RESULTS OF SOIL STABILIZATION STUDY

GRATWICK-RIVERSIDE PARK SITE
NORTH TONAWANDA, NEW YORK

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GRATWICK-RIVERSIDE PARK SITE
NORTH TONAWANDA, NEW YORK

OCTOBER 1998
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EXECUTIVE SUMMARY

A soil stabilization was performed to assess the feasibility of the stabilization/solidification technology using cement as a viable option to reduce the leachable lead concentrations in the fill material to below the TCLP regulatory level of 5 mg/L. The material of concern was the soil to be excavated at the Gratwick-Riverside Park Site between the barrier wall and the Niagara River from the mid-point of BH20-96 and BH21-96 to the north Site boundary. This material had a TCLP concentration of 10 mg/L in the pre-design composite sample obtained from BH21-96 through BH23-96.

Two composite soil samples were collected from four test pits on June 12, 1998. The samples from TP-1 and TP-2 were composited to form composite sample A and the samples from TP-3 and TP-4 were composited to form composite sample B.

The sole purpose of the stabilization was to reduce the TCLP lead concentration to levels below the TCLP regulatory level of 5 mg/L. While the addition of cement increased the unconfined compressive strength of the stabilized material, the unconfined compressive strength was not a criterion under consideration for the project. The physical characteristics of the soil to be stabilized do not require cement to increase its compressive strength because the strength of material was adequate in its original condition.

Based on the maximum TCLP lead concentration detected in the predesign sample (i.e. 10 mg/L) it was only necessary to reduce the leachable lead concentration by a factor of two to achieve the TCLP regulatory level. This reduction was achieved by adding 1 percent cement to the excavated soils based on the testing results. It is recommended that the soil excavated during RA construction along the shoreline from the mid-point of BH20-96 and BH21-96 to the north Site boundary outside of the barrier wall alignment be stabilized using 1 percent cement.

1.0 INTRODUCTION

A soil stabilization was performed to assess the feasibility of the stabilization/solidification technology using cement as a viable option to reduce the leachable lead concentrations in the fill material to below the TCLP regulatory level of 5 mg/L. The material of concern was the soil to be excavated at the Gratwick-Riverside Park Site between the barrier wall and the Niagara River from the mid-point of BH20-96 and BH21-96 to the north Site boundary. This material had a TCLP concentration of 10 mg/L in the pre-design composite sample obtained from BH21-96 through BH23-96.

2.0 TREATABILITY STUDY OBJECTIVES

The main objectives of the proposed bench-scale treatability study can be summarized as follows:

i) to assess the feasibility of stabilization/solidification techniques as a viable option to reduce lead mobility in existing select Site shoreline soils so that the TCLP lead for the treated soil is below the regulatory level;

ii) to characterize the chemical, physical, engineering, and geotechnical properties of the treated soil; and

iii) to determine the quantitative increase in the soil volume as a result of the stabilization/solidification treatment for modification of Site design contour plans.

The study was performed using the procedures presented in Appendix A of the Performing Parties (PPs) responses submitted May 29, 1998 with the modifications described in the following sections.

3.0 SAMPLE COLLECTION

Soil samples were collected June 12, 1998 from four tests for the soil stabilization/solidification study. A 2.5 gallon sample was collected from each of four test pits (see Figure 3.1 for location). The depths of the test pits were:

Test Pit	*Depth (ft. bgs)*
TP-1	3.7
TP-2	3.8
TP-3	3.8
TP-4	3.9

Materials observed in the test pits were 4 ± inches of topsoil underlain with refuse (i.e., brick, glass, wood, cinder, ash, pieces of slag, etc.).

The samples from TP-1 and TP-2 were composited to form composite sample A and the samples from TP-3 and TP-4 were composited to form composite sample B.

4.0 INITIAL SOIL CHARACTERIZATION

The soils were characterized for the following parameters, prior to performing the treatability study:

- Particle size
- TCLP-lead
- pH
- Moisture content
- Total organic matter.

The tests were conducted at CRA Services laboratory facility at the Niagara Falls office except particle size and TCLP-lead analyses which were conducted by outside independent laboratories. Particle size analyses were conducted by Barron & Associates (Clarence, New York), and TCLP-based analysis were conducted at H2M Labs, Inc., a certified analytical laboratory in Melville, New York. All the soil used in this study, except those used for the initial particle size analysis, were sieved through #4 screen because the soils contained a high percentage of pebbles, stones, and brick debris. The preliminary TCLP-lead analytical results were 0.68 and 2.2 mg/L (see Table 4.1) which are below the TCLP regulatory level of 5 mg/L. The range of TCLP lead results described above (i.e., 0.68 to 10 mg/L) show the variability of lead concentrations in solid material. This variability was not unexpected given the variability of the material composition (i.e., varying quantities of soil, brick, ash, slag, wood, glass, etc.) at each location.

5.0 TREATABILITY TESTING PROCEDURE

A two tier testing approach was followed to evaluate the efficiency of the stabilization/solidification formulation for the Site soils. This approach included a preliminary screening test to identify the most promising formulation ratios, and a final test to fine-tune the results obtained from the preliminary screening and confirm the most appropriate formulation ratio.

5.1 PRELIMINARY SCREENING

The preliminary screening was conducted to assess the proper cement/soil ratio, as well as the amount of water needed to yield the desired solidified products which would meet the requirements of reduced lead leachability. The screening assessment included a series of experimental tests involving several combinations of soil: cement: water ratios. Four different cement ratios were examined for soil solidification (3.0 percent, 5.0 percent, 7.5 percent and 10.0 percent, cement: soil, weight/weight). In each test, a 100 gm portion of soil material was weighed into an 8 oz glass jar to which a pre-determined weight of type I Portland cement was added to produce the appropriate cement:soil ratio. This was followed by the addition of the appropriate amount of tap water, depending on the type of soil and amount of cement added. The amount of water needed was determined by the visual appearance of the resulting mixtures, because there should be no standing water on the surface of the mixture. Three different water: soil ratios were tested for this purpose (7.5, 10.0 and 12.5 percent, weight:weight). Mixing was performed manually with a spoon for two minutes and the resulting mixture was packed evenly to give a flat surface. The surface level was marked on the outside of the glass jar, so that the volume with and without cement and water added could be measured and compared. The open glass jars were cured in a chamber with high humidity (over 90 percent) at 25°C. The samples were evaluated for hardness/structural strength after 1, 3, 5 and 7 days, using a pocket penetrometer (model CL700C by SOILTEST, Inc.).

5.2 FINAL TESTING

Based on the maximum TCLP lead concentration detected (i.e. 10 mg/L) it was necessary to reduce the leachable lead concentration by a factor of two to achieve the TCLP regulatory level. The results on Table 4.1 show that factors on the order of 24 to 54 were achieved when 3 percent cement was added.

Based on the results obtained from the preliminary screening test, the final testing was conducted using two cement ratios (1 and 3 gm of cement per 100 gm soil); and 7.5 ml of water per 100 gm soil). The test was conducted on a one kg portion of the soil material which was mixed with a predetermined amount of cement to produce the appropriate cement: soil ratio. Water was then added (7.5 percent of soil weight) and mixed, using a heavy duty electric mixer until a uniform mixture was obtained (about 3-5 minutes). The resulting mixture was packed evenly into plastic cylinders (2 x 4 inch). The samples were cured in the cylinders (without covers), in a high humidity chamber (over 90 percent) at 25°C for 28 days. At the end of the curing period, the samples were tested for unconfined compressive strength test, TCLP-lead, moisture content and pH.

6.0 SUMMARY OF THE RESULTS

6.1 PRELIMINARY SCREENING

6.1.1 INITIAL SOIL CHARACTERIZATION

Both samples A and B were sandy and contained a large amount of pebbles, stones, and brick debris (approximately 31 percent and 28 percent by weight, respectively for soil A and soil B). To ensure reproducible results, all the soil used in this study, except those used for the initial particle size analysis, was sieved through a #4 screen. For particle size analysis, stones having a diameter larger than one inch were removed. The results of particle size analysis, are included in Appendix A. Soils A and B had sand contents of 49 percent and 47 percent, silt contents of 12.9 percent and 13.4, and clay contents of 3.5 percent and 2.7 percent, respectively.

Table 4.2 summarizes the results of the soil pH, moisture content and total organic matter. Both samples had a slight acidic pH, and relatively high organic content-(11.7 - 13.3 percent). Moisture contents of samples A and B were 22.2 percent and 17.5 percent respectively.

6.1.2 TCLP-LEAD

The analytical results of TCLP-lead for the initial soil as well as for samples from the preliminary screening are summarized in Table 4.1. Soil A and B samples used in the present study were found to exhibit lower concentrations (0.68 and 2.2 mg/L, respectively) than the predesign composite sample.

During the preliminary screening test, there was no volume increase for all the samples treated with cement. The sandy nature of the soils and the relatively high pore volume of the soil appeared to be large enough to accommodate the added cement and water without any significant increase in the volume of the treated soil even when up to ten percent cement was added. There was no apparent gas formation during mixing of soil/cement/water. The slight heat exertion observed was within the normal acceptable range to be expected for soil/cement/water mixing process for type I Portland cement.

6.1.3 UNCONFINED COMPRESSIVE STRENGTH

Tables 6.1 and 6.2 show the results of the unconfined compressive strength for the preliminary screening for soil A and soil B, respectively. All samples with cement addition over 3 percent produced over 50 psi of unconfined compressive strength after 24 hours, compared to 11 and 12 psi in the control samples (without the addition of any cement or water). The unusual strength observed for samples with and without cement addition suggested that the strength measured might more closely resemble those of confined compressive strength, instead of unconfined compressive strength, because the samples were contained in glass jars.

6.2 FINAL TESTING

Table 6.3 shows duplicate results for all the characterization of final testing products after 28 days of curing time. It includes moisture, pH, specific gravity, TCLP-lead content, and unconfined compressive strength. Curing in the high humidity (over 90 percent) chamber caused an increase of 10-12 percent moisture content for the control samples. Samples with 1 and 3 percent of cement added had alkaline pH of 9.2 to 11.2, while the untreated samples had pH of 6.3-6.9. The greater the amount of cement added, the higher the pH of the resulting mixture. TCLP-lead concentration was reduced by the addition of cement. Higher cement percentages resulted in lower TCLP-lead concentration for the treated samples. Duplicate analysis of the samples gave good agreement for TCLP-lead, except those for control A soil (3.3 and 0.53 mg/L for duplicate samples). The analytical data were quality control reviewed (see Appendix B). The review judged the data to be acceptable for use.

The TCLP lead results show that adding 1 percent cement reduced the TCLP lead concentration by factors ranging from 1.7 (i.e, 1370 ÷ 828 µg/L for Sample B) to 16.2 (i.e, 3280 ÷ 203 µg/L for Sample A). The larger reductions occurred for the samples with higher initial TCLP lead concentrations. The results show that adding 3 percent cement reduced the TCLP lead concentration by factors ranging from 4.7 (i.e, 1400 ÷ 300 µg/L for Sample B) to 47 (i.e, 3300 ÷ 70 µg/L for Sample A).

