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DAVID R. BERZ
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October 24, 1986

Norman Spiegel, Esq.
Assistant Attorney General
Environmental Protection Bureau
State of New York
Office of Attorney General
Two World Trade Center
New York, NY 10047

Re: Mitchel Field Remediation

Dear Mr. Spiegel:

Enclosed is Canonie Environmental's Construction Report for the Vibratory Beam Grout Curtain.

By this letter, I am also forwarding Canonie's and Woodward-Clyde's reports on the same project to Albert Machlin and Norman H. Nosenchuck.

Best regards,

David R. Berz

DRB/ch

Enclosure

cc: Albert Machlin
Norman H. Nosenchuck
Jeffrey M. Smith

RECEIVED
OCT 30 1986
ENVIRONMENTAL QUALITY
REGION 1

Project CH 85-096
September, 1986

CanonieEnvironmental

Construction Report

Vibratory Beam Grout Curtain Mitchel Field Remedial Action

Garden City
New York

Prepared For:

TP Industrial, Inc.
Carson, California

Construction Report

Vibratory Beam Grout Curtain Mitchel Field Remedial Action

CanonieEnvironmental

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CONSTRUCTION REPORT
VIBRATORY BEAM GROUT CURTAIN
MITCHEL FIELD REMEDIAL ACTION

1.0 INTRODUCTION

A vibrated beam grout curtain wall was installed around the source area at the Mitchel Field remedial action project in the first half of 1986. The wall is installed to an approximate depth of 60 feet completely penetrating the glacial sands and gravels, and keying into the underlying Magothy aquifer. The purpose of the wall is to control the horizontal flow of water in the upper sand and gravel aquifer, while a systematic program is undertaken to remove volatile organic compounds from the source area by extracting water from the upper sand and gravel and concurrently flushing the entire depth of the glacial sand and gravel with clean water to remove volatile organic compounds.

1.1 Method

The method is based on driving a large steel I-beam with a vibratory pile driving hammer through sand, silt, or gravel formations while injecting a grout composed of Portland cement, bentonite, and water. As the vibratory beam is driving into the ground, the injected grout penetrates into the sand and gravel formation to form an impermeable barrier. When the final depth is reached, the vibratory beam is withdrawn, and concurrently, the cement-bentonite grout is injected from the tip of the beam to backfill the slot left by the beam. This process is shown schematically on Figure 1.

The distance to which the cement-bentonite grout penetrates into the soil formation depends upon the type of soil. In a silt formation, very little penetration of grout occurs, and the wall thickness is approximately the same as the thickness of the vibratory beam. In a sand formation, the grout penetrates some distance into the formation creating a wall thicker than the vibratory beam. The more permeable the formation, the greater the penetration of the cement-bentonite grout. The depth of grout penetration during the driving of the beam is also dependent upon the degree of saturation in the soil deposit. In dry soil or areas above the normal ground water table, the penetration of grout is restricted by early formation of filter cake in the dry soil. At depths below the ground water table where the soil is already saturated with water, the grout will penetrate further before the formation of filter cake prevents further movement. The grout injection pressure and the rate of beam penetration also affects the distance of grout penetration into the soil formation.

1.2 Purpose

This report presents the as-built construction details of the grout curtain. The report includes a description of the grout curtain installation, including details of the physical alignment, depth, and thickness of the constructed wall, Section 2. Section 3 of the report includes the quality control information for the grout mix and the cured grout. Section 4 of the report discusses the expected performance of the curtain as a hydraulic barrier in the remedial activities at the source area.

2.0 GROUT CURTAIN INSTALLATION

The mobilization for installation of the grout curtain began in mid-November, 1985, with actual production beginning in January, 1986. The grout curtain was completed in June, 1986. During this time, the wall was installed by driving both a 33-inch and 38-inch-wide I-beam using an electric and a hydraulic hammer. The earliest parts of the wall were installed by driving the vibratory beam to full depth. Many of these installations resulted in lengthy penetration times and high grout injection rates. Because of the difficulty with penetration, a predrilling program was started to increase the penetration rate.

Equipment used during installation included:

1. An American 100-ton crane;
2. A set of fixed guide leads to control wall alignment;
3. A Foster 4-75 tandem hammer and an I.C.E. 1412 hammer;
4. A grout batching plant.

The as-built location of the wall and the construction sequence are shown on Figures 2 and 3, respectively.

2.1 Alignment, Depth, and Thickness

The centerline of the grout curtain wall was established with grade and line stakes driven on 25-foot centers from which 20-foot offsets were marked. The stations were used to record the beam location and daily progress. A 24-inch-wide by 18-inch-deep trench was excavated along the grout curtain centerline prior to wall installation. This trench served as a reservoir to hold excess grout and as a method to identify near surface (man-made) obstructions.

The beam was aligned prior to each penetration with a Wild T1 theodolite. Alignment included verifying the plumbness of the beam web, the plumbness of the beam flange, the horizontal location of the beam, and the verticality at full insertion in accordance with the criteria in the approved Quality Control Program, Appendix A. Individual penetration records which include the starting station, grade elevation, tip of beam elevation at full insertion, and the horizontal location for each beam penetration are presented in Appendix B.

The base of the grout curtain penetrates into the Magothy formation. Figure 3 shows the tip elevation of the wall sections in relation to the top of the Magothy formation. The tip elevations average +15.9 ± 0.1 feet MSL over the entire wall, which is approximately 5 feet below the interface zone between the upper sand and gravel and the Magothy aquifer. The top of the Magothy aquifer was characterized during driving by an increased beam penetration rate in the silty interface zone at the top of the Magothy aquifer followed by an abrupt decrease in the beam penetration as the dense fine sands of the Magothy aquifer were encountered. The base elevation was confirmed by the soil borings of Goldberg-Ziono and Associates (BG-101 through BG-111) and verification borings (SSB-1 through SSB-9) installed during wall construction. The SSB borings were installed using a 3.25-inch I.D. hollow-stem auger with samples recovered by a modified split-spoon sampler. The logs of the SSB borings are presented in Appendix C. The boring locations are shown on Figures 2 and 3. The SSB borings confirm the elevations for the top of the Magothy formation indicated by the Golberg-Ziono borings.

The thickness of the wall is calculated based on the volume of grout injected during driving of the beam plus the grout used to backfill the slot left by the beam. Table 1 includes a weekly summary of the grout injected. This summary does not include the grout wasted due to overfilling of the starter trench or grout disposed of because of equipment downtime. The volume of grout used is compared to the weekly production and a wall thickness is computed as:

$$t = \frac{V/P - 0.333}{0.3} + 0.333$$

t = wall thickness (feet)

V = volume of grout (ft^3)

P = production (ft^2)

Thickness of beam = 0.333 ft.

Porosity of sand and gravel = 0.3

This analysis indicates that long driving times result in a thicker average wall section over the depth of the wall. In all cases, the wall is thicker than 1 foot with an average thickness of 1.7 feet.

A section of the wall above the ground water table at Station 10+32 was excavated in April, 1986. Measurements at this location indicate more than one foot wall thickness in the dry unsaturated zone of the glacial sand and gravel. Photographs of the wall excavation are presented in Appendix D. Attempts to obtain undisturbed samples of this wall section were unsuccessful because of the gravel matrix within the wall.

2.2 Utility Crossings

Water, electric, and telephone lines to the present MSBA garage were encountered during wall construction. A three-inch copper water line was crossed near the front entrance of the bus garage at Station 6+92. The water line was crossed again at Commercial Avenue (Station 1+89) where it was a five-inch ductile iron pipe. The electric and telephone lines were crossed at Station 6+20 and on Commercial Avenue at Station 2+68. The electric line was exposed and the telephone lines were encased in a four-inch PVC pipe at both crossings. The utilities were crossed by placing the beam as close as possible to the utility and then driving the beam at a 1 to 3 degree batter to close directly under the utility. This method did not damage the utilities, did not require interruption of service to the bus garage, and created an inter-tied wall below the utility and above the normal ground water level. The individual utility crossings are shown on Figure 4.

2.3 Grout Curtain Cap

The grout curtain cap was constructed of bank run gravel, Figure 4. On completion of the grout curtain, a trench was excavated along the centerline of the curtain approximately 30 inches deep by 24 inches wide. Bank run gravel was then placed and compacted in the trench up to existing grade. The cap was compacted by driving the tractor backhoe over the bank run gravel.

3.0 QUALITY CONTROL DATA

The grout consists of bentonite and Portland cement in a water suspension. The quantity of bentonite in the mixture is limited by the workability, set strength, penetrability, and stability requirements of the mixture. The grout mixture chosen for the installation was a bentonite-cement gel of low compressive strength conforming to the requirements of a Zone C mixture, Figure 5, (Reference 1). Appendix E includes the percentages of Portland cement and bentonite in the grout mixture. The quantity of bentonite averaged 6 percent by weight and the quantity of Portland cement averaged 11 percent, by weight. The grout mix meets the requirements of a Zone C material, Figure 5.

The grout mixture was prepared in a portable on-site batch plant. The specific weight, viscosity, and filtrate loss of the grout was tested and recorded for each batch. The constituents of the grout included water, Portland Type I cement, Bariod Premium Grade 200 mesh bentonite, soda ash, a water conditioner which aids in the hydration of the bentonite, and tamol and tetrasodium pyrophosphate, used as dispersants. The manufacturer's certifications of the constituents are presented in Appendix F.

3.1 Grout Sampling

3.1.1 Sampling Containers

The sampling containers for the collection of grout for testing hydraulic conductivity and compressive strength were heavily waxed cardboard cylinders with a metal bottom. The cylinders were three inches in diameter and six inches in length. The container used to collect grout for all field control tests was a gallon pitcher.

3.1.2 Sampling Frequency

Samples taken for viscosity, specific weight, and filtrate loss were collected for each batch of grout prepared. Samples for unconfined compressive strength and hydraulic conductivity were collected for each 200 cubic yards of grout used for the construction of the wall.

3.1.3 Sample Preparation

The grout samples were collected at the batch plant and analyzed on-site for viscosity, specific weight, and filtrate loss. The samples for unconfined compression and hydraulic conductivity tests were collected at the batch plant, cured in a moisture-controlled environment on-site for 7 days, and hand delivered to Converse Consultants, Inc, for curing from 7 to 28 days and testing.

3.1.4 Testing Methods

The hydraulic conductivity of the 28-day-old grout was measured using the procedures in U.S. Army Corps of Engineers Manual Number EM1110-2, Appendix VII.

The specific weight of the grout was determined by the mud balance test API RP-13B. Marsh funnel viscosity was determined by using a marsh funnel viscometer. The funnel of the device was filled with 1,500 cubic centimeters of homogeneous grout, and the time for 946 cubic centimeters of the grout to flow through the funnel was measured and recorded as the viscosity in seconds. The method reference for the determination of marsh funnel viscosity is API RP-13B. The filtrate loss was measured in accordance with "Low Temperature Filtration Test" API RP-13B. The data for specific weight, viscosity, and filtrate loss is averaged on a daily basis and is included in Appendix E.

3.2 Grout Properties

The grout was prepared by the vibratory beam grout curtain subcontractor. The bentonite was mixed with a specific volume of water until the bentonite was thoroughly hydrated. Centrifugal pump dispersant additives were added in the mix at this time to aid in the hydration of the bentonite and to condition the water. This mixture was then circulated by a centrifugal pump for approximately six minutes to complete the hydration of the bentonite and thoroughly mix the materials. The water conditioner and soda ash were then included in the mixture to prevent the contamination of the bentonite by cement. Finally, Portland cement was added and mixed by circulating the grout for approximately three minutes to obtain a homogeneous mixture.

The average grout properties were: viscosity, 46 seconds; specific weight, 1.12; and filtrate loss, 49 millimeters. The viscosity and specific weight are within normal limits for cement-bentonite slurries used in well boring and excavation stabilizing activities. The filtrate losses are greater than the 30 millimeters in 30 minutes, a typical requirement. The higher filtrate loss characterizes a grout that will be less likely to form a filter cake and will achieve greater penetration into the adjacent soil areas. The filtrate loss results are compatible with the intended purpose of the wall as a hydraulic barrier.

The unconfined compressive strength of the 28-day-old grout was determined using ASTM D2166. The average compressive strength was 3.2 psi for those samples tested without consolidation. The unconfined compressive strength for tests run on samples after consolidation at 16 psi in the triaxial permeability apparatus averaged 20 psi. The peak loads were all recorded at low strains of 1 to 2 percent. The unconfined compressive strength tests are summarized in Appendix G. A single sample was tested in triaxial shear to measure the ultimate strain response of the grout. Figure 6 shows the results of this test which indicate the plasticity of the grout. The grout continues to carry load without failure well beyond 10 percent total strain.

The triaxial permeability test was performed at an effective confining pressure of 16 psi (the approximate confining pressure at 20 feet). The sample was allowed to consolidate until the flow of excess water from the sample stopped. The permeability was then measured by applying a differential pressure across the sample of 10 psi. The permeating fluid during the test was ground water from Wells SW-5 and SW-6 in the source area at the Mitchel Field site. The permeability tests indicate an average grout permeability of 8.9 x 10^{-7} cm/sec. The grout test results are summarized in Appendix G.

4.0 GROUT CURTAIN QUALITY AS A HYDRAULIC BARRIER

The purpose of the vibrated beam grout curtain is to prevent further migration of organic compounds from the source area by hydraulically controlling the movement of ground water into or out of the source area. The grout curtain will provide a hydraulic barrier for the closed loop ground water extraction, treatment, and recirculation program, designed to remove the organics from the ground water and vadose zone within the source area. Ground water recovery wells located within the barrier area will maintain a gradient inward across the barrier walls and upward from the Magothy formation below. The low permeability of the Portland cement/bentonite grout curtain greatly reduces the volume of ground water inflow through the barrier walls, allowing the recirculation/flushing concept to work, Figure 7.

The vibrated beam grout curtain acts as a seepage barrier designed to limit ground water infiltration into the source area during the on-site remediation effort. In accordance with the Phase I Conceptual Design Report (Consent Judgment Exhibit 1), Reference 2, and the Phase I Technical Specifications (Consent Judgment Exhibit 5), Reference 3, the grout curtain will serve as an effective hydraulic barrier if the containment walls:

1. Are keyed into the relatively impervious clayey silt and silty clay aquiclude which separates the upper glacial deposits from the lower Magothy formation;

2. Exhibit a hydraulic conductivity which limits ground water infiltration into the source area comparable to that of a three-inch (minimum) thick containment wall producing an effective hydraulic conductivity of 1×10^{-7} cm/sec.

As discussed in Section 2.1 (Alignment, Depth, and Thickness) the beam was driven into the Magothy formation to an average depth of five feet below the top of the confining layer (clayey silt and silty clay aquiclude). Verification of the beam penetration through the confining layer was accomplished by retrieving split-spoon samples from soil borings completed at various locations along the base of the containment wall.

The ability of the grout curtain to limit ground water seepage into the source area is dependent upon the wall thickness and the hydraulic conductivity of the grout. The Darcy velocity of ground water infiltration through the grout curtain is represented by the product of hydraulic gradient (water level difference between the inside and outside of the wall divided by the wall thickness) and hydraulic conductivity. Therefore, a three-inch-thick barrier wall having a hydraulic conductivity of 1×10^{-7} cm/sec is equally as effective in limiting flow as a 30-inch-thick containment wall having a hydraulic conductivity of 1×10^{-6} cm/sec. Based on conditions at the Mitchel Field site with a water level difference between the inside and outside of the wall of 5 feet, a 3-inch-thick containment wall with a hydraulic conductivity of 1×10^{-7} cm/sec would limit total ground water flow into the source area through the wall to approximately 1.1 gpm. Total inflow from the Magothy aquifer under the same conditions would be approximately 100 gpm, Reference 4.

The vibrated beam grout curtain installed at the Mitchel Field site averages 20.4 inches thick with an average hydraulic conductivity of 8.9×10^{-7} cm/sec. Under equivalent water level differences, this equates to a ground water infiltration rate through the wall of approximately 1.4 gpm; comparable to the 1.1 gpm design criteria. The average wall thickness of 20.4 inches is based on the actual volume of grout used during construction of the grout curtain, as previously discussed in Section 2.1 (Alignment, Depth, and Thickness). The average hydraulic conductivity of 8.9×10^{-7} cm/sec is based on the laboratory results of 12 triaxial permeability tests performed on the grout mix by Converse Consultants, Inc. Calculations for the design and as-built flow through the wall are contained in Appendix H.

5.0 CONCLUSIONS

The data collected during installation of the grout curtain wall indicates that the curtain will perform as an adequate hydraulic barrier for the control of ground water in the upper sand and gravel aquifer at the Mitchel Field source area. Infiltration to the area during remedial activities will be primarily from the underlying Magothy aquifer and will be monitored by piezometers located at four separate locations around the grout curtain perimeter.

Respectfully submitted,

Mark R Zoeteman

Mark R. Zoeteman
Engineer

Timothy J. Harrington

Timothy J. Harrington
Project Manager

MRZ/TJH/dcs

REFERENCES

1. Jones, G. K., 1963, Chemistry and Flow Properties of Bentonite Grouts, in Grouts and Drilling Muds in Engineering Practice, Butterworths, London.

2. Camp, Dresser & McKee, "Conceptual Design Report for Implementation of the Remedial Action Plan for the Mitchel Field Transit Facility Site, Town of Hempstead, New York", Consent Judgment Exhibit 1, November, 1983.

3. Camp, Dresser & McKee, "Technical Specifications for Mitchel Field Transit Facility Site Remedial Action - Phase I, Town of Hempstead, New York", Consent Judgment Exhibit 5, November, 1984.

4. Canonie Technology, "Aquifer Performance and Phase I Recovery Well Placement Mitchel Field Remedial Action Program", Garden City, New York, May, 1986.

TABLES

TABLE 1

Grout Curtain Thickness

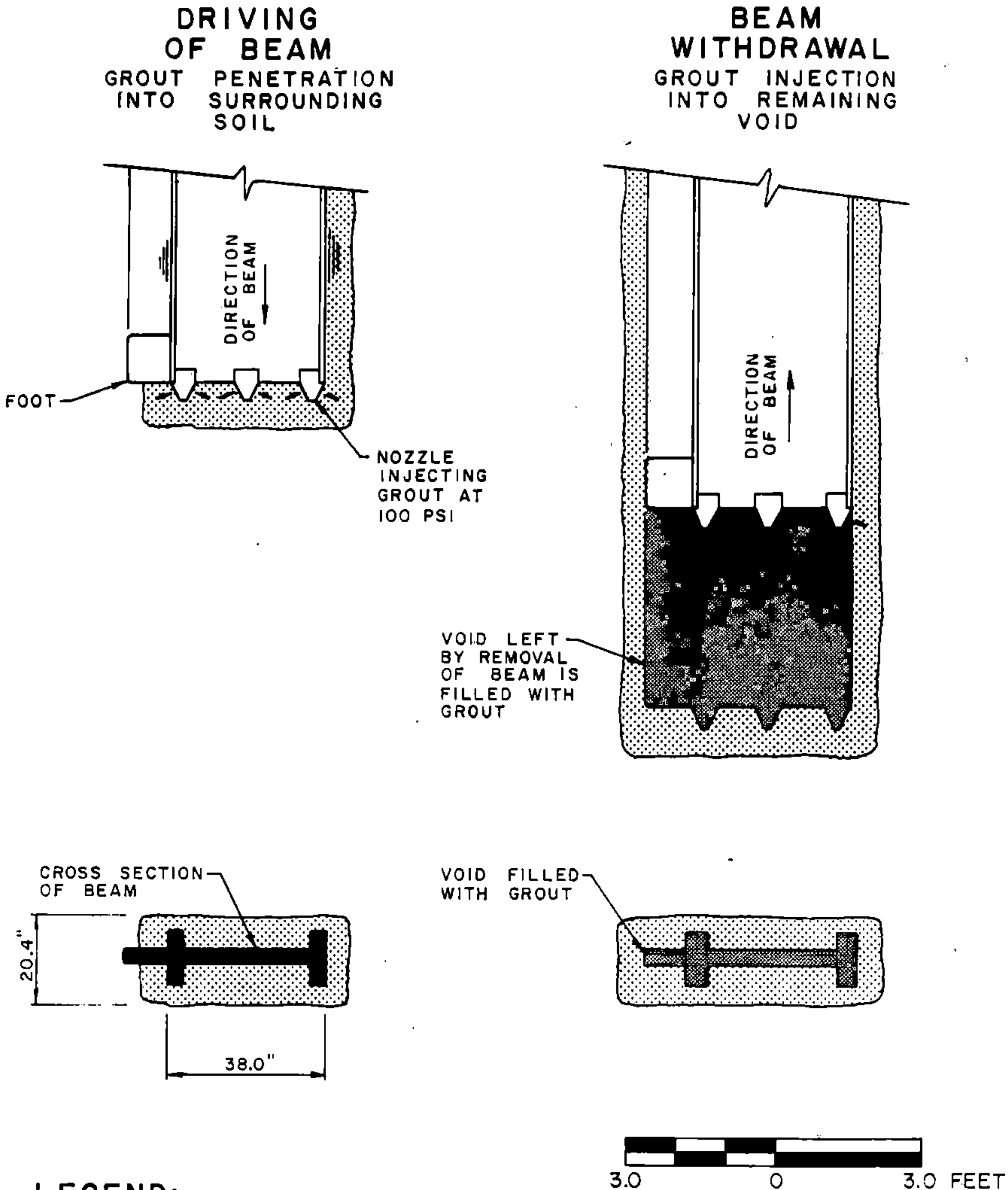
Week Ending	Net Volume of Grout[1] (C.F.)	Production[2] (S.F.)	Average Thickness[3] (Ft)
01-11-86	535	328	4.65
01-18-86	1,571	1,280	3.32
01-25-86	1,304	1,918	1.49
02-01-86	707	1,014	1.54
02-08-86	1,193	1,802	1.43
02-15-86	1,544	2,357	1.40
03-01-86	2,986	4,136	1.62
03-08-86	1,577	2,893	1.02
03-15-86	3,553	4,470	1.87
03-22-86	4,185	5,856	1.60
03-29-86	3,861	4,672	1.97
04-05-86	2,643	2,919	2.24
04-12-86	1,539	2,027	1.75
04-19-86	3,321	3,865	2.08
05-03-86	902	772	3.11
05-10-86	1,731	2,278	1.75
05-17-86	3,316	3,038	2.85
05-31-86	2,333	2,991	1.82
06-07-86	4,755	8,538	1.09
06-14-86	6,612	10,413	1.35
06-21-86	5,238	7,663	1.49
TOTALS	55,406	75,230	1.7

[1]Spoiled grout and grout from the starter trench has already seen subtracted.

[2]Production equals the lineal feet traveled multiplied by the average depth driven.

[3]The thickness of the four-inch wall has been added.

