Permit # 15-16
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HYDROGEOLOGIC REPORT

J.H. BAXTER

NORTH WOODWASTE LANDFILL

ARLINGTON, WASHINGTON

Place in Permit file
Per GGH 9/04

Sweet, Edwards & Associates, Inc.

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HYDROGEOLOGIC REPORT
J.H. BAXTER NORTH WOODWASTE LANDFILL
ARLINGTON, WASHINGTON

Prepared for
J.H. Baxter Company

November, 1987

Prepared by
Sweet, Edwards & Associates, Inc.
Redmond, Washington

Project S91-01.03

Sweet, Edwards & Associates, Inc.
Ground Water, Waste Management, Engineering Geology & Drilling Services
14590 N.E. 95th • Redmond, WA 98052-2251 • (206) 881-0415

November 18, 1987

Mr. Mike Spies
J.H. Baxter
P.O. Box 305
Arlington, Washington 98223

Re: Hydrogeologic Report
J.H. Baxter North Woodwaste
Landfill Arlington, Washington

Dear Mike:

Attached is Sweet, Edwards & Associates, Inc. Hydrogeologic Report regarding the J.H. Baxter North Landfill. We have enclosed three copies of the report, two of which should be forwarded to Snohomish Health District. We are available to meet with you to discuss the contents of this report or other aspects of this project.

It has been a pleasure working with you on this project.

Respectfully submitted,
Sweet, Edwards & Associates, Inc.

Steven R. Sagstad
Senior Hydrogeologist

SRS:kk
Enclosure

J.H. BAXTER

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Summary and Conclusions

1. The site is underlain by a shallow recessional sand and gravel aquifer. Published data suggest the sand and gravel deposits may be over 100-feet thick.

2. The depth to ground water beneath the landfill was between 42- and 47-feet at the time of our field investigation. Ground water appeared to be at least 9-feet below the bottom of the woodwaste in August, although ground water levels will rise in the wetter months. The magnitude of the water rise is not known.

3. The permeability of the sand and gravel aquifer ranges from 3×10^{-2} to 6×10^{-2} cm/sec based upon grain size analysis.

4. The ground water flow direction in the shallow aquifer is to the northwest beneath the site.

5. The site is located in a regional ground water discharge area which implies that any ground water impact will be to the shallow aquifer.

6. Ground water from the shallow aquifer is utilized in the vicinity of the subject site for human consumption purposes.

1.0 INTRODUCTION

This report presents the results of Sweet, Edwards and Associates, Inc. (Sweet-Edwards) geologic and hydrogeologic investigation of the existing woodwaste landfill facility operated by J.H. Baxter in Arlington, Washington. The landfill is approximately 8.8 acres in size and has been in operation since prior to 1970. The site is located approximately one mile southwest of Arlington in the NW-1/4 of Section 15, T31N.R5E W.M.

1.1 PURPOSE AND SCOPE OF WORK

Sweet-Edwards was retained by J.H. Baxter to evaluate hydrogeologic conditions at the company's north woodwaste landfill site. The hydrogeologic investigation was completed following guidelines outlined in the Minimum Functional Standards for solid waste handling; WAC 173-304-462, Woodwaste Landfilling Facility requirements, and WAC 173-304-360, Permitting Requirements for Solid Waste facilities. The Scope-of-Work included the following tasks:

- Review existing hydrogeologic data and evaluate regional and local conditions;
- Evaluate and describe hydrologic conditions;
- Drill, install and develop four (4) monitoring wells;
- Measure ground water levels
- Estimate hydraulic conductivity using grain size analysis;
- Determine direction of ground water flow;

- Determine beneficial use of ground water surrounding the landfill;

- Calculate a site water balance.

2.0 SITE CONDITIONS

The site is located approximately 2 miles south of the Stillaguamish River on the eastern side of a valley, which trends north-south from Arlington to Marysville. The landfill site is located on an old river terrace within a previous sand and gravel quarry.

No surface water was observed at the site during the field investigations. Portage Creek is located approximately 1500-feet to the northwest. Land use within one mile of the site is a combination of wood processing facilities, other light industrial, farming and residential.

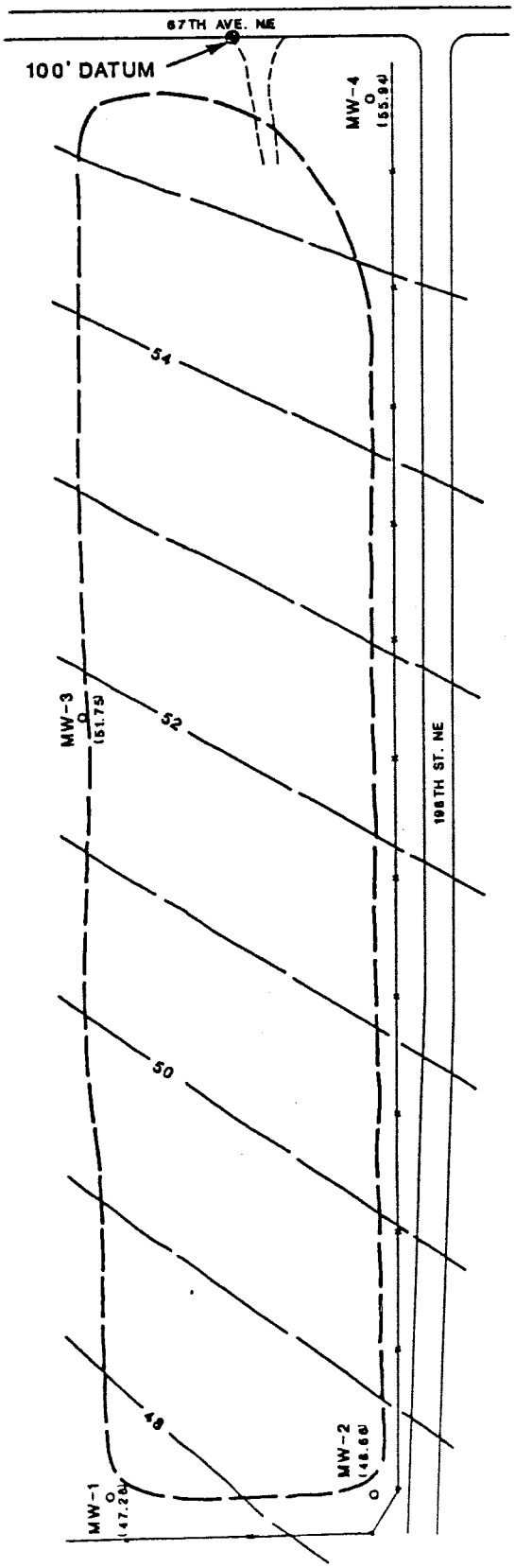
3.0 SUBSURFACE EXPLORATIONS

Subsurface explorations consisted of drilling four (4) borings and installation of monitoring wells at locations shown on Upper Aquifer Potentiometric Surface Map, Figure 1. The purpose of the borings was to evaluate geologic materials underlying the site, determine ground water levels, perform permeability testing and obtain ground water samples.

The monitoring wells were drilled and installed using a truck mounted hollow stem auger drill rig operated by Pacific Testing Laboratories. Soil samples were obtained at five foot vertical intervals. The borings were completed to depths ranging from 53- to 58-feet. All drilling and sampling was completed in accordance with QA/QC procedures which meet or exceed MFS requirements.

Monitoring wells were constructed with 2.0-inch, schedule 40 PVC threaded riser pipe and screen. All screens were 10.0-feet in length with 0.010-inch slots. A select washed silica sand pack was installed around the screen, where possible, and bentonite seals were placed from the top of the sand pack to the ground surface. Locking steel security casings were installed at each wellhead. The well logs and well construction details are provided in Appendix A. A variance was obtained from the Washington State DOE for those wells with less than the 18-foot minimum well seal.

Monitoring wells MW-1 and MW-3 were also completed with gas probes. After the washed silica sand was installed around the 2-inch PVC well screen, a 10-foot bentonite seal was installed. Pea gravel was then installed to a depth of 10-feet below ground surface. A gas probe was installed in the upper two feet of the gravel pack. Following the installation of the gas probe, the upper 10-feet of the boring was sealed with bentonite. Figure 2 is a schematic drawing of a typical gas probe.