The TCLP lead concentration for the composite sample from BH21-96, BH22-96 and BH23-96 was 10 mg/L. The regulatory level is 5 mg/L. Thus, a reduction on the order of two would reduce the 10 mg/L concentration to the regulatory level. This reduction was achieved by adding one percent cement as described above.

During the final testing of the unconfined compressive strength, a pocket penetrometer had to be used for control soil A samples as well as soil A samples with one percent cement added, because the samples split horizontally or vertically while being removed from the sample holders. The unconfined compressive strengths ranged from 2.1 to 11.6 psi when 1 percent cement was added and from 6.6 to 86 psi when 3 percent cement was added. It is believed these compressive strengths are lower than those that would be achieved in the field because the laboratory samples were kept humid, which resulted in the samples remaining soft which decreased the compressive strength, whereas the material in the field would be in the unsaturated soil zone and would be dryer and firmer. The physical characteristics of the soil being excavated and stabilized is representative of the rest of the Site. The addition of cement to this soil would serve to increase its existing compressive strength which would then be greater than the untreated soil present in the rest of the Site. The unconfined compressive strength testing report is attached as Appendix C.

7.0 RECOMMENDATIONS

The sole purpose of the stabilization was to reduce the TCLP lead concentration to levels below the TCLP regulatory level of 5 mg/L. While the addition of cement increased the unconfined compressive strength of the stabilized material, the unconfined compressive strength was not a criterion under consideration for the project. The physical characteristics of the soil to be stabilized do not require cement to increase its compressive strength because the strength of material was adequate in its original condition.

The use of 1 percent cement increases the pH the least and has less impact as water leaches through the stabilized materials.

Based on the results described in the previous sections, it is recommended that the soil excavated during RA construction along the shoreline from the mid-point of BH20-96 and BH21-96 to the north Site boundary outside of the barrier wall alignment be stabilized using 1 percent cement.

FIGURES

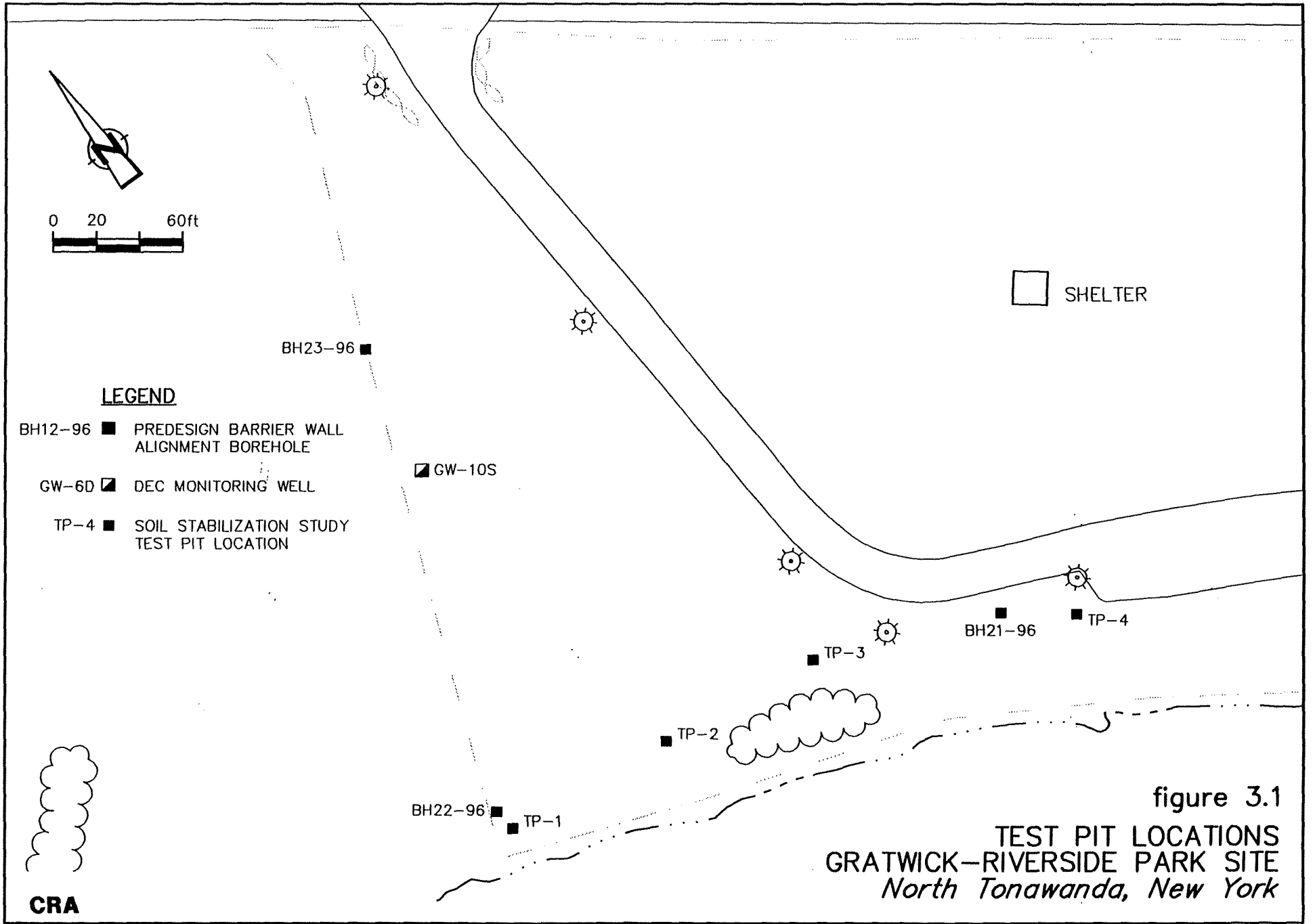


figure 3.1
TEST PIT LOCATIONS
GRATWICK-RIVERSIDE PARK SITE
North Tonawanda, New York

07987-00(020)GN-WA001 SEP 22/98

TABLES

TABLE 4.1

**PRELIMINARY SCREENING RESULTS OF TCLP-LEAD
SOIL SOLIDIFICATION/STABILIZATION STUDY
GRATWICK-RIVERSIDE PARK SITE
NORTH TONAWANDA, NEW YORK**

Soil A (gm)	*Cement (gm)*	*Water (ml)*	*TCLP-Lead (µg/L)*
Initial Soil	0	0	680
100	3	10	13
100	5	10	0.7
100	10	12.5	0.7
Soil B			
Initial Soil	0	0	2200
100	3	10	90
100	5	12.5	0.7
100	10	12.5	0.7

Note:

The solidified samples were cured for 7-9 days before the analysis was conducted.

TABLE 4.2

INITIAL SOIL CHARACTERIZATION
SOIL SOLIDIFICATION/STABILIZATION STUDY
GRATWICK-RIVERSIDE PARK SITE
NORTH TONAWANDA, NEW YORK

Soil/Parameter	*pH (Unit)*	*Moisture Content (%)*	*Total Organic Matter (%)*
Soil A	6.5	21.8	13.8
Soil A, (Dup)	6.6	20.6	12.7
Soil B	6.8	17.6	12.0
Soil B (Dup)	6.7	17.4	11.3

TABLE 6.1

PRELIMINARY SCREENING RESULTS SAMPLE A
SOIL SOLIDIFICATION/STABILIZATION STUDY
GRATWICK RIVERSIDE PARK SITE
NORTH TONAWANDA, NEW YORK

Sample A-100 gm each

Cement (gm)	*Water (ml)*	Unconfined Compressive Strength (PSI)			
		Day 1	*Day 3*	*Day 5*	*Day 7*
0	0	11	12	14	21
0	0	12	12	14	14
3	10	57	>71	>71	>71
3	10	64	>71	>71	>71
5	10	>71	>71	>71	>71
5	10	>71	>71	>71	>71
7.5	12.5	>71	>71	>71	>71
7.5	12.5	>71	>71	>71	>71
10	12.5	>71	>71	>71	>71
10	12.5	>71	>71	>71	>71

Note:

1. The sample has been sifted through #4 sieve, which has 4.75 mm (0.187 in.) opening.
2. A pocket penetrometer (Model 700A by Soiltest, Inc.) was used for measuring the unconfined compressive strength.

TABLE 6.2

PRELIMINARY SCREENING RESULTS - SAMPLE B
SOIL SOLIDIFICATION/STABILIZATION STUDY
GRATWICK RIVERSIDE PARK SITE
NORTH TONAWANDA, NEW YORK

Sample B-100 gm each

Cement (gm)	*Water (ml)*	Unconfined Compressive Strength (PSI)			
		Day 1	*Day 3*	*Day 5*	*Day 7*
0	0	14	12	14	21
0	0	14	14	14	25
3	10	>71	>71	>71	>71
3	10	>71	>71	>71	>71
5	12.5	>71	>71	>71	>71
5	12.5	>71	>71	>71	>71
7.5	12.5	>71	>71	>71	>71
7.5	12.5	>71	>71	>71	>71
10	12.5	>71	>71	>71	>71
10	12.5	>71	>71	>71	>71

Note:

1. The sample has been sifted through #4 sieve, which has 4.75 mm (0.187 in.) opening.
2. A pocket penetrometer (Model 700A by Soiltest, Inc.) was used for measuring the unconfined compressive strength.

TABLE 6.3

FINAL TESTING RESULTS
SOIL SOLIDIFICATION/STABILIZATION STUDY
GRATWICK-RIVERSIDE PARK SITE
NORTH TONAWANDA, NEW YORK

Sample/Parameter (Soil:Cement:Water)	*Moisture Content (%)*	*pH (Unit)*	*Specific Gravity*	*TCLP-Lead (µg/L)*	*Unconfined Compressive Strength (PSI)*
100 Soil A: 0: 0	33.5	6.3	1.275	3300	5.3*
100 Soil A: 0: 0	35.6	6.4	1.275	530	11*
100 Soil A: 1: 7.5	29.5	9.2	1.650	200	4.4*
100 Soil A: 1: 7.5	29.6	9.3	1.703	300	12*
100 Soil A: 3: 7.5	28.5	10.9	1.733	71	6.6
100 Soil A: 3: 7.5	28.6	11.2	1.722	70	6.6
100 Soil B: 0:0	25.7	6.8	1.355	1900	--
100 Soil B: 0:0	26.4	6.9	1.366	1400	--
100 Soil B: 1: 7.5	25.1	10.0	1.807	830	2.4
100 Soil B: 1: 7.5	24.1	10.1	1.832	670	2.1
100 Soil B: 3: 7.5	24.1	11.1	1.778	300	72
100 Soil B: 3: 7.5	26.0	11.1	1.778	160	86

Note:
* Pocket penetrometer was used in measuring the strength.
- No measurement made because the sample split during extraction from tube.

