WATERLOO BARRIER® SYSTEM INSTALLATION REPORT

Subsurface Containment Barrier Wall
Test Demonstration - Sheet Piling With Sealed Interlocks

ROCKAWAY PARK FORMER MANUFACTURED GAS PLANT SITE

Rockaway Park, Queens County, New York

Prepared for:

KeySpan Corporation
175 East Old Country Road
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EXECUTIVE SUMMARY

This report provides details of the test demonstration installation of a Waterloo Barrier® cut-off wall at the KeySpan Corporation Rockaway Park Former MGP Site, located in Rockaway Park, Queens County, NY (hereafter referred to as the site). The test demonstration was conducted from February 13th to February 17th, 2006.

The test demonstration utilized four (4) WEZ95 profile Waterloo Barrier® sheet piles which were field spliced to achieve a total length of 120 ft. Four 65 foot full-length sheet piles were installed. The top five foot reinforced section was removed and a 60 foot section was spliced to field fabricate the 120 foot long pile.

After the driving process, the interlock joints of the sheet piling were flushed full length with pressurized water to simulate the primary flushing and grouting processes. Once the flushing was terminated the piles were extracted. The piles were decontaminated using water during the extraction. The decontamination water was allowed to percolate back into the ground from the trench. The trench was then backfilled. During the extraction the individual piles were cut just above the splice plates resulting in a top section of approximately 58 feet in length and a bottom section with the splice plate being approximately 62 feet in length.

The extracted sheets were stored on site for use in a contemplated future full scale project. The four spare piles also remained on site.

Based upon the test demonstration results, we are confident that a Waterloo Barrier® containment wall using 120 foot spliced WEZ95 sheet piles can be installed at the site safely and effectively.

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1. WATERLOO BARRIER® SYSTEM

The Waterloo Barrier® is a low hydraulic conductivity groundwater cut-off wall, which was developed by the Waterloo Centre for Groundwater Research (WCGR) at the University of Waterloo, under the direction of Professor John Cherry. This patented groundwater containment system is composed of the following two basic elements:

- Custom rolled steel sheet piling incorporating a sealable cavity at the joint, and
- Site specific grouts used for sealing the Waterloo Barrier® joints.

The sheet piling is available in a 7.5 mm (0.295 inch) thickness (WZ75) and 9.5 mm (0.375 inch) thickness (WEZ95) and has been rolled in lengths up to 24.3 meters (80 feet). The patented section produced by this rolling method has the following advantages:

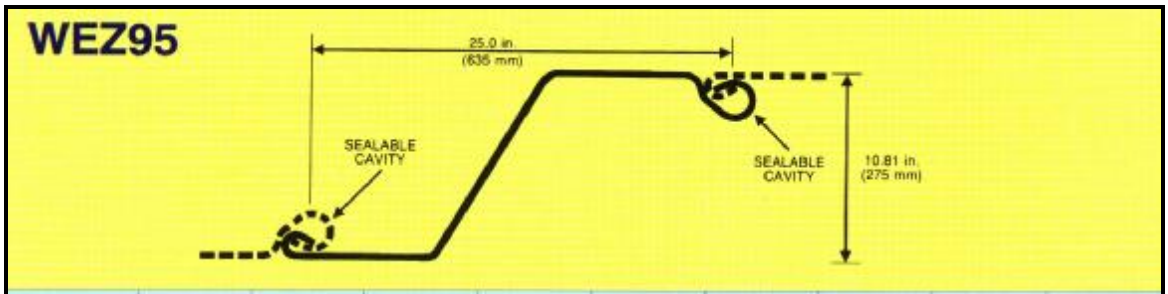
- It provides a cavity that can be inspected and can be used to confirm the integrity of the sheets and joints after driving, and
- It provides a controlled leak path that can be sealed with various grouting compounds.

2. WATERLOO BARRIER® SHEET PILE SPECIFICATIONS

The steel sheet piling used to construct the cut-off wall at the site was the WEZ95 profile of the Waterloo Barrier®. A typical cross-section and general section properties of these sheet piles are shown in Figure 1.

The Waterloo Barrier® WEZ95 sheet piles are patented sections with enlarged female joints that allow for the installation of a site-specific sealant material to seal the barrier wall.

A key procedure in ensuring proper installation of the WEZ95 sheet piles is the attachment of a foot plate at the base of every enlarged female joint (Figure 2 and Photo 1). The foot plate minimizes the entry of debris through the base of the joint during sheet pile installation.



SECTION	THICKNESS in (mm)	HEIGHT in (mm)	NOMINAL WIDTH in (mm)	SECTION AREA in² (cm²)	WEIGHT lbs/lin. ft. (kg/lin. m	WEIGHT lbs/ft² (kg/m²)	MOMENT OF INERTIA in⁴/wall ft. (cm⁴/wall m)	RADIUS OF GYRATION in (mm)	SECTION MODULUS in³/wall ft. (cm³/wall m)
WEZ95	.375 (9.50)	10.81 (275)	25.0 (635)	14.9 (96.2)	50.5 (75.2)	24.3 (119)	134 (18300)	4.33 (110)	24.9 (1340)

Figure 1: WEZ95 Cross-Section

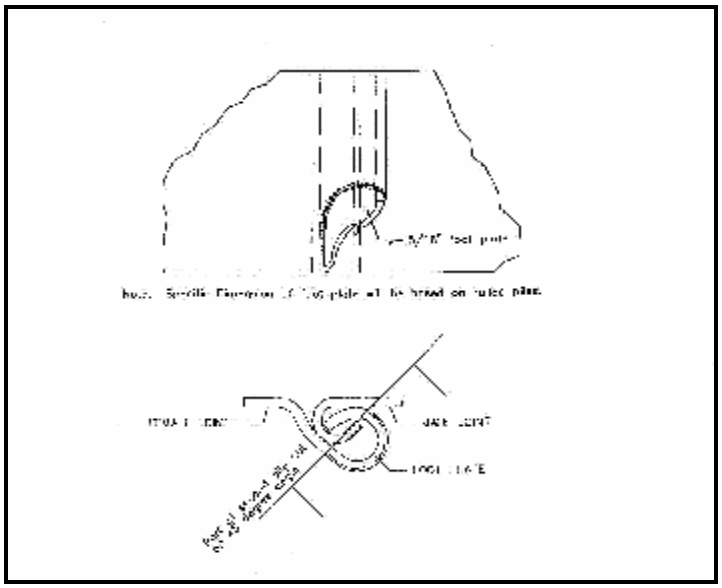


Figure 2: Foot Plate Cross-Section

Photo 1: Typical Footplate

3. SHEET PILE INSTALLATION EQUIPMENT

The equipment used during this demonstration project included the following:

- 140-ton mobile Crane;
- APE 200 vibratory hammer and diesel power unit;
- JLG telescopic boom lift, and
- Welding and cutting equipment.

Some of the equipment used to install the sheet piling is shown in Photos 2 and 3.

Photo 2: 140 Ton Crane with Power Pack

Photo 3: APE 200 Vibrator/Extractor

4. WATERLOO BARRIER® INSTALLATION PROCEDURES

All sheet piles are driven with the male joint leading in the direction of pile installation. The purpose of this procedure was to ensure that the enlarged joint (female joint) with the foot plate was driven onto the smaller interlock (male joint), thus minimizing the entry of debris into the cavity.

