GEOTECHNICAL INVESTIGATION AND FOUNDATION RECOMMENDATION REPORT

TOADLENA NORTH BRIDGE (N241) REPLACEMENT
NAVAJO NATION
SAN JUAN COUNTY, NEW MEXICO

TERRACON PROJECT NO. 66015021I
November 4, 2002
Revised - September 19, 2003

Prepared for:

PAIKI
11200 Lomas Boulevard NE
Suite 100
Albuquerque, New Mexico 87112

Prepared by:

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Terracon

September 19, 2003

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PAIKI
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Attn: Mr. Dave Apple, P.E.

Re: Geotechnical Investigation and Foundation Recommendation Report - Revised
Toadlena North Bridge (N241) Replacement
Navajo Nation
San Juan County, New Mexico
Terracon Project No. 66015021I

Terracon has completed the geotechnical engineering exploration for the proposed Toadlena North Bridge (N241) replacement to be located within the Navajo Nation Reservation, approximately 0.5 km south of Toadlena, in San Juan County, New Mexico. This study was performed in general accordance with Terracon proposal P01-019G in reference to the project.

The results of our engineering study, including the site plan, laboratory test results, logs of borings, and the geotechnical recommendations needed to aid in the design and construction of foundations and other earth connected phases of this project are attached.

We appreciate being of service to you in the geotechnical engineering phase of this project, and are prepared to assist you during the construction phases as well. If you have any questions concerning this report or any of our testing, inspection, design and consulting services, please do not hesitate to contact us.

Sincerely,
TERRACON

Jeff S. Mann, E.I.T.
Geotechnical Staff Engineer

KEVIN J. SCOTT
NEW MEXICO
14680
REGISTERED PROFESSIONAL ENGINEER
9-19-03

Kevin J. Scott, P.E.
Geotechnical Department Manager

Terracon

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Terracon

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GEOTECHNICAL INVESTIGATION AND FOUNDATION RECOMMENDATION REPORT

TOADLENA NORTH BRIDGE (N241)
NAVAJO NATION
SAN JUAN COUNTY, NEW MEXICO

TERRACON PROJECT NO. 66015021I
SEPTEMBER 19, 2003

INTRODUCTION

This report contains the results of our geotechnical engineering exploration for the proposed bridge replacement to be located approximately 0.5 km south of Toadlena, in San Juan County, New Mexico. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- subsurface soil conditions
- groundwater conditions
- foundation design and construction
- lateral earth pressures
- earthwork
- drainage

The recommendations contained in this report are based upon the results of field and laboratory testing, engineering analyses, and experience with similar soil conditions, structures and our understanding of the proposed project.

PROPOSED CONSTRUCTION

We understand that the existing Toadlena North Bridge, identified as N241, will be replaced with a two-barrel concrete box culvert system. The approximate location of the existing bridge is shown on the Site Location Map, Figure A1. Based on the most recent information provided by Mr. Dave Apple of PAIKI, the new box structures are planned to be 1.83 m high by 2.44 m wide and approximately 9.75 m in length. The boxes are not anticipated to support fill, as the top of the boxes will act as the pavement subgrade and directly support the proposed roadway, with the proposed top of road elevation of about 2062.5. Based on previous discussions with PAIKI, it is our understanding that the alignment of the new roadway will follow the existing roadway, and the center of the concrete boxes will be about the centerline of the roadway alignment. No information was provided by the structural engineer pertaining to the anticipated loading conditions.

SITE EXPLORATION

The scope of the services performed for this project included site reconnaissance by Terracon's field engineer, a subsurface exploration program, laboratory testing and engineering analyses.

Field Exploration: A total of three test borings were drilled between August 8 and 9, 2001. The borings were drilled to an approximate depth of about 12.65 m below existing site grades at the approximate locations shown on the Boring Location Plan, Figure A2. The borings were advanced with a CME-75, truck-mounted drilling rig utilizing of 8.25 centimeter (cm) inside diameter, hollow-stem augers.

The borings were located in the field by measurements from the existing bridge abutments and roadway centerline. The surface elevation at each boring location was interpolated from a topographical map provided by PAIKI. The accuracy of the boring locations and elevations should only be assumed to the level implied by the methods used.

Logs of each boring were recorded by the Terracon field engineer during the drilling operations. At selected intervals, samples of the subsurface materials were taken by driving either split-barrel or ring-barrel samplers.

Penetration resistance measurements were obtained by driving the sampler into the subsurface materials with a 63.5-kilogram (kg) hammer falling 76.2 cm. The penetration resistance value is a useful index in estimating the consistency, relative density or hardness of the materials encountered.

Groundwater conditions were evaluated in each boring at the time of site exploration, and upon completion of drilling.

Laboratory Testing: Samples retrieved during the field exploration were returned to the laboratory for observation by the project geotechnical engineer and were classified in general accordance with the Unified Soil Classification System described in Appendix C. At that time, an applicable laboratory testing program was formulated to determine engineering properties of the subsurface materials and the field descriptions were confirmed or modified as necessary. Logs of Borings were prepared and are presented in Appendix A.

Laboratory tests were conducted on selected soil and weathered rock samples and are presented on the Logs of Borings and in Appendix B. The test results were used for the geotechnical engineering analyses, and the development of foundation and earthwork recommendations. Laboratory tests were performed in general accordance with the applicable local or other accepted procedures.

Selected soil samples were tested for the following engineering properties:

- Electrical Resistivity
- Chloride Content
- Water Soluble Sulfate Content

SITE CONDITIONS

The existing bridge is a single span steel beam bridge with steel grate decking. The abutments are supported by an unknown foundation type. At the time of our exploration, the Toadlena North Wash had a small flow running through the main channel, about 0.2 m deep. The existing roadway on either side of the bridge is an unpaved road, two lanes in width with minimal shoulders. The topography on either side of the bridge is moderate to steeply sloping towards the wash. The area surrounding the bridge approaches is covered with native vegetation and some rip-rap.

Soil and Rock Conditions: As presented on the Logs of Boring, the subsurface soil conditions, consisted generally layers of silty clayey sands with varying amounts of gravel and small cobbles, clayey sand, and clay of medium to high plasticity with varying amounts of sand.

Field and Laboratory Test Results: Field test results indicate a generally very loose to medium dense relative density of the sand material with the clay layers typically being medium stiff in consistency. The relative density consistency correlation is based upon the Standard Penetration Test results obtained in the field.

Groundwater Conditions: Groundwater was observed in the borings at elevations varying from about 2056.8 m to 2057.9 m at the time of the field exploration. These observations represent groundwater conditions at the time of the field exploration, and may not be indicative of other times, or at other locations. Groundwater conditions can change with varying seasonal and weather conditions, and other factors.