102340



LEGEND:

- VOID FILLED WITH GROUT
- GROUT PENETRATION INTO THE SURROUNDING SOIL

BEAM INSTALLATION DIAGRAM

PREPARED FOR

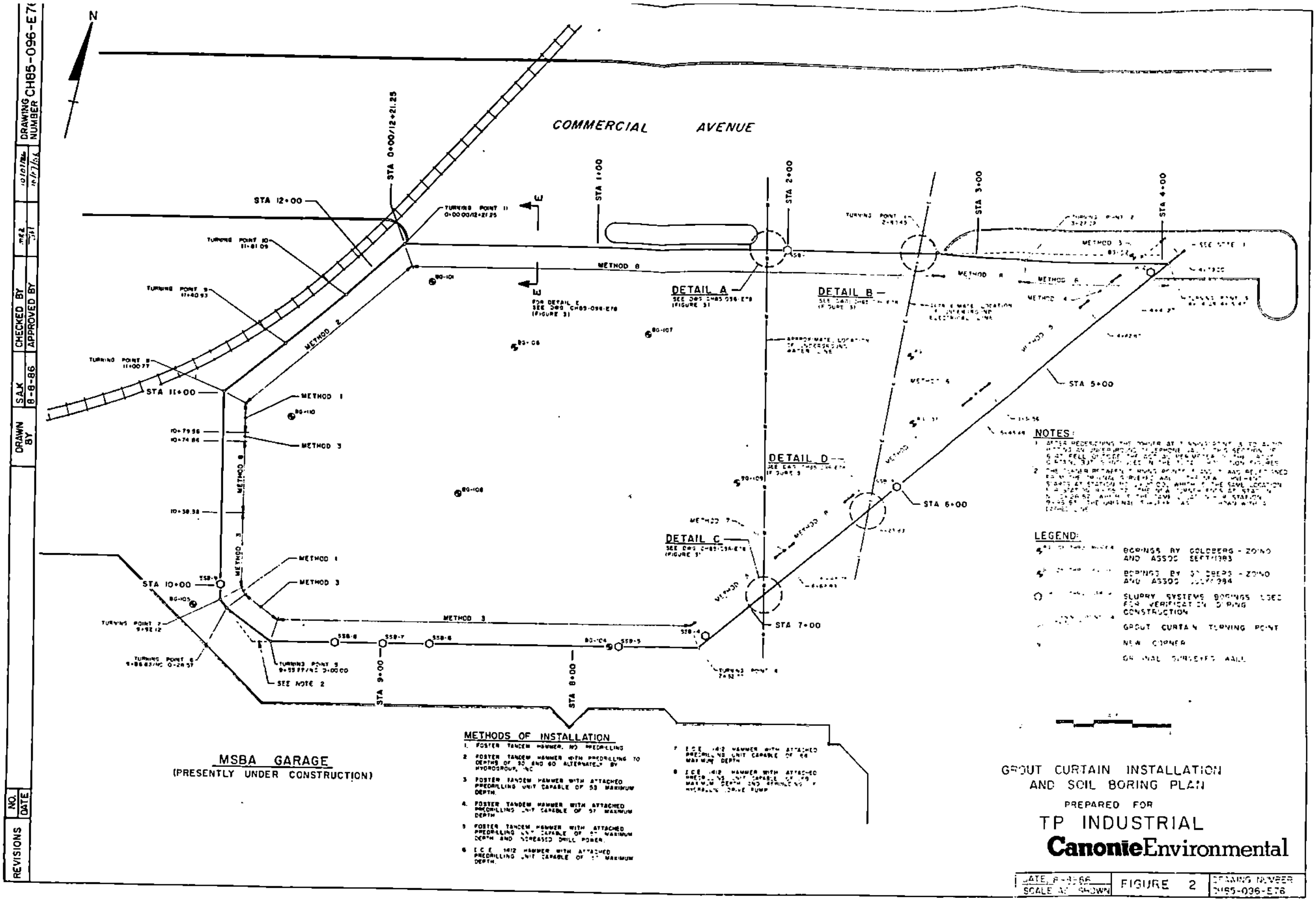
TP INDUSTRIAL

Canonie Environmental

DATE: 9-9-86 SCALE: AS SHOWN	FIGURE 1	DRAWING NUMBER CH85-096-A89

DRAWN BY	BJH	9-9-86	
CHECKED BY	MRZ	10-9-86	DRAWING NUMBER CH85-096-A89
APPROVED BY	TJH	10-9-86	

REVISIONS — NO. | DATE



N
COMMERCIAL AVENUE
STA 0+00/12+21.25
STA 12+00
STA 11+00
STA 10+00
STA 9+00
STA 8+00
STA 7+00
STA 6+00
STA 5+00
STA 4+00
STA 3+00
STA 2+00
STA 1+00
METHOD 1
METHOD 2
METHOD 3
METHOD 5
METHOD 6
METHOD 8
DETAIL A
DETAIL B
DETAIL C
DETAIL D
SEE NOTE 2
MSBA GARAGE
(PRESENTLY UNDER CONSTRUCTION)
METHODS OF INSTALLATION
1. FOSTER TANDEM HAMMER, NO PREDRILLING
3. FOSTER TANDEM HAMMER WITH ATTACHED PREDRILLING UNIT CAPABLE OF 53 MAXIMUM DEPTH.
NOTES:
LEGEND:
SLURRY SYSTEMS BORINGS USED FOR VERIFICATION DURING CONSTRUCTION
GROUT CURTAIN TURNING POINT
NEW CORNER
GROUT CURTAIN INSTALLATION AND SOIL BORING PLAN
PREPARED FOR
TP INDUSTRIAL
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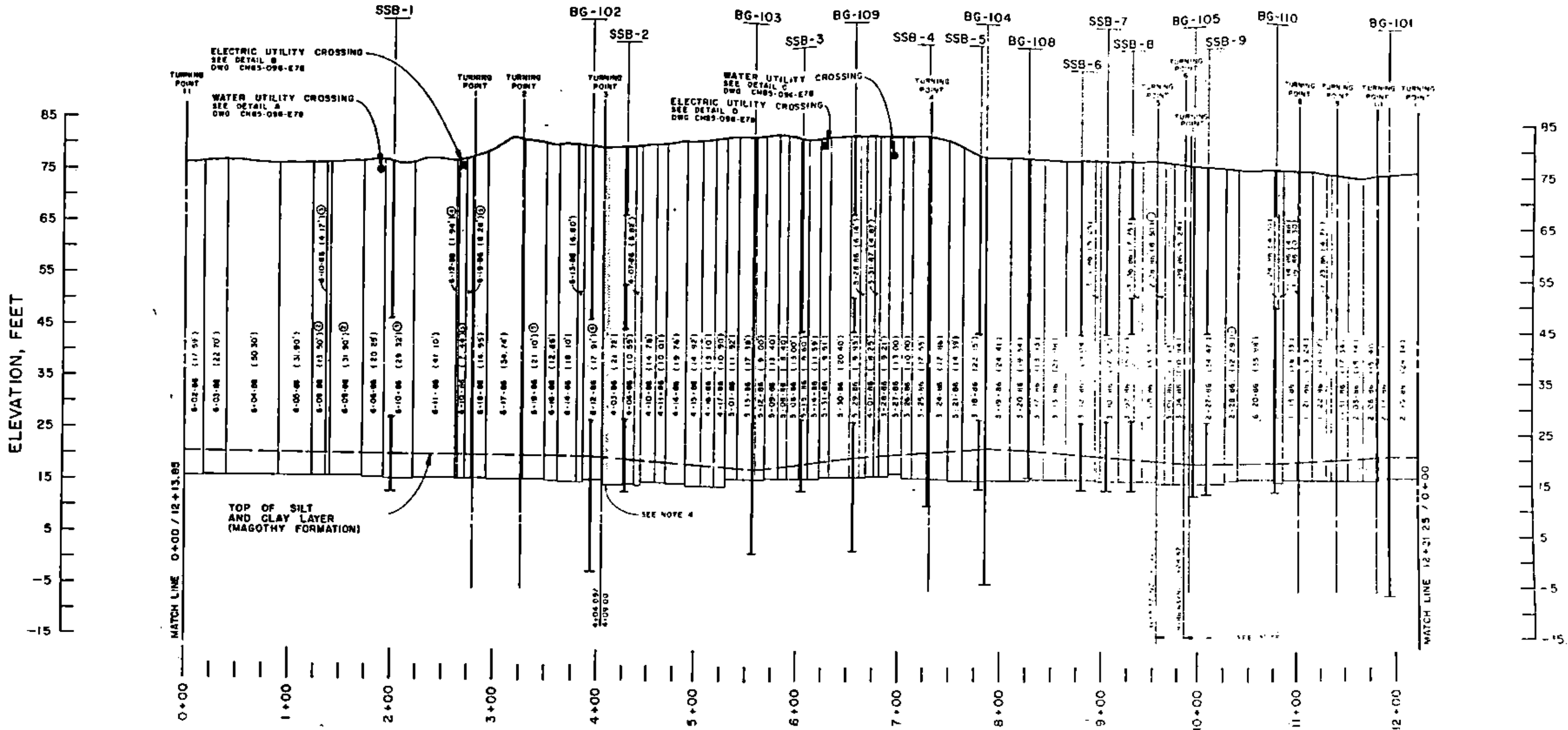
FIGURE 2
DRAWING NUMBER CH85-096-E76
DRAWN BY
CHECKED BY
APPROVED BY
REVISIONS
NO.
DATE



NOTES:

1. THE CORNER BETWEEN TURNING POINTS 5 AND 7 WAS REDESIGNED FROM THE ORIGINAL SURVEYED WALL. THE NEW CORNER(NC) STARTS AT STATION NC 0+00.00, WHICH IS THE SAME LOCATION FOR STATION 9+59.77. THE NEW CORNER ENDS AT STATION NC 0+28.57, WHICH IS THE SAME LOCATION FOR STATION 9+86.83.
2. INSTALLATION OF THE GROUT CURTAIN COMMENCED ON JANUARY 9, 1986 AND WAS COMPLETED ON JUNE 20, 1986.
3. ON THE FOLLOWING 5 DATES MULTIPLE SECTIONS OF THE GROUT CURTAIN WERE INSTALLED. THE TOTAL FOOTAGE IS GIVEN BELOW FOR THOSE DATES.

	DATE	TOTAL FOOTAGE
①	2-28-86	(20.79')
②	6-09-86	(45.40')
③	6-10-86	(40.93')
④	6-12-86	(19.85')
⑤	6-19-86	(27.39')

4. AFTER REDESIGNING THE CORNER AT TURNING POINT 3 TO AVOID HITTING AN UNDERGROUND TELEPHONE VAULT, THIS SECTION OF 6.47' FELL OUTSIDE THE ACTUAL PERIMETER OF THE GROUT CURTAIN, BUT IS INCLUDED IN THE TOTAL PRODUCTION FIGURES.

LEGEND:

BG-101 THRU BG-104	BORINGS BY GOLDBERG-ZOINO AND ASSOC, SEPT/1983
BG-105 THRU BG-111	BORINGS BY GOLDBERG-ZOINO AND ASSOC, JULY/1984
SSB-1 THRU SSB-9	SLURRY SYSTEMS' BORINGS FOR VERIFICATION DURING CONSTRUCTION
4-14-86 (9.76')	DATE AND AMOUNT OF PRODUCTION
NC	NEW CORNER

VERTICAL SCALE

HORIZONTAL SCALE

AS BUILT PROFILE ALONG ℄ OF GROUT CURTAIN

PREPARED FOR

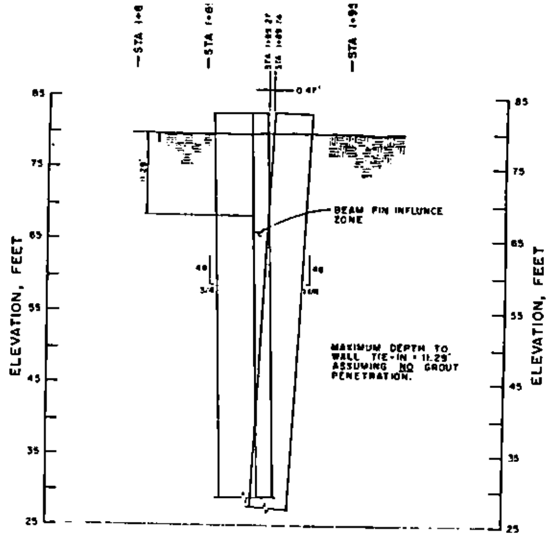
T. P. INDUSTRIAL, INC.

CanonieEnvironmental

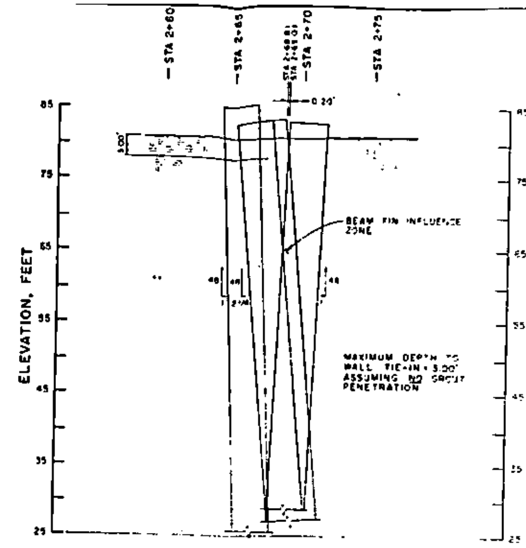
DATE 7-30-86	FIGURE 3	DRAWING NUMBER CH85-096-E75	
SCALE AS SHOWN			

DRAWN BY	GWB 7-30-86	CHECKED BY	APPROVED BY	DRAWING NUMBER CH85-096-E

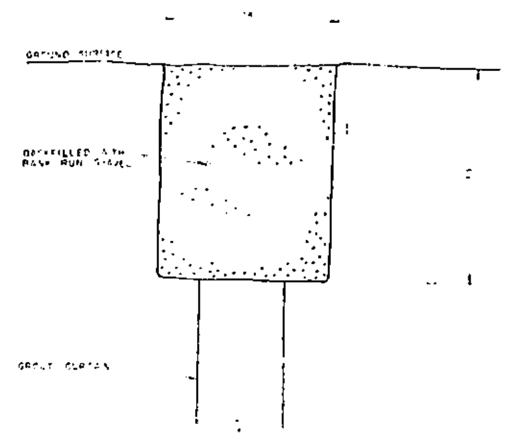
REVISIONS NO. DATE



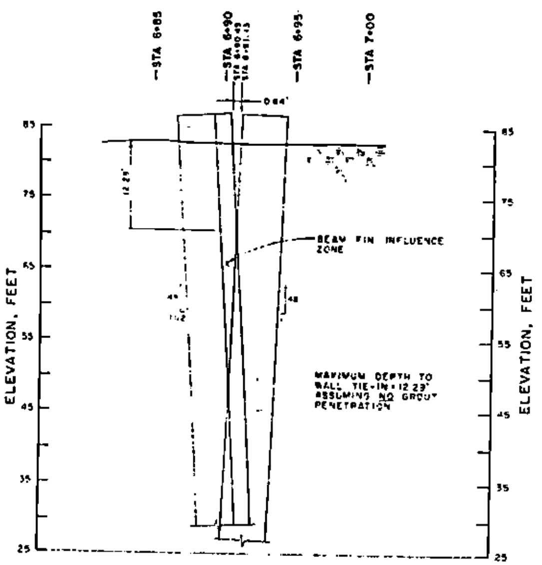
WATER LINE CROSSING
AT STA 1+89.50
DETAIL A



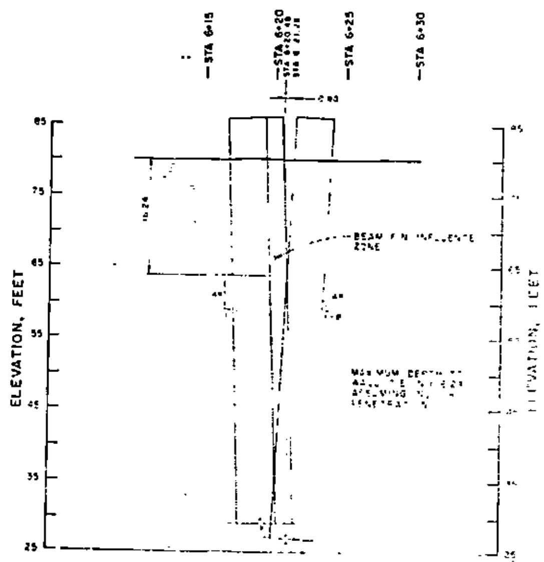
ELECTRICAL LINE CROSSING
AT STA 2+69.00
DETAIL B



TYPICAL GROUT CURTAIN CAP
DETAIL E



WATER LINE CROSSING
AT STA 6+90.50
DETAIL C



ELECTRICAL LINE CROSSING
AT STA 6+21.00
DETAIL D

UTILITY CROSSINGS AND
GROUT CURTAIN CAP DETAILS

PREPARED FOR

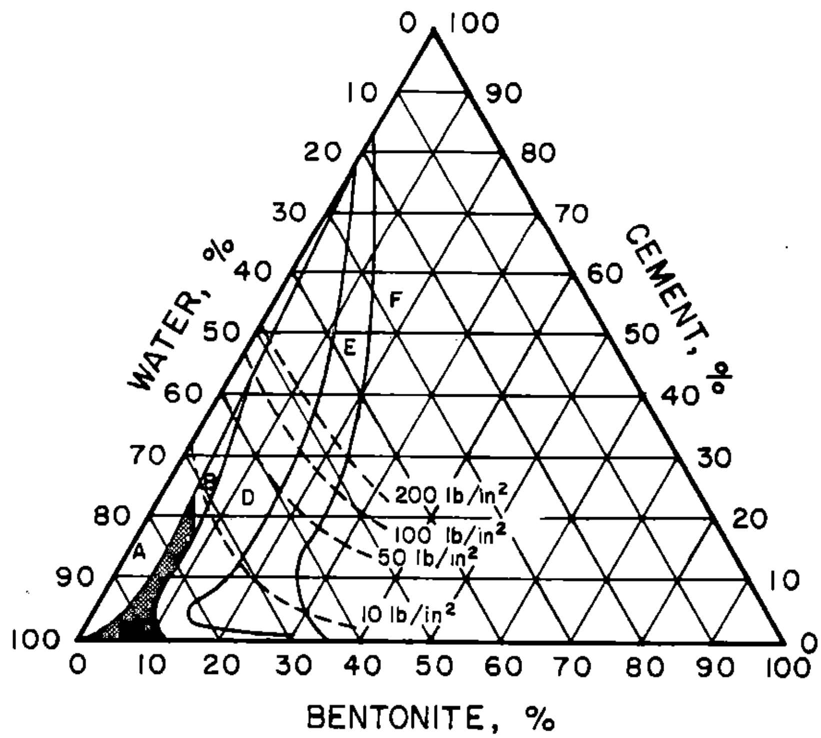
T.P. INDUSTRIAL

CanonieEnvironmental

REVISIONS	NO.	DATE	DRAWN BY	BJH	8-18-86	CHECKED BY	APPROVED BY	DRAWING NUMBER CH85-096-E7

DATE	FIGURE 4	DRAWING NUMBER
SCALE: AS SHOWN		CH85-096-E78

102340



LEGEND:

CEMENT-BENTONITE COMPOSITIONS

- A UNSTABLE SUSPENSION: PORTLAND CEMENT SETTLES
- B TEMPORARILY STABLE SUSPENSIONS: PORTLAND CEMENT SETTLES BEFORE SETTING
- C CEMENT-BENTONITE GELS OF LOW COMPRESSIVE STRENGTH
- D FREE-FLOWING, STABLE, AND PUMPABLE SUSPENSIONS
- E STABLE PUTTY-LIKE SUSPENSIONS
- F SOLID UNWORKABLE MIXES, NORMALLY POWDERS

▓ ZONE C

REFERENCE:

JONES, G. K., 1963: CHEMISTRY AND FLOW PROPERTIES OF BENTONITE GROUTS IN "GROUTS AND DRILLING MUDS IN ENGINEERING PRACTICE," BUTTERWORTHS, LONDON.

PHASE DIAGRAM FOR CEMENT-BENTONITE GROUT MIXTURES

PREPARED FOR

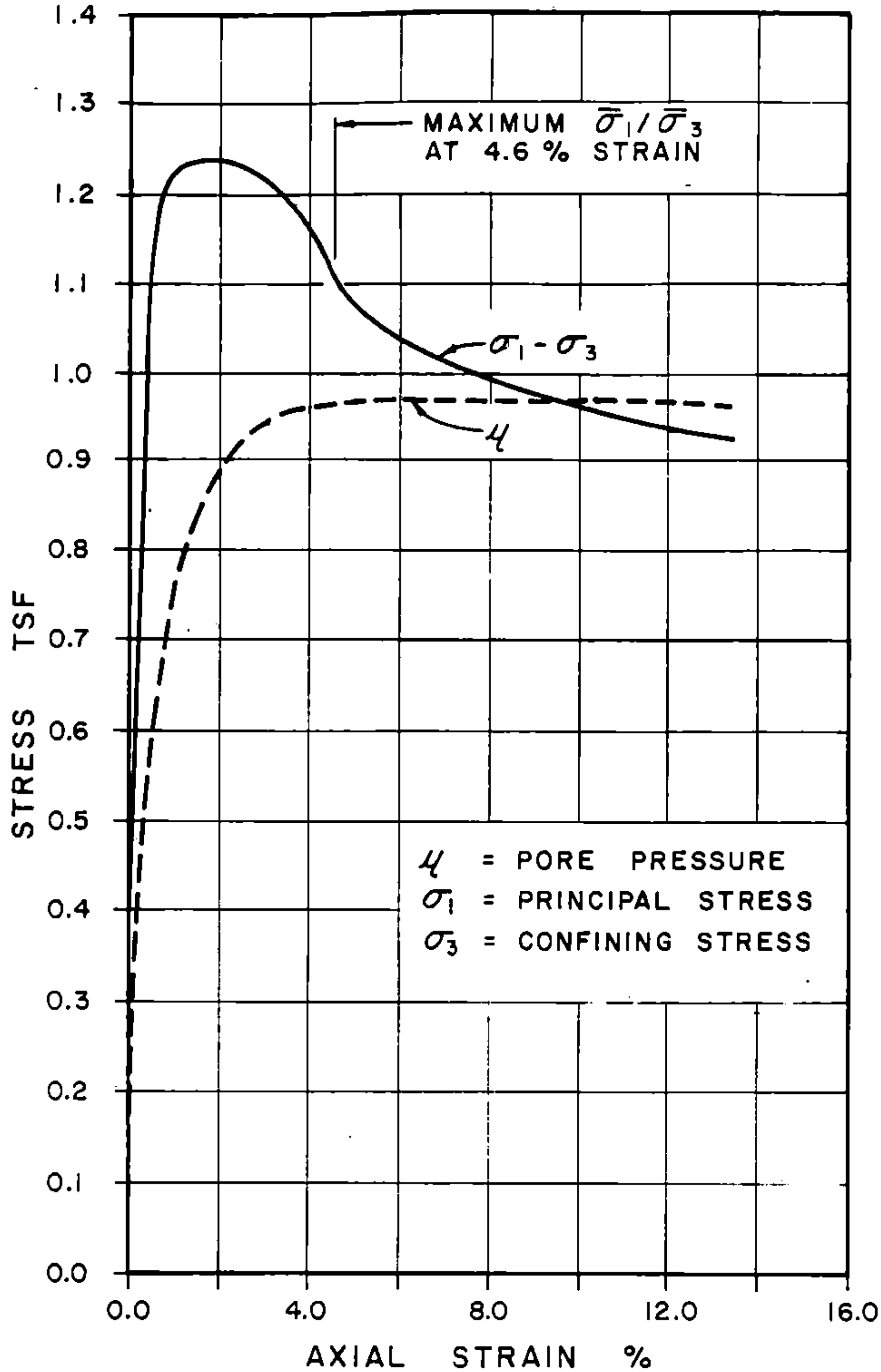
TP INDUSTRIAL

CanonieEnvironmental

DATE: 9-10-86 SCALE: N.T.S.	FIGURE 5	DRAWING NUMBER CH85-096-A90

DRAWING NUMBER	CH85-096-A90
DRAWN BY	GWB 9-10-86
CHECKED BY	MRZ 10-9-86
APPROVED BY	TDH 10-9-86
REVISIONS	NO. DATE

102340



NOTES:

1. UNIT DRY WEIGHT=12.9 PCF
2. CONFINING STRESS= 1.16 TSF
3. RATE OF SHEAR= 1.5 % PER HR

CONSOLIDATED UNDRAINED TRIAXIAL STRENGTH
PORTLAND CEMENT-BENTONITE GROUT
STATION 10+59

PREPARED FOR

TP INDUSTRIAL

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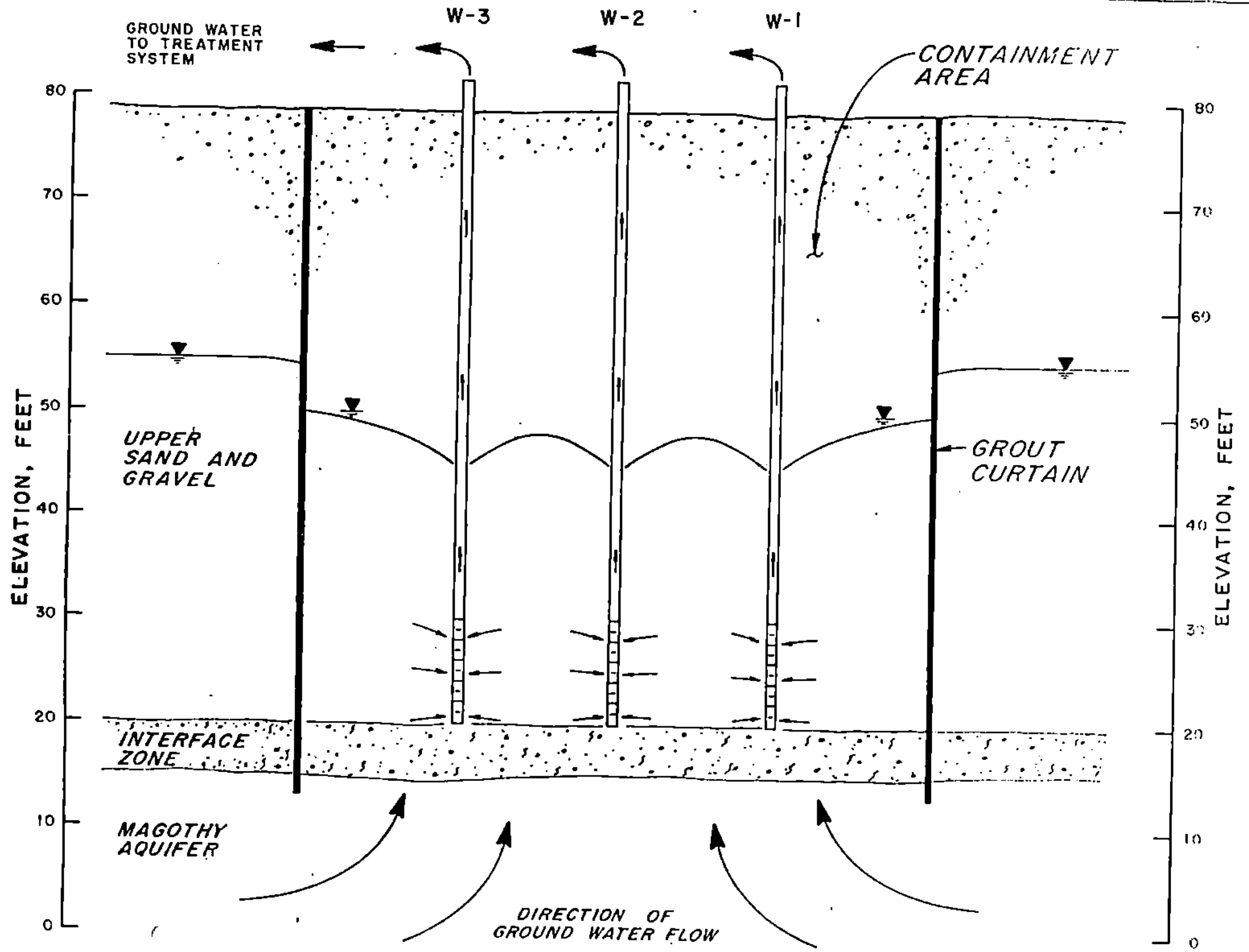
DATE: 9-10-86	FIGURE 6	DRAWING NUMBER
SCALE: NTS		CH85-096-A91

REVISIONS	NO.	DATE

DRAWN BY	BJH	9-10-86
CHECKED BY	MRB	10-9-86
APPROVED BY	TJH	10-9-86
DRAWING NUMBER	CH85-096-A91	



REVISIONS | NO. | DATE
DRAWN BY | BJH | 9-8-86
CHECKED BY
APPROVED BY
DRAWING NUMBER CH85-096-B88

CROSS SECTION OF CONTAINMENT AREA

PREPARED FOR

TP INDUSTRIAL

CanonieEnvironmental

DATE 9-8-86 SCALE NTS	FIGURE 7	DRAWING NUMBER CH85-096-B88

APPENDIX A

QUALITY CONTROL PROGRAM - PHASE 1A

QUALITY CONTROL PROGRAM FOR THE INSTALLATION OF THE VIBRATED BEAM METHOD (VBM) CONTAINMENT WALL

Canonie Environmental

TABLE OF CONTENTS

TABLE OF CONTENTS

QUALITY CONTROL PROGRAM

DIVISION I. CONTAINMENT WALL

1.0 PROJECT DESCRIPTION

1.1 Project Background

A Consent Decree has been signed which obligates TP Industrial, Inc. to undertake the remediation of the Mitchel Field site in the town of Hempstead, Nassau County, New York. The site was initially occupied by a company engaged in the storage and recycling of industrial chemicals. Subsequently, the site was occupied by the Metropolitan Suburban Bus Authority, which operates a small maintenance and washing garage, but has plans for the construction of a larger bus maintenance facility on the site. The Consent Decree requires that the site soils and ground water be remediated according to prepared plans and specifications. This work includes the installation of a containment wall to restrict the migration of chemical constituents in the subsurface, and to make more efficient the proposed flushing of the site soils to eliminate the source of chemical constituents contained therein.

1.2 Project Objectives

The objective of the project with respect to the containment wall is to install a continuous grout curtain around the site, which will extend to the depths indicated in the specifications and will hydraulically control the movement of ground water, containing identified chemical constituents, by restricting the horizontal permeability through the grout curtain to less than 1×10^{-7} cm/sec. The method selected to accomplish this objective employs the vibrating beam technology of slurry wall installation to alter the horizontal conductivity of in-situ soils. A grout slurry composed primarily of high-grade bentonite, cement, and ash will be utilized to provide the hydraulic barrier specified.

1.3 Reports

Upon the conclusion of the installation of the slurry wall, and after the testing and evaluation of samples has been completed, a report on the construction of the wall and drawings documenting the location and analytical results of quality control data and in-situ characteristics of the containment wall will be issued to TP Industrial for review.

2.0 QUALITY ASSURANCE OBJECTIVES

2.1 General

The quality of measurements made during the project will be determined by the following characteristics: representativeness, precision, accuracy, completeness, and comparability. Specific objectives for each characteristic are established to develop sampling and testing protocols, and identify applicable documentation. These objectives are established based upon site conditions, objectives of the project, and knowledge of available measurement systems. The subsequent use of the measurements and test results are also subject to aspects of the objectives set forth in this quality assurance program.

Canonie Construction Co., (Canonie), in conjunction with Slurry Systems, Inc., will, under the allowance provisions of the technical specifications, arrange for the collection of all samples and conduct all field measurements for the preparation, conduct, and analysis of the work. Sample collection and field handling will be in accordance with the sampling and sample handling protocols established in this program. Sample analysis for soil characteristics will occur on-site, as appropriate, or at an off-site soils laboratory. Field measurements will be supervised by Canonie Construction.

2.2 Representativeness, Precision, Accuracy, Completeness, and Comparability

Measurements completed during the course of the work will be taken so that survey results are as representative of the actual field conditions as possible. Sampling protocols will be utilized to assure that the samples collected in the field are representative of the media present in the field. Sample holding protocols, including such tasks as storage, transportation, and preservation, will be used to protect the representativeness of the samples gathered during the project. Proper documentation in the field and in the laboratory will establish that protocols have been followed, and that sample identification as well as integrity have been preserved. Representativeness of samples will be assured by the collection of random samples from the mix batches of slurry produced by the containment wall subcontractor.

Precision is the characteristic which reflects the ability to replicate a previously obtained value using identical test or measurement procedures, while accuracy is the characteristic which reflects the ability to obtain a value which equals, or approaches within certain pre-determined limits, the true value of a certain phenomenon. Each of these two characteristics are addressed in all data gathering and reporting conducted by Canonie. Data quality objectives for precision and accuracy are established for each of the major paramenters to be measured or tested during the project. These objectives are based upon prior experience in executing remediation activities or construction activities similar to those required at the Mitchel Field site, on prior knowledge of the capabilities of the measurement or testing system to be employed during activity at the site, and on the limitations which are present in execution of the project. The precision and accuracy requirements for certain data gathering and reporting activities may vary based upon the anticipated use of the information. For example, the precision and accuracy requirements of data gathered to determine the quantity of grout injected for every 100 lineal feet of wall installed will not be as strict as the precision and accuracy of data gathered to determine the in-situ permeability of the grout injected into the soil to form the containment curtain.

In general, horizontal alignment of the installed containment wall will be determined every 25 feet, utilizing survey staking set prior to the initiation of actual construction. Horizontal alignment will be checked on a random basis at locations intermediate to the 25-foot stations if deemed necessary by on-site supervisory personnel. The horizontal alignment of the wall shall be within +/- 0.1 feet of the control points positioned every 25 feet on the proposed line of the wall. Wall alignment, in terms of verticality, will be measured at least every 25 feet, and usually as often as possible. Wall verticality shall be maintained plumb on both axes to an accuracy of 0.25 percent of total wall depth. The depth of penetration of the vibrating beam shall be measured each time the beam is driven, with measurements taken to the nearest 0.1 feet. At a minimum, Canonie will obtain the elevation of the beam tip, prior to withdrawal, using an engineer's level. In the laboratory, ten percent of the samples taken for analysis of hydraulic conductivity will be analyzed as replicates to evaluate laboratory precision. These replicate samples will be chosen at random from the samples submitted to the laboratory for analysis.

The characteristic of completeness is a measure of the amount of valid data obtained compared to the amount that was specified to be obtained under normal conditions. The amount of valid data specified is established based on the measurements required to accomplish project objectives. The extent of completeness must be reviewed on a relative basis for sample collection, testing, and measurement activities, since the amount of valid data anticipated prior to data collection activities may not accurately define the amount of data necessary to render a correct decision about the current activities of the project. Therefore, on-site personnel for Canonie will maintain testing and data collection current with the project, and daily review the information collected, so that a timely decision may be made whether to alter the type and/or quantity of data being collected to produce the required project documentation.

The characteristic of comparability reflects both the internal consistency of data collected with regard to a single parameter and an expression of data in units which are consistent with the units which data, gathered by other organizations measuring the same parameter, are presented. Comparability of data gathering and measuring procedures should also be addressed if data is to be reliably compared. Thus, the characteristic of comparability implies that the personnel involved in data acquisition and reduction must operate measurements systems within the calibrated range of the particular instrument as well as utilize analytical and data gathering methodologies which produce comparable results. In order that data gathered from the activities of the containment wall installation may be reliably compared, sampling and data gathering protocols, outlined in this program, shall be followed by all personnel at all times. When the county or engineer seek samples of the grout mixture being injected to form the containment wall, those samples will be obtained by inspection personnel in a manner consistent with sampling protocols currently in use and specified by this plan. Where measurements are being sought, inspection personnel will assist in the taking of the measurements in order that methodologies of measurement may be observed and procedures which may result in significant deviations are noted.

2.3 Objectives

The quality control objectives relating to the installation of the containment wall at the Mitchel Field site include the following:

To produce documented, traceable, and consistent data on the installation of the wall and the grout utilized in the construction thereof;

To collect sufficient field data and samples as well as duplicate samples to allow for assessment of sample representativeness and sample collection protocol precision;

To collect sufficient split-spoon samples (VBM) to confirm that the containment wall has been adequately keyed into the bottom aquiclude;

To collect sufficient measurements to provide for an accurate assessment of the placement of the containment wall in relation to the technical requirements;

To collect and analyze sufficient samples to determine the in-situ hydraulic conductivity of the containment wall;

To produce documented, consistent, and technically defensible data and reports which will indicate that the containment wall installed at the Mitchel Field site complies with the requirements of the Consent Decree.

3.0 EQUIPMENT AND MATERIALS

3.1 Equipment

The containment wall shall be constructed utilizing suitable equipment capable of attaining the required depths and wall continuity. Equipment shall be in good operating condition, and shall meet all applicable safety standards.

The vibrating beam utilized for the containment wall installation of 30 inches and a flange width of at least 15 inches. The beam shall have a built up web thickness of at least 4 inches, and a minimum flange thickness of 2 inches for the bottom 3 feet. The beam shall be controlled by fixed guide leads that provide positive plumbness adjustment in both axes. This guide lead set-up shall be capable of providing vibrating beam insertions with a maximum deviation of 1 percent from vertical and with a minimum overlap of 3 inches with the pervious insertion. The guide lead and beam arrangement shall be mounted on a crane, and shall be driven with a vibratory driver capable of an insertion rate insuring maximum verticality and an extraction rate that allows proper grout placement. The grout batching plant shall include mixers, pumps, valves, hoses, supply and storage tanks, and lines, and all other equipment as required. Pumping equipment and supply lines shall be capable of supplying a continuous flow of grout to the tip of the beam at a pressure and rate insuring a continuous grout membrane not less than 4 inches thick. Excavation of containment wall cap shall be accomplished by use of suitable earth-moving equipment along the wall centerline to the limits shown on the drawings.

3.2 Materials

Bentonite used in the make-up of the grout for the containment wall shall be pulverized, natural Wyoming sodium-cation material conforming to API Standard 13A. The manufacturer's certification that the bentonite incorporated into the grout mix meets this specification shall be supplied to Canonie for inclusion in the containment wall report.

Cement used in the make-up of the grout for the containment wall shall meet the requirements of ASTM C150 Type I cement. The manufacturer's certification that the cement incorporated into the grout mix meets this specification shall be supplied to Canonie for inclusion in the containment wall report.

Water used in the make-up of the grout mix, and for all cleaning of equipment, shall be clean, fresh, and free from oil and alkalines, organic matter, and all other deleterious substances which will have an adverse effect on the hydraulic conductivity or compressive strength of the completed wall.

The manufacturer's certification for all additives incorporated into the grout mix shall be supplied to Canonie for inclusion in the containment wall report. Additives shall be brought to the jobsite in the manufacturer's containers and shall be properly labeled as to contents with directions for proper mixing and the limitations under which the additives are useful available for inspection.

4.0 GROUT

4.1 Grout Design

The grout chosen for use in the installation of the Mitchel Field containment wall consists of a mixture of the following:

6.5 percent by weight Baroid Premium Grade 200 Mesh Bentonite

11.0 percent by weight Portland Type I Cement

< 0.1 percent by weight Tamol (a dispersant)

< 0.1 percent by weight trisodium phosphate (a dispersant)

< 0.2 percent by weight soda ash (a water conditioner which aids in the hydration of the bentonite)

4.2 Grout Preparation

The grout shall be prepared in equipment designed especially for the preparation of the grout. All equipment and materials needed to provide grout to the injection system in an uninterrupted fashion shall be available to the work at all times. Sufficient supplies of materials, such as bentonite and cement, shall be stocked on-site so that delays in delivery of these materials does not delay or halt the installation of the containment wall.

The grout shall be prepared by the containment wall subcontractor in accordance with customary practice. In general, the bentonite shall be weighed and then mixed with the proper volume of water until the bentonite is thoroughly hydrated. Dispersant additives may be included in the mix at this time to aid in the hydration of the bentonite or to condition the water. The bentonite/water mixture shall be circulated by a centrifugal pump for approximately six minutes to accomplish the hydration of the bentonite and the thorough mixing of all materials added. An additive shall also be included in the mixture at this time to prevent the contamination of the bentonite by cement. Next the cement shall be weighed and the full mix shall be circulated through the centrifugal pump for an additional three minutes to obtain a homogeneous mixture. In general, only two to three cubic yards of grout shall be mixed at one time so that acceptable pumpability and liquidity is maintained in the mix prior to injection in the wall. Grout which has not been placed within four hours of the completion of mixing shall be discarded off-site.

4.3 Grout Injection

The injection of the grout shall proceed after it has been determined that the beam has been vibrated down to the elevation necessary to contact the bottom aquiclude. When the proper depth of insertion has been obtained, the injection of the grout shall be commenced in conjunction with the withdrawal of the beam from the ground. Beam withdrawal shall proceed at a rate not greater than ten feet per minute. Beam withdrawal shall be determined by measuring the time taken to withdraw a specified length of the beam. Grout injection shall be continuous and at a constant flow rate, with pressure maintained at a level which does not produce "boiling" of the grout in the previously-placed, adjacent wall areas. Grout injection shall continue until the entire depth of the annular space created by the beam insertion is filled.

5.0 SAMPLING

5.1 Sampling Containers

Sampling containers for the collection of grout for testing for viscosity, unit weight, and filtrate loss shall consist of clean mason jars with a volume of approximately one quart. These containers will provide easy filling and transferring of the grout without substantial separation of the grout mixture.

Sampling containers for the collection of grout for testing for hydraulic conductivity and compressive strength will be split barrel tubes which are filled with grout collected in large buckets. The split barrel tubes will provide an efficient means of removing the cured grout from the container when testing is required, while providing for proper shaping of the sample during the curing phase. Split barrel tubes for the unconfined compressive strength testing will be two inches in diameter and four inches in length. Split barrel tubes for triaxial hydraulic conductivity testing will be 2.8 inches in diameter and approximately six inches in length.

Sampling containers for the retrieval of soil samples from beneath the containment wall will be brass tubes approximately one inch in diameter and four inches long. The brass tubes will have fitted plastic caps for placement over the ends of the tube to retain the soil in the tube during storage. In addition, the caps will be taped to the tube to prevent accidental loss of the sample due to the inadvertent handling of the tube.

5.2 Sampling Locations

Samples will be retrieved from the batch mix of grout by tapping into the injection feed line just after the mix tank. Samples will be collected in glass mason jars at this location and transported to the on-site laboratory area for analysis of viscosity, unit weight, and filtrate loss.

Samples will be retrieved from the grout exiting the injection nozzles on the end of the beam by allowing grout to flow out of the nozzles at a controlled rate. Samples collected from this location will be collected in a large bucket and then transferred to the split barrel tubes for testing of compressive strength and hydraulic conductivity. On a random basis, grout which has been released from the nozzles will be retrieved for analysis of viscosity, unit weight, and filtrate loss and compared with results obtained from samples taken from the mixer.

Samples of soil from the base of the containment wall will be retrieved using a split spoon attached to the fin of the vibrating beam to verify that the wall has been driven deep enough to contact the bottom aquiclude. Samples of the soil beneath the wall will be retrieved every 15 feet along the length of the wall.

5.3 Sample Procedures

Samples of the soil beneath the containment wall will be retrieved by attaching a split spoon sampler to the fin of the vibrating beam. As the beam is driven into the soil, the split spoon will travel down through grout which has been placed in the annular space created by previous beam insertions. When the beam has reached the bottom elevation of the wall, the beam will be driven an additional 12 inches to "set" the split spoon sampler into "undisturbed" soil. When the beam has been withdrawn, site personnel will detach the split-spoon from the fin and inspecting personnel will open the split-spoon and visually classify the soils, recording the time the sample was taken, the person classifying the soil, and the location from which the sample was taken. The brass tube containing a sample of the soils retrieved will be capped with tight fitting plastic caps and the caps taped to the tube. The tube will be marked with an appropriate sample number and the tube retained for future reference. The sample number given to each brass tube soil sample will be recorded on a sample log together with the time the sample was taken and the location from which the sample was retrieved. This sample log shall remain in the permanent files of the project.

Samples of the grout from the injection nozzles attached to the end of the beam will be taken by instructing the vibrating beam rig operator to release a small amount of grout into buckets stationed below the beam. The grout collected will be taken to the on-site testing area and immediately transferred into the split barrel tubes reserved for hydraulic conductivity and compressive strength testing. The samples will be marked with a tag indicating the time the grout was collected and the location where the grout was placed in the wall. The samples will then be capped and readied for shipment to the soils laboratory for analysis. Upon receipt of the samples at the laboratory, the analytical technician shall place the samples in an environment where the temperature is maintained at 70 degrees farenheit and the humidity is maintained at 100 percent.

Samples collected for marsh funnel viscosity, filtrate loss, and unit weight testing will be collected in clean, glass mason jars. The grout collected will then be transferred to the on-site testing area and the samples tested. The samples will be collected by tapping into the grout feed line leading from the mix tank or storage tank to the vibrating beam rig. Approximately three quarts of grout will be withdrawn from the line and placed in the mason jars for transfer to the testing area. The time of collection of the grout and the location of the containment wall currently being installed will be noted on the sample log for each sample batch collected. This information, together with the name of the sampler and the results of the testing will be recorded and kept in the permanent file of the project.

5.4 Sample Custody and Handling

An established program of sample chain-of-custody procedures, that is followed during sample collection and handling activities in both the field and laboratory operations, will be instituted during the remediation activities associated with the Mitchel Field site. The program is designed to assure that each sample is accounted for at all times. To maintain the highest degree of control in sample handling for the remediation of the

Mitchel Field site, labels will be utilized so that all necessary information is retained with the sample, and chain-of-custody records and shipping manifests will be employed to maintain control over access to and destination of samples after shipment from the location of sample collection. Additionally, proper completion of field sample logs and analytical logs by appropriate field and laboratory personnel provide for thorough monitoring of the sample from collection through analysis and final report generation.

The objective of sample identification, custody, and monitoring procedures is to assure that:

All samples collected are uniquely labeled for identification purposes throughout the analytical process;

Samples are correctly analyzed and that results are traceable to field records;

Important sample characteristics are preserved;

Samples are protected from loss, damage, and tampering;

Any alteration of samples (e.g., damage due to shipment or other processes) is documented;

A record of sample integrity and analytical fate is established for legal purposes.

5.4.1 Sample Monitoring Forms

The use of the indicated forms listed above accomplishes one or more of the specific objectives of sample custody, identification, or control. The use of each of the listed forms is discussed below.

5.4.2 Sample Log

The sample log is completed in the field by the individual physically in charge of the sample collection. The sample log correlates the assigned sample bottle designation to a specific sample location or other distinguishing feature or attribute (i.e., dummy sample, replicate sample, etc.). The sample log also contains information concerning day and time of sampling, type, location, and depth, procedures utilized to preserve the sample for analysis, and the sequence in which sampling was completed. Other relevant information, such as weather conditions, may also be included. The sample log is attached to the chain-of-custody record and shipped with the samples to the laboratory. A sample log is presented in Appendix A.

5.4.3 Chain-of-Custody Record

The chain-of-custody record is completed in the field by the individual physically in charge of the sample collection. The chain-of-custody record may be completed contemporaneously with the sample log or prior to the shipment of samples to the laboratory. The chain-of-custody record contains information on the date of sample collection, the sampler, and project name and number, laboratory project number, the number of containers of each sample being shipped, and an itemization of the analyses requested for each sample together with any remarks about the sample prior to shipment. The chain-of-custody record is enclosed with the samples after it has been signed by the sampler. The record is then signed each time possession of the sample changes, with the signature of the person relinquishing and receiving the sample, as well as the time of exchange being indicated on the record. A sample copy of a chain-of-custody form is set forth in Appendix B.

5.5 Packing and Shipping

In addition to sample collection and preservation requirements, especially the maintenance of sample temperature at four degrees centigrade, until extraction or analysis, samples should be packed and shipped properly to maintain the health and safety of sample transporters. Guidelines for packing and shipping of samples are included in Appendix C.

6.0 MEASUREMENTS

Measurements will be made on a periodic basis to record the location of the containment wall both in horizontal and in vertical extent. The location of the wall shall be measured in relation to survey markers which are set in the field prior to the commencement of containment wall installation. These markers will be placed such that their areal location is known within 0.1 feet based upon a survey conducted from USGS benchmark. Field notes as the installation of the wall proceeds will be kept in a survey field book. All measurements will be taken to the nearest 0.1 feet. Elevations of the bottom of the containment wall will be measured to within 0.1 feet. The survey markers shall be placed every 25 feet along the length of the wall. These markers will be used to determine the horizontal location of the wall and used as temporary benchmarks for the determination of the elevation of the wall. Tapes used to measure distances shall be true and whole, without defects which would result in an error. Tapes which have been broken and then mended shall not be used. In general, all measurements should be made using a metal based tape. The inclination of the beam shall be measured using a four foot carpenter's level and a small metal ruler with at least markings every sixteenth of an inch.

7.0 CALIBRATION PROCEDURES

All equipment and analytical testing instruments shall be calibrated according to the manufacturer's instructions. Measuring equipment, while not required to be traceable to National Bureau of Standards calibration devices, shall measure true to scale. Any instrument in error due to the use of a faulty measuring device shall be reviewed with appropriate remeasurement completed if required.

8.0 ANALYTICAL PROCEDURES

The analysis of the grout for quality control purposes involves the determination on a regular basis of viscosity, unit weight, filtrate loss, triaxial hydraulic conductivity, and unconfined compressive strength. The procedures to be followed for assessing the triaxial hydraulic conductivity of the cured grout will be those procedures set forth in U.S. Army Corps of Engineers Manual Number EM1110-2, Appendix VII. The unconfined compressive strength of the cured grout will be determined using the procedures set forth in ASTM D 2166.

Unit weight of the grout will be determined by filling a 100 ml volumetric flask with a homogeneous mixture of the grout and weighing the filled flask to the nearest 0.01 gram. The unit weight of the sampled grout shall be calculated by subtracting the weight of the empty flask from the weight of the filled flask and then dividing the resultant weight by 100 cubic centimeters. Unit weight of the grout shall be not less than 1.07 grams per cubic centimeter and not more than 1.50 grams per cubic centimeter.