The sheet pile QA/QC inspections are performed in the following three stages:

4.1. Visual Inspection

A visual survey of the Waterloo Barrier® sheet piles are conducted by C3. The following is a brief outline of the inspection points:

1) **Pile Thickness** - To verify the thickness of the sheet piling.

2) **Linearity Inspection** - To ensure that the piles have not been bent or bowed during transportation to the site.

3) **Surface Condition** - The surface of the piles are inspected for defects and/or deformations prior to installation.

4) **Sheet Pile Length** - Each sheet pile is measured to confirm the specified length.

5) **Pile Marking** – One-foot graduations are marked on the sheet piles to assist in the recording of driving logs during pile installation.

6) **Foot Plate Inspection** - A visual inspection of each foot plate is conducted to ensure proper installation of the foot plate prior to driving.

4.2. Monitoring of Sheet Pile Driving

Records are collected for each of the sheet piles as they are installed. The C3 QA/QC Engineer, Mr. Joe Heinisch, P.Eng., was on-site during the entire driving process. The following is a brief description of the documented inspection items:

1) **Sheet Pile Identification** - Each sheet pile is numbered for reference purposes.

2) **Driving Records** - Driving records are collected on a laptop computer for each sheet pile installed in the Waterloo Barrier® System. These records document the driving rates and any notes regarding the installation.

3) **Driving Depth** - The installed depth of each sheet pile is measured and documented. These depths are a measure of amount of sheet pile driven. They are relative to the top elevation of the sheet pile, not the elevation of the ground level.

4) **Sheet Pile Alignment** - After the installation of the sheet piles, the alignment of each pile is recorded using a digital inclinometer. The alignment is measured in two directions, or axes. See Figure 3 for axes definition.

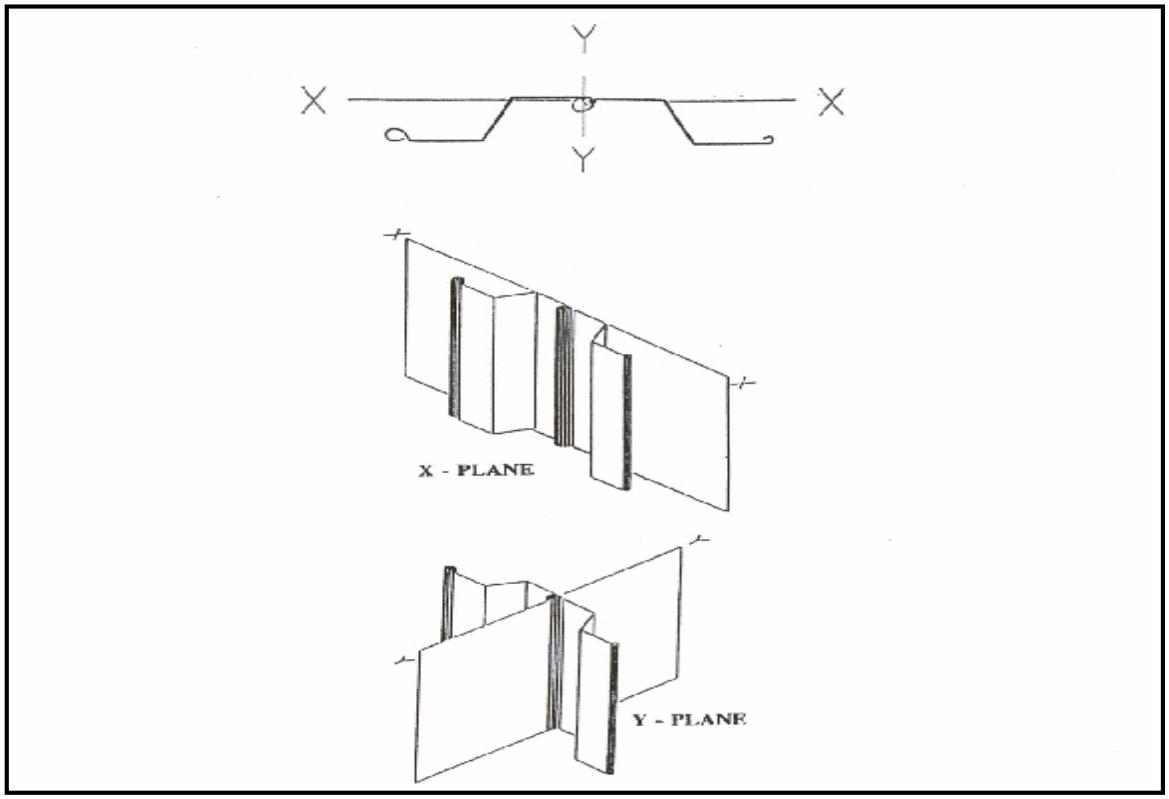


Figure 3: Waterloo Barrier® Sheet Pile Axes

4.3. Sealable Cavity Inspection

Inspection of the sealable cavities is the final stage of the Sheet Pile Installation QA/QC Program. Joint flushing equipment is used to inspect the integrity of each of the WEZ95 sealable cavities. The first time a joint is flushed is referred to as primary flushing (see Photo 4). Water delivered under pressure is used to flush out each joint until clean. Primary joint flushing is completed to determine if:

- A sound sealable cavity exists in the installed sheet piles, and
- The sealable cavity is free of obstructions for the full length.

The following is a description of the documented inspection items:

1) **Depth Measurement** - The depth of penetration of the inspection probe is recorded for each joint, along with any of the inspector's comments.

2) **Condition of Sealable Cavity** - Any unusual conditions encountered during the inspection of the sealable cavities are recorded. Documented conditions could include any of the following:

    - Damage to the top of joint (due to driving);
    - Debris present at the base of the sealable cavity, and
    - Obstructions/restrictions present in the sealable cavity.

3) **Inspection Report** - Deficiencies are reported and addressed prior to the initiation of joint sealing.

Photo 4: Typical Primary Flushing and VOC Monitoring

5. PROJECT OVERVIEW

Paulus, Sokolowski and Sartor Engineering PC was contracted by KeySpan Corporation to oversee the test demonstration of the Waterloo Barrier® cut-off wall system on the site. C3 Environmental Limited as the licensed Waterloo Barrier® installer was contracted by KeySpan Corporation to complete the test demonstration including the Quality Assurance/Quality Control (QA/QC) inspection. J.D. Posillico, Inc. was contracted by C3 Environmental Limited to conduct the pile driving of the barrier wall.

5.1. Driveability and flushing demonstration

The objectives of the test demonstration were:

To test and confirm on site the following:

- 65 foot reinforced full-length sheet pile drivability;
- Field splicing of a 60 foot sheet pile to the previously driven 65 foot sheet cut to 60 feet;
- The drivability of a field spliced 120 foot long sheet;
- Requirement for reinforcement on the top and bottom of sheet piles, and
- Suitability of the selected vibratory hammer for sheet pile installation;
- Joint flushing capability.

The Waterloo Barrier® cut-off wall was installed from February 13th to the 17th, 2006 at the site.

Prior to the installation of the sheet piles, PS&S arranged to have a 20 feet long trench cleared at the site to a depth of eight feet to allow the sheet pile installation work to be unhindered by shallow subsurface obstructions. The test demonstration wall was installed in this trenched area.