Zones of perched and/or trapped groundwater may occur at times in the subsurface soils overlying the sandstone layer, or within permeable fractures in the sandstone materials. The location and amount of perched water is dependent upon several factors, including hydrologic conditions, type of site development, irrigation demands on or adjacent to the site, fluctuations in water features, seasonal and weather conditions.

ENGINEERING ANALYSES AND RECOMMENDATIONS

Geotechnical Considerations: Our analysis of subsurface conditions for the concrete box structure foundation support is based upon available information of the proposed structure type, estimated fill, and scour. It should also be noted that the project site is identified as having no seismic risks in accordance with AASHTO guidelines.

Design and construction recommendations for the recommended foundation systems was evaluated and other earth related phases of the project are outlined below.

Shallow Foundation Systems: Due to the potential for excessive settlements due to the low relative density of the native soils, it is our opinion that the support of the double box structure bear on a minimum of 2.0 m of engineered fill prepared in accordance with the recommendations in this report. Footings bearing on a minimum of 2.0 m of properly compacted fill could provide a maximum allowable bearing pressure of 120 kPa. The design bearing pressure applies to dead loads plus design live load conditions.

Engineered fill should extend below proposed footings a depth equal to the width of individual footings; however, a minimum of 2.0 m of engineered fill is recommended below all footings. Previously, we recommended that the subgrade soils be removed to a minimum depth of 2.0 m and a minimum of 1.5 m horizontally beyond the edge of footings. However, based on the new design, we recommend that the subgrade soils be removed to elevation 2057. The engineered fill should extend laterally a minimum distance of 1.9 m beyond the edge of the box, and an additional distance of 0.2 m for each additional 0.3 m of excavation beyond the recommended depth. The soils should be replaced as engineered fill, conditioned to near optimum moisture content and compacted. If engineered fill is placed beneath the entire structure, it should extend horizontally a minimum distance of 1.5 m beyond the outside edge of the structure.

Footings should be placed a minimum of 0.7 m below finished grade for frost protection, to provide confinement for the bearing soils and extend a minimum of 0.5 m below anticipated scour depth. Finished grade is the lowest adjacent grade for perimeter footings. If unsuitable bearing soils are encountered in footing excavations, the excavations should be extended deeper to suitable soils and the footings could bear directly on these soils at the lower level, on engineered fill, or on lean concrete backfill placed in the excavations.

Foundation excavations should be observed by the geotechnical engineer. If the soil conditions encountered differ significantly from those presented in this report, supplemental recommendations will be required.

Structure Settlement: The largest settlement of the structure will likely be caused by the fill placed adjacent to and over the structure. Based on information provided, it is estimated that up to 1.0 m of fill will be placed over the structure, with up to about 3.5 m placed adjacent to the structure. The stresses from this fill and the proposed pavement will cause some movement of the structure.

Maximum total movement of the fill and structure are estimated to be on the order of about 50 mm. Differential movements across the structure, due to nonuniform loading and variation in the subsurface conditions are estimated to be up to about 25 mm. The largest differential movement should be expected to be between the ends of the structure and the centerline of the proposed roadway, where the lightest and heaviest loads, respectively, will be located.

Cut-off Walls: Due to the granular nature of the existing soils and the material to be placed around the structure, seepage keys or cut-off walls should be provided under the ends of the structure, and around the structure at the third points. The seepage keys or cut-off walls should reduce the flow beneath and around the structure and reduce the risk of undermining the structure and roadway. Seepage keys or cut-off walls should extend a minimum of 1.5 m into the native soils beneath the structure bottom and at least 1 m around the sides and top of the structure. It should be noted that this depth is in excess of the recommended minimum depth presented in the DASR, however, based on discussions with ZIA Engineering, the 1.0 m recommended depth was the minimum requirements, and was based on typical flows and did not account for the erosion potential of the soils encountered on this site. As such, the 1.5 m depth recommended in this report is to take precedence over the DASR.

Lateral Earth Pressures: Based upon recommended design parameters and procedures as outlined in Section 6.2.1 of AASHTO[1] (1996), an equivalent fluid pressure of 12 kPa/m should be used for the design of the horizontal and vertical loading of the structure. A passive pressure of 32.5 kPa/m can be utilized for the portion of the footing below the estimated depth of scour plus 0.2 m

The active lateral earth pressures herein do not include any factor of safety and are not applicable for submerged soils/long-term hydrostatic loading. Additional recommendations may be necessary if submerged conditions are to be included in the design. Short-term hydrostatic loading as typically associated with flooding and/or short-term saturation due to storm water run-off/snow melt do not require additional recommendations.

Fill against the structure should be compacted to densities specified in the Earthwork section of this report. Compaction of each lift adjacent to the walls of the structure should be accomplished with hand-operated tampers or other lightweight compactors. Overcompaction may cause excessive lateral earth pressures which could result in wall movement.

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[3] *American Association of State Highway and Transportation Officials, 1996,* **"Standard Specifications for Highway Bridges"**, *16th Edition.*

Corrosion Protection: Results of soluble sulfate testing (18-171 ppm) indicate that ASTM Type II Portland cement should be used for all project concrete on and below grade to reduce the potential for sulfate reaction of the concrete.

Laboratory test results indicate that on-site soils have resistivities ranging from 3,900 to 8,700 ohm-centimeters, and pH values ranging from 6.9 to 8.7. Criteria published by the Federal Highway Administration (FHWA) indicates that these values are indicative of the soils being potentially corrosive to buried ferrous materials. Review of data published by the FHWA indicates that the measured resistivity places the soils in the moderately corrosive category.

While resistivity and pH are two parameters which indicate the potential of corrosion, these properties alone are not solely responsible for the corrosive effects of soil. One major consideration in combination with other parameters is the in-situ moisture content of the soils. As the moisture content of soils increases, the corrosion potential increases in like manner provided that other properties of the soils indicate corrosive potential.

Based on the measured soil properties and the subsurface moisture content, it is our opinion that the site soils present a corrosive environment for steel piles. We recommend that pile wall, or section thickness be increased to provide sacrificial material due to corrosive loss.

Earthwork:

General Considerations: The following presents recommendations for site preparation, excavation, subgrade preparation and placement of engineered fills on the project.

Earthwork on the project should be observed and tested by Terracon. These services should include observation and testing of engineered fill, subgrade preparation, foundation bearing soils, and other geotechnical conditions exposed during the construction of the project.

Site Preparation: Strip and remove existing vegetation, debris, and other deleterious materials from the proposed construction areas. Exposed surfaces should be free of mounds and depressions which could prevent uniform compaction.

Stripped materials consisting of vegetation and organic materials should be wasted from the site, or used to revegetate landscaped areas or exposed slopes after completion of grading operations. If it is necessary to dispose of organic materials on-site, they should be placed in non-structural areas, and in fill sections not exceeding 1.5 m in height.