APPENDIX A

INITIAL PARTICLE SIZE RESULTS

BARRON & ASSOCIATES, P.C.
10440 Main Street
Clarence, New York 14031

Tel: (716) 759-7821 Fax: (716) 759-7823

June 30, 1998 Job No.: 98-1282C

CRA Services
2055 Niagara Falls Boulevard, Suite Three
Niagara Falls, New York 14304

ATTN: Dr. Cindy Lin

RE: Laboratory Testing Results of
Soil Particle Size Distribution for
Gratwick Park, North Tonawanda, N.Y.
(CRA Project Ref. No. 07987-00)
(P.O. No. P0tt0008371)

Ladies/Gentlemen:

Barron & Associates, P.C. (B&A) is enclosing the results of the requested laboratory testing for the above referenced project. The samples were tested in accordance with the following methods:

- ASTM D421 & D422 - Particle Size Analysis of Soils

This data represents the laboratory testing results for the two grab samples that were provided on June 17, 1998. The entire contents of the containers for each of these aforementioned samples were used in the analysis. Due to the presence of gravel sized material, the dry weight of samples CL-A and CL-B were less than that required for grain size testing purposes. A copy of the geotechnical testing order/chain-of-custody record is enclosed.

Please call either James S. Barron, P.E. or the undersigned at your earliest convenience, if questions should arise.

Very truly yours,
BARRON & ASSOCIATES, P.C..

Carmen M. Panuccio
Geotechnical Engineer

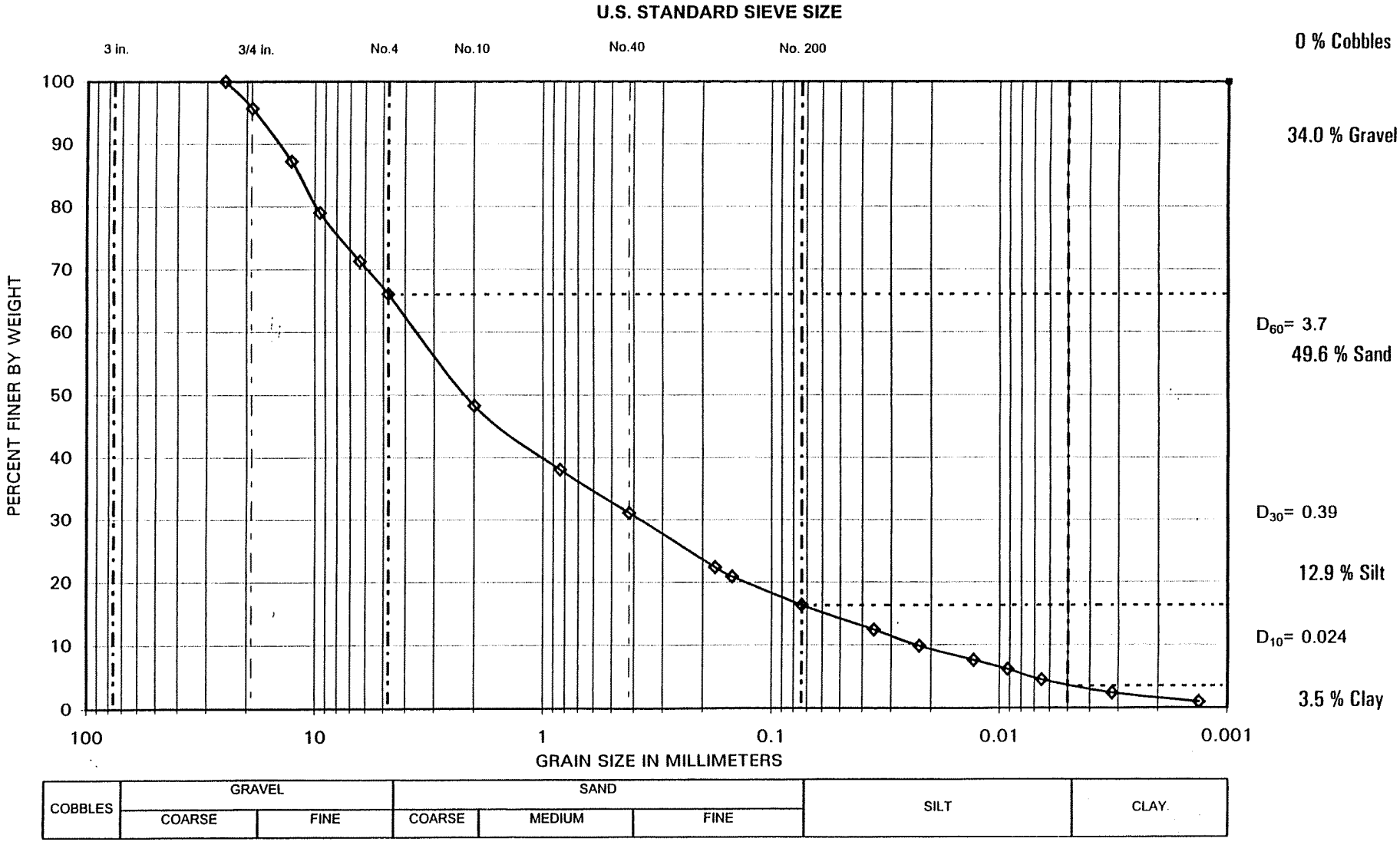
encls.

BARRON & ASSOCIATES, P.C. &
BUFFALO DRILLING COMPANY, INC.
10440 MAIN STREET
CLARENCE, N.Y. 14031
(716) 759-7821
FAX (716) 759-7823

Job No.: 98-1282C
Project: CRA Soil Samples
Specific Gravity = 2.67
(Assumed)

GRAIN SIZE ANALYSIS ASTM D-422

C_C= - C_U= - LL= N/A PL= N/A PI= N/A USCS= SM



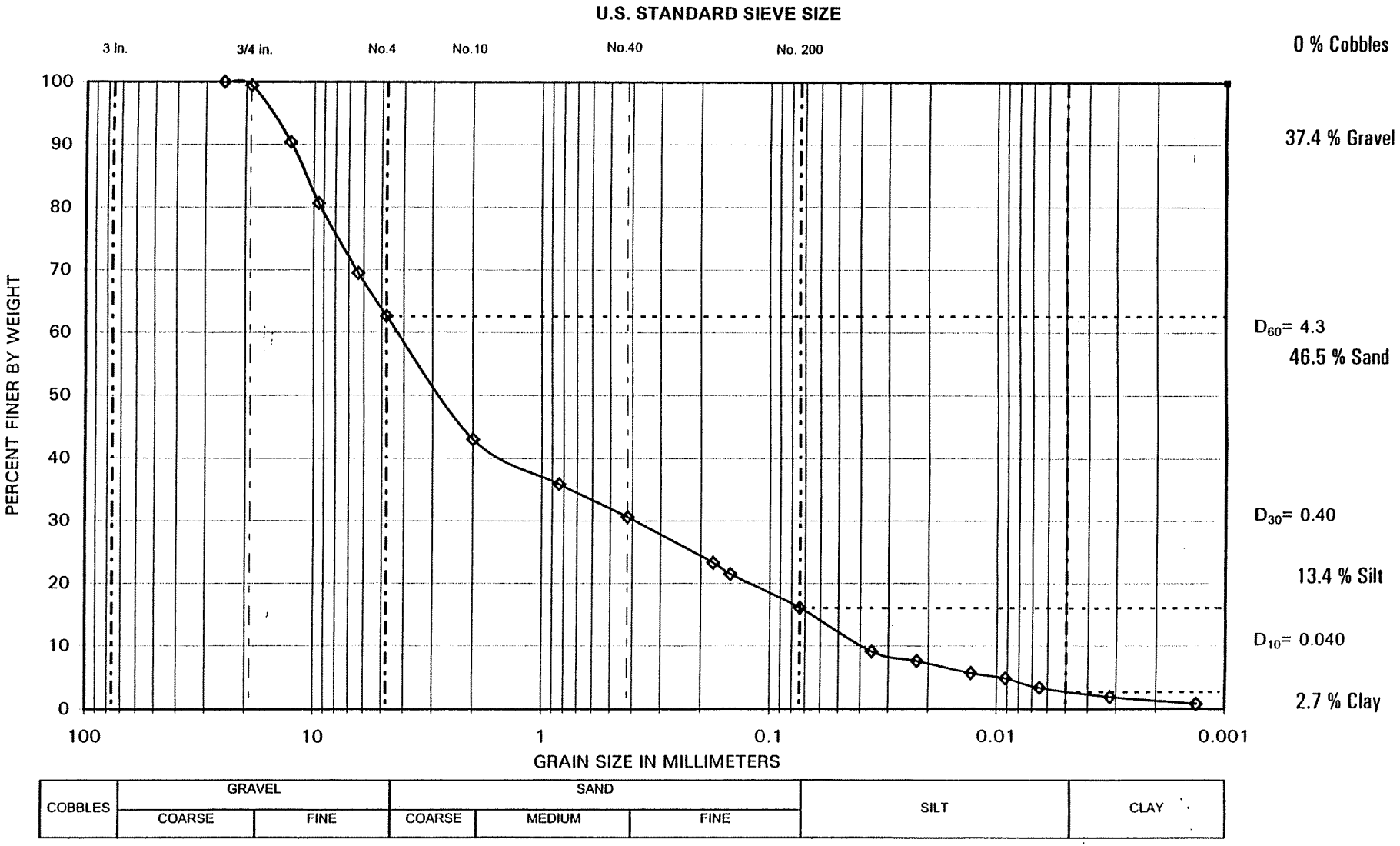
Test Date: 6/20/98 Sample: S-7987-980616-CL-A

BARRON & ASSOCIATES, P.C. &
BUFFALO DRILLING COMPANY, INC.
10440 MAIN STREET
CLARENCE, N.Y. 14031
(716) 759-7821
FAX (716) 759-7823

Job No.: 98-1282C
Project: CRA Sludge Samples
Specific Gavity = 2.67
(Assumed)

GRAIN SIZE ANALYSIS ASTM D-422

C_C= – C_U= – LL= N/A PL= N/A PI= N/A USCS= SM



Test Date: 6/20/98 Sample: S-7987-980616-CL-B

CHAIN OF CUSTODY RECORD

TreaTek - CRA™ COMPANY
2055 Niagara Falls Blvd. Suite Three
Niagara Falls, N.Y. 14304 (716) 297-2160

SHIPPED TO (Laboratory Name): Buffalo Drilling

REFERENCE NUMBER: 7987 - Gratwick Park

SAMPLER'S SIGNATURE: Cynthia Lin PRINTED NAME: Cynthia Lin

SEQ. No.	DATE	TIME	SAMPLE No.	SAMPLE TYPE	No. OF CONTAINERS	PARAMETERS (particle size)	REMARKS
	6/16/98	2pm	S-7987-980616-CL-A	S	1	✓	SIEVING + HYDROMETER ON JAR LABELS
	6/16/98	2pm	S-7987-980616-CL-B	S	1	✓	

TOTAL NUMBER OF CONTAINERS

HEALTH/CHEMICAL HAZARDS

RELINQUISHED BY: ① Cynthia Lin	DATE: 6/16/98 TIME: 2PM	RECEIVED BY: ② Allen Kramer	DATE: 6/17/98 TIME: 1115
RELINQUISHED BY: ② Allen Kramer	DATE: 6/17/98 TIME: 1215	RECEIVED BY: ③	DATE: TIME:
RELINQUISHED BY: ③	DATE: TIME:	RECEIVED BY: ④	DATE: TIME:

METHOD OF SHIPMENT: WAY BILL No.