EXPLANATION

— 54 — WATER TABLE CONTOURS (FEET ABOVE ARBITRARY 100.0' DATUM)

— — — APPROXIMATE LIMIT OF WOODWASTE

(51.75) WATER TABLE ELEVATION (ON 8/18/87)

N

0 100 200

Scale in Feet

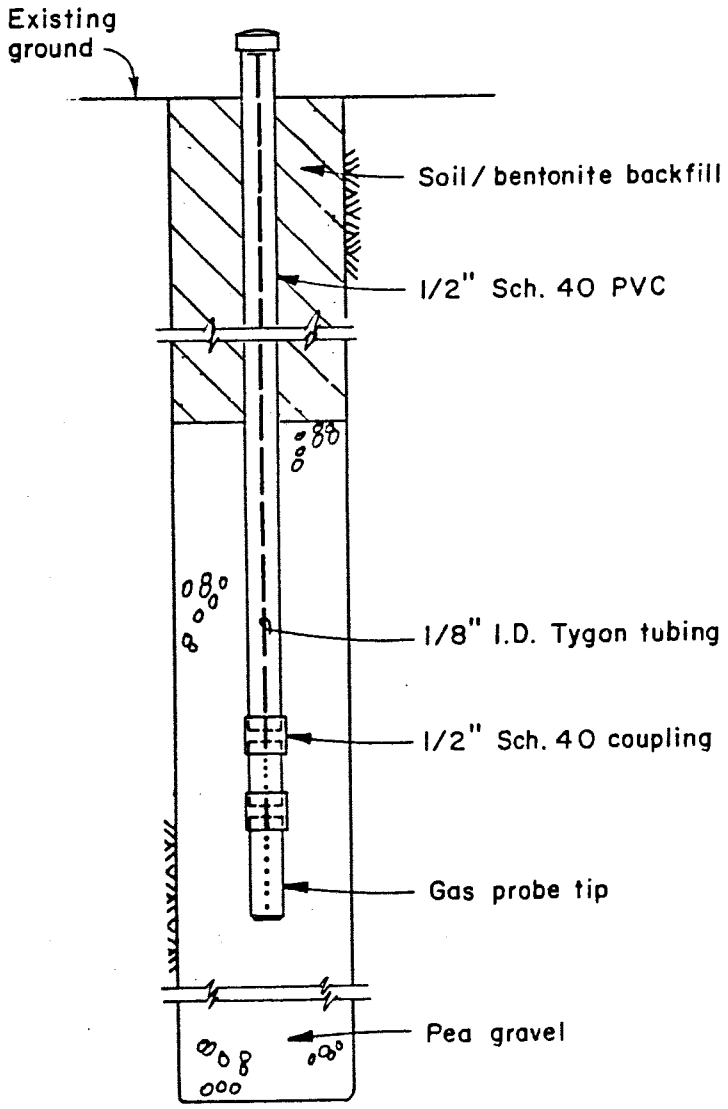
J.H. BAXTER LANDFILL

POTENTIOMETRIC SURFACE OF UPPER AQUIFER

Sweet, Edwards & Associates

	INITIALS	DATE
DRAWN BY	MC	
CHECKED BY		
REVISED		

Figure 1



J.H. BAXTER LANDFILL

GAS MONITORING PROBE

Sweet, Edwards & Associates

	INITIALS	DATE
DRAWN BY	MC	
CHECKED BY		
REVISED		

Figure 2

4.0 REGIONAL GEOLOGY

4.1 REGIONAL GEOLOGY

The J.H. Baxter North Landfill woodwaste site is located in the Puget Sound lowlands of western Washington. The Puget Sound lowlands consist of a trough between the Cascade Range to the east and the Olympic Mountains to the west.

The geology of the study area is primarily influenced by glacial action and stream erosion and deposition. Pleistocene glaciers advancing from the north eroded the valley bedrock in the Arlington area, creating a broad trough from Arlington to Marysville, which was subsequently filled with glacial deposits as the glaciers retreated. Depth to bedrock beneath the project site is unknown.

4.2 SITE GEOLOGY

The geology beneath the site reportedly consists of glacial recessional deposits, of unknown thickness. All four monitoring wells were completed in these recessional deposits, to depths ranging from 52- to 59-feet below existing grade. The deposits consist of stratified to massively bedded, fine to coarse sand with some gravel. These deposits are loose to medium dense and in many places poorly graded. The recessional sand and gravel unit correlates with the Marysville Sand Member, as described in Newcomb (1952). This sand is believed to occupy much of the valley that extends south to Marysville. Well logs in the area suggest the recessional deposits are in excess of one hundred feet in total thickness within the valley.

5.0 HYDROGEOLOGY

5.1 REGIONAL HYDROGEOLOGY

The site is located in a regional ground water discharge area with a superimposed local flow system. This implies that infiltrating moisture will recharge the local flow system and likely discharge into the Stillaguamish River or an associated tributary.

A regional ground water study of the Arlington area, completed by Newcomb (1952), reported that a deeper artesian aquifer is present beneath the site. The recharge source to the deep aquifer is likely rainfall infiltration on the foothills and Cascade Mountain slopes to the east.

5.2 LOCAL HYDROGEOLOGY

A water table aquifer is present in the recessional outwash deposits beneath the project site at depths ranging from 42- to 47-feet below existing grade. The deeper, regional ground water aquifer reported by Newcomb (1952), and the water table aquifer are believed to be separated by a low permeability glacial till layer.

5.3 GROUND WATER FLOW-SHALLOW AQUIFER

The local flow system in the Arlington-Marysville valley is reported to have both a northerly and southerly flow direction (Newcomb, 1952). A ground water divide is located near Edgecomb, approximately 1.5 miles south of the landfill site. To the south of the divide, ground water flows toward the Snohomish River estuary and Puget Sound. To the north of the divide, ground water flows toward the Stillaguamish River.

A phreatic surface map was completed for the J.H. Baxter site (Figure 1). Depth to water measurements relative to measuring point elevations (top of PVC well casing) were used to construct the map. The measuring point elevations were based on an assumed 100-foot datum on top of asphalt, on the west edge of pavement of 67th Ave. NE (see Figure 1).

The ground water flow direction beneath the J.H. Baxter North landfill is to the northwest, based upon water levels measured on August 18,1987. The ground water appears to be flowing towards Portage Creek, a tributary to the Stillaguamish River. Portage Creek is located approximately 1500-feet to the northwest of the project site. The primary source of recharge to the shallow aquifer is infiltration from precipitation and surface waters. Eventual discharge of ground water is believed to be the Stillaguamish River.

Ground water levels were at least 9-feet below the base of the woodwaste in August, 1987. This distance is based upon the August water level measurements and a 1971 Site Topographic map.

All four monitoring wells have been installed on the outside perimeter of the active landfill's area. The wells are located where both offsite and onsite migration of ground water can be detected (refer to Figure 1). With a northwest ground water flow direction, MW-1, MW-2 and MW-3 are all down gradient of the landfill and MW-4 is up gradient (background). Ground water monitoring will therefore provide an indication of water quality passing the point of compliance, as defined in WAC 173-304-100(58).

5.4 HYDRAULIC CONDUCTIVITY

An estimated range of hydraulic conductivity for the recessional outwash deposits has been determined on the basis of grain size distribution of these materials. Grain size distribution analyses were performed on three samples.

The grain size analyses were conducted by Hong Consulting Engineers, Inc. using standard sieve analysis testing methods. A sample from monitoring well MW-3 and from MW-4 were selected because they represent poorly graded sand common to the aquifer. A sample from MW-1 is typical of the gravelly but less common strata in the aquifer. Table 1 summarizes the boreholes, sample number, sample interval, and results.

Data from the sieve analyses were plotted on standard gradation charts, and are presented in Appendix B. Grain size values for the 10, 50 and 60 percent passing distribution (D_{10}, D_{50} and D_{60}) were interpolated from the charts for each sample. The ratio D_{60}/D_{10}, called the uniformity coefficient, and the D_{50} grain size values were compared to Moretrench American Corporation Type curves to estimate hydraulic conductivity.