Bottom and Top Sheet Piles

The Waterloo Barrier® cut-off wall system was constructed from eight pieces of WEZ95 sheet piling, four 65 foot full-length sheets with footplate and four 60 foot length sheet piles. Details of the sheet pile fabrication are shown in Appendix E.

Installation Sequence

The driving of the four 65 foot long sheet piles with reinforcing top and bottom was successfully completed using only the vibratory hammer. These 65 foot bottom sheets were driven leaving about 6 feet exposed above ground surface. Once the bottom sheets were installed, the 5 foot reinforced sections were cut off of the top of the sheet. Subsequently the top 60 foot piles were threaded onto the installed bottom sheets and welded together. The welds at the splices were full penetration welds with additional reinforcement plates (fish plates) which were welded on each side of the sheets. During the welding process, the sheets were held in place by the vibratory hammer. A safety tag line also remained attached to the top of the sheets. Once the splices were completed the piles were driven to final elevation of 119 +/- ft below ground surface (bgs) by mid day Thursday 16 February.

Joint Flushing

Primary flushing was begun after the sheet pile driving was completed. The first joint (joint 1) of any wall is not flushed for this reason since there is no male joint. All three joints were successfully flushed.

All three joints were flushed using both a 5/8" and 1/2" flushing hose. The first 105 to 110 ft was done fairly easily. Below that the joints were more difficult and it was necessary to use the hammer to shake the piles to get to full depth.

After flushing was completed all of the sheet piles were removed using the vibratory hammer. The sheets were decontaminated and stored on site for future reuse.

Sheet Pile	Driven Depth (ft)	Flushed Length (ft)	Comments
1	119 +/-	-	Not flushed
2	119 +/-	120	Flushed full length to footplate
3	119 +/-	120	Flushed full length to footplate
4	119 +/-	120	Flushed full length to footplate

5.1.1. Field Observations

- The 65 foot reinforced sheet piles could be installed using the APE 200 vibratory hammer.
- The 5 foot reinforcements of the top and bottom of the sheet piles were adequate for the driving conditions encountered.
- The field splicing procedure was verified and the top 60 feet was successfully spliced to the bottom sheet once the top 5 feet of reinforcing had been removed.
- Drivability of the 120 foot spliced sheet with the selected hammer was verified.
- It was necessary to vibrate the sheet piles in order to clear obstructions in the last 15 feet.
- Flushing was possible for the complete length of the sealable cavity, but it was noticeably more difficult in the last 10 to 15 feet.

6. DISCUSSION

The test demonstration verified the pile fabrications, the driving methods, the field splice and flushing procedures for installing 120 foot long WEZ95 Waterloo Barrier® sheet piling as a cut-off wall at this site. Based on the field observations and the demonstrated results the following installation rates can be applied to the full scale project.

6.1. Summary of Anticipated Full-Scale Work Progress

The following table assumes the use of:

- An APE 200 vibratory hammer or similar;
- All sheet piles reinforced at the top and bottom

Task	Projected Work Rates (including handling)
Bottom 65 ft length Pile Driving	9/10 sheet piles/day (20wall feet/day)
Field splicing	Two welders, 5/6 sheet piles/day (10 wall feet/day) *
Top 60 ft length Pile Driving	10/12 sheet piles/day (20/24 wall feet/day))
Joint Flushing	8/10 joints/day
Estimated production cycle, 120 spliced sheets	9/10 sheets complete in three day period.
Estimated production rate, 60 to 80 foot sheets	1200 square feet per day under typical conditions

*Note that on this site the welders must be from a specific union hall. This is the most critical labor time sensitive operation.

7. WATERLOO BARRIER® PROJECT RECORDS

The following appendices contain data collected during the sheet pile installation and joint flushing phases of the project. Information provided is as follows:

Appendix A Overview of Pile Driving Sequence
Appendix B Sheet Pile Driving Log
Appendix C Sheet Pile Driving Summary
Appendix D Sealable Cavity Inspection Summary
Appendix E Pile Reinforcing Details

Appendix A, Overview of Pile Driving Sequence

OVERVIEW OF PILE DRIVING SEQUENCE

ROCKAWAY, NEW YORK

Waterloo Barrier System

DATE	PILE ID	DEPTH (ft) - TIME		COMMENTS
14-Feb-06	1	0.0	11:41:14	Start Driving Sheet # 1
		57.0	11:57:19	
		57.0	11:57:20	Stop for Adjustment
14-Feb-06	2	0.0	1:05:56	Start Driving Sheet # 2
		57.0	1:09:10	Move to Sheet # 1 and # 2
		60.0	1:14:12	Move to Sheet # 3
14-Feb-06	3	0.0	1:26:06	Start Driving Sheet # 3
		60.0	1:29:57	Move to Sheet # 4
14-Feb-06	4	0.0	1:39:56	Start Driving Sheet # 4
		53.0	1:45:44	Move to Sheet # 3
14-Feb-06	1 & 2	60.0	1:50:22	Pull sheet 1 & 2 to cut and splice
		55.0	1:50:35	Cut 1 and set up to thread 1 into 2
15-Feb-06	1	54.0	12:52:23	Start Driving Sheet # 1
		115.0	12:56:43	Weld extension on # 2
15-Feb-06	2	54.0	3:33:43	Start Driving Sheet # 2
		115.0	3:37:29	End of Day
16-Feb-06	3	53.0	10:00:56	Start Driving Sheet # 3
		108.0	10:13:23	Move to Sheet # 4 weld splice
16-Feb-06	4	56.0	11:50:02	Start Driving Sheet # 4
		118.0	12:04:52	End of Driving

Appendix B, Sheet Pile Driving Log

SHEET PILE DRIVING LOG
ROCKAWAY, NEW YORK
Waterloo Barrier System

SHEET PILE ID: 1

DATE	DEPTH (ft)	TIME	OPERATION COMMENTS
14-Feb-06			
	0.0	11:41:14	Start Driving Sheet # 1
	1.0	11:41:16	
	2.0	11:41:18	
	3.0	11:41:20	
	3.0	11:41:29	Stop for Adjustment
	3.0	11:43:05	Start Driving Sheet # 1
	4.0	11:43:06	
	5.0	11:43:08	
	6.0	11:43:11	
	6.0	11:43:15	Stop for Adjustment
	6.0	11:43:51	Start Driving Sheet # 1
	7.0	11:43:52	
	8.0	11:43:56	
	9.0	11:44:01	
	9.0	11:44:02	Stop for Adjustment
	9.0	11:44:24	Start Driving Sheet # 1
	10.0	11:44:27	
	11.0	11:44:28	
	12.0	11:44:30	
	13.0	11:44:32	
	13.0	11:44:34	Stop for Adjustment
	13.0	11:46:30	Start Driving Sheet # 1
	14.0	11:46:31	
	15.0	11:46:35	
	15.0	11:46:36	Stop for Adjustment
	15.0	11:47:16	Start Driving Sheet # 1
	14.0	11:47:18	
	13.0	11:47:21	
	13.0	11:47:24	Stop for Adjustment
	13.0	11:47:57	Start Driving Sheet # 1
	12.0	11:48:03	
	12.0	11:48:08	Stop for Adjustment
	12.0	11:49:00	Start Driving Sheet # 1
	13.0	11:49:03	
	14.0	11:49:05	
	14.0	11:49:06	Stop for Adjustment
	14.0	11:49:29	Start Driving Sheet # 1
	15.0	11:49:34	
	15.0	11:49:38	Stop for Adjustment
	15.0	11:49:57	Start Driving Sheet # 1
	16.0	11:49:59	
	17.0	11:50:00	
	18.0	11:50:02	
	18.0	11:50:06	Stop for Adjustment
	18.0	11:51:03	Start Driving Sheet # 1