White –Fully Executed Copy
Yellow –Receiving Laboratory Copy
Pink –Shipper Copy
Goldenrod –Sampler Copy

SAMPLE TEAM:

RECEIVED FOR LABORATORY BY: Corine McManus #98-1282C
DATE: 6-17-98 TIME: 12:15PM

Nº NF-0194

1001 (D) OCT 31/94(NF) REV.0 (F-14)


B

APPENDIX B

FINAL TESTING ANALYTICAL RESULTS
QUALITY CONTROL REVIEW

CONESTOGA-ROVERS & ASSOCIATES
2055 Niagara Falls Blvd., Suite Three
Niagara Falls, NY 14304

TELEPHONE: (716) 297-6150
FAX: (716) 297-2265

MEMORANDUM

TO:	Klaus Schmidtke	REF. NO.:	7987
FROM:	Susan Scrocchi/mk/2	DATE:	September 11, 1998
C.C.:	Cindy Lin		
RE:	**Gratwick Park Treatability Study** **TCLP - Lead**		

INTRODUCTION

Soil samples were treated with various amounts of the cement and water for the stabilization of lead in the soil. Samples cured for 28 days in a high humidity chamber at 25°C and were then submitted to the laboratory for toxicity characteristic leaching procedure (TCLP) lead analyses.

A summary of the analytical results is presented in Table 1. The quality control (QC) data associated with these results were reviewed as detailed in the following section.

QC REVIEW

All samples were prepared and/or analyzed within the required holding times.

Method blanks were prepared and analyzed with the samples and the results were non-detect for the analyte of interest.

Sample S-7987-A-1 was analyzed as the matrix spike sample and the results showed acceptable analytical accuracy.

Sample S-7987-A-1 was analyzed in duplicate and the results showed good precision.

A laboratory control sample was analyzed and the results showed acceptable analytical accuracy.

CONCLUSION

Based on the QC review, the data summarized in Table 1 were judged to be acceptable for use.

TABLE 1

ANALYTICAL RESULTS SUMMARY
TREATABILITY STUDY
GRATWICK PARK SITE
AUGUST 1998

			Location ID:	*S-7987-A-1*	*S-7987-A-2*	*S-7987-A-3*	*S-7987-A-4*	*S-7987-A-5*	*S-7987-A-6*
			Collection Date:	*08/24/98*	*08/24/98*	*08/24/98*	*08/24/98*	*08/24/98*	*08/24/98*
	Regulatory Limits	*Units*							
TCLP Metals									
Lead	5.0	mg/L		3.3	0.53	0.20	0.30	0.070	0.070

			Location ID:	*S-7987-B-1*	*S-7987-B-2*	*S-7987-B-3*	*S-7987-B-4*	*S-7987-B-5*	*S-7987-B-6*
			Collection Date:	*08/24/98*	*08/24/98*	*08/24/98*	*08/24/98*	*08/24/98*	*08/24/98*
	Regulatory Limits	*Units*							
TCLP Metals									
Lead	5.0	mg/L		1.9	1.4	0.83	0.67	0.30	0.16

Notes:
TCLP Toxicity Characteristic Leaching Procedure.

C

APPENDIX C

FINAL TESTING UNCONFINED COMPRESSIVE STRENGTH RESULTS

BARRON & ASSOCIATES, P.C.
10440 Main Street
Clarence, New York 14031

Tel: (716) 759-7821 Fax: (716) 759-7823

September 3, 1998 Job No.: 98-1282E

CRA Services
2055 Niagara Falls Boulevard, Suite Three
Niagara Falls, New York 14304

ATTN: Dr. Cindy Lin

RE: Laboratory Testing Results of
Unconfined Compression Testing for
Stabilized Soil-Material Samples
Gratwick Park, North Tonawanda, N.Y.
(CRA Project Ref. No. 7987)
(P.O. No. POtt0008618)

Ladies/Gentlemen:

Barron & Associates, P.C. (B&A) is enclosing the results of the requested laboratory testing for the above referenced project. The samples were tested in accordance with the following methods:

- ASTM D2166 - Unconfined Compression Strength of Soils

This data represents the laboratory testing results for the 12 samples that were provided on August 24, 1998. A copy of the geotechnical testing order/chain-of-custody record is enclosed.

Please call either James S. Barron, P.E. or the undersigned at your earliest convenience, if questions should arise.

Very truly yours,
BARRON & ASSOCIATES, P.C..

Carmen M. Panuccio
Geotechnical Engineer

encls.

BARRON & ASSOCIATES, P.C. &
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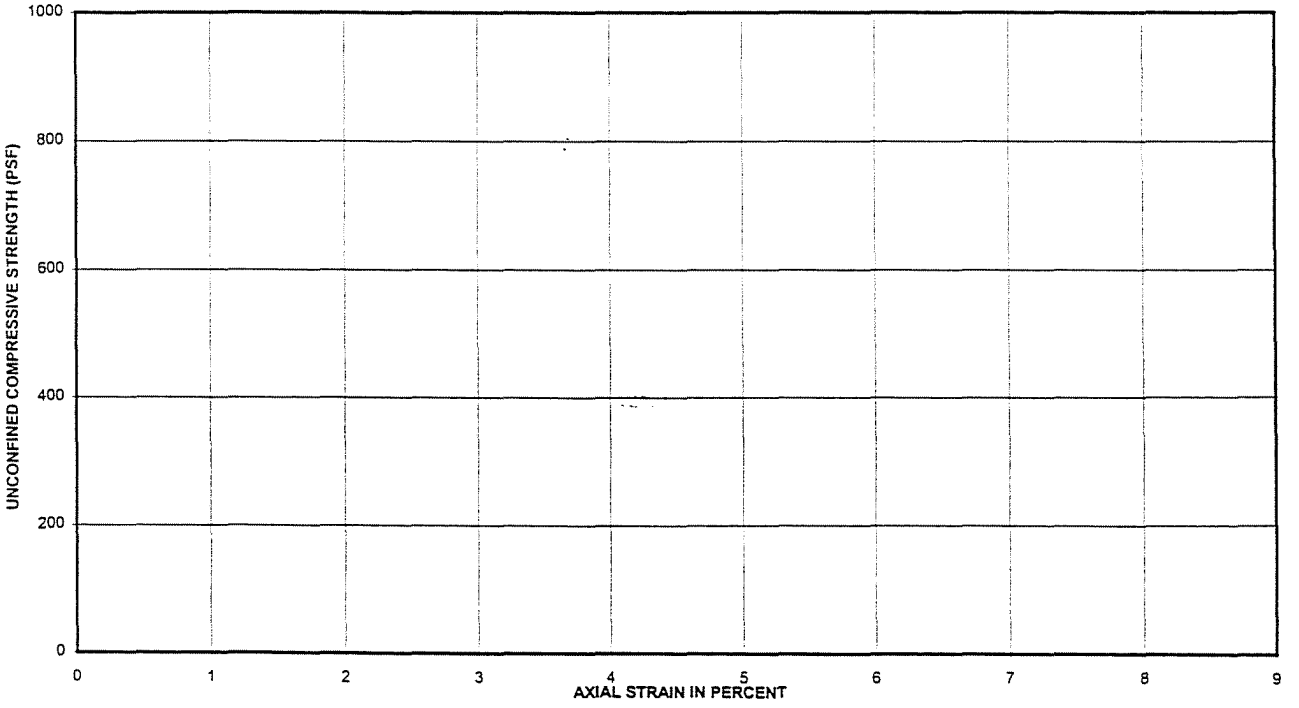
UNCONFINED COMPRESSIVE STRENGTH TEST
ASTM D2166

Client:	CRA Services
Project:	Gratwick Park, North Tonawanda, NY
File No:	98-1282E
Boring No:	-
Sample No:	S-7987-A-1
Depth:	-
Sample Method:	Client Prepared
Sample Descrpition:	Brown/gray, uncemented, fine to coarse sand-sized particles
Test Date:	8/24/98
Sample Height (in.):	3.93
Sample Diameter (in.):	2.00
Rate of Strain (%/min.):	-
Initial Water Content (%):	52.1
Initial Wet Density (pcf):	79.6
Initial Dry Density (pcf):	52.3
Max. Unconfined Stength (psi):	-
Max. Strength from Pocket Penetrometer (psi):	5.3*

SKETCH AT FAILURE

NOTE:
* = While extracting from tube, sample split vertically .
Pocket penetrometer run, however, data may not be valid due to the presence of coarse to fine sand sized particles.



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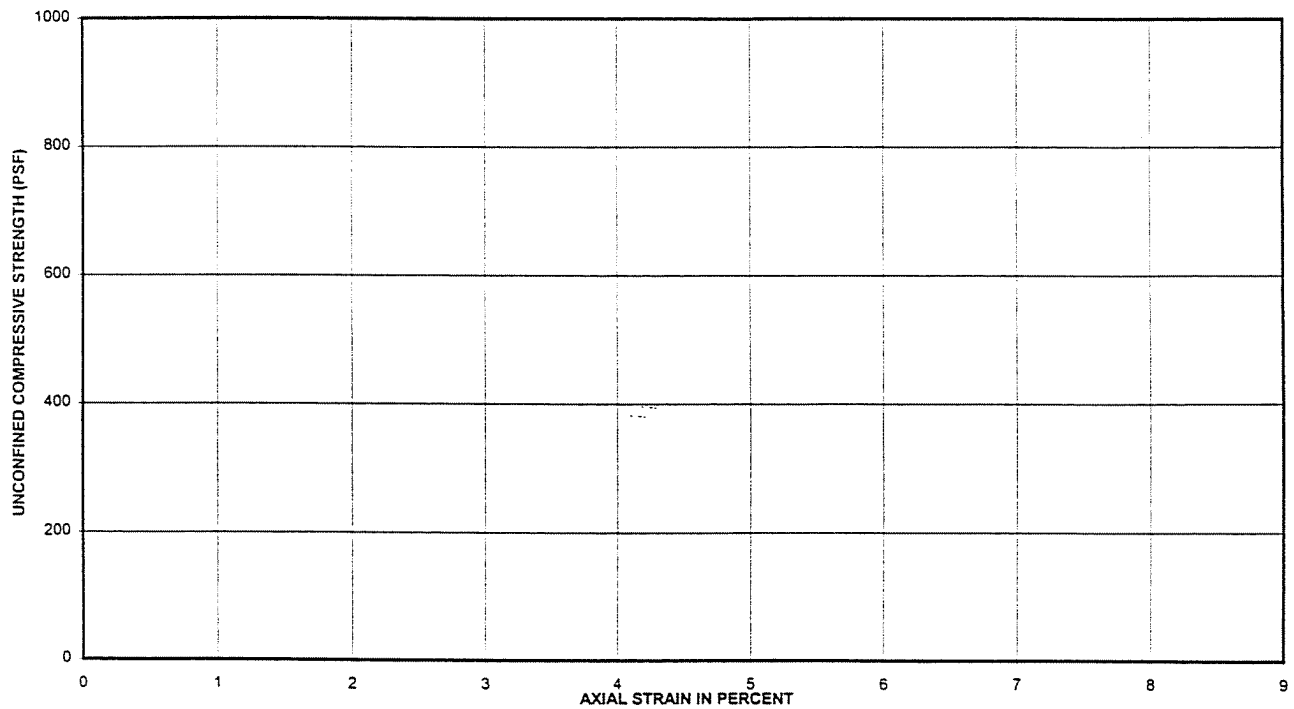
UNCONFINED COMPRESSIVE STRENGTH TEST
ASTM D2166

Client:	CRA Services
Project:	Gratwick Park, North Tonawanda, NY
File No:	98-1282E
Boring No:	-
Sample No:	S-7987-A-2
Depth:	-
Sample Method:	Client Prepared
Sample Descrpition:	Brown/gray, uncemented, fine to coarse sand-sized particles
Test Date:	8/24/98
Sample Height (in.):	3.93
Sample Diameter (in.):	2.00
Rate of Strain (%/min.):	-
Initial Water Content (%):	48.2
Initial Wet Density (pcf):	79.6
Initial Dry Density (pcf):	53.7
Max. Unconfined Stength (psi):	-
Max. Strength from Pocket Penetrometer (psi):	11.1*

SKETCH AT FAILURE

NOTE:
* = While extracting from tube, sample split horizontally .
Pocket penetrometer run, however, data may not be valid due to the presence of coarse to fine sand sized particles.