Hydraulic conductivity for both MW-3 and MW-4 ranged from 3×10^{-2} to 6×10^{-2} cm/sec. These values are within a range expected for poorly graded fine sands. Hydraulic conductivity was not calculated for MW-1 because of its well graded characteristics.

5.5 BENEFICIAL USE

A beneficial use survey was completed as a part of this study. The survey included collection of well logs from Washington State DOE, communication with local water purveyors, and canvassing of homes and businesses within a one-mile radius of the site. A

Table 1

Samples Used for Grain Size Analyses

Borehole	Sample Number	Sample Depth (ft)	Hydraulic Conductivity (cm/sec)
MW-3	#10	47 1/2-49	3 to $6x10^{-2}$
MW-4	#10	47 1/2-49	3 to $6x10^{-2}$

summary of the well information is presented in Table 2 and a map showing location of the wells is presented in Figure 3.

At least ten (10) private domestic wells are in use within a 2000-foot radius of the J.H. Baxter North Landfill site. Based on ground water elevations from accessible domestic wells and monitoring wells, the ground water flow direction is toward the northwest. At least nine (9) wells lie in a down gradient direction, and three of these lie within 200-feet of the north site boundary.

The uppermost aquifer is believed to be the primary source of ground water in the area. The aquifer consists of recessional outwash sands and gravels. Depths to water range from 21-feet to 55-feet below ground surface within the 2000-foot radius.

5.6 SITE WATER BALANCE

The Hydrologic Evaluation of Landfill Performance (HELP) model developed by the Environmental Protection Agency was used to calculate a site water balance.

The method is based on the relationship between precipitation, evapotranspiration, surface runoff and soil moisture storage. Since a precise knowledge of all four factors is rarely available and field measurements difficult to obtain, estimations for this study are taken from known site conditions and published data. The following assumptions were made in applying this model:

1. The weather data is that of the Seattle, and Arlington, Washington weather stations (1980 through 1985).

2. The sole source of infiltration is that falling directly on the wood waste surface by precipitation.

Table 2

DOMESTIC WELL DETAILS

Well #	Reported Owner	Approximate Ground Elevation (amsl)	Total Depth (ft)	Approximate Elevation of Piezo Surface (amsl)	Perf/ Screen Interval (ft)	Use	Remarks
1	G.P. Jenson 7811 204th Arlington	115	40	103		Not in Use	Log*
2	G.P. Jenson Dairy Site	130	50	112		Not in Use	Log*
5	M. Radler 19908 67th Ave NE					Domestic	No access to well
6	Mobile States (mobile home park) Mr. Shultz	127		87		Domestic	(Now on public water (as of 7/87))
7	G. Zachary 19604 67th Ave NE	145	70	92	60-70	Domestic	
8	Arlington Cemetary Association	119	77	76	73-77	Irrigation	Log* pH: 6.66 cond: 298 mmhos
9	The Petal Patch (flower shop)					Domestic	No access to well

Table 2 (cont.)

DOMESTIC WELL DETAILS

Well #	Reported Owner	Approximate Ground Elevation (amsl)	Total Depth (ft)	Approximate Elevation of Piezo Surface (amsl)	Perf/ Screen Interval (ft)	Use	Remarks
10	E.E. Donning Box 182 Arlington	94		74		Domestic	pH: 6.34 cond: 298 mmhos
11	Mrs. Sharp 6804 204th St N.E.	114	46	91		Domestic	
12	Mr. Willett "Cozy Heating" 20221 67th Ave N.E.	116		91		Not in use	
13	Mr. C. Osbourne 6511 199th St. N.E.	127		85		Domestic	
14	Mr. E. Experdal 5822 Cemetary Rd.	120	65	51		Domestic	
15	Mr. E. Maynard (next to #14)					Domestic	No access to well

Table 2 (cont.)

DOMESTIC WELL DETAILS

Well #	Reported Owner	Approximate Ground Elevation (amsl)	Total Depth (ft)	Approximate Elevation of Piezo Surface (amsl)	Perf/ Screen Interval (ft)	Use	Remarks
16	Mr. B. Hoggrath 6225 204th Pl N.E.	110	69	58		Domestic	
17	Mr. Gray 6115 204th Pl N.E.	110	69	58	60-69	Domestic	
18	Kim Hudnall 5530 Cemetary Rd.	117		65		Domestic	
19	Mr. Hans Bohn Cemetary Rd.						No access to well
20	Perry Erickson 6819 188th (Jehova Witness Church Site)	150	30	146		Domestic	
21	Mrs. McDonald 6722 188th	147		126		Domestic	
22	Bob Bertilson Airway Mobile Park					Domestic to well	No access to well

Table 2 (cont.)

DOMESTIC WELL DETAILS

Well #	Reported Owner	Approximate Ground Elevation (amsl)	Total Depth (ft)	Approximate Elevation of Piezo Surface (amsl)	Perf/ Screen Interval (ft)	Use	Remarks
23	Mrs. Livingstone 6803 188th					Domestic	No access
24	Shirley Kennedy 18705 67th Ave N.E.	148		132			
25	Loess Gildersleeve 18204 67th Ave N.E.	158	20	137		Domestic	Log*
26	Mr.Albert Kluin 18110 67th Ave N.E.	158	23	148		Domestic	
27	Mr. C. Engerseth 18007 67th Ave N.E.						Well filled in
28						Domestic	Community Well - 3 houses
29	Sharon Christman 17722 1/2 67th Ave	140		129		Domestic to well	

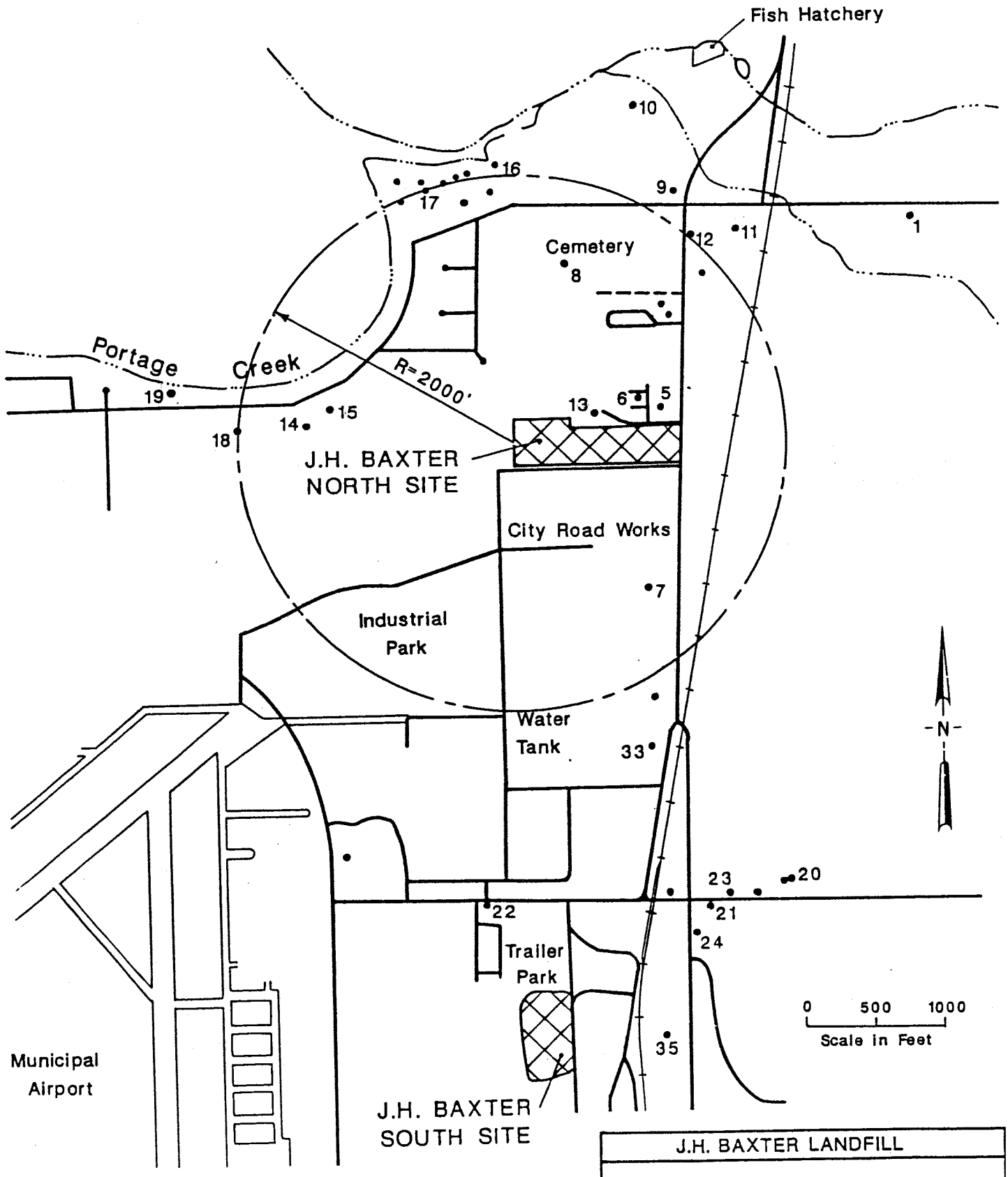
Table 2 (cont.)

