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INTERIM MEASURE PHASE I ACTIVITIES: SYSTEM INSTALLATION TECHNICAL MEMORANDUM FOR SITE 11 NSB KINGS BAY GA

3/1/1994

ABB ENVIRONMENTAL

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INTERIM MEASURE
PHASE I ACTIVITIES: SYSTEM INSTALLATION
TECHNICAL MEMORANDUM
SITE 11, OLD CAMDEN COUNTY LANDFILL

NAVAL INSTALLATION RESTORATION PROGRAM
NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

CONTRACT NO. N62467-89-D-0317

MARCH 1994

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
NORTH CHARLESTON, SOUTH CAROLINA
29419-9010

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notification of the chief official of the activity studied.

ABB
ASEA BROWN BOVERI

21 March 1994

Commanding Officer
Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive
North Charleston, SC 29418

ATTN: David Driggers

SUBJECT: **Interim Measure Phase I Activities**
System Installation Technical Memorandum
Site 11, Old Camden County Landfill
Naval Submarine Base, Kings Bay, Georgia
Contract Task Order #094
Contract N62467-89-D-0317

Dear David:

ABB Environmental Services (ABB-ES), Inc. is pleased to provide you with two copies of the above reference document for your review. We have also provided two copies to Mr. John Garner for his review. Upon receipt of comments from Southern Division and NSB Kings Bay, we will finalize this document for distribution. In an attempt to control costs, we have submitted these as unbound three-hole punched copies. We would appreciate your comments being forwarded to me by 8 April 1994.

Please contact me at (615) 531-1922 if you have any questions or would like any additional information regarding this submittal.

Sincerely,

ABB ENVIRONMENTAL SERVICES, INC.

Frank B. Cater, P.E.
Task Order Manager

cc: File: CTO #094

ABB Environmental Services Inc.

1400 Centerpoint Blvd
Suite 158
Knoxville, Tennessee 37932-1968

Telephone
(615) 531-1922

Fax
(615) 531-8226

ASEA BROWN BOVERI

21 March 1994

Commanding Officer
Naval Submarine Base
Kings Bay, GA 31547

ATTN: Public Works Department
John Garner

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System Installation Technical Memorandum
Site 11, Old Camden County Landfill
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ABB Environmental Services Inc.

1400 Centerpoint Blvd
Suite 158
Knoxville Tennessee 37932-1968

Telephone
(615) 531-1922

Fax
(615) 531-8226

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INTERIM MEASURE
PHASE I ACTIVITIES: SYSTEM INSTALLATION
TECHNICAL MEMORANDUM
SITE 11, OLD CAMDEN COUNTY LANDFILL

CONTRACT TASK ORDER NO. 094
CONTRACT NO. N62467-89-D-0317

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

Prepared for:

Southern Division
Naval Facilities Engineering Command
North Charleston, South Carolina 29418

Prepared by:

ABB Environmental Services, Inc.
1400 Centerpoint Boulevard, Suite 158
Knoxville, Tennessee 37932-1968

March 1994

EXECUTIVE SUMMARY

This technical memorandum is developed in association with an interim corrective measure being conducted at Site 11, Old Camden County Landfill, at Naval Submarine Base, Kings Bay, Georgia. The interim measure is being conducted in response to detection of volatile organic compounds in groundwater at the site. Specifically, the contents of the technical memorandum address activities associated with the installation of a pilot-scale groundwater extraction and treatment system. Monitoring of this extraction and treatment system during the first phase (Phase I) of system operations will provide performance data to support full-scale (Phase II) interim measure system design. The Phase I Interim Measure Work Plan (ABB-ES, 1994) describes the site conditions and phased approach of these installation and operation activities in greater detail.

Site set-up activities included installation of a groundwater extraction system, conveyance system, and treatment system. The pilot-scale groundwater extraction system includes five groundwater recovery wells that were installed during October and November 1993. The five recovery wells are piped to the treatment pad where an air sparging unit and *ex situ* biological treatment unit are located. These treatment units will reduce volatile organic compound concentrations within the extracted groundwater to levels acceptable for discharge to a publicly owned treatment works or the NSB Kings Bay land application system.

Phase I activities of the interim measure will include background monitoring of water levels in the surficial aquifer, well performance testing, three stages of pumping tests on the recovery wells, and treatment system(s) performance monitoring. Completion of these field activities will be followed by development of an Evaluations and Recommendations Report. The various components of the pilot-scale system will be evaluated and recommendations made for the full scale interim measure (Phase II).

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ACRONYMS

AAC	Acceptable Ambient Concentrations
ACGIH	American Conference of Governmental and Industrial Hygienists
AWG	American wire gauge
BE	barometric efficiency
BOD	biochemical oxygen demand
bgs	below ground surface
btoc	below top of casing
$CaCO_3$	calcium carbonate
CLEAN	Comprehensive Long-term Environmental Action Navy
COD	chemical oxygen demand
°C	degrees celsius
ETP	engineering and treatability parameters
elev.	elevation
ft	feet
ft^3/min	cubic feet per minute
gal	gallons
gal/min	gallons per minute
gpm	gallons per minute
gpm/ft	gallons per minute per foot
GWE	groundwater extraction system
HDPE	high density polyethylene
IM	Interim Measure
J	estimated concentration
LAS	Land Application System
lb/hr	pound per hour
μg/l	micrograms per liter
$\mu g/m^3$	micrograms per meter cubed
MCL	Maximum Contaminant Level
mg/l	milligrams per liter
mg/m^3	milligram per meter cubed
mlw	mean low water
mRBC	methanotrophic rotating biological contactor
N	nitrogen
NA	Not Applicable
Navy	U.S. Department of the Navy
NSB	Naval Submarine Base

ACRONYMS (Continued)

P&ID	piping and instrumentation diagram
PFD	process flow diagram
POTW	Publicly Owned Treatment Works
psi	pounds per square inch
PVC	polyvinyl chloride
SOUTHNAVFACENGCOM	Southern Division, Naval Facilities Engineering Command
TAL	target analyte list
TDS	total dissolved solids
TLV	Threshold Limit Value
toc	top of casing
TOC	total organic carbon
TSS	total suspended solids
U	not detected
USEPA	United States Environmental Protection Agency
WHPA	Wellhead Protection Area

1.0 INTRODUCTION

Under contract to the U.S. Department of the Navy (Navy) Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM), this technical memorandum was prepared for Site 11, the Old Camden County Landfill, located on the Naval Submarine Base (NSB) in Kings Bay, Georgia. This technical memorandum was prepared under the Comprehensive Long-term Environmental Action Navy (CLEAN) Contract No. N62467-89-D-0317, Contract Task Order No. 094.

1.1 PURPOSE. This technical memorandum addresses completion of site set-up for the Phase I activities of the Interim Measure (IM) being conducted at Site 11. It is intended to provide a brief summary of (1) system installation, (2) preliminary testing, and (3) decision/analysis supporting system design. These activities were completed during the period September 1993, when site set-up began, through the completion of system installation activities at the end of January 1994. Design of the groundwater extraction (GWE), conveyance, and treatment systems are presented.

1.2 REPORT ORGANIZATION. The material presented in this technical memorandum has been organized into five sections. The contents of each section are described below.

Section 1.0, Introduction, presents the purpose and organization of the technical memorandum. Section 2.0, Groundwater Extraction System, describes the GWE system that was installed at the site. The results of an initial 25-hour pump test conducted on one of the groundwater recovery wells, as well as radius-of-influence and capture zone analysis, are presented. Section 3.0, Conveyance System, describes the groundwater conveyance system that was installed at the site. Section 4.0, Groundwater Treatment System, presents the design for the IM groundwater treatment system. Chemical data obtained since development of the IM Work Plan are presented in this section. Section 5.0, Summary, provides a synopsis of work completed and summarizes activities planned for the IM Phase I operations.

2.0 GROUNDWATER EXTRACTION SYSTEM

The following subsections provide information related to installation of five groundwater recovery wells, selection and installation of pumps for the wells, and results of an initial 25-hour pump test conducted on one of the recovery wells.

2.1 EXTRACTION SYSTEM INSTALLATION. This subsection discusses installation of recovery wells and observation wells during October and November 1993. Figure 2-1 shows the locations of five groundwater recovery wells, KBA-RW-01 through KBA-RW-05, installed along the western margin of the landfill and on the western right-of-way of Spur 40. Also shown on Figure 2-1 are the locations of 10 observation wells.

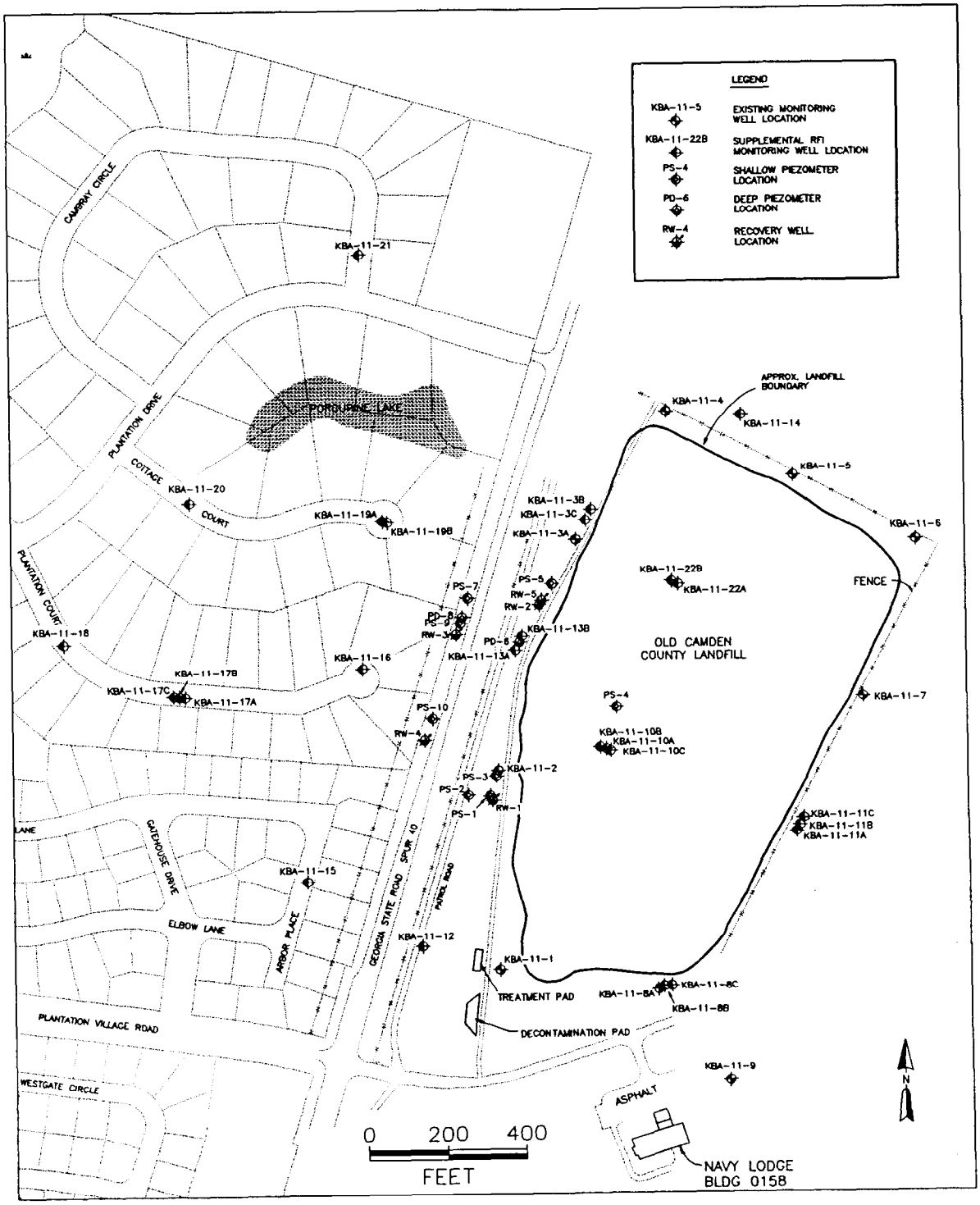
The recovery wells were installed using mud rotary drilling methods. The wells were constructed as proposed in the work plan (ABB-ES, 1993), with few exceptions noted in this subsection. Boring logs and construction diagrams are included in Appendix A. Construction data for each of the recovery wells is summarized in Table 2-1.

During drilling of boreholes for recovery wells soil samples were collected and submitted to a contract laboratory for sieve analysis. Eight soil samples, plus a duplicate sample, were submitted for grain size determination. Grain size distribution curves were prepared from the laboratory data and are included in Appendix B. The soil samples were collected from the four deep recovery wells, KBA-RW-01 through KBA-RW-04, using split-spoon samplers. No samples were collected from KBA-RW-05 due to the close proximity to KBA-RW-02. Sample depths ranged from 20 to 67 feet bgs. The sieve analysis data indicate the soil is comprised of poorly graded fine-grained sand. The percentage of fine-sand sized material (40 to 200 sieve) in the samples ranged from 93 to 99 percent by weight. Visual observations of the soil indicate the material is predominantly quartz.

Well screens were based on ground surface elevations and vertical extent of contamination. Previous data indicate that the southern portion of the plume extends to a depth approximately 55 to 60 feet below ground surface (bgs), whereas to the north the depth of the contamination is greater, extending approximately 60 to 70 feet bgs. Recovery wells KBA-RW-01 and KBA-RW-04 were installed with 40 feet of 0.030-inch continuous slot, wire-wrapped, stainless-steel well screen. Recovery wells KBA-RW-02 and KBA-RW-03 were installed with 50 feet of 0.030-inch, continuous slot, wire-wrapped, stainless-steel well screen. Recovery well KBA-RW-05 was installed with 20 feet of 0.030-inch, continuous slot, wire-wrapped, stainless-steel well screen.

Ten observation wells were installed at pre-determined locations surrounding the recovery wells. These observation wells will be used for the collection of hydraulic head data during the IM Phase I operations. With the exception of KBA-PD-06 and KBA-PD-08, the observation wells were installed using hollow stem auger drilling methods. Observation wells KBA-PD-06 and KBA-PD-08 were installed using rotasonic drilling methods.

The construction of the observation wells is described in the IM Work Plan (ABB-ES, 1994). Construction data for each of the observation wells is summarized in



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DWN: NLW	PROJECT NO.: 08503	TITLE: MONITORING WELL, RECOVERY WELL, AND PIEZOMETER LOCATIONS	IM TECHNICAL MEMORANDUM
CHKD: KDS	FIGURE NO.: 2-1		NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
DATE: 3/20/94			

Table 2-1 Recovery Well Construction Data

Recovery Well No.	Ground Surface (ft, mlw)	toc Elev.* (ft, mlw)	Borehole Depth (ft, bgs)	Borehole Depth (ft, btoc)	Total Well Depth (ft, bgs)	Total Well Depth (ft, btoc)	Screened Interval (ft, bgs)	Screened Interval (ft, btoc)	Top of Sand (ft, bgs)	Top of Bentonite (ft, bgs)	Screened Interval Elev. (mlw)
RW-1	33.45	32.47	67.0	66.02	66.36	65.38	20.98 - 60.98	20.0 - 60.0	17.0	14.0	12.47 - (27.53)
RW-2	31.66	30.49	76.0	74.83	76.55	75.38	21.17 - 71.17	20.0 - 70.0	18.0	15.0	10.49 - (39.51)
RW-3	29.61	27.70	78.0	76.09	77.29	75.38	21.91 - 71.91	20.0 - 70.0	18.0	15.0	7.70 - (42.30)
RW-4	30.92	28.89	73.0	70.97	72.41	70.38	27.03 - 67.03	25.0 - 65.0	22.0	19.0	3.89 - (36.11)
RW-5	31.65	30.27	32.0	30.62	31.76	30.38	6.38 - 26.38	5.0 - 25.0	4.5	2.5	25.27 - 5.27

Notes:

* Measured 25 January 1994 and computed difference from top of recovery well piezometers.

6-inch diameter stainless-steel type 304 Schedule 10S with 0.030-inch slot.

Values in parentheses () are negative elevations, mlw.

bgs = below ground surface
btoc = below top of casing
elev. = elevation
ft = feet
mlw = mean low water
toc = top of casing

Table 2-2. The observation wells are temporary and will be abandoned following completion of Phase I activities. These observation wells are constructed of 2-inch-diameter, polyvinyl chloride (PVC). Boring logs and construction diagrams for the observation wells are included in Appendix A.

Development of the recovery wells was performed using a submersible pump equipped with a surge block or surging sleeve. Each well was surged by raising or lowering the pump/sleeve assembly through the screened interval while pumping. During development of each recovery well, parameters (pH, conductivity, and temperature), flow rates, and water levels were periodically measured.

Potable water was used to flush formation sand out of the well prior to development. Following development, minimal formation sand reentered the wells, indicating the filter packs were well seated in the annular space and effectively preventing formation material from entering the well screens. A summary of field data collected during development of each recovery well is provided in Appendix C.

Flow rates and drawdown levels were used to calculate the specific capacity of the wells. Specific capacity is a measurement of flow rate per foot of drawdown within the well. Specific capacity values for each recovery well, with respect to total development, are provided in Appendix C.

The 2-inch observation wells were developed using a surge block affixed to a polyethylene suction hose, and a centrifugal pump was used to withdraw water and fines from the well. Field data collected during development of the observation wells is provided in Appendix C.

Sieve analysis was also conducted on a sample of the filter pack material used for the recovery wells. The material delivered to the site contained a slightly greater percentage of fine sand than specified in the performance criteria (Appendix B). Based on well development operations, this deviation from specification is not expected to adversely affect performance of the recovery wells. No adverse affects (i.e., pumping filter pack sand) were observed during the pumping test conducted at KBA-RW-01 or during development of all five wells.

2.2 INITIAL PUMPING TEST. An aquifer pumping test was conducted as part of the IM Phase I activities at Site 11, Old Camden County Landfill. This initial pumping test was conducted on the first recovery well installed at the site, KBA-RW-01, located along the western side of the landfill (Figure 2-2). This test was conducted during the early portion of the Phase I activities to guide the IM project team's well installation program and support design specifications. This initial test was designed to:

- provide a reality check on preliminary estimates of aquifer parameters and proposed well pumping rates,
- assess vertical head potential relationships within the stressed (due to pumping) aquifer, and
- provide preliminary radius of influence data.

2.2.1 Initial Pumping Test Operations A submersible pump (Grundfos Model No. 10S03-06) was temporarily installed within the sump of KBA-RW-01 for this initial aquifer pumping test. The well was pumped at a constant rate of 6.47 gallons per

Table 2-2 Observation Wells Construction Data

Observation Wells No.	Ground Surface (ft, mlw)	Observation Well toc Elev. (ft, mlw)	Borehole Depth (ft, bgs)	Borehole Depth (ft, btoc)	Total Well Depth (ft, bgs)	Total Well Depth (ft, btoc)	Screened Interval (ft, bgs)	Screened Interval (ft, btoc)	Top of Sand (ft, bgs)	Top of Bentonite (ft, bgs)	Screened Interval Elev. (ft, mlw)
PS-1	33.24	33.02	39.5	39.28	38.22	38.00	30.22-35.22	30.0-35.0	28.0	25.0	3.02-(1.98)
PS-2	33.12	33.59	39.0	39.47	40.20	40.67	33.18-38.20	32.65-37.67	28.0	26.0	(0.06)-(5.08)
PS-3	33.24	34.49	40.0	41.25	38.21	39.46	30.20-35.21	31.45-36.46	28.0	25.6	3.04-(1.97)
PS-4	35.32	36.91	39.0	40.59	36.58	38.17	28.47-33.48	30.06-35.07	28.0	25.0	6.85-1.84
PS-5	31.34	33.37	38.0	40.03	35.19	37.22	27.19-32.19	29.22-34.22	26.0	24.0	4.15-(0.85)
PD-6	32.33	33.35	68.5	69.52	68.00	69.02	60.00-65.00	61.02-66.02	58.5	56.0	(27.67)-(32.67)
PS-7	29.55	28.20	35.0	33.65	31.35	30.00	23.35-28.35	22.0-27.0	23.5	21.0	6.20-1.20
PD-8	29.37	28.53	57.0	56.16	55.34	54.50	47.34-52.34	46.50-51.50	44.0	41.0	(17.97)-(22.97)
PS-9	29.63	28.72	35.0	34.09	36.36	35.45	28.36-33.36	27.45-32.45	24.0	21.0	1.27-(3.73)
PS-10	31.24	30.54	35.0	34.30	34.70	34.00	26.70-31.70	26.00-31.00	24.0	21.7	4.54-(0.46)
RW-P1	33.45	32.60	67.0	66.15	60.85	60.00	20.85-60.85	20.0 -60.0	17.0	14.0	12.60-(27.40)
RW-P2	31.66	30.11	76.0	74.45	72.55	71.00	22.55-72.55	21.0 -71.0	18.0	15.0	9.11-(40.89)
RW-P3	29.61	27.93	78.0	76.32	73.18	71.50	23.18-73.18	21.50-71.50	18.0	15.0	6.43-(43.57)
RW-P4	30.92	28.92	73.0	71.0	66.90	64.90	28.50-66.90	26.50-64.90	22.0	19.0	2.42-(35.98)
RW-P5	31.65	30.25	32.0	30.6	27.40	26.00	7.40-27.40	6.00-26.00	4.5	2.5	24.25-4.25

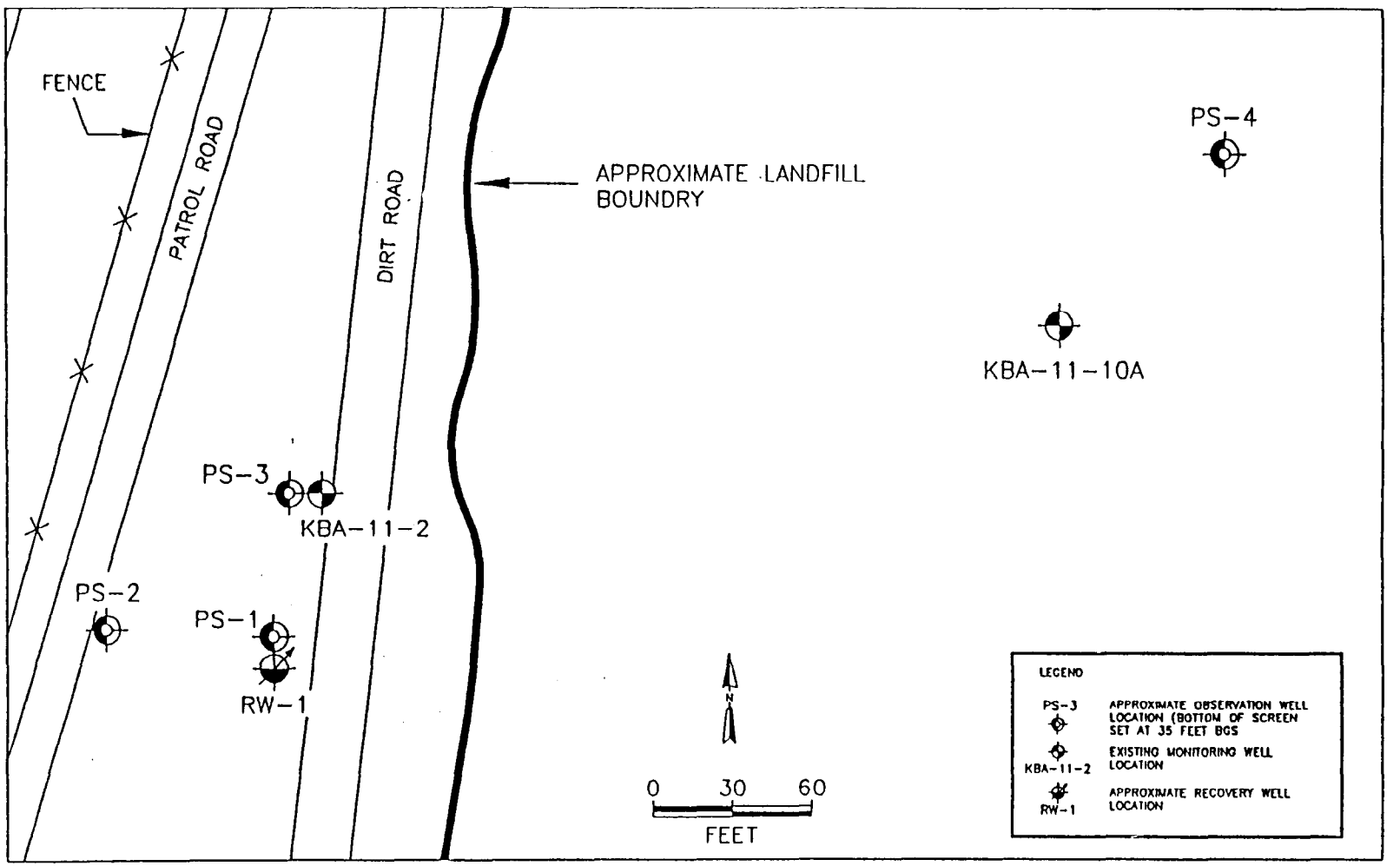
Notes:

PS and PD are 2-inch-diameter Schedule 40 polyvinyl chloride (PVC) with 0.020-inch slot screen.

RW-P_ series are 1-inch-diameter Schedule 40 PVC with 0.030-slot screen. These piezometers are installed in the annular space of corresponding recovery wells.

Values in parentheses () are negative elevations, mlw.

bgs = below ground surface
btoc = below top of casing
elev. = elevation
ft = feet
mlw = mean low water
toc = top of casing



DWN: NLW	PROJECT NO.: 08503	TITLE: INITIAL PUMPING TEST MONITORING LOCATIONS	IM TECHNICAL MEMORANDUM
APPD: KDS	FIGURE NO.: 2-2		NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
DATE: 12/02/93			

minute (0.865 cubic feet per minute [ft^3/min]) for a 25-hour period. Pumping started on October 25, 1993, at 11:00 AM and ended on October 26, 1993, at 12:01 PM. A total of 9,707 gallons of water was pumped from the aquifer and discharged to a 21,000-gallon holding tank situated on the landfill site. Flow was controlled with a full-port ball valve and monitored with an in-line totalizing flow meter.

Water levels within selected wells were monitored for drawdown response. Water levels were collected during the discharge phase of the pumping test and for approximately 5 hours after the pump was shut off to monitor aquifer recovery. Wells were monitored using an InSitu SE2000 electronic data logger and eight pressure transducers. Seven of these transducers were installed in wells to measure water levels, and one transducer was placed in an ambient location to measure barometric pressure effects. The locations of the instrumented observation wells are shown on Figure 2-2. Raw data from the data logger has been reported in Technical Bulletin TB S11-01, Interim Measure Activities Site 11, Old Camden County Landfill, NSB Kings Bay, Georgia, dated December 3, 1993. Periodic measurements of the water levels were also collected using a water level indicator to confirm that the data logger was functioning properly and to obtain water levels from other (un-instrumented) wells. Raw data from these measurements has been placed in the project files and is available upon request.

A sample of groundwater discharge was collected during the last hour of the pumping test and shipped to a contract laboratory for chemical analysis. This groundwater sample has been analyzed for selected constituents and engineering treatability parameters (ETPs). The results of these analyses are provided in Technical Bulletin TB S11-01, dated December 3, 1993. Based on the relatively low concentrations of dissolved iron and other ETPs indicated by the analytical results, pretreatment upstream of the pilot-scale air sparging unit will not be necessary.

2.2.2 Aquifer Test Analysis and Results Aquifer response due to pumping stress at KBA-RW-01 has been analyzed to provide preliminary estimates of transmissivity and to assess the physical nature of the aquifer. The following portion of this technical memorandum provides an overview of the analysis.

The scope of this **initial** aquifer pumping test did not include a period of background monitoring to establish a baseline of water level measurements. Baseline water level readings are useful for the evaluation of aquifer response to external influences, such as other discharging wells, tidal cycle, or atmospheric pressure changes. Background, or baseline water level data, will be collected during the Phase I (pilot-scale operation) activities. However, as stated above, barometric pressure data was collected **during** the discharge and recovery phases of the initial pumping test.

Barometric pressure did vary during the course of this test; atmospheric pressure fell from a high of 34.03 feet of [equivalent] water (ft-H_2O) (14.73 pounds per square inch [psi]) to a low of 33.86 ft-H_2O (14.66 psi) over the first 1,000 minutes of the pumping test. Atmospheric pressure rose from 33.86 ft-H_2O (14.66 psi) to 33.99 ft-H_2O (14.71 psi) during the last 500 minutes of the discharge phase of the pumping test and fell again to 33.94 ft-H_2O (14.69 psi) at the end of the monitoring period. A graph of the barometric pressure fluctuation with respect to elapsed time is provided in Appendix E. The magnitude of the **decrease** in atmospheric pressure, 0.17 ft-H_2O (0.07 psi), during the first 1,000 minutes of the test would have an effect of causing water levels to rise in compensation,

if the aquifer is influenced by barometric pressure changes. The **increase** in atmospheric pressure, 0.13 ft-H_2O (0.06 psi), during the last 500 minutes of the discharge phase would have an effect of causing water levels to drop in the observation wells, if the aquifer is influenced by barometric pressure.