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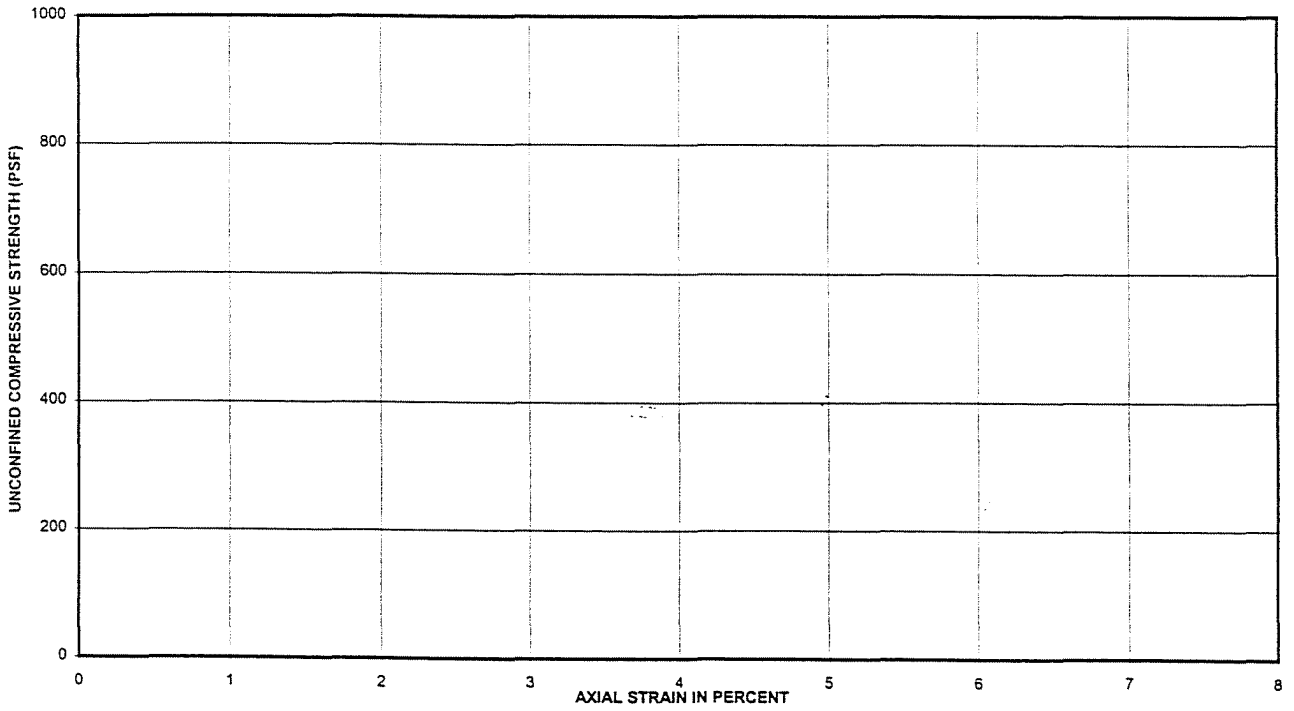
UNCONFINED COMPRESSIVE STRENGTH TEST
ASTM D2166

Client:	CRA Services
Project:	Gratwick Park, North Tonawanda, NY
File No:	98-1282E
Boring No:	-
Sample No:	S-7987-A-3
Depth:	-
Sample Method:	Client Prepared
Sample Descrpition:	Brown/gray, uncemented, fine to coarse sand-sized particles
Test Date:	8/24/98
Sample Height (in.):	3.95
Sample Diameter (in.):	2.00
Rate of Strain (%/min.):	-
Initial Water Content (%):	42.7
Initial Wet Density (pcf):	103.0
Initial Dry Density (pcf):	72.2
Max. Unconfined Stength (psi):	-
Max. Strength from Pocket Penetrometer (psi):	4.4*

SKETCH AT FAILURE

NOTE:
* = While extracting from tube, sample split horizontally .
Pocket penetrometer run, however, data may not be valid due to the presence of coarse to fine sand sized particles.



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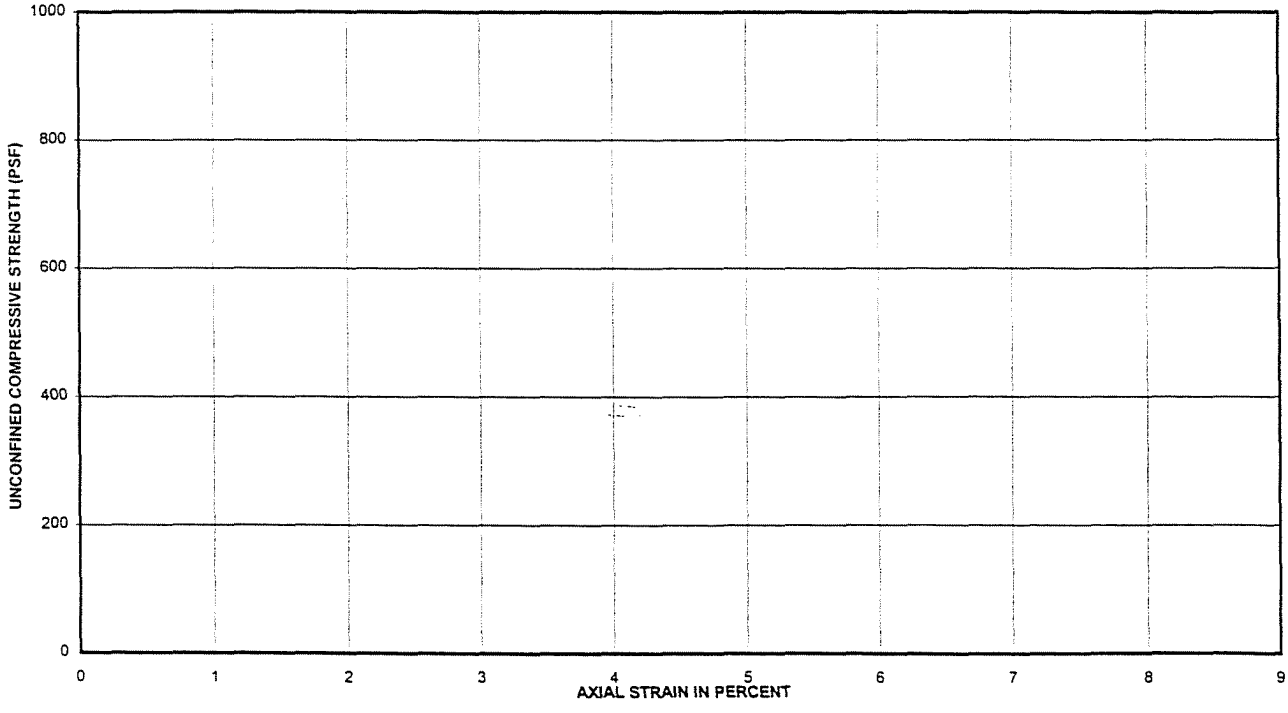
UNCONFINED COMPRESSIVE STRENGTH TEST
ASTM D2166

Client:	CRA Services
Project:	Gratwick Park, North Tonawanda, NY
File No:	98-1282E
Boring No:	-
Sample No:	S-7987-A-4
Depth:	-
Sample Method:	Client Prepared
Sample Descrpition:	Brown/gray, uncemented, fine to coarse sand-sized particles
Test Date:	8/24/98
Sample Height (in.):	3.80
Sample Diameter (in.):	2.00
Rate of Strain (%/min.):	-
Initial Water Content (%):	41.8
Initial Wet Density (pcf):	106.3
Initial Dry Density (pcf):	74.9
Max. Unconfined Stength (psi):	-
Max. Strength from Pocket Penetrometer (psi):	11.6*

SKETCH AT FAILURE

NOTE:
* = While extracting from tube, sample split horizontally .
Pocket penetrometer run, however, data may not be valid due to the presence of coarse to fine sand sized particles.



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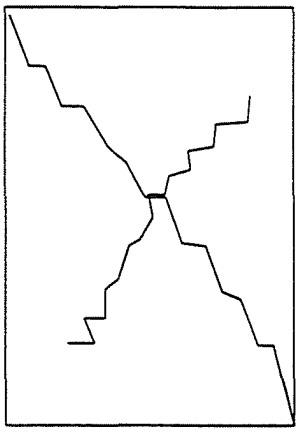
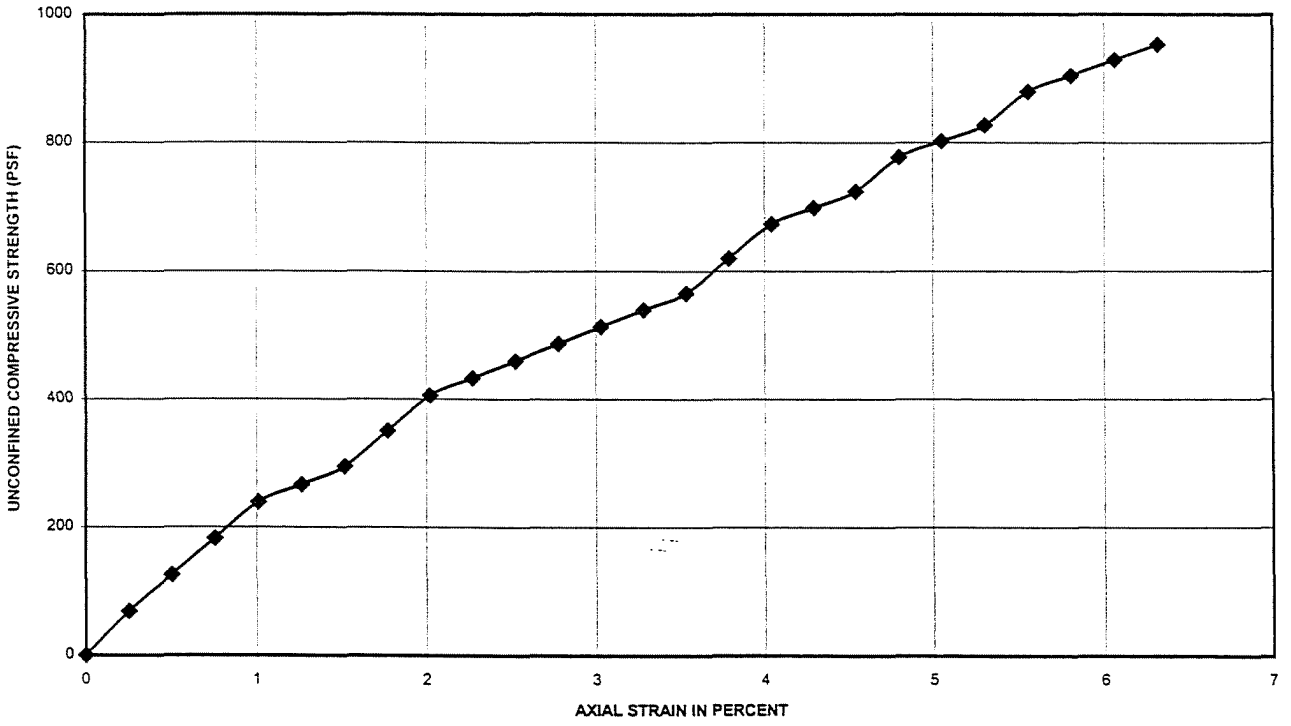
UNCONFINED COMPRESSIVE STRENGTH TEST
ASTM D2166