Marsh funnel viscosity is determined by using a marsh funnel viscometer. The funnel of the device is filled with 1500 cubic centimeters of homogeneous grout, and the time for 946 cubic centimeters of the grout to flow through the funnel is measured and quoted as the viscosity in seconds. Viscosity shall be not less than 35 marsh funnel seconds. Method reference for the determination of marsh funnel viscosity is API RP-13B.

Filtrate loss is measured in accordance with "Low Temperature Filtration Test" API RP-13B. Water loss shall not be greater than 60 cubic centimeters at 50 psig when tested under these conditions.

APPENDIX A

FIELD SAMPLE DATA LOG

CanonieEnvironmental

Field Sample Data

PROJECT No. ______

PAGE ______ OF ______

PROJECT NAME ______ SAMPLED BY ______

STATION No./LOCATION ______ DATE ______

SKETCH ON BACK YES ☐ NO ☐ PHOTOGRAPHS YES ☐ NO ☐ ROLL No./EXPOSURE No. ______

FIELD DATA

TIME ______ AIR TEMP. °F ______ WEATHER ______

WELL DEPTH ______ WATER DEPTH ______ SAMPLE DEPTH ______ SAMPLE METHOD ______

VOL. PURGED ______ SAMPLE TEMP. ______ °C ☐ IN SITU ☐ IN BOTTLE SP. COND. ______ / ______ AT 25° C ☐ IN SITU ☐ IN BOTTLE

pH ______ ☐ IN SITU ☐ IN BOTTLE Eh ______ ☐ IN SITU ☐ IN BOTTLE DISSOLVED O_2 ______ ppm ☐ IN SITU ☐ IN BOTTLE

VOA LEVEL (ppm) AMBIENT ______ SAMPLE LOCATION ______ HEADSPACE ______

BOTTLE ID	LAB ID	VOL	MATERIAL	FILTERED	PRES./VOL.	ANALYSIS REQUESTED
					/	
					/	
					/	
					/	
					/	
					/	
					/	
					/	
					/	
					/	

REMARKS: ______

FIELD EQUIPMENT QUALITY ASSURANCE CHECKLIST

pH METER BUFFER CHECK pH 4 ______ pH 7 ______ pH 10 ______

SP. COND. METER STANDARDS CHECK ______ Eh PROBE ______

PUMP TUBING RINSED ______ CHANGED ______ SAMPLER BLANK ______

FILTRATION BLANK WITH PRES. ______ FILTERS ACID WASHED ______

APPENDIX B

CHAIN-OF-CUSTODY

PROJ NO	PROJECT NAME	NO. OF CONTAINERS	ANALYSIS												REMARKS
L P NO.	SAMPLERS. (Signature)														
DATE	SAMPLE I.D.														

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Remarks
Relinquished by: (Signature)	Date/Time	Received by: (Signature)	
Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)	

№ 1104

White Sampler   Canary Return Copy To Shipper   Pink Lab Copy

CHAIN OF CUSTODY

Canonie Environmental

APPENDIX B

PENETRATION RECORD

Penetration Record

DATE	PENETRATION NUMBER	STATION	GRADE (FEET)	TIP ELEVATION (FEET)	HORIZONTAL LOCATION (DEVIATION FROM CENTERLINE) (FEET)
01/09/86	1	9+90.00	77.6	14.00	0
01/09/86	2	9+92.29	77.6	14.00	0
01/13/86	3	11+03.59	76.3	16.00	0
01/13/86	4	11+01.44	76.2	16.00	0
01/13/86	5	10+99.27	76.3	16.00	0
01/13/86	6	10+96.77	76.4	16.00	0
01/13/86	7	10+94.27	76.5	16.00	0
01/13/86	8	10+91.94	76.5	15.00	0
01/13/86	9	10+89.61	76.6	15.00	0
01/13/86	10	10+87.61	76.6	15.00	0
01/14/86	11	10+86.82	76.6	15.00	0
01/14/86	12	10+85.36	76.7	15.00	0
01/14/86	13	10+83.48	76.7	15.00	0
01/14/86	14	10+82.73	76.7	15.00	0
01/16/86	15	11+01.07	76.3	16.75	0
01/21/86	16	11+03.35	76.3	16.00	0
01/21/86	17	11+05.63	76.3	16.00	0
01/21/86	18	11+07.91	76.3	16.00	0
01/21/86	19	11+10.28	76.3	16.00	0
01/21/86	20	11+12.29	76.2	16.00	0
01/21/86	21	11+14.31	76.2	16.00	0
01/22/86	22	11+16.32	76.2	16.40	0
01/22/86	23	11+18.11	76.2	16.20	0
01/22/86	24	11+19.90	76.2	15.80	0
01/22/86	25	11+21.82	76.2	15.90	0
01/22/86	26	11+23.80	76.2	15.80	0
01/22/86	27	11+25.78	76.1	16.00	0.10 Out

Notes:

1. Out indicates a horizontal deviation to the outside of the grout curtain.
2. In indicates a horizontal deviation to the inside of the grout curtain.

Penetration Record
(Continued)

DATE	PENETRATION NUMBER	STATION	GRADE (FEET)	TIP ELEVATION (FEET)	HORIZONTAL LOCATION (DEVIATION FROM CENTERLINE) (FEET)
01/22/86	28	11+27.38	76.1	14.60	0.20 Out
01/22/86	29	11+28.98	76.1	15.00	0.20 Out
01/23/86	30	11+30.48	76.1	16.10	0.10 Out
01/23/86	31	11+31.86	76.1	16.40	0.20 Out
01/23/86	32	11+33.69	76.1	16.40	0.30 Out
01/31/86	33	11+37.91	76.1	15.70	0.05 Out
01/31/86	34	11+35.80	76.1	15.70	0.20 Out
01/31/86	35	11+40.19	76.1	16.40	0.05 Out
01/31/86	36	11+41.80	76.1	16.00	0.05 Out
01/31/86	37	11+43.21	76.1	16.00	0
01/31/86	38	11+45.00	76.1	16.20	0.10 In
01/31/86	39	11+46.78	76.1	16.20	0
01/31/86	40	11+48.57	76.1	16.20	0
01/31/86	41	11+51.03	76.1	16.50	0.10 Out
02/03/86	42	11+52.97	76.1	15.80	0.10 Out
02/03/86	43	11+54.37	76.2	16.10	0.05 Out
02/03/86	44	11+56.54	76.2	16.00	0
02/03/86	45	11+58.70	76.2	16.10	0.05 Out
02/03/86	46	11+60.74	76.2	16.10	0
02/03/86	47	11+62.78	76.3	16.10	0
02/03/86	48	11+64.58	76.3	16.40	0
02/03/86	49	11+66.37	76.3	16.50	0.05 In

Notes:

1. Out indicates a horizontal deviation to the outside of the grout curtain.
2. In indicates a horizontal deviation to the inside of the grout curtain.

<u>Penetration Record</u>
(Continued)

DATE	PENETRATION NUMBER	STATION	GRADE (FEET)	TIP ELEVATION (FEET)	HORIZONTAL LOCATION (DEVIATION FROM CENTERLINE) (FEET)
02/06/86	50	11+68.48	76.3	16.00	0
02/06/86	51	11+70.47	76.3	16.00	0.05 Out
02/06/86	52	11+72.45	76.3	16.10	0
02/06/86	53	11+74.30	76.3	16.10	0
02/06/86	54	11+76.14	76.3	16.20	0.05 Out
02/06/86	55	11+77.99	76.3	16.30	0.10 Out
02/06/86	56	11+79.87	76.3	16.30	0.10 Out
02/06/86	57	11+81.78	76.3	16.20	0.10 Out
02/10/86	58	12+22.25	76.8	14.90	0.20 Out
02/10/86	59	12+20.14	76.8	14.90	0.25 Out
02/10/86	60	12+17.85	76.8	15.00	0.20 Out
02/10/86	61	12+15.56	76.8	15.10	0.10 Out
02/10/86	62	12+13.27	76.8	15.10	0
02/10/86	63	12+10.93	76.7	15.00	0.10 Out
02/10/86	64	12+08.60	76.7	15.10	0.05 Out
02/10/86	65	12+07.02	76.7	15.10	0
02/10/86	66	12+04.93	76.7	14.90	0
02/10/86	67	12+02.89	76.7	15.10	0
02/10/86	68	12+00.85	76.7	15.20	0
02/10/86	69	11+98.72	76.7	15.20	0.15 Out
02/10/86	70	11+96.60	76.7	15.10	0.05 Out
02/10/86	71	11+94.52	76.7	15.20	0
02/12/86	72	11+92.52	76.7	16.20	0

<u>Notes:</u>

1. Out indicates a horizontal deviation to the outside of the grout curtain.
2. In indicates a horizontal deviation to the inside of the grout curtain.

Penetration Record
(Continued)

DATE	PENETRATION NUMBER	STATION	GRADE (FEET)	TIP ELEVATION (FEET)	HORIZONTAL LOCATION (DEVIATION FROM CENTERLINE) (FEET)
02/12/86	73	11+90.68	76.5	16.40	0.05 Out
02/12/86	74	11+88.43	76.5	16.40	0.05 Out
02/12/86	75	11+86.18	76.4	16.50	0
02/12/86	76	11+84.52	76.4	16.80	0.15 Out
02/12/86	77	11+82.58	76.3	16.80	0.15 Out
02/24/86	78	10+82.73	76.7	16.60	0.20 Out
02/24/86	79	10+81.25	76.8	16.30	0.15 Out
02/24/86	80	10+79.35	76.8	16.60	0.25 Out
02/24/86	81	10+77.44	76.8	16.60	0.25 Out
02/27/86	82	9+93.70	77.6	15.60	0
02/27/86	83	9+95.61	77.6	15.80	0.05 Out
02/27/86	84	9+97.65	77.6	16.00	0.05 Out
02/27/86	85	9+99.68	77.5	15.90	0
02/27/86	86	10+01.81	77.5	15.90	0.10 In
02/27/86	87	10+03.93	77.4	15.91	0.10 In
02/27/86	88	10+06.10	77.4	16.00	0
02/27/86	89	10+08.26	77.3	16.00	0
02/27/86	90	10+10.51	77.3	16.10	0
02/27/86	91	10+12.76	77.2	16.00	0
02/27/86	92	10+15.18	77.2	16.00	0
02/27/86	93	10+17.59	77.1	16.00	0.10 Out
02/27/86	94	10+19.76	77.1	16.00	0.05 Out
02/27/86	95	10+21.93	77.0	16.00	0

Notes:

1. Out indicates a horizontal deviation to the outside of the grout curtain.
2. In indicates a horizontal deviation to the inside of the grout curtain.

Penetration Record
(Continued)

DATE	PENETRATION NUMBER	STATION	GRADE (FEET)	TIP ELEVATION (FEET)	HORIZONTAL LOCATION (DEVIATION FROM CENTERLINE) (FEET)
02/27/86	96	10+24.26	77.0	16.40	0.10 In
02/27/86	97	10+26.59	76.9	16.30	0
02/28/86	98	10+28.84	76.9	16.00	0.15 In
02/28/86	99	10+30.93	76.9	16.00	0.15 In
02/28/86	100	10+33.01	76.8	16.00	0.10 In
02/28/86	101	10+34.93	76.8	16.00	0.10 In
02/28/86	102	10+36.84	76.7	15.80	0.10 In
02/28/86	103	10+38.88	76.7	16.00	0.15 In
02/28/86	104	NC 0+01.58	78.2	15.90	0.15 In
02/28/86	105	NC 0+03.89	78.2	15.90	0.15 In
02/28/86	106	NC 0+06.19	78.2	16.00	0.10 In
02/28/86	107	NC 0+08.50	78.2	16.00	0.15 In
03/01/86	108	NC 0+11.08	78.2	16.00	0.10 In
03/01/86	109	NC 0+13.36	78.2	16.00	0
03/01/86	110	NC 0+15.63	78.2	16.00	0
03/01/86	111	NC 0+17.63	78.2	16.20	0
03/04/86	112	NC 0+19.63	78.2	16.10	0.10 Out
03/04/86	113	NC 0+21.51	78.1	16.10	0.15 Out
03/04/86	114	NC 0+23.38	78.0	16.10	0.10 Out
03/04/86	115	NC 0+25.01	77.9	16.10	0.10 Out
03/04/86	116	NC 0+26.63	77.8	16.10	0.20 Out
03/04/86	117	NC 0+28.42	77.7	16.10	0.20 Out
03/04/86	118	NC 0+30.21	77.6	16.10	0.15 Out
03/05/86	119	9+56.77	78.2	15.80	0.30 In

Notes:

1. Out indicates a horizontal deviation to the outside of the grout curtain.
2. In indicates a horizontal deviation to the inside of the grout curtain.

<u>Penetration Record</u>
(Continued)

DATE	PENETRATION NUMBER	STATION	GRADE (FEET)	TIP ELEVATION (FEET)	HORIZONTAL LOCATION (DEVIATION FROM CENTERLINE) (FEET)
03/05/86	120	9+54.98	78.2	16.00	0.15 In
03/05/86	121	9+53.19	78.2	16.00	0.15 In
03/05/86	122	9+51.40	78.2	15.90	0
03/05/86	123	9+49.27	78.2	15.90	0
03/05/86	124	9+47.15	78.2	16.00	0
03/05/86	125	9+44.98	78.2	16.00	0
03/06/86	126	9+42.98	78.2	16.00	0
03/06/86	127	9+40.98	78.2	16.00	0
03/06/86	128	9+38.98	78.2	16.00	0.10 In
03/06/86	129	9+37.23	78.2	16.00	0
03/07/86	130	9+35.23	78.1	15.50	0.10 In
03/07/86	131	9+33.23	78.1	15.80	0.05 In
03/07/86	132	9+31.23	78.1	15.90	0.10 In
03/07/86	133	9+29.20	78.1	16.00	0
03/07/86	134	9+27.18	78.1	16.00	0
03/07/86	135	9+25.15	78.1	16.00	0
03/07/86	136	9+23.36	78.1	16.00	0
03/07/86	137	9+21.57	78.1	16.00	0
03/10/86	138	9+19.57	78.1	15.90	0.05 In
03/10/86	139	9+17.61	78.1	15.90	0
03/10/86	140	9+15.65	78.1	15.90	0
03/10/86	141	9+13.82	78.1	16.00	0
03/10/86	142	9+11.98	78.1	16.00	0
03/10/86	143	9+10.15	78.1	16.00	0

<u>Notes:</u>

1. Out indicates a horizontal deviation to the outside of the grout curtain.
2. In indicates a horizontal deviation to the inside of the grout curtain.

Penetration Record
(Continued)

DATE	PENETRATION NUMBER	STATION	GRADE (FEET)	TIP ELEVATION (FEET)	HORIZONTAL LOCATION (DEVIATION FROM CENTERLINE) (FEET)
03/10/86	144	9+08.23	78.1	16.00	0
03/10/86	145	9+05.90	78.1	16.00	0
03/10/86	146	9+03.90	78.1	16.00	0
03/11/86	147	9+01.90	78.1	16.10	0
03/11/86	148	9+01.15	78.1	16.00	0.10 In
03/11/86	149	8+98.65	78.1	16.00	0.25 In
03/12/86	150	8+96.65	78.1	16.20	0.15 In
03/12/86	151	8+94.82	78.1	16.20	0
03/12/86	152	8+92.99	78.1	16.10	0.10 In
03/12/86	153	8+90.93	78.2	16.20	0
03/12/86	154	8+88.87	78.2	16.40	0.05 In
03/12/86	155	8+86.81	78.2	16.40	0
03/12/86	156	8+84.75	78.2	16.70	0
03/12/86	157	8+82.69	78.2	16.60	0
03/12/86	158	8+80.58	78.2	16.60	0.05 In
03/12/86	159	8+78.47	78.3	16.60	0
03/12/86	160	8+76.36	78.3	16.60	0.10 In
03/12/86	161	8+75.36	78.3	16.60	0
03/12/86	162	8+73.44	78.3	16.60	0
03/12/86	163	8+71.53	78.3	16.60	0
03/12/86	164	8+69.61	78.3	16.60	0
03/13/86	165	8+72.11	78.3	16.30	0.10 In
03/13/86	166	8+69.98	78.3	16.40	0.10 In
03/13/86	167	8+67.97	78.3	16.30	0.10 In

Notes:

1. Out indicates a horizontal deviation to the outside of the grout curtain.
2. In indicates a horizontal deviation to the inside of the grout curtain.

Penetration Record
(Continued)

DATE	PENETRATION NUMBER	STATION	GRADE (FEET)	TIP ELEVATION (FEET)	HORIZONTAL LOCATION (DEVIATION FROM CENTERLINE) (FEET)
03/13/86	168	8+65.96	78.3	16.30	0
03/13/86	169	8+63.93	78.3	16.30	0
03/13/86	170	8+61.95	78.3	16.30	0
03/13/86	171	8+59.98	78.4	16.30	0
03/13/86	172	8+57.98	78.4	16.20	0
03/13/86	173	8+55.91	78.4	16.10	0.10 Out
03/13/86	174	8+53.84	78.4	16.20	0.10 Out
03/13/86	175	8+51.77	78.4	16.10	0.10 Out
03/13/86	176	8+49.70	78.4	16.40	0.05 Out
03/13/86	177	8+47.63	78.4	16.20	0
03/17/86	178	8+45.63	78.4	16.00	0
03/17/86	179	8+43.60	78.5	16.10	0
03/17/86	180	8+41.48	78.5	16.00	0
03/17/86	181	8+39.40	78.6	15.80	0.10 Out
03/17/86	182	8+37.50	78.6	15.60	0.10 Out
03/17/86	183	8+35.60	78.7	15.60	0
03/17/86	184	8+33.70	78.7	15.60	0.10 In
03/18/86	185	7+67.60	78.8	15.60	0.10 In
03/18/86	186	7+69.81	78.8	15.60	0.10 In
03/18/86	187	7+72.01	78.8	15.60	0.10 In
03/18/86	188	7+74.22	78.8	15.60	0
03/18/86	189	7+76.42	78.8	15.60	0
03/18/86	190	7+78.52	78.8	15.60	0
03/18/86	191	7+80.67	78.8	15.60	0

Notes:

1. Out indicates a horizontal deviation to the outside of the grout curtain.
2. In indicates a horizontal deviation to the inside of the grout curtain.

Penetration Record
(Continued)

DATE	PENETRATION NUMBER	STATION	GRADE (FEET)	TIP ELEVATION (FEET)	HORIZONTAL LOCATION (DEVIATION FROM CENTERLINE) (FEET)
03/18/86	192	7+82.82	78.8	15.60	0
03/18/86	193	7+84.97	78.8	15.60	0.10 In
03/18/86	194	7+87.17	78.8	15.60	0.10 In
03/19/86	195	7+89.17	78.8	15.50	0
03/19/86	196	7+91.42	78.8	15.50	0.10 In
03/19/86	197	7+93.67	78.8	15.50	0
03/19/86	198	7+95.93	78.8	15.50	0
03/19/86	199	7+98.18	78.8	15.60	0.10 In
03/19/86	200	8+00.43	78.8	15.50	0
03/19/86	201	8+02.68	78.8	15.50	0
03/19/86	202	8+04.68	78.8	15.50	0.10 Out
03/19/86	203	8+06.98	78.8	15.70	0
03/19/86	204	8+09.28	78.8	15.50	0
03/19/86	205	8+11.58	78.8	15.50	0
03/20/86	206	8+13.58	78.8	15.40	0
03/20/86	207	8+15.78	78.8	15.40	0
03/20/86	208	8+17.99	78.8	15.60	0
03/20/86	209	8+20.19	78.8	15.70	0
03/20/86	210	8+22.40	78.8	15.90	0.15 In
03/20/86	211	8+24.60	78.8	16.00	0.05 In
03/20/86	212	8+26.80	78.8	16.00	0
03/20/86	213	8+28.65	78.8	16.00	0.10 In
03/20/86	214	8+30.50	78.8	16.00	0.10 In

Notes:

1. Out indicates a horizontal deviation to the outside of the grout curtain.
2. In indicates a horizontal deviation to the inside of the grout curtain.

Penetration Record
(Continued)

DATE	PENETRATION NUMBER	STATION	GRADE (FEET)	TIP ELEVATION (FEET)	HORIZONTAL LOCATION (DEVIATION FROM CENTERLINE) (FEET)
03/20/86	215	8+32.30	78.8	16.00	0
03/21/86	216	7+66.00	81.9	16.10	0
03/21/86	217	7+64.18	81.9	16.00	0
03/21/86	218	7+62.37	82.0	16.00	0
03/21/86	219	7+60.55	82.0	16.00	0
03/21/86	220	7+58.58	82.0	16.00	0.10 In
03/21/86	221	7+56.60	82.0	16.10	0.10 In
03/21/86	222	7+54.63	82.1	16.10	0
03/21/86	223	7+53.21	82.1	16.10	0.10 In
03/24/86	224	7+51.55	82.1	16.10	0.10 In
03/24/86	225	7+49.97	82.1	16.10	0.10 In
03/24/86	226	7+47.80	82.1	16.10	0.10 In
03/24/86	227	7+45.74	82.2	16.10	0.10 In
03/24/86	228	7+43.68	82.2	16.00	0.10 In
03/24/86	229	7+41.63	82.2	16.20	0.15 In
03/24/86	230	7+39.40	82.2	16.30	0.15 In
03/24/86	231	7+37.17	82.3	16.40	0.10 In
03/24/86	232	7+34.93	82.3	16.50	0.10 In
03/24/86	233	7+33.18	82.3	16.50	0.10 In
03/25/86	234	7+33.77	82.8	15.80	0.15 In
03/25/86	235	7+30.61	82.8	15.90	0.10 In
03/25/86	236	7+28.25	82.8	16.00	0.05 In
03/25/86	237	7+25.89	82.8	16.20	0.10 In

Notes:

1. Out indicates a horizontal deviation to the outside of the grout curtain.
2. In indicates a horizontal deviation to the inside of the grout curtain.

Penetration Record
(Continued)

DATE	PENETRATION NUMBER	STATION	GRADE (FEET)	TIP ELEVATION (FEET)	HORIZONTAL LOCATION (DEVIATION FROM CENTERLINE) (FEET)
03/25/86	238	7+24.47	82.8	16.30	0.15 In
03/25/86	239	7+22.25	82.8	16.30	0.10 In
03/25/86	240	7+20.02	82.8	16.30	0.05 In
03/25/86	241	7+17.80	82.8	16.30	0.05 In
03/26/86	242	7+15.80	82.8	16.20	0.05 In
03/26/86	243	7+13.80	82.8	16.30	0
03/26/86	244	7+11.80	82.8	16.50	0
03/26/86	245	7+09.80	82.8	16.50	0
03/26/86	246	7+07.80	82.8	16.50	0.05 In
03/27/86	247	7+05.80	82.8	16.40	0.05 In
03/27/86	248	7+03.63	82.8	16.50	0.10 In
03/27/86	249	7+01.47	82.8	17.00	0.05 In
03/27/86	250	6+99.25	82.8	17.00	0
03/27/86	251	6+97.02	82.8	17.30	0.10 Out
03/27/86	252	6+94.80	82.8	17.50	0.10 Out
03/28/86	253	6+94.30	82.8	17.50	0
03/28/86	254	6+87.79	82.8	16.20	0.10 In
03/28/86	255	6+85.59	82.8	16.50	0
03/28/86	256	6+87.79	82.8	16.50	0
03/31/86	257	6+84.59	82.8	16.50	0.15 In
03/31/86	258	6+83.30	82.8	16.80	0.10 In
03/31/86	259	6+82.01	82.8	16.80	0
03/31/86	260	6+80.72	82.8	16.40	0
04/01/86	261	6+78.72	82.8	16.60	0

Notes:

1. Out indicates a horizontal deviation to the outside of the grout curtain.
2. In indicates a horizontal deviation to the inside of the grout curtain.