SHEET PILE DRIVING LOG
ROCKAWAY, NEW YORK
Waterloo Barrier System

SHEET PILE ID: 1

DATE	DEPTH (ft)	TIME	OPERATION COMMENTS
	19.0	11:51:12	
	19.0	11:51:16	Stop for Adjustment
	19.0	11:51:37	Start Driving Sheet # 1
	20.0	11:51:40	
	21.0	11:51:42	
	22.0	11:51:44	
	23.0	11:51:45	
	23.0	11:51:48	Stop for Adjustment
	23.0	11:53:14	Start Driving Sheet # 1
	24.0	11:53:18	
	25.0	11:53:19	
	26.0	11:53:21	
	27.0	11:53:23	
	28.0	11:53:25	
	28.0	11:53:27	Stop for Adjustment
	28.0	11:53:58	Start Driving Sheet # 1
	29.0	11:54:00	
	30.0	11:54:02	
	31.0	11:54:04	
	32.0	11:54:07	
	33.0	11:54:09	
	33.0	11:54:11	Stop for Adjustment
	33.0	11:54:28	Start Driving Sheet # 1
	34.0	11:54:30	
	35.0	11:54:32	
	36.0	11:54:34	
	37.0	11:54:35	
	38.0	11:54:37	
	39.0	11:54:40	
	39.0	11:54:45	Stop for Adjustment
	39.0	11:55:29	Start Driving Sheet # 1
	40.0	11:55:33	
	41.0	11:55:38	
	42.0	11:55:41	
	43.0	11:55:46	
	43.0	11:55:51	Stop for Adjustment
	43.0	11:56:06	Start Driving Sheet # 1
	44.0	11:56:07	
	45.0	11:56:10	
	46.0	11:56:12	
	47.0	11:56:15	
	48.0	11:56:19	
	48.0	11:56:20	Stop for Adjustment
	48.0	11:56:35	Stop for Adjustment
	49.0	11:56:37	
	50.0	11:56:39	

SHEET PILE DRIVING LOG
ROCKAWAY, NEW YORK
Waterloo Barrier System

SHEET PILE ID: 1

DATE	DEPTH (ft)	TIME	OPERATION COMMENTS
	51.0	11:56:42	
	52.0	11:56:45	
	53.0	11:56:47	
	54.0	11:56:49	
	55.0	11:56:52	
	56.0	11:57:15	
	57.0	11:57:19	
	57.0	11:57:20	Stop for Adjustment, Break for lunch
	58.0	1:14:04 PM	
	59.0	1:14:08 PM	
	60.0	1:14:12 PM	Move to Sheet # 2
	60.0	1:50:22 PM	Start Driving Sheet # 1 and # 2
	59.0	1:50:26 PM	
	58.0	1:50:29 PM	
	57.0	1:50:31 PM	
	56.0	1:50:33 PM	
	55.0	1:50:35 PM	
	54.0	1:50:36 PM	
	54.0	1:50:49 PM	Stop for Adjustment, Weld on next piece
15-Feb-06			
	54.0	12:52:23 PM	Start Driving Sheet # 1
	55.0	12:52:25 PM	
	56.0	12:52:27 PM	
	57.0	12:52:28 PM	
	58.0	12:52:31 PM	
	59.0	12:52:32 PM	
	60.0	12:52:35 PM	
	61.0	12:52:37 PM	
	62.0	12:52:38 PM	
	63.0	12:52:40 PM	
	64.0	12:52:42 PM	
	65.0	12:52:44 PM	
	66.0	12:52:45 PM	
	67.0	12:52:47 PM	
	68.0	12:52:48 PM	
	69.0	12:52:50 PM	
	70.0	12:52:52 PM	
	71.0	12:52:54 PM	
	72.0	12:52:57 PM	
	73.0	12:52:59 PM	
	74.0	12:53:02 PM	
	75.0	12:53:04 PM	
	76.0	12:53:07 PM	
	77.0	12:53:09 PM	
	78.0	12:53:12 PM	
	79.0	12:53:15 PM	

SHEET PILE DRIVING LOG
ROCKAWAY, NEW YORK
Waterloo Barrier System

SHEET PILE ID: 1

DATE	DEPTH (ft)	TIME	OPERATION COMMENTS
	80.0	12:53:17 PM	
	81.0	12:53:19 PM	
	82.0	12:53:21 PM	
	83.0	12:53:24 PM	
	84.0	12:53:26 PM	
	85.0	12:53:29 PM	
	86.0	12:53:31 PM	
	87.0	12:53:33 PM	
	88.0	12:53:34 PM	
	89.0	12:53:37 PM	
	90.0	12:53:39 PM	
	91.0	12:53:41 PM	
	92.0	12:53:43 PM	
	93.0	12:53:45 PM	
	94.0	12:53:48 PM	
	95.0	12:53:49 PM	
	96.0	12:53:52 PM	
	97.0	12:53:54 PM	
	98.0	12:53:57 PM	
	99.0	12:53:59 PM	
	100.0	12:54:01 PM	
	101.0	12:54:03 PM	
	102.0	12:54:06 PM	
	103.0	12:54:08 PM	
	104.0	12:54:10 PM	
	105.0	12:54:11 PM	
	105.0	12:54:12 PM	Stop for Adjustment
	105.0	12:54:28 PM	Start Driving Sheet # 1
	106.0	12:54:30 PM	
	107.0	12:54:32 PM	
	108.0	12:54:33 PM	
	109.0	12:54:35 PM	
	110.0	12:54:37 PM	
	111.0	12:54:41 PM	
	112.0	12:54:44 PM	
	113.0	12:54:46 PM	
	114.0	12:54:49 PM	
	114.0	12:54:51 PM	Stop for Adjustment
	114.0	12:56:29 PM	Start Driving Sheet # 1
	115.0	12:56:32 PM	
	115.0	12:56:43 PM	Weld extension on # 2
16-Feb-06			
	115.0	11:57:52	Move to Sheet # 1 and # 2
	115.0	12:00:09 PM	Start Driving Sheet # 1 and # 2
	116.0	12:00:21 PM	
	117.0	12:00:42 PM	

SHEET PILE DRIVING LOG
ROCKAWAY, NEW YORK
Waterloo Barrier System

SHEET PILE ID: **1**

DATE	DEPTH (ft)	TIME	OPERATION COMMENTS
	118.0	12:01:10 PM	Move to Sheet # 3 and # 4