The site should be initially graded to create a relatively level surface to receive fill, and to provide for a relatively uniform thickness of fill beneath proposed building structures. If fill is placed in areas of the site where existing slopes are steeper than 5:1 (horizontal:vertical), the area should be benched to reduce the potential for slippage between existing slopes and fills. Benches should be wide enough to accommodate compaction and earth moving equipment, and to allow placement of horizontal lifts of fill.

Exposed areas which will receive fill, once properly cleared and benched where necessary, should be scarified to a minimum depth of 20 cm, conditioned to near optimum moisture content, and compacted.

Demolition of the existing bridge should include complete removal of all foundation systems within the proposed construction area to a minimum of 1m below the proposed bottom of the structure. This should include removal of any loose backfill found adjacent to existing foundations. All materials derived from the demolition of existing structures and pavements should be removed from the site, and not be allowed for use in any on-site fills.

Based upon the subsurface conditions determined from the geotechnical exploration, subgrade soils exposed during construction are anticipated to be relatively stable. However, the stability of the subgrade may be affected by precipitation, repetitive construction traffic or other factors. If unstable conditions develop, workability may be improved by scarifying and drying. Overexcavation of wet zones and replacement with granular materials may be necessary.

The individual contractor(s) is responsible for designing and constructing stable, temporary excavations as required to maintain stability of both the excavation sides and bottom. All excavations should be sloped or shored in the interest of safety following local, and federal regulations, including current OSHA excavation and trench safety standards.

Subgrade Preparation: Engineered fill should extend below proposed footings a depth equal to the width of individual footings. The subgrade soils should be removed to an elevation of 2057 and a minimum of 1.9 m horizontally beyond the edge of footings. The engineered fill should extend laterally an additional distance of 0.2 m for each additional 0.3 m of excavation beyond the recommended elevation. The soils should be replaced as engineered fill, conditioned to near optimum moisture content and compacted. If engineered fill is placed beneath the entire structure building, it should extend horizontally a minimum distance of 1.5 m beyond the outside edge of the structure.

Areas of loose soils may be encountered after excavations are completed. When such conditions exist beneath planned structural areas, the subgrade soils should be compacted prior to placement of the engineered fill.

Subgrade soils beneath approach slabs, footings and beneath pavements should be scarified, moisture conditioned and recompacted to a minimum depth of 20 cm. The moisture content and compaction of subgrade soils should be maintained until slab, footing or pavement construction.

Fill Materials and Placement: Clean on-site soils or approved imported materials may be used as fill material. Imported soils (if required) should conform to the following:

Gradation	Percent finer by weight (ASTM C136)
25 mm	100
4.75 mm	50-100
0.075 µm	12-35

- Liquid Limit .... 35 (max)
- Plasticity Index .... 14 (max)

Engineered fill should be placed and compacted in horizontal lifts not exceeding 20 cm in loose thickness, using equipment and procedures that will produce recommended moisture contents and densities throughout the lift. Recommended compaction criteria for engineered fill materials and scarified subgrade soils are as follows:

Material	Minimum Percent (ASTM D1557)
Scarified subgrade soils	95
On-site and imported fill soils:	
Beneath foundations and embankment fills	95
Beneath pavements	95
Aggregate base (beneath slabs)	95
Miscellaneous backfill (non-structural areas)	90

On-site and imported soils should be compacted within a moisture content range of 3 percent below, to 3 percent above optimum.

Slopes: For permanent slopes in native soils or in compacted fill areas comprised of on-site material, the recommended maximum configurations for on-site materials is 2.5:1 (Horizontal:Vertical). If steeper slopes are required for site development, stability analyses should be completed to design the grading plan.

The face of all fill slopes should be compacted to the minimum specification for fill embankments. Alternately, fill slopes can be over-built and trimmed to compacted material. If any slope in cut or fill will exceed 7.5 m in height, the grading design should include mid-height benches to intercept surface drainage and divert flow from the face of the embankment.

Excavation and Trench Construction: Excavations into the on-site soils may encounter caving soils, depending upon the final depth of excavation. The individual contractor(s) should be made responsible for designing and constructing stable, temporary excavations as required to maintain stability of both the excavation sides and bottom. All excavations should be sloped or shored in the interest of safety following local, and federal regulations, including current OSHA excavation and trench safety standards.

The soils to be penetrated by excavations may vary across the site. The soil classifications presented in this report are based solely on the materials encountered in the test borings. The contractor should verify that similar conditions exist throughout the proposed area of excavation. If different subsurface conditions are encountered at the time of construction, the actual conditions should be evaluated to determine any excavation modifications necessary to maintain safe conditions.
As a safety measure, it is recommended that all vehicles and soil piles be kept to a minimum lateral distance from the crest of the slope equal to no less than the slope height. The exposed slope face should be protected against the elements.

GENERAL COMMENTS

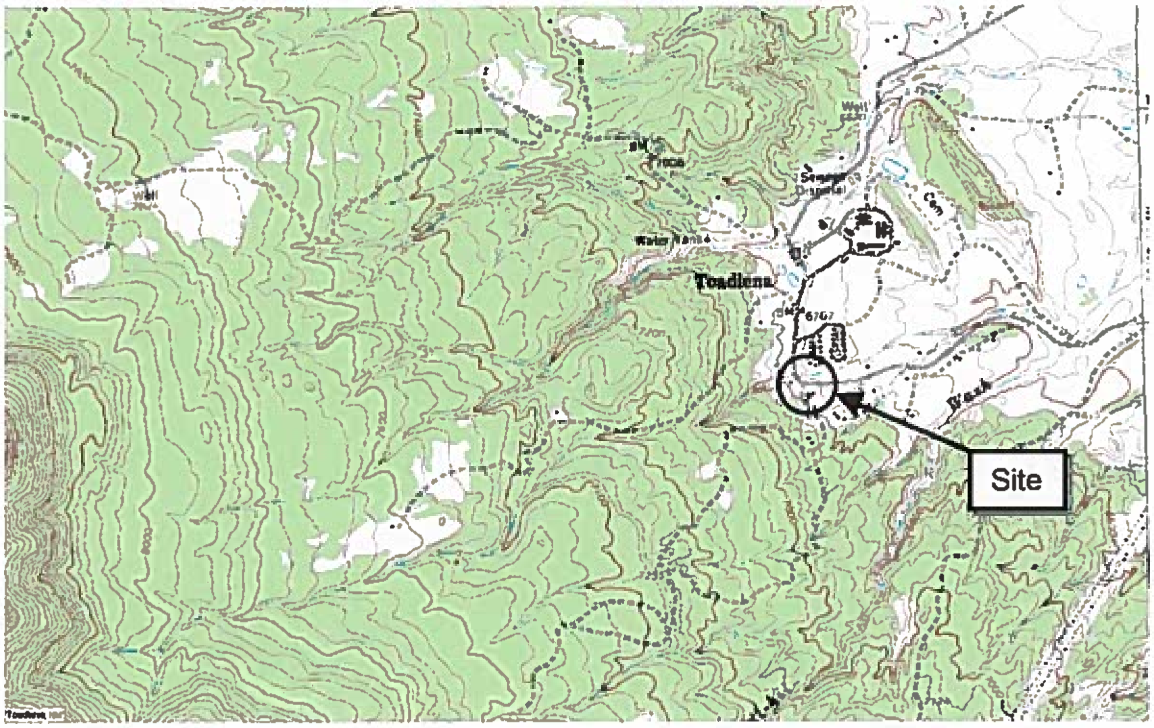
Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. Terracon also should be retained to provide testing and observation during excavation, grading, foundation and construction phases of the project.