Client:	CRA Services
Project:	Gratwick Park, North Tonawanda, NY
File No:	98-1282E
Boring No:	-
Sample No:	S-7987-A-5
Depth:	-
Sample Method:	Client Prepared
Sample Descrpition:	Brown/gray, cemented, fine to coarse sand-sized particles
Test Date:	8/24/98
Sample Height (in.):	3.96
Sample Diameter (in.):	1.98
Rate of Strain (%/min.):	1.26
Initial Water Content (%):	40.4
Initial Wet Density (pcf):	108.2
Initial Dry Density (pcf):	77.0
Max. Unconfined Stength (psi):	6.6
Max. Strength from Pocket Penetrometer (psi):	-

SKETCH AT FAILURE





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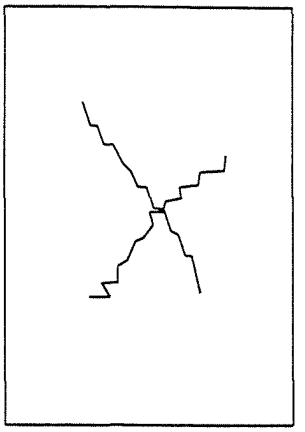
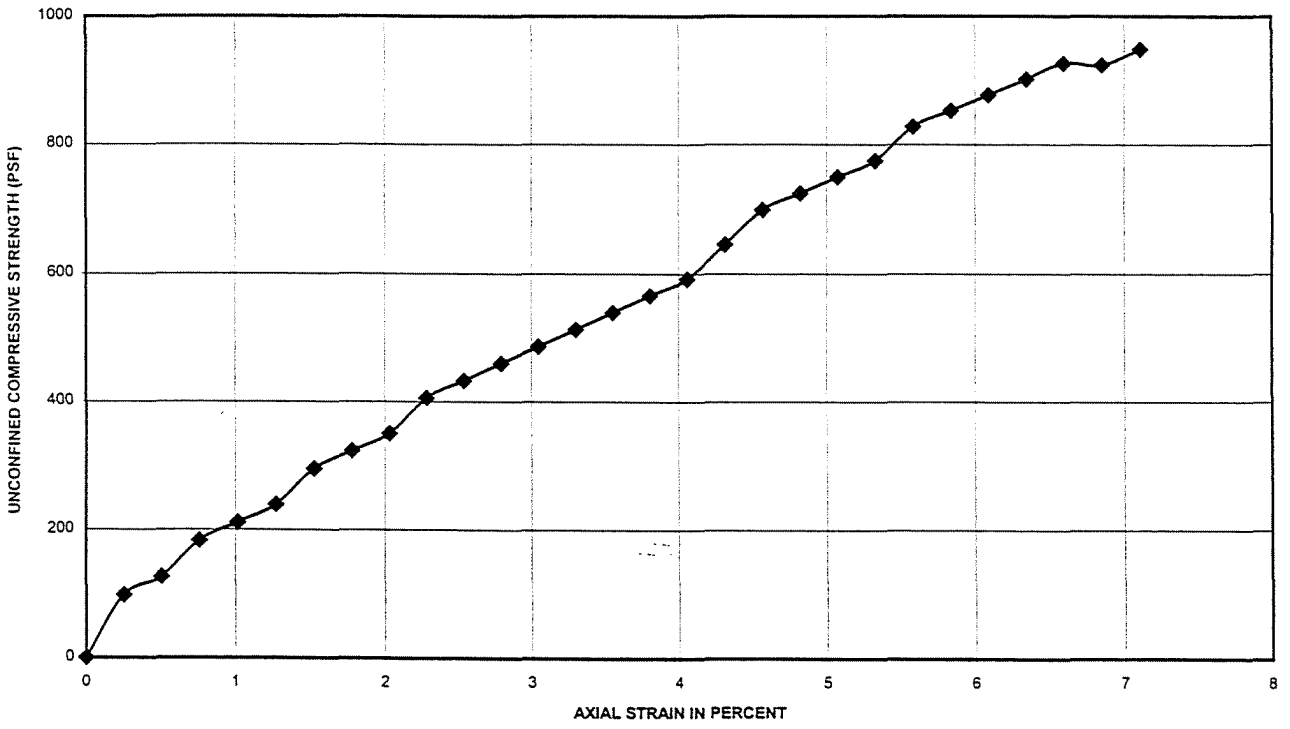
UNCONFINED COMPRESSIVE STRENGTH TEST
ASTM D2166

Client:	CRA Services
Project:	Gratwick Park, North Tonawanda, NY
File No:	98-1282E
Boring No:	-
Sample No:	S-7987-A-6
Depth:	-
Sample Method:	Client Prepared
Sample Descrpition:	Brown/gray, cemented, fine to coarse sand-sized particles
Test Date:	8/24/98
Sample Height (in.):	3.94
Sample Diameter (in.):	1.97
Rate of Strain (%/min.):	1.27
Initial Water Content (%):	42.0
Initial Wet Density (pcf):	107.5
Initial Dry Density (pcf):	75.8
Max. Unconfined Stength (psi):	6.6
Max. Strength from Pocket Penetrometer (psi):	-

SKETCH AT FAILURE





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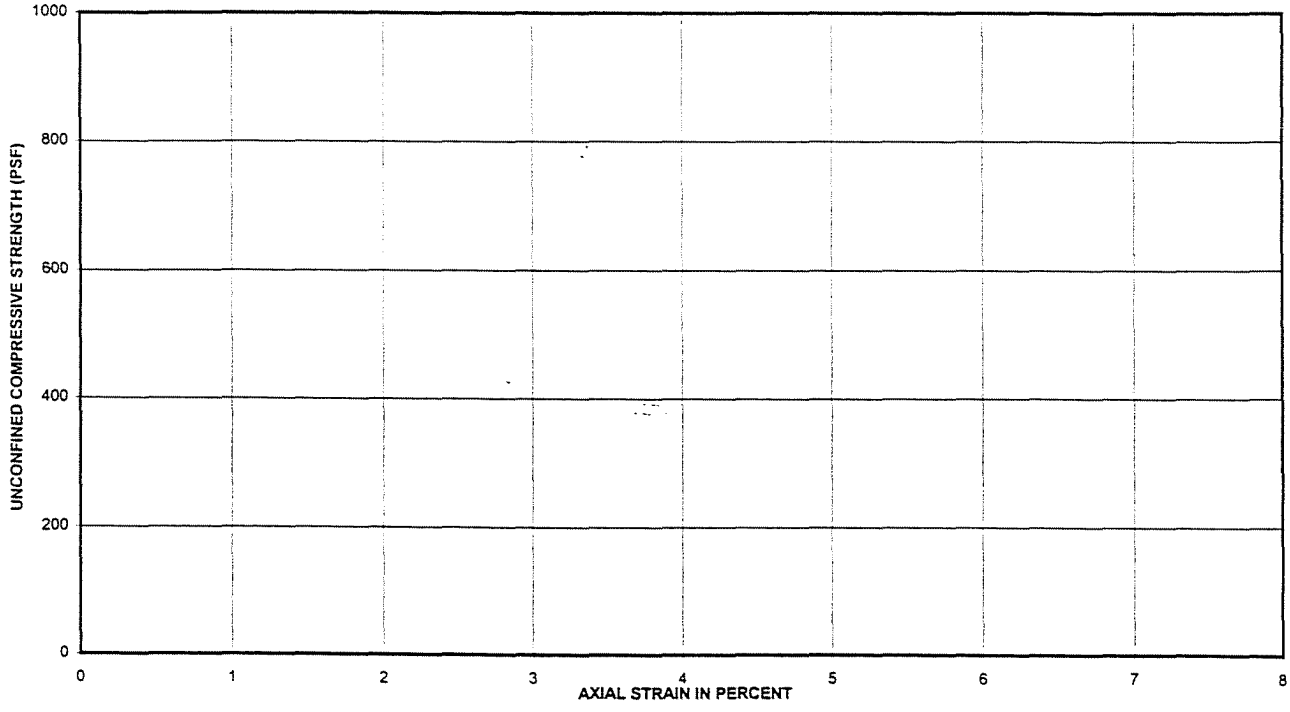
UNCONFINED COMPRESSIVE STRENGTH TEST
ASTM D2166

Client:	CRA Services
Project:	Gratwick Park, North Tonawanda, NY
File No:	98-1282E
Boring No:	-
Sample No:	S-7987-B-1
Depth:	-
Sample Method:	Client Prepared
Sample Descrpition:	Brown/gray, uncemented, fine to coarse sand-sized particles
Test Date:	8/24/98
Sample Height (in.):	3.95
Sample Diameter (in.):	2.00
Rate of Strain (%/min.):	-
Initial Water Content (%):	39.7
Initial Wet Density (pcf):	84.6
Initial Dry Density (pcf):	60.6
Max. Unconfined Stength (psi):	-
Max. Strength from Pocket Penetrometer (psi):	-

SKETCH AT FAILURE

NOTE:
* = After extraction from tube, sample split while attempting to measure dimensions