The magnitude of potential water level changes within the aquifer are dependent upon the barometric efficiency (BE) of the surficial aquifer. Values for BE generally range from 0.2 to 0.75 ft-H_2O/ft-H_2O (Kruseman and De Ridder, 1989) for semi-confined to confined aquifers. Based on some of the slight variations of water levels in the observation wells during the course of the pumping test, the surficial aquifer may be influenced by atmospheric pressure; this possibility will be evaluated from data collected during the planned background monitoring period.

The initial aquifer test data were interpreted using several methods of analysis. Drawdown values at each of four observation wells KBA-PS-1 through KBA-PS-4 (PS-1, PS-2, PS-3, and PS-4) and the recovery well were plotted with respect to time. These computer-generated plots and hand-plotted graphs were analyzed using the Cooper-Jacob method of analysis. The Neuman method of analysis (unconfined aquifer with delayed gravity response) was used for interpretation of PS-2 and PS-3 data to check the validity of the Cooper-Jacob method results. Drawdown values for all observation wells indicated on Table 2-3 were plotted with respect to radial distance from KBA-RW-01 and analyzed using the Copper-Jacob method. Residual drawdown values at KBA-RW-01 after the pump was shut-off were plotted with respect to time since pumping started over time since pumping stopped and analyzed using the Theis Recovery method of analysis. Appendix E includes the hand-plotted graphs and computer-generated plots for KBA-RW-01, KBA-PS-01, KBA-PS-02, KBA-PS-03, and KBA-PS-04. Results of the analyses are indicated in Table 2-4.

Transmissivity values estimated from this aquifer pumping test ranged from 97 ft^2/day to 5,181 ft^2/day. Table 2-4 provides transmissivity and hydraulic conductivity values calculated from the graphical analyses.

Storage coefficient values provided on Table 2-4 are indicative of either early-time data from a delayed-yield situation or semi-confined behavior within the aquifer. As indicated on the graph of drawdown versus time for PS-4, the elapsed time of this initial pumping test was too short and the radius of PS-4 from the pumping well (KBA-RW-01) was too far to meet the $u < 0.01$ method assumption, or standard. Therefore, a transmissivity of 5,181 ft^2/day should be considered too high. The transmissivity value of 2,682 ft^2/day, calculated from the hand-generated plot of PS-1 data, should also be considered too high because the straight-line regression is fit to data that is coincident with delayed-yield/gravity drainage. Based on all of the analyses of the initial pumping test data, the most realistic estimates of transmissivity range from 717 ft^2/day to 1,185 ft^2/day. Drawdown data from PS-4 does fit the trend of drawdown versus radial distance from the pumping well, as shown on the graph included in Appendix E. The transmissivity value estimated from the distance versus drawdown plot was 970 ft^2/day.

An anomalous aquifer response was observed at a paired-set of observation wells. Wells KBA-11-02 and KBA-PS-03 are clustered together at a location approximately 65 feet north of KBA-RW-01. The screen of monitoring well KBA-11-2 extends from 3 to 13 feet bgs. The screen of observation well KBA-PS-03 extends from 31 to 36 feet bgs. A drawdown of 0.49 feet was observed in observation well KBA-PS-03,

Table 2-3 Initial Aquifer Pumping Test
Measured Drawdown at End of Initial Pumping Test
NSB Kings Bay

Well Number	Distance from KBA-RW-01 (ft)	Orientation From KBA-RW-01	Static Water Level Elev. (ft)	Total Well Depth (ft, bgs)	Screened Interval Elev. (ft, mlw)	Drawdown (ft)	Water Level Elev. (ft)
KBA-RW-1	0	NA	26.05	66.36	12.47 - (27.53)	12.48	13.57
KBA-PS-1	13	N-NW	26.07	38.22	3.02 - (1.98)	0.80	25.27
KBA-PS-2	62	W	25.95	40.20	0.06 - (5.08)	0.51	25.44
KBA-PS-3	65	N	26.05	38.21	3.04 - (1.97)	0.49	25.56
KBA-PS-4	400	NE	26.70	36.58	6.85 - 1.84	0.10	26.60
KBA-11-1	436	S-SE	28.27	14.50	31.66 - 21.66	0.02	28.25
KBA-11-2	66	N	27.22	15.00	30.32 - 20.32	0.05	27.17
KBA-11-6	1,230	NE	27.93	15.00	31.63 - 21.63	0.01	27.92

Notes:

bgs = below ground surface
elev. = elevation
ft = feet
mlw = mean low water
N = north
NA = not applicable
NE = northeast
N-NW = north northwest
S-SE = south southeast
W = west

Values in parentheses () are negative elevations, mlw.

Table 2-4 Initial Aquifer Pumping Test
Aquifer Properties
NSB Kings Bay

Well Number	Transmissivity (ft^2/min)	Transmissivity (ft^2/day)	Hydraulic Conductivity (cm/sec)	Storage Coefficient (C)
KBA-RW-01	(A) 0.1220	(A) 175	$8.2E^{-4}$	----
	(B) 0.1143	(B) 164	$7.7E^{-4}$	2.06E-06
	(E) 0.0674	(E) 24	$4.6E^{-4}$	----
KBA-PS-01	(A) 1.8626	(A) 2,682 (D)	$1.3E^{-2}$	----
	(B) 0.7105	(B) 1,023	$4.8E^{-3}$	3.39E-03
KBA-PS-02	(B) 0.6891	(B) 992	$4.7E^{-3}$	4.14E-03
	(B) 0.5667	(B) 816	$3.8E^{-3}$	1.32E-03
KBA-PS-03	(B) 0.8231	(B) 1,185	$5.6E^{-3}$	1.35E-03
	(B) 0.4978	(B) 717	$3.4E^{-3}$	1.02E-03
KBA-PS-04	(A) 3.5979 (D)	(A) 5,181 (D)	$2.4E^{-2}$	----
	(B) 0.7717	(B) 1,111	$5.2E^{-3}$	5.53E-03
All Wells (Distance versus Drawdown)	**(A) 0.6737**	**(A) 970**	**$4.6E^{-3}$**	----

Notes:

---- = no data
cm/sec = centimeters per second
ft^2/min = feet squared per minute
ft^2/day = feet squared per day

(A) = hand plot
(B) = computer generated plot
(C) = dimensionless (These values are relatively low for an unconfined aquifer; long-term test should provide more accurate estimations of storage coefficient.)
(D) = Values too high, should not be considered.
(E) = Handplot Theis Recovery Method

which is located approximately 62 feet north of the recovery well. Monitoring well KBA-11-2 is approximately 66 feet north of the recovery well and approximately 4 feet from the observation well. The observed drawdown in the monitoring well was negligible, being only 0.03 feet. This may indicate that the upper portion of the surficial aquifer is hydraulically isolated from and/or more permeable than the underlying portion. These data indicate that pairs of recovery wells may be needed to control migration of contaminants in the surficial aquifer. Pumping tests conducted during future Phase I operation (Stage 1 and Stage 2) activities will provide additional information regarding the necessity of well pairs in controlling contaminant migration.

2.2.3 Radius-of-Influence and Preliminary Capture Zone Analysis Early projections of the radius-of-influence have been estimated from distance versus drawdown data. The distance versus drawdown plot (see Appendix E) indicates a radius-of-influence of 680 feet projected from KBA-RW-01. Assuming similar aquifer characteristics, the Figure in Appendix E shows projected radius-of-influence surrounding each of the four recovery well locations. Actual radius-of-influence for these wells, which will include synergistic effects on drawdown caused by well interference, will be monitored during IM Phase I operations (pilot-scale operations).

The IM Phase I activities were scoped for as many as six recovery wells. The radius of influence indicated by drawdown results from the pumping test of KBA-RW-01 indicate that recovery wells at four locations will hydraulically control the areas of greatest groundwater contamination and slow further contaminant migration within the plume. Phase I operations of the extraction system will provide the basis for a more conclusive decision regarding the number and locations of additional recovery wells for the full-scale interim measure (Phase II activities).

Preliminary capture zone analysis has been performed using the United States Environmental Protection Agency's (USEPA) Wellhead Protection Area (WHPA) Model to determine the optimum location of the forth recovery well, KBA-RW-04.

Preliminary capture zone analysis of the planned GWE system was performed with the USEPA's WHPA model. The semi-analytical model RESSQC, a module of WHPA, was used to model several different scenarios. Variations on well placement (location) of KBA-RW-04, direction of ambient hydraulic gradient, effective porosity, and pumping rates were input to the model. Transmissivity, saturated thickness, and hydraulic gradient were kept constant at 1,000 ft^2/day, 75 feet, and 0.003 feet/foot, respectively. RESSQC output represents time related capture zones with streamlines indicating flow toward a well (location) center.

Capture zones of the GWE system with the original plan locations and the refined plan locations are included in Technical Bulletin TB S11-01. The location of KBA-RW-04 was originally proposed for placement in a previously determined "hot spot" of contamination. Modelling indicated that KBA-RW-04 would contain this "hot spot"; however, the capture zone(s) created by KBA-RW-01 and KBA-RW-04 might not overlap with the capture zone(s) created by pumping from KBA-RW-02/KBA-RW-05 and KBA-RW-03. This might allow contaminants within the landfill area to "slip through" the two capture zones. KBA-RW-04 was shifted approximately 150 feet northward in attempt to close this gap and to minimize the potential of contaminants passing through the IM Phase I GWE capture zone.

Preliminary estimates of pumping rates for the proposed recovery wells that were used for the design of the conveyance system piping and the treatment system capacity were between 1.5 gallons per minute (gpm) to 15.5 gpm with four to 19 feet of drawdown, respectively. This initial pumping test, which sustained approximately 6.5 gpm with 12 feet of drawdown, confirmed the design flow (rate) estimates. KBA-RW-01 was redeveloped following the pumping test to increase efficiency of the well. The specific capacity of the well increased from 0.54 gallons per minute per foot (gpm/ft) to 1.1 gpm/ft. Actual well efficiency of all five recovery wells will be measured during the performance testing period of the IM pilot-scale test operations.

A shallow recovery well, KBA-RW-05, was installed adjacent to well KBA-RW-02 (Figure 2-1) and is screened from 6 to 26 feet bgs. This well was installed to withdraw groundwater from the shallowest portion of the surficial aquifer. KBA-RW-05 is designed to extract contaminated groundwater that is not controlled by the deeper recovery well KBA-RW-02. Well pair KBA-RW-02/KBA-RW-05 is a test site that will be used to collect data for evaluating the efficiency and design of well pairs.

This initial aquifer pumping test was an intermediate step towards supporting design considerations for the IM Phase I activities. The aquifer test approached steady-state conditions but did not achieve these conditions. These initial aquifer test results are preliminary in nature and will be verified during subsequent longer-term testing. Long-term aquifer pumping tests will be conducted during the Phase I operation period. These longer-term tests will be conducted over periods lasting seven or more days. A single well pumping stage is planned, followed by a recovery period. A double well pumping stage is planned at the recovery well KBA-RW-02 and KBA-RW-05 cluster. A third stage will include pumping from all five wells to develop the actual multiple well capture zone. Comprehensive evaluation of data from these three stages, as well as a background monitoring period and well performance tests, will be performed after the Phase I activities (pilot-scale operation) have been completed.

3.0 CONVEYANCE SYSTEM

The conveyance system consists of piping and electrical conduit that connects each of the five recovery wells to the treatment system and pump controls. Piping and conduit were installed during November and December 1993 after the wells were completed. Record drawings of the conveyance system layout will be generated for inclusion in the IM Phase I Activities: Evaluation and Recommendations Report.

Conveyance lines were installed at each of the five recovery wells. The lines run along the west side of the access road adjacent to the west side of the landfill. PVC pipe 1.5-inch in diameter was installed 24 to 36 inches bgs and conveys water from the wells to the treatment system. Two separate PVC conduits, 1-inch-diameter, were also installed 24 to 36 inches bgs and encases pump control sensor wires (in one conduit) and 10 American wire gauge (AWG) wire for power supply to the submersible pump. Both conveyance lines are installed under Spur 40 and are 12 feet bgs. The various components of the conveyance system (i.e., check valves and ball valves) were installed as described in the IM Work Plan (ABB-ES, 1994).

The conveyance lines from recovery wells KBA-RW-03 and KBA-RW-04 were routed under Spur 40 using directional drilling. An 8-inch diameter borehole was drilled, extending 180 feet from the western right-of-way of Spur 40 to the west side of the access road that runs along the west side of the landfill. Seven high density polyethylene (HDPE) lines were installed in the borehole. The annular space between the conveyance lines within the boring was filled with cement grout. Four of the HDPE pipes are 1.5 inches in diameter and three are 2 inches in diameter. Two of the HDPE lines are conveyance lines for groundwater from recovery wells KBA-RW-03 and KBA-RW-04. Two other lines are for electrical-power and control conduit. The remaining three lines are presently unused and are available for future use in the full-scale interim measure (Phase II activities).

Two pressure gauges were added to each water conveyance line at the well head and the manifold on the treatment pad. The two pressure gauges, at either end of each recovery well's discharge pipeline, will allow pressure losses to be monitored.

Pump controls and switches were centralized at the treatment pad rather than being located at each well head. The centralized location is more cost effective by eliminating the need for installation of a relay switch box at each well head.

4.0 GROUNDWATER TREATMENT SYSTEM

4.1 FINAL DESIGN. The IM Work Plan presents two groundwater treatment technologies to be used during the IM Phase I activities; one treatment technology is an air stripping technology and the other *ex situ* bioremediation. This section presents the design process using an "observational approach" and the installation of both treatment technologies. Record drawings are not available for this Technical Memorandum but will be presented in the IM Phase I Activities: Evaluation and Recommendations Report.

4.1.1 Air Sparger Two types of air stripping technologies were discussed in the IM work plan; one proposed technology was packed tower aeration and the other was air sparging. This subsection discusses the basis for selecting air sparging, as well as the basis for elimination of pretreatment from the IM Phase I system design.

A groundwater sample was collected from recovery well KBA-RW-01 during the initial pumping test on October 26, 1993. These samples were submitted for analysis of selected metals and ETPs, including:

- cadmium,
- chromium,
- iron,
- lead,
- manganese,
- hardness,
- total dissolved solids (TDS),
- total suspended solids (TSS),
- chloride, and
- total organic carbon (TOC).

Analytical data are summarized in Table 4-1 and on the process flow diagram (PFD) (Figure 4-1). Also shown on Table 4-1 are the results of analyses conducted on groundwater samples collected from monitoring well KBA-11-10A, which is a 20-foot deep monitoring well located in the landfill. Using an observational approach to optimize our treatment system design, the data from groundwater samples from KBA-RW-01 and KBA-11-10A formed the basis for selecting an air sparger without pretreatment processes. These decisions were supported by target analyte list (TAL) data for groundwater samples from four recovery wells, KBA-RW-01 through KBA-RW-04. The TAL data for these samples are summarized in Table 4-2.

Concentrations of iron and manganese in the initial groundwater sample from KBA-RW-01 (October 1993) were 1,600 and 31 micrograms per liter (μg/l), respectively, which would not pose a fouling problem for either air stripping technology. Groundwater samples collected in November 1993 from three of four recovery wells contained iron concentrations less than 1,500 μg/l, but the sample from KBA-RW-04 contained iron at a concentration of 6,260 μg/l, indicating potential problems with iron oxide. The groundwater sample collected from KBA-11-10 in July 1993 contained iron at a concentration of 55,600 μg/l, which also indicated a potential problem with iron. Hardness (as calcium carbonate ($CaCO_3$)) concentrations in the samples from KBA-RW-01 and KBA-11-10 were 38 milligrams per liter (mg/l) and 251 mg/l, respectively. These hardness concentrations indicate the potential for scaling problems.

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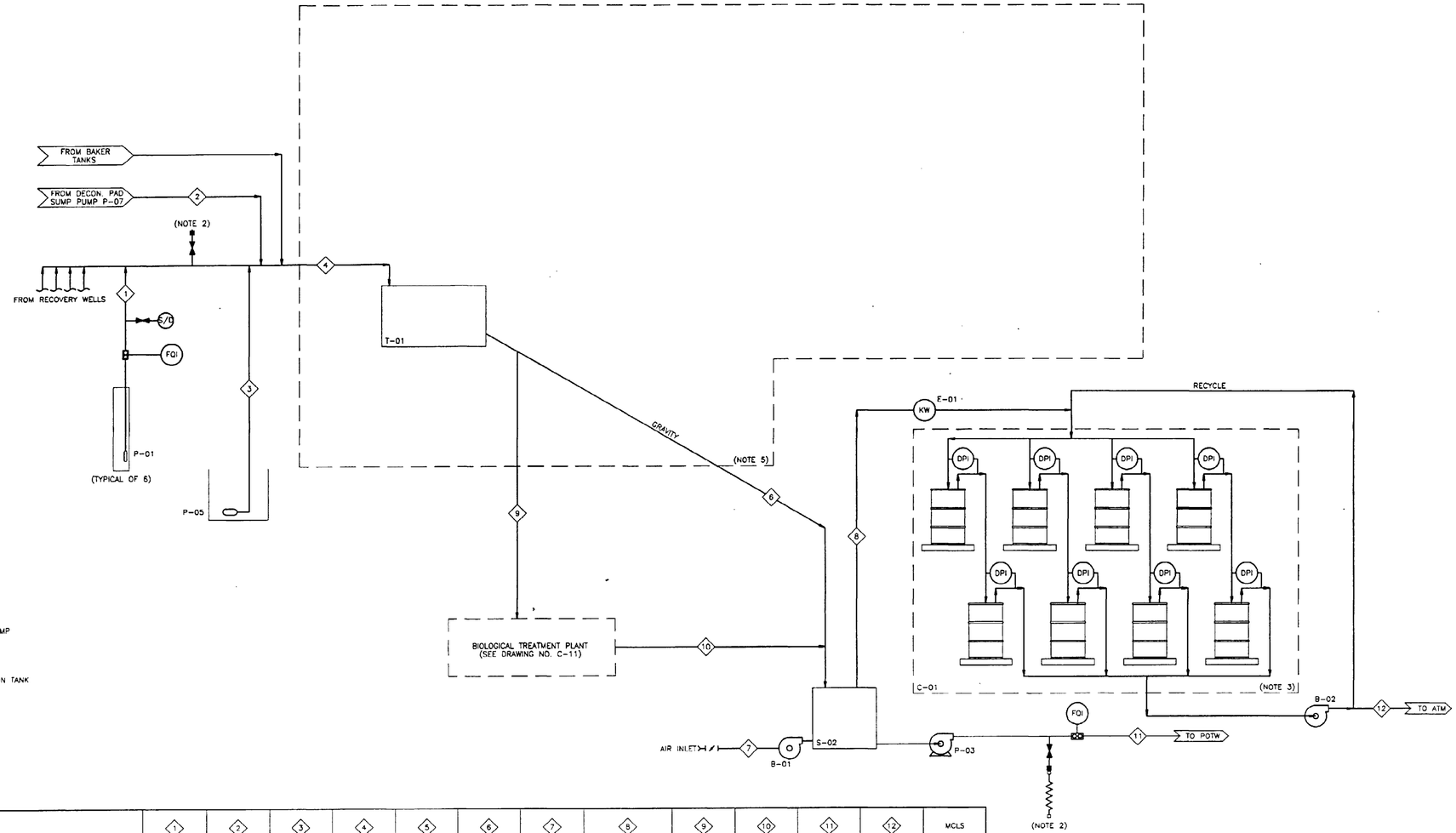


ABBREVIATIONS

B-01 – BLOWER

B-02 – CARBON ID FAN

C-01 – CARBON UNIT

E-01 – PREHEATER

P-01A THROUGH E – RECOVERY PUMPS

P-03 – EFFLUENT PUMP

P-05 – TREATMENT PAD SUMP PUMP

P-07 – DECONTAMINATION PAD SUMP PUMP

S-02 – AIR SPARGER

T-01 – PRETREATMENT TANK/EQUALIZATION TANK

LEGEND OF SYMBOLS

- POSITIVE DISPLACEMENT PUMP
- DIAPHRAGM PUMP (ELECTRICAL)
- SUBMERGED SUMP PUMP
- CENTRIFUGAL PUMP
- FLOW TOTALIZER INDICATOR
- DIRECT CONNECTION
- DIRECT CONNECTION BLOCK VALVE IN CAP
- ELECTRICAL CONNECTION
- PACKAGED EQUIPMENT OR INTEGRAL UNITS
- FLOW STREAM
- HEATER
- FLEXIBLE HOSE
- PIPE ENDED WITH CAP
- IN-LINE DEVICE
- AGITATOR
- DRAIN
- SAMPLE TAP
- SAMPLE TAP/DRAIN
- PRIMARY PROCESS
- NOT PIPING
- ELECTRICAL
- LINE BREAK OR RESUMPTION POINT
- QUICK DISCONNECT
- GLOBE VALVE
- GATE VALVE
- CHECK VALVE
- BALL VALVE
- BUTTERFLY VALVE IN LIQUID LINES, LOUVER IN AIR SERVICE

NOTES

1. FOR LEGEND OF SYMBOLS SEE THIS SHEET.
2. FOR RECYCLE.
3. CARBON TO BE PLACED ON PALLETS.
4. PRETREATMENT MAY BE INSTALLED AT A LATER DATE.

	1	2	3	4	5	6	7	8	9	10	11	12	MCLS
FLOW STREAM	RECOVERY WELLS (TYP.)	DECON. SUMP	TREATMENT PAD SUMP	INFLUENT		SPARGER FEED	AIR *	VAPOR EFFLUENT	RBC FEED	RBC EFFLUENT	DISCHARGE	VAPOR TO ATM	DISCHARGE CRITERIA
PARAMETER													
AVG. FLOW RATE gpm	8			40		40			1	1	40		
DESIGN													
PUMP FLOW RATE gpm	8	5	5	60		60		*	1	1	60		
DESIGN TOTAL lb/hr	4003.2	2502	2502	30,024		30,024			8.3	8.3	30,024		
SOLIDS lb/hr	2.0			15.3		15.3							
IRON mg/l	3			3		3			55.6				
MANGANESE mg/l	0.434			0.434		0.434			0.434				
ALKALINITY AS $CaCO_3$ mg/l	296			296		296			296				
SULFATE mg/l	26			26		26			26				
HARDNESS AS $CaCO_3$ mg/l	251			251		251			251				
DISSOLVED SOLIDS mg/l	319			319		319			319				
SUSPENDED SOLIDS mg/l	510			510		510			510				
BENZENE ug/l	5			5		5		0.0017 mg/m³	5		0.12		5
2-BUTANONE ug/l	580			580		580			580		580		
CHLOROBENZENE ug/l	10			10		10		0.0034 mg/m³	10		0.35		
1,4-DICHLOROBENZENE ug/l	12			12		12		0.0040 mg/m³	12		0.55		75
1,1-DICHLOROETHANE ug/l	24			24		24		0.0081 mg/m³	24		0.81		
1,2-DICHLOROETHANE ug/l	9			9		9		0.0029 mg/m³	9		0.80		5
CIS-1,2-DICHLOROETHENE ug/l	3600			3600		3600		1.2294 mg/m³	3600		63.28		70
TRANS-1,2-DICHLOROETHENE ug/l	23			23		23		0.0080 mg/m³	23		23		100
1,2-DICHLOROPROPANE ug/l	6			6		6		0.0020 mg/m³	6		0.34		5
ETHYLBENZENE ug/l	41			41		41		0.0140 mg/m³	41		0.85		700
2-HEXANONE ug/l	70			70		70			70		70		
4-METHYL-2-PENTANONE ug/l	110			110		110			110		110		
TETRACHLOROETHENE ug/l	3			3		3		0.0010 mg/m³	3		0.03		5
TOLUENE ug/l	840			840		840		0.2835 mg/m³	840		24.57		1000
TRICHLOROETHENE ug/l	45			45		45		0.0154 mg/m³	45		0.67		5
XYLENES (TOTAL) ug/l	120			120		120		0.0410 mg/m³	120		2.05		10,000
VINYL CHLORIDE ug/l	310			310		310		0.1076 mg/m³	310		0.40		2

* – TO BE DETERMINED BY VENDOR

ABB ASEA BROWN BOVERI	ABB Environmental Services Inc.	DWN: DMF	DES: HF	CONTRACT NO.: SE 3-21-037	TITLE: PROCESS FLOW DIAGRAM AIR SPARGER UNIT
		CHKD: KDS	APPD.: GMB	PROJECT NO.: 08503.02	
		DATE: 3-8-94	REV.: VAR	SHEET NO.: C-10	

Table 4-1 Summary of Analytical Data for Samples Collected for Pretreatment Evaluation

Analyte	KBA-11-10A Unfiltered 7-1-93 (µg/l)	KBA-11-10A Filtered 7-1-93 (µg/l)	KBA-RW-01 10-26-93 (µg/l)	KBA-RW-01 Duplicate 10-26-93 (µg/l)
Aluminum	32,800	272	NA	NA
Antimony	20.2 U	20.2 U	NA	NA
Arsenic	9.2 J	2.9 J	NA	NA
Barium	87.1 J	53.3 J	NA	NA
Beryllium	0.61 J	0.41 J	NA	NA
Cadmium	2.6 U	2.6 U	<5	<5
Calcium	71,800	68,200	NA	NA
Chromium	24.2	2.5 U	<10	<10
Cobalt	4.8 U	4.8 U	NA	NA
Copper	8.7 J	2.6 J	NA	NA
Iron	55,600	47,500	1,610	1,620
Lead	3.9	1.4 J	<3	<3
Magnesium	17,400	17,500	NA	NA
Manganese	434	405	31	31
Mercury	0.41	0.08 J	NA	NA
Nickel	11.7 J	9.2 U	NA	NA
Potassium	16,200	12,700	NA	NA
Selenium	3.4 J	1.6 U	NA	NA
Silver	2.4 U	2.9 J	NA	NA
Sodium	10,600	10,800	NA	NA
Thallium	1.6 J	1.3 U	NA	NA
Vanadium	19.0 J	2.0 U	NA	NA
Zinc	133	20.9	NA	NA

See notes at end of table.

Table 4-1 (Continued) Summary of Analytical Data for Samples Collected for Pretreatment Evaluation

Parameter	KBA-11-10A Unfiltered 7-1-93 (mg/l)	KBA-11-10A Filtered 7-1-93 (mg/l)	KBA-RW-01 10-26-93 (mg/l)	KBA-RW-01 Duplicate 10-26-93 (mg/l)
Alkalinity (as $CaCO^3$)	296		NA	NA
Hardness, Total (as $CaCO_3$)	251		38	39
Total Dissolved Solids	319		178	172
Total Suspended Solids	510		2.7	9.8
Volatile Suspended Solids	174		NA	NA
Total Volatile Solids	619		NA	NA
Total Solids	830		NA	NA
Chloride	1.9		65	65
Sulfate	26		NA	NA
Sulfide	1.1		NA	NA
Ammonia (as N)	18.0		NA	NA
Nitrate and Nitrite (as N)	<0.02		NA	NA
Kjeldahl Nitrogen (as N)	18.9		NA	NA
BOD (5 day)	14.3		NA	NA
BOD (20 day)	33		NA	NA
COD	200		NA	NA
Grease and Oil Li-Li	18.0		NA	NA
TOC - Liquid	54.6		22.5	19.6

Notes:

BOD = biochemical oxygen demand
$CaCO_3$ = calcium carbonate
COD = chemical oxygen demand
J = estimated concentration
µg/l = micrograms per liter
mg/l = milligrams per liter
N = nitrogen
NA = not analyzed
TOC = total organic carbon
U = not detected

The list uses a different measurement increment starting with alkalinity.

KBA-11-10A is screened in the upper portion of the surficial aquifer.

KBA-RW-01 is screened over a 40-foot interval within the surficial aquifer. Samples collected during the initial aquifer pumping test are assumed to be more representative of influent to Phase I (pilot-scale) treatment system.

Table 4-2 Summary of Inorganic Analysis of Groundwater Samples Collected from Interim Measure Recovery Wells - November 1993

Analyte Detected	MCL (μg/l)	Number of Detections/Number of Samples[1]	Concentration Range (μg/l)	Frequency Above MCL
Aluminum	NA	4/4	478 - 10,600	NA
Arsenic	50	4/4	1.2 - 5.5	0/4
Barium	2,000	4/4	32.4 - 94.9	0/4
Beryllium	4	1/4	0.80	0/1
Calcium	NA	4/4	5,680 - 13,500	NA
Chromium	100	4/4	3.4 - 17.4	0/4
Copper	1,300	1/4	4.5	0/1
Iron	NA	4/4	1,110 - 6,780	NA
Lead	15	2/4	0.46 - 5.4	0/2
Magnesium	NA	4/4	2,740 - 6,260	NA
Manganese	NA	4/4	35.4 - 92.1	NA
Nickel	100	3/4	9.5 - 10.7	0/3
Potassium	NA	4/4	3,700 - 24,400	NA
Sodium	NA	4/4	36,900 -47,000	NA
Vanadium	NA	4/4	2.7 - 14.4	NA
Zinc	NA	4/4	13.5 - 823	NA
Cyanide	200	3/4	1.9 - 2.1	0/3
Sulfide	NA	4/4	1.8 - 22.7	NA

Notes:

μg/l = micrograms per liter
MCL = Maximum Contaminant Level
NA = Not Applicable

[1] The total number of samples includes those samples that contained at least one or more inorganic analytes.