The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings or across the site. The nature and extent of such variations may not become evident until construction. If variations appear, it will be necessary to reevaluate the recommendations of this report.

The scope of services for this project does not include either specifically or by implication any environmental assessment of the site or identification of contaminated or hazardous materials or conditions. If the owner is concerned about the potential for such contamination, other studies should be undertaken.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. In the event that changes in the nature, design, or location of the project as outlined in this report, are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes, and either verifies or modifies the conclusions of this report in writing.

Appendix A



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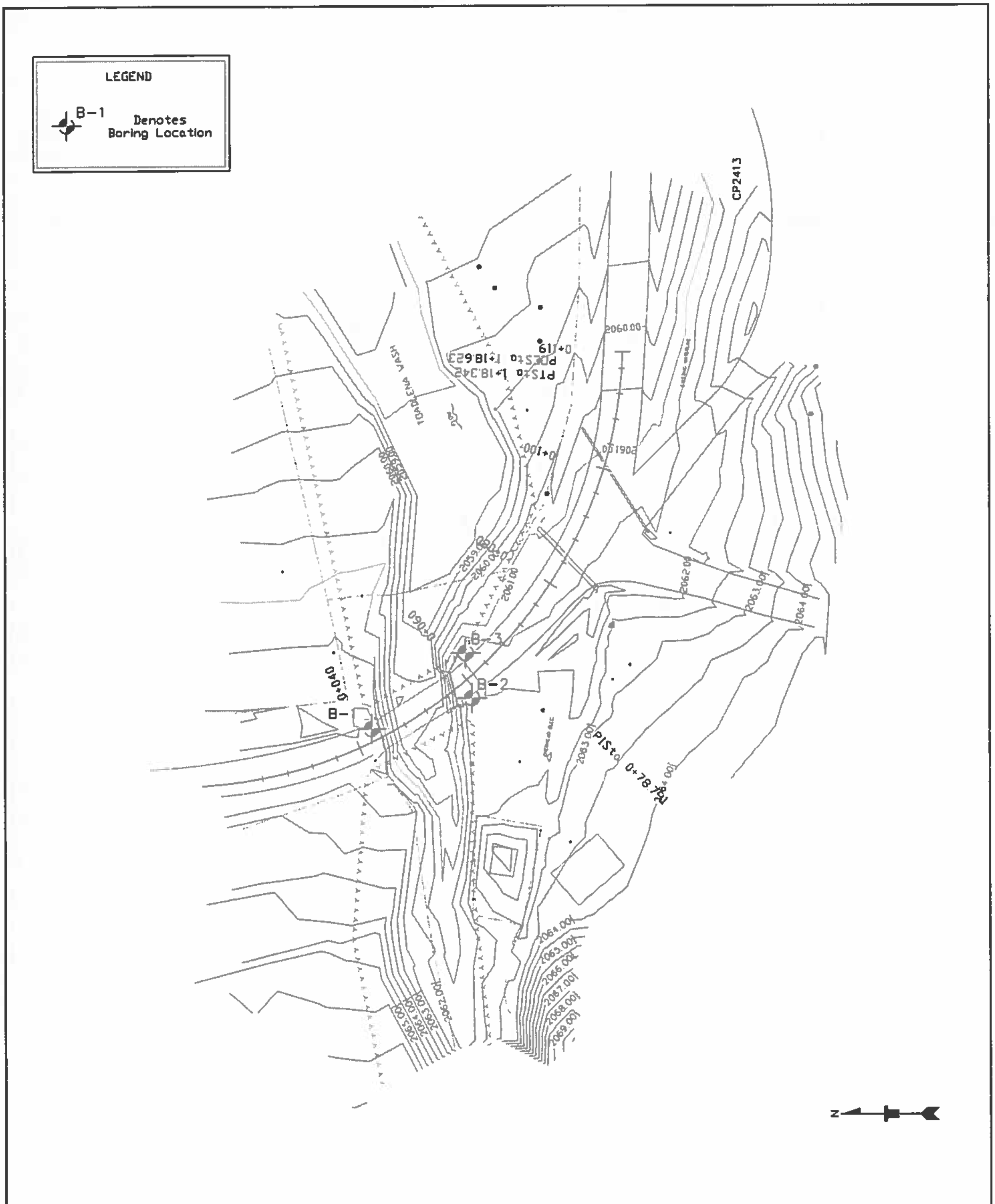
SOURCE: USGS TOPOGRAPHIC MAPS, 7.5-MINUTE SERIES,
Toadlena, New Mexico, 1978.

Terracon 4416 Anaheim Northeast Albuquerque, New Mexico 87113 (505) 797-4287 Fax (505) 797-4288	SITE LOCATION MAP Toadlena North Bridge No. 241 Navajo Nation San Juan County, New Mexico	Project No. 66015021I Date: September 17, 2001 Scale: 1 cm. = 256 m (approx.) **FIGURE A1**



Terracon

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BORING LOCATION PLAN

TERRACON PROJECT NO. 66015021I

DRAWN BY: MAP
CHECKED BY: KJS
FILE:
SCALE: Not to Scale
DATE: 6/17/01

Toadlena North Bridge #221
Navajo Nation
San Juan County, New Mexico

FIGURE NO.: A2

LOG OF BORING NO. B-1

CLIENT: PAIKI

SITE: No. 241, San Juan County, New Mexico

PROJECT: TOADLENA NORTH BRIDGE

Approx. Surface Elev.: 2062 m

Depth to base, m	Description	Elev. at base, m	Sample depth, m	USCS Symbol	Number	Type	Recovery, m.	SPT - N Blows / 0.3m.	Water Content, %	Dry Unit Wt kN/m³	Unconfined Strength, kPa
2.7	**SILTY CLAYEY SAND;** Brown, Medium Dense, Fine To Coarse Grained, Some Fine Gravel And Cobbles, Moist.	2059.3	1.5	SC SM	1	SS	0.36	22	6.1		
4.3	**CLAYEY SAND;** Grey, Very Loose, Low To Medium Plasticity, Fine To Medium Grained, Some Organics, Moist.	2057.7	3.0	SC	2	SS	0.18	3	17.9		
5.2	**CLAY;** Grey, Medium Stiff, Some Sand, Medium To High Plasticity, Moist.	▽ 2056.8	4.5	CL CH	3	RS	0.23	11	15.9		
	SILTY CLAYEY SAND; Brown, Very Loose To Medium Dense, Fine To Coarse Grained, Some Organics, Moist.		6.1		4	SS	0.36	3	24.1		
			7.6		5	SS	0.46	1	25.2		
			9.1		6	SS	0.46	1	27.2		