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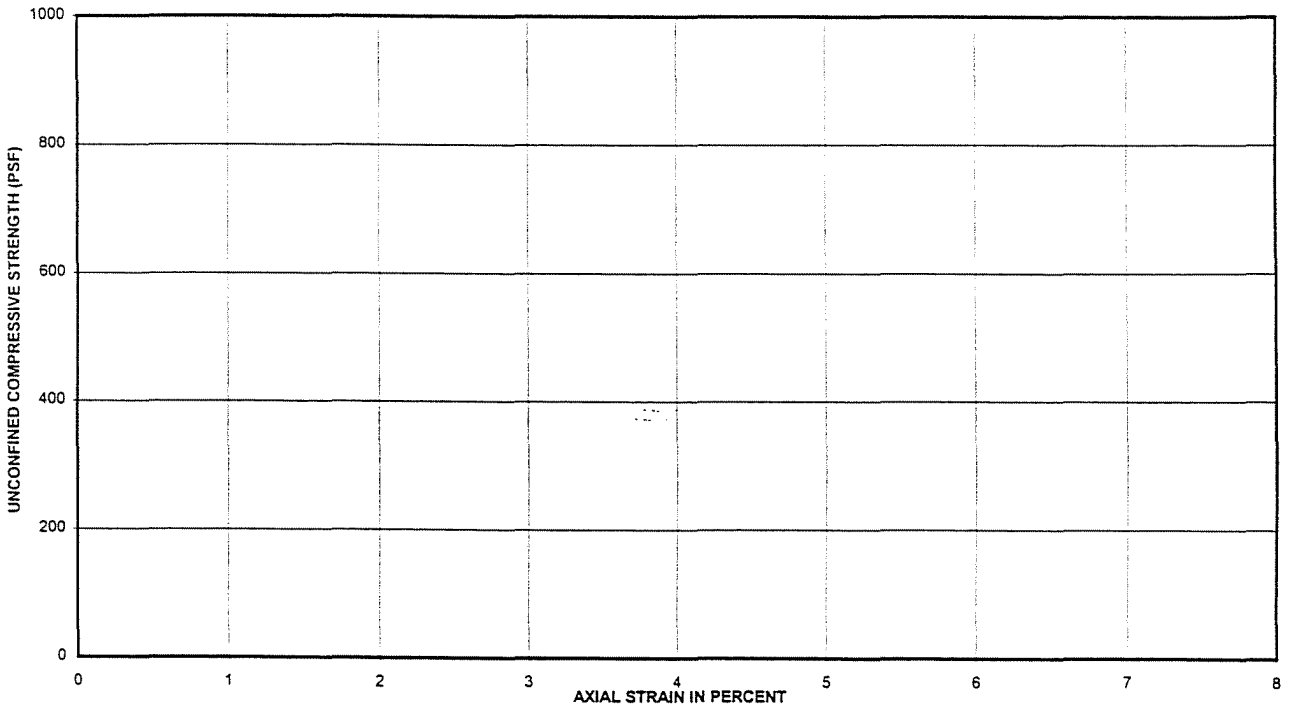
UNCONFINED COMPRESSIVE STRENGTH TEST
ASTM D2166

Client:	CRA Services
Project:	Gratwick Park, North Tonawanda, NY
File No:	98-1282E
Boring No:	-
Sample No:	S-7987-B-2
Depth:	-
Sample Method:	Client Prepared
Sample Descrpition:	Brown/gray, uncemented, fine to coarse sand-sized particles
Test Date:	8/24/98
Sample Height (in.):	3.95
Sample Diameter (in.):	1.97
Rate of Strain (%/min.):	-
Initial Water Content (%):	35.3
Initial Wet Density (pcf):	85.3
Initial Dry Density (pcf):	63.0
Max. Unconfined Stength (psi):	-
Max. Strength from Pocket Penetrometer (psi):	-

SKETCH AT FAILURE

NOTE:
* = After extraction from tube, sample crumbled while attempting to measure dimensions.



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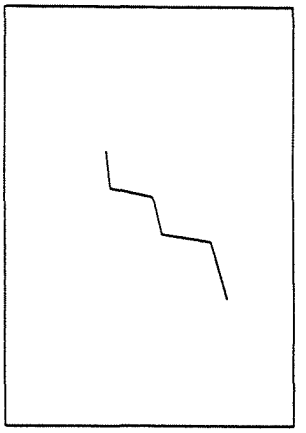
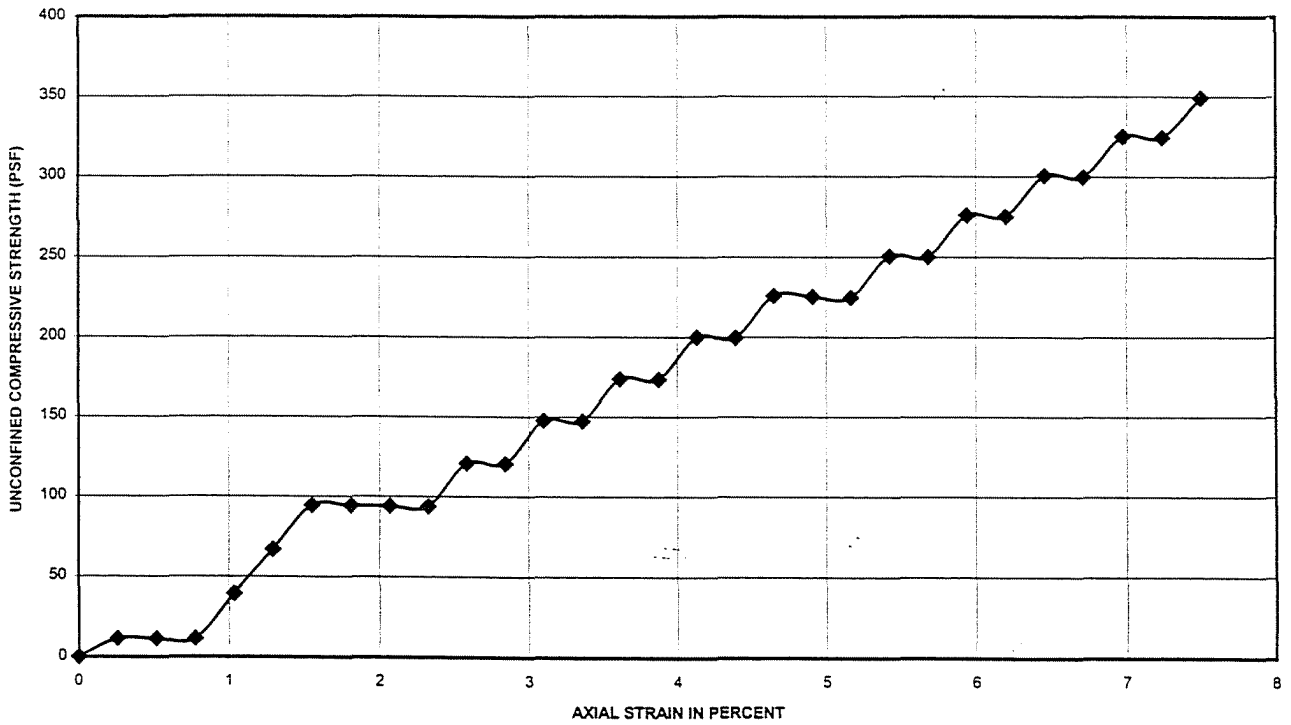
UNCONFINED COMPRESSIVE STRENGTH TEST
ASTM D2166

Client:	CRA Services
Project:	Gratwick Park, North Tonawanda, NY
File No:	98-1282E
Boring No:	-
Sample No:	S-7987-B-3
Depth:	-
Sample Method:	Client Prepared
Sample Descrpition:	Brown/gray, cemented, fine to coarse sand-sized particles
Test Date:	8/24/98
Sample Height (in.):	3.87
Sample Diameter (in.):	2.00
Rate of Strain (%/min.):	1.29
Initial Water Content (%):	33.5
Initial Wet Density (pcf):	112.8
Initial Dry Density (pcf):	84.5
Max. Unconfined Stength (psi):	2.4
Max. Strength from Pocket Penetrometer (psi):	-

SKETCH AT FAILURE





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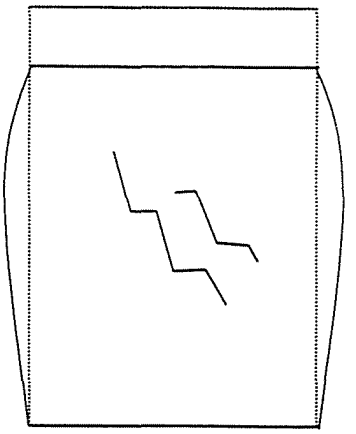
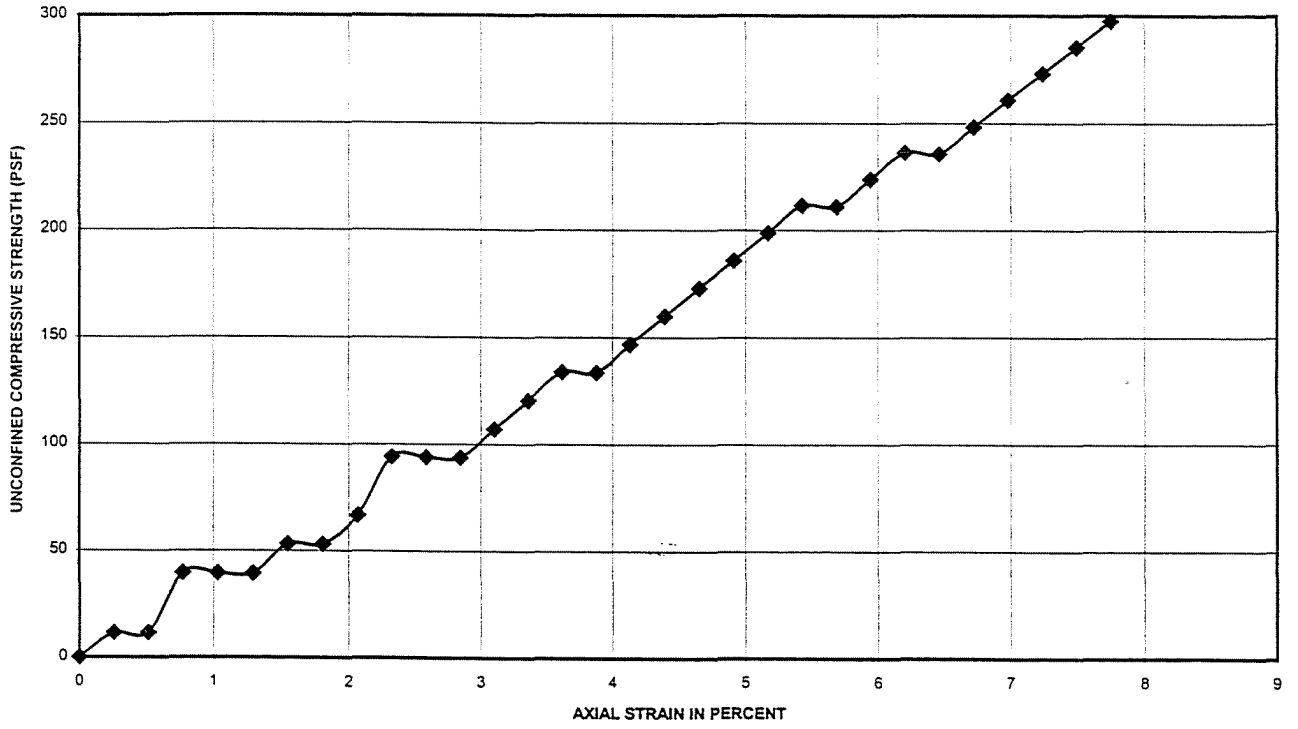
UNCONFINED COMPRESSIVE STRENGTH TEST
ASTM D2166