The design for the treatment system did not include pretreatment to reduce metals and hardness concentrations. Air spargers have less stringent pretreatment requirements than packed tower aeration units. Since an air sparger will be used, pretreatment for iron and hardness is not expected to be required. Iron fouling and scale buildup will be visually monitored throughout operation of the unit, a benefit provided by the air sparger design. The naturally low pH of the water also will help to minimize fouling and scaling. The treatment pad is of sufficient size to contain pretreatment equipment if determined at a later date that pretreatment is needed.

Concentrations of inorganics in groundwater samples relative to Maximum Contaminant Levels (MCLs) also influenced the decision to not include pretreatment processes in the system design. Concentrations of inorganics detected in the groundwater samples from the recovery wells, summarized in Table 4-2, are below MCLs.

In consideration of the data discussed in the preceding paragraph, a diffused aeration tank that utilizes air sparging process was selected for installation and operation during the Phase I activities. Figure 4-1 is a PFD for the air sparger treatment system. The air sparger was chosen for the following reasons:

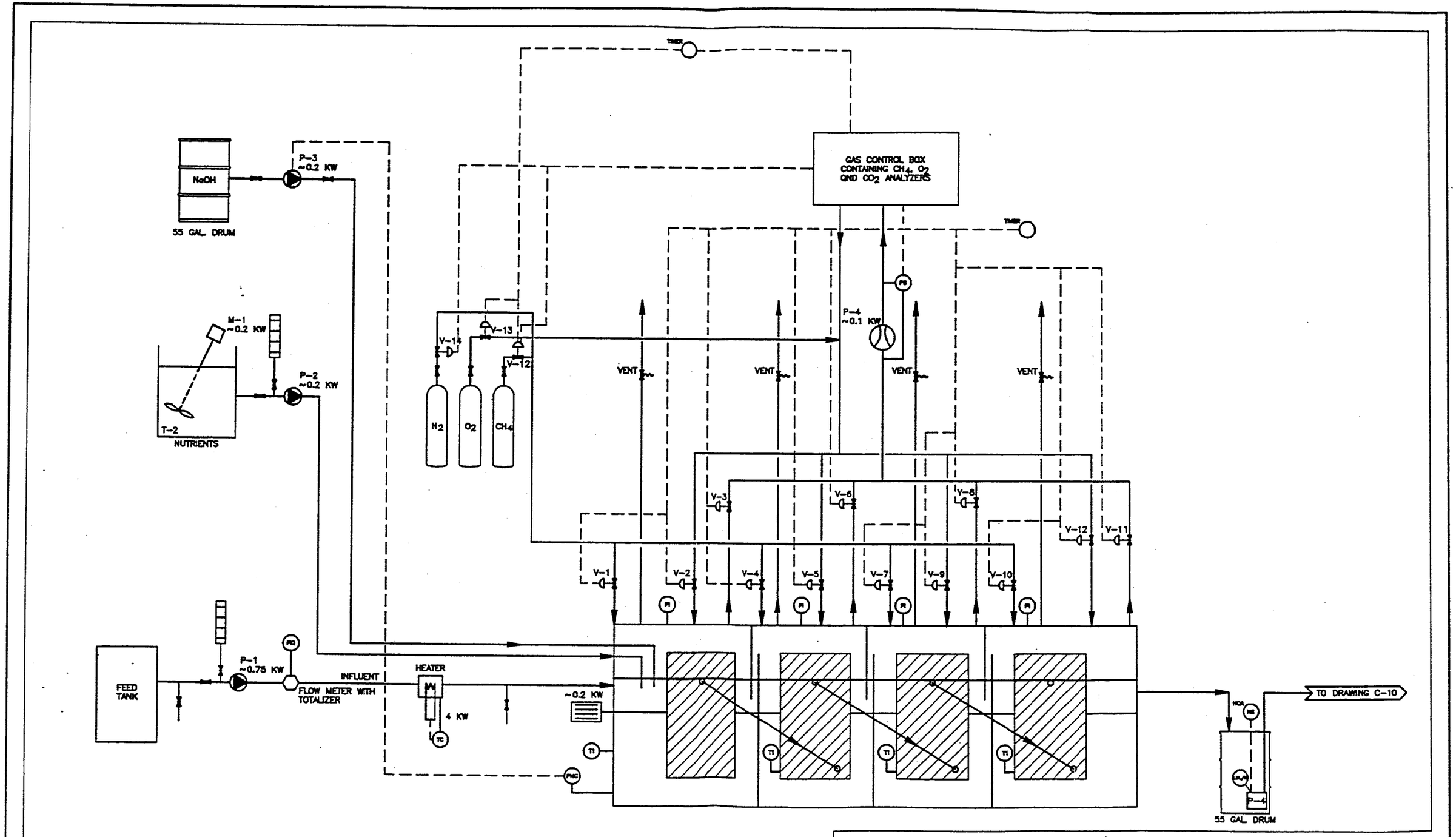
- Air spargers are more resistant to iron fouling and scaling than packed towers. If plugging does occur, all air sparger internal components, including the air diffusers, can be cleaned or replaced easily and with minimal downtime.

- As a pilot scale test unit (for Phase I activities), operation of an air sparger will provide more information regarding potential pretreatment requirements in a full scale treatment system by enabling visual monitoring of scaling, fouling, or solids build-up.

- Any solids carried over from the recovery wells during the initial well operations can be removed from the air sparger easily.

Additionally, an air sparger treatment system allows gravity flow of water from the equalization tank. A packed tower aeration unit would require a feed pump and feed tank level controls, increasing cost, operation, and maintenance requirements.

4.1.2 *Ex Situ* Biological Treatment Figure 4-2 is a piping and instrumentation diagram (P&ID) for the methanotrophic rotating biological contactor (mRBC) unit. The final design for the mRBC unit is as proposed in the IM Work Plan (ABB-ES, 1994), but with one minor change related to transferring the effluent from the mRBC unit to the air sparger. The proposed design indicated the mRBC unit would discharge to the air sparger sump. As shown on the P&ID, the final design for the mRBC unit indicates the effluent will flow to a 55-gallon drum, where a submersible pump would transfer the effluent to the air sparger. Rather than use a 55-gallon drum, a 50-gallon polyethylene tank was positioned beneath the mRBC unit. The mRBC unit was elevated approximately 20 inches to accommodate the tank. A submersible pump equipped with a float switch sensitive to 12 inches of water will feed the effluent to the air sparger. This allows variations in flow rate from the mRBC unit to be managed so that influent flow rate to the air sparger is not affected.



DWN: DMF	DES: VAR	PROJECT NO.: 08503.02	TITLE: PIPING & INSTRUMENTATION DIAGRAM ROTATING BIOLOGICAL CONTACTOR UNIT
CHKD: KDS	APPD.: GMB	SHEET NO.: 4-2	
DATE: 2-7-94	REV.:		

0515C02Z

The mRBC unit was installed on the treatment pad during December 1993 and January 1994. Set-up of the unit included instrumentation assembly (e.g., timer system, Servomex gas analyzer system, and the pH monitoring system); installation of methane and oxygen gas feed controls; installation of the gas analyzing and delivery system; and assembly of the influent/effluent water delivery and monitoring system. Gas and water analyzing instrumentation are housed in a wooden box constructed on the treatment pad. The gas analyzing system was installed to allow continuous monitoring of methane, oxygen, and carbon dioxide in each compartment of the mRBC unit. Potable water was added to the mRBC unit during the later part of December 1993, and the unit was seeded with methanotrophic bacteria. Cultivation of biomass in the mRBC continued throughout January 1994.

The mRBC unit is scheduled to begin treatment of contaminated groundwater in February 1994.

4.2 DISCHARGE. The Navy has been authorized by the Georgia Department of Natural Resources to discharge treated groundwater to the NSB Land Application System (LAS). This subsection summarizes the scenario under which the discharge will occur.

The effluent from the IM treatment systems will meet requirements, as described in the Request for Authorization for Groundwater Discharge into the NSB Kings Bay Land Application System (ABB-ES, 1993), for discharge to the NSB Kings Bay LAS. During the Phase I operations of the (pilot-scale) treatment system, the concentrations of constituents of concern discharged to the LAS influent should meet or exceed federal drinking water criteria (MCLs) listed in Table 4-3.

During Phase I operations, analytical results of the untreated groundwater will be used to evaluate treatment and performance standards required for full-scale (Phase II) IM operation. Currently, available groundwater data does not sufficiently support a no-treatment alternative for the groundwater extracted during Phase I operation of the GWE system. Treatment and monitoring of the groundwater extracted during Phase I operations will be performed to prevent the receiving treatment facility from being adversely affected by the IM discharge stream.

Liquid effluent from the air sparger will be collected in the air sparger sump. Three-inch PVC pipe has been installed to convey the effluent from the treatment system to a manhole that is linked to the LAS. Instantaneous and daily flow rates will be recorded throughout the operation of the system using a totalizing flow meter placed at the air sparger effluent pipe. A hand-operated gate valve has been installed in the effluent line, downstream of the air sparger and totalizing flow water, to allow the system to be isolated from the LAS, when necessary.

4.3 AIR EMISSIONS. The air sparger is a diffused aeration system where air is released into the water through diffusers that produce coarse bubbles. Mass transfer occurs across the air-water interface of the bubbles. Vapor treatment, in the form of carbon adsorption units, was added to the design for the IM pilot study treatment system (Figure 4-1). Exhaust air exits the unit and is directed to a series of activated carbon adsorbers before being discharged through a single PVC stack to be released to the atmosphere at a minimum height of 12 feet.

Table 4-3 Phase I Treatment System, Efficiencies and Estimated Effluent Concentrations for Treatment of Volatile Organic Compounds (VOCs)

Constituent of Concern	Estimated Influent Concentration[1]	Percent Efficient Removal	System Effluent Estimated Concentrations (μg/l)	Performance Criteria[2] (μg/l)
Benzene	28 μg/l	99.9	<1	5
2-Butanone	580 μg/l	7	541	NA
Chlorobenzene	10 μg/l	99.8	<1	100
1,4-Dichlorobenzene	12 μg/l	99.7	<1	75
1,1-Dichloroethane	100 μg/l	99.9	<1	NA
1,2-Dichloroethane	9 μg/l	95.3	<1	5
cis-1,2-Dichloroethene	3,600 μg/l	98.9	40	70
trans-1,2-Dichloroethene	23 μg/l	99.9	<1	100
1,2-Dichloropropane	6 μg/l	99.0	<1	5
Ethylbenzene	200 μg/l	99.9	<1	700
2-Hexanone	70 μg/l	3	68	NA
Methylene Chloride	41 μg/l			5
4-Methyl-2-pentanone	1,400 μg/l	25.8	1,039	NA
Tetrachloroethene	24 μg/l	99.9	<1	5
Toluene	840 μg/l	99.9	<1	1,000
Trichloroethene	45 μg/l	99.9	<1	5
Xylenes (total)	155 μg/l	99.9	<1	10,000
Vinyl Chloride	1,400 μg/l	100	0	2
BOD	14.3 mg/l			*
TSS	9.8 mg/l			*
pH	4 - 6			*

Notes:

* = to be set by the Base Land Application System
BOD = biochemical oxygen demand
μg/l = micrograms per liter
mg/l = milligrams per liter
NA = not applicable
TSS = total suspended solids

1 Maximum concentration detected from previous studies.

2 Performance criteria are the maximum contaminant levels for constituents of concern as established by the State of Georgia (1993) and USEPA (1993).

Vapor phase activated carbon has been documented to remove a minimum of 99 percent of each constituent of concern with a retention time of 1.7 to 2 seconds. Four parallel streams of carbon adsorbers will be used to provide a retention time of 1.8 seconds in each adsorber. Two units will be placed in series in each parallel stream to provide a polishing stage. Vapor sample points will be placed between the two units and on the 8-inch-diameter stack to monitor for breakthrough.

Design air flow through the air sparger is 840 cubic feet per minute for an air to water ratio of 100 to 1 at a water feed rate of up to 60 gallons per minute. The Phase I operations will operate up to 24 hours per day, 7 days per week, for a total of 45 days.

Table D-1 in Appendix D lists the constituents that have been identified in the groundwater that are present at concentrations of concern, the maximum concentration detected at any point in the constituent plume, and indicates known carcinogens as category A and all other pollutants as category B (Columns 1, 2, and 4, respectively). Table D-1 (Appendix D) also provides American Conference of Governmental and Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) recommendations for each constituent of concern that have been adjusted for operation 24 hours a day, 7 days a week (Column 3) and Acceptable Ambient Criteria (AAC) (Column 4). TLVs have also been adjusted by a safety factor that accounts for pollutant exposure to members of the public who may be more sensitive to pollutant effects than the average citizen. AACs originate from the toxicity data priority schedule provided in Part III, paragraph 1 of the guidance document, Guideline for Ambient Impact Assessment of Toxic Air Pollutant Emissions, July 1984.

To estimate expected ambient air quality concentrations during the pilot test, air dispersion modeling was conducted. Maximum predicted impacts were then compared with calculated acceptable ambient concentrations to ensure public health would not be threatened during the system operation.

The USEPA SCREEN model was used to predict air quality impacts for each chemical of concern. SCREEN uses a number of conservative assumptions and provides conservative estimates of ambient air concentrations. This model is recommended by the USEPA for conducting dispersion modeling for air pathway analyses. Based upon discussions with staff at the Georgia Air Protection Branch, the SCREEN model is the preferred screening model for estimating air quality impacts.

The point source algorithm in SCREEN was used in the analysis. Flat terrain and rural dispersion were assumed. Concentrations were calculated for the full range of meteorological conditions available in the model. To reduce the number of model runs and for ease of calculating air quality impacts for each of the chemicals, the model was conducted using a unit emission rate of one pound per hour (lb/hr).

The emission concentrations and modeled maximum ground level concentrations for each chemical of concern are provided in Table D-2. Table D-3 presents the SCREEN model documentation for calculating the maximum ground level concentrations. Stack parameters used as input to the model are shown in Table D-4.

As indicated on Table D-2, the maximum ground level concentrations calculated by the SCREEN model are well below the AACs. The analysis reaffirms that air

emissions will result in a negligible impact on air quality during the IM Phase I operations.

Daily stack monitoring for vinyl chloride will be conducted during Phase I operations to collect actual air emission data. The modeling shows that a concentration of 37 mg/m^3 of vinyl chloride at the stack should not exceed a maximum ground level concentration of 0.01004 mg/m^3 (Table D-5) for worst case meteorological conditions. This is less than the required AAC. ABB-ES has proposed to monitor the stack and to initiate corrective action if the stack concentration exceeds 3.7 mg/m^3, providing a minimum safety factor of 10 times the AAC. If a stack concentration of 3.7 mg/m^3 of vinyl chloride is exceeded, corrective measures to reduce emissions will be initiated. Corrective measures will be defined in a brief Operations and Maintenance Plan. The on-site laboratory that will be used initially for this stack monitoring will use a maximum detection limit of 0.1 mg/m^3. When analytical functions are transferred to an off-site laboratory, this maximum detection limit will continue to be used.

5.0 SUMMARY

5.1 SUMMARY. During the time period September 1993 through January 1994, GWE and treatment system installation activities were conducted at Site 11 for Phase I of the Interim Measure. These activities included installation of the GWE system, groundwater conveyance system, and groundwater treatment system.

The GWE system includes five recovery wells. Three of the recovery wells are located along the western side of the landfill and two are located on the western right-of-way of Spur 40. Three of the recovery wells, KBA-RW-01, KBA-RW-02, and KBA-RW-03, were installed at the locations proposed in the Interim Measure Work Plan (ABB-ES, 1994). Two other recovery wells were located based on results of an initial pumping test conducted on recovery well KBA-RW-01. Four of the five recovery wells are deep wells, with 40- to 50-foot screened intervals approximately 60 to 72 feet bgs at the base of the well screens. The fifth recovery well has a 20-foot well screen with the base at approximately 26 feet bgs.

A 25-hour pumping test was conducted on one of the recovery wells, KBA-RW-01. The results of this pumping test were used to provide preliminary radius-of-influence data and to guide the IM project team's well installation program. The radius-of-influence data from this pumping test formed the basis for shifting the location of recovery well KBA-RW-04 approximately 150 feet to the north of its proposed location. The data indicated that the capture zone created by KBA-RW-04 at its proposed location may not interconnect with that created by KBA-RW-03. The results also indicate that, at the location chosen for installation, KBA-RW-04 will hydraulically control migration of contaminants in the hot spot to the south as well as prevent contaminants from passing through the extraction system's combined capture zone.

The pumping test data also indicated that the upper portion of the surficial aquifer may be more permeable than and/or may be hydraulically separated from the lower portion. The data indicated that pumping the deep recovery wells causes negligible drawdown in the upper 20 feet of the surficial aquifer. A fifth, shallow recovery well, KBA-RW-05, was installed adjacent to one of the deep recovery wells (KBA-RW-02). This well pair will be used during the pilot study to obtain information regarding the suitability of well pairs to hydraulically control migration of contaminated groundwater.

All five recovery wells are connected to the IM Phase I treatment system via an underground conveyance system. Conventional trenching methods were used to install the majority of the conveyance lines; directional drilling was used to install the conveyance lines under Spur 40 and the NSB patrol road. Three auxiliary lines were installed under Spur 40 to accommodate further expansion of the GWE system for the full-scale interim measure (Phase II). The pump controls and switches for the conveyance system were centralized at the treatment pad. Pressure gauges were installed at the manifold and well heads so that pressure losses across the conveyance system can be monitored.

The design for the treatment system followed an "observational approach" that resulted in selection of an air sparger as the preferred air stripping technology for the IM Phase I activities. The air sparger was selected rather than a packed tower aeration unit based on groundwater analytical data that indicated that fouling and scaling may occur. Air spargers are more resistant to iron fouling

and scaling than packed tower aeration units, and can also be cleaned or repaired more easily if fouling and/or scaling does occur. The air sparger will allow visual monitoring of fouling, scaling, and solids buildup. The information gained during this monitoring will be useful in evaluating potential pretreatment requirements for the full-scale interim measure (Phase II). The design for pretreatment was not implemented because concentration levels of iron and hardness were evaluated and found to be acceptable levels for air sparging technology levels. The naturally low pH of the groundwater will also help minimize fouling and scaling. Also, concentrations of inorganics detected in groundwater samples from the recovery wells were below MCLs, indicating that pretreatment was not needed to reduce concentrations of inorganic constituents prior to discharge to the NSB Kings Bay LAS.

The mRBC unit has been installed. A polyethylene holding tank and submersible pump has been incorporated into the original design. The holding tank and pump were needed to regulate flow to the air sparger, because effluent rates from the mRBC unit will vary during the pilot-scale test of the unit. The tank has a capacity of 50 gallons and is located beneath the mRBC unit, which was elevated approximately 20 inches off the ground to accommodate the tank. A submersible pump is equipped with a float switch so that the effluent will be transferred automatically.

5.2 STATUS OF PHASE I. System installation activities will be followed by Phase I operations of the IM groundwater extraction and treatment systems. This section provides a brief narrative describing the activities planned to complete Phase I of the IM. Phase I operations includes five facets as follows:

1) Background Monitoring - includes collection of water levels over a 7- to 10-day period when the surficial aquifer is not being stressed by GWE system pumping. The data will be collected using electronic pressure transducers and data loggers. The measurements will provide baseline data for use in evaluating water level fluctuations recorded during periods of groundwater extraction.

2) Well Performance Testing - includes step-drawdown pumping tests on all five recovery wells. Each test will be comprised of three 100 minute pumping intervals.

3) Stage 1 Pumping Test - a 7-day pumping test on KBA-RW-02. The test will be followed by a 3- to 7-day recovery period during which time the groundwater extraction system will be inactive.

4) Stage 2 Pumping Test - a 7-day combined discharge pumping test on KBA-RW-02 and KBA-RW-05. Both wells will be pumping simultaneously. There will be no recovery phase following this pumping test.

5) Stage 3 Pumping Test - following completion of the Stage 2 pumping test the remaining three recovery wells will be sequentially activated. This pumping test will be approximately 30 days in duration.

The data collected during the Phase I operations program described in this subsection will be used in developing the IM Phase I Activities: Evaluations and Recommendations Report, as described in the Interim Measure Work Plan (ABB-ES, 1994). The evaluation will be of the various components of the pilot-scale

system, including the groundwater extraction system, the conveyance system, the air sparging treatment system, the mRBC treatment unit, and the discharge permit and options. The results of these evaluations will be used to make recommendations for the full-scale interim measure (Phase II).

REFERENCES

ABB-ES, 1994. "Interim Measure Work Plan for Site 11, Old Camden County Landfill, Phase 1 Activities, NSB Kings Bay, Georgia." March 1994.

ABB-ES, 1993. "Request for Authorization for Groundwater Discharge into the NSB Kings Bay Land Application System."

Georgia Department of Natural Resources, 1993. Rules of Georgia Department of Natural Resources Environmental Protection Division; Rules for Safe Drinking Water. Chapter 391-3-5. Revised July 1993.

Georgia Department of Natural Resources, 1984. Guideline for Ambient Impact Assessment of Toxic Air Pollutant Emissions, July.

Kruseman and de Ridder, 1989. Analysis and Evaluation of Pumping Test Data, Bulletin 11. International Institute for Land Reclamation and Improvement/ILRI. 4th edition, 1989.

U.S. Environmental Protection Agency (USEPA), 1993. Drinking Water Regulations and Health Advisories. Office of Water, Washington, D.C. May.

APPENDIX A

Boring Logs and Construction Diagrams for Recovery Wells and Piezometers

TITLE: NSB KINGS BAY		**LOG of WELL:**	**BORING NO.** KBA-PS-01
CLIENT: U.S. NAVY			**PROJECT NO:** 8503-03
CONTRACTOR: Alliance Environmental Inc.		**DATE STARTED:** 10/20/93	**COMPLTD:** 10/21/93
METHOD: HSA	**CASE SIZE:** 2"	**BORING DIA.:** 8.25"	**PROTECTION LEVEL:** D
GROUND ELEV.: 33.02 FT.	**MONITOR INST.:** FID	**TOT DPTH:** 38.5FT.	**DPTH TO ∇** 8.44 FT.
LOGGED BY: P. Craine	**WELL DEVELOPMENT DATE:** 10/24/93		**SITE:** Old Camden County Landfill

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
				0	Fine sand, light gray		SP		
5				0	Fine sand, light gray to white, damp between 6-7 ft., color changes to dark brown to black between 7-8 ft., wet				
10				0	Fine sand, same as above				
15				0	Fine sand, same as above				
20				0	Fine sand, same as above				
25									

 ABB ENVIRONMENTAL SERVICES, INC.

TITLE: NSB KINGS BAY		**LOG of WELL:**	**BORING NO.** KBA-PS-01
CLIENT: U.S. NAVY			**PROJECT NO:** 8503-03
CONTRACTOR: Alliance Environmental Inc.		**DATE STARTED:** 10/20/93	**COMPLTD:** 10/21/93
METHOD: HSA	**CASE SIZE:** 2"	**BORING DIA.:** 8.25"	**PROTECTION LEVEL:** D
GROUND ELEV.: 33.02 FT.	**MONITOR INST.:** FID	**TOT DPTH:** 38.5FT.	**DPTH TO ∇** 8.44 FT.
LOGGED BY: P. Craine	**WELL DEVELOPMENT DATE:** 10/24/93		**SITE:** Old Camden County Landfill

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
					Continued from PAGE 1				
				0	Fine sand, same as above		SP		
30				0	Fine sand, light brown to dark brown,				
35									
					total depth = 38.5 ft.				
40									
45									
50									

 ABB ENVIRONMENTAL SERVICES, INC.

TITLE: NSB KINGS BAY		**LOG of WELL:**	**BORING NO.** KBA-PS-02
CLIENT: U.S. NAVY			**PROJECT NO:** 8503-03
CONTRACTOR: Alliance Environmental Inc.		**DATE STARTED:** 10/21/93	**COMPLTD:** 10/21/93
METHOD: HSA	**CASE SIZE:** 2"	**BORING DIA.:** 8.25"	**PROTECTION LEVEL:** D
TOC ELEV.: 35.59 FT.	**MONITOR INST.:** FID	**TOT DPTH:** 39FT.	**DPTH TO ∇** 4.87 FT.
LOGGED BY: P. Craine	**WELL DEVELOPMENT DATE:** 10/24/93		**SITE:** Old Camden County Landfill

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS
				0	Fine sand, dark brown w/organics, changes to tan at 2 ft. depth		SP
5				0	Fine sand, light gray to white, damp to wet		
10				0	Fine sand, as above, becoming dark brown		
15				0	Fine sand, same as above		
20				0	Fine sand, same as above, lighter brown		
25							

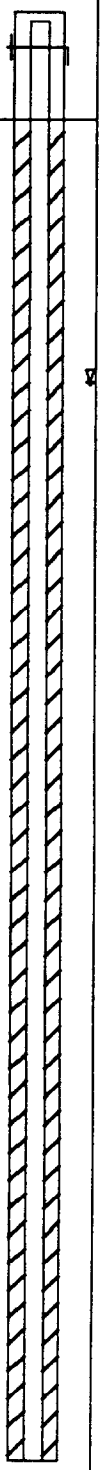


ABB ENVIRONMENTAL SERVICES, INC.

TITLE: NSB KINGS BAY		**LOG of WELL:**	**BORING NO.** KBA-PS-02
CLIENT: U.S. NAVY			**PROJECT NO:** 8503-03
CONTRACTOR: Alliance Environmental Inc.		**DATE STARTED:** 10/21/93	**COMPLTD:** 10/21/93
METHOD: HSA	**CASE SIZE:** 2"	**BORING DIA.:** 8.25"	**PROTECTION LEVEL:** D
TOC ELEV.: 35.59 FT.	**MONITOR INST.:** FID	**TOT DPTH:** 39FT.	**DPTH TO ∇** 4.87 FT.
LOGGED BY: P. Craine	**WELL DEVELOPMENT DATE:** 10/24/93		**SITE:** Old Camden County Landfill

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS
					Continued from PAGE 1		
				0	Fine sand, same as above		SP
30				990	Fine sand, light brown, grading to tan gray to gray white		
35							
					total depth = 39 ft.		
40							
45							
50							

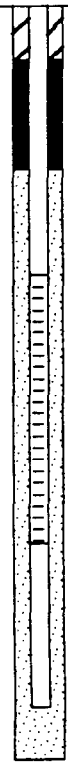


 ABB ENVIRONMENTAL SERVICES, INC.

TITLE: NSB KINGS BAY		**LOG of WELL:**	**BORING NO.** KBA-PS-03
CLIENT: U.S. NAVY			**PROJECT NO:** 8503-03
CONTRACTOR: Alliance Environmental Inc.		**DATE STARTED:** 10/22/93	**COMPLTD:** 10/22/93
METHOD: HSA	**CASE SIZE:** 2"	**BORING DIA.:** 8.25"	**PROTECTION LEVEL:** D
TOC ELEV.: 34.49 FT.	**MONITOR INST.:** FID	**TOT DPTH:** 38FT.	**DPTH TO ∇** 8.45 FT.
LOGGED BY: P. Craine	**WELL DEVELOPMENT DATE:** 10/24/93		**SITE:** Old Camden County Landfill

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS
				0	Fine sand, gray, loose, dry		SP
5				0	Fine sand, dark brown, traces of clay, some organics		
10				0	Fine sand, dark brown to black, saturated		
15				0	Fine sand, same as above		
20				0	Fine sand, same as above		
25							

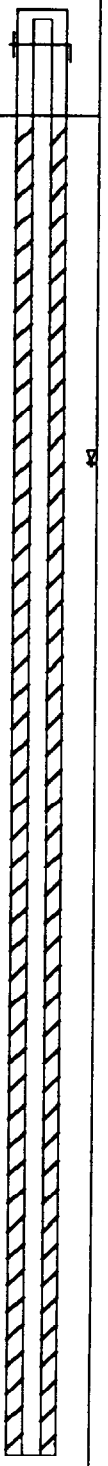


ABB ENVIRONMENTAL SERVICES, INC.

TITLE: NSB KINGS BAY		**LOG of WELL:**	**BORING NO.** KBA-PS-03
CLIENT: U.S. NAVY			**PROJECT NO:** 8503-03
CONTRACTOR: Alliance Environmental Inc.		**DATE STARTED:** 10/22/93	**COMPLTD:** 10/22/93
METHOD: HSA	**CASE SIZE:** 2"	**BORING DIA.:** 8.25"	**PROTECTION LEVEL:** D
TOC ELEV.: 34.49 FT.	**MONITOR INST.:** FID	**TOT DPTH:** 39FT.	**DPTH TO ∇** 8.45 FT.
LOGGED BY: P. Craine	**WELL DEVELOPMENT DATE:** 10/24/93		**SITE:** Old Camden County Landfill

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS Continued from PAGE 1	LITHOLOGIC SYMBOL	SOIL CLASS	
				0	Fine sand, same as above		SP	
30				0	Fine sand, light brown, grading to tan gray to gray white			
			24"	0	Fine sand, greenish brown 8" over black 3" over wood			17,10,9,8
				0	Fine sand, dark brown			
35								
					total depth = 39 ft.			
40								
45								
50								

 ABB ENVIRONMENTAL SERVICES, INC.