DOMESTIC WELL DETAILS

Well #	Reported Owner	Approximate Ground Elevation (amsl)	Total Depth (ft)	Approximate Elevation of Piezo Surface (amsl)	Perf/ Screen Interval (ft)	Use	Remarks
30						Domestic	No access to well
31	George Seacome 1689 80th					Domestic	No access to well
32	Mr. S. Swanson 1689 67th Ave. N.E.					Domestic	
33	Mr. Kantzer 19120 66th Ave. N.E.	145		105		Domestic	
34	Mrs. Bogart 6121 172nd St. N.E.	125		119		Domestic	
35	HCI Steel Products Joe Holden	148	36	133		Domestic	

* Notes: 1) Logs are available where noted

2) Wells not shown on Figure 3 are outside of the boundaries of the map



EXPLANATION

- • Private well-no information or not in use
- •7 Private well-information in Table 2

J.H. BAXTER LANDFILL

BENEFICIAL USE MAP

Sweet, Edwards & Associates

	INITIALS	DATE
DRAWN BY	MG	
CHECKED BY		
REVISED		

Figure 3

3. The wood waste is of uniform thickness (25-feet).

4. The unsaturated formation underlying wood waste materials is 9-feet thick (average thickness is 9-feet extending from base of wood waste to water table).

5. Infiltration is by vertical percolation only.

6. The hydraulic conductivity (permeability) is uniform in all directions.

7. The area of wood waste is 7.7 acres.

8. The wood waste exhibits the properties of porosity, field capacity, wilting point and evaporation coefficient similar to the default values for waste.

The input parameters are summarized in Table 3. The model was a two layer configuration. The upper layer was wood waste with no vegetation. The lower layer was a gravelly sand (Recessional Outwash). The hydraulic conductivity for the lower layer was taken as 3.5×10^{-2} cm/sec, as discussed in Section 5.4, above.

The results of the simulation suggest that 56% of the precipitation that falls on the waste fill percolates into the shallow ground water aquifer (Table 4).

Table 3

Summary of HELP Model Input Parameters

LAYER 1		
Waste Layer Thickness	=	300-inches
Evaporation Coefficient	=	3.300 mm/day**0.5
Porosity	=	0.5200 vol/vol
Field Capacity	=	0.3200 vol/vol
Wilting Point	=	0.1900 vol/vol
Effective Hydraulic Conductivity	=	0.28299999-inches/hr
LAYER 2		
Vertical Percolation Layer Thickness	=	108-inches
Evaporation Coefficient	=	3.300 mm/day**0.5
Porosity	=	0.3890 vol/vol
Field Capacity	=	0.1990 vol/vol
Wilting Point	=	0.0660 vol/vol
Effective Hydraulic Conductivity	=	50.00000000000-inches/hr
GENERAL SIMULATION DATA		
SCS Runoff Curve Number	=	90.00
Total Area of Cover	=	336000-sq ft
Evaporative Zone Depth	=	4.00-inches
Potential Runoff Fraction	=	0.0000000
Effective Evaporation Coefficient	=	3.300 mm/day**0.5
Upper Limit Veg. Storage	=	2.0800-inches
Initial Veg. Storage	=	1.0200-inches

Table 4

Summary of Site Water Balance

Precipitation	48.7-inches/year
Runoff	0%
Evapotranspiration	43.7%
Percolation	56.2%

6.0 WATER QUALITY

Water samples were collected from the four monitoring wells on August 18, 1987. A transfer blank was collected at the same time. Field measurements were taken of pH, temperature and electrical conductivity. Samples from each well were analyzed for the constituents specified by the Minimum Functional Standards, [WAC 173-304-490 (2)(d)(i)] as well as Tannin-Lignin. These constituents are listed in Appendix C. The procedures and techniques for ground water sampling and statical evaluation of monitoring results a requirement in Minimum Functional Standards are included in Appendix C. Included in Appendix C is the site safety plan, and discussions regarding monitoring well construction, ground water sampling and laboratory analysis procedures. The results from the August sampling have been included in Appendix D.

7.0 REFERENCES

Newcomb, R.C., 1952, Ground Water Resources of Snohomish County, Washington; U.S. Geological Survey Water Supply Paper 1135.

Appendix A

BORING LOGS

Sweet, Edwards & Associates, Inc.

BORING LOG

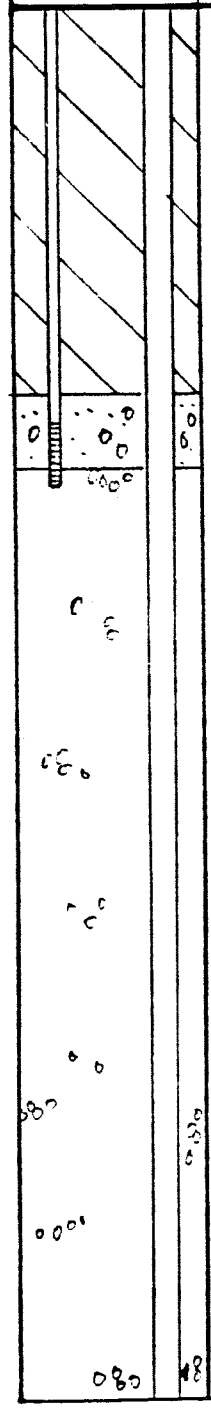
PROJECT J. H. Baxter North Landfill

Location Northwest corner of landfill **Boring No.** MW-1

Surface Elevation 95.50' **Drilling Method** 4" hallow stem auger

Total Depth 57-1/2' **Drilled By** Pacific Testing Laboratory

Date Completed 17 July 1987 **Logged By** G. S. Mack



WELL DETAILS	PENETRATION TIME/ RATE	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	PERMEABILITY TESTING	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
							0-2' SOIL, medium yellowish brown, some organic material	
		5	1	SPT		GW	2-10' SANDY GRAVEL, light olive gray to white, medium to coarse sand, gravel to 2", medium dense, well graded, dry.	
		10	2	SPT				
		15	3	SPT			10-40' SAND, mottled very light gray to dark yellowish brown, medium to coarse sand, trace gravel to 2", trace of silt.	
		20	4	SPT				
		25	5	SPT		SP	23' less than trace of gravel	
		30	6	SPT			28' trace of gravel	
		35	7	SPT			33' no gravel	

Sweet, Edwards & Associates, Inc.

