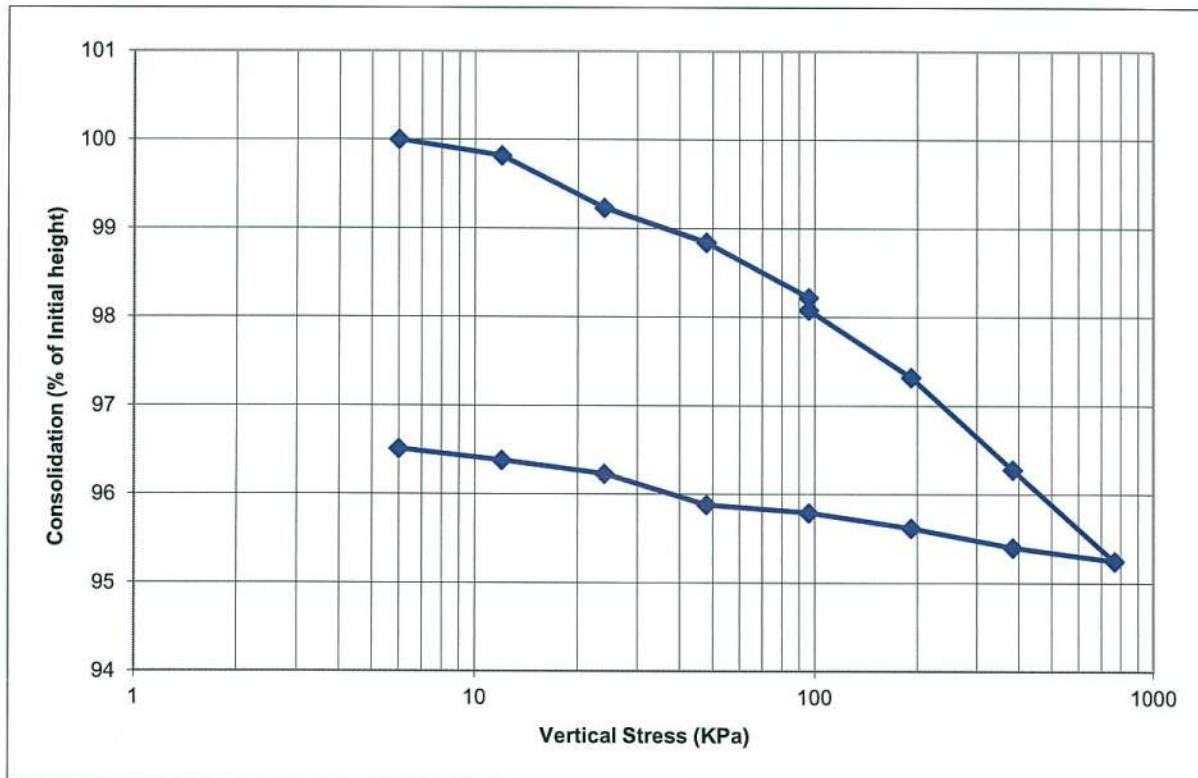


PROJECT: BIA project N12(12-2)(19-2)2+4
LOCATION: Navajo, NM to N64 junction AZ (near Tsaille, AZ)
MATERIAL: Bore hole samples
SAMPLE SOURCE: N613 B-4 @ 3.05 m - 3.35 m
SAMPLE PREP: Undisturbed
 Saturate at 96 Kpa

JOB NO: 1720134030.0002
WORK ORDER NO: 4
LAB NO: 457
DATE SAMPLED: 11/4/13

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (AASHTO T216-07)

INITIAL VOLUME (cu.cm)	75.37	FINAL VOLUME (cu.cm)	71.79
INITIAL MOISTURE CONTENT	12.6%	FINAL MOISTURE CONTENT	14.8%
INITIAL DRY DENSITY (kg per cu.m)	1763.3	FINAL DRY DENSITY (kg per cu.m)	1844.3
INITIAL DEGREE OF SATURATION	73%	FINAL DEGREE OF SATURATION	100%
INITIAL VOID RATIO	0.45	FINAL VOID RATIO	0.38
ESTIMATED SPECIFIC GRAVITY	2.540	SATURATED AT	95.785 KPa



REVIEWED BY _____