TITLE: NSB KINGS BAY		**LOG of WELL:**	**BORING NO.** KBA-PS-04
CLIENT: U.S. NAVY			**PROJECT NO:** 8503-03
CONTRACTOR: Alliance Environmental Inc.		**DATE STARTED:** 10/22/93	**COMPLTD:** 10/22/93
METHOD: HSA	**CASE SIZE:** 2"	**BORING DIA.:** 8.25"	**PROTECTION LEVEL:** D
TOC ELEV.: 38.91 FT.	**MONITOR INST.:** FID	**TOT DPTH:** 39FT.	**DPTH TO ∇** 8.88 FT.
LOGGED BY: P. Craine	**WELL DEVELOPMENT DATE:** 10/24/93		**SITE:** Old Camden County Landfill

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS
				0	Fine sand, brown w/domestic debris		SP
5				0	Fine sand, light brown to tan, grading to light gray		
10				0	Fine sand, dark brown to black, wet		
15				0	Fine sand, same as above, damp to wet		
20				0	Fine sand, same as above, saturated, liquid sands		
25							

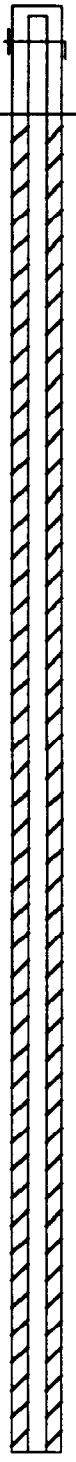


 ABB ENVIRONMENTAL SERVICES, INC.

TITLE: NSB KINGS BAY		**LOG of WELL:**	**BORING NO.** KBA-PS-04
CLIENT: U.S. NAVY			**PROJECT NO:** 8503-03
CONTRACTOR: Alliance Environmental Inc.		**DATE STARTED:** 10/22/93	**COMPLTD:** 10/22/93
METHOD: HSA	**CASE SIZE:** 2"	**BORING DIA.:** 8.25"	**PROTECTION LEVEL:** D
TOC ELEV.: 36.91 FT.	**MONITOR INST.:** FID	**TOT DPTH:** 39FT.	**DPTH TO ∇** 8.68 FT.
LOGGED BY: P. Craine	**WELL DEVELOPMENT DATE:** 10/24/93		**SITE:** Old Camden County Landfill

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	
					Continued from PAGE 1			
				0	Fine sand, same as above		SP	
30				0	Fine sand, same as above			
			24"	1	Fine sand, greenish gray, very dense			1,5,7,8
				0	Fine sand, same as above			
35								
					total depth = 39 ft.			
40								
45								
50								

 ABB ENVIRONMENTAL SERVICES, INC.

TITLE: NSB KINGS BAY		**LOG of WELL:**	**BORING NO.** KBA-PS-05
CLIENT: U.S. NAVY			**PROJECT NO:** 8503-03
CONTRACTOR: Alliance Environmental Inc.		**DATE STARTED:** 10/25/93	**COMPLTD:** 10/25/93
METHOD: HSA	**CASE SIZE:** 2"	**BORING DIA.:** 8.25"	**PROTECTION LEVEL:** D
TOC ELEV.: 33.37 FT.	**MONITOR INST.:** FID	**TOT DPTH:** 38FT.	**DPTH TO ∇** 4.71 FT.
LOGGED BY: C. Goodwin	**WELL DEVELOPMENT DATE:** 11/17/93		**SITE:** Old Camden County Landfill

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS
				0	Fine sand, light brown		SP
				0	Fine sand, gray, changing to black to light brown to tan		
5				0	Fine sand, tan to white, becoming wet at 6-7 ft.		
					Fine sand, dark brown to black, saturated		
10				0	Fine sand, dark brown to black		
15				0	Fine sand, same as above		
20				0	Fine sand, same as above		
25							

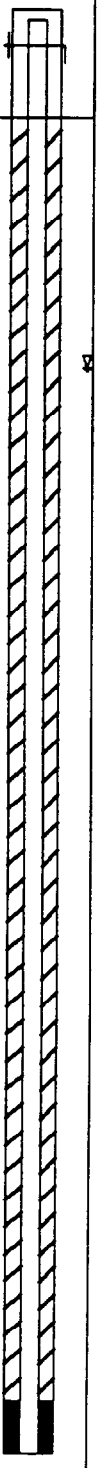


 ABB ENVIRONMENTAL SERVICES, INC.

TITLE: NSB KINGS BAY		**LOG of WELL:**	**BORING NO.** KBA-PS-05
CLIENT: U.S. NAVY			**PROJECT NO:** 8503-03
CONTRACTOR: Alliance Environmental Inc.		**DATE STARTED:** 10/25/93	**COMPLTD:** 10/25/93
METHOD: HSA	**CASE SIZE:** 2"	**BORING DIA.:** 8.25"	**PROTECTION LEVEL:** D
TOC ELEV.: 33.37 FT.	**MONITOR INST.:** FID	**TOT DPTH:** 38FT.	**DPTH TO ∇** 4.71 FT.
LOGGED BY: C. Goodwin	**WELL DEVELOPMENT DATE:** 11/17/93		**SITE:** Old Camden County Landfill

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS
					Continued from PAGE 1		
				0	Fine sand, same as above; liquid sand		SP
30				0	Fine sand, grayish green		
35				0	Fine sand, same as above		
					total depth = 38 ft.		
40							
45							
50							

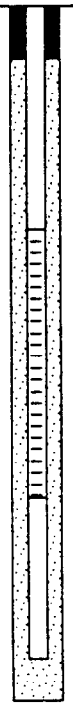


 ABB ENVIRONMENTAL SERVICES, INC.

TITLE: NSB KINGS BAY		**LOG of WELL:**	**BORING NO.** KBA-PD-06
CLIENT: U.S. NAVY			**PROJECT NO:** 8503-03
CONTRACTOR: Alliance Environmental Inc.		**DATE STARTED:** 11/18/93	**COMPLTD:** 11/18/93
METHOD: Rotosonic	**CASE SIZE:** 2"	**BORING DIA.:** 8.25"	**PROTECTION LEVEL:** D
TOC ELEV.: 33.35 FT.	**MONITOR INST.:** FID	**TOT DPTH:** 72FT.	**DPTH TO ∇** 7.21 FT.
LOGGED BY: C. Goodwin	**WELL DEVELOPMENT DATE:** 11/21/93		**SITE:** Old Camden County Landfill

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS
				0	Fine sand brown		SP
5							
				0	Fine sand, grayish white		
10							
15							
				0	Fine sand, light brown		
20							
25							

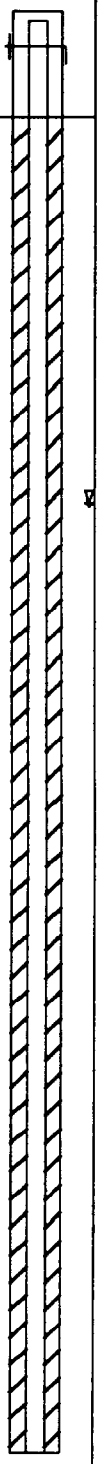


ABB ENVIRONMENTAL SERVICES, INC.

TITLE: NSB KINGS BAY		**LOG of WELL:**	**BORING NO.** KBA-PD-06
CLIENT: U.S. NAVY			**PROJECT NO:** 8503-03
CONTRACTOR: Alliance Environmental Inc.		**DATE STARTED:** 11/18/93	**COMPLTD:** 11/18/93
METHOD: Rotosonic	**CASE SIZE:** 2"	**BORING DIA.:** 8.25"	**PROTECTION LEVEL:** D
TOC ELEV.: 33.35 FT.	**MONITOR INST.:** FID	**TOT DPTH:** 72FT.	**DPTH TO ∇** 7.21 FT.
LOGGED BY: C. Goodwin	**WELL DEVELOPMENT DATE:** 11/21/93		**SITE:** Old Camden County Landfill

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS
					Continued from PAGE 1		
							SP
30							
35							
				0	Fine sand, gray, moist		
40							
				0			
				0	Clay, gray w/silt		CL
					Fine sand, gray w/clay lenses		SP
45							
50							

 ABB ENVIRONMENTAL SERVICES, INC.

TITLE: NSB KINGS BAY		**LOG of WELL:**	**BORING NO.** KBA-PD-06
CLIENT: U.S. NAVY			**PROJECT NO:** 8503-03
CONTRACTOR: Alliance Environmental Inc.		**DATE STARTED:** 11/16/93	**COMPLTD:** 11/16/93
METHOD: Rotosonic	**CASE SIZE:** 2"	**BORING DIA.:** 8.25"	**PROTECTION LEVEL:** D
TOC ELEV.: 33.35 FT.	**MONITOR INST.:** FID	**TOT DPTH:** 72FT.	**DPTH TO ∇** 7.21 FT.
LOGGED BY: C. Goodwin	**WELL DEVELOPMENT DATE:** 11/21/93		**SITE:** Old Camden County Landfill

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS
					Continued from PAGE 2		
							SP
				0			
				0	Clay, gray w/silt		CL
					Fine sand, gray		SP
55							
				0	Clayey sand, gray w/silt and clay lenses		SC
60							
65				0			
				0	Clay, gray		CL
					Clayey sand, gray w/silt		SC
				0	Fine sand		SP
70							
					total depth = 72 ft.		
75							

 ABB ENVIRONMENTAL SERVICES, INC.

TITLE: NSB KINGS BAY		**LOG of WELL:**	**BORING NO.** KBA-PS-07
CLIENT: U.S. NAVY			**PROJECT NO:** 8503-03
CONTRACTOR: Alliance Environmental Inc.		**DATE STARTED:** 11/4/93	**COMPLTD:** 11/4/93
METHOD: HSA	**CASE SIZE:** 2"	**BORING DIA.:** 8.25"	**PROTECTION LEVEL:** D
GROUND ELEV.: 28.20 FT.	**MONITOR INST.:** FID	**TOT DPTH:** 35FT.	**DPTH TO ∇** 3.74 FT.
LOGGED BY: C. Goodwin	**WELL DEVELOPMENT DATE:** 11/20/93		**SITE:** Old Camden County Landfill

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
				0	Fine sand, light gray to white		SP		
				0	Fine sand, as above with yellow-brown becoming dark brown to black				
5									
10				0	Fine sand, as above, dark brown to black				
15				0	Fine sand, same as above				
20				0	Fine sand, yellowish brown				
25									

 ABB ENVIRONMENTAL SERVICES, INC.

TITLE: NSB KINGS BAY		**LOG of WELL:**	**BORING NO.** KBA-PS-07
CLIENT: U.S. NAVY			**PROJECT NO:** 8503-03
CONTRACTOR: Alliance Environmental Inc.		**DATE STARTED:** 11/4/93	**COMPLTD:** 11/4/93
METHOD: HSA	**CASE SIZE:** 2"	**BORING DIA.:** 8.25"	**PROTECTION LEVEL:** D
GROUND ELEV.: 28.20 FT.	**MONITOR INST.:** FID	**TOT DPTH:** 35FT.	**DPTH TO ∇** 3.74 FT.
LOGGED BY: C. Goodwin	**WELL DEVELOPMENT DATE:** 11/20/93		**SITE:** Old Camden County Landfill

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
					Continued from PAGE 1				
				0	Fine sand, as above, yellowish brown to greenish gray		SP		
30				0	Fine sand, same as above				
35					total depth = 35 ft.				
40									
45									
50									

 ABB ENVIRONMENTAL SERVICES, INC.

TITLE: NSB KINGS BAY		**LOG of WELL:**	**BORING NO.** KBA-PD-08
CLIENT: U.S. NAVY			**PROJECT NO:** 8503-03
CONTRACTOR: Alliance Environmental Inc.		**DATE STARTED:** 11/22/93	**COMPLTD:** 11/22/93
METHOD: Rotosonic	**CASE SIZE:** 2"	**BORING DIA.:** 8.25"	**PROTECTION LEVEL:** D
GROUND ELEV.: 28.53 FT.	**MONITOR INST.:** FID	**TOT DPTH:** 57FT.	**DPTH TO ∇** 3.54 FT.
LOGGED BY: C. Goodwin	**WELL DEVELOPMENT DATE:** 11/24/93		**SITE:** Old Camden County Landfill

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
				0	Fine sand, brown to light gray		SP		
5									
					Fine sand, dark brown				
10									
				10					
				20	Fine sand, brown				
15									
				10	Fine sand, brown				
20									
25									

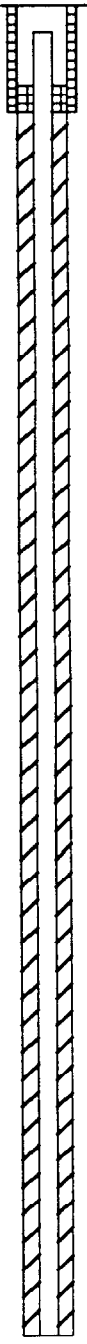


ABB ENVIRONMENTAL SERVICES, INC.

TITLE: NSB KINGS BAY		**LOG of WELL:**	**BORING NO.** KBA-PD-08
CLIENT: U.S. NAVY			**PROJECT NO:** 8503-03
CONTRACTOR: Alliance Environmental Inc.		**DATE STARTED:** 11/22/93	**COMPLTD:** 11/22/93
METHOD: Rotosonic	**CASE SIZE:** 2"	**BORING DIA.:** 8.25"	**PROTECTION LEVEL:** D
GROUND ELEV.: 28.53 FT.	**MONITOR INST.:** FID	**TOT DPTH:** 57FT.	**DPTH TO ∇** 3.54 FT.
LOGGED BY: C. Goodwin	**WELL DEVELOPMENT DATE:** 11/24/93		**SITE:** Old Camden County Landfill

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS Continued from PAGE 1	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
					Fine sand, as above, saturated		SP		
				40					
				15	Fine sand, gray				
30									
35									
				17	Fine sand, same as above				
40									
45									
				0	Fine sand, gray w/gray clay lenses				
50									

 ABB ENVIRONMENTAL SERVICES, INC.

TITLE: NSB KINGS BAY		**LOG of WELL:**	**BORING NO.** KBA-PD-08
CLIENT: U.S. NAVY			**PROJECT NO:** 8503-03
CONTRACTOR: Alliance Environmental Inc.		**DATE STARTED:** 11/22/93	**COMPLTD:** 11/22/93
METHOD: Rotosonic	**CASE SIZE:** 2"	**BORING DIA.:** 8.25"	**PROTECTION LEVEL:** D
GROUND ELEV.: 28.53 FT.	**MONITOR INST.:** FID	**TOT DPTH:** 57FT.	**DPTH TO ∇** 3.54 FT.
LOGGED BY: C. Goodwin	**WELL DEVELOPMENT DATE:** 11/24/93		**SITE:** Old Camden County Landfill

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
					Continued from PAGE 2				
							SP		
				0	Clay, gray		CL		
					Fine sand, gray		SP		
55									
					total depth = 57 ft.				
60									
65									
70									
75									

 ABB ENVIRONMENTAL SERVICES, INC.

TITLE: NSB KINGS BAY		**LOG of WELL:**	**BORING NO.** KBA-PS-09
CLIENT: U.S. NAVY			**PROJECT NO:** 8503-03
CONTRACTOR: Alliance Environmental Inc.		**DATE STARTED:** 11/3/93	**COMPLTD:** 11/3/93
METHOD: Rotosonic	**CASE SIZE:** 2"	**BORING DIA.:** 8.25"	**PROTECTION LEVEL:** D
GROUND ELEV.: 28.72 FT.	**MONITOR INST.:** FID	**TOT DPTH:** 35FT.	**DPTH TO ∇** 3.7 FT.
LOGGED BY: C. Goodwin	**WELL DEVELOPMENT DATE:** 11/20/93		**SITE:** Old Camden County Landfill

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
				0	Fine sand, brown gray to tan, wet at 3.5 ft.		SP		
				0	Fine sand, yellow to white grading dark brown to black, saturated				
5									
10				0					
15	SBPS915			0	Fine sand, yellow-brown, trace cemented brown sand			6,12,12,10	
				0	Fine sand, same as above				
20									
25	SBPS925			0				3,3,4,6	

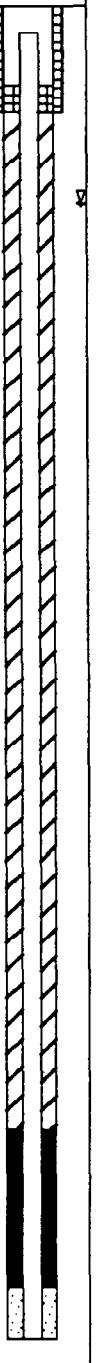


ABB ENVIRONMENTAL SERVICES, INC.

TITLE: NSB KINGS BAY		**LOG of WELL:**	**BORING NO.** KBA-PS-09
CLIENT: U.S. NAVY			**PROJECT NO:** 8503-03
CONTRACTOR: Alliance Environmental Inc.		**DATE STARTED:** 11/3/93	**COMPLTD:** 11/3/93
METHOD: Rotosonic	**CASE SIZE:** 2"	**BORING DIA.:** 8.25"	**PROTECTION LEVEL:** D
GROUND ELEV.: 28.72 FT.	**MONITOR INST.:** FID	**TOT DPTH:** 35FT.	**DPTH TO ∇** 3.7 FT.
LOGGED BY: C. Goodwin	**WELL DEVELOPMENT DATE:** 11/20/93		**SITE:** Old Camden County Landfill

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS Continued from PAGE 1	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
					Fine sand, brown w/some traces of clay; yellow with brown		SP		
				0	Fine sand, yellow-brown w/trace clay				
30									
35					total depth = 35 ft.				
40									
45									
50									

 ABB ENVIRONMENTAL SERVICES, INC.

TITLE: NSB KINGS BAY		**LOG of WELL:**	**BORING NO.** KBA-PS-10
CLIENT: U.S. NAVY			**PROJECT NO:** 8503-03
CONTRACTOR: Alliance Environmental Inc.		**DATE STARTED:** 11/19/93	**COMPLTD:** 11/19/93
METHOD: Rotosonic	**CASE SIZE:** 2"	**BORING DIA.:** 8.25"	**PROTECTION LEVEL:** D
GROUND ELEV.: 30.54 FT.	**MONITOR INST.:** FID	**TOT DPTH:** 35FT.	**DPTH TO ∇** 5.1 FT.
LOGGED BY: C. Goodwin	**WELL DEVELOPMENT DATE:** 11/20/93		**SITE:** Old Camden County Landfill

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
				0	Fine sand, dark brown to yellow brown		SP		
				0	Fine sand, yellow brown				
5				0	Fine sand, white, w/trace medium grains, saturated, color grading to dark brown				
10				0	Fine sand, dark brown, saturated				
15	SBS01015			0	Fine sand, yellow brown			9,7,7,8	
				0	Fine sand, same as above				
20									
25	SBS01025			0					

ABB ENVIRONMENTAL SERVICES, INC.

TITLE: NSB KINGS BAY		**LOG of WELL:**	**BORING NO.** KBA-PS-10
CLIENT: U.S. NAVY			**PROJECT NO:** 8503-03
CONTRACTOR: Alliance Environmental Inc.		**DATE STARTED:** 11/19/93	**COMPLTD:** 11/19/93
METHOD: Rotosonic	**CASE SIZE:** 2"	**BORING DIA.:** 8.25"	**PROTECTION LEVEL:** D
GROUND ELEV.: 30.54 FT.	**MONITOR INST.:** FID	**TOT DPTH:** 35FT.	**DPTH TO ∇** 5.1 FT.
LOGGED BY: C. Goodwin	**WELL DEVELOPMENT DATE:** 11/20/93		**SITE:** Old Camden County Landfill

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
					Continued from PAGE 1				
			0"				SP		
30									
35					total depth = 35 ft.				
40									
45									
50									

ABB ENVIRONMENTAL SERVICES, INC.

TITLE: NSB KINGS BAY		**LOG of WELL:** KBA-RW-01	**BORING NO.** SBRW1
CLIENT: U.S. NAVY			**PROJECT NO:** 8503-03
CONTRACTOR: Alliance Environmental Inc.		**DATE STARTED:** 10/21/93	**COMPLTD:** 10/22/93
METHOD: MUD ROTARY	**CASE SIZE:** 8.25"	**BORING DIA.:** 12"	**PROTECTION LEVEL:** D
GROUND ELEV.: 32.8 FT.	**MONITOR INST.:** FID	**TOT DPTH:** 87FT.	**DPTH TO ▽** 6.47 FT.
LOGGED BY: H. Faircloth	**WELL DEVELOPMENT DATE:**		**SITE:** Camden County Landfill

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
				0			SP		
5	SBRW105		14"	0	Fine sand, grayish brown (buff), loose			4,4,6,8	
10	SBRW110		18"	0	Fine sand, black to brown, dense, trace of silt, slight sulfur odor			9,14,18,18	
15	SBRW115		18"	2	Fine sand, grayish brown, very dense Fine sand, black to brown, organic, has slight mottling			24,50,50,45	
20	SBRW120		14"	310	Fine sand, brown, medium dense			7,8,7,10	
25									

ABB ENVIRONMENTAL SERVICES, INC.

TITLE: NSB KINGS BAY		**LOG of WELL:** KBA-RW-01	**BORING NO.** SBRW1
CLIENT: U.S. NAVY			**PROJECT NO:** 8503-03
CONTRACTOR: Alliance Environmental Inc.		**DATE STARTED:** 10/21/93	**COMPLTD:** 10/22/93
METHOD: MUD ROTARY	**CASE SIZE:** 6.25"	**BORING DIA.:** 12"	**PROTECTION LEVEL:** D
GROUND ELEV.: 32.8 FT.	**MONITOR INST.:** FID	**TOT DPTH:** 67FT.	**DPTH TO ∇** 6.47 FT.
LOGGED BY: H. Faircloth	**WELL DEVELOPMENT DATE:**		**SITE:** Camden County Landfill

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS Continued from PAGE 1	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
							SP		
30	SBRW130		22"	2	Fine sand, gray brown, medium dense Grain Size Analysis:, #200 - 99.0%, #100 - 53.1%, #80 - 23.5%, #40 - 2.1%, #20 - 0.4%, #10 - 0.0%			11,13,16,22	
35	SBRW135		22"	0	Fine sand, brown, dense Fine sand, dark gray			10,16,16,24	
40									
45	SBRW145		24"	30	Fine sand, medium gray, very dense			13,28,44,50	
50									

ABB ENVIRONMENTAL SERVICES, INC.

TITLE: NSB KINGS BAY		**LOG of WELL:** KBA-RW-01	**BORING NO.** SBRW1
CLIENT: U.S. NAVY			**PROJECT NO:** 8503-03
CONTRACTOR: Alliance Environmental Inc.		**DATE STARTED:** 10/21/93	**COMPLTD:** 10/22/93
METHOD: MUD ROTARY	**CASE SIZE:** 8.25"	**BORING DIA.:** 12"	**PROTECTION LEVEL:** D
GROUND ELEV.: 32.8 FT.	**MONITOR INST.:** FID	**TOT DPTH:** 87FT.	**DPTH TO ∇** 8.47 FT.
LOGGED BY: H. Faircloth	**WELL DEVELOPMENT DATE:**		**SITE:** Camden County Landfill

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
					Continued from PAGE 2				
	SBRW150		7"	0	Fine sand, medium gray, dense		SP	14,24,24,25	
55									
	SBRW157		12"	1	Fine sand, medium gray, medium dense			8,12,12,15	
60									
	SBRW163		17"	0	Fine sand, medium gray, dense			17,17,18,22	
65									
					total depth = 87 ft.				
70									
75									

 ABB ENVIRONMENTAL SERVICES, INC.

TITLE: NSB KINGS BAY		**LOG of WELL:** KBA-RW-02	**BORING NO.** SBRW2
CLIENT: U.S. NAVY			**PROJECT NO:** 8503-03
CONTRACTOR: Alliance Environmental Inc.		**DATE STARTED:** 11/5/93	**COMPLTD:** 11/6/93
METHOD: MUD ROTARY	**CASE SIZE:** 6.25"	**BORING DIA.:** 12"	**PROTECTION LEVEL:** D
GROUND ELEV.: 30.11 FT.	**MONITOR INST.:** FID	**TOT DPTH:** 78FT.	**DPTH TO ∇** 5.49 FT.
LOGGED BY: H. Faircloth	**WELL DEVELOPMENT DATE:**		**SITE:** Camden County Landfill

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN
							SP	
5	SBRW205		13"	0	Fine sand, light gray, loose to medium dense			3,6,7,8
10	SBRW210		12"	0	Fine sand, dark brown, organic, dense			10,18,22,25
15								
20	SBRW220		18"	0	Fine sand, brown, medium dense			7,7,7,7
25								

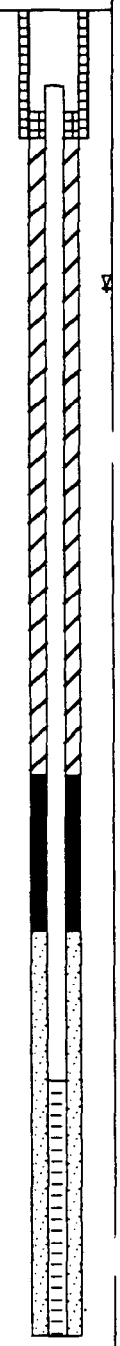


ABB ENVIRONMENTAL SERVICES, INC.

TITLE: NSB KINGS BAY		**LOG of WELL:** KBA-RW-02	**BORING NO.** SBRW2
CLIENT: U.S. NAVY			**PROJECT NO:** 8503-03
CONTRACTOR: Alliance Environmental Inc.		**DATE STARTED:** 11/5/93	**COMPLTD:** 11/8/93
METHOD: MUD ROTARY	**CASE SIZE:** 6.25"	**BORING DIA.:** 12"	**PROTECTION LEVEL:** D
GROUND ELEV.: 30.11 FT.	**MONITOR INST.:** FID	**TOT DPTH:** 78FT.	**DPTH TO ∇** 5.49 FT.
LOGGED BY: H. Faircloth	**WELL DEVELOPMENT DATE:**		**SITE:** Camden County Landfill

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
					Continued from PAGE 1				
							SP		
31									
	SBRW234		19"	0	Fine sand, brown to dark gray, dense			15,24,24,30	
36									
41									
	SBRW245		19"	0	Fine sand, gray to olive gray, dense to very dense			16,25,25,25	
46									
51									

ABB ENVIRONMENTAL SERVICES, INC.

TITLE: NSB KINGS BAY		**LOG of WELL:** KBA-RW-02	**BORING NO.** SBRW2
CLIENT: U.S. NAVY			**PROJECT NO:** 8503-03
CONTRACTOR: Alliance Environmental Inc.		**DATE STARTED:** 11/5/93	**COMPLTD:** 11/6/93
METHOD: MUD ROTARY	**CASE SIZE:** 6.25"	**BORING DIA.:** 12"	**PROTECTION LEVEL:** D
GROUND ELEV.: 30.11 FT.	**MONITOR INST.:** FID	**TOT DPTH:** 76FT.	**DPTH TO ∇** 5.49 FT.
LOGGED BY: H. Faircloth	**WELL DEVELOPMENT DATE:**		**SITE:** Camden County Landfill

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
					Continued from PAGE 2				
							SP		
	SBRW254		19"	0	Fine sand, light gray, dense			15,14,22,33	
57									
62									
	SBRW265			0	Fine sand, gray, medium dense			10,15,13,17	
67									
72									
					total depth = 76 ft.				
77									

ABB ENVIRONMENTAL SERVICES, INC.

TITLE: NSB KINGS BAY		**LOG of WELL:** KBA-RW-03	**BORING NO.** SBRW3
CLIENT: U.S. NAVY			**PROJECT NO:** 8503-03
CONTRACTOR: Alliance Environmental Inc.		**DATE STARTED:** 11/8/93	**COMPLTD:** 11/9/93
METHOD: MUD ROTARY	**CASE SIZE:** 6.25"	**BORING DIA.:** 12"	**PROTECTION LEVEL:** D
GROUND ELEV.: 27.93 FT.	**MONITOR INST.:** OVA	**TOT DPTH:** 78FT.	**DPTH TO ∇** 3.39 FT.
LOGGED BY: H. Faircloth	**WELL DEVELOPMENT DATE:** 11/9/93		**SITE:** Camden County Landfill

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN
							SP	
5	SBRW305		13"	0	Fine sand, light gray, medium dense			6,13,10,8
10	SBRW310		14"	1	Fine sand, dark brown, very dense			23,28,38,42
15								
20	SBRW320		15"	7	Fine sand, light brown, loose to medium dense			4,5,8,9
25								

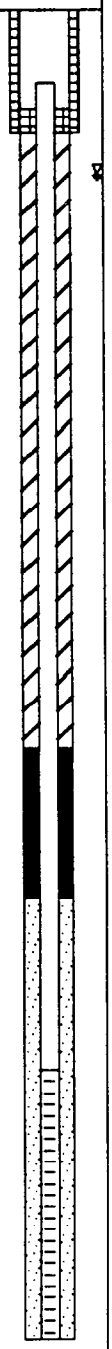


ABB ENVIRONMENTAL SERVICES, INC.