SHEET PILE DRIVING LOG
ROCKAWAY, NEW YORK
Waterloo Barrier System

SHEET PILE ID: 2

DATE	DEPTH (ft)	TIME	OPERATION COMMENTS
14-Feb-06			
	0.0	1:05:56 PM	Start Driving Sheet # 2
	1.0	1:06:01 PM	
	2.0	1:06:02 PM	
	3.0	1:06:03 PM	
	4.0	1:06:05 PM	
	5.0	1:06:06 PM	
	6.0	1:06:09 PM	
	6.0	1:06:10 PM	Stop for Adjustment
	6.0	1:06:31 PM	Start Driving Sheet # 2
	7.0	1:06:33 PM	
	8.0	1:06:34 PM	
	9.0	1:06:36 PM	
	10.0	1:06:37 PM	
	11.0	1:06:39 PM	
	12.0	1:06:40 PM	
	13.0	1:06:42 PM	
	14.0	1:06:43 PM	
	15.0	1:06:44 PM	
	16.0	1:06:45 PM	
	17.0	1:06:46 PM	
	17.0	1:06:49 PM	Stop for Adjustment
	17.0	1:07:22 PM	Start Driving Sheet # 2
	18.0	1:07:24 PM	
	19.0	1:07:25 PM	
	20.0	1:07:26 PM	
	21.0	1:07:27 PM	
	22.0	1:07:29 PM	
	23.0	1:07:30 PM	
	24.0	1:07:31 PM	
	25.0	1:07:32 PM	
	26.0	1:07:33 PM	
	27.0	1:07:34 PM	
	28.0	1:07:36 PM	
	29.0	1:07:37 PM	
	30.0	1:07:38 PM	
	31.0	1:07:41 PM	
	31.0	1:07:42 PM	Stop for Adjustment
	31.0	1:08:00 PM	Start Driving Sheet # 2
	32.0	1:08:02 PM	
	33.0	1:08:03 PM	
	34.0	1:08:04 PM	
	35.0	1:08:05 PM	
	36.0	1:08:06 PM	
	37.0	1:08:07 PM	
	38.0	1:08:08 PM	

SHEET PILE DRIVING LOG
ROCKAWAY, NEW YORK
Waterloo Barrier System

SHEET PILE ID: 2

DATE	DEPTH (ft)	TIME	OPERATION COMMENTS
	39.0	1:08:09 PM	
	40.0	1:08:10 PM	
	41.0	1:08:11 PM	
	42.0	1:08:12 PM	
	43.0	1:08:13 PM	
	44.0	1:08:14 PM	
	45.0	1:08:16 PM	
	45.0	1:08:17 PM	Stop for Adjustment
	45.0	1:08:43 PM	Start Driving Sheet # 2
	46.0	1:08:46 PM	
	47.0	1:08:48 PM	
	48.0	1:08:49 PM	
	49.0	1:08:51 PM	
	50.0	1:08:53 PM	
	51.0	1:08:55 PM	
	52.0	1:08:57 PM	
	53.0	1:09:00 PM	
	54.0	1:09:03 PM	
	55.0	1:09:05 PM	
	56.0	1:09:08 PM	
	57.0	1:09:10 PM	Move to Sheet # 1 and # 2
	58.0	1:14:04 PM	
	59.0	1:14:08 PM	
	60.0	1:14:12 PM	Move to Sheet # 3 and # 4
	60.0	1:50:22 PM	Start Driving Sheet # 1 and # 2
	59.0	1:50:26 PM	
	58.0	1:50:29 PM	
	57.0	1:50:31 PM	
	56.0	1:50:33 PM	
	55.0	1:50:35 PM	
	54.0	1:50:36 PM	
	54.0	1:50:49 PM	Stop for Adjustment, Weld on next piece
15-Feb-06			
	54.0	3:33:43 PM	Start Driving Sheet # 2
	55.0	3:33:47 PM	
	56.0	3:33:53 PM	
	57.0	3:33:55 PM	
	58.0	3:33:57 PM	
	59.0	3:33:59 PM	
	60.0	3:34:00 PM	
	61.0	3:34:02 PM	
	62.0	3:34:05 PM	
	63.0	3:34:07 PM	
	64.0	3:34:18 PM	
	65.0	3:34:22 PM	
	66.0	3:34:25 PM	

SHEET PILE DRIVING LOG
ROCKAWAY, NEW YORK
Waterloo Barrier System

SHEET PILE ID: 2

DATE	DEPTH (ft)	TIME	OPERATION COMMENTS
	67.0	3:34:27 PM	
	68.0	3:34:30 PM	
	69.0	3:34:31 PM	
	70.0	3:34:33 PM	
	71.0	3:34:34 PM	
	72.0	3:34:37 PM	
	73.0	3:34:38 PM	
	74.0	3:34:39 PM	
	75.0	3:34:40 PM	
	76.0	3:34:42 PM	
	77.0	3:34:42 PM	
	78.0	3:34:43 PM	
	79.0	3:34:48 PM	
	80.0	3:34:49 PM	
	81.0	3:34:51 PM	
	82.0	3:34:52 PM	
	83.0	3:34:55 PM	
	84.0	3:34:56 PM	
	85.0	3:34:57 PM	
	86.0	3:34:59 PM	
	87.0	3:35:01 PM	
	88.0	3:35:02 PM	
	89.0	3:35:04 PM	
	90.0	3:35:06 PM	
	91.0	3:35:11 PM	
	92.0	3:35:12 PM	
	93.0	3:35:13 PM	
	94.0	3:35:15 PM	
	95.0	3:35:16 PM	
	96.0	3:35:18 PM	
	97.0	3:35:21 PM	
	98.0	3:35:21 PM	
	99.0	3:35:23 PM	
	100.0	3:35:25 PM	
	101.0	3:35:27 PM	
	102.0	3:35:28 PM	
	103.0	3:35:31 PM	
	104.0	3:35:33 PM	
	105.0	3:35:34 PM	
	106.0	3:35:35 PM	
	107.0	3:35:39 PM	
	108.0	3:35:43 PM	
	109.0	3:35:49 PM	
	110.0	3:35:53 PM	
	110.0	3:36:06 PM	Stop for Adjustment
	110.0	3:37:09 PM	Start Driving Sheet # 2

SHEET PILE DRIVING LOG
ROCKAWAY, NEW YORK
Waterloo Barrier System

SHEET PILE ID:	2		
DATE	**DEPTH (ft)**	**TIME**	**OPERATION COMMENTS**
	111.0	3:37:12 PM	
	112.0	3:37:14 PM	
	113.0	3:37:17 PM	
	114.0	3:37:21 PM	
	115.0	3:37:24 PM	
	115.0	3:37:29 PM	End of Day
16-Feb-06			
	115.0	12:00:09 PM	Start Driving Sheet # 1 and # 2
	116.0	12:00:21 PM	
	117.0	12:00:42 PM	
	118.0	12:01:10 PM	Move to Sheet # 3 and # 4