BORING LOG

PROJECT J. H. Baxter North Landfill

Boring No. MW-1

WELL DETAILS	PENETRATION TIME/ RATE	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	PERMEABILITY TESTING	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
		35				SP	Sand - Continued	
		40	8	SPT		SW	40-50' GRAVELLY SAND, mottled very pale orange to dark yellowish brown, fine to coarse sand, gravel is subangular to subrounded, medium dense to dense, heaving below water.	
		45	9	SPT				
		50	10	SPT		SP	50-57½' SAND, mottled very pale orange to dark yellowish brown, trace of fines, fine to coarse sand, gravel is sub-angular to subrounded, medium dense, heaving.	
		55	11	SPT				
		60	12	SPT			T.D. = 57-1/2'	

Pea Gravel

Bentonite

2", Sch 40, PVC

Sand

2", Sch 40, Slotted (0.010")

Sweet, Edwards & Associates, Inc.

BORING LOG

PROJECT J. H. Baxter North Landfill

Location Southwest corner of landfill **Boring No.** MW-2

Surface Elevation 93' **Drilling Method** 4" hollow steam auge

Total Depth 57½' **Drilled By** Pacific Testing Lab

Date Completed 7/20/87 **Logged By** G. S. Mack

WELL DETAILS	PENE-TRATION TIME/ RATE	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	PERME-ABILITY TESTING	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
							0.0-2.0' SOIL, redish brown, organic material.	
		5	1	SPT		GW	2.0-11.0' SANDY GRAVEL, mottled light olive gray to white, fine to coarse sand, some cobbles to 4", rounded. Well graded medium dense.	
		10	2	SPT				
		15	3	SPT		SP	11-25 SAND, mottled white to light yellowish brown. Fine to coarse sand. Fine gravel, some thinly beded, poorly graded, medium dense, dry.	
		20	4	SPT				
		25	5	SPT		SW	25-31' GRAVELLY SAND, mottled white to light brown, fine to coarse sand. Gravel to ½". Well graded, medium dense, damp.	
		30	6	SPT				
		35	7	SPT		SP	31-35' SAND, mottled white to light brownish gray, fine to medium sand. Trace of gravel, poorly graded, damp.	

Bentonite

2" Sch 40 Riser

Heave

Sweet, Edwards & Associates, Inc.

BORING LOG

PROJECT J. H. Baxter North Landfill

Boring No. MW-2

WELL DETAILS	PENETRATION TIME/ RATE	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	PERMEABILITY TESTING	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
Bentonite Pellets	Heave	35					Sand - Continued	
	2" Sch 40 PVC, Riser					GW	35-45' SANDY GRAVEL, mottled yellowish white to medium greenish gray, fine to coarse sand, gravel to 1", trace of silt, well graded. Medium dense to dense.	
		40	8	SPT				
			9	SPT				
		45						▽
	2" Sch 40 slotted (0.010")		10	SPT		SP	45-57½' SAND, mottled very light gray to medium greenish gray. Trace of coarse sand. Some gravel to 3/8", subrounded. Trace of silt in places. Moderately poorly graded, medium dense.	
		50						
			11	SPT				
		55						
			12	SPT			T.D. = 57-1/2	
		60						

Sweet, Edwards & Associates, Inc.

BORING LOG

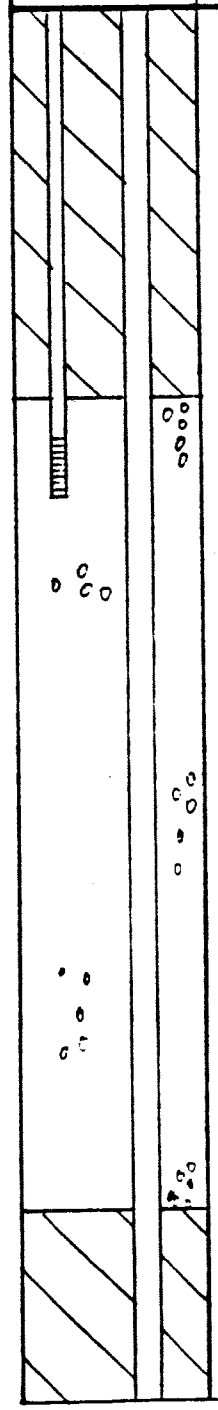
PROJECT J. H. Baxter North Landfill

Location North side, midway **Boring No.** MW-3

Surface Elevation 97.23' **Drilling Method** 4" hallow stem auger

Total Depth 58' bgs **Drilled By** Pacific Testing Laboratory

Date Completed 22 July 1987 **Logged By** G. S. Mack



PENE-TRATION TIME/ RATE	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	PERME-ABILITY TESTING	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
						0-5' SOIL, medium yellowish brown, silt and fine sand with some fine gravel and some organic material.	
		1	SPT		GW	5-11' SANDY GRAVEL, mottled white to medium yellowish brown. Fine to coarse sand, cobbles to 4", poorly graded, medium dense, dry.	
		2	SPT				
		3	SPT		SP	11-57½' SAND, mottled grayish white to medium gray, to medium yellowish brown, grace of gravels, subrounded. Clast are weathered. ish brown, trace of with depth. Well graded, loose to medium dense, dry.	
		4	SPT				
		5	SPT				
		6	SPT			Samples became damp.	
		7	SPT				

Sweet, Edwards & Associates, Inc.

BORING LOG

PROJECT J. H. Baxter North Landfill

Boring No. MW-3

WELL DETAILS	PENETRATION TIME/ RATE	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	PERMEABILITY TESTING	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
		35					Sand - Continued	
			8	SPT			38' Samples became moist.	
		40				SP		
			9	SPT			43' Samples were mottled white to medium greenish gray.	▽
		45						
			10	SPT				
		50						
			11	SPT			53' Samples were mottled very light gray to medium bluish gray. Trace of silt.	
		55						
			12	SPT			T.D. 58'	
		60						

Bentonite

2", Sch 40, PVC

Sand

2", Sch 40, Slotted (0.010")

Sweet, Edwards & Associates, Inc.

BORING LOG

PROJECT J. H. Baxter North Landfill

Location South east corner **Boring No.** MW 4

Surface Elevation 98.76' **Drilling Method** 4" hollow stem auger

Total Depth 53' **Drilled By** Pacific Testing Laboratory

Date Completed 23 July 1987 **Logged By** G. S. Mack

WELL DETAILS	PENETRATION TIME/ RATE	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	PERMEABILITY TESTING	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
Bentonite; 2" Sch. 40, PVC Riser; Heave		5					0-2.5' SOIL, medium yellowish brown.	
			1	SPT			2.5-10' SANDY GRAVEL, mottled grayish yellow to moderate olive brown. Gravel to 4", loose, well graded, dry.	
		10	2	SPT				
			3	SPT			10-54' SAND, mottled very light gray to light olive gray, fine to coarse sand, some gravel in places, loose to medium dense, poorly graded, saturated at 41'.	
		15	4	SPT				
		20	5	SPT			19' some gravel	
		25	6	SPT				
		30	7	SPT			33' trace of gravels	
		35						

Sweet, Edwards & Associates, Inc.

BORING LOG

PROJECT J. H. Baxter North Landfill

Boring No. MW-4

WELL DETAILS	PENETRATION TIME/ RATE	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	PERMEABILITY TESTING	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
	2", Sch 40, (0.010") Slotted PVC 2", Sch 40 PVC	35					Sand - Continued	
		40	8	SPT		SP	38' trace of gravels	▽
		45	9	SPT				
		50	10	SPT				
		55	11	SPT			Total depth 53'	
		60						
		65						

Appendix B

GRAIN SIZE DISTRIBUTION CHARTS

HONG CONSULTING ENGINEERS, INC.

• Geotechnical Engineering • Material Testing • Construction Quality Control Inspection •

SIEVE ANALYSIS TEST DATA

Project: Baxter North
Address:
Project Number: 8756
Date Tested: 8-17-87 By: SEG
Client: Sweet Edwards

Sample Number: MW-3, #10 47.5-49
Sample Description: Medium brown, coarse-medium grained sand
Initial Weight of Sample: _____ (gm)

SIEVE SIZE	WT. RETAINED	TOTAL WEIGHT PASSING	TOTAL PERCENT PASSING	SPECIFICATION LIMITS
3"				
1½"				
1"				
¾"				
½"				
⅜"			100	
No. 4			99.8	
No. 8				
No. 12			98.6	
No. 16				
No. 20			91.9	
No. 30				
No. 40			52.5	
No. 50				
No. 60			18.7	
No. 100			7.8	
No. 200			4.4	
Pan				
Wash				

Note: Total Weight Passing #200 Sieve = Wt. on Pan (Gr) + Wt. of Wash (Gr)

Remarks:

All tests performed in accordance with ASTM

HONG CONSULTING ENGINEERS, INC.