Penetration Record
(Continued)

DATE	PENETRATION NUMBER	STATION	GRADE (FEET)	TIP ELEVATION (FEET)	HORIZONTAL LOCATION (DEVIATION FROM CENTERLINE) (FEET)
04/01/86	262	6+76.72	82.8	16.60	0.15 Out
04/01/86	263	6+75.30	82.8	16.60	0.10 Out
04/01/86	264	6+73.89	82.8	16.60	0.10 Out
04/01/86	265	6+72.47	82.8	16.70	0.10 Out
04/03/86	266	4+08.50	79.9	14.00	0.10 In
04/03/86	267	4+10.77	80.0	14.40	0.10 In
04/03/86	268	4+13.03	80.0	14.30	0
04/03/86	269	4+15.30	80.1	14.90	0
04/03/86	270	4+17.56	80.1	14.90	0
04/03/86	271	4+19.83	80.2	15.10	0
04/03/86	272	4+22.09	80.2	14.30	0
04/03/86	273	4+24.12	80.3	14.60	0
04/03/86	274	4+26.14	80.3	14.90	0
04/03/86	275	4+28.14	80.3	14.90	0
04/04/86	276	4+30.14	80.3	15.00	0.10 In
04/04/86	277	4+32.59	80.4	15.10	0
04/04/86	278	4+35.04	80.4	15.20	0
04/04/86	279	4+36.87	80.5	15.40	0
04/04/86	280	4+38.69	80.5	15.40	0
04/07/86	281	4+40.69	80.4	15.00	0
04/07/86	282	4+42.30	80.4	15.40	0.15 Out
04/07/86	283	4+43.90	80.4	15.60	0.10 Out
04/07/86	284	4+45.51	80.4	15.60	0
04/10/86	285	4+47.89	80.4	15.40	0

Notes:

1. Out indicates a horizontal deviation to the outside of the grout curtain.
2. In indicates a horizontal deviation to the inside of the grout curtain.

Penetration Record
(Continued)

DATE	PENETRATION NUMBER	STATION	GRADE (FEET)	TIP ELEVATION (FEET)	HORIZONTAL LOCATION (DEVIATION FROM CENTERLINE) (FEET)
04/10/86	286	4+49.39	80.5	14.90	0.10 In
04/10/86	287	4+51.56	80.6	15.00	0.10 In
04/10/86	288	4+50.56	80.7	15.00	0
04/10/86	289	4+55.80	80.8	15.00	0
04/10/86	290	4+58.05	80.8	14.80	0
04/10/86	291	4+60.29	80.9	15.00	0
04/11/86	292	4+62.38	80.9	15.00	0
04/11/86	293	4+64.47	81.0	14.80	0
04/11/86	294	4+66.79	81.1	14.80	0
04/11/86	295	4+68.55	81.2	15.30	0
04/11/86	296	4+70.30	81.3	15.50	0
04/14/86	297	4+72.29	81.2	15.00	0
04/14/86	298	4+74.49	81.2	15.00	0
04/14/86	299	4+76.49	81.3	15.00	0
04/14/86	300	4+78.14	81.3	15.00	0
04/14/86	301	4+79.79	81.4	14.80	0
04/14/86	302	4+81.99	81.4	14.70	0
04/14/86	303	4+84.19	81.5	14.60	0
04/14/86	304	4+85.95	81.5	14.60	0
04/14/86	305	4+87.71	81.6	14.50	0.10 In
04/14/86	306	4+89.47	81.6	14.60	0
04/15/86	307	4+91.47	81.6	14.70	0.15 In
04/15/86	308	4+93.32	81.7	14.50	0.20 In
04/15/86	309	4+95.16	81.7	14.60	0.15 In

Notes:

1. Out indicates a horizontal deviation to the outside of the grout curtain.
2. In indicates a horizontal deviation to the inside of the grout curtain.

Penetration Record
(Continued)

DATE	PENETRATION NUMBER	STATION	GRADE (FEET)	TIP ELEVATION (FEET)	HORIZONTAL LOCATION (DEVIATION FROM CENTERLINE) (FEET)
04/15/86	310	4+97.01	81.8	14.60	0.20 In
04/15/86	311	4+98.85	81.8	14.50	0.20 In
04/15/86	312	5+00.70	81.9	13.90	0.20 In
04/15/86	313	5+02.54	81.9	13.90	0.15 In
04/15/86	314	5+04.39	81.9	14.00	0.20 In
04/16/86	315	5+06.39	82.0	14.20	0.20 In
04/16/86	316	5+07.89	82.0	14.20	0.15 In
04/16/86	317	5+09.39	82.0	14.10	0.10 In
04/15/86	318	5+10.89	82.0	14.10	0.10 In
04/15/86	319	5+12.39	82.1	14.10	0.10 In
04/15/86	320	5+13.89	82.1	14.40	0.10 In
04/15/86	321	5+15.09	82.1	14.40	0.10 In
04/15/86	322	5+16.29	82.1	14.40	0.10 In
04/15/86	323	5+16.89	82.1	14.20	0.10 In
04/15/86	324	5+17.49	82.1	14.20	0.10 In
04/17/86	325	5+18.99	82.2	14.20	0.10 In
04/17/86	326	5+20.39	82.2	14.10	0.10 In
04/17/86	327	5+21.79	82.2	14.10	0.10 In
04/17/86	328	5+23.39	82.3	14.10	0
04/17/86	329	5+24.99	82.3	14.10	0
04/17/86	330	5+26.69	82.3	14.30	0
04/17/86	331	5+28.39	82.3	14.90	0
05/01/86	332	5+30.17	82.4	15.70	0.10 In
05/01/86	333	5+32.17	82.4	15.90	0.10 In

Notes:

1. Out indicates a horizontal deviation to the outside of the grout curtain.
2. In indicates a horizontal deviation to the inside of the grout curtain.

Penetration Record
(Continued)

DATE	PENETRATION NUMBER	STATION	GRADE (FEET)	TIP ELEVATION (FEET)	HORIZONTAL LOCATION (DEVIATION FROM CENTERLINE) (FEET)
05/01/86	334	5+33.83	82.4	16.10	0.10 In
05/01/86	335	5+35.50	82.5	16.10	0.10 In
05/01/86	336	5+37.16	82.5	16.10	0.10 In
05/01/86	337	5+39.16	82.5	16.60	0.10 In
05/01/86	338	5+40.31	82.5	16.80	0.10 In
05/06/86	339	6+04.66	82.3	15.40	0
05/06/86	340	6+02.38	82.3	15.70	0
05/06/86	341	6+00.11	82.4	15.80	0
05/06/86	342	5+98.11	82.4	15.80	0
05/06/86	343	5+96.11	82.4	16.00	0.05 Out
05/06/86	344	5+94.27	82.5	16.00	0
05/08/86	345	5+92.27	82.6	16.00	0.10 Out
05/08/86	346	5+90.14	82.7	15.90	0
05/08/86	347	5+88.00	82.8	15.90	0
05/08/86	348	5+85.87	82.9	15.90	0
05/09/86	349	5+83.87	83.0	15.70	0
05/09/86	350	5+81.37	83.1	15.80	0
05/09/86	351	5+78.87	83.1	15.80	0
05/09/86	352	5+76.27	83.2	15.80	0
05/09/86	353	5+73.77	83.3	15.80	0
05/09/86	354	5+72.47	83.3	16.00	0
05/12/86	355	5+70.47	83.3	15.60	0.10 Out
05/12/86	356	5+68.17	83.2	15.70	0
05/12/86	357	5+65.87	83.2	15.70	0

Notes:

1. Out indicates a horizontal deviation to the outside of the grout curtain.
2. In indicates a horizontal deviation to the inside of the grout curtain.

Penetration Record
(Continued)

DATE	PENETRATION NUMBER	STATION	GRADE (FEET)	TIP ELEVATION (FEET)	HORIZONTAL LOCATION (DEVIATION FROM CENTERLINE) (FEET)
05/12/86	358	5+63.47	83.1	15.70	0
05/13/86	359	5+61.07	83.0	15.80	0.10 Out
05/13/86	360	5+58.67	82.9	15.80	0
05/13/86	361	5+57.07	82.9	15.80	0.10 Out
05/13/86	362	5+54.67	82.8	16.00	0
05/13/86	363	5+52.27	82.8	16.00	0.10 Out
05/13/86	364	5+49.87	82.7	16.00	0
05/13/86	365	5+47.47	82.6	16.00	0
05/13/86	366	5+45.07	82.6	18.10	0.15 Out
05/14/86	367	6+23.89	82.5	15.80	0.10 Out
05/14/86	368	6+19.31	82.5	16.30	0
05/14/86	369	6+17.31	82.4	15.80	0
05/14/86	370	6+14.91	82.4	15.80	0
05/15/86	371	6+13.51	82.4	15.80	0
05/15/86	372	6+11.11	82.4	15.80	0
05/15/86	373	6+08.71	82.5	16.00	0
05/15/86	374	6+06.31	82.3	16.00	0
05/28/86	375	6+70.89	82.8	16.00	0.10 In
05/28/86	376	6+68.59	82.8	16.00	0.10 In
05/28/86	377	6+66.29	82.8	16.00	0.05 In
05/29/86	378	6+64.19	82.8	16.00	0.10 In
05/29/86	379	6+63.24	82.8	16.00	0.05 In
05/29/86	380	6+60.94	82.9	16.00	0
05/29/86	381	6+58.64	82.9	16.00	0

Notes:

1. Out indicates a horizontal deviation to the outside of the grout curtain.
2. In indicates a horizontal deviation to the inside of the grout curtain.

Penetration Record
(Continued)

DATE	PENETRATION NUMBER	STATION	GRADE (FEET)	TIP ELEVATION (FEET)	HORIZONTAL LOCATION (DEVIATION FROM CENTERLINE) (FEET)
05/29/86	382	6+56.34	82.9	16.00	0
05/30/86	383	6+54.34	82.9	16.00	0.05 Out
05/30/86	384	6+52.04	82.9	16.00	0
05/30/86	385	6+49.74	82.9	16.00	0
05/30/86	386	6+47.44	82.8	16.00	0
05/30/86	387	6+45.14	82.8	16.00	0.05 Out
05/30/86	388	6+42.84	82.8	16.00	0
05/30/86	389	6+40.54	82.8	16.00	0
05/30/86	390	6+38.24	82.7	16.00	0
05/30/86	391	6+35.94	82.7	16.00	0.05 Out
05/31/86	392	6+33.94	82.7	16.00	0
05/31/86	393	6+31.64	82.6	16.00	0
05/31/86	394	6+29.34	82.6	16.00	0
05/31/86	395	6+27.04	82.6	21.00	0.05 Out
05/31/86	396	6+89.32	82.8	50.90	0
06/02/86	397	-0+01.00	76.8	16.00	0
06/02/86	398	0+01.30	76.9	16.00	0
06/02/86	399	0+03.60	77.0	16.00	0
06/02/86	400	0+05.85	77.1	16.00	0.10 Out
06/02/86	401	0+08.15	77.1	16.00	0.05 Out
06/02/86	402	0+10.45	77.2	16.00	0
06/02/86	403	0+12.75	72.3	16.00	0.05 Out
06/02/86	404	0+15.05	72.3	16.00	0
06/03/86	405	0+17.05	77.4	15.90	0

Notes:

1. Out indicates a horizontal deviation to the outside of the grout curtain.
2. In indicates a horizontal deviation to the inside of the grout curtain.

Penetration Record
(Continued)

DATE	PENETRATION NUMBER	STATION	GRADE (FEET)	TIP ELEVATION (FEET)	HORIZONTAL LOCATION (DEVIATION FROM CENTERLINE) (FEET)
06/03/86	406	0+19.35	77.4	15.90	0
06/03/86	407	0+21.65	77.5	16.00	0.10 In
06/03/86	408	0+23.95	77.5	16.00	0
06/03/86	409	0+26.25	77.5	16.00	0
06/03/86	410	0+28.55	77.6	16.00	0.05 In
06/03/86	411	0+30.85	77.6	16.00	0
06/03/86	412	0+33.15	77.6	16.00	0.10 In
06/03/86	413	0+35.45	77.6	16.00	0
06/03/86	414	0+37.75	77.7	16.00	0
06/04/86	415	0+39.75	77.7	15.80	0
06/04/86	416	0+42.05	77.7	15.60	0
06/04/86	417	0+44.35	77.7	15.70	0
06/04/86	418	0+46.65	77.7	15.70	0
06/04/86	419	0+48.95	77.7	15.80	0
06/04/86	420	0+51.25	77.7	15.80	0
06/04/86	421	0+53.55	77.6	15.70	0.10 Out
06/04/86	422	0+55.85	77.5	15.80	0.05 Out
06/04/86	423	0+55.15	77.4	15.80	0.10 Out
06/04/86	424	0+60.45	77.4	15.80	0
06/04/86	425	0+62.75	77.3	15.80	0.05 Out
06/04/86	426	0+65.05	77.2	15.80	0
06/04/86	427	0+67.35	77.1	15.70	0.10 Out
06/04/86	428	0+69.65	77.1	15.70	0.05 Out
06/04/86	429	0+71.95	77.0	15.70	0

Notes:

1. Out indicates a horizontal deviation to the outside of the grout curtain.
2. In indicates a horizontal deviation to the inside of the grout curtain.

Penetration Record
(Continued)

DATE	PENETRATION NUMBER	STATION	GRADE (FEET)	TIP ELEVATION (FEET)	HORIZONTAL LOCATION (DEVIATION FROM CENTERLINE) (FEET)
06/04/86	430	0+74.25	76.9	15.70	0
06/04/86	431	0+76.55	76.9	15.80	0
06/04/86	432	0+78.85	76.9	15.70	0
06/04/86	433	0+81.15	76.9	15.60	0.10 Out
06/04/86	434	0+83.45	76.9	15.70	0
06/04/86	435	0+85.75	76.9	15.70	0.10 Out
06/04/86	436	0+88.05	76.9	15.80	0.10 Out
06/05/86	437	0+90.05	76.9	15.70	0
06/05/86	438	0+92.35	76.9	15.80	0
06/05/86	439	0+94.67	76.8	15.80	0
06/05/86	440	0+96.97	76.8	15.80	0
06/05/86	441	0+99.27	76.7	15.80	0.10 Out
06/05/86	442	1+01.57	76.6	15.80	0
06/05/86	443	1+03.87	76.6	15.80	0
06/05/86	444	1+06.15	76.5	15.90	0
06/05/86	445	1+08.45	76.5	15.90	0.10 Out
06/05/86	446	1+10.75	76.4	15.90	0
06/05/86	447	1+13.05	76.4	15.90	0
06/05/86	448	1+15.35	76.3	15.90	0
06/05/86	449	1+17.65	76.3	15.90	0.10 In
06/05/86	450	1+19.95	76.2	15.90	0

Notes:

1. Out indicates a horizontal deviation to the outside of the grout curtain.
2. In indicates a horizontal deviation to the inside of the grout curtain.

Penetration Record
(Continued)

DATE	PENETRATION NUMBER	STATION	GRADE (FEET)	TIP ELEVATION (FEET)	HORIZONTAL LOCATION (DEVIATION FROM CENTERLINE) (FEET)
06/06/86	451	1+88.10	77.4	15.50	0.10 Out
06/06/86	452	1+92.35	77.4	15.80	0
06/06/86	453	1+86.10	77.3	16.00	0
06/06/86	454	1+83.80	77.3	15.70	0
06/06/86	455	1+81.50	77.3	16.00	0
06/06/86	456	1+79.20	77.3	16.00	0.10 In
06/06/86	457	1+76.90	77.3	16.00	0
06/06/86	458	1+74.60	77.2	16.00	0
06/09/86	459	1+72.60	77.2	15.80	0.10 In
06/09/86	460	1+70.30	77.2	15.80	0.10 In
06/09/86	461	1+68.00	77.2	15.80	0.05 In
06/09/86	462	1+65.70	77.2	15.80	0
06/09/86	463	1+63.40	77.2	15.90	0.10 In
06/09/86	464	1+61.10	77.2	15.90	0
06/09/86	465	1+58.80	77.2	15.90	0
06/09/86	466	1+56.50	77.2	15.80	0
06/09/86	467	1+54.20	77.2	15.90	0.10 In
06/09/86	468	1+51.90	77.2	15.90	0
06/09/86	469	1+49.60	77.2	15.90	0
06/09/86	470	1+47.30	77.1	15.90	0.05 In
06/09/86	471	1+45.00	77.1	15.90	0
06/09/86	472	1+42.70	77.1	16.00	0
06/09/86	473	1+21.95	77.0	16.00	0

Notes:

1. Out indicates a horizontal deviation to the outside of the grout curtain.
2. In indicates a horizontal deviation to the inside of the grout curtain.

Penetration Record
(Continued)

DATE	PENETRATION NUMBER	STATION	GRADE (FEET)	TIP ELEVATION (FEET)	HORIZONTAL LOCATION (DEVIATION FROM CENTERLINE) (FEET)
06/09/86	474	1+24.25	77.0	15.80	0
06/09/86	475	1+26.55	77.1	15.80	0
06/09/86	476	1+28.85	77.1	16.00	0
06/09/86	477	1+31.15	77.1	16.00	0
06/09/86	478	1+33.45	77.2	15.90	0
06/10/86	479	1+35.79	77.1	15.80	0.05 Out
06/10/86	480	1+38.79	77.1	16.00	0
06/10/86	481	1+91.85	77.4	15.70	0
06/10/86	482	1+94.13	77.4	15.70	0.10 In
06/10/86	483	1+96.43	77.5	15.80	0.05 In
06/10/86	484	1+98.73	77.5	15.80	0
06/10/86	485	2+67.80	77.9	15.10	0.10 In
06/10/86	486	2+66.75	77.9	15.50	0
06/10/86	487	2+66.65	77.9	15.50	0
06/10/86	488	2+71.55	77.9	15.50	0
06/10/86	489	2+00.73	77.5	15.80	0
06/10/86	490	2+03.03	77.5	15.80	0
06/10/86	491	2+05.33	77.6	15.80	0
06/10/86	492	2+07.63	77.6	15.80	0
06/10/86	493	2+09.93	77.6	15.70	0
06/10/86	494	2+12.23	77.6	15.80	0
06/10/86	495	2+14.53	77.7	15.80	0
06/10/86	496	2+16.83	77.7	15.70	0

Notes:

1. Out indicates a horizontal deviation to the outside of the grout curtain.
2. In indicates a horizontal deviation to the inside of the grout curtain.

Penetration Record
(Continued)

DATE	PENETRATION NUMBER	STATION	GRADE (FEET)	TIP ELEVATION (FEET)	HORIZONTAL LOCATION (DEVIATION FROM CENTERLINE) (FEET)
06/10/85	497	2+19.13	77.7	15.80	0
06/11/86	498	2+21.13	77.7	14.80	0
06/11/86	499	2+23.43	77.7	15.30	0
06/11/86	500	2+25.73	77.7	15.80	0
06/11/86	501	2+28.03	77.8	15.80	0
06/11/86	502	2+30.33	77.8	15.80	0
06/11/86	503	2+32.63	77.8	15.80	0
06/11/86	504	2+34.93	77.8	15.40	0
06/11/86	505	2+37.23	77.8	15.30	0
06/11/86	506	2+39.53	77.9	15.60	0
06/11/86	507	2+41.83	77.9	15.50	0
06/11/86	508	2+44.13	77.9	15.60	0
06/11/86	509	2+46.43	77.9	15.60	0
06/11/86	510	2+48.73	77.9	15.80	0
06/11/86	511	2+51.03	77.9	15.80	0
06/11/86	512	2+53.33	77.9	15.80	0.10 In
06/11/86	513	2+55.63	77.9	16.00	0
06/11/86	514	2+57.93	77.9	16.00	0
06/11/86	515	2+60.23	77.9	16.00	0
06/12/86	516	2+62.33	77.9	16.00	0.10 Out
06/12/86	517	4+04.82	78.9	16.00	0
06/12/86	518	4+02.52	78.9	16.00	0
06/12/86	519	4+00.22	78.9	16.00	0

Notes:

1. Out indicates a horizontal deviation to the outside of the grout curtain.
2. In indicates a horizontal deviation to the inside of the grout curtain.

Penetration Record
(Continued)

DATE	PENETRATION NUMBER	STATION	GRADE (FEET)	TIP ELEVATION (FEET)	HORIZONTAL LOCATION (DEVIATION FROM CENTERLINE) (FEET)
06/12/86	520	3+97.92	78.9	16.00	0
06/12/86	521	3+95.62	78.9	16.00	0
06/12/86	522	3+93.32	78.9	16.00	0
06/12/86	523	3+91.02	78.9	16.00	0
06/12/86	524	3+88.72	78.9	16.00	0
06/13/86	525	3+86.72	78.9	16.00	0
06/13/86	526	3+84.42	78.9	16.00	0
06/13/86	527	3+82.12	78.9	16.00	0
06/14/86	528	3+80.12	78.9	16.00	0
06/14/86	529	3+77.82	78.9	16.00	0.05 In
06/14/86	530	3+75.52	78.9	16.00	0.05 In
06/14/86	531	3+73.22	78.9	16.00	0
06/14/86	532	3+70.92	78.9	16.00	0
06/14/86	533	3+68.62	78.9	16.00	0
06/14/86	534	3+66.32	78.9	16.00	0
06/14/86	535	3+64.02	78.9	16.00	0
06/16/86	536	3+62.02	78.9	16.00	0
06/16/86	537	3+60.36	78.9	16.00	0
06/16/86	538	3+58.06	78.9	16.00	0
06/16/86	539	3+55.76	78.9	16.00	0
06/16/86	540	3+53.46	78.9	16.00	0
06/16/86	541	3+51.16	78.9	16.00	0
06/17/86	542	3+27.52	78.9	15.60	0

Notes:

1. Out indicates a horizontal deviation to the outside of the grout curtain.
2. In indicates a horizontal deviation to the inside of the grout curtain.

Penetration Record
(Continued)

DATE	PENETRATION NUMBER	STATION	GRADE (FEET)	TIP ELEVATION (FEET)	HORIZONTAL LOCATION (DEVIATION FROM CENTERLINE) (FEET)
06/17/86	543	3+25.25	78.9	15.70	0
06/17/86	544	3+22.95	78.9	15.60	0
06/17/86	545	3+20.65	78.9	15.80	0
06/17/86	546	3+18.35	78.9	15.80	0
06/17/86	547	3+16.05	78.9	15.80	0
06/17/86	548	3+13.75	78.9	15.80	0
06/17/86	549	3+11.45	78.9	15.80	0
06/17/86	550	3+09.15	78.9	15.80	0
06/17/86	551	3+06.85	78.9	15.80	0
06/17/86	552	3+04.55	78.9	15.80	0
06/17/86	553	3+02.25	78.9	15.80	0.05 In
06/17/86	554	2+99.95	78.9	15.80	0.10 In
06/17/86	555	2+97.62	78.9	15.80	0
06/17/86	556	2+95.32	78.9	15.80	0.10 In
06/18/86	557	2+93.32	78.9	15.80	0
06/18/86	558	2+91.02	78.9	15.80	0
06/18/86	559	2+88.72	78.9	15.80	0
06/18/86	560	2+86.42	78.9	15.80	0
06/18/86	561	2+84.12	78.9	15.80	0
06/18/86	562	2+81.82	78.9	15.80	0
06/18/86	563	2+81.00	78.9	15.80	0
06/19/86	564	2+78.60	78.9	16.00	0
06/19/86	565	2+76.20	78.9	15.80	0.10 Out

Notes:

1. Out indicates a horizontal deviation to the outside of the grout curtain.
2. In indicates a horizontal deviation to the inside of the grout curtain.

Penetration Record
(Continued)

DATE	PENETRATION NUMBER	STATION	GRADE (FEET)	TIP ELEVATION (FEET)	HORIZONTAL LOCATION (DEVIATION FROM CENTERLINE) (FEET)
06/19/86	566	2+73.80	78.9	15.80	0.10 Out
06/19/86	567	3+49.12	78.9	16.00	0
06/19/86	568	3+46.62	78.9	16.00	0
06/19/86	569	3+44.12	78.9	16.00	0.10 Out
06/19/86	570	3+41.62	78.9	16.00	0.10 Out
06/19/86	571	3+39.12	78.9	15.90	0
06/19/86	572	3+36.62	78.9	16.00	0
06/19/86	573	3+34.12	78.9	15.80	0
06/19/86	574	3+31.62	78.9	16.00	0
06/19/86	575	3+29.12	78.9	16.00	0
06/20/86	576	10+75.86	76.9	16.00	0
06/20/86	577	10+73.06	76.9	16.00	0
06/20/86	578	10+70.26	76.8	16.00	0
06/20/86	579	10+67.46	76.8	16.00	0
06/20/86	580	10+64.66	76.7	16.00	0
06/20/86	581	10+61.86	76.7	16.00	0
06/20/86	582	10+59.06	76.6	16.00	0
06/20/86	583	10+56.26	76.6	16.00	0
06/20/86	584	10+53.46	76.5	16.00	0
06/20/86	585	10+51.66	76.5	16.00	0
06/20/86	586	10+47.86	76.5	16.00	0
06/20/86	587	10+45.06	76.6	16.00	0
06/20/86	588	10+42.26	76.6	16.00	0
06/20/86	589	10+41.05	76.6	16.00	0

Notes:

1. Out indicates a horizontal deviation to the outside of the grout curtain.
2. In indicates a horizontal deviation to the inside of the grout curtain.