Continued Next Page

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, m			
WL	▽ 5.2	WD	▼
WL	▽		▽
WL			

Terracon

BORING STARTED	8-9-01
BORING COMPLETED	8-9-01
RIG: CME 75	FOREMAN: BB
LOGGED: BB	JOB #: 66015021I

BOREHOLE 99 66150211.GPJ TERRACON.GDT 9/19/03

LOG OF BORING NO. B-1

CLIENT
PAIKI

SITE
No. 241
San Juan County, New Mexico

PROJECT
TOALDLENA NORTH BRIDGE

GRAPHIC LOG	DESCRIPTION	DEPTH, m.	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, m.	SAMPLES: SPT - N BLOWS / 0.3m.	TESTS: WATER CONTENT, %	TESTS: DRY UNIT WT kN/m³	TESTS: UNCONFINED STRENGTH, kPa
	SILTY CLAYEY SAND: Brown, Very Loose To Medium Dense, Fine To Coarse Grained, Some Organics, Moist.									
		11		7	SS	0.18	6	24.8		
		12		8	SS	0.18	4	25.4		
	12.6 — 2049.4									
	Boring Terminated at 12.65 m.									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, m		
WL	5.2	WD
WL		
WL		

Terracon

BORING STARTED	8-9-01
BORING COMPLETED	8-9-01
RIG CME 75	FOREMAN BB
LOGGED BB	JOB # 66015021I

LOG OF BORING NO. B-2

CLIENT: PAIKI

SITE: No. 241, San Juan County, New Mexico

PROJECT: TOADLENA NORTH BRIDGE

Approx. Surface Elev.: 2062.1 m

Depth / Elev.	DESCRIPTION	DEPTH, m	USCS SYMBOL	NUMBER	TYPE	RECOVERY, m.	SPT - N BLOWS / 0.3m.	WATER CONTENT, %	DRY UNIT WT kN/m^3	UNCONFINED STRENGTH, kPa
	SILTY CLAYEY SAND: Brown, Medium Dense, Fine To Coarse Grained, Some Fine Gravel And Cobbles, Moist.		SC SM	1	SS	0.08	5	2.7		
2.1 / 2060	**CLAY;** Grey, Some Sand, Medium To High Plasticity, Moist.									
2.7 / 2059.4	**SILTY CLAYEY SAND:** Brown, Very Loose To Medium Dense, Fine To Coarse Grained, Some Fine Gravel And Cobbles, Moist.		SC SM	2	SS	0.1	1	25.5		
	▽		SC	3	SS	0.46	2	20.8		
			SC	4	RS	0.2	11			
7.3 / 2054.8	**CLAY;** Grey, Stiff, Some Sand, Medium To High Plasticity, Moist.		CL CH	5	SS	0.33	16	16.3		
8.8 / 2053.3	**CLAYEY SAND:** Grey, Medium Dense, Low To Medium Plasticity, Fine To Medium Grained, Some Organics, Moist.		SC SM	6	SS	0.46	19	12.6		

Continued Next Page

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, m		
WL	▽ 4.6	WD ▼
WL	▽	▼
WL		

Terracon

BORING STARTED	8-8-01
BORING COMPLETED	8-8-01
RIG CME 75	FOREMAN BB
LOGGED BB	JOB # 66015021I

LOG OF BORING NO. B-2

CLIENT
PAIKI

SITE No. 241
San Juan County, New Mexico

PROJECT
TOADLENA NORTH BRIDGE

GRAPHIC LOG	DESCRIPTION	DEPTH, m.	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, m.	SAMPLES: SPT - N BLOWS / 0.3m.	TESTS: WATER CONTENT, %	TESTS: DRY UNIT WT kN/m³	TESTS: UNCONFINED STRENGTH, kPa
	CLAYEY SAND; Grey, Medium Dense, Low To Medium Plasticity, Fine To Medium Grained, Some Organics, Moist.									
		11	SC SM	7	SS	0.36	14	17.4		
	11.3 — 2050.8									
	CLAY; Grey, Hard, Some Sand, Medium To High Plasticity, Moist.	12								
			SC SM	8	SS	0.36	33	16.1		
	12.6 — 2049.4									
	Boring Terminated at 12.65 m.									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, m		
WL	∇ 4.6	WD ▼
WL	∇	▼
WL		

Terracon

BORING STARTED	8-8-01
BORING COMPLETED	8-8-01
RIG CME 75	FOREMAN BB
LOGGED BB	JOB # 66015021I

BOREHOLE 99 66150211.GPJ TERRACON.GDT 9/19/03

LOG OF BORING NO. B-3

CLIENT PAIKI	
SITE No. 241 San Juan County, New Mexico	PROJECT TOADLENA NORTH BRIDGE

GRAPHIC LOG	DESCRIPTION Approx. Surface Elev.: 2061.9 m	Depth, m	Elev., m
	SILTY CLAYEY SAND; Brown, Loose To Medium Dense, Fine To Coarse Grained, Some Fine Gravel And Cobbles, Moist.	4.3	2057.6
	CLAYEY SAND; Grey, Very Loose To Loose, Low To Medium Plasticity, Fine To Medium Grained, Some Organics, Moist. ▽	6.7	2055.2
	CLAY; Grey, Medium Stiff, Some Sand, Medium To High Plasticity, Moist.	8.2	2053.7
	SILTY CLAYEY SAND; Brown, Medium Dense To Very Dense, Fine To Coarse Grained, Some Organics, Some Fine To Coarse Gravel, Some Cobbles, Moist.		