TITLE: NSB KINGS BAY		**LOG of WELL:** KBA-RW-03	**BORING NO.** SBRW3
CLIENT: U.S. NAVY			**PROJECT NO:** 8503-03
CONTRACTOR: Alliance Environmental Inc.		**DATE STARTED:** 11/8/93	**COMPLTD:** 11/9/93
METHOD: MUD ROTARY	**CASE SIZE:** 6.25"	**BORING DIA.:** 12"	**PROTECTION LEVEL:** D
GROUND ELEV.: 27.93 FT.	**MONITOR INST.:** OVA	**TOT DPTH:** 78FT.	**DPTH TO ∇** 3.39 FT.
LOGGED BY: H. Faircloth	**WELL DEVELOPMENT DATE:** 11/9/93		**SITE:** Camden County Landfill

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS Continued from PAGE 1	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
							SP		
	SBRW33			0	Fine sand, gray, dense			8,18,21,26	
32			18"						
37									
	SBRW34			0	Fine sand, gray w/some light brown mixed in, very dense			20,37,47,55	
			18"						
42									
47									
	SBRW35			0	Fine sand, light gray, medium dense			5,6,18,31	
52			20"						
					Sandy clay, gray - greenish, lense		SC		
							SP		

ABB ENVIRONMENTAL SERVICES, INC.

TITLE: NSB KINGS BAY		**LOG of WELL:** KBA-RW-03	**BORING NO.** SBRW3
CLIENT: U.S. NAVY			**PROJECT NO:** 8503-03
CONTRACTOR: Alliance Environmental Inc.		**DATE STARTED:** 11/8/93	**COMPLTD:** 11/8/93
METHOD: MUD ROTARY	**CASE SIZE:** 6.25"	**BORING DIA.:** 12"	**PROTECTION LEVEL:** D
GROUND ELEV.: 27.93 FT.	**MONITOR INST.:** OVA	**TOT DPTH:** 78FT.	**DPTH TO ∇** 3.39 FT.
LOGGED BY: H. Faircloth	**WELL DEVELOPMENT DATE:** 11/9/93		**SITE:** Camden County Landfill

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
					Continued from PAGE 2		SP		
59	SBRW380		14"	0	Fine sand, gray, very dense, small traces of clay			30,38,60,100	
64	SBRW380		18"	0	Fine sand, greenish gray, very dense			12,32,48,63	
69									
74									
79					total depth = 78 ft.				

 ABB ENVIRONMENTAL SERVICES, INC.

TITLE: NSB KINGS BAY	**LOG of WELL:** KBA-RW-04	**BORING NO.** SBRW4
CLIENT: U.S. NAVY		**PROJECT NO:** 8503-03
CONTRACTOR: Alliance Environmental Inc.	**DATE STARTED:** 11/16/93	**COMPLTD:**
METHOD: MUD ROTARY	**CASE SIZE:** 6.25" / **BORING DIA.:** 12"	**PROTECTION LEVEL:** D
GROUND ELEV.: 28.92 FT.	**MONITOR INST.:** FID / **TOT DPTH:** 73FT.	**DPTH TO ∇** 5.0 FT.
LOGGED BY: H. Faircloth	**WELL DEVELOPMENT DATE:** 11/17/93	**SITE:** Camden County Landfill

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
							SP		
5									
10									
15									
20									
25									

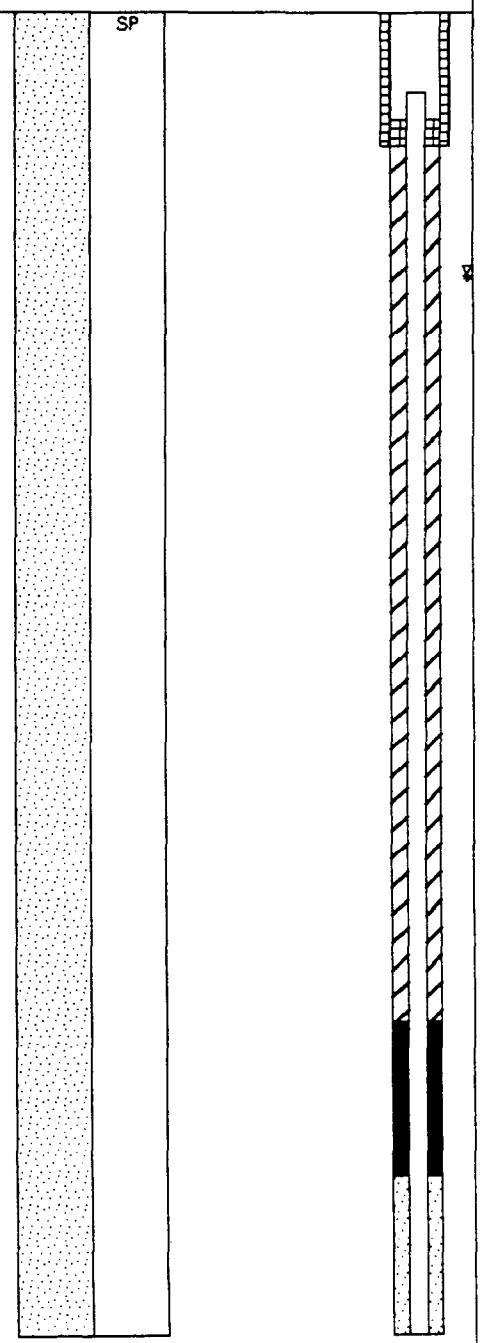


ABB ENVIRONMENTAL SERVICES, INC.

TITLE: NSB KINGS BAY		**LOG of WELL:** KBA-RW-04	**BORING NO.** SBRW4
CLIENT: U.S. NAVY			**PROJECT NO:** 8503-03
CONTRACTOR: Alliance Environmental Inc.		**DATE STARTED:** 11/18/93	**COMPLTD:**
METHOD: MUD ROTARY	**CASE SIZE:** 6.25"	**BORING DIA.:** 12"	**PROTECTION LEVEL:** D
GROUND ELEV.: 28.92 FT.	**MONITOR INST.:** FID	**TOT DPTH:** 73FT.	**DPTH TO ∇** 5.0 FT.
LOGGED BY: H. Faircloth	**WELL DEVELOPMENT DATE:** 11/17/93		**SITE:** Camden County Landfill

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS Continued from PAGE 1	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
							SP		
30	SBRW430		17"	0	Fine sand, brown, dense Fine sand, greenish gray			7,13,22,25	
35									
40	SBRW440		24"	0	Fine sand, brown, very dense			8,20,43,60	
45	SBRW445		17"	0	Fine sand, brown, loose to medium dense, traces of clay			5,5,10,13	
50									

ABB ENVIRONMENTAL SERVICES, INC.

TITLE: NSB KINGS BAY		**LOG of WELL:** KBA-RW-04	**BORING NO.** SBRW4
CLIENT: U.S. NAVY			**PROJECT NO:** 8503-03
CONTRACTOR: Alliance Environmental Inc.		**DATE STARTED:** 11/18/93	**COMPLTD:**
METHOD: MUD ROTARY	**CASE SIZE:** 6.25"	**BORING DIA.:** 12"	**PROTECTION LEVEL:** D
GROUND ELEV.: 28.92 FT.	**MONITOR INST.:** FID	**TOT DPTH:** 73FT.	**DPTH TO ∇** 5.0 FT.
LOGGED BY: H. Faircloth	**WELL DEVELOPMENT DATE:** 11/17/93		**SITE:** Camden County Landfill

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
					Continued from PAGE 2		SP		
	SBRW453		18"	0	Fine sand, brown, medium dense			8,12,16,19	
					Fine sand, gray, traces of clay				
55									
60	SBRW460		17"	0	Fine sand, gray-brown, dense, traces of clay			10,18,21,21	
					Clay, olive gray, lense		CL		
							SP		
65									
70									
					total depth = 73 ft.				
75									

 ABB ENVIRONMENTAL SERVICES, INC.

TITLE: NSB KINGS BAY		**LOG of WELL:** KBA-RW-05	**BORING NO.** SBRW5
CLIENT: U.S. NAVY			**PROJECT NO:** 8503-03
CONTRACTOR: Alliance Environmental Inc.		**DATE STARTED:** 10/26/93	**COMPLTD:** 10/26/93
METHOD: MUD ROTARY	**CASE SIZE:** 6.25"	**BORING DIA.:** 12"	**PROTECTION LEVEL:** D
GROUND ELEV.: 30.25 FT.	**MONITOR INST.:** FID	**TOT DPTH:** 32FT.	**DPTH TO ∇** 4.54 FT.
LOGGED BY: H. Faircloth	**WELL DEVELOPMENT DATE:** 10/27/93		**SITE:** Camden County Landfill

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
					Lithology as described for KBA-RW-2		SP		
5					Fine sand, light gray, loose to medium dense				
10					Fine sand, dark brown, organic, dense				
15									
20					Fine sand, brown, medium dense				
25									

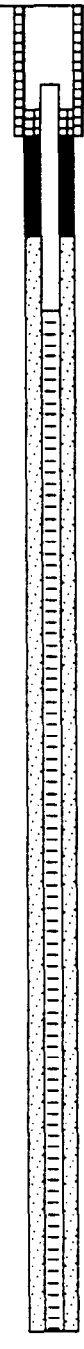


ABB ENVIRONMENTAL SERVICES, INC.

TITLE: NSB KINGS BAY		**LOG of WELL:** KBA-RW-05	**BORING NO.** SBRW5
CLIENT: U.S. NAVY			**PROJECT NO:** 8503-03
CONTRACTOR: Alliance Environmental Inc.		**DATE STARTED:** 10/26/93	**COMPLTD:** 10/26/93
METHOD: MUD ROTARY	**CASE SIZE:** 6.25"	**BORING DIA.:** 12"	**PROTECTION LEVEL:** D
GROUND ELEV.: 30.25 FT.	**MONITOR INST.:** FID	**TOT DPTH:** 32FT.	**DPTH TO ∇** 4.54 FT.
LOGGED BY: H. Faircloth	**WELL DEVELOPMENT DATE:** 10/27/93		**SITE:** Camden County Landfill

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
					Continued from PAGE 1		SP		
31									
					total depth = 32 ft.				
36									
41									
46									
51									

 ABB ENVIRONMENTAL SERVICES, INC.