APPENDIX C

BORING LOGS

Canonie

Boring Log

PROJECT No. CH 85-396
BORING No. SSB-1
LOGGED BY J. MCLAY
PAGE 1 OF 2

PROJECT NAME TP INDUSTRIAL
BORING LOCATION CENTERLINE GROUT CURTAIN - STATION 2 + 00 SURFACE ELEV. 77.5
DRILLER HYDRO GROUP, INC. DATE: START 4-11-86 FINISH 4-11-86

DEPTH	SAMPLE No.	TYPE	INTERVAL FROM	INTERVAL TO	BLOW COUNT 0-6	BLOW COUNT 6-12	BLOW COUNT 12-18	RECOVERY IN INCHES	U.S.C.S. SOIL TYPE	PERCENT MOISTURE	qu TSF	CONTACT DEPTH	SOIL DESCRIPTION AND REMARKS	PIEZO.
													NO SAMPLES TAKEN ABOVE 55.5 FT.	
55														
	1	SS	55.5	57.5				14	SP			55.5	BROWN FINE SAND, SOME SILT, TRACE OF CLAY, TRACE OF MICA FLAKES.	
56									ML			55.8	BROWN SILT, SOME CLAY, TRACE OF FINE SAND, TRACE OF MICA FLAKES.	
57									SP			56.3	BROWN FINE SAND, SOME SILT, TRACE OF MICA FLAKES.	
	2	SS	57.5	59.5				14	GM			57.5	BROWN SILT, SOME CLAY, TRACE OF FINE GRAVEL, TRACE OF FINE SAND, TRACE OF MICA FLAKES.	
58														
59									SM			58.1	BROWN FINE SAND, SOME SILT, TRACE OF COARSE SAND, TRACE OF CLAY, TRACE OF MICA FLAKES.	
	3	SS	59.5	61.5				16				59.5	LIGHT BROWN FINE TO MEDIUM SAND, SOME SILT, TRACE OF MICA FLAKES.	
60														
61									CL			60.6	BROWN CLAY, SOME SILT, TRACE OF MICA FLAKES.	
									SM			61.2	BROWN FINE SAND, SOME SILT, TRACE OF MICA FLAKES.	
	4	SS	61.5	63.5					ML			61.5	LIGHT BROWN SILT, SOME CLAY, TRACE OF FINE TO COARSE SAND, TRACE OF FINE GRAVEL.	
62														

Rev. 2-86

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Boring Log

PROJECT No. CH 85-096
BORING No. SSB-1
LOGGED BY D. McLAY

PROJECT NAME TP INDUSTRIAL
BORING LOCATION CENTERLINE GROUT CURTAIN - STATION 2 + 00 SURFACE ELEV. 77.5
DRILLER HYDRO GROUP, INC. DATE: START 4-11-86 FINISH 4-11-86

DEPTH	SAMPLE No.	SAMPLE TYPE	INTERVAL FROM	INTERVAL TO	BLOW COUNT 0-6	BLOW COUNT 6-12	BLOW COUNT 12-18	RECOVERY IN INCHES	U.S.C.S. SOIL TYPE	PERCENT MOISTURE	qu TSF	CONTACT DEPTH	SOIL DESCRIPTION AND REMARKS	PIEZO.
63								18	SM			63.0	BROWN FINE TO MEDIUM SAND, SOME SILT, TRACE OF CLAY, TRACE OF MICA FLAKES.	
												63.5	BOTTOM OF BORING AT 63.5 FT.	
64														
65														

NOTES:

1. BORING WAS DRILLED USING A 3-¼-IN. HOLLOW STEM AUGER.
2. SAMPLES WERE RETRIEVED BY A SPLIT SPOON USING A LONG STROKE JAR TO DRIVE THE CORE BARREL.
3. BORING WAS BACKFILLED AFTER COMPLETION.

Rev. 2-86

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Boring Log

PROJECT No. CH 85-396
BORING No. SSB-2
LOGGED BY D. McLAY
PAGE 1 OF 2

PROJECT NAME TP INDUSTRIAL
BORING LOCATION 3 FT. INSIDE CENTERLINE GROUT CURTAIN STA 4+25 SURFACE ELEV. 80.26
DRILLER HYDRO GROUP, INC. DATE: START 4-10-86 FINISH 4-11-86

DEPTH	SAMPLE No.	TYPE	INTERVAL FROM	INTERVAL TO	BLOW COUNT 0-6	BLOW COUNT 6-12	BLOW COUNT 12-18	RECOVERY IN INCHES	U.S.C.S. SOIL TYPE	PERCENT MOISTURE	qu TSF	CONTACT DEPTH	SOIL DESCRIPTION AND REMARKS	PIEZO.
55														
56													No Samples Taken Above 58.3 Ft.	
57														
58														
	1	SS	58.3	60.3								58.3		
									SM				Light Brown Fine To Medium Sand, Some Silt, Trace Of Mica Flakes.	
59								16				58.9		
									ML				Brown Silt, Some Clay, Trace Of Fine Sand, Trace Of Mica Flakes.	
60												59.9		
	2	SS	60.3	62.3					SM				Light Brown Fine Sand, Some Silt, Trace Of Mica Flakes.	
61								16				60.9		
									ML				Light Brown Silt, Some Clay, Trace Of Fine To Coarse Sand, Trace Of Mica Flakes.	
62														
												62.3		

Rev. 2-86

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Boring Log

PROJECT No. CH 85-096
BORING No. SSB-2
LOGGED BY D. McLAY
PAGE 2 OF 2

PROJECT NAME TP INDUSTRIAL
BORING LOCATION 3 FT. INSIDE CENTERLINE GROUT CURTAIN STA 4+25 SURFACE ELEV. 80.26
DRILLER HYDRO GROUP, INC. DATE: START 4-10-86 FINISH 4-11-86

DEPTH	SAMPLE No.	SAMPLE TYPE	INTERVAL FROM	INTERVAL TO	BLOW COUNT 0-6	BLOW COUNT 6-12	BLOW COUNT 12-18	RECOVERY IN INCHES	U.S.C.S. SOIL TYPE	PERCENT MOISTURE	qu TSF	CONTACT DEPTH	SOIL DESCRIPTION AND REMARKS	PIEZO
	3	SS	62.3	64.3					SW				BROWN FINE TO COARSE SAND, SOME FINE TO COARSE GRAVEL, TRACE OF SILT, TRACE OF MICA FLAKES.	
63								16				62.9		
									ML				LIGHT BROWN SILT, SOME CLAY, SOME FINE GRAVEL, TRACE OF FINE TO COARSE SAND, TRACE OF MICA FLAKES.	
												63.7		
64									SW				LIGHT BROWN FINE TO COARSE SAND, SOME FINE GRAVEL, TRACE OF SILT, TRACE OF MICA FLAKES.	
	4	SS	64.3	66.3								64.3		
65								16	CL				LIGHT BROWN CLAY, SOME SILT, TRACE OF FINE SAND, TRACE OF MICA FLAKES.	
												65.4		
66									SM				LIGHT BROWN FINE TO COARSE SAND, SOME SILT, TRACE OF FINE GRAVEL.	
												66.3	BOTTOM OF BORING AT 66.3 FT.	
67													NOTES:	
													1. BORING WAS DRILLED USING A 3-1/4-IN. HOLLOW STEM AUGER.	
68													2. SAMPLES WERE RETRIEVED BY A SPLIT SPOON USING A LONG STROKE JAR TO DRIVE THE CORE BARREL.	
69													3. BORING WAS BACKFILLED AFTER COMPLETION.	
70														

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Boring Log

PROJECT No. CH 85-096
BORING No. SSB-3
LOGGED BY D. MCLAY
PAGE 1 OF 3

PROJECT NAME TP INDUSTRIAL
BORING LOCATION CENTERLINE OF GROUT CURTAIN STATION 6+00 SURFACE ELEV. 82.22
DRILLER HYDRO GROUP, INC. DATE: START 4-10-86 FINISH 4-10-86

DEPTH	SAMPLE No.	SAMPLE TYPE	INTERVAL FROM	INTERVAL TO	BLOW COUNT 0-6	BLOW COUNT 6-12	BLOW COUNT 12-18	RECOVERY IN INCHES	U.S.C.S. SOIL TYPE	PERCENT MOISTURE	qu TSF	CONTACT DEPTH	SOIL DESCRIPTION AND REMARKS	PIEZO
55														
56														
57													NO SAMPLES TAKEN ABOVE 60.2 FT.	
58														
59														
60												60.2		
	1	SS	60.2	62.2					SW				LIGHT BROWN FINE TO COARSE SAND, TRACE OF FINE GRAVEL, TRACE OF SILT.	
61												61.0		
								16	SM				BROWN FINE SAND AND SILT, TRACE OF CLAY, TRACE OF MICA FLAKES.	
62														
	2	SS	62.2	64.2										

Rev. 2-86

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Boring Log

PROJECT No. CH 85-096
BORING No. SSB-3
LOGGED BY D. MCLAY
PAGE 2 OF 3

PROJECT NAME TP INDUSTRIAL
BORING LOCATION CENTERLINE OF GROUT CURTAIN STATION 6+00 SURFACE ELEV. 32.22
DRILLER HYDRO GROUP, INC. DATE: START 4-10-86 FINISH 4-10-86

DEPTH	SAMPLE No.	TYPE	INTERVAL FROM	INTERVAL TO	BLOW COUNT 0-6	BLOW COUNT 6-12	BLOW COUNT 12-18	RECOVERY IN INCHES	U.S.C.S. SOIL TYPE	PERCENT MOISTURE	qu TSF	CONTACT DEPTH	SOIL DESCRIPTION AND REMARKS	PIEZO.
													BROWN FINE SAND AND SILT, TRACE OF CLAY, TRACE OF MICA FLAKES.	
63												62.9		
								16	SP				ORANGE-BROWN FINE SAND, SOME SILT, TRACE OF MICA FLAKES.	
64												64.0		
	3	SS	64.2	66.2										
65														
								16	SM				BROWN FINE SAND AND SILT, SOME CLAY, TRACE OF MICA FLAKES.	
66														
	4	SS	66.2	68.2								66.6		
67									SP				BROWN FINE SAND, SOME SILT, TRACE OF CLAY, TRACE OF MICA FLAKES.	
								16				67.3		
68									ML				LIGHT BROWN SILT, SOME CLAY, TRACE OF FINE SAND, TRACE OF MICA FLAKES.	
												68.2	BOTTOM OF BORING AT 68.2 FT.	
69														
70														

Rev. 2-86

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Boring Log

PROJECT No. CH 35-096

BORING No. SSB-3

LOGGED BY D. McLAY

PROJECT NAME TP INDUSTRIAL

BORING LOCATION CENTERLINE OF GROUT CURTAIN STATION 6+00 SURFACE ELEV. 82.22

DRILLER HYDRO GROUP, INC. DATE: START 4-10-86 FINISH 4-10-86

DEPTH	SAMPLE No.	SAMPLE TYPE	INTERVAL FROM	INTERVAL TO	BLOW COUNT 0-6	BLOW COUNT 6-12	BLOW COUNT 12-18	RECOVERY IN INCHES	U.S.C.S. SOIL TYPE	PERCENT MOISTURE	qu TSF	CONTACT DEPTH	SOIL DESCRIPTION AND REMARKS	PIEZO.
													NOTES: 1. BORING WAS DRILLED USING A 3-1/4-IN. HOLLOW STEM AUGER. 2. SAMPLES WERE RETRIEVED BY A SPLIT SPOON USING A LONG STROKE JAR TO DRIVE THE CORE BARREL. 3. BORING WAS BACKFILLED AFTER COMPLETION.	

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Boring Log

PROJECT No. CH 85-396
BORING No. SSB-4
LOGGED BY D. MCLAY

PROJECT NAME TP INDUSTRIAL
BORING LOCATION 3 FT. INSIDE CENTERLINE GROUT CURTAIN STA 7+25 SURFACE ELEV. 82.75
DRILLER HYDRO GROUP, INC. DATE: START 4-09-86 FINISH 4-09-86

DEPTH	SAMPLE No.	SAMPLE TYPE	INTERVAL FROM	INTERVAL TO	BLOW COUNT 0-6	BLOW COUNT 6-12	BLOW COUNT 12-18	RECOVERY IN INCHES	U.S.C.S. SOIL TYPE	PERCENT MOISTURE	qu TSF	CONTACT DEPTH	SOIL DESCRIPTION AND REMARKS	PIEZO
55														
56														
57														
58													NO SAMPLES TAKEN ABOVE 61.0 FT.	
59														
60														
61												61.0		
	1	SS	61.0	63.0					SW				BROWN FINE TO COARSE SAND, SOME FINE TO COARSE GRAVEL, TRACE OF SILT.	
												61.5		
62								18						

Rev. 2-86

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Boring Log

PROJECT No. CH 85-396
BORING No. SSB-4
LOGGED BY D. McLAY

PROJECT NAME TP INDUSTRIAL
BORING LOCATION 3 FT. INSIDE CENTERLINE GROUT CURTAIN STA 7+25 SURFACE ELEV. 82.75
DRILLER HYDRO GROUP, INC. DATE: START 4-09-86 FINISH 4-09-86

DEPTH	SAMPLE No.	SAMPLE TYPE	INTERVAL FROM	INTERVAL TO	BLOW COUNT 0-6	BLOW COUNT 6-12	BLOW COUNT 12-18	RECOVERY IN INCHES	U.S.C.S. SOIL TYPE	PERCENT MOISTURE	qu TSF	CONTACT DEPTH	SOIL DESCRIPTION AND REMARKS	PIEZO
									ML-CL				BROWN SILT AND CLAY, TRACE OF FINE SAND, TRACE OF MICA FLAKES.	
63												63.0		
	2	SS	63.0	65.0										
64								18						
65														
	3	SS	65.0	67.0										
66								18	SM				BROWN FINE SAND, SOME SILT, TRACE OF MICA FLAKES.	
67														
	4	SS	67.0	69.0										
68								18						
69														
	5	SS	69.0	71.0										
70								18						

Canonie

Boring Log

PROJECT No. CH 85-096
BORING No. 558-4
LOGGED BY D. McLAY
PAGE 3 OF 3

PROJECT NAME TP INDUSTRIAL
BORING LOCATION 3 FT. INSIDE CENTERLINE GROUT CURTAIN STA 7+25 SURFACE ELEV. 82.75
DRILLER HYDRO GROUP, INC. DATE: START 4-09-86 FINISH 4-09-86

DEPTH	SAMPLE No.	TYPE	INTERVAL FROM	INTERVAL TO	BLOW COUNT 0-6	6-12	12-18	RECOVERY IN INCHES	U.S.C.S. SOIL TYPE	PERCENT MOISTURE	qu TSF	CONTACT DEPTH	SOIL DESCRIPTION AND REMARKS	PIEZO.
71												71.0	BOTTOM OF BORING AT 71.0 FT.	
													NOTES:	
72													1. BORING WAS DRILLED USING A 3-1/4-IN. HOLLOW STEM AUGER.	
73													2. SAMPLES WERE RETRIEVED BY A SPLIT SPOON USING A LONG STROKE JAR TO DRIVE THE CORE BARREL.	
74													3. BORING WAS BACKFILLED AFTER COMPLETION.	
75														

Rev. 2-86

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Boring Log

PROJECT No. CM 85-096
BORING No. SSa-5
LOGGED BY E. BIELECKI
PAGE 1 OF 2

PROJECT NAME TP INDUSTRIAL
BORING LOCATION CENTERLINE OF GROUT CURTAIN STATION 7+75 SURFACE ELEV. 78.60
DRILLER HYDRO GROUP, INC. DATE: START 3-19-86 FINISH 3-20-86

DEPTH	SAMPLE No.	SAMPLE TYPE	INTERVAL FROM	INTERVAL TO	BLOW COUNT 0-6	BLOW COUNT 6-12	BLOW COUNT 12-18	RECOVERY IN INCHES	U.S.C.S. SOIL TYPE	PERCENT MOISTURE	qu TSF	CONTACT DEPTH	SOIL DESCRIPTION AND REMARKS	PIEZO.
55														
56												56.6	NO SAMPLES TAKEN ABOVE 56.6 FT.	
57	1	SS	56.6	58.6				18	SW				BROWN FINE TO COARSE SAND, TRACE OF FINE GRAVEL, TRACE OF MICA FLAKES.	
58												58.6		
59	2	SS	58.6	60.6				18					LIGHT BROWN TO DARK BROWN FINE TO COARSE SAND, TRACE OF FINE GRAVEL, TRACE OF MICA FLAKES.	
60												60.6		
61	3	SS	60.6	62.6										
62								18	SP				BROWN TO DARK BROWN FINE TO MEDIUM SAND, TRACE OF FINE TO MEDIUM GRAVEL, TRACE OF MICA FLAKES.	

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Boring Log

PROJECT No. CH 85-096
BORING No. SSB-5
LOGGED BY E. BIELECKI

PROJECT NAME TP INDUSTRIAL
BORING LOCATION CENTERLINE OF GROUT CURTAIN STATION 7+75 SURFACE ELEV. 778.60
DRILLER HYDRO GROUP, INC. DATE: START 3-19-86 FINISH 3-20-86

DEPTH	SAMPLE No.	SAMPLE TYPE	INTERVAL FROM	INTERVAL TO	BLOW COUNT 0-6	BLOW COUNT 6-12	BLOW COUNT 12-18	RECOVERY IN INCHES	U.S.C.S. SOIL TYPE	PERCENT MOISTURE	qu TSF	CONTACT DEPTH	SOIL DESCRIPTION AND REMARKS	PIEZO.
	4	SS	62.6	64.6										
63													Brown To Dark Brown Fine To Medium Sand, Trace Of Fine To Medium Gravel, Trace Of Mica Flakes.	
64								18						
												64.6		
65													Bottom Of Boring At 64.6 Ft.	
66														
67														
68														
69														
70														

NOTES:

1. Boring Was Drilled Using A 3-1/4-In. Hollow Stem Auger.
2. Samples Were Retrieved By A Split Spoon Using A Long Stroke Jar To Drive The Core Barrel.
3. Boring Was Backfilled After Completion.

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Boring Log

PROJECT No. CH 85-096
BORING No. SSB-6
LOGGED BY E. BIELECKI
PAGE 1 OF 2

PROJECT NAME TP INDUSTRIAL
BORING LOCATION CENTERLINE OF GROUT CURTAIN STATION 8+75 SURFACE ELEV. 73.34
DRILLER HYDRO GROUP, INC. DATE: START 3-20-86 FINISH 3-20-86

DEPTH	SAMPLE No.	SAMPLE TYPE	INTERVAL FROM	INTERVAL TO	BLOW COUNT 0-6	BLOW COUNT 6-12	BLOW COUNT 12-18	RECOVERY IN INCHES	U.S.C.S. SOIL TYPE	PERCENT MOISTURE	qu TSF	CONTACT DEPTH	SOIL DESCRIPTION AND REMARKS	PIEZO.
55													NO SAMPLES TAKEN ABOVE 56.0 FT.	
56												56.0		
	1	SS	56.0	58.0										
57								18						
58														
	2	SS	58.0	60.0										
59								18	SW				BROWN FINE TO COARSE SAND, TRACE OF FINE TO MEDIUM GRAVEL, TRACE OF MICA FLAKES.	
60														
	3	SS	60.0	62.0										
61								18				61.0		
									ML				BROWN CLAYEY FINE TO MEDIUM SAND AND SILT, TRACE OF MICA FLAKES.	
												61.7	BROWN CLAYEY SILT, TRACE OF FINE SAND, TRACE OF MICA FLAKES.	
62												62.0		

Rev. 2-86

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Boring Log

PROJECT No. CH 85-096
BORING No. SSB-6
LOGGED BY E. BIELECKI
PAGE 2 OF 2

PROJECT NAME TP INDUSTRIAL
BORING LOCATION CENTERLINE OF GROUT CURTAIN STATION 8+75 SURFACE ELEV. 78.34
DRILLER HYDRO GROUP, INC. DATE: START 3-20-86 FINISH 3-20-86

DEPTH	SAMPLE No.	SAMPLE TYPE	INTERVAL FROM	INTERVAL TO	BLOW COUNT 0-6	BLOW COUNT 6-12	BLOW COUNT 12-18	RECOVERY IN INCHES	U.S.C.S. SOIL TYPE	PERCENT MOISTURE	qu TSF	CONTACT DEPTH	SOIL DESCRIPTION AND REMARKS	PIEZO.
	4	SS	62.0	64.0										
63								18	SW				YELLOW-BROWN FINE TO COARSE SAND, TRACE OF FINE TO MEDIUM GRAVEL, TRACE OF MICA FLAKES.	
64												64.0		
													BOTTOM OF BORING AT 64.0 FT.	
65														

NOTES:

1. BORING WAS DRILLED USING A 3-1/4-IN. HOLLOW STEM AUGER.
2. SAMPLES WERE RETRIEVED BY A SPLIT SPOON USING A LONG STROKE JAR TO DRIVE THE CORE BARREL.
3. BORING WAS BACKFILLED AFTER COMPLETION.

Rev. 2-86

Canonie

Boring Log

PROJECT No. CH 85-096
BORING No. SSB-7
LOGGED BY E. BIELECKI
PAGE 1 OF 2

PROJECT NAME TP INDUSTRIAL
BORING LOCATION CENTERLINE OF GROUT CURTAIN STATION 9+00 SURFACE ELEV. 77.90
DRILLER HYDRO GROUP, INC. DATE: START 3-19-86 FINISH 3-19-86

DEPTH	SAMPLE No.	SAMPLE TYPE	INTERVAL FROM	INTERVAL TO	BLOW COUNT 0-6	BLOW COUNT 6-12	BLOW COUNT 12-18	RECOVERY IN INCHES	U.S.C.S. SOIL TYPE	PERCENT MOISTURE	qu TSF	CONTACT DEPTH	SOIL DESCRIPTION AND REMARKS	PIEZO.
55													NO SAMPLES TAKEN ABOVE 56.0 FT.	
56	1	SS	56.0	58.0				18	SC			56.0	DARK BROWN MEDIUM TO COARSE CLAYEY SAND, TRACE OF MEDIUM GRAVEL, TRACE OF MICA FLAKES.	
57									SP			56.9	BROWN FINE TO MEDIUM SAND, NONE TO TRACE OF SILT, TRACE OF MICA FLAKES.	
												57.5	BROWN FINE TO MEDIUM SAND, NONE TO TRACE OF SILT, TRACE OF MEDIUM GRAVEL, TRACE OF MICA FLAKES.	
58	2	SS	58.0	60.0				18	SC			58.5	DARK BROWN TO GRAY MEDIUM TO COARSE CLAYEY SAND, TRACE FINE TO MEDIUM GRAVEL, TRACE OF MICA FLAKES.	
59									SM			58.7	BROWN FINE TO MEDIUM SILTY SAND, TRACE OF MEDIUM GRAVEL, TRACE OF MICA FLAKES.	
												59.1		
60	3	SS	60.0	62.0				18	ML				BROWN CLAYEY SILT, NONE TO TRACE FINE SAND, TRACE OF MICA FLAKES.	
61									SM			60.5	BROWN TO DARK BROWN FINE TO MEDIUM SILTY SAND, TRACE OF FINE TO MEDIUM GRAVEL, TRACE OF SILTY CLAYEY ORGANICS.	
												61.4		
62														

Rev. 2-86

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Boring Log

PROJECT No. CH 85-096
BORING No. SSB-7
LOGGED BY E. BIELECKI

PROJECT NAME TP INDUSTRIAL
BORING LOCATION CENTERLINE OF GROUT CURTAIN STATION 9+00 SURFACE ELEV. 77.90
DRILLER HYDRO GROUP, INC. DATE: START 3-19-86 FINISH 3-19-86

DEPTH	SAMPLE No.	SAMPLE TYPE	INTERVAL FROM	INTERVAL TO	BLOW COUNT 0-6	BLOW COUNT 6-12	BLOW COUNT 12-18	RECOVERY IN INCHES	U.S.C.S. SOIL TYPE	PERCENT MOISTURE	qu TSF	CONTACT DEPTH	SOIL DESCRIPTION AND REMARKS	PIEZO.
	4	SS	62.0	64.0								62.5	BROWN FINE TO MEDIUM SILTY SAND, TRACE OF FINE TO COARSE GRAVEL, TRACE OF MICA FLAKES.	
63								18	SP				LIGHT BROWN FINE TO MEDIUM SAND, TRACE OF FINE TO MEDIUM GRAVEL, TRACE OF CLAYEY ORGANIC SILT.	
64												64.0	BOTTOM OF BORING AT 64.0 FT.	
65													NOTES:	

NOTES:

1. BORING WAS DRILLED USING A 3-1/4-IN. HOLLOW STEM AUGER.
2. SAMPLES WERE RETRIEVED BY A SPLIT SPOON USING A LONG STROKE JAR TO DRIVE THE CORE BARREL.
3. BORING WAS BACKFILLED AFTER COMPLETION.