Continued Next Page

USCS SYMBOL	SAMPLES: NUMBER	TYPE	RECOVERY, m.	SPT - N BLOWS / 0.3m.	TESTS: WATER CONTENT, %	DRY UNIT WT kN/m³	UNCONFINED STRENGTH, kPa
SC SM	1	SS	0.46	5	7.2		
SC SM	2	RS	0.3	4	20.4		
SC	3	SS	0.46	4	23.3		
SC	4	SS	0.36	2	23.9		
CL CH	5	SS	0.18	8	24.1		
SC SM	6	SS	0.2	21	11.1		

DEPTH, m.: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, m		
WL	▽ 4.7	WD ▼
WL	▽	▽
WL		

Terracon

BORING STARTED			8-8-01
BORING COMPLETED			8-8-01
RIG	CME 75	FOREMAN	BB
LOGGED	BB	JOB #	66015021I

BOREHOLE 99 66015021I.GPJ TERRACON.GDT 9/19/03

LOG OF BORING NO. B-3

CLIENT
PAIKI

SITE **No. 241**
San Juan County, New Mexico

PROJECT
TOADLENA NORTH BRIDGE

GRAPHIC LOG	DESCRIPTION	DEPTH, m.	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, m.	SAMPLES: SPT - N BLOWS / 0.3m.	TESTS: WATER CONTENT, %	TESTS: DRY UNIT WT kN/m^3	TESTS: UNCONFINED STRENGTH, kPa
	SILTY CLAYEY SAND: Brown, Medium Dense To Very Dense, Fine To Coarse Grained, Some Organics, Some Fine To Coarse Gravel, Some Cobbles, Moist.									
		11	SC SM	7	SS	0.25	55	9.5		
		12								
	12.6 — 2049.3		SC SM	8	SS	0.23	66	14.1		
	Boring Terminated at 12.65 m.									

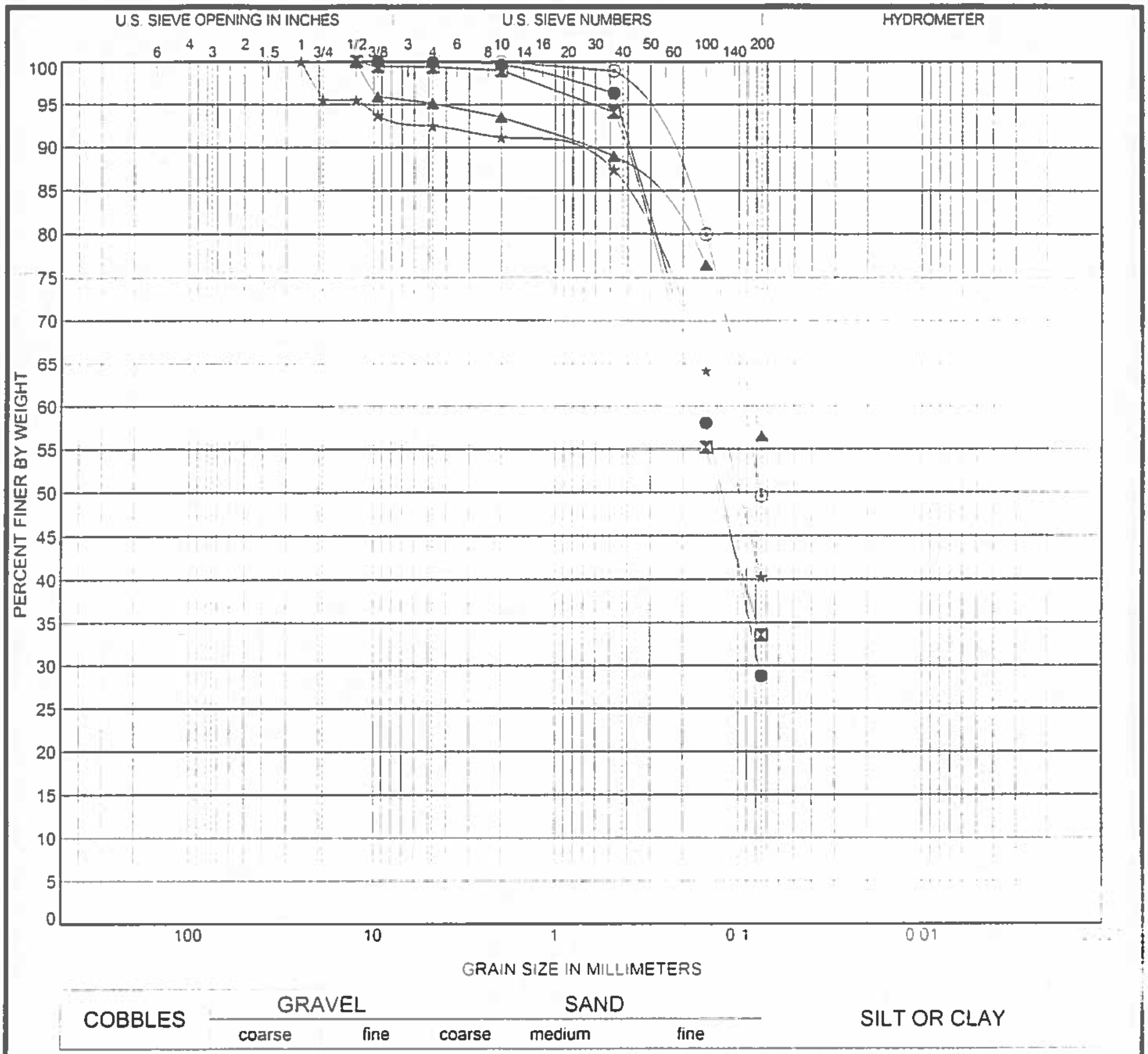
The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, m		
WL	▽ 4.7	WD ▼
WL	▽	▼
WL		

Terracon

BORING STARTED	8-8-01
BORING COMPLETED	8-8-01
RIG CME 75	FOREMAN BB
LOGGED BB	JOB # 66015021I

Appendix B



Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● B-1	7.62 m	SILTY SAND SM	0	0	0		
⧗ B-1	10.67 m	SILTY SAND SM	0	0	0		
▲ B-2	7.62 m	SANDY LEAN CLAY CL	23	12	11		
★ B-3	1.52 m	SILTY, CLAYEY SAND SC-SM	22	15	7		
⊙ B-3	6.10 m	CLAYEY SAND SC	26	15	11		

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-1	7.62 m	9.5	0.159	0.077		0.1	71.2	28.8	
⧗ B-1	10.67 m	12.5	0.173			0.6	65.8	33.5	
▲ B-2	7.62 m	12.5	0.085			4.9	38.6	56.5	
★ B-3	1.52 m	25	0.133			7.5	52.2	40.3	
⊙ B-3	6.10 m	2	0.095			0.0	50.4	49.6	

GRAIN SIZE DISTRIBUTION

Terracon

Project: TOADLENA NORTH BRIDGE
Site: No. 241 San Juan County, New Mexico
Job #: 66015021I
Date: 11-4-02

TC GRAIN SIZE METRIC 66150211.GPJ TERRACON.GDT 11/4/02

International Lubrication and Fuel Consultants Inc.
Creating the standards for industry.