• Geotechnical Engineering • Material Testing • Construction Quality Control Inspection •

SIEVE ANALYSIS TEST DATA

Project: Baxter North
Address:
Project Number: 8756
Date Tested: 8-17-87 By: SEG
Client: Sweet Edwards

Sample Number: MW-4, #10, 47½-49
Sample Description: Medium brown medium to fine grained sand
Initial Weight of Sample: (gm)

SIEVE SIZE	WT. RETAINED	TOTAL WEIGHT PASSING	TOTAL PERCENT PASSING	SPECIFICATION LIMITS
3"				
1½"				
1"				
¾"				
½"				
⅜"			100	
No. 4			99.8	
No. 8				
No. 12			99.0	
No. 16				
No. 20			96.3	
No. 30				
No. 40			77.6	
No. 50				
No. 60			36.4	
No. 100			12.1	
No. 200			4.6	
Pan				
Wash				

Note: Total Weight Passing #200 Sieve = Wt. on Pan (Gr) + Wt. of Wash (Gr)

Remarks:

All tests performed in accordance with ASTM

HONG CONSULTING ENGINEERS, INC.

• Geotechnical Engineering • Material Testing • Construction Quality Control Inspection •

SIEVE ANALYSIS TEST DATA

Project: Baxter North
Address:
Project Number: 8756
Date Tested: 8-17-87 By:
Client: Sweet Edwards

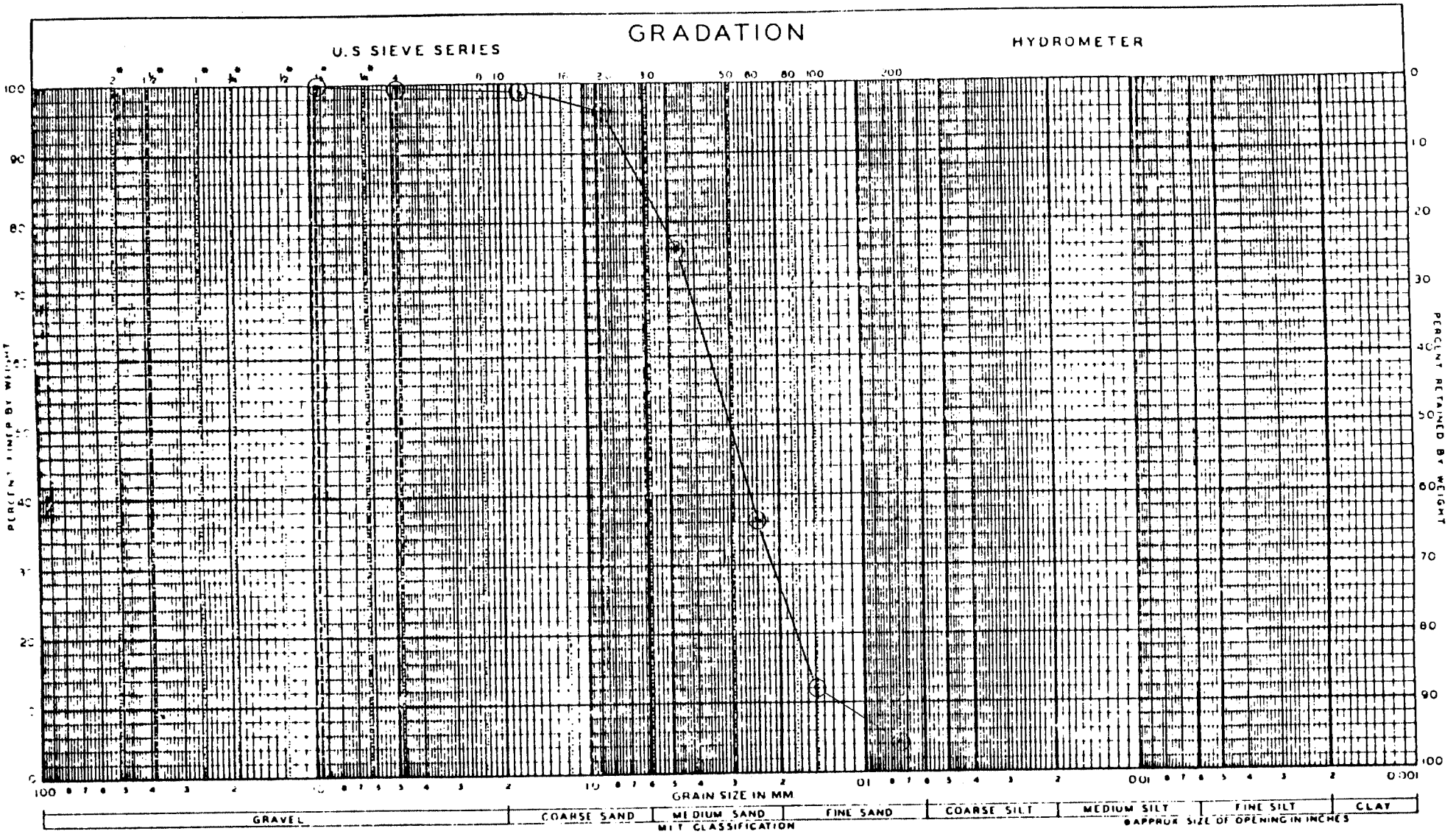
Sample Number: MW-1 #10, 47½ -49
Sample Description: Medium brown, coarse - medium sand with some gravel
Initial Weight of Sample: (gm)

SIEVE SIZE	WT. RETAINED	TOTAL WEIGHT PASSING	TOTAL PERCENT PASSING	SPECIFICATION LIMITS
3"				
1½"				
1"			100	
¾"			95.7	
½"			89.4	
⅜"			85.3	
No. 4			75.9	
No. 8				
No. 12			57.2	
No. 16				
No. 20			49.9	
No. 30				
No. 40			34.9	
No. 50				
No. 60			16.4	
No. 100			8.9	
No. 200			4.6	
Pan				
Wash				

Note: Total Weight Passing #200 Sieve = Wt. on Pan (Gr) + Wt. of Wash (Gr)

Remarks:

All tests performed in accordance with ASTM



$D_{60} = .36$ mm

$D_{10} = .13$ mm

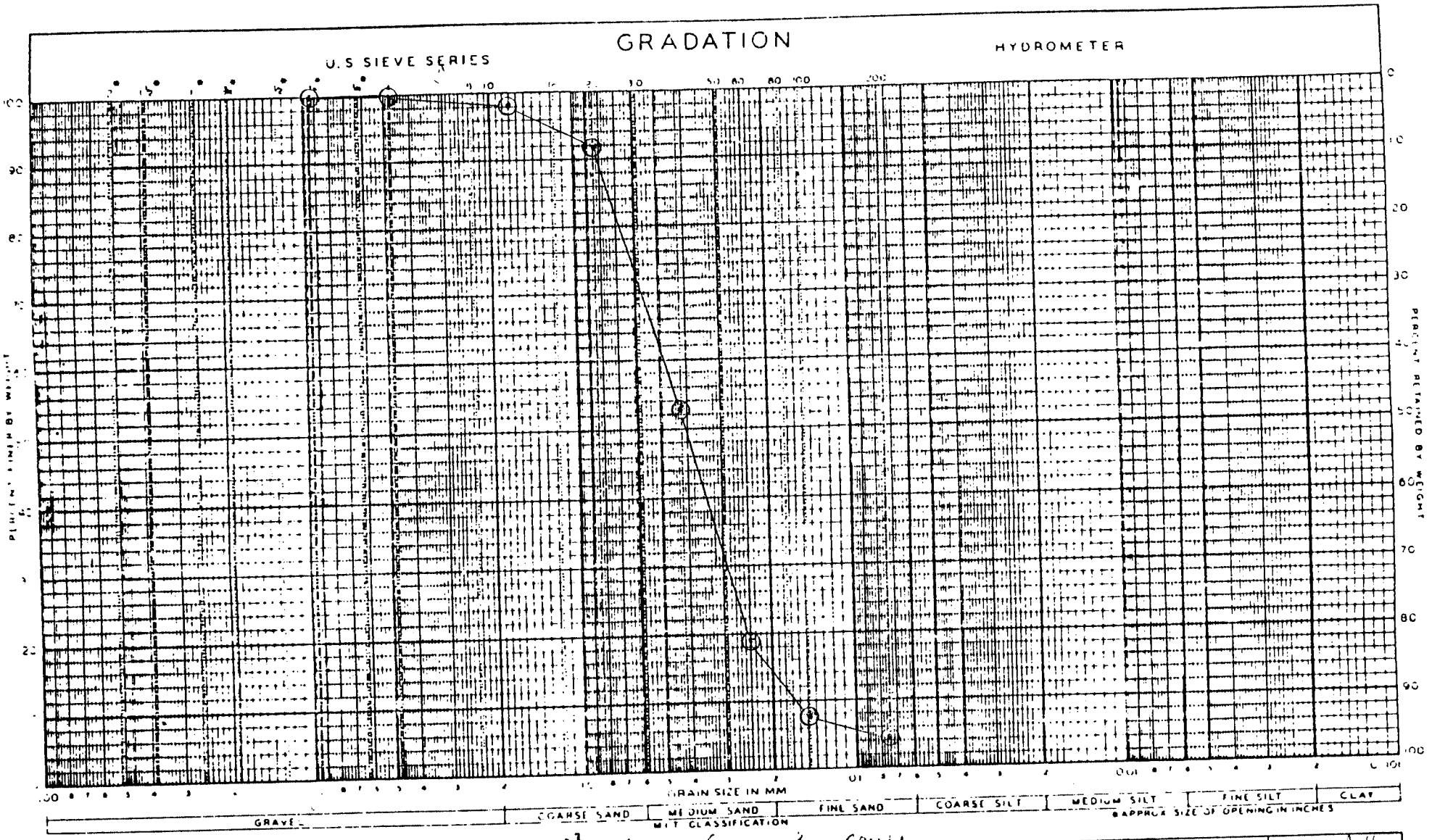
$D_{50} = .31$ mm

$D_{60}/D_{10} = 2.0$

5.7×10^{-2} cm/sec – loose

3.3×10^{-2} cm/sec – [illegible]

PROJECT	Baxter - North Landfill
LOCATION	MW-4 #10 42½-47
STATION	
OFFSET	
HOLE NO	TEST PIT
AUGER HOLE	UNDISTURBED SAMPLE



$D_{60} = .48$

$D_{10} = .17$

$D_{50} = .41$

$D_{60}/D_{10} = 2.8$

Dense - 3.3×10^{-2} cm/sec. (5×10^{-2} cm/sec)

Loose - 5.8×10^{-2} cm/sec (6×10^{-2} cm/sec)

PROJECT Baxter - North Ledge Drill

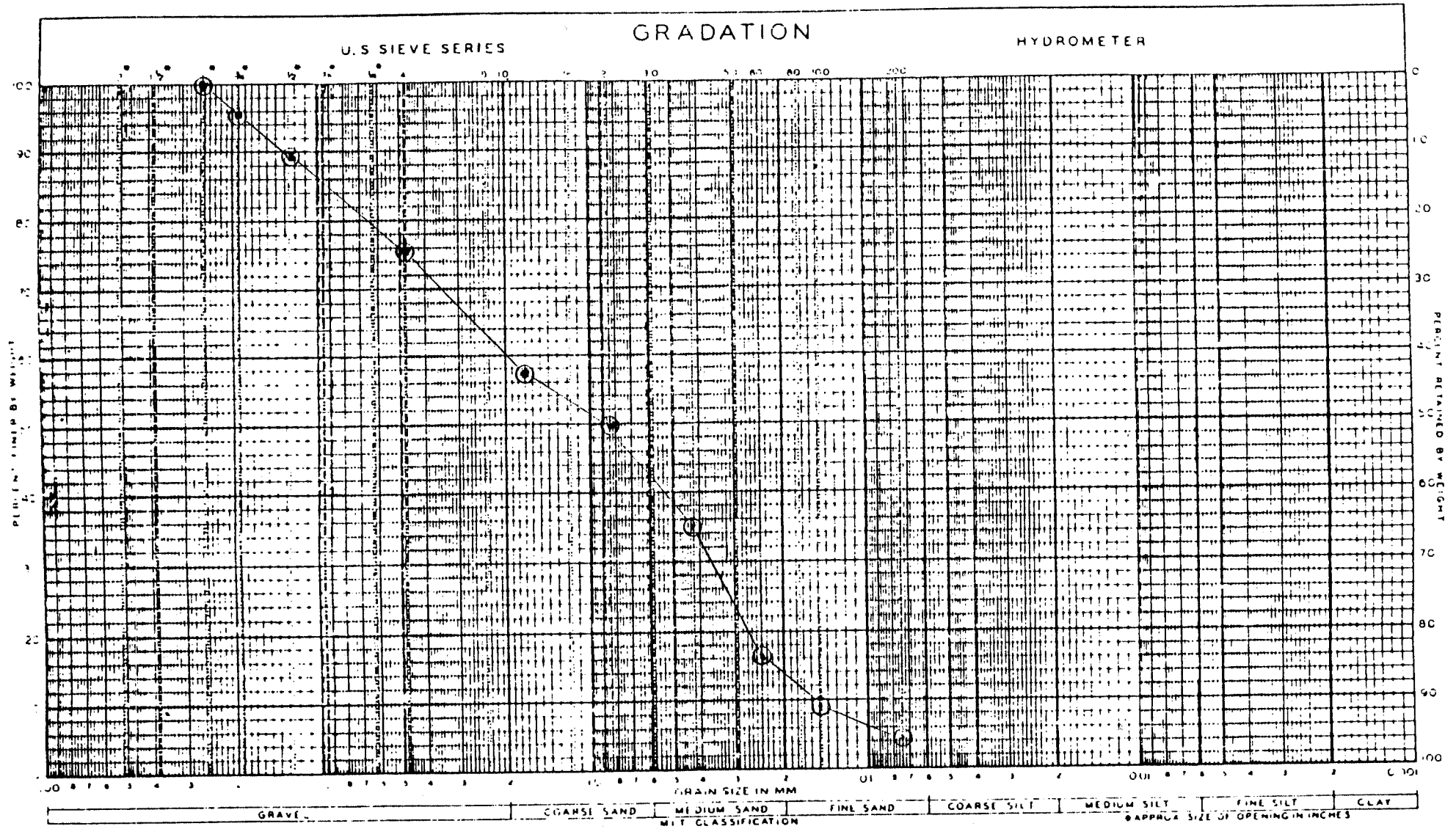
LOCATION Hole 3 = 47.5 - 49

STATION

OFFSET

HOLE NO _____ TEST PIT _____

AUGER HOLE _____ UNDISTURBED SAMPLE _____



D_{10} = .16

D_{60} = 2.0

D_{50} = .85

D_{60}/D_{10} = 12.5 ← off scale.

PROJECT Easton - Youth Landfill

LOCATION MW-1, ±'s, 47½-49

STATION _____

OFFSET _____

HOLE NO _____ TEST PIT _____

AUGER HOLE _____ UNDISTURBED SAMPLE _____

Appendix C

PROCEDURES FOR GROUND WATER CHEMISTRY SAMPLING AND EVALUATION

GROUND WATER MONITORING PLAN AND METHODS OF STATISTICAL ANALYSIS

I. SITE SAFETY

The field investigations will follow the Site Safety and Operations Plan which is attached. This plan will be followed with regard to personnel safety and procedures as well as the handling and sampling of soils and water during the investigations.

All drill cuttings and ground water from site boreholes will be disposed of on site by Sweet, Edwards & Associates, Inc. (Sweet-Edwards).