Canonie

Boring Log

PROJECT No. CH 85-096
BORING No. SSB-8
LOGGED BY E. BIELECKI
PAGE 1 OF 2

PROJECT NAME TP INDUSTRIAL
BORING LOCATION CENTERLINE OF GROUT CURTAIN STATION 9+25 SURFACE ELEV. 77.91
DRILLER HYDRO GROUP, INC. DATE: START 3-18-86 FINISH 3-19-86

DEPTH	SAMPLE No.	TYPE	INTERVAL FROM	INTERVAL TO	BLOW COUNT 0-6	6-12	12-18	RECOVERY IN INCHES	U.S.C.S. SOIL TYPE	PERCENT MOISTURE	qu TSF	CONTACT DEPTH	SOIL DESCRIPTION AND REMARKS	PIEZO
55													NO SAMPLES TAKEN ABOVE 56.0 FT.	
56	1	SS	56.0	58.0				18	SM			56.0	BROWN TO BLACK FINE TO COARSE SAND AND ORGANIC SILT, SOME GRAVEL AND CLAY, TRACE OF MICA FLAKES.	
57												57.1	LIGHT BROWN TO BROWN FINE TO MEDIUM SILTY SAND, TRACE OF FINE GRAVEL, TRACE OF MICA FLAKES.	
58	2	SS	58.0	60.0				18	ML			58.5	LIGHT BROWN TO DARK GRAY CLAYEY SILT, SOME FINE SAND, TRACE OF GRAVEL, TRACE OF MICA FLAKES.	
59												59.3	DARK BROWN FINE TO COARSE SAND, TRACE OF FINE TO MEDIUM GRAVEL, TRACE OF MICA FLAKES.	
60	3	SS	60.0	62.0				18	SW			60.5		
61														
62									SM				LIGHT BROWN FINE TO MEDIUM SAND, TRACE OF SILT, TRACE OF MICA FLAKES.	

Rev. 2-86

Canonie

Boring Log

PROJECT No. CH 85-096
BORING No. SSB-8
LOGGED BY E. BIELECKI

PROJECT NAME TP INDUSTRIAL
BORING LOCATION CENTERLINE OF GROUT CURTAIN STATION 9+25 SURFACE ELEV. 77.91
DRILLER HYDRO GROUP, INC. DATE: START 3-18-86 FINISH 3-19-86

DEPTH	SAMPLE No.	SAMPLE TYPE	INTERVAL FROM	INTERVAL TO	BLOW COUNT 0-6	BLOW COUNT 6-12	BLOW COUNT 12-18	RECOVERY IN INCHES	U.S.C.S. SOIL TYPE	PERCENT MOISTURE	qu TSF	CONTACT DEPTH	SOIL DESCRIPTION AND REMARKS	PIEZO.
	4	SS	62.0	64.0										
63								18					LIGHT BROWN FINE TO MEDIUM SAND, TRACE OF SILT, TRACE OF MICA FLAKES.	
64												64.0		
													BOTTOM OF BORING AT 64.0 FT.	
65													NOTES:	

NOTES:

1. BORING WAS DRILLED USING A 3-1/4-IN. HOLLOW STEM AUGER.
2. SAMPLES WERE RETRIEVED BY A SPLIT SPOON USING A LONG STROKE JAR TO DRIVE THE CORE BARREL.
3. BORING WAS BACKFILLED AFTER COMPLETION.

Canonie

Boring Log

PROJECT No. CH 85-096
BORING No. SSB-9
LOGGED BY E. BIELECKI
PAGE 1 OF 2

PROJECT NAME IP INDUSTRIAL
BORING LOCATION CENTERLINE OF GROUT CURTAIN STATION 10+00 SURFACE ELEV. 77.48
DRILLER HYDRO GROUP, INC. DATE: START 3-21-86 FINISH 3-21-86

DEPTH	SAMPLE No.	TYPE	INTERVAL FROM	INTERVAL TO	BLOW COUNT 0-6	BLOW COUNT 6-12	BLOW COUNT 12-18	RECOVERY IN INCHES	U.S.C.S. SOIL TYPE	PERCENT MOISTURE	qu TSF	CONTACT DEPTH	SOIL DESCRIPTION AND REMARKS	PIEZO.
55													NO SAMPLES TAKEN ABOVE 55.5 FT.	
	1	SS	55.5	57.5								55.5		
56									SW				LIGHT BROWN FINE TO COARSE SAND, SOME FINE TO MEDIUM GRAVEL.	
												56.7	LIGHT BROWN FINE TO MEDIUM SAND, TRACE OF SILT, TRACE OF MICA FLAKES.	
57								*	SP			57.0	LIGHT BROWN CLAYEY SILT, SOME FINE SAND, TRACE OF MICA FLAKES.	
	2	SS	57.5	59.5					ML			57.5		
58														
59								*						
	3	SS	59.5	61.5										
60									SP				LIGHT BROWN FINE TO MEDIUM SAND, TRACE OF SILT, TRACE OF FINE GRAVEL, TRACE OF MICA FLAKES.	
61								*						
	4	SS	61.5	63.5										
62														

Rev. 2-86

*RECOVERY LENGTH NOT RECORDED

Canonie

Boring Log

PROJECT No. CH 85-096
BORING No. SSB-9
LOGGED BY E. BIELECKI
PAGE 2 OF 2

PROJECT NAME TP INDUSTRIAL
BORING LOCATION CENTERLINE OF GROUT CURTAIN STATION 10+00 SURFACE ELEV. 77.48
DRILLER HYDRO GROUP, INC. DATE: START 3-21-86 FINISH 3-21-86

DEPTH	SAMPLE No.	TYPE	INTERVAL FROM	INTERVAL TO	BLOW COUNT 0-6	BLOW COUNT 6-12	BLOW COUNT 12-18	RECOVERY IN INCHES	U.S.C.S. SOIL TYPE	PERCENT MOISTURE	qu TSF	CONTACT DEPTH	SOIL DESCRIPTION AND REMARKS	PIEZO.
63								*						
									ML			63.1	LIGHT BROWN CLAYEY SILT, TRACE OF FINE SAND, TRACE OF MICA FLAKES.	
												63.5	BOTTOM OF BORING AT 63.5 FT.	
64														
65														

NOTES:

1. BORING WAS DRILLED USING A 3-¼-IN. HOLLOW STEM AUGER.
2. SAMPLES WERE RETRIEVED BY A SPLIT SPOON USING A LONG STROKE JAR TO DRIVE THE CORE BARREL.
3. BORING WAS BACKFILLED AFTER COMPLETION.

Rev. 2-86

*RECOVERY LENGTH NOT RECORDED

APPENDIX D

PHOTOGRAPHS OF EXCAVATED WALL

CH 85-096-01

Excavated Grout Curtain at Station 10+32

CH 85-096-02

Measurement indicates one foot wall thickness in the dry unsaturated zone of the glacial sands and gravel at Station 10+32.

APPENDIX E

GROUT COMPOSITION AND PROPERTIES

	GROUT COMPOSITION						GROUT PROPERTIES		
DATE	WATER (%)	CEMENT (%)	BENTONITE (%)	SODA ASH (%)	TAMOL (%)	TETRA SODIUM PYROPHOSPHATE (%)	SPECIFIC WEIGHT (g/cc)	MARSH FUNNEL VISCOSITY (SEC)	FILTRATE LOSS AT 100 PSI (ML @ 30 MIN.)
01/09/86	77.52	10.38	5.52	4.63	1.09	0.86	1.11	42	42
01/10/86	82.26	11.01	5.86	0.62	0.14	0.11	1.12	64	42
01/13/86	82.26	11.01	5.86	0.62	0.14	0.11	1.12	46	42
01/14/86	82.26	11.01	5.86	0.62	0.14	0.11	1.12	45	43
01/16/86	82.26	11.01	5.86	0.62	0.14	0.11	1.13	47	37
01/21/86	82.26	11.01	5.86	0.62	0.14	0.11	1.13	43	43
01/22/86	82.26	11.01	5.86	0.62	0.14	0.11	1.12	46	44
01/23/86	82.26	11.01	5.86	0.62	0.14	0.11	1.12	48	45
01/31/86	73.56	16.41	8.73	0.92	0.21	0.17	1.11	42	42
02/03/86	--	--	--	--	--	--	1.12	41	42
02/06/86	--	--	--	--	--	--	1.12	42	44
02/10/86	--	--	--	--	--	--	1.12	42	43
02/12/86	--	--	--	--	--	--	1.12	41	42
02/24/86	73.56	16.41	8.73	0.92	0.21	0.17	1.11	43	42
02/27/86	66.17	21.32	11.34	0.83	0.19	0.15	1.12	44	44
02/28/86	84.77	9.60	5.03	0.42	0.10	0.08	1.12	42	44
03/01/86	67.54	20.55	10.93	0.69	0.16	0.13	1.12	42	44
03/04/86	73.56	16.41	8.73	0.92	0.21	0.17	1.12	41	44
03/05/86	73.56	16.41	8.73	0.92	0.21	0.17	1.12	42	43

-- Denotes data not available

	GROUT COMPOSITION						GROUT PROPERTIES		
DATE	WATER (%)	CEMENT (%)	BENTONITE (%)	SODA ASH (%)	TAMOL (%)	TETRA SODIUM PYROPHOSPHATE (%)	SPECIFIC WEIGHT (g/cc)	MARSH FUNNEL VISCOSITY (SEC)	FILTRATE LOSS AT 100 PSI (ML @ 30 MIN.)
03/06/86	73.56	16.41	8.73	0.91	0.22	0.17	1.12	41	44
03/07/86	72.99	16.79	8.93	0.91	0.21	0.17	1.12	41	44
03/10/86	84.77	9.45	5.03	0.53	0.12	0.10	1.13	42	46
03/11/86	84.77	9.45	5.03	0.53	0.12	0.10	1.11	48	45
03/12/86	84.81	9.46	5.03	0.49	0.12	0.09	1.12	45	45
03/13/86	84.76	9.48	5.03	0.51	0.12	0.10	1.12	45	46
03/17/86	84.78	9.47	5.03	0.51	0.12	0.09	1.12	43	44
03/18/86	84.77	9.45	5.03	0.53	0.12	0.10	1.12	45	44
03/19/86	84.77	9.45	5.03	0.53	0.12	0.10	1.12	44	46
03/20/86	84.22	9.90	5.13	0.53	0.12	0.10	1.12	43	45
03/21/86	84.79	9.46	5.03	0.51	0.12	0.09	1.12	45	47
03/24/86	84.78	9.45	5.03	0.52	0.12	0.10	1.12	44	46
03/25/86	84.77	9.45	5.03	0.53	0.12	0.10	1.13	44	47
03/26/86	84.13	10.14	4.99	0.52	0.12	0.10	1.12	46	48
03/27/86	84.61	9.63	5.02	0.52	0.12	0.10	1.12	45	47
03/28/86	84.77	9.45	5.03	0.53	0.12	0.10	1.13	46	46
03/31/86	84.77	9.45	5.03	0.53	0.12	0.10	1.12	46	50
04/01/86	84.78	9.46	5.03	0.51	0.12	0.10	1.12	44	47
04/03/86	84.77	9.45	5.03	0.53	0.12	0.10	1.12	44	48
04/04/86	84.77	9.45	5.03	0.53	0.12	0.10	1.12	45	46
04/07/86	84.77	9.45	5.03	0.53	0.12	0.10	1.11	46	49

-- Denotes data not available

	GROUT COMPOSITION						GROUT PROPERTIES		
DATE	WATER (%)	CEMENT (%)	BENTONITE (%)	SODA ASH (%)	TAMOL (%)	TETRA SODIUM PYROPHOSPHATE (%)	SPECIFIC WEIGHT (g/cc)	MARSH FUNNEL VISCOSITY (SEC)	FILTRATE LOSS AT 100 PSI (ML @ 30 MIN.)
04/10/86	84.77	9.45	5.03	0.53	0.12	0.10	1.12	48	48
04/11/86	84.79	9.46	5.03	0.51	0.12	0.09	1.16	47	46
04/14/86	84.78	9.45	5.03	0.52	0.12	0.10	1.12	45	49
04/15/86	84.77	9.45	5.03	0.53	0.12	0.10	1.12	44	47
04/16/86	84.73	9.45	5.10	0.50	0.12	0.10	1.11	45	49
04/17/86	84.79	9.45	5.03	0.51	0.12	0.10	1.12	46	48
05/01/86	84.77	9.45	5.03	0.53	0.12	0.10	1.11	45	49
05/06/86	84.77	9.45	5.03	0.53	0.12	0.10	1.11	43	50
05/08/86	84.77	9.45	5.03	0.53	0.12	0.10	1.11	56	57
05/09/86	--	--	--	--	--	--	1.11	47	53
05/12/86	84.77	9.45	5.03	0.53	0.12	0.10	1.11	48	52
05/13/86	84.77	9.45	5.03	0.53	0.12	0.10	1.11	47	50
05/14/86	84.58	9.65	5.02	0.53	0.12	0.10	1.11	48	52
05/15/86	84.77	9.45	5.03	0.53	0.12	0.10	1.11	46	53
05/28/86	84.77	9.45	5.03	0.53	0.12	0.10	1.11	52	53
05/29/86	84.77	9.45	5.03	0.53	0.12	0.10	1.11	48	53
05/30/86	84.77	9.45	5.03	0.53	0.12	0.10	1.12	47	55
05/31/86	84.77	9.45	5.03	0.53	0.12	0.10	1.11	50	63
06/02/86	84.77	9.45	5.03	0.53	0.12	0.10	1.12	50	50
06/03/86	84.77	9.45	5.03	0.53	0.12	0.10	1.11	47	55
06/04/86	84.50	9.73	5.02	0.53	0.12	0.10	1.11	47	55
06/05/86	84.77	9.45	5.03	0.53	0.12	0.10	1.11	47	56

-- Denotes data not available

	GROUT COMPOSITION						GROUT PROPERTIES		
DATE	WATER (%)	CEMENT (%)	BENTONITE (%)	SODA ASH (%)	TAMOL (%)	TETRA SODIUM PYROPHOSPHATE (%)	SPECIFIC WEIGHT (g/cc)	MARSH FUNNEL VISCOSITY (SEC)	FILTRATE LOSS AT 100 PSI (ML @ 30 MIN.)
06/06/86	84.77	9.45	5.03	0.53	0.12	0.10	1.11	47	56
06/09/86	84.77	9.45	5.03	0.53	0.12	0.10	1.12	47	55
06/10/86	--	--	--	--	--	--	1.11	47	56
06/11/86	84.77	9.45	5.03	0.53	0.12	0.10	1.12	47	54
06/12/86	84.77	9.45	5.03	0.53	0.12	0.10	1.12	47	53
06/13/86	84.77	9.45	5.03	0.53	0.12	0.10	1.11	48	55
06/14/86	84.77	9.45	5.03	0.53	0.12	0.10	1.12	47	56
06/16/86	84.77	9.45	5.03	0.53	0.12	0.10	1.11	49	57
06/17/86	84.77	9.45	5.03	0.53	0.12	0.10	1.11	47	57
06/18/86	84.77	9.45	5.03	0.53	0.12	0.10	1.11	48	56
06/19/86	84.77	9.45	5.03	0.53	0.12	0.10	1.11	47	56
06/20/86	84.77	9.45	5.03	0.53	0.12	0.10	1.11	47	56

-- Denotes data not available

APPENDIX F

MANUFACTURERS' CERTIFICATION
OF GROUT CONSTITUENTS

THE **WHITEHALL CEMENT MANUFACTURING** COMPANY

5160 MAIN STREET, CEMENTON • WHITEHALL, PA. 18052

MILL TEST REPORT

Car Number ______________ CWT ______________ Date ______________

Shipped to ______________

CHEMICAL COMPOSITION	PERCENT
Silicon dioxide	19.92
Aluminum oxide	5.02
Ferric oxide	2.42
Magnesium oxide	3.17
Sulfur trioxide	3.84
Loss on ignition	1.85
Insoluble residue	0.18
Tricalcium silicate	50.5
Dicalcium silicate	19.0
Tricalcium aluminate	10.9

PHYSICAL TESTS

FINENESS Sq. cm./g.		SETTING TIME		Autoclave Expansion	TENSILE STRENGTH P. S. I.				COMPRESSIVE STRENGTH P. S. I.			
Wagner	Blaine	INITIAL Hrs.-Min.	FINAL Hrs.-Min.	Percent	1-Day	3-Days	7-Days	28-Days	1-Day	3-Days	7-Days	28-
----	3849	2:40	5:00	0.26	----	----	----	----	----	3350	4250	--

8.6 Per Cent Air Entrained in Standard Mortar

The test results given above were made on cement withdrawn from Silo listed below, which cement complies with specification also listed below.

Silo No. B-3 Specification ASTM C-150/AASHTO M-85 Type 1

This report is in compliance with your request.

WHITEHALL

5M 50P 4-76 BR

THE WHITEHALL CEMENT MANUFACTURING CO.

Chief Chemist

NATIONAL® Premium Western Bentonite

Slurry Trench and Soil Sealing Grade - 200 Mesh

Typical Physical and Chemical Properties*

X-RAY ANALYSIS

85% Montmorillonite
5% Quartz
5% Feldspars
2% Cristobalite
2% Illite
1% Calcium and Gypsum

CHEMICAL ANALYSIS	
SiO_2	55.44%
Al_2O_3	20.14%
Fe_2O_3	3.67%
CaO	0.49%
MgO	2.49%
Na_2O	2.67%
K_2O	0.60%
Water	5.50%
Moisture at 220°F	8.00%
TOTAL	99.09%

SCREEN ANALYSIS	TYPICAL	SPECIFICATION
Dry Screen, percent minus 200 mesh	77	70 min
Wet Screen, percent plus 200 mesh	2	4 max
Wet Screen, percent plus 325 mesh	3	5 max
SLURRY PROPERTIES (6% SUSPENSION)		
Viscosity-Fann 600 RPM	34	30 min
Apparant Viscosity, cps	17	-----
Plastic Viscosity (PV)	12	-----
Yield Point, lb/100 ft^2	10	3X PV max
Filtrate, 30 minutes @ 100 psi	11	13.5 cm^3 max
Yield - 42 gal bbl of 15 cps slurry/ton	93	91 min
Filter Cake	3/32	
OTHER PROPERTIES		
Moisture - percent	9	10 max
Free Swell (ml)	25	
Specific Gravity	2.5	
pH - 6% Suspension	8.8	
Bulk Density (lbs. per ft^3) compacted	73	

*The typical chemical and physical values listed are not to be construed as rigid specifications. Metals listed in the chemical analysis are complexed in the mineral. They do not necessarily exist as free oxides.

NATIONAL® Premium bentonite - 200 mesh meets or exceeds API specification 13A.

September 9, 1986

Technical data

Soda Ash

CAS No 497-19-8

TAB CHEMICALS, INC.
4801 So. Austin Ave.
Chicago, Illinois 60638
Phone 586-2000

Chemical name	Sodium carbonate, anhydrous
CAS name	Disodium carbonate
Formula	Na_2CO_3
Molecular weight (mol)	105.99
General physical properties	
Description	white granular solid
Melting point, °C (°F)	851 (1564)
General chemical properties	
Solubility, max % @ 35.4°C	33.2
pH, 1% solution @ 25°C	11.4
Heat of fusion, MJ/kg (BTU/lb)	0.318 (136)
Heat of hydration, MJ/kg (BTU/lb)	
monohydrate	0.126 (54)
heptahydrate	0.653 (282)
decahydrate	0.874 (376)

Light Density Grades

Chemical properties	Grade 100		Grade 120	
	Typical	Specification	Typical	Specification
Na_2O, % by weight	58.3	58.0 min	58.4	58.0 min
Na_2CO_3, %	99.8	99.2 min	99.8	99.2 min
Na_2SO_4, %	0.04	0.20 max	0.06	0.20 max
NaCl, %	0.03	0.20 max	0.03	0.20 max
Fe_2O_3, ppm	6	20 max	6	20 max
Water insolubles, %	0.00	0.05 max	0.00	0.05 max
Ignition loss, %	0.2		0.2	
Heavy metals (as Pb), ppm	< 10		< 10	
COD (as O_2), ppm	230		120	
Pb, ppm	1		1	
As_2O_3, ppm	0.1		0.1	
B, ppm	3		3	
CaO, ppm	150		140	
Cu, ppm	0.1		0.1	
MgO, ppm	50		50	
SiO_2, ppm	30		30	

Physical properties	Typical	Specification	Typical	Specification
Bulk density, lb/ft³	48	44-54	50	46-56
g/cm³	0.77	0.70-0.86	0.80	0.74-0 90
Particle density, g/cm³	1.494		1 536	
Particle shape	Needle-like		Needle-like	
Angle of repose, deg	50		58	
Screen analysis, cumulative %				
On U.S. 30 (600 µm)	0.7		0 4	
U.S. 40 (425 µm)	8	15 max	8	15 max
U.S. 100 (150 µm)	87		83	
Thru U.S. 200 (75 µm)	2	7 max	4	10 max

Dense Grades

Chemical properties

	Grade 160		Grade 260	
	Typical	Specification	Typical	Specificatio
Na_2O, % by weight	58.4	58.0 min	58.4	58.0 min
Na_2CO_3, %	99.8	99.2 min	99.8	99.2 min
Na_2SO_4, %	0.06	0.20 max	0.05	0.20 max
NaCl, %	0.03	0.20 max	0.02	0.20 max
Fe_2O_3, ppm	7	20 max	4	20 max
Water insolubles, %	0.00	0.05 max	0.01	0.05 max
Ignition loss, %	0.1		0.1	
Heavy metals (as Pb), ppm	<10		<10	
COD (as O_2), ppm	40		200	
Pb, ppm	1		1	
As_2O_3, ppm	0.1		0.1	
B, ppm	3		6	
CaO, ppm	140		80	
Cu, ppm	0.1		0.1	
MgO, ppm	50		20	
SiO_2, ppm	30		150	

Physical properties

	Typical	Specification	Typical	Specificatic
Bulk density, lb/ft³	59	54-62	65	60-70
g/cm³	0.95	0.86-0.99	1.06	0.96-1.1
Particle density, g/cm³	1.826		1.960	
Particle shape	Needle-like		Blocky	
Angle of repose, deg	52		40	
Screen analysis, cumulative %				
On U.S. 30 (600 µm)	0.4		1.5	
U.S. 40 (425 µm)	8	15 max	16	27 max
U.S. 100 (150 µm)	88		90	
Thru U.S. 200 (75 µm)	1	5 max	2	7 max

FMC

Uses

Glass manufacture, detergent manufacture, sodium chemicals and carbonate chemicals manufacture, pulp and paper, brine treatment, water hardness removal, pH adjustment in water or waste water, flue gas desulfurization.

Standard containers

Bulk hopper cars and trucks; 100 lb (45.4 kg) multi-wall paper bags.

FMC Corporation Industrial Chemical Group 2000 Market Street Philadelphia Pennsylvania 19103

FMC

Technical data

Tetrasodium Pyrophosphate
Technical Grade
CAS No 7722-88-5

TAB CHEMICALS, INC.
4801 So. Austin Ave.
Chicago, Illinois 60638
Phone 586-2000

Formula	$Na_4P_2O_7$	MW (mol) 265.9
Synonyms	Sodium pyrophosphate, tetrasodium diphosphate, TSPP	
Grades	Powder, granular	

Chemical properties

	Typical analysis	Specification
P_2O_5, % by weight	53.1	—
Orthophosphate, %	0.5	1.0 max
pH, 1% solution	10.3	9.9 min, 10.6 max
Insolubles, %	0.01	0.05 max
Iron (Fe), ppm (µg/g)	30	—

Screen analyses*

	Cumulative %	
	Typical analysis	Specification
Powder, thru U. S. 20 (850µm)	100	98 min
thru U. S. 100 (150µm)	94	90 min
Granular, thru U. S. 14 (1.40 mm)	100	—
thru U. S. 20	93	90 min
thru U. S. 100	9	30 max

*Metric-SI values from ASTM Standard E-11-70 based on ISO recommendation.