ILFC LABORATORY REPORT

FOR:

Terracon

4416 Anaheim Northeast
Albuquerque, NM 87113

PROJECT ID:	**Not Given**
PROJECT PO NO:	**66015021 I**
PROJECT LOCATION:	**Not Given**
ILFC BATCH NO.:	**01063**

Accredited in accordance with

NELAC

National Environmental Laboratory Accreditation Conference

New York Certification No.: 11141

New Jersey Certification No.: 71800

Prepared By: [signature] Date: 9-12-2001
(Quality Assurance Officer/ Chemist)

Reviewed By: George H Kitchen Date: 9-12-2001

* This Laboratory report meets the requirements for NELAC accredited states.

Mail: P.O. Box15212 • Rio Rancho, NM 87174
Deliveries: 1201 Rio Rancho Blvd., Suite C • Rio Rancho, NM 87124
Phone: (505) 892-1666 –or– (800) 237-4532
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E-mail: ilfcinc@ilfcinc.com

International Lubrication and Fuel Consultants Inc.
1201 Rio Rancho, NM 87124

Phone # 1-800-237-4532
Fax # 1-505-892-9601

Client ID:	**Terracon**	**Project Name:**	**Sample ID:** B-1 10-11 1/2
Project PO Number:	**66015021 I**	**Not Given**	B-2 30-31 1/2 B-2 16-16 1/2

ILFC, Inc Batch Number:	01063	Laboratory Number:	10208-->10210	Date Sampled:	08/30/01
% Moisture:	N/A	Temperature upon delivery:	N/A	Time Sampled:	2:00pm
Matrix:	X Soil	___ Other	___ Water	Date Received:	08/30/01
Reporting in:	___ Dry Weig	X Wet Weight	___ N/A	Time Received:	2:00pm

Client I. D.	ILFC Lab#	Method	Analyte	Results	MDL	Units	Date Completed
B-1 10-11 1/2	10208	EPA 300.0	Soluble Sulfate	171	0.05	mg/Kg	09/08/01
B-2 30-31 1/2	10209	EPA 300.0	Soluble Sulfate	80.9	0.05	mg/Kg	09/08/01
B-3 15-16 1/2	10210	EPA 300.0	Soluble Sulfate	18.4	0.05	mg/Kg	09/08/01

Client I. D.	ILFC Lab#	Method	Analyte	Results	MDL	Units	Date Completed
B-1 10-11 1/2	10208	-------	pH	7.5	-------	-------	09/03/01
B-2 30-31 1/2	10209	-------	pH	8.9	-------	-------	09/03/01
B-3 15-16 1/2	10210	-------	pH	6.9	-------	-------	09/03/01

Client I. D.	ILFC Lab#	Method	Analyte	Results	MDL	Units	Date Completed
B-1 10-11 1/2	10208	Soil Box	Resistivity	6,700	ohm-cm	-------	09/07/01
B-2 30-31 1/2	10209	Soil Box	Resistivity	8,700	ohm-cm	-------	09/07/01
B-3 15-16 1/2	10210	Soil Box	Resistivity	3,900	ohm-cm	-------	09/07/01

Client I. D.	ILFC Lab#	Method	Analyte	Results	MDL	Units	Date Completed
B-1 10-11 1/2	10208	-------	Chloride	< MDL	10	ppm	09/03/01
B-2 30-31 1/2	10209	-------	Chloride	< MDL	10	ppm	09/03/01
B-3 15-16 1/2	10210	-------	Chloride	< MDL	10	ppm	09/03/01

Accredited in accordence with
NELAC

NY Cert. No. 11141
NJ Cert. No. 71800

Date: 9/12/01
Time:12:50 PM

T2F07A

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Suite C
Rio Rancho, NM 87124
(505) 892-1666 (800) 237-4532

D1063

ANALYSIS REQUEST AND CHAIN OF CUSTODY FORM

Project Manager & Company: Gabe Burgess, Terracon

Phone #: 797 4281

Address: 4416 Anaheim NE Albuquerque NM 87113

FAX #: 797 4288

Project PO No.: 66015021T

Project No.: Same

Project Name: Tucumcari

Project Location: Tucumcari, NM

Sampler Signature: [signature]

Sample ID	Lab # lab use only	# Containers	Volume/Amount	Matrix: Water	Matrix: Soil	Matrix: Sludge	Matrix: Other	Matrix: Other	PAH?, Benzene, Chloride content	Sulfides, Sulfates
B1 10-11½	10208	1			✓				✓	✓
B2 30-31½	10209	1			✓				✓	✓
B3 15-16½	10210	1			✓				✓	✓

Method Preserved: Ice, HCl, HNO3, None, Other
Sampling: DATE, TIME

ANALYSIS REQUEST: BTEX (EPA NO.), TPH (EPA NO.), BTEX & TPH (EPA NOS.), Total Oil & Grease (EPA NO.), Metals Analysis (EPA NO.), TEP, Certified CP Plans, Forensic

OTHER

HANDLING: Priority One Service (24-48 hrs) No TEP; Expedited Service (2-3 working days); Normal Service; Verbals/FAX; Special Detection Limits (Specify); Special Reporting Requirements

Relinquished by:	Date	Time	Received by:	Date	Time	Remarks:
[signature]	8-30-01	2:00pm	[signature]	8-30-01	2pm	

PO No. must be included or work may be delayed. Please call 1-2 days in advance to arrange for priority or expedited service, if not samples may be delayed.

Appendix C

GENERAL NOTES

DRILLING & SAMPLING SYMBOLS:

SS:	Split Spoon - 1-3/8" I.D., 2" O.D., unless otherwise noted	HS:	Hollow Stem Auger
ST:	Thin-Walled Tube - 2" O.D., unless otherwise noted	PA:	Power Auger
RS:	Ring Sampler - 2.42" I.D., 3" O.D., unless otherwise noted	HA:	Hand Auger
DB:	Diamond Bit Coring - 4", N, B	RB:	Rock Bit
BS:	Bulk Sample or Auger Sample	WB:	Wash Boring or Mud Rotary

The number of blows required to advance a standard 2-inch O.D. split-spoon sampler (SS) the last 12 inches of the total 18-inch penetration with a 140-pound hammer falling 30 inches is considered the "Standard Penetration" or "N-value". For 3" O.D. ring samplers (RS) the penetration value is reported as the number of blows required to advance the sampler 12 inches using a 140-pound hammer falling 30 inches, reported as "blows per foot," and is not considered equivalent to the "Standard Penetration"or "N-value".

WATER LEVEL MEASUREMENT SYMBOLS:

WL:	Water Level	WS:	While Sampling
WCI:	Wet Cave in	WD:	While Drilling
DCI:	Dry Cave in	BCR:	Before Casing Removal
AB:	After Boring	ACR:	After Casing Removal

Water levels indicated on the boring logs are the levels measured in the borings at the times indicated. Groundwater levels at other times and other locations across the site could vary. In pervious soils, the indicated levels may reflect the location of groundwater. In low permeability soils, the accurate determination of groundwater levels may not be possible with only short-term observations.