APPENDIX B

Grain Size Distribution Curves

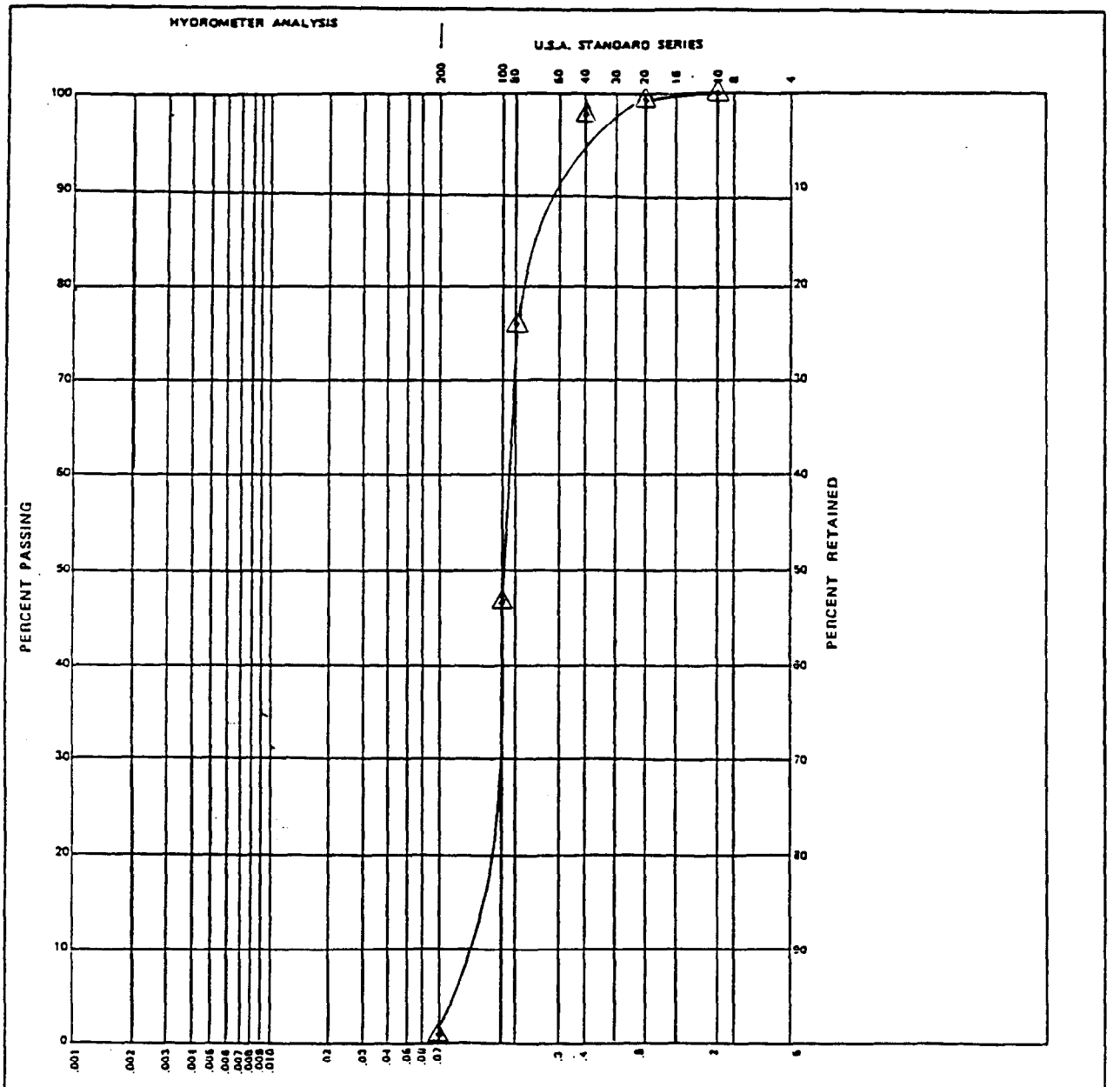
PARTICLE SIZE ANALYSIS

PROJECT DESCRIPTION: NSB Kings Bay

MATERIALS LABORATORY: CH2M Hill

SAMPLE LOCATION: KBA-RW-1 SAMPLE NO. SBRW130

TYPE OF SAMPLE: Soil



SAMPLE CLASSIFICATION Fine Sand

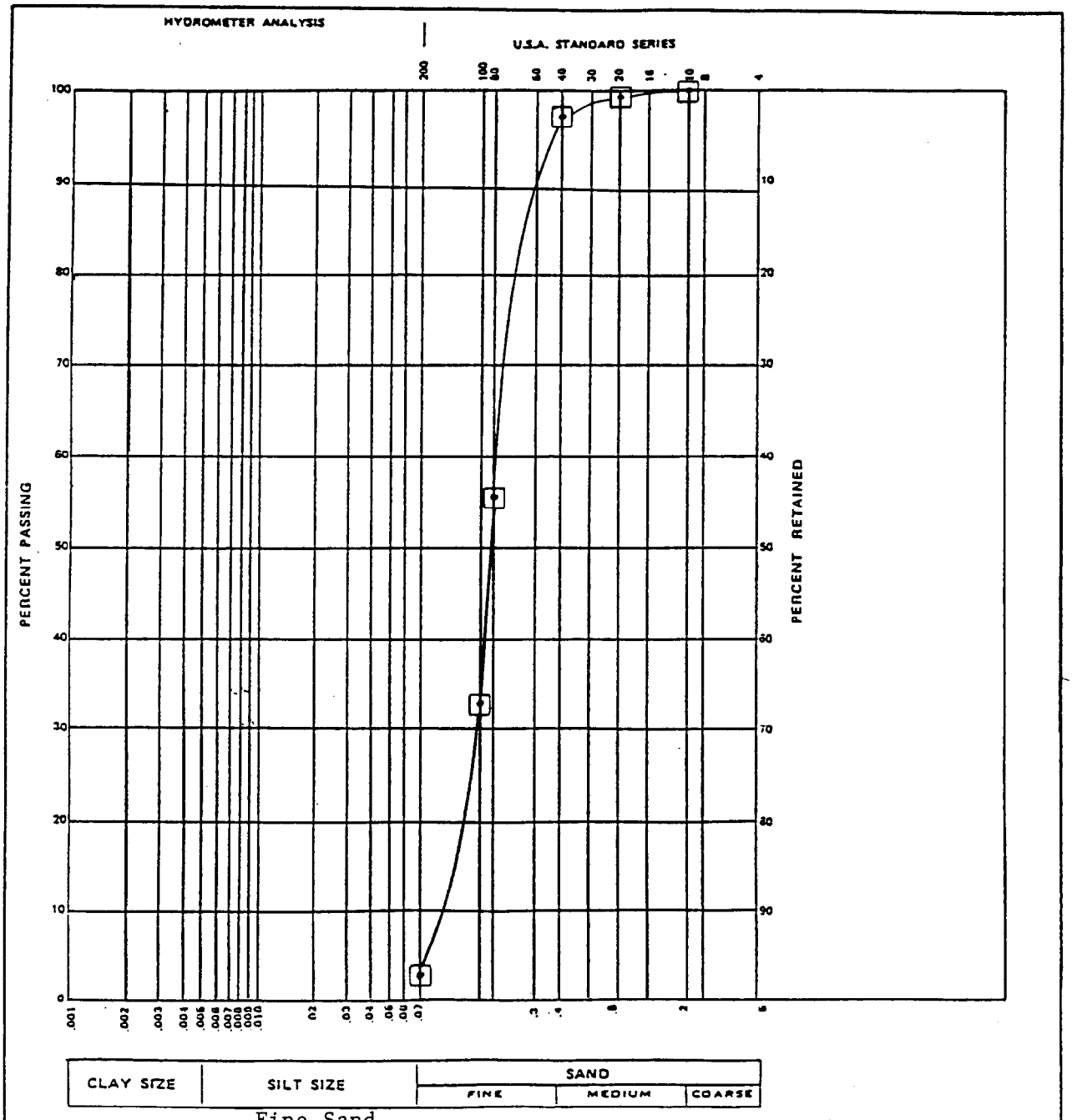
PARTICLE SIZE ANALYSIS

PROJECT DESCRIPTION: NSB Kings Bay

MATERIALS LABORATORY: CH2M Hill

SAMPLE LOCATION: KBA-RW-1 SAMPLE NO. SBRW150

TYPE OF SAMPLE: Soil



SAMPLE CLASSIFICATION Fine Sand

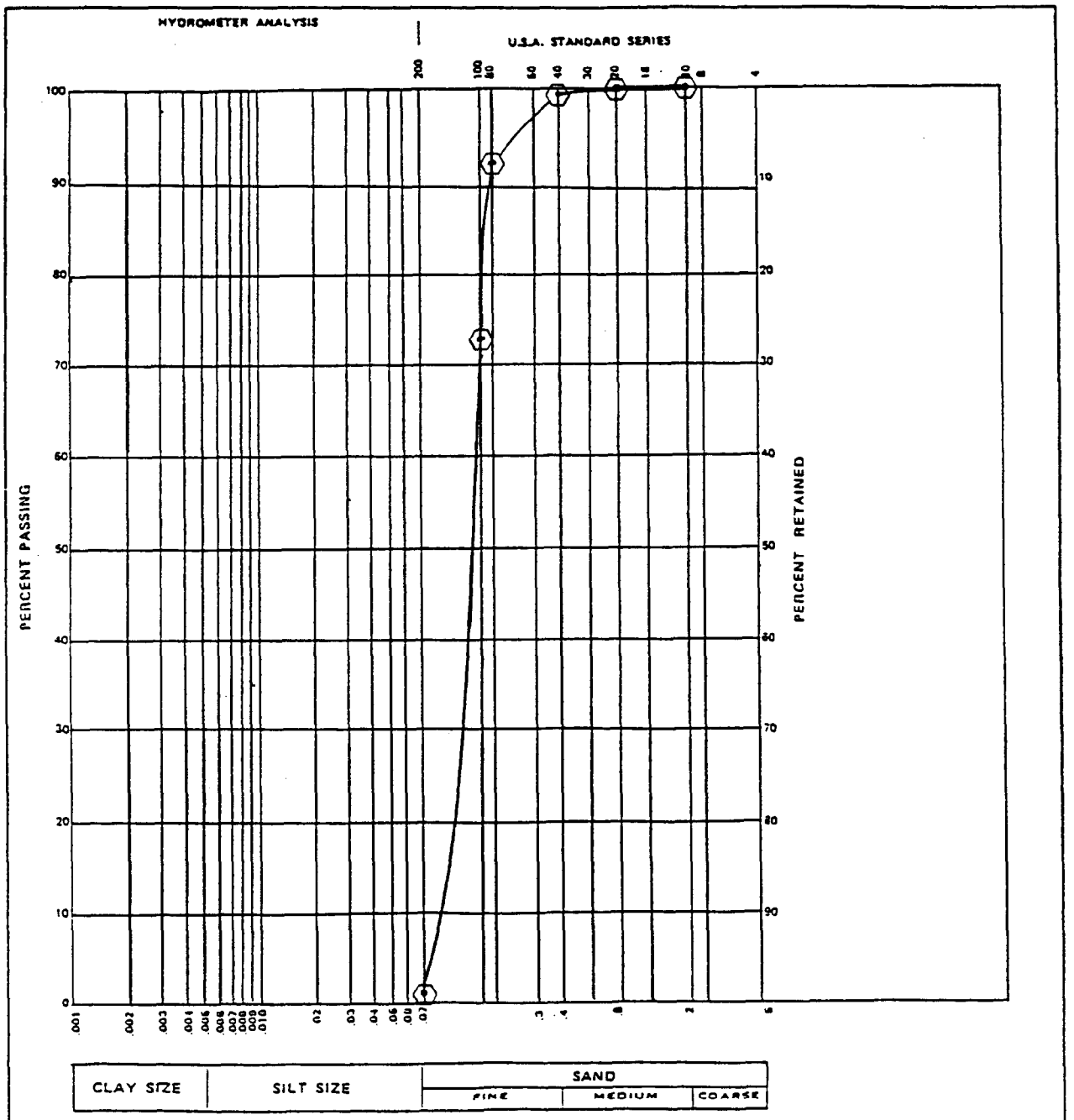
PARTICLE SIZE ANALYSIS

PROJECT DESCRIPTION: NSB Kings Bay

MATERIALS LABORATORY: CH2M Hill

SAMPLE LOCATION: KBA-RW-2 SAMPLE NO. SBRW220

TYPE OF SAMPLE: Soil



SAMPLE CLASSIFICATION Fine Sand

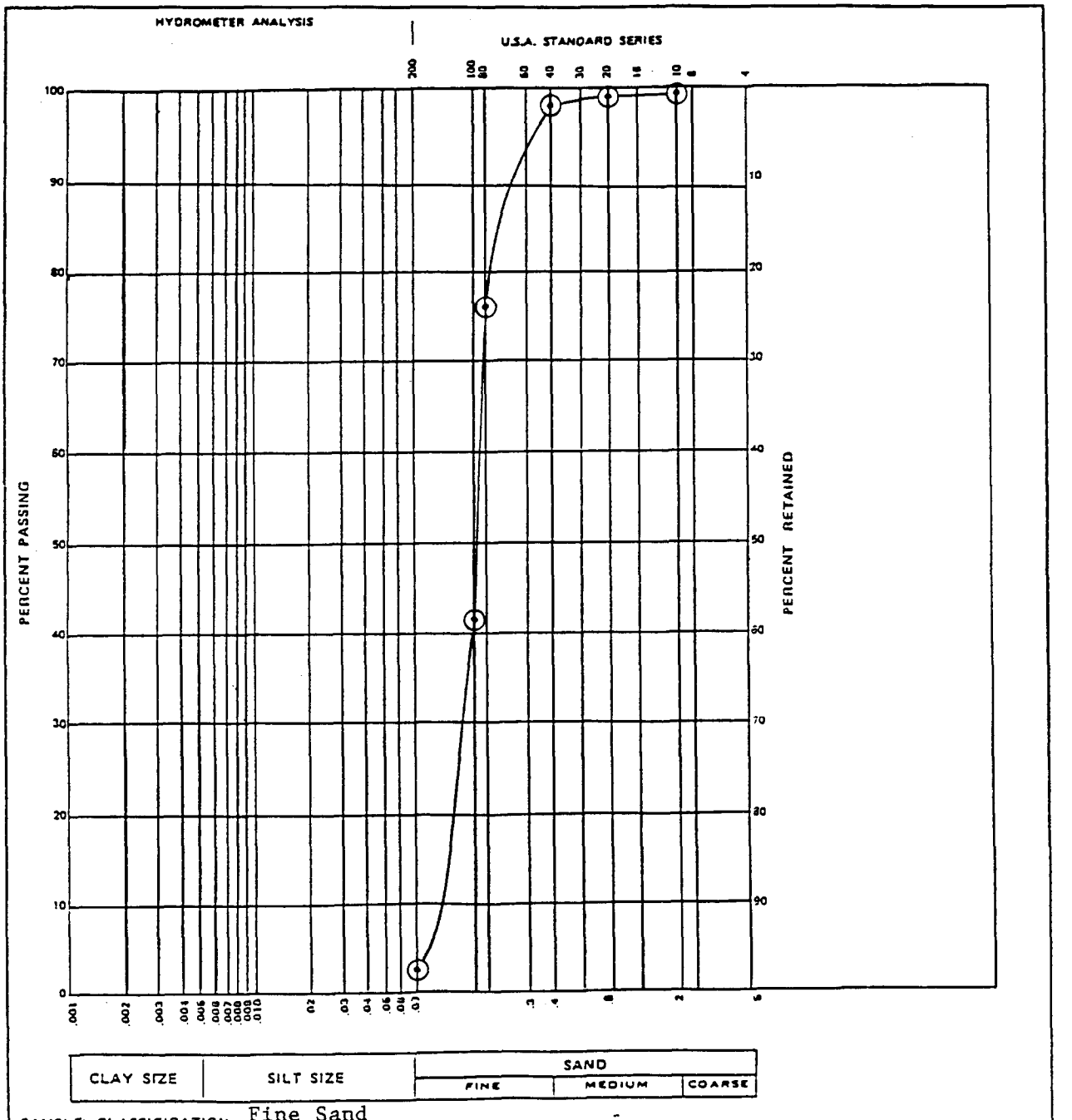
PARTICLE SIZE ANALYSIS

PROJECT DESCRIPTION: NSB Kings Bay

MATERIALS LABORATORY: CH2M Hill

SAMPLE LOCATION: KBA-RW-2 SAMPLE NO. SBRW245

TYPE OF SAMPLE: Soil



SAMPLE CLASSIFICATION Fine Sand

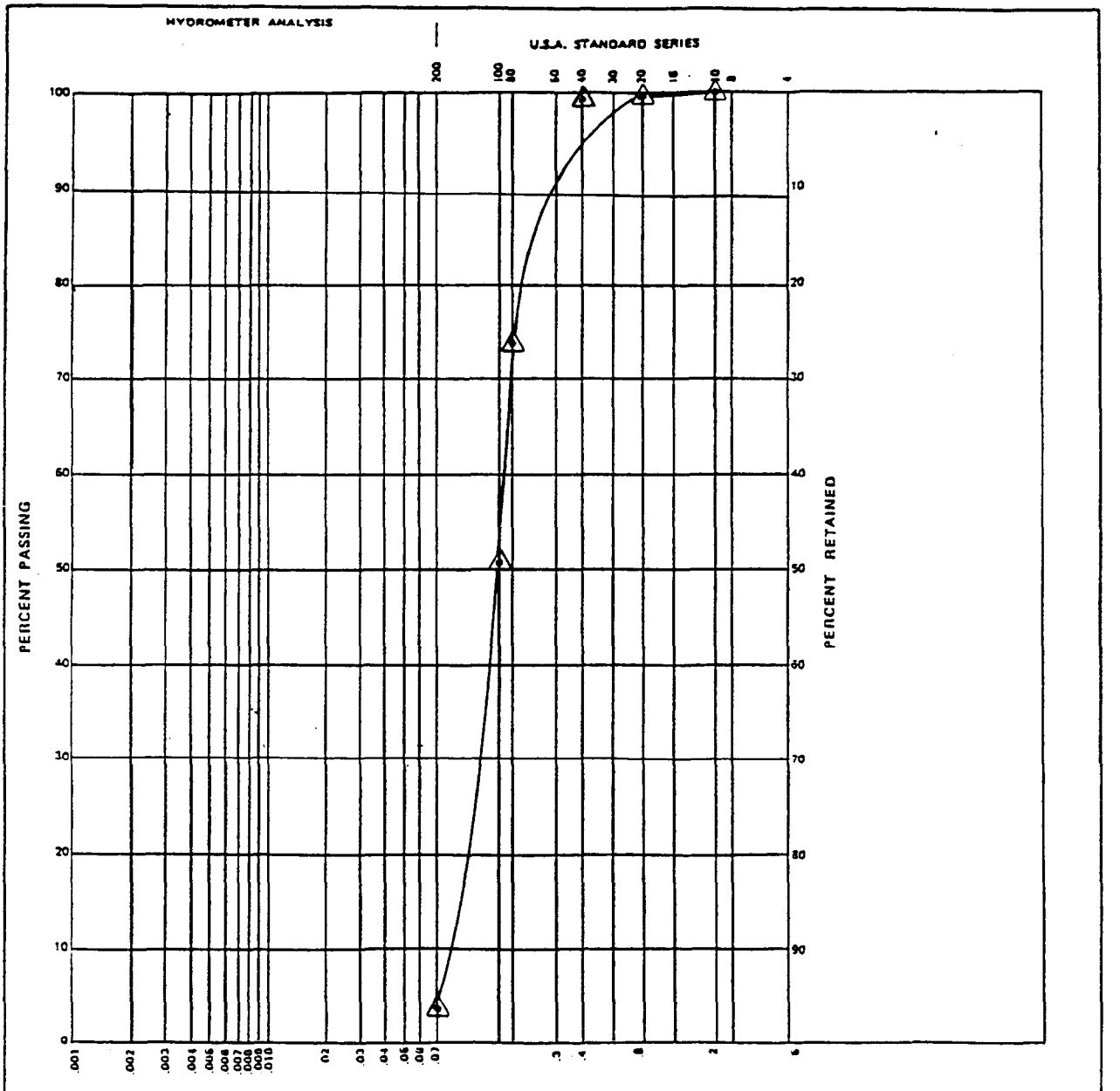
PARTICLE SIZE ANALYSIS

PROJECT DESCRIPTION: NSB Kings Bay

MATERIALS LABORATORY: CH2M Hill

SAMPLE LOCATION: KBA-RW-2 SAMPLE NO. SBRW265

TYPE OF SAMPLE: Soil



SAMPLE CLASSIFICATION Fine Sand

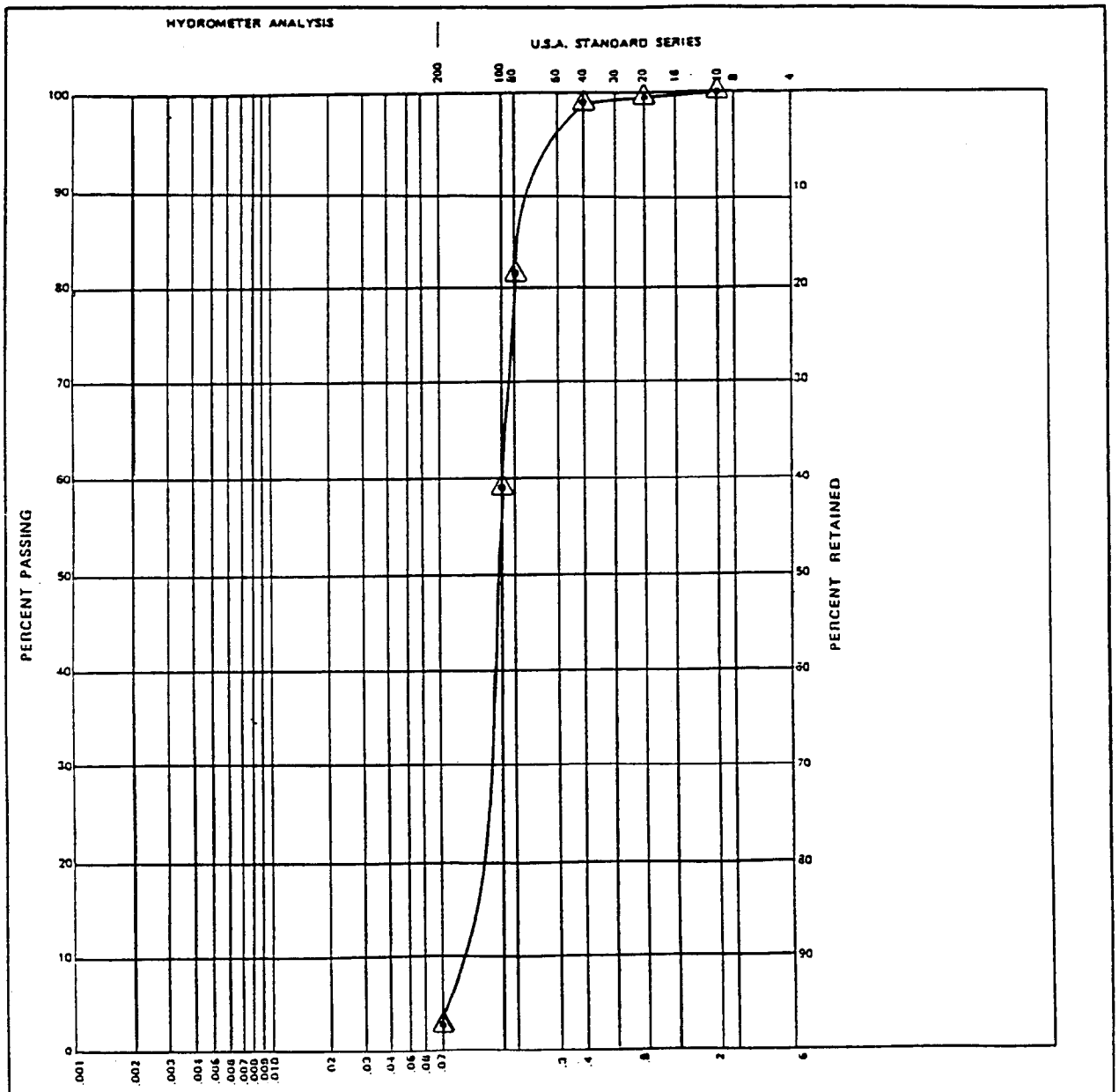
PARTICLE SIZE ANALYSIS

PROJECT DESCRIPTION: NSB Kings Bay

MATERIALS LABORATORY: CH2M Hill

SAMPLE LOCATION: KBA-RW-3 SAMPLE NO. SBRW340

TYPE OF SAMPLE: Soil



SAMPLE CLASSIFICATION Fine Sand

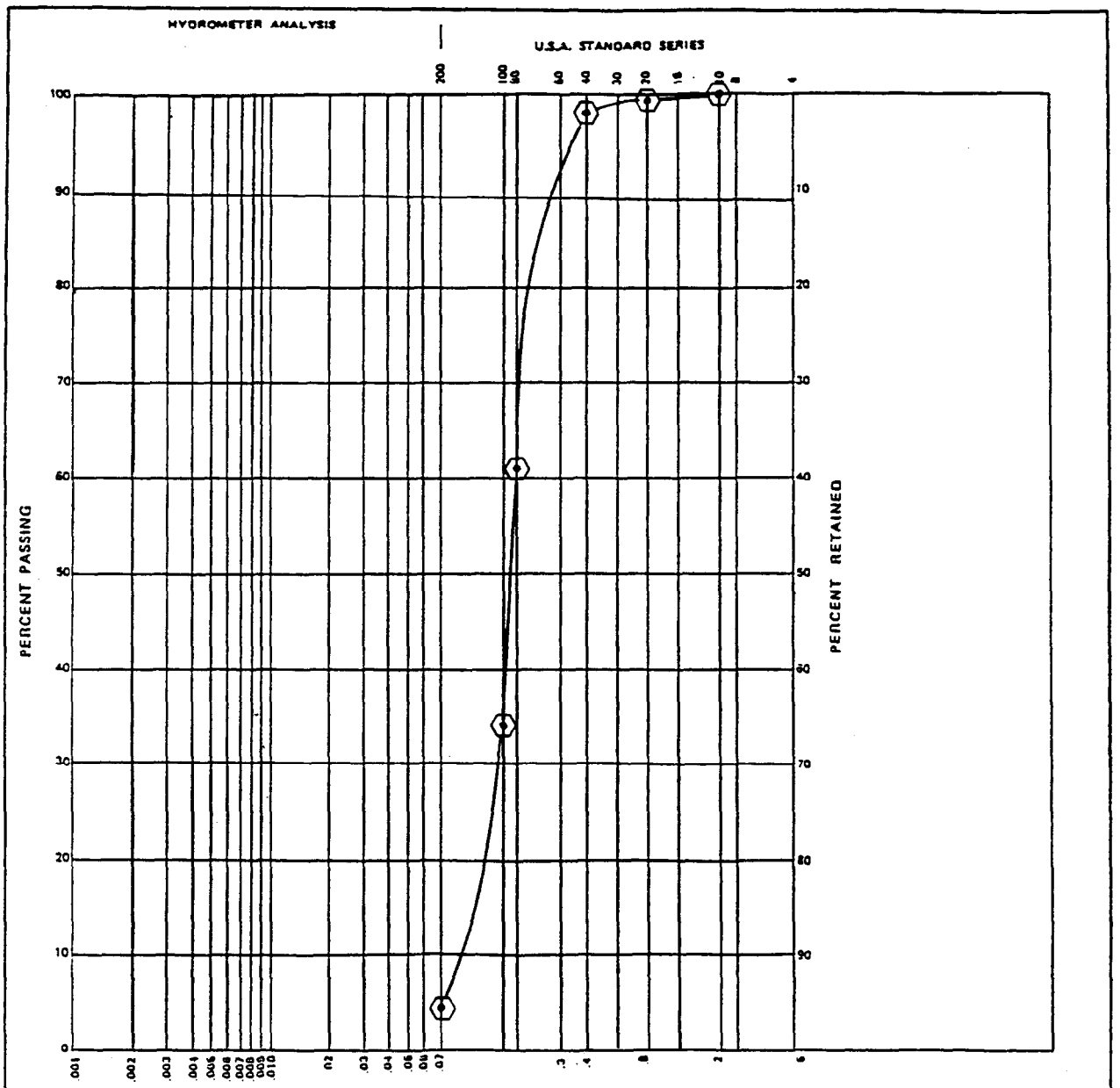
PARTICLE SIZE ANALYSIS

PROJECT DESCRIPTION: NSB Kings Bay

MATERIALS LABORATORY: CH2M Hill

SAMPLE LOCATION: KBA-RW-3 SAMPLE NO. SBRW360

TYPE OF SAMPLE: Soil



SAMPLE CLASSIFICATION Fine Sand

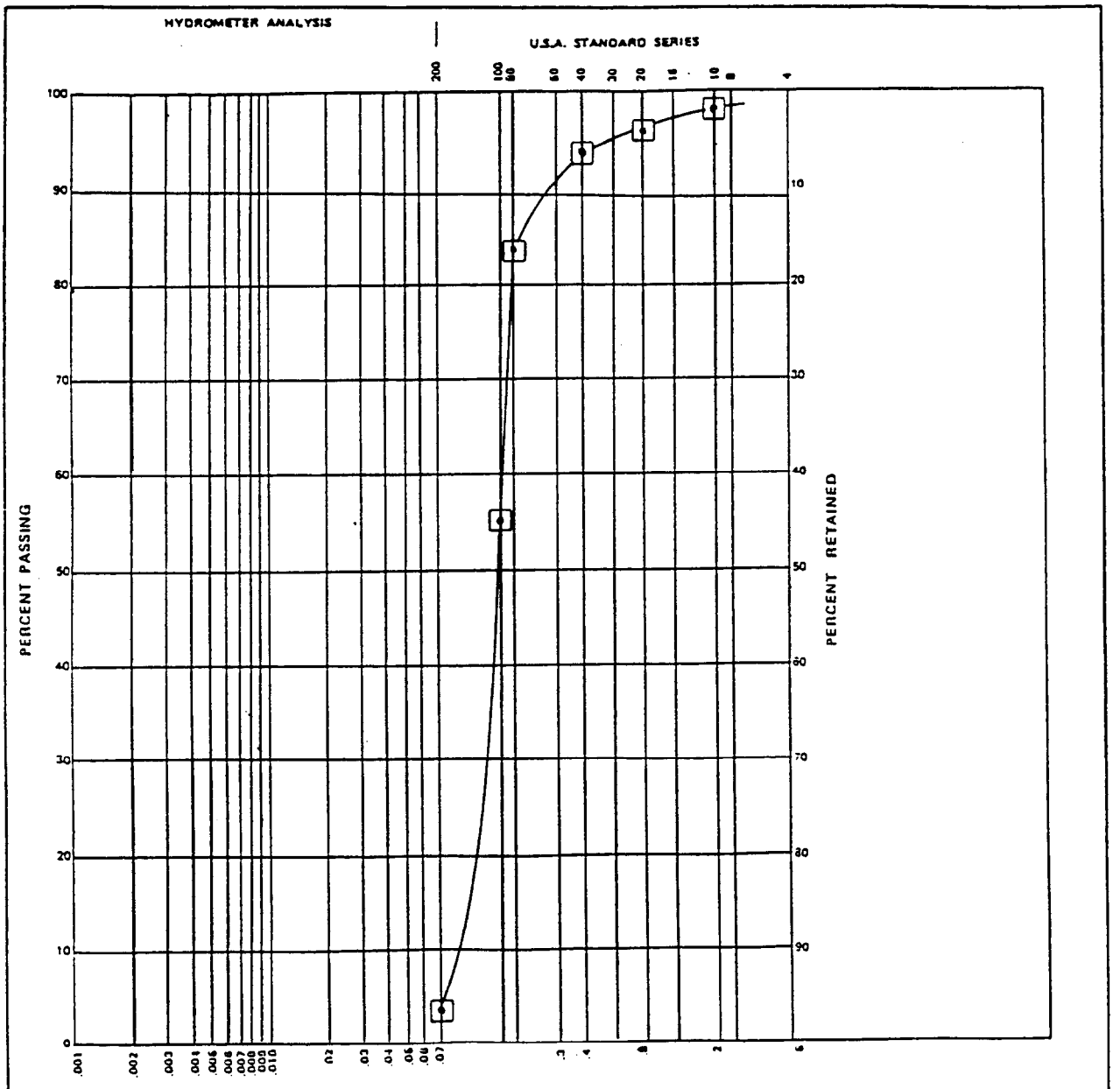
PARTICLE SIZE ANALYSIS

PROJECT DESCRIPTION: NSB Kings Bay

MATERIALS LABORATORY: CH2M Hill

SAMPLE LOCATION: KBA-RW-4 SAMPLE NO. SBRW453

TYPE OF SAMPLE: Soil



SAMPLE CLASSIFICATION Fine Sand

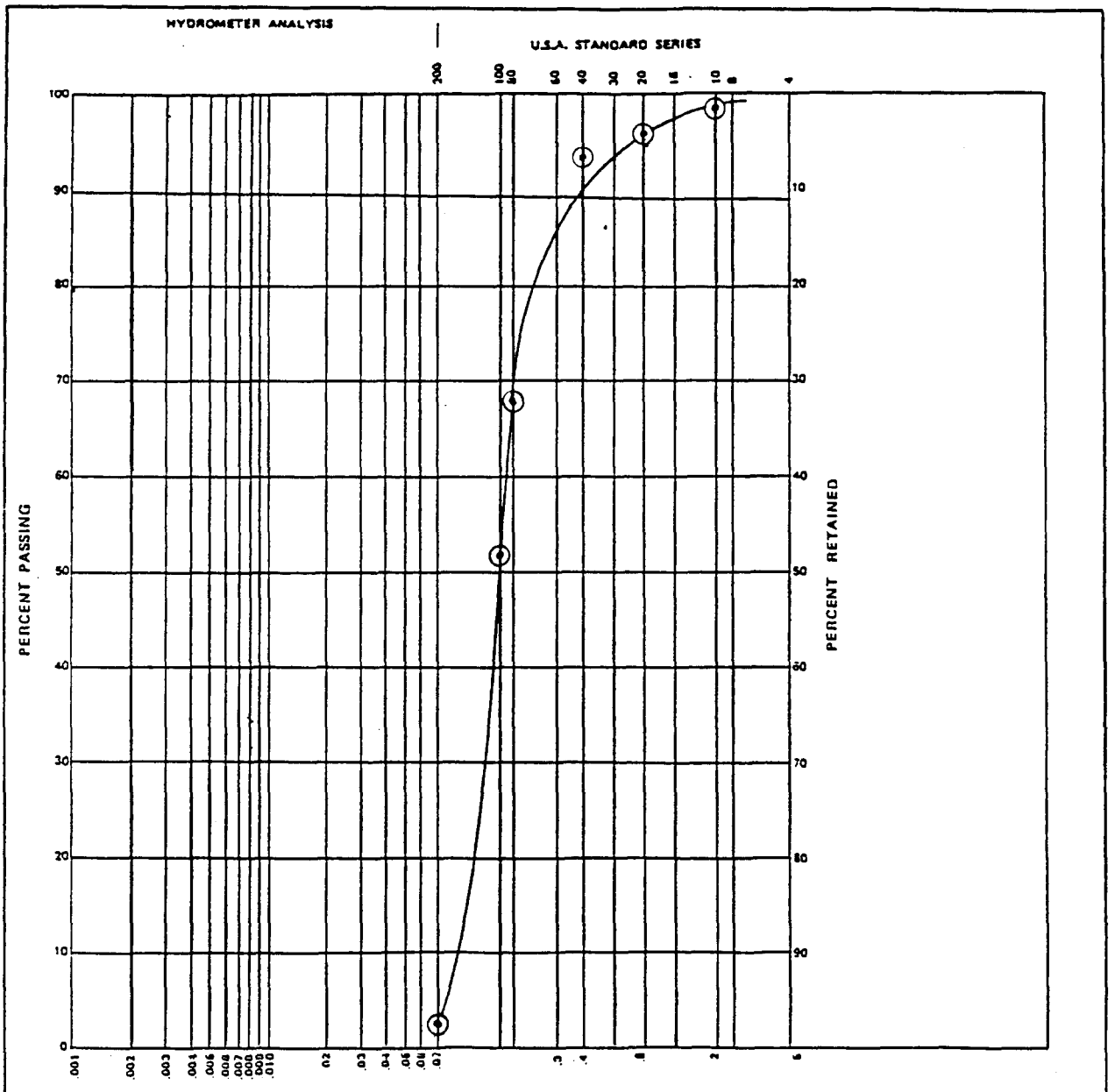
PARTICLE SIZE ANALYSIS

PROJECT DESCRIPTION: NSB Kings Bay

MATERIALS LABORATORY: CH2M Hill

SAMPLE LOCATION: KBA-RW-4 SAMPLE NO. SBRW453D

TYPE OF SAMPLE: Soil



SAMPLE CLASSIFICATION Fine Sand

APPENDIX C

Well Development Data

Observation Well Development Data Summary Table

Observation Well No.	Initial Parameters			Flow Rate (gal/min)	Amount of H_2O Removed (gal)	Final Parameters		
	pH	Specific Conductivity	Temperature (°C)			pH	Specific Conductivity	Temperature
PS-1	6.51	1,280	28.5	1.9	70	5.34	525	23.9
PS-2	5.71	610	28.1	1.0	74	5.13	590	24.7
PS-3	5.11	580	23.0	2.7	68	4.94	590	23.6
PS-4	6.01	695	32.9	1.3	77	5.87	580	24.1
PS-5	5.64	600	25.0	2.1	250	5.77	550	23.0
PS-6	11.50	1,500	25.4	2.4	300	6.11	120	22.0
PS-7	5.51	700	24.0	2.6	170	4.99	470	23.6
PS-8	5.71	600	23.9	5.0	170	5.10	395	22.8
PS-9	5.75	410	26.2	2.8	170	4.94	390	24.1
PS-10	5.56	480	26.9	2.8	230	5.07	255	23.6

Notes:

Amount of H_2O = gallons
Flow Rate = gallons per minute
gal = gallons
gal/min = gallons per minute
Specific Conductivity = centimeters per second
Temperature = degrees celsius (°C)

Recovery Well Development Data Summary Table

Recovery Well No.	Initial Parameters			Amount of H_2O Removed (gal)	Final Parameters		
	pH	Specific Conductivity	Temperature °C		pH	Specific Conductivity	Temperature
RW-1 (10/23/93)	5.59	410	21.7	2,500	5.72	420	22.8
RW-1 (11/05/93)	7.01	750	22.3	1,148	5.72	420	22.8
RW-2	7.44	500	23.0	4,000	5.80	600	21.8
RW-3	7.42	600	19.5	3,000	5.55	400	20.0
RW-4	7.00	650	24.3	2,500	5.01	300	24.0
RW-5 (10/26/93)	7.50	70	25.0	850	6.09	700	25.0
RW-5 (11/01/93)	7.74	500	19.0	500	6.07	650	21.5

Notes:

Amount of H_2O = gallons
gal = gallons
gal/min = gallons per minute
Specific Conductivity = centimeters per second
Temperature = degrees celsius (°C)

Recovery Well Efficiency Data Summary Table

	RW-1	RW-2	RW-3	RW-4	RW-5
Time[1] (hr.)	29.83	8.25	0.12	0.17	3.75
Volume (gal.)	18,940	4,100	75	100	1,530
Flow[2] (GPM)	15.96	15.9	10.8	10.6	12.0
Drawdown (ft.)	14.8	15.6	21.8	9.4	6.6
Specific Capacity (GPM/ft.)	1.08	1.01	0.49	1.13	1.82
Time[1] (hr.)	30.17	8.58	0.63	0.78	3.92
Volume (gal.)	19,290	4,300	400	500	1,700
Flow[2] (GPM)	15.8	16.0	10.6	11.6	11.8
Drawdown (ft.)	15.0	17.5	21.7	9.5	7.2
Specific Capacity (GPM/ft.)	1.05	0.92	0.49	1.22	1.63
Time[1] (hr.)			1.42	1.42	4.17
Volume (gal.)			900	900	1,800
Flow[2] (GPM)			11.1	11.6	12.2
Drawdown (ft.)			16.7	9.7	7.3
Specific Capacity (GPM/ft.)			0.67	1.20	1.66
Time[1] (hr.)			2.33	1.88	
Volume (gal.)			1,300	1,300	
Flow[2] (GPM)			11.2	15.4	
Drawdown (ft.)			15.3	11.7	
Specific Capacity (GPM/ft.)			0.73	1.30	
Time[1] (hr.)			3.17	2.80	
Volume (gal.)			1,750	1,800	
Flow[2] (GPM)			11.4	15.2	
Drawdown (ft.)			15.1	12.1	
Specific Capacity (GPM/ft.)			0.76	1.25	

See notes at end of table.

Recovery Well Efficiency Data Summary Table (Continued)

	RW-1	RW-2	RW-3	RW-4	RW-5
Time[1] (hr.)			3.58	3.35	
Volume (gal.)			2,000	2,200	
Flow[2] (GPM)			12.3	15.0	
Drawdown (ft.)			15.2	10.9	
Specific Capacity (GPM/ft.)			.81	1.38	
Time[1] (hr.)			4.00	3.73	
Volume (gal.)			2,000	2,500	
Flow[2] (GPM)			12.1	14.85	
Drawdown (ft.)			14.7	11.3	
Specific Capacity (GPM/ft.)			0.82	1.31	
Time[1] (hr.)			4.75		
Volume (gal.)			2,700		
Flow[2] (GPM)			11.5		
Drawdown (ft.)			14.2		
Specific Capacity (GPM/ft.)			0.81		
Time[1] (hr.)			5.33		
Volume (gal.)			3,000		
Flow[2] (GPM)			11.4		
Drawdown (ft.)			14.7		
Specific Capacity (GPM/ft.)			0.78		

Notes:

ft. = feet
GPM = gallons per minute
GPM/ft. = gallons per minute per foot
gal. = gallon
hr. = hour

[1] Development time, elapsed since start of development. Development time for RW-1 includes 25-hour initial pumping test. No well efficiency data was collected prior to the 25-hour initial pumping test.

[2] Flow estimates based on discharge to 5-gallon buckets measured periodically.

APPENDIX D

Output from SCREEN Model

SCREEN MODEL EVALUATION
GROUNDWATER INFLUENT CONCENTRATIONS
INTERIM MEASURE DESIGN CALCULATIONS
NSB KINGS BAY, GEORGIA

ABB-ES Project No.: 8503-01
Designed By: V. RULE
Date: NOVEMBER 24, 1993
Checked By: S. Pierett
Date: December 8, 1993

Source Identification: Site 11 Landfill
Source Location: NSB Kingsbay, GA

Max. Influent Flow Rate (GPM) : 60
Max. Air Flow Rate (CFM) : 800
Emission Pt. Height (St. Height) (ft) : 16
Max. Hrs. of Operation (hrs/wk) : 168

#	Contaminant Name	Max Conc in Ground Water (ppb)	TLV (Note 2) (mg/m3)	Category (Note 3) (A or B)	AAC (Note 4) (mg/m3)
1	Benzene	5	3	A	0.00238
2	2-Butanone (MEK)	580	590	A	0.46825
3	Chlorobenzene	10	350	A	0.27778
4	1,4-Dichlorobenzene	12	450	B	1.07143
5	1,1-Dichloroethane	24	810	A	0.64286
6	1,2-Dichloroethane	9	40	A	0.03175
7	cis-1,2-Dichloroethene	3600	790	A	0.62698
8	trans-1,2-Dichloroethene	23	790	A	0.62698
9	1,2-Dichloropropane	6	345	A	0.27381
10	Ethylbenzene	41	435	A	0.34524
11	2-Hexanone (MBK)	70	20	A	0.01587
12	MIBK	110	205	A	0.16270
13	Tetrachloroethene	3	335	A	0.26587
14	Toluene	840	375	B	0.89286
15	Trichloroethene	45	270	A	0.21429
16	Total Xylenes	120	435	A	0.34524
17	Vinyl chloride	310	13	A	0.01032

NOTES:
1) BASED ON 1 LB/HR MODEL
2) THRESHOLD LIMIT VALUE
) CATEGORY A - CARCINOGEN
CATEGORY B - OTHER
4) ACCEPTABLE AMBIENT CRITERIA

SCREEN MODEL EVALUATION
24 HOUR POINT SOURCE CONCENTRATION VALUES
INTERIM MEASURE DESIGN CALCULATIONS
NSB KINGS BAY, GEORGIA

ABB-ES Project No.: 8503-01
Designed By: V. RULE
Date: NOVEMBER 24, 1993
Checked By: S. Pierett
Date: December 8, 1993

Source Identification: Site 11 Landfill
Source Location: NSB Kingsbay, GA

Max. Influent Flow Rate (GPM):	60
Max. Air Flow Rate (CFM):	800
Emission Pt. Height (St. Height){ft} :	16
Max. Hrs. of Operation (hrs/wk) :	168

#	Contaminant Name	Max Conc in Ground Water (ppb)	Max. Vapor Emission from Air Sparger (mg/m3)	Max. Vapor Emission from Carbon (mg/m3)	Maximum Ground Level Concentration (mg/m3)	AAC (Note 2) (mg/m3)
1	Benzene	5	0.12030	0.00120	0.00000	0.00238
2	2-Butanone (MEK)	580	0.93700	0.00937	0.00000	0.46825
3	Chlorobenzene	10	0.24030	0.00240	0.00000	0.27778
4	1,4-Dichlorobenzene	12	0.28800	0.00288	0.00000	1.07143
5	1,1-Dichloroethane	24	0.57700	0.00577	0.00000	0.64286
6	1,2-Dichloroethane	9	0.20650	0.00207	0.00000	0.03175
7	cis-1,2-Dichloroethene	3600	8.56480	0.08565	0.00001	0.62698
8	trans-1,2-Dichloroethene	23	0.55320	0.00553	0.00000	0.62698
9	1,2-Dichloropropane	6	0.14300	0.00143	0.00000	0.27381
10	Ethylbenzene	41	0.98630	0.00986	0.00000	0.34524
11	2-Hexanone (MBK)	70	0.05240	0.00052	0.00000	0.01587
12	MIBK	110	0.06830	0.00068	0.00000	0.16270
13	Tetrachloroethene	3	0.07200	0.00072	0.00000	0.26587
14	Toluene	840	20.19700	0.20197	0.00002	0.89286
15	Trichloroethene	45	0.10800	0.00108	0.00000	0.21429
16	Total Xylenes	120	2.88000	0.02880	0.00000	0.34524
17	Vinyl chloride	310	7.45800	0.07458	0.00001	0.01032

Notes:
1) BASED ON 1 LB/HR MODEL
2) ACCEPTABLE AMBIENT CRITERIA

11-30-93
13:48:37

*** SCREEN-1.1 MODEL RUN ***
*** VERSION DATED 88300 ***

NSB Kings Bay, GA - Interim Measure - TABLE 4 - SCREEN MODEL

SIMPLE TERRAIN INPUTS:

SOURCE TYPE	=	POINT
EMISSION RATE (G/S)	=	.1260
STACK HEIGHT (M)	=	4.88
STK INSIDE DIAM (M)	=	.10
STK EXIT VELOCITY (M/S)	=	46.50
STK GAS EXIT TEMP (K)	=	293.00
AMBIENT AIR TEMP (K)	=	293.00
RECEPTOR HEIGHT (M)	=	.00
IOPT (1=URB,2=RUR)	=	2
BUILDING HEIGHT (M)	=	2.13
MIN HORIZ BLDG DIM (M)	=	1.83
MAX HORIZ BLDG DIM (M)	=	1.83

1 lb/hr

BUOY. FLUX = .00 M**4/S**3; MOM. FLUX = 5.41 M**4/S**2.