SHEET PILE DRIVING LOG
ROCKAWAY, NEW YORK
Waterloo Barrier System

SHEET PILE ID: 3

DATE	DEPTH (ft)	TIME	OPERATION COMMENTS
14-Feb-06			
	-1.0	1:13:21 PM	Move to Sheet # 1 and # 2
	-1.0	1:16:35 PM	Move to Sheet # 3
	-1.0	1:26:04 PM	Start Driving Sheet # 3
	0.0	1:26:06 PM	
	1.0	1:26:07 PM	
	2.0	1:26:08 PM	
	3.0	1:26:10 PM	
	3.0	1:26:11 PM	Stop for Adjustment
	3.0	1:27:19 PM	Start Driving Sheet # 3
	4.0	1:27:22 PM	
	5.0	1:27:23 PM	
	6.0	1:27:24 PM	
	7.0	1:27:25 PM	
	8.0	1:27:27 PM	
	9.0	1:27:31 PM	
	9.0	1:27:33 PM	Stop for Adjustment
	9.0	1:27:51 PM	Start Driving Sheet # 3
	10.0	1:27:53 PM	
	11.0	1:27:55 PM	
	12.0	1:27:56 PM	
	13.0	1:27:58 PM	
	14.0	1:27:59 PM	
	15.0	1:28:00 PM	
	16.0	1:28:01 PM	
	17.0	1:28:02 PM	
	18.0	1:28:03 PM	
	19.0	1:28:04 PM	
	20.0	1:28:05 PM	
	21.0	1:28:08 PM	
	21.0	1:28:09 PM	Stop for Adjustment
	21.0	1:28:36 PM	Start Driving Sheet # 3
	22.0	1:28:39 PM	
	23.0	1:28:41 PM	
	24.0	1:28:42 PM	
	25.0	1:28:43 PM	
	26.0	1:28:44 PM	
	27.0	1:28:46 PM	
	28.0	1:28:47 PM	
	29.0	1:28:49 PM	
	30.0	1:28:50 PM	
	30.0	1:28:53 PM	Stop for Adjustment
	30.0	1:29:07 PM	Start Driving Sheet # 3
	31.0	1:29:10 PM	
	32.0	1:29:11 PM	
	33.0	1:29:12 PM	

SHEET PILE DRIVING LOG
ROCKAWAY, NEW YORK
Waterloo Barrier System

SHEET PILE ID: 3

DATE	DEPTH (ft)	TIME	OPERATION COMMENTS
	34.0	1:29:14 PM	
	35.0	1:29:15 PM	
	36.0	1:29:17 PM	
	37.0	1:29:18 PM	
	38.0	1:29:19 PM	
	39.0	1:29:20 PM	
	40.0	1:29:22 PM	
	41.0	1:29:23 PM	
	42.0	1:29:25 PM	
	43.0	1:29:26 PM	
	44.0	1:29:27 PM	
	45.0	1:29:29 PM	
	46.0	1:29:30 PM	
	47.0	1:29:31 PM	
	48.0	1:29:33 PM	
	49.0	1:29:34 PM	
	50.0	1:29:36 PM	
	51.0	1:29:37 PM	
	52.0	1:29:38 PM	
	53.0	1:29:39 PM	
	54.0	1:29:41 PM	
	55.0	1:29:42 PM	
	56.0	1:29:43 PM	
	57.0	1:29:45 PM	
	58.0	1:29:46 PM	
	59.0	1:29:51 PM	
	60.0	1:29:53 PM	
	60.0	1:29:57 PM	Move to Sheet # 4
	60.0	1:46:10 PM	Start Driving Sheet # 3
	59.0	1:46:13 PM	
	58.0	1:46:15 PM	
	57.0	1:46:16 PM	
	56.0	1:46:18 PM	
	55.0	1:46:21 PM	
	54.0	1:46:23 PM	
	53.0	1:46:25 PM	
	53.0	1:46:27 PM	Move to Sheet # 1
16-Feb-06			
	53.0	10:00:56	Start Driving Sheet # 3
	54.0	10:00:58	
	55.0	10:01:00	
	56.0	10:01:02	
	57.0	10:01:04	
	58.0	10:01:06	
	59.0	10:01:10	
	60.0	10:01:12	

SHEET PILE DRIVING LOG
ROCKAWAY, NEW YORK
Waterloo Barrier System

SHEET PILE ID: 3

DATE	DEPTH (ft)	TIME	OPERATION COMMENTS
	61.0	10:01:14	
	62.0	10:01:16	
	63.0	10:01:17	
	64.0	10:01:18	
	65.0	10:01:19	
	66.0	10:01:20	
	67.0	10:01:21	
	68.0	10:01:23	
	69.0	10:01:25	
	70.0	10:01:27	
	70.0	10:01:29	Stop for Adjustment
	70.0	10:01:34	Start Driving Sheet # 3
	71.0	10:01:50	
	72.0	10:02:11	
	73.0	10:02:14	
	74.0	10:02:16	
	75.0	10:02:19	
	76.0	10:02:23	
	77.0	10:02:28	
	78.0	10:02:31	
	78.0	10:02:33	Stop for Adjustment
	78.0	10:06:53	Start Driving Sheet # 3
	79.0	10:06:56	
	80.0	10:06:58	
	81.0	10:07:00	
	82.0	10:07:02	
	83.0	10:07:04	
	84.0	10:07:06	
	85.0	10:07:08	
	86.0	10:07:09	
	86.0	10:07:13	Stop for Adjustment
	86.0	10:07:22	Start Driving Sheet # 3
	87.0	10:07:27	
	88.0	10:07:35	
	89.0	10:07:53	
	90.0	10:07:59	
	91.0	10:08:03	
	92.0	10:08:06	
	93.0	10:08:15	
	94.0	10:08:33	
	95.0	10:08:38	
	96.0	10:08:46	
	97.0	10:08:52	
	98.0	10:09:01	
	99.0	10:09:06	
	100.0	10:09:13	

SHEET PILE DRIVING LOG
ROCKAWAY, NEW YORK
Waterloo Barrier System

SHEET PILE ID: 3

DATE	DEPTH (ft)	TIME	OPERATION COMMENTS
	100.0	10:09:18	Move to Sheet # 4
	100.0	10:11:52	Start Driving Sheet # 3
	101.0	10:11:54	
	102.0	10:11:56	
	103.0	10:12:00	
	104.0	10:12:03	
	105.0	10:12:07	
	105.0	10:12:17	Stop for Adjustment
	105.0	10:13:12	Start Driving Sheet # 3
	106.0	10:13:16	
	107.0	10:13:20	
	108.0	10:13:23	Move to Sheet # 4
	108.0	12:02:22 PM	Start Driving Sheet # 3 and # 4
	109.0	12:02:27 PM	
	110.0	12:02:35 PM	
	111.0	12:02:44 PM	
	112.0	12:02:51 PM	
	113.0	12:02:58 PM	
	114.0	12:03:10 PM	
	115.0	12:03:26 PM	
	116.0	12:03:41 PM	
	117.0	12:04:00 PM	
	118.0	12:04:52 PM	End of Driving

SHEET PILE DRIVING LOG
ROCKAWAY, NEW YORK
Waterloo Barrier System

SHEET PILE ID: 4

DATE	DEPTH (ft)	TIME	OPERATION COMMENTS
14-Feb-06			
	0.0	1:39:56 PM	Start Driving Sheet # 4
	1.0	1:39:59 PM	
	0.0	1:40:13 PM	
	0.0	1:40:14 PM	Stop for Adjustment
	0.0	1:40:22 PM	Start Driving Sheet # 4
	1.0	1:40:26 PM	
	2.0	1:40:27 PM	
	3.0	1:40:29 PM	
	4.0	1:40:31 PM	
	5.0	1:40:32 PM	
	6.0	1:40:34 PM	
	6.0	1:40:35 PM	Stop for Adjustment
	6.0	1:41:27 PM	Start Driving Sheet # 4
	7.0	1:41:29 PM	
	8.0	1:41:30 PM	
	9.0	1:41:31 PM	
	10.0	1:41:33 PM	
	11.0	1:41:35 PM	
	12.0	1:41:35 PM	
	13.0	1:41:36 PM	
	14.0	1:41:38 PM	
	15.0	1:41:39 PM	
	16.0	1:41:40 PM	
	16.0	1:41:42 PM	Stop for Adjustment
	16.0	1:42:05 PM	Start Driving Sheet # 4
	17.0	1:42:07 PM	
	18.0	1:42:08 PM	
	19.0	1:42:09 PM	
	20.0	1:42:10 PM	
	21.0	1:42:11 PM	
	22.0	1:42:12 PM	
	23.0	1:42:13 PM	
	24.0	1:42:14 PM	
	25.0	1:42:15 PM	
	26.0	1:42:16 PM	
	27.0	1:42:17 PM	
	28.0	1:42:18 PM	
	29.0	1:42:19 PM	
	30.0	1:42:20 PM	
	31.0	1:42:21 PM	
	32.0	1:42:22 PM	
	33.0	1:42:23 PM	
	34.0	1:42:24 PM	
	35.0	1:42:25 PM	
	36.0	1:42:27 PM	