DESCRIPTIVE SOIL CLASSIFICATION: Soil classification is based on the Unified Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

CONSISTENCY OF FINE-GRAINED SOILS

Unconfined Compressive Strength, Qu, psf	Standard Penetration or N-value (SS) Blows/Ft.	Consistency
< 500	<2	Very Soft
500 – 1,000	2-3	Soft
1,001 – 2,000	4-6	Medium Stiff
2,001 – 4,000	7-12	Stiff
4,001 – 8,000	13-26	Very Stiff
8,000+	26+	Hard

RELATIVE DENSITY OF COARSE-GRAINED SOILS

Standard Penetration or N-value (SS) Blows/Ft.	Ring Sampler (RS) Blows/Ft.	Relative Density
0 – 3	0-6	Very Loose
4 – 9	7-18	Loose
10 – 29	19-58	Medium Dense
30 – 49	59-98	Dense
50+	99+	Very Dense

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 – 29
Modifier	> 30

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 – 12
Modifiers	> 12

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300mm)
Cobbles	12 in. to 3 in. (300mm to 75 mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm)
Silt or Clay	Passing #200 Sieve (0.075mm)

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1-10
Medium	11-30
High	30+

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UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]				Soil Classification: Group Symbol	Group Name[B]
Coarse Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines[C]	Cu ≥ 4 and 1 ≤ Cc ≤ 3[E]	GW	Well-graded gravel[F]
			Cu < 4 and/or 1 > Cc > 3[E]	GP	Poorly graded gravel[F]
		Gravels with Fines More than 12% fines[C]	Fines classify as ML or MH	GM	Silty gravel[F,G,H]
			Fines classify as CL or CH	GC	Clayey gravel[F,G,H]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines[D]	Cu ≥ 6 and 1 ≤ Cc ≤ 3[E]	SW	Well-graded sand[I]
			Cu < 6 and/or 1 > Cc > 3[E]	SP	Poorly graded sand[I]
		Sands with Fines More than 12% fines[D]	Fines classify as ML or MH	SM	Silty sand[G,H,I]
			Fines Classify as CL or CH	SC	Clayey sand[G,H,I]
Fine-Grained Soils 50% or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	inorganic	PI > 7 and plots on or above "A" line[J]	CL	Lean clay[K,L,M]
			PI < 4 or plots below "A" line[J]	ML	Silt[K,L,M]
		organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OL	Organic clay[K,L,M,N]
					Organic silt[K,L,M,O]
	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line	CH	Fat clay[K,L,M]
			PI lots below "A" line	MH	Elastic Silt[K,L,M]
		organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OH	Organic clay[K,L,M,P]
					Organic silt[K,L,M,Q]
Highly organic soils	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-in. (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

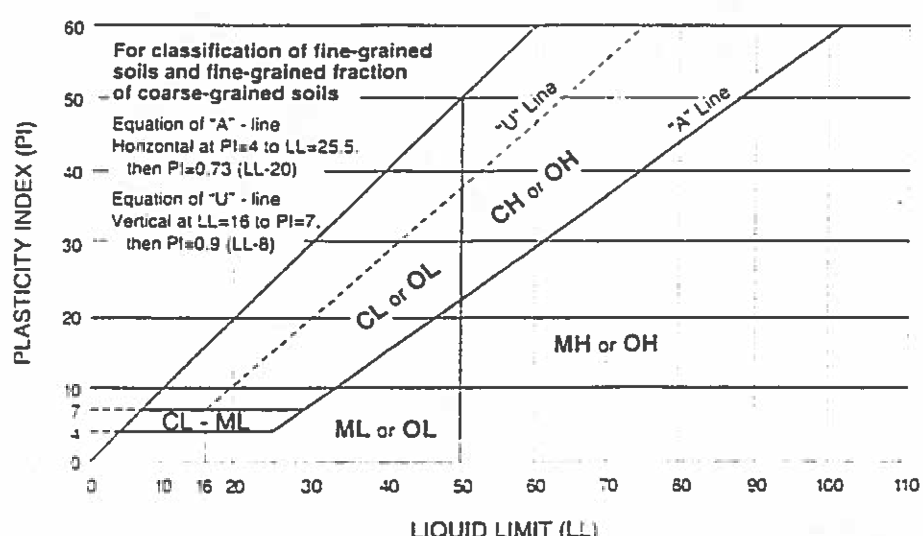
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



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ROCK CLASSIFICATION
(Based on ASTM C-294)

Sedimentary Rocks

Sedimentary rocks are stratified materials laid down by water or wind. The sediments may be composed of particles of pre-existing rocks derived by mechanical weathering, evaporation or by chemical or organic origin. The sediments are usually indurated by cementation or compaction.

Chert: Very fine-grained siliceous rock composed of micro-crystalline or crypto-crystalline quartz, chalcedony or opal. Chert is various colored, porous to dense, hard and has a conchoidal to splintery fracture.

Claystone: Fine-grained rock composed of or derived by erosion of silts and clays or any rock containing clay. Soft massive; gray, black, brown, reddish or green and may contain carbonate minerals.

Conglomerate: Rock consisting of a considerable amount of rounded gravel, sand and cobbles with or without interstitial or cementing material. The cementing or interstitial material may be quartz, opal, calcite, dolomite, clay, iron oxides or other materials.

Dolomite: A fine-grained carbonate rock consisting of the mineral dolomite [$CaMg(CO_3)_2$]. May contain noncarbonate impurities such as quartz, chert, clay minerals, organic matter, gypsum and sulfides. Reacts with hydrochloric acid (HCL).

Limestone: A fine-grained carbonate rock consisting of the mineral calcite ($CaCo_3$). May contain noncarbonate impurities such as quartz, chert, clay minerals, organic matter, gypsum and sulfides. Reacts with hydrochloric acid (HCL).

Sandstone: Rock consisting of particles of sand with or without interstitial and cementing materials. The cementing or interstitial material may be quartz, opal, calcite, dolomite, clay, iron oxides or other material.

Shale: Fine-grained rock composed of, or derived by erosion of silts and clays or any rock containing clay. Shale is hard, platy, or fissile may be gray, black, reddish or green and may contain some carbonate minerals (calcareous shale).

Siltstone: Fine grained rock composed of, or derived by erosion of silts or rock containing silt. Siltstones consist predominantly of silt sized particles (0.0625 to 0.002 mm in diameter) and are intermediate rocks between claystones and sandstones, may be gray, black, brown, reddish or green and may contain carbonate minerals.