Physical properties

Solubility, g/kg water, @ 10°C (50°F)	40
@ 25°C (77°F)	80
@ 50°C (122°F)	160
Bulk density, lb/ft³ (kg/m³), powder	58 (930)
granular	61 (980)

Standard container

100 pound (45.4 kg) multi-wall paper bags, bulk hopper cars and trucks

Uses

Detergents and soaps, dispersing clay, oil well drilling mud conditioner, wet process cement, water conditioning and textile processing, pitch control in paper mills, bleach bath stabilizer

FMC Corporation Industrial Chemical Group 2000 Market Street Philadelphia Pennsylvania 19103

POLYMERIC ADDITIVES

FOR AQUEOUS SYSTEMS

ROHM HAAS

INDUSTRIAL CHEMICALS

TAMOL® 850 **TAMOL 731**
TAMOL 960 **ACRYSOL® A-41**

SCALE INHIBITORS

In aqueous systems, such as boiler feed water and recirculated cooling water, dissolved salts and solid particles are present which can form harmful scale deposits on equipment surfaces. These deposits can lead to restricted water circulation, heat transfer inefficiency, corrosion, and costly equipment damage. Prevention of these deposits is essential for efficient equipment operation. Scale inhibition can be accomplished effectively with the use of synthetic polymers. Highly carboxyl-functional polymers such as TAMOL 850, TAMOL 960, TAMOL 731, and ACRYSOL A-41 scale inhibitors can be used in various aqueous systems over a wide temperature range.

MECHANISM FOR SCALE INHIBITION

Polymeric scale inhibitors like TAMOL 850, TAMOL 960, TAMOL 731, and ACRYSOL A-41 have several functions. The specific conditions in the aqueous system give predominance to one or more functions:

- Anti-precipitant action: Adsorption on the active sites of the crystal nuclei delays crystal growth and precipitation.
- Adsorption on positive sites of growing crystals forms crystals of distorted structure which are weak and less adherent to surfaces.
- Dispersant action by adsorption increases the negative charge on the sludge particles, reduces their tendency to agglomerate, and inhibits scale formation by keeping them suspended.

October, 1985

TABLE I

TYPICAL PHYSICAL PROPERTIES

(these do not constitute specifications)

Product	Type	Molecular Weight $\bar{M}_w$[1]	Appearance	% Total Solids	Density 25°C. lbs/gal	pH	Brookfield Viscosity 25°C., cps	Spindle/Speed
TAMOL 960	Na Salt of PMAA	4200	Clear, pale yellow liquid	39-41	10.6	8-9	300-800	# 2 @ 30
TAMOL 850	Na Salt of PMAA	12000	Clear, pale yellow liquid	29-31	9.9	9.0-10.8	125-325	# 2 @ 60
TAMOL 731	Na Salt of a maleic anhydride copolymer	15000	Clear, pale yellow liquid	24-26	9.2	9.5-10.5[3]	19-182	# 2 @ 60
TAMOL 731 SD	Na Salt of a maleic anhydride copolymer	15000	White to tan free-flowing powder	91 min.	26[2]	9.3-10.5[3]	—	
ACRYSOL A-41	Methacrylic acid copolymer	8400	Clear to slightly turbid liquid	29-31	9.2	3.0 max.	1700-4500	

[1] Weight average molecular weight determined by aqueous GPC.

[2] Average bulk density of Tamol 731 SD is expressed in units of lbs/ft^3.

[3] Measured on a 10% aqueous solution.

THERMAL STABILITY

High temperature stability is an important requirement in most water treatment applications and is a fundamental requirement for polymers used in internal boiler-water treatment. Thermogravimetric analysis is often used to rank polymers in order of their thermal stability. This is done by comparing polymer weight loss vs. temperature. In Table II the decomposition temperature is the temperature at which the onset of significant polymer weight loss occurs.

TABLE II

THERMOGRAVIMETRIC ANALYSIS OF TAMOL AND ACRYSOL POLYMERS

Polymer	Decomposition Temperature (in air, °C)
TAMOL 850	450
TAMOL 960	425
TAMOL 731	365
ACRYSOL A-41	455

As the data in Table II indicate, TAMOL 850, TAMOL 960, and ACRYSOL A-41 are stable to temperatures above the critical point of water (375°C): this suggests that these polymers have potential as sludge scale inhibitors even in high-pressure boiler-water treatment.

DISPERSANT ACTIVITY

The dispersant activity of carboxyl-functional polymers is an important element of their ability to inhibit scale formation. The effectiveness of a polymeric dispersant is dependent on the particle to be dispersed, the medium in which it is being dispersed, and the chemical structure of the dispersant. A determination of Fluidity Point gives a general indication of the dispersant activity of a polymer. The Fluidity Point is determined by a titration method and is defined as the concentration of dispersant needed to achieve fluidity in a mass of particles in an aqueous system. The Fluidity Point is the minimum amount of dispersant which must be used to deflocculate the particles in the system.

The data in Table III illustrate that TAMOL 850, TAMOL 960, TAMOL 731, and ACRYSOL A-41 exhibit good dispersant activity, an important function for effective scale inhibition.

TABLE III

	FLUIDITY POINT			
	% Polymer Solids Based on Dispersed Solids			
Compound	TAMOL 850	TAMOL 960	TAMOL 731	ACRYSOL A-41
Calcium Phosphate	0.05	0.07	0.09	0.03
Calcium Carbonate	0.04	0.04	0.05	0.03
Magnesium Oxide	1.01	0.90	1.08	0.70
Iron Oxide	0.13	0.13	0.15	0.09

TAMOL 731 dispersant is exceptionally effective for stabilizing dilute iron oxide suspensions, as Table IV shows. In this study, a suspension containing 700 ppm of iron oxide (pH 7.5) was allowed to settle four hours. The turbidity of the uppermost layer was measured in a nephelometer. The higher the turbidity value, the greater is the stability of the suspension and the more effective is the dispersant. The result suggests that TAMOL 731 dispersant should greatly reduce the tendency of iron oxide to form deposits from recirculated cooling and boiler feed waters.

TABLE IV

TURBIDITY OF IRON OXIDE SUSPENSIONS

Dispersant	Turbidity Units
None	77
TAMOL 731 (3 ppm)	860
Polyacrylate (3 ppm)	100
Phosphonate (3 ppm)	60

VISCOSITY CHARACTERISTICS

TAMOL 850, TAMOL 960, and TAMOL 731 have low viscosity at temperatures as low as 5°C and should present no handling problems at temperatures above freezing, as indicated in Table V. ACRYSOL A-41 is moderately viscous at 25°C and very viscous at low temperatures.

TABLE V

VISCOSITY VS. TEMPERATURE

	Viscosity (cps), 12 rpm			
Temperature, °C	TAMOL 850 30%	TAMOL 960 40%	TAMOL 731 25%	ACRYSOL A-41 30%
5	470	2,300	150	44,000
25	250	500	70	8,400

SURFACE-ACTIVE AND FOAMING PROPERTIES

TAMOL 850, TAMOL 960, and ACRYSOL A-41 exhibit very little surface activity and are essentially non-foaming. TAMOL 731 is weakly surface-active and produces somewhat more foam than the other polymers; however, at low use levels, TAMOL 731 should present no foaming problem. Table VI illustrates the effect of these polymers on the surface tension and the interfacial tension between water and a highly refined mineral oil. The properties of TRITON® X-100, a commonly used surfactant, are included for comparison. Values were obtained by ASTM Method D 1331-56, using a du Nouy Tensiometer. Table VII gives the foam heights for several concentrations of the TAMOL and ACRYSOL polymers.

TABLE VI SURFACE-ACTIVE PROPERTIES OF TAMOL AND ACRYSOL POLYMERS AT 25°C				
Product	Surface Tension (dynes/cm)		Interfacial Tension of Acroprime 90 vs. water (dynes/cm)	
Active Ingredient, %	1.0%	0.1%	1.0%	0.1%
TAMOL 850	71	–	51	–
TAMOL 960	63	–	42	–
TAMOL 731	36	64	15	40
ACRYSOL A-41	64	–	48	–
TRITON X-100	30	29	1	5
None	72	–	52	–

TABLE VII FOAM HEIGHT OF TAMOL AND ACRYSOL POLYMERS (Hamilton Beach Test, 25°C, cm)					
Polymer	TAMOL 850	TAMOL 960	TAMOL 731		ACRYSOL A-41 (Na Salt)
Active Ingredient	0.1%	0.1%	0.1%	0.01%	0.1%
5 seconds	0.6	0.2	4.4	0.6	2.2
15 seconds	0.2	0.2	4.0	0.4	0.4
30 seconds	0.2	0.1	3.3	0.3	0.2

FDA CLEARANCE

TAMOL 850, TAMOL 960, and TAMOL 731 conform with the FDA regulations indicated below provided that the final formulation meets any extractives limitations and other conditions prescribed by the regulation:

Number	Regulation Title or Application	TAMOL 850 TAMOL 960	TAMOL 731
173.310	Boiler water additives	X	
175.105	Adhesives	X	X
175.300	Resinous and polymeric coatings	X[a]	
176.170	Components of paper, paperboard in contact with aqueous and fatty food	X[b]	
176.180	Components of paper, paperboard in contact with dry food	X	X
176.210	Defoaming agents in manufacture of paper, paperboard	X	

[a]Only if converted to free acid form.
[b]TAMOL 850 limited to 0.3% or less of TAMOL 850 solids on total coating solids.
TAMOL 960 limited to 0.1% or less of TAMOL 960 solids on total coating solids.

SAFE HANDLING INFORMATION

CAUTION: CONTACT CAUSES IRRITATION OF THE EYES AND SKIN.

Vapors may irritate the eyes and respiratory tract, especially in poorly ventilated areas. Avoid breathing the vapors.

KEEP OUT OF THE REACH OF CHILDREN

FIRST AID MEASURES

In case of contact, flush the eyes immediately with plenty of water at least 15 minutes; call a physician. Wash the skin thoroughly with soap and water. If clothing is drenched with the liquid products, remove and launder them before rewearing.

If swallowed and victim is conscious, dilute by giving two glasses of water to drink and call a physician immediately. Never give anything by mouth to an unconscious person.

If overcome by vapors, remove victim to fresh air. Administer oxygen or artificial respiration if victim shows difficulty in breathing.

TOXICITY

Toxicity screening tests have shown that the acute oral toxicity (LD_{50}) in rats is greater than 5 g/kg for all of these materials. The acute dermal toxicity (LD_{50}) in rabbits is greater than 2 g/kg for TAMOL 850 and TAMOL 731 and greater than 5 g/kg for ACRYSOL A-41. The TAMOL brand products contain a low level of formaldehyde preservative. TAMOL 850 and TAMOL 960 contain a low level (below 0.1%) residual monomer and ACRYSOL A-41 may contain up to 0.2% residual monomer. Inhaling vapors of these materials may irritate the eyes and respiratory tract and may cause headache and nausea, especially in poorly ventilated workplace areas. High levels of irritating monomer vapors may be released when ACRYSOL A-41 is cured thermally or dried during processing at high temperatures and should be dispelled by providing good ventilation.

Direct contact with the liquid grades or TAMOL 731 SD irritates the eyes and prolonged or repeated contact with the skin may be irritating and produce rashes.

GENERAL HANDLING INFORMATION

Provide adequate ventilation in the workplace or storage areas to remove irritating vapors and dusts. In storing the liquid grades, keep from freezing. Wastes can be directed to a sewage treatment plant. The biological oxygen demand of these materials is low; the value for TAMOL 850, for example, is about 3,100 ppm.

MATERIAL SAFETY DATA SHEETS

Rohm and Haas Company maintains Material Safety Data Sheets (MSDS) on all of its products. These contain pertinent information that you may need to protect your employees and customers against any known health and safety hazards associated with our products.

Rohm and Haas Company recommends that you obtain copies of our Material Safety Data Sheets from your local Rohm and Haas representative on our products before using them in your facilities. We also suggest that you contact your supplier of other materials recommended for use with our products for appropriate health and safety precautions before using them.

To order Rohm and Haas products and to obtain purchasing assistance, technical information, Material Safety Data Sheets, samples, or literature, write or call the nearest Rohm and Haas branch office:

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FORM 30080

APPENDIX G

PHYSICAL TEST RESULTS OF GROUT

SUMMARY
PHYSICAL TEST RESULTS
CEMENT-BENTONITE GROUT

Sample Number	Station	Date Sample/Test	Water Content (%)	Unconfined Compression Strength (psi)	Unconfined Compression Strain (%)	Dry Unit Weight ($lb./ft^3$)	Hydraulic Conductivity ($x\ 10^{-7}$ cm/sec)
1	10+97	01-13/02-13	380	7.2	1.4	14.6	--
2	10+83	01-14/02-13	348	6.0	1.7	--	--
3	10+83	01-14/02-13	360 (294)	--	--	15.4 (18.8)	6.5
4	11+11	01-21/02-19	382	3.9	1.9	14.5	--
5	11+27	01-22/02-21	398	3.1	1.4	14.1	--
6	11+27	01-22/06-15	371 (323)	--	--	14.9 (16.9)	9.7
7	11+51	01-30/02-28	378	5.4	1.6	14.7	--
8	11+51	01-30/02-28	332 (272)	(19.0)	1.1	16.6 (19.5)	9.1
9	11+78	02-04/03-05	417	1.4	3.1	13.6	--
10	12+05	02-10/03-10	491	1.3	1.3	11.7	--
11	10+79	02-24/03-24	386	1.7	1.3	14.5	--
12	10+27	02-27/03-28	344	6.0	1.3	16.0	--
13	NC 0+06	02-28/03-28	372	4.2	1.3	14.9	--
14	NC 0+28	03-04/04-03	366	5.0	1.5	15.1	--
15	9+47	03-05/04-03	433	3.5	1.7	13.0	--
16	9+39	03-06/04-06	434 (305)	--	--	13.1 (17.7)	7.1
17	9+39	03-06/04-06	423	3.2	2.0	13.3	--
18	9+33	03-07/04-07	437	2.8	1.7	13.0	--

( ) - Denotes value after hydraulic conductivity test

-- - Indicates that the sample was not tested for this parameter
NC - Denotes New Corner station numbers

SUMMARY
PHYSICAL TEST RESULTS
CEMENT-BENTONITE GROUT
(Continued)

Sample Number	Station	Date Sample/Test	Water Content (%)	Unconfined Compression Strength (psi)	Unconfined Compression Strain (%)	Dry Unit Weight (lb./ft³)	Hydraulic Conductivity (x 10^{-7} cm/sec)
19	9+06	03-10/04-08	384	3.8	1.5	14.5	--
20	8+78	03-12/04-10	373	4.9	1.6	14.9	--
21	8+55	03-13/04-12	407	4.2	1.3	13.7	--
22	10+27	02-27/04-12	342 (289)	(20.6)	1.2	16.1 (18.8)	7.0
23	8+39	03-17/04-18	478	1.9	1.3	11.9	--
24	7+79	03-18/04-18	432 (340)	(21.5)	1.4	13.1 (16.3)	17.0
25	8+09	03-19/04-18	446	4.4	1.3	12.6	--
26	8+27	03-20/04-18	358	4.7	1.5	14.8	--
27	7+55	03-21/04-22	398	4.2	1.4	14.1	--
28	7+40	03-24/04-22	413	4.2	1.1	13.5	--
29	7+20	03-25/04-23	408 (308)	--	--	13.8 (17.6)	8.3
30	7+20	03-25/04-23	390	3.8	1.5	14.3	--
31	6+95	03-27/04-25	428	3.6	1.4	13.1	--
32	6+85	03-28/04-25	400	3.8	1.6	14.0	--
33	4+26	04-03/05-02	481	1.8	2.0	11.8	--
34	4+46	04-07/05-02	457 (321)	--	--	12.4 (17.0)	8.8
35	4+56	04-10/05-09	489	1.9	2.3	11.7	--

( ) - Denotes value after hydraulic conductivity test

-- - Indicates that the sample was not tested for this parameter

NC - Denotes New Corner station numbers

SUMMARY
PHYSICAL TEST RESULTS
CEMENT-BENTONITE GROUT
(Continued)

Sample Number	Station	Date Sample/Test	Water Content (%)	Unconfined Compression Strength (psi)	Unconfined Compression Strain (%)	Dry Unit Weight (lb./ft^3)	Hydraulic Conductivity (x 10^{-7} cm/sec)
36	4+69	04-11/05-09	469	1.4	1.7	11.3	--
37	4+82	04-14/05-15	447	2.4	1.5	12.3	--
38	4+97	04-15/05-15	424	2.8	1.9	13.3	--
39	4+97	04-15/05-15	433 (311)	--	--	13.1 (17.6)	7.6
40	5+12	04-16/05-17	448	2.2	1.9	12.7	--
41	5+23	04-17/05-17	370	5.7	1.4	14.0	--
42	5+73	05-09/06-10	432	1.94	2.7	13.2	--
43	5+68	05-12/06-15	453	2.8	1.8	12.6	--
44	5+50	05-13/06-15	456	3.6	2.3	12.4	--
45	6+08	05-13/06-15	430	4.0	1.8	13.1	--
46	6+08	05-15/06-15	444 (311)	--	--	12.8 (17.4)	9.2
47	6+45	05-30/06-30	454	3.6	0.8	12.5	--
48	0+08	06-02/07-01	452	0.8	4.6	12.6	--
49	0+29	06-03/07-01	496	1.2	2.3	11.6	--
50	0+54	06-04/07-03	454	1.7	3.2	12.5	--
51	1+06	06-05/07-03	431	2.6	1.5	13.1	--
52	1+06	06-05/07-03	439 (305)	--	--	12.9 (17.6)	6.5

( ) - Denotes value after hydraulic conductivity test

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NC - Denotes New Corner station numbers

SUMMARY
PHYSICAL TEST RESULTS
CEMENT-BENTONITE GROUT
(Continued)

Sample Number	Station	Date Sample/Test	Water Content (%)	Unconfined Compression Strength (psi)	Unconfined Compression Strain (%)	Dry Unit Weight (lb./ft^3)	Hydraulic Conductivity (x 10^{-7} cm/sec)
53	1+84	06-06/07-07	481	1.9	2.5	11.8	--
54	1+56	06-09/07-09	529	1.0	3.0	10.9	--
55	2+72	06-10/07-09	458	2.2	2.4	12.5	--
56	2+37	06-11/07-11	460	4.2	1.8	12.3	--
57	3+98	06-12/07-11	514	1.7	2.3	11.1	--
58	3+23	06-17/07-18	457	2.2	2.5	11.8	--
59	2+74	06-19/07-21	484	2.4	2.5	11.8	--
60	10+59	06-20/07-21	427	2.8	1.5	13.3	--
61	10+59	06-20/07-21	443 (300)	4.6	--	12.9 (18.3)	10

( ) - Denotes value after hydraulic conductivity test

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NC - Denotes New Corner station numbers

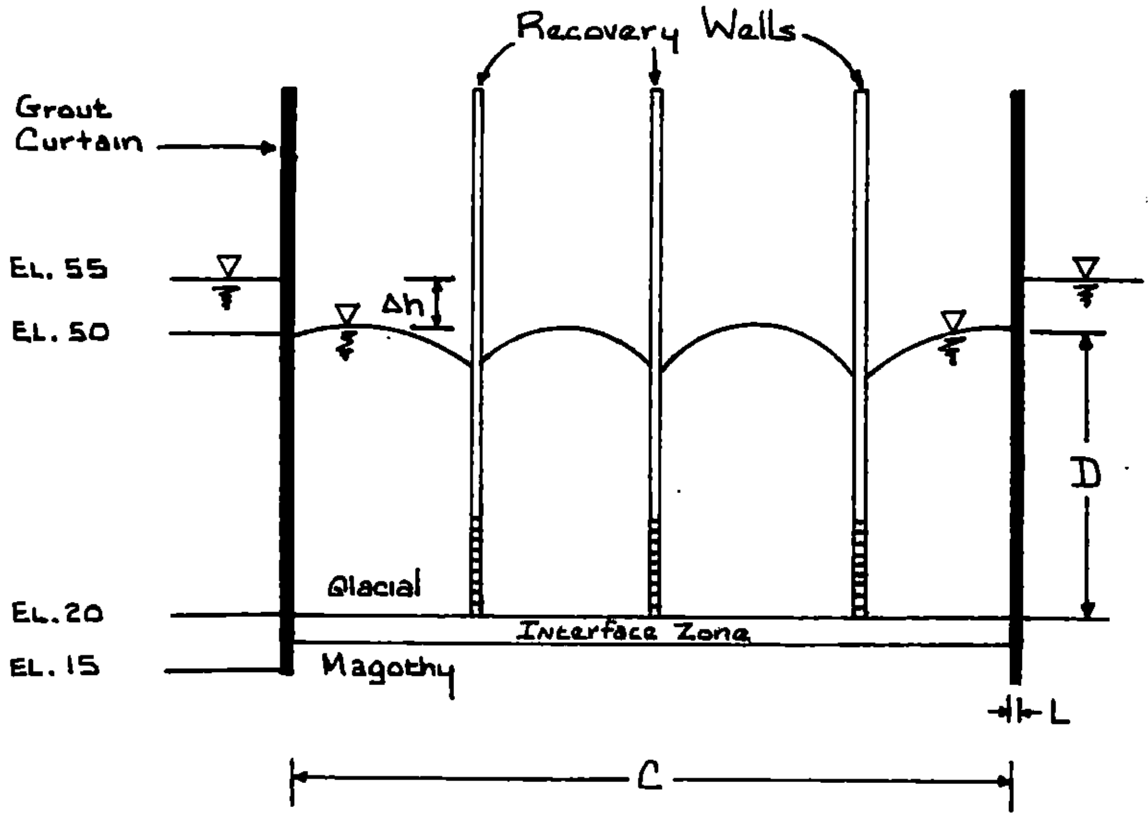
APPENDIX H

DESIGN AND AS-BUILT FLOW CALCULATIONS THROUGH THE WALL

Canonie

By CEA Date 9/11/86 Subject Source Area Hydraulic Control Sheet No. 1 of 2
Chkd. By MRZ Date 9/12/86 Mitchel Field Remedial Action Proj. No. CH85-096

1/4" X 1/4"



Δh = Piezometric Head Differential (Ft.)

i = Hydraulic Gradient (Ft./Ft.)

L = Containment Wall Thickness (Ft.)

K = Coefficient Of Permeability (Ft./Sec.)

D = Depth of Saturated Zone Within Containment (Ft.)

C = Perimeter of Containment Wall (Ft.)

CDM CONCEPTUAL DESIGN

Velocity $V = Ki$ where: $K = 1 \times 10^{-7}$ cm/sec $= 3.28 \times 10^{-9}$ Ft/Sec
$i = \Delta h / L = 5$ Ft./.25 Ft. = 20 Ft./Ft.

$V = (3.28 \times 10^{-9}$ Ft./Sec$)(20$ Ft./Ft.$) = 6.56 \times 10^{-8}$ Ft/Sec

Area $A = CD$ where: $C = 1{,}221$ Ft.
$D = 30$ Ft.

$A = (1{,}221$ Ft.$)(30$ Ft.$) = 36{,}630$ Ft^2

Flow Across Containment Wall, $Q = VA$

$Q = (36{,}630$ Ft$^2)(6.56 \times 10^{-8}$ Ft/Sec$) = 0.0024$ Ft^3/sec = 1.1 gpm

---

INSTALLED GROUT CURTAIN

Velocity $V = Ki$ where: $K = 8.9 \times 10^{-7}$ cm/sec $= 2.92 \times 10^{-8}$ Ft./Sec.
$i = \Delta h / L = 5$ Ft./1.7 Ft. = 2.94 Ft./Ft.

$V = (2.92 \times 10^{-8}$ Ft/Sec$)(2.94$ Ft./Ft.$) = 8.58 \times 10^{-8}$ Ft./Sec.

Area $A = CD$ where: $C = 1{,}221$ Ft.
$D = 30$ Ft.

$A = (1{,}221$ Ft$)(30$ Ft.$) = 36{,}630$ Ft^2

Flow Across Containment Wall, $Q = VA$

$Q = (8.58 \times 10^{-8}$ Ft/sec$)(36{,}630$ Ft$^2) = 0.0031$ Ft^3/sec = 1.4 gpm