SHEET PILE DRIVING LOG
ROCKAWAY, NEW YORK
Waterloo Barrier System

SHEET PILE ID: 4

DATE	DEPTH (ft)	TIME	OPERATION COMMENTS
	37.0	1:42:28 PM	
	38.0	1:42:29 PM	
	39.0	1:42:30 PM	
	40.0	1:42:32 PM	
	40.0	1:42:34 PM	Stop for Adjustment
	40.0	1:42:47 PM	Start Driving Sheet # 4
	41.0	1:42:48 PM	
	42.0	1:42:49 PM	
	43.0	1:42:50 PM	
	44.0	1:42:52 PM	
	45.0	1:42:56 PM	
	46.0	1:43:00 PM	
	47.0	1:43:04 PM	
	48.0	1:43:06 PM	
	49.0	1:43:08 PM	
	49.0	1:43:11 PM	Move to Sheet # 3
	49.0	1:45:23 PM	Start Driving Sheet # 4
	50.0	1:45:26 PM	
	51.0	1:45:33 PM	
	52.0	1:45:38 PM	
	53.0	1:45:43 PM	
	53.0	1:45:44 PM	Move to Sheet # 3
16-Feb-06			
	53.0	10:02:11	Start Driving Sheet # 4
	54.0	10:02:11	Hitching with sheet # 3
	55.0	10:02:14	Hitching with sheet # 3
	56.0	10:02:16	Hitching with sheet # 3
	57.0	10:02:19	Hitching with sheet # 3
	58.0	10:02:23	Hitching with sheet # 3
	59.0	10:02:28	Hitching with sheet # 3
	60.0	10:02:31	Hitching with sheet # 3
	60.0	10:04:35	Start Driving Sheet # 4
	59.0	10:04:39	
	58.0	10:04:41	
	57.0	10:04:45	
	56.0	10:04:48	
	55.0	10:04:51	
	54.0	10:04:54	
	53.0	10:04:57	
	52.0	10:05:01	
	51.0	10:05:04	
	51.0	10:05:06	Move to Sheet # 3
	52.0	10:08:15	Hitching with sheet # 3
	53.0	10:08:33	Hitching with sheet # 3
	54.0	10:08:38	Hitching with sheet # 3
	55.0	10:08:46	Hitching with sheet # 3

SHEET PILE DRIVING LOG
ROCKAWAY, NEW YORK
Waterloo Barrier System

SHEET PILE ID: 4

DATE	DEPTH (ft)	TIME	OPERATION COMMENTS
	56.0	10:08:52	Hitching with sheet # 3
	57.0	10:09:01	Hitching with sheet # 3
	58.0	10:09:06	Hitching with sheet # 3
	59.0	10:09:13	Hitching with sheet # 3
	59.0	10:10:43	Start Driving Sheet # 4
	58.0	10:10:46	
	57.0	10:10:48	
	56.0	10:10:50	
	55.0	10:10:51	
	54.0	10:10:53	
	53.0	10:10:54	
	52.0	10:10:56	
	51.0	10:10:58	
	50.0	10:10:59	
	49.0	10:11:02	
	48.0	10:11:04	Move to Sheet # 3
	48.0	10:16:18	Start Driving Sheet # 4
	49.0	10:16:20	
	50.0	10:16:21	
	51.0	10:16:22	
	52.0	10:16:25	
	53.0	10:16:27	
	54.0	10:16:31	
	55.0	10:16:35	
	56.0	10:16:49	Weld extension on # 4
	56.0	11:50:02	Start Driving Sheet # 4
	57.0	11:50:07	
	58.0	11:50:10	
	59.0	11:50:17	
	60.0	11:50:21	
	61.0	11:50:26	
	62.0	11:50:28	
	63.0	11:50:29	
	64.0	11:50:31	
	65.0	11:50:33	
	66.0	11:50:36	
	67.0	11:50:38	
	68.0	11:50:39	
	69.0	11:50:41	
	70.0	11:50:43	
	71.0	11:50:45	
	72.0	11:50:46	
	73.0	11:50:50	
	74.0	11:50:53	
	75.0	11:50:56	
	76.0	11:51:06	

SHEET PILE DRIVING LOG
ROCKAWAY, NEW YORK
Waterloo Barrier System

SHEET PILE ID: 4

DATE	DEPTH (ft)	TIME	OPERATION COMMENTS
	77.0	11:51:09	
	78.0	11:51:12	
	79.0	11:51:15	
	80.0	11:51:18	
	81.0	11:51:20	
	82.0	11:51:25	
	83.0	11:51:31	
	84.0	11:51:34	
	85.0	11:51:38	
	86.0	11:51:42	
	87.0	11:51:45	
	88.0	11:51:49	
	89.0	11:51:55	
	90.0	11:52:03	
	90.0	11:52:04	Stop for Adjustment
	91.0	11:52:28	
	92.0	11:52:32	
	93.0	11:52:35	
	94.0	11:52:44	
	95.0	11:52:59	
	94.0	11:53:06	
	95.0	11:53:15	
	96.0	11:53:25	
	97.0	11:53:39	
	98.0	11:53:50	
	99.0	11:54:04	
	100.0	11:54:19	
	101.0	11:54:33	
	102.0	11:54:43	
	103.0	11:55:00	
	104.0	11:55:13	
	105.0	11:55:24	
	106.0	11:55:35	
	107.0	11:55:45	
	108.0	11:55:54	Move to Sheet # 1
	108.0	11:56:35	Stop for Adjustment
	108.0	12:02:22 PM	Start Driving Sheet # 3 and # 4
	109.0	12:02:28 PM	
	110.0	12:02:35 PM	
	111.0	12:02:44 PM	
	112.0	12:02:51 PM	
	113.0	12:02:58 PM	
	114.0	12:03:10 PM	
	115.0	12:03:26 PM	
	116.0	12:03:42 PM	
	117.0	12:04:00 PM	