Client:	CRA Services
Project:	Gratwick Park, North Tonawanda, NY
File No:	98-1282E
Boring No:	-
Sample No:	S-7987-B-4
Depth:	-
Sample Method:	Client Prepared
Sample Descrpition:	Brown/gray, cemented, fine to coarse sand-sized particles
Test Date:	8/24/98
Sample Height (in.):	3.87
Sample Diameter (in.):	1.99
Rate of Strain (%/min.):	1.29
Initial Water Content (%):	33.1
Initial Wet Density (pcf):	114.4
Initial Dry Density (pcf):	86.0
Max. Unconfined Stength (psi):	2.1
Max. Strength from Pocket Penetrometer (psi):	-

SKETCH AT FAILURE





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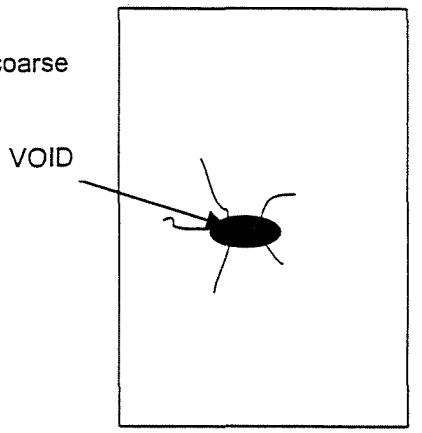
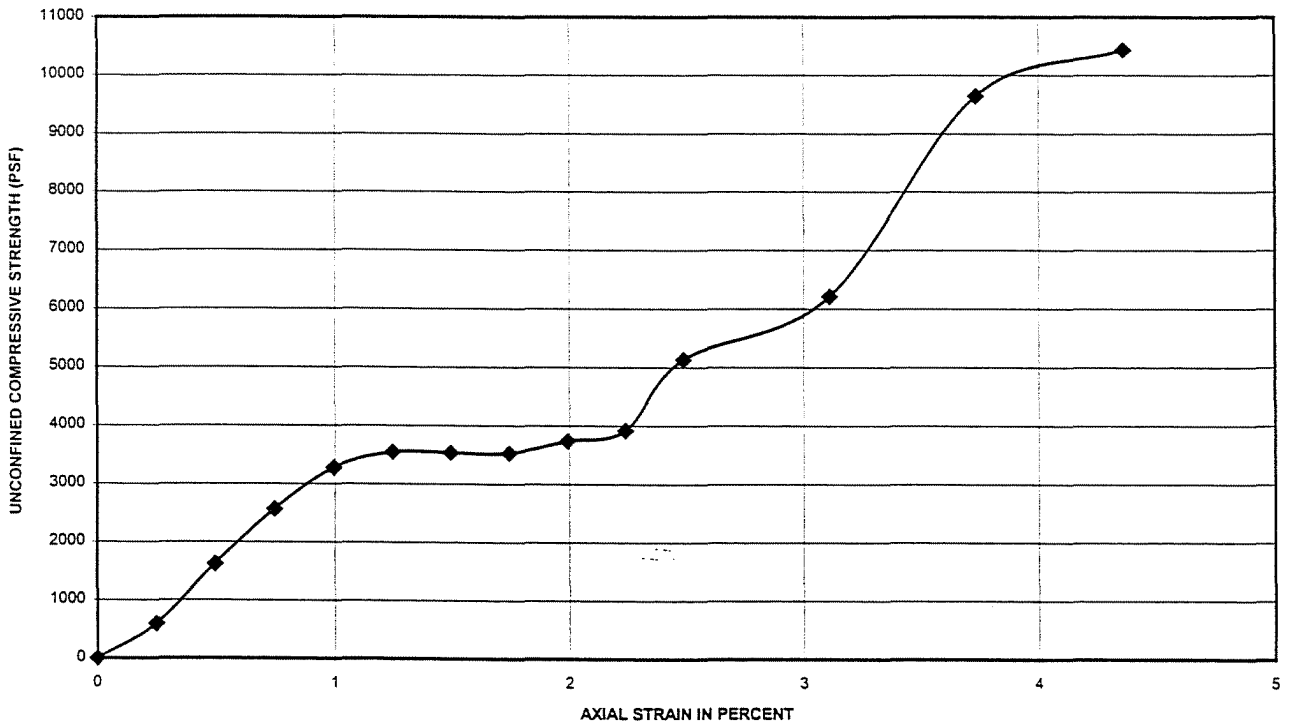
UNCONFINED COMPRESSIVE STRENGTH TEST
ASTM D2166

Client:	CRA Services
Project:	Gratwick Park, North Tonawanda, NY
File No:	98-1282E
Boring No:	-
Sample No:	S-7987-B-5
Depth:	-
Sample Method:	Client Prepared
Sample Descrpition:	Brown/gray, cemented, fine to coarse sand-sized particles
Test Date:	8/24/98
Sample Height (in.):	4.02
Sample Diameter (in.):	2.00
Rate of Strain (%/min.):	1.24
Initial Water Content (%):	33.0
Initial Wet Density (pcf):	109.5
Initial Dry Density (pcf):	82.3
Max. Unconfined Stength (psi):	72.4
Max. Strength from Pocket Penetrometer (psi):	-

SKETCH AT FAILURE





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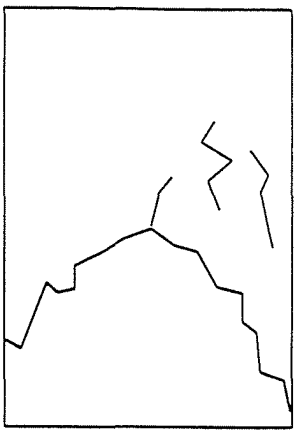
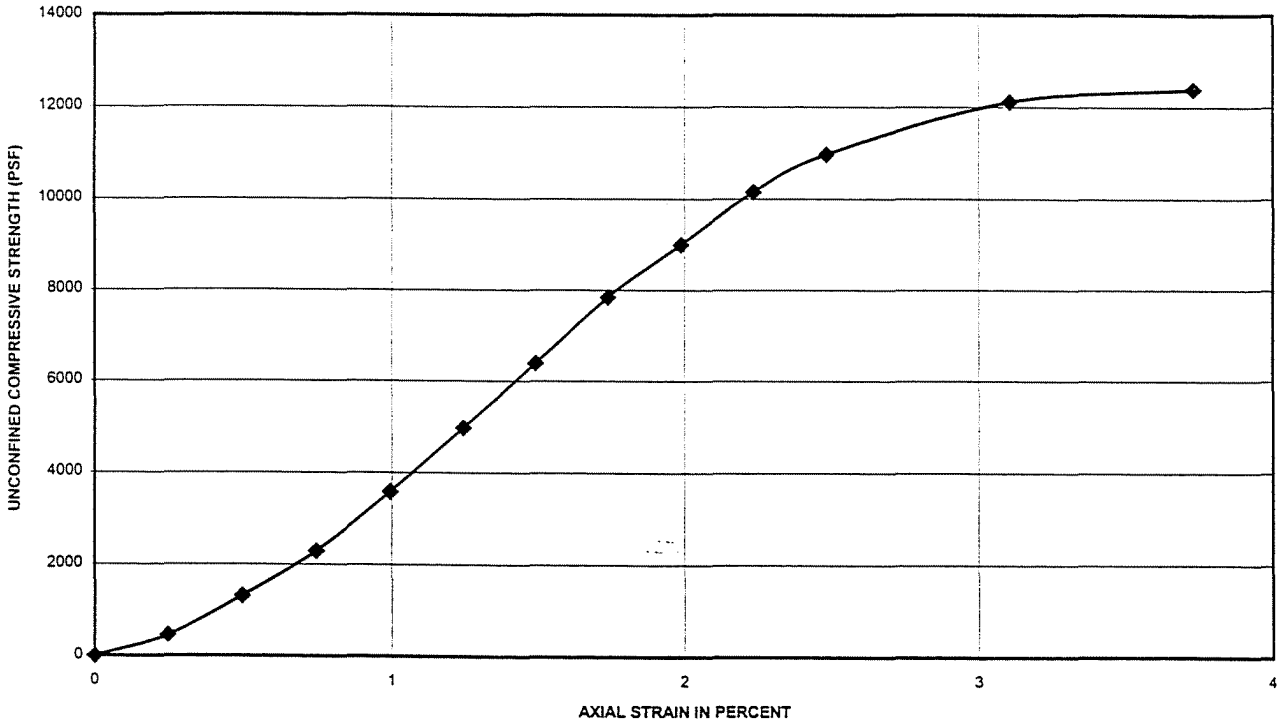
UNCONFINED COMPRESSIVE STRENGTH TEST
ASTM D2166

Client:	CRA Services
Project:	Gratwick Park, North Tonawanda, NY
File No:	98-1282E
Boring No:	-
Sample No:	S-7987-B-6
Depth:	-
Sample Method:	Client Prepared
Sample Descrpition:	Brown/gray, cemented, fine to coarse sand-sized particles
Test Date:	8/24/98
Sample Height (in.):	4.03
Sample Diameter (in.):	2.00
Rate of Strain (%/min.):	1.24
Initial Water Content (%):	32.8
Initial Wet Density (pcf):	111.0
Initial Dry Density (pcf):	83.6
Max. Unconfined Stength (psi):	86.0
Max. Strength from Pocket Penetrometer (psi):	-

SKETCH AT FAILURE





CHAIN OF CUSTODY RECORD

CRA SERVICES
2055 Niagara Falls Blvd. Suite Three
Niagara Falls, N.Y. 14304 (716) 297-2160

SHIPPED TO (Laboratory Name): Buffalo Drilling
Tel 759-7821

REFERENCE NUMBER: 7987

SAMPLER'S SIGNATURE: Cynthia Lin PRINTED NAME: Cynthia Lin

SEQ. No.	DATE	TIME	SAMPLE No.	SAMPLE TYPE	No. OF CONTAINERS	PARAMETERS (Unconfined Compressive Strength)	REMARKS
	8/24/98	10Am	S-7987-A-1	S	1	X	
			-2		1		
			-3		1		
			-4		1		
			-5		1		
			-6		1		
			S-7987-B-1		1		
			-2		1		
			-3		1		
			-4		1		
			-5		1		
			-6		1		

TOTAL NUMBER OF CONTAINERS: 12 HEALTH/CHEMICAL HAZARDS:

RELINQUISHED BY: ① Cynthia Lin	DATE: 8/24/98 TIME: 10:35 Am	RECEIVED BY: ② Karen Kremer	DATE: 8/24/98 TIME: 1100
RELINQUISHED BY: ② Karen Kremer	DATE: 8/24/98 TIME: 1145	RECEIVED BY: ③	DATE: TIME:
RELINQUISHED BY: ③	DATE: TIME:	RECEIVED BY: ④	DATE: TIME:

METHOD OF SHIPMENT: WAY BILL No.

White –Fully Executed Copy
Yellow –Receiving Laboratory Copy
Pink –Shipper Copy
Goldenrod –Sampler Copy

SAMPLE TEAM:

RECEIVED FOR LABORATORY BY: [signature]
DATE: 8-24-98 TIME: 11:45 AM

No. 1501 NF
#98-1282E

1001 (D) OCT 31/94(NF) REV.0 (F-14)