*** FULL METEOROLOGY ***

****
** SCREEN AUTOMATED DISTANCES ***
****

*** TERRAIN HEIGHT OF 0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH
1.	.0000	0	.0	.0	.0	.0	.0	.0	NA
100.	63.74	3	3.0	3.0	960.0	9.5	12.5	7.6	NO
200.	77.95	5	1.0	1.0	5000.0	13.8	12.3	7.4	NO
300.	85.58	5	1.0	1.0	5000.0	13.8	17.4	9.6	NO
400.	90.19	6	1.0	1.0	5000.0	13.0	15.2	8.1	NO
500.	88.32	6	1.0	1.0	5000.0	13.0	18.4	9.3	NO
600.	82.15	6	1.0	1.0	5000.0	13.0	21.6	10.5	NO
700.	74.60	6	1.0	1.0	5000.0	13.0	24.8	11.6	NO
800.	67.03	6	1.0	1.0	5000.0	13.0	27.9	12.6	NO
900.	60.24	6	1.0	1.0	5000.0	13.0	31.0	13.6	NO
1000.	54.27	6	1.0	1.0	5000.0	13.0	34.1	14.5	NO
1100.	49.14	6	1.0	1.0	5000.0	13.0	37.2	15.3	NO
1200.	44.69	6	1.0	1.0	5000.0	13.0	40.2	16.2	NO
1300.	40.82	6	1.0	1.0	5000.0	13.0	43.2	16.9	NO
1400.	37.44	6	1.0	1.0	5000.0	13.0	46.2	17.7	NO
1500.	34.48	6	1.0	1.0	5000.0	13.0	49.2	18.5	NO
1600.	31.87	6	1.0	1.0	5000.0	13.0	52.1	19.2	NO
1700.	29.55	6	1.0	1.0	5000.0	13.0	55.1	19.9	NO
1800.	27.50	6	1.0	1.0	5000.0	13.0	58.0	20.6	NO
1900.	25.66	6	1.0	1.0	5000.0	13.0	60.9	21.3	NO
2000.	24.01	6	1.0	1.0	5000.0	13.0	63.8	22.0	NO
2100.	22.59	6	1.0	1.0	5000.0	13.0	66.7	22.6	NO
2200.	21.30	6	1.0	1.0	5000.0	13.0	69.5	23.1	NO
2300.	20.13	6	1.0	1.0	5000.0	13.0	72.4	23.7	NO
2400.	19.07	6	1.0	1.0	5000.0	13.0	75.2	24.2	NO

2500.	18.09	6	1.0	1.0	5000.0	13.0	78.0	24.7	NO
2600.	17.20	6	1.0	1.0	5000.0	13.0	80.9	25.3	NO
2700.	16.38	6	1.0	1.0	5000.0	13.0	83.7	25.8	NO
2800.	15.62	6	1.0	1.0	5000.0	13.0	86.5	26.3	NO
2900.	14.92	6	1.0	1.0	5000.0	13.0	89.2	26.8	NO
3000.	14.27	6	1.0	1.0	5000.0	13.0	92.0	27.3	NO
3500.	11.75	6	1.0	1.0	5000.0	13.0	105.7	29.3	NO
4000.	9.914	6	1.0	1.0	5000.0	13.0	119.2	31.1	NO
4500.	8.525	6	1.0	1.0	5000.0	13.0	132.6	32.8	NO
5000.	7.443	6	1.0	1.0	5000.0	13.0	145.7	34.4	NO
5500.	6.579	6	1.0	1.0	5000.0	13.0	158.7	36.0	NO
6000.	5.876	6	1.0	1.0	5000.0	13.0	171.6	37.4	NO
6500.	5.295	6	1.0	1.0	5000.0	13.0	184.4	38.8	NO
7000.	4.806	6	1.0	1.0	5000.0	13.0	197.0	40.2	NO
7500.	4.405	6	1.0	1.0	5000.0	13.0	209.6	41.4	NO
8000.	4.059	6	1.0	1.0	5000.0	13.0	222.0	42.5	NO
8500.	3.759	6	1.0	1.0	5000.0	13.0	234.4	43.5	NO
9000.	3.496	6	1.0	1.0	5000.0	13.0	246.6	44.6	NO
9500.	3.264	6	1.0	1.0	5000.0	13.0	258.8	45.6	NO
10000.	3.058	6	1.0	1.0	5000.0	13.0	270.9	46.6	NO
15000.	1.825	6	1.0	1.0	5000.0	13.0	388.4	55.0	NO
20000.	1.295	6	1.0	1.0	5000.0	13.0	501.0	60.4	NO
25000.	.9922	6	1.0	1.0	5000.0	13.0	609.8	65.0	NO
30000.	.7986	6	1.0	1.0	5000.0	13.0	715.6	69.0	NO
40000.	.5755	6	1.0	1.0	5000.0	13.0	920.2	74.6	NO
50000.	.4466	6	1.0	1.0	5000.0	13.0	1117.4	79.3	NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND 1. M:

421.	90.37 for 1 lb/hr	6	1.0	1.0	5000.0	13.0	15.9	8.4	NO

DWASH= MEANS NO CALC MADE (CONC = 0.0)
DWASH=NO MEANS NO BUILDING DOWNWASH USED
DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

****
*** SCREEN DISCRETE DISTANCES ***
****

*** TERRAIN HEIGHT OF 0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH
61.	59.82	2	3.0	3.0	960.0	9.5	12.3	6.8	NO

DWASH= MEANS NO CALC MADE (CONC = 0.0)
DWASH=NO MEANS NO BUILDING DOWNWASH USED
DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

****
* SUMMARY OF TERRAIN HEIGHTS ENTERED FOR *
* SIMPLE ELEVATED TERRAIN PROCEDURE *
****

TERRAIN HT (M)	DISTANCE RANGE (M) MINIMUM	MAXIMUM

```
-------        --------      --------
     0.             1.        50000.
     0.            61.           --

 *** CAVITY CALCULATION - 1 ***        *** CAVITY CALCULATION - 2 ***
  CONC (UG/M**3)       =    .0000       CONC (UG/M**3)       =    .0000
  CRIT WS @10M (M/S)   =   99.99        CRIT WS @10M (M/S)   =   99.99
  CRIT WS @ HS (M/S)   =   99.99        CRIT WS @ HS (M/S)   =   99.99
  DILUTION WS (M/S)    =   99.99        DILUTION WS (M/S)    =   99.99
  CAVITY HT (M)        =    3.25        CAVITY HT (M)        =    3.25
  CAVITY LENGTH (M)    =    3.02        CAVITY LENGTH (M)    =    3.02
  ALONGWIND DIM (M)    =    1.83        ALONGWIND DIM (M)    =    1.83

CAVITY CONC NOT CALCULATED FOR CRIT WS > 20.0 M/S.  CONC SET = 0.0

     ****************************************
     *** SUMMARY OF SCREEN MODEL RESULTS ***
     ****************************************

 CALCULATION          MAX CONC     DIST TO    TERRAIN
  PROCEDURE          (UG/M**3)     MAX (M)     HT (M)
---------------     -----------    -------    -------
SIMPLE TERRAIN        90.37          421.        0.

*****************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
*****************************************************
```

for 1 lb/hr input

STACK PARAMETERS

Source Type:	Point	
Emission Rate:	0.1260 g/s	(1 lb/hr)
Stack Height:	4.88 meters	(16 feet)
Stack Inside Diameter:	0.1 meters	(4 inches)
Stack Exit Velocity:	46.5 m/s	(152.7 ft/s)
Stack Gas Exit Temp:	293 K	(68 °F)
Ambient Air Temp:	293 K	(68 °F)
Receptor Height:	0 meters	
Nearby Structure Height:	2.13 meters	(7 feet)
Minimum Horizon Dim:	1.83	(6 feet)
Maximum Horizon Dim:	1.83	(6 feet)

11-30-93
13:51:51

*** SCREEN-1.1 MODEL RUN ***
*** VERSION DATED 88300 ***

NSB Kings Bay, GA - Interim Measure - TABLE 8 - STACK MONITORING

SIMPLE TERRAIN INPUTS:

SOURCE TYPE	=	POINT
EMISSION RATE (G/S)	=	.1400E-01 = 37 mg/m³ @ stack
STACK HEIGHT (M)	=	4.88
STK INSIDE DIAM (M)	=	.10
STK EXIT VELOCITY (M/S)	=	46.50
STK GAS EXIT TEMP (K)	=	293.00
AMBIENT AIR TEMP (K)	=	293.00
RECEPTOR HEIGHT (M)	=	.00
IOPT (1=URB,2=RUR)	=	2
BUILDING HEIGHT (M)	=	2.13
MIN HORIZ BLDG DIM (M)	=	1.83
MAX HORIZ BLDG DIM (M)	=	1.83

BUOY. FLUX = .00 M**4/S**3; MOM. FLUX = 5.41 M**4/S**2.

*** FULL METEOROLOGY ***

****
*** SCREEN AUTOMATED DISTANCES ***
****

*** TERRAIN HEIGHT OF 0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH
1.	.0000	0	.0	.0	.0	.0	.0	.0	NA
100.	7.083	3	3.0	3.0	960.0	9.5	12.5	7.6	NO
200.	8.661	5	1.0	1.0	5000.0	13.8	12.3	7.4	NO
300.	9.509	5	1.0	1.0	5000.0	13.8	17.4	9.6	NO
400.	10.02	6	1.0	1.0	5000.0	13.0	15.2	8.1	NO
500.	9.813	6	1.0	1.0	5000.0	13.0	18.4	9.3	NO
600.	9.128	6	1.0	1.0	5000.0	13.0	21.6	10.5	NO
700.	8.289	6	1.0	1.0	5000.0	13.0	24.8	11.6	NO
800.	7.447	6	1.0	1.0	5000.0	13.0	27.9	12.6	NO
900.	6.693	6	1.0	1.0	5000.0	13.0	31.0	13.6	NO
1000.	6.030	6	1.0	1.0	5000.0	13.0	34.1	14.5	NO
1100.	5.460	6	1.0	1.0	5000.0	13.0	37.2	15.3	NO
1200.	4.965	6	1.0	1.0	5000.0	13.0	40.2	16.2	NO
1300.	4.535	6	1.0	1.0	5000.0	13.0	43.2	16.9	NO
1400.	4.160	6	1.0	1.0	5000.0	13.0	46.2	17.7	NO
1500.	3.831	6	1.0	1.0	5000.0	13.0	49.2	18.5	NO
1600.	3.541	6	1.0	1.0	5000.0	13.0	52.1	19.2	NO
1700.	3.284	6	1.0	1.0	5000.0	13.0	55.1	19.9	NO
1800.	3.055	6	1.0	1.0	5000.0	13.0	58.0	20.6	NO
1900.	2.851	6	1.0	1.0	5000.0	13.0	60.9	21.3	NO
2000.	2.668	6	1.0	1.0	5000.0	13.0	63.8	22.0	NO
2100.	2.510	6	1.0	1.0	5000.0	13.0	66.7	22.6	NO
2200.	2.367	6	1.0	1.0	5000.0	13.0	69.5	23.1	NO
2300.	2.237	6	1.0	1.0	5000.0	13.0	72.4	23.7	NO
2400.	2.119	6	1.0	1.0	5000.0	13.0	75.2	24.2	NO

2500.	2.010	6	1.0	1.0	5000.0	13.0	78.0	24.7	NO
2600.	1.911	6	1.0	1.0	5000.0	13.0	80.9	25.3	N
2700.	1.820	6	1.0	1.0	5000.0	13.0	83.7	25.8	N
2800.	1.736	6	1.0	1.0	5000.0	13.0	86.5	26.3	NO
2900.	1.658	6	1.0	1.0	5000.0	13.0	89.2	26.8	NO
3000.	1.586	6	1.0	1.0	5000.0	13.0	92.0	27.3	NO
3500.	1.306	6	1.0	1.0	5000.0	13.0	105.7	29.3	NO
4000.	1.102	6	1.0	1.0	5000.0	13.0	119.2	31.1	NO
4500.	.9473	6	1.0	1.0	5000.0	13.0	132.6	32.8	NO
5000.	.8270	6	1.0	1.0	5000.0	13.0	145.7	34.4	NO
5500.	.7310	6	1.0	1.0	5000.0	13.0	158.7	36.0	NO
6000.	.6529	6	1.0	1.0	5000.0	13.0	171.6	37.4	NO
6500.	.5883	6	1.0	1.0	5000.0	13.0	184.4	38.8	NO
7000.	.5340	6	1.0	1.0	5000.0	13.0	197.0	40.2	NO
7500.	.4894	6	1.0	1.0	5000.0	13.0	209.6	41.4	NO
8000.	.4510	6	1.0	1.0	5000.0	13.0	222.0	42.5	NO
8500.	.4177	6	1.0	1.0	5000.0	13.0	234.4	43.5	NO
9000.	.3885	6	1.0	1.0	5000.0	13.0	246.6	44.6	NO
9500.	.3627	6	1.0	1.0	5000.0	13.0	258.8	45.6	NO
10000.	.3398	6	1.0	1.0	5000.0	13.0	270.9	46.6	NO
15000.	.2028	6	1.0	1.0	5000.0	13.0	388.4	55.0	NO
20000.	.1439	6	1.0	1.0	5000.0	13.0	501.0	60.4	NO
25000.	.1102	6	1.0	1.0	5000.0	13.0	609.8	65.0	NO
30000.	.8873E-01	6	1.0	1.0	5000.0	13.0	715.6	69.0	NO
40000.	.6394E-01	6	1.0	1.0	5000.0	13.0	920.2	74.6	NO
50000.	.4963E-01	6	1.0	1.0	5000.0	13.0	1117.4	79.3	NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND 1. M:

421.	10.04	6	1.0	1.0	5000.0	13.0	15.9	8.4	N

DWASH= MEANS NO CALC MADE (CONC = 0.0)
DWASH=NO MEANS NO BUILDING DOWNWASH USED
DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

```
*********************************************
*  SUMMARY OF TERRAIN HEIGHTS ENTERED FOR   *
*     SIMPLE ELEVATED TERRAIN PROCEDURE     *
*********************************************
```

TERRAIN HT (M)	DISTANCE RANGE (M) MINIMUM	MAXIMUM
0.	1.	50000.

*** CAVITY CALCULATION - 1 ***			*** CAVITY CALCULATION - 2 ***		
CONC (UG/M**3)	=	.0000	CONC (UG/M**3)	=	.0000
CRIT WS @10M (M/S)	=	99.99	CRIT WS @10M (M/S)	=	99.99
CRIT WS @ HS (M/S)	=	99.99	CRIT WS @ HS (M/S)	=	99.99
DILUTION WS (M/S)	=	99.99	DILUTION WS (M/S)	=	99.99
CAVITY HT (M)	=	3.25	CAVITY HT (M)	=	3.25
CAVITY LENGTH (M)	=	3.02	CAVITY LENGTH (M)	=	3.02
ALONGWIND DIM (M)	=	1.83	ALONGWIND DIM (M)	=	1.83