SHEET PILE DRIVING LOG
ROCKAWAY, NEW YORK
Waterloo Barrier System

SHEET PILE ID: 4

DATE	DEPTH (ft)	TIME	OPERATION COMMENTS
	118.0	12:04:52 PM	End of Driving

Appendix C, Sheet Pile Driving Summary

SHEET PILE DRIVING SUMMARY
ROCKAWAY, NEW YORK
Waterloo Barrier System

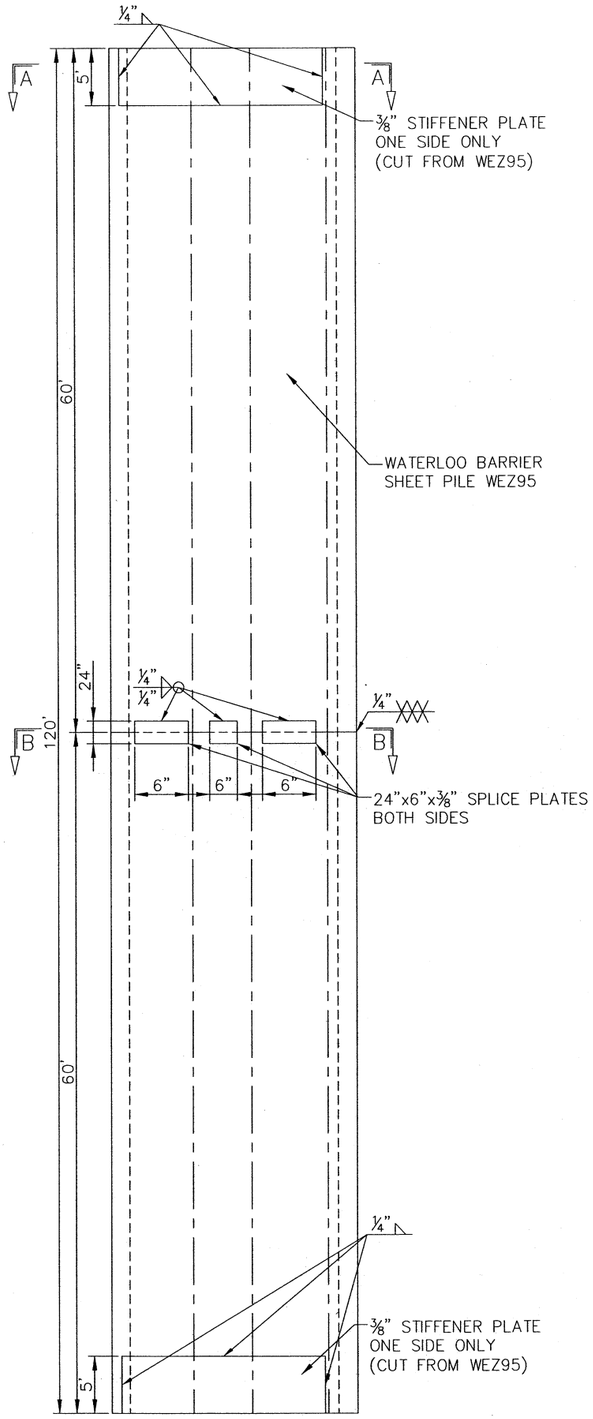
Pile ID	Date Driven	Pile Length (ft)	Length Driven (ft)	Plumbness X-Axis	Plumbness Y-Axis	COMMENTS
1	16-Feb-06	120.00	118.0	89.9 E	89.6 S	Left 2' above grade for flushing.
2	16-Feb-06	120.00	118.0	90.0 E	89.6 S	Left 2' above grade for flushing.
3	16-Feb-06	120.00	118.0	89.8 E	89.7 S	Left 2' above grade for flushing.
4	16-Feb-06	120.00	118.0	89.9 E	89.9 N	Left 2' above grade for flushing.

Appendix D, Sealable Cavity Inspection Summary

SEALABLE CAVITY INSPECTION SUMMARY
ROCKAWAY, NEW YORK
Waterloo Barrier System

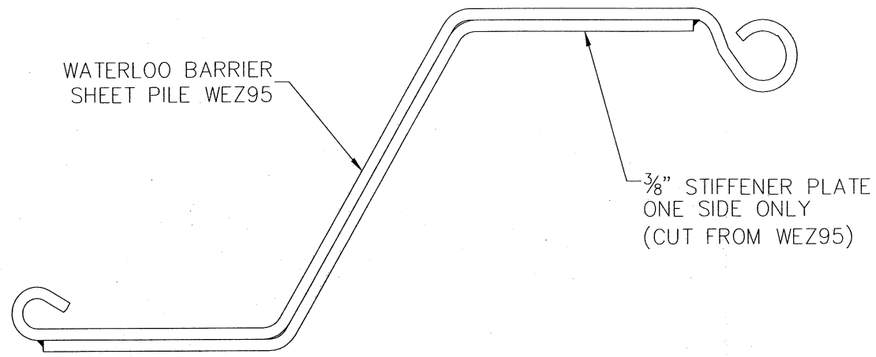
Pile ID	Date Flushed	Pile Length (ft)	Cutoff (ft)	Final Pile Length (ft)	Probe Depth (ft)	COMMENTS
1		120.0	0.00	120.00		
2	16-Feb-06	120.0	0.00	120.00	120.00	5/8" hose, bottom 15' to 20' more difficult
3	16-Feb-06	120.0	0.00	120.00	120.00	5/8" hose, bottom 15' to 20' more difficult
4	16-Feb-06	120.0	0.00	120.00	120.00	5/8" hose, bottom 15' to 20' more difficult

Appendix E, Pile Reinforcing Details



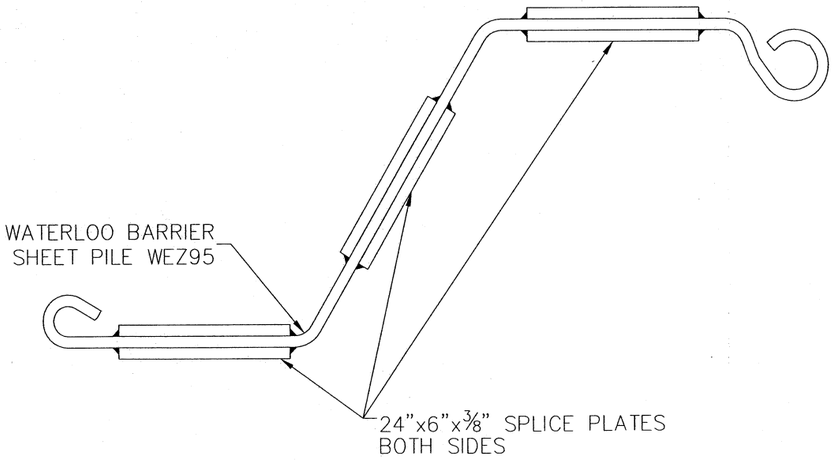
MODIFIED SHEET PILE WELDING DETAILS

(NOTE: VERTICAL:HORIZONTAL SCALE = 1:10)



SECTION 'A–A'

CROSS–SECTION AT STIFFENER PLATE



SECTION 'B–B'

CROSS–SECTION AT SPLICE

NO.	DATE	REVISION

C3 ENVIRONMENTAL LIMITED
Environmental Contractors & Engineers
350 Woolwich Street South, Breslau, Ontario N0B 1M0
Telephone: (519) 648-3611 Fax: (519) 648-3505
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PROJECT

C3 ENVIRONMENTAL
WATERLOO BARRIER SPLICING

DRAWING

WATERLOO BARRIER
SPLICING DETAILS

DRW'N BY TGQ	SCALE: NTS
CHECKED	DATE: Jan. 25, 2006
PROJECT No.	DWG. No.