II. DRILLING, SOIL SAMPLING, AND LOGGING

Drilling Equipment and Soil Sampling Procedures.

1. A 4-inch I.D. hollow stem auger drill will be used to drill the monitoring well borings.

2. Soil sampling in the monitoring well borings will be accomplished with a split spoon or split barrel sampler. The samples will be obtained ahead of the augered borehole at minimum 5-foot depth intervals or changes in lithology.

3. Steam cleaning or high pressure, hot water washing and rinsing of all downhole equipment will be done between boreholes to avoid cross contamination. Clean storage of all decontaminated equipment will be done when the equipment is not in use.

4. All sediment samples will be field logged and described in terms of color, grain size, organic matter, moisture content, density, and other appropriate characteristics. These descriptions will be recorded on the boring log (SEA form 300-02-A).

5. Labeling, preservation, and transport of sediment/ sludge samples will be documented on the appropriate Chain of Custody/Laboratory Analysis Request form (SEA-400-01).

III. MONITORING WELL CONSTRUCTION

A. Materials (see attached figure for typical monitoring well installation)

1. Monitoring well casing and screen

a. Schedule 40, 2-inch diameter PVC casing and screen.

b. Casing and screen connections will be threaded without solvent welding.

c. The well screen will have 0.010-inch machine slots and a conical PVC point where needed.

2. Annular backfill

Number 8-12 Colorado silica sand will be used as the porous annular backfill around the screen sections of the monitoring wells.

3. Annular seal

Following installation of the silica sand backfill, a minimum 3-foot plug of bentonite pellets will be

installed on top of the sand. The remainder of the annular space will be backfilled by tremie methods with bentonite grout.

4. Security casing (see attached figure for the typical above ground security casing)

   a. The above ground security casings will be composed of a minimum 4-inch diameter steel pipe which extends at least 6 inches above and 2 feet below ground surface. This casing will have a steel, lockable lid.

   b. The above ground casing will be set in a shallow, concrete base with the concrete slightly above natural ground surface and sloped away from the well.

B. Monitoring Well Installation

1. The monitoring well installations will be done through 4-inch I.D. hollow stem augers.

2. The well casing and screen will be steam cleaned, or high pressure hot water washed and the labels and binding tape removed, along with other potentially contaminating materials, prior to installation.

3. The well screen and casing assembly, sand backfill, bentonite plug, and bentonite seal will be installed as the hollow stem auger is withdrawn from the borehole.

4. At least 24 hours grout curing time will be allowed following installation of the monitoring well before

screen development is begun. The height of the grout in the borehole will be visually checked during the curing period and topped off periodically to insure that the height of the grout is all the way to the ground surface.

5. The well screen zone will be developed by pumping and/or surging until the return water is sediment free or continued development shows no further improvement after 4 hours.

6. Following installation of the security casing, the top of the well casing will be surveyed to the nearest 0.01 feet elevation.

IV. GROUND WATER SAMPLING (see attached form SEA-400-01, Field Sampling Data)

A. The ground water sampling method to be used is designed to obtain samples representative of in situ ground water quality, with minimum contamination due to sampling techniques or materials.

B. All field ground water sampling equipment will be cleaned between boreholes to minimize cross contamination. This cleaning will include a non-phosphate detergent wash, followed by distilled water rinse, acid (HCl) wash, distilled water rinse, methanol or ethanol rinse, and a final distilled water rinse. During sampling, at least one daily method blank will be collected for quality control (QC) purposes.

C. During well purging, monitoring of water pH, specific conductance, and temperature will be done until these parameters have stabilized to within ±10%. All field testing equipment will be calibrated at least twice daily.

Sweet, Edwards & Associates, Inc.

Field Sampling Data/ Chain of Custody

Station _____
Well or Surface Site Number _____
Date, Time _____
Weather _____

PROJECT _____
CLIENT _____

HYDROLOGY MEASUREMENTS:

(Nearest .01 ft.)	Elevation	Date, Time	Method Used (M-Scope Number or Other)

WELL EVACUATION:

Gallons	Pore Volumes	Method Used	Rinse Method	Date, Time

Surface Water Flow Speed _____, Measurement Method _____, Date, Time _____,

SAMPLING:

Sample Number	Date, Time	Method	Volume (ml)	Container Type	Depth Taken (feet)	Field Filtered (yes,no)	Preservative	Iced (yes,no)	Sampler Cleaning Method
									Non-Phosphatic detergent wash H2O rinse MeOH rinse Distilled H2O rinse

FIELD WATER QUALITY TESTS:

Pore Vol. Number	pH	DO (mg/l)	Specific Conductivity	Temp	Eh			

NOTES:

_____
_____
_____
_____
_____
_____

CUSTODY RECORD:

Field Personnel	Signature	Date, Time
	Relinquished	
	Received	
	Relinquished	
	Received	
	Relinquished	
	Received	

Sampler Signature

Total No. of Bottles - this station: _____

Date, Time

SEA-400-01

D. Prior to well screen development, depth to water measurements were taken and recorded to the nearest 1/100th of a foot using an ACTAT Olympic well probe. Readings were measured from the uncapped rims of the PVC casing.

E. The wells will be purged with a suction lift pump or bailer. A double check valve Teflon bailer will be used to obtain the ground water samples. The samples to be tested for dissolved metals will be field filtered through a .45-micron nitrocellulose filter.

F. The ground water samples will be preserved as per the recommendations given in Methods for Chemical Analysis of Water and Waste (EPA-600/4-79-020, March 1979). The samples collected each day will be delivered or shipped to a certified testing laboratory that same evening. The samples will be kept cool in an iced cooler until delivery to the lab. The Chain of Custody and Laboratory Analysis Request information will be recorded on form SEA-400-05 (attached). Field Sampling Data form, SEA-400-01, is used to record important data during field ground water sampling. These data include hydrology measurements, well purge data, field water quality test results, sampling methodologies, and equipment.

G. Constituents to be chemically tested include:

temperature
conductivity
pH
chloride
nitrate, nitrite and ammonia as nitrogen
sulphate

dissolved iron, zinc and manganese
COD
TOC
total coliform
tannin and lignin

V. STATISTICAL ANALYSIS OF MONITORING RESULTS

For each indicator parameter specified in IV-G above, the owner will calculate the arithmetic mean and variance, based on four sample analyses from each well and compare these results with its background values. The comparison will consider individually each of the wells in the monitoring system and will use the student's t-test over initial background. For application of statistical significance determination, the Cochran's Approximation to the Behren's-Fisher Student t-test is proposed as outlined in CFR 40, Chapter 1 Part 26, App IV, of which a copy is attached.

However, the owner reserves the right to evaluate the monitoring results using other applicable statistical methods to determine if statistically significant changes in ground water quality is present.

Appendix D

GROUND WATER QUALITY RESULTS

COLUMBIA ANALYTICAL SERVICES, INC.
1152 3RD AVE. LONGVIEW, WA 98632
(206) 577-7222

CLIENT: Sweet & Edwards
--Lisa Adolfson

September 25, 1987

PROJECT: Baxter North Project

WORK ORDER #: 87469

Analytical Report
mg/L

Sample Name: 81787-	BKG MW 4 #1	MW 3 #2	Blank #3	MW 2 #4	MW 1 #5
Lab Code:	469-1	469-2	469-3	469-4	469-5
Chloride	4	13	2	6	7
Sulfate	6	5	<5	<10	<10
Tannin-Lignin	5	2	<1	2	3
Nitrite - N	<0.01	0.04	<0.01	<0.01	<0.01
Nitrate - N	1.06	0.44	0.03	1.83	0.02
Ammonia - N	0.06	0.56	0.07	<0.05	0.08
Iron	0.51	52.9	0.06	0.16	1.7
Manganese	<0.01	1.65	<0.01	<0.01	9.5
Zinc	<0.03	0.07	0.03	0.02	0.03
pH	6.1	6.2	5.3	6.8	6.0
Conductivity	250	344	5	304	570
COD	14	23	18	<10	8.
TOC	2.5	3.0	<1.0	2.5	1.0
Total Coliforms	14	4.5	2	7.8	2

Approved by: _____ Date: _____