CAVITY CONC NOT CALCULATED FOR CRIT WS > 20.0 M/S. CONC SET = 0.0

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****************************************
*** SUMMARY OF SCREEN MODEL RESULTS ***
****************************************
```

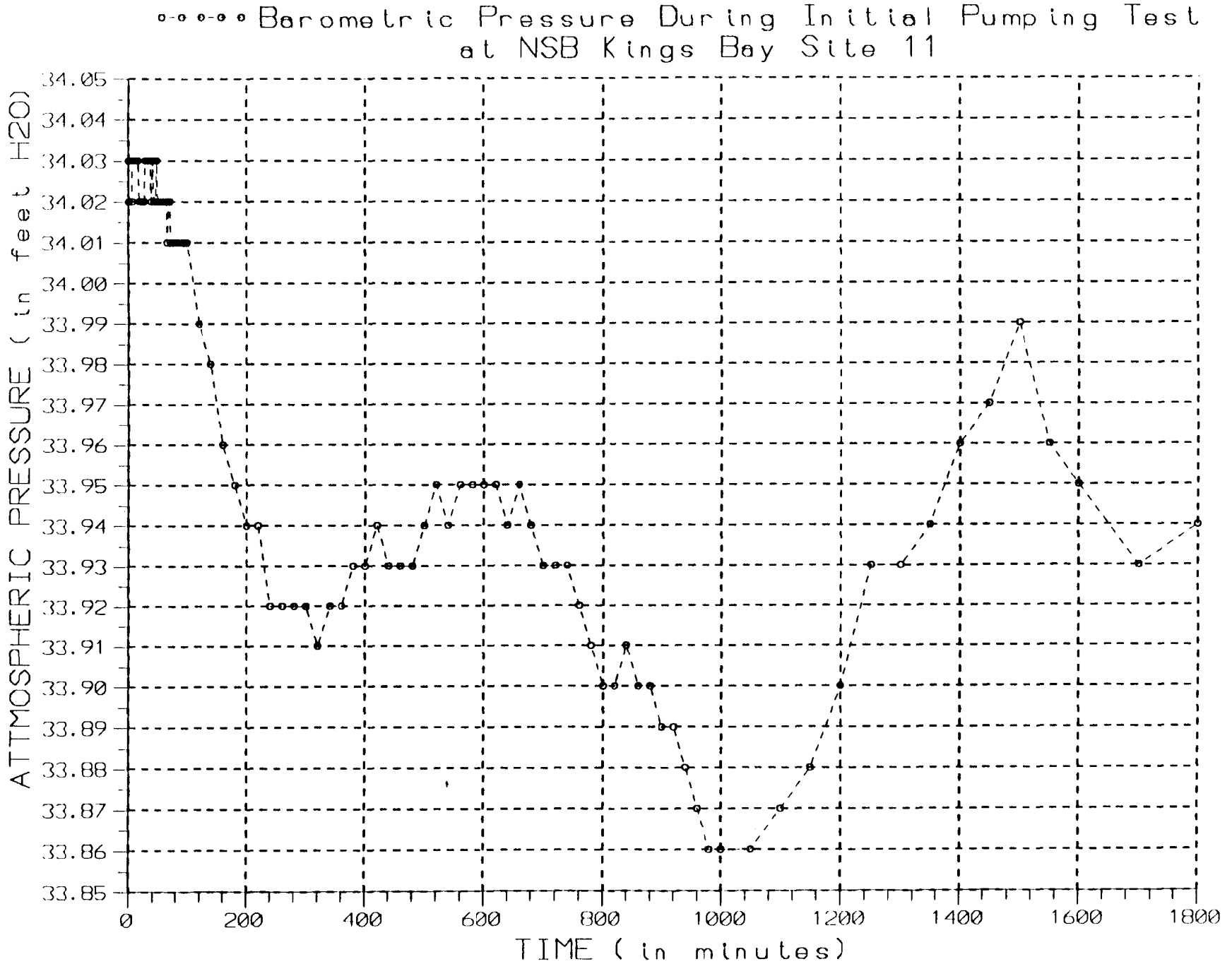
CALCULATION PROCEDURE	MAX CONC (UG/M**3)	DIST TO MAX (M)	TERRAIN HT (M)
SIMPLE TERRAIN	10.04	421.	0.

for 37 mg/m³ @ stack

****
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
****

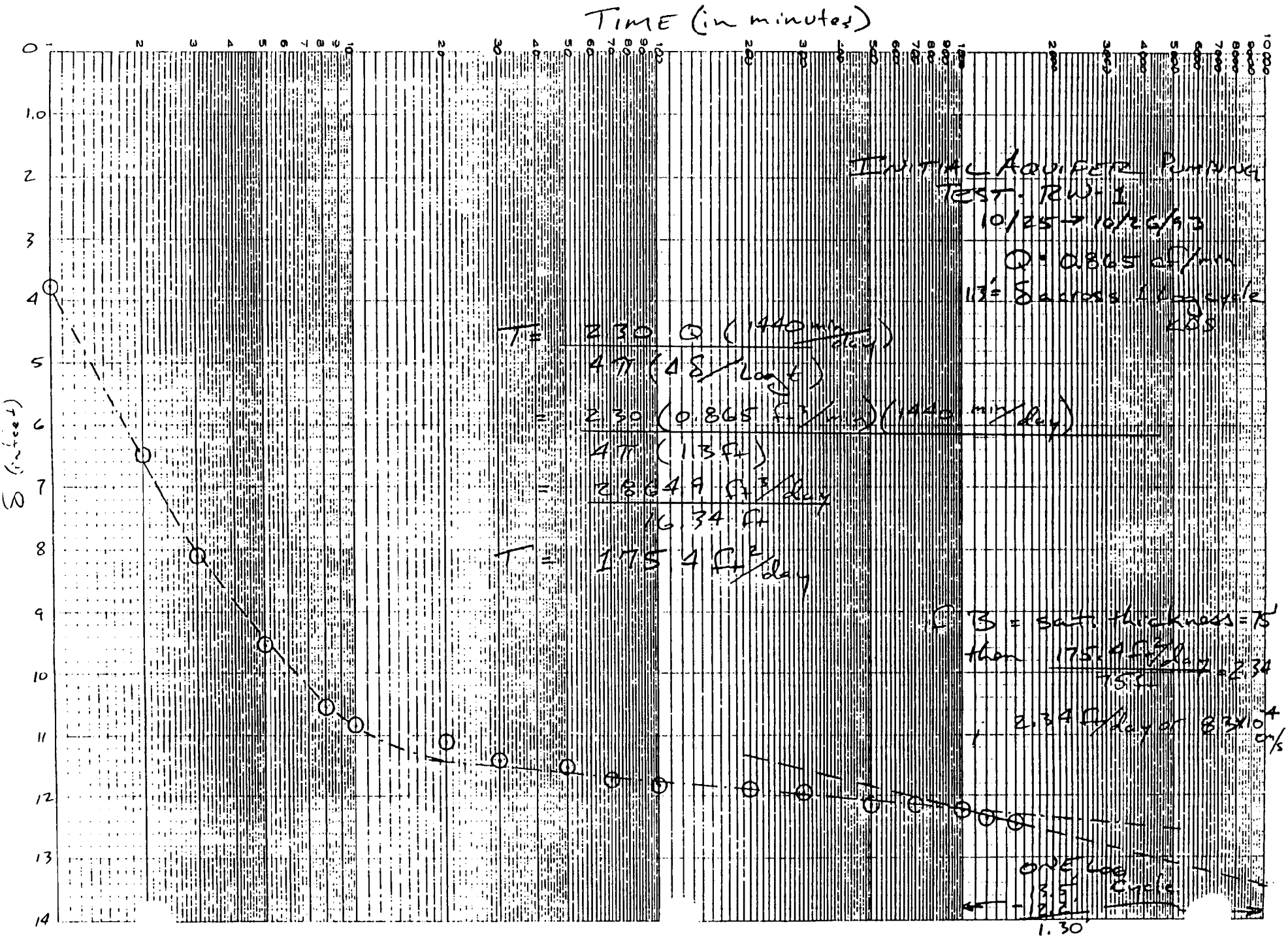
APPENDIX E

Initial Pumping Test Analysis

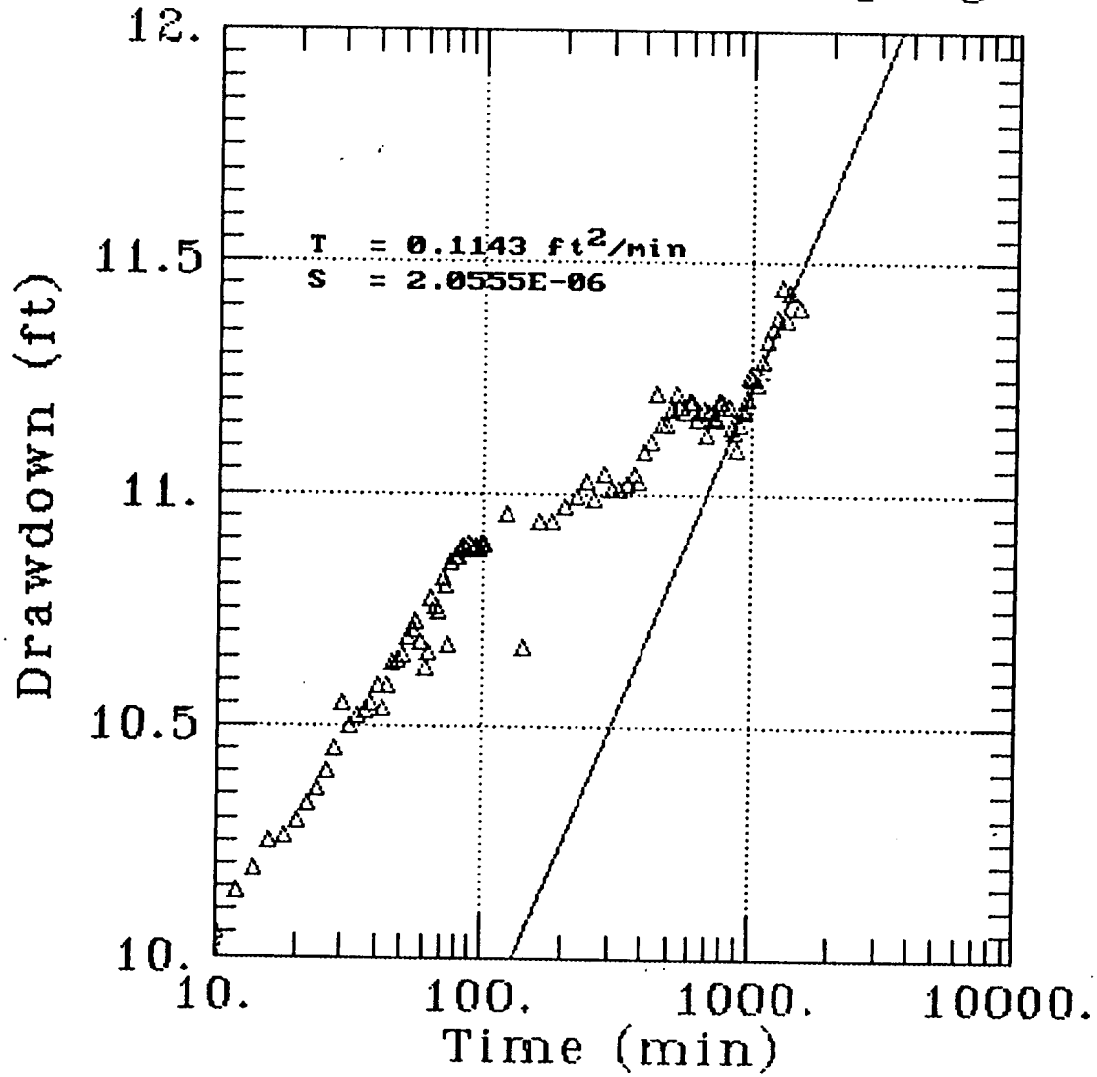

Barometric Pressure During Initial Pumping Test
at NSB Kings Bay Site 11
ATTMOSPHERIC PRESSURE (in feet H2O)
34.05
34.04
34.03
34.02
34.01
34.00
33.99
33.98
33.97
33.96
33.95
33.94
33.93
33.92
33.91
33.90
33.89
33.88
33.87
33.86
33.85
0
200
400
600
800
1000
1200
1400
1600
1800
TIME (in minutes)

NO. 340R-L410 DIETZGEN GRAPH PAPER
SEMI-LOGARITHMIC
4 CYCLES X 10 DIVISIONS PER INCH

DIETZGEN CORPORATION
MADE IN U.S.A.

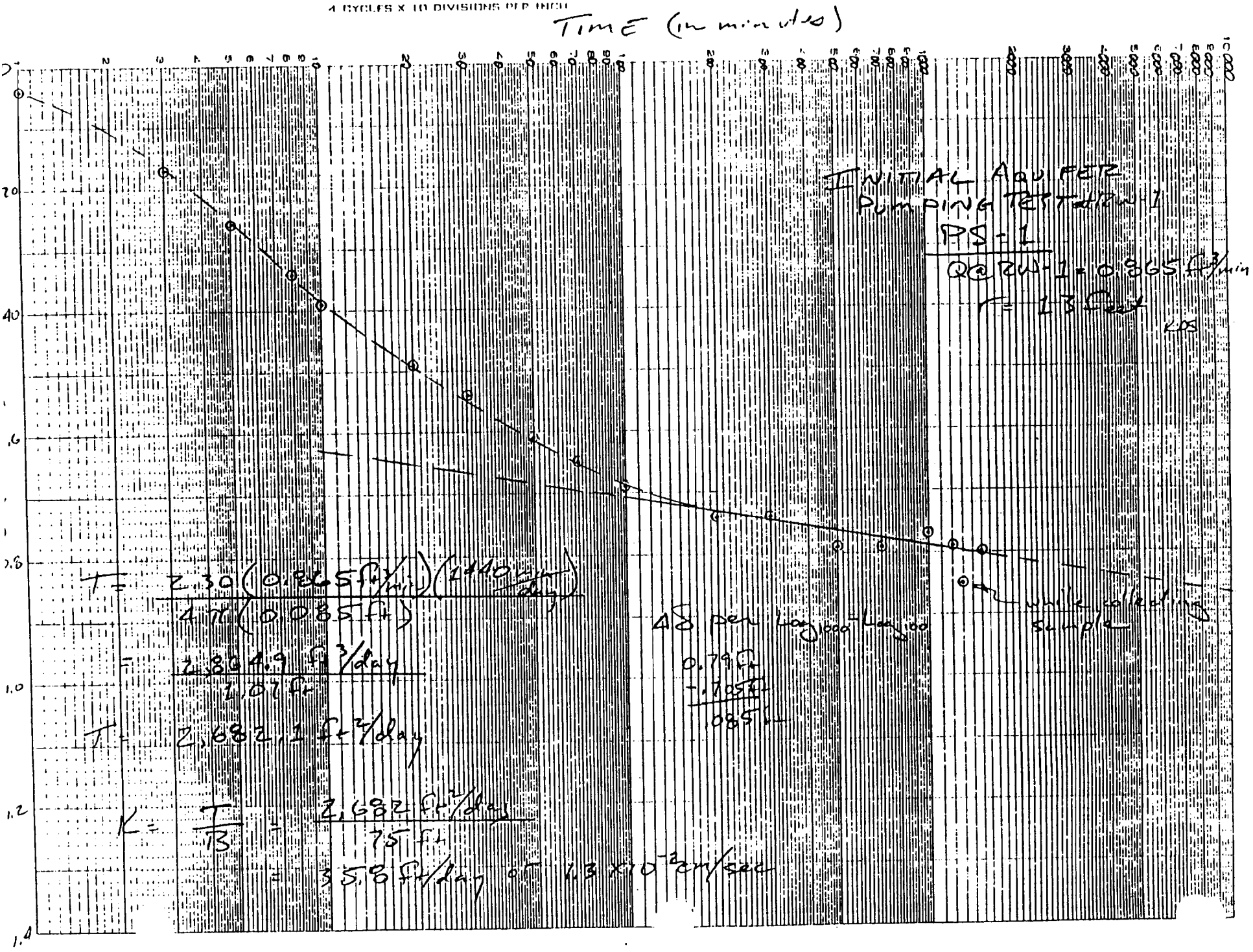


NSB KingsBay:IM Initial Pumping Test RW1



NO. 340R-L410 DIETZGEN GRAPH PAPER
SEMI-LOGARITHMIC
4 CYCLES X 10 DIVISIONS PER INCH

DIETZGEN CORPORATION
MADE IN U.S.A.



$$T = \frac{2.30(0.865\ ft^3/min)(1440\ min/day)}{4\pi(0.085\ ft)}$$

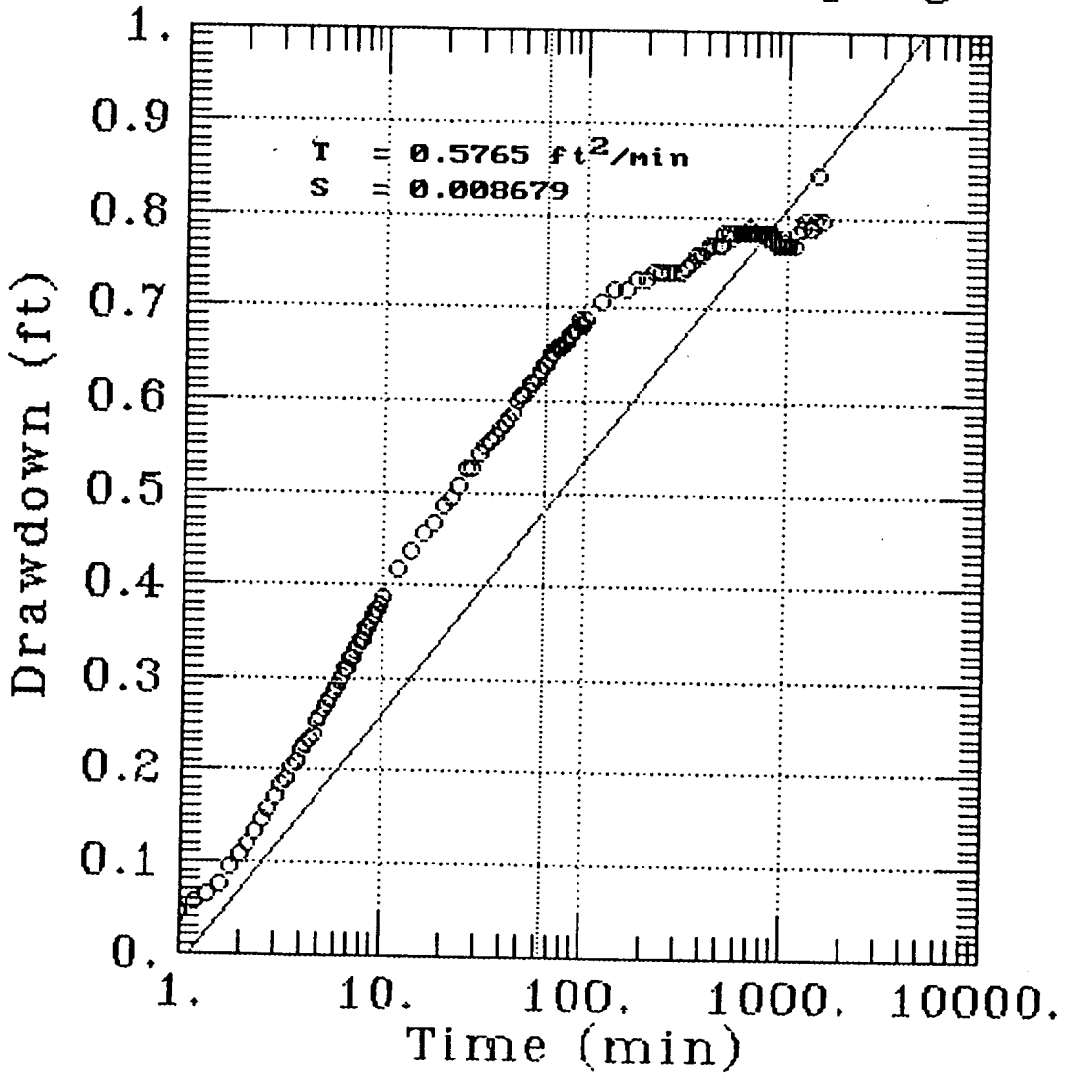
$$= \frac{2,884.9\ ft^3/day}{1.07\ ft}$$

$$T = 2,682.1\ ft^2/day$$

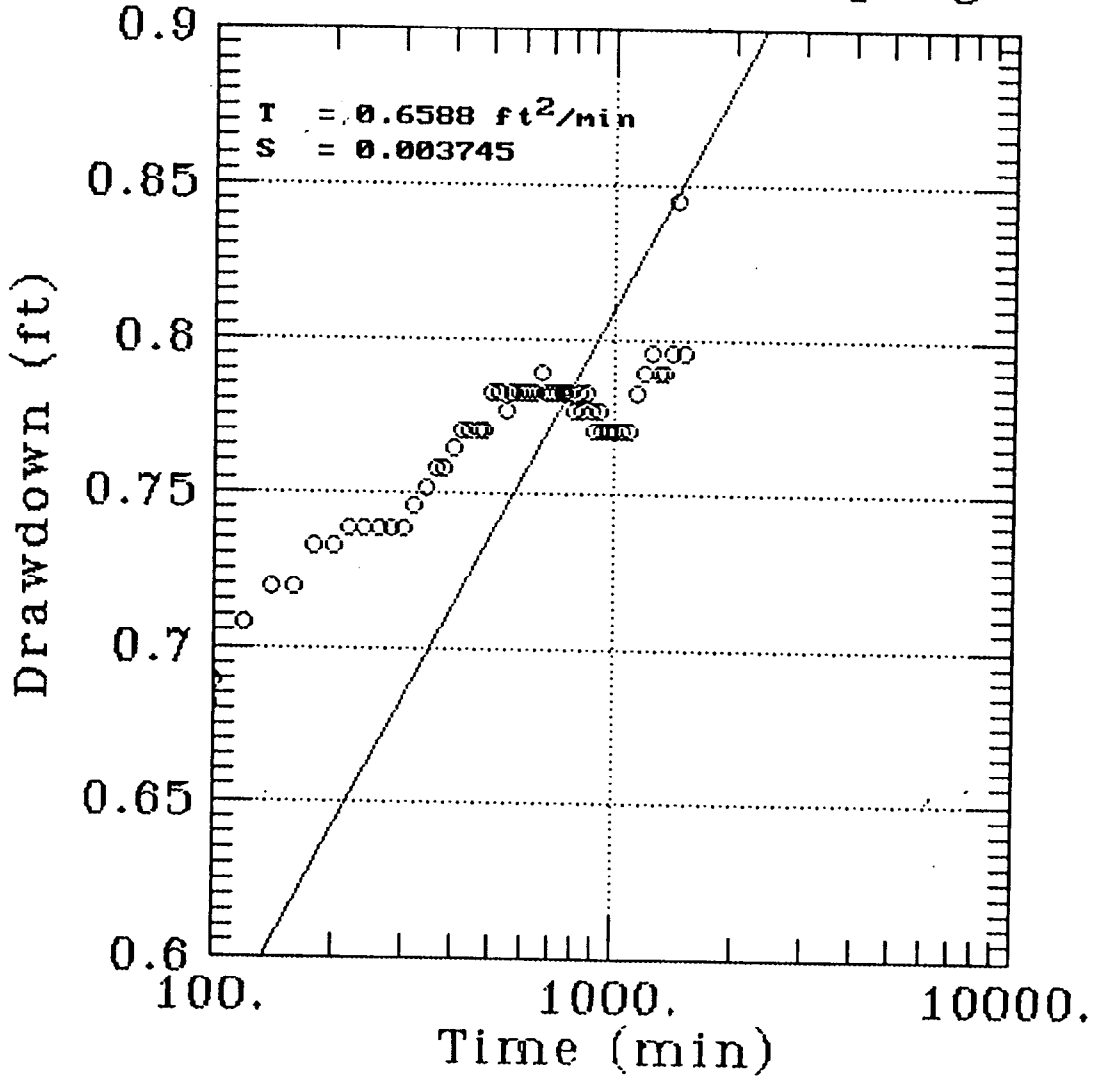
$$K = \frac{T}{B} = \frac{2,682\ ft^2/day}{75\ ft}$$

$$= 35.8\ ft/day \text{ or } 1.3 \times 10^{-2}\ cm/sec$$

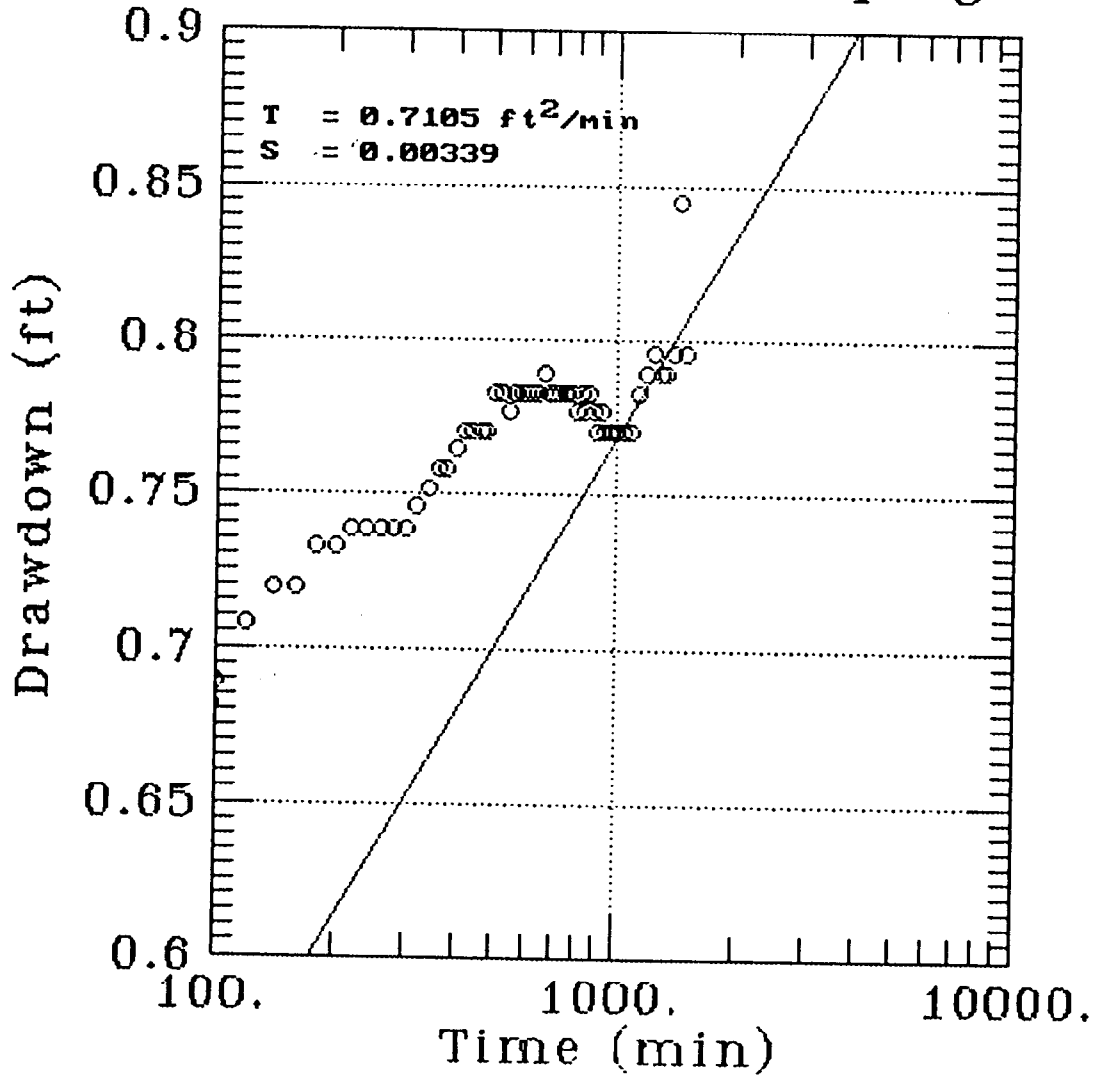
NSB KingsBay IM:Initial Pumping Test/PS1



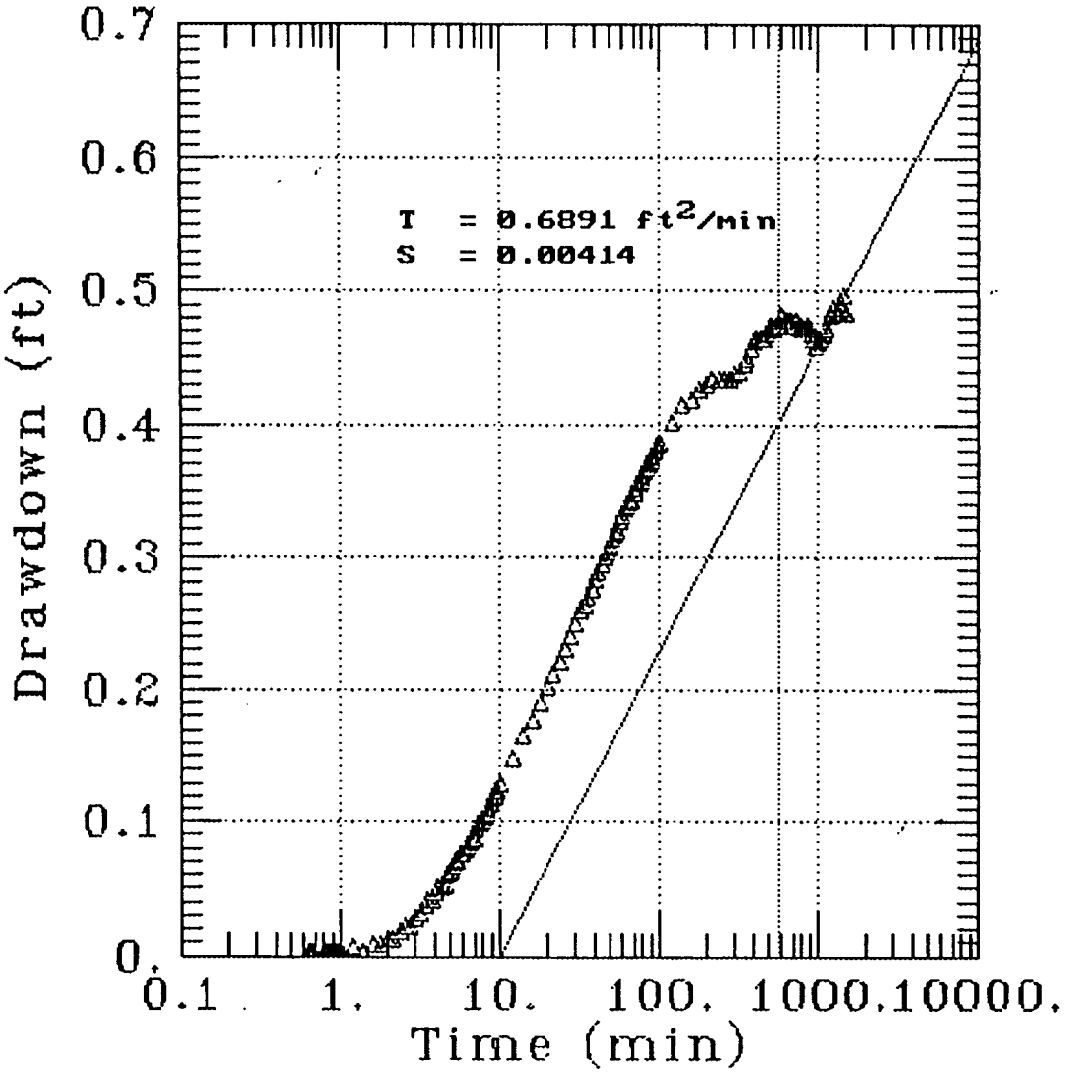
NSB KingsBay IM:Initial Pumping Test/PS1



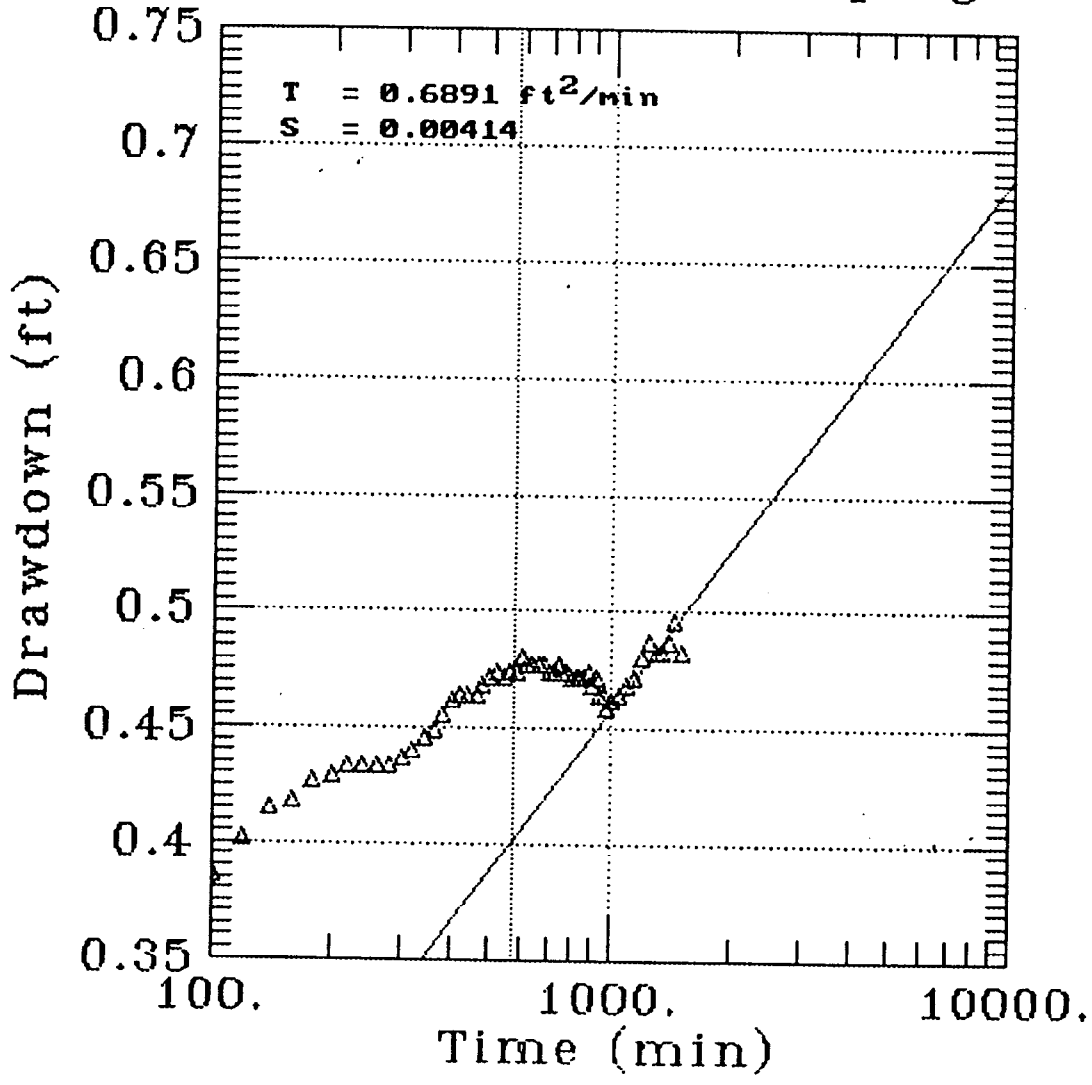
NSB KingsBay IM:Initial Pumping Test/PS1



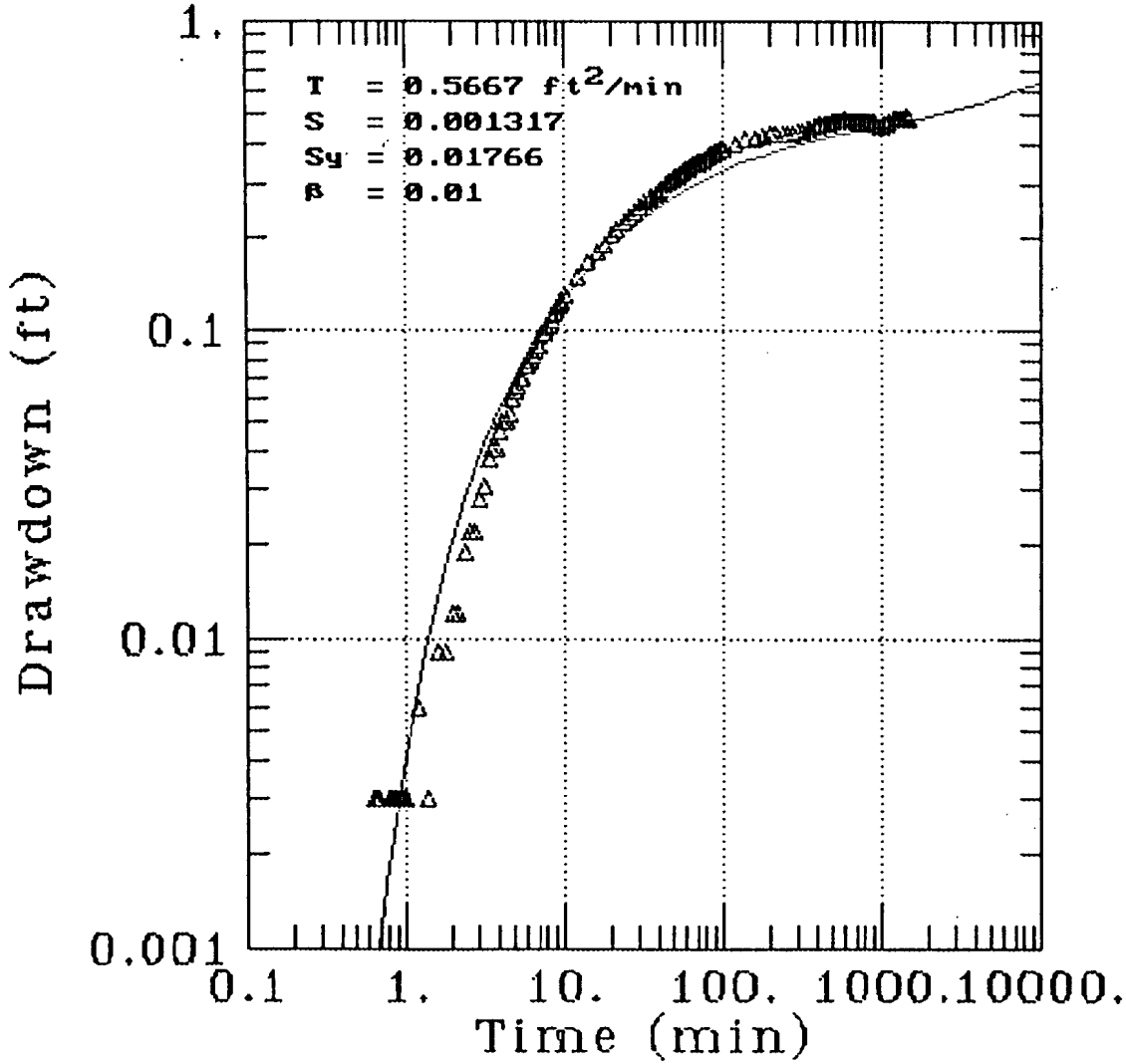
NSB KingsBay IM:Initial Pumping Test/PS2



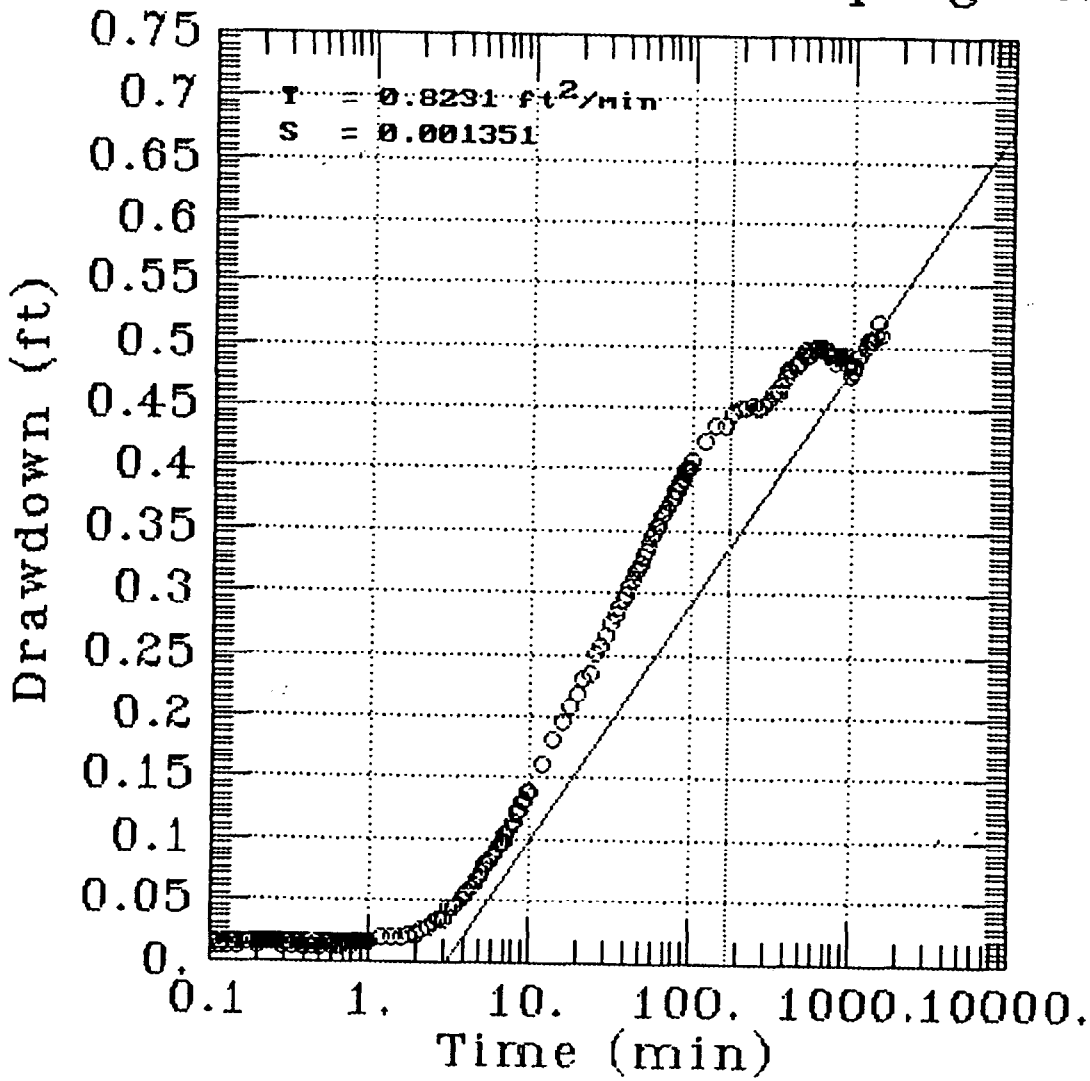
NSB KingsBay IM:Initial Pumping Test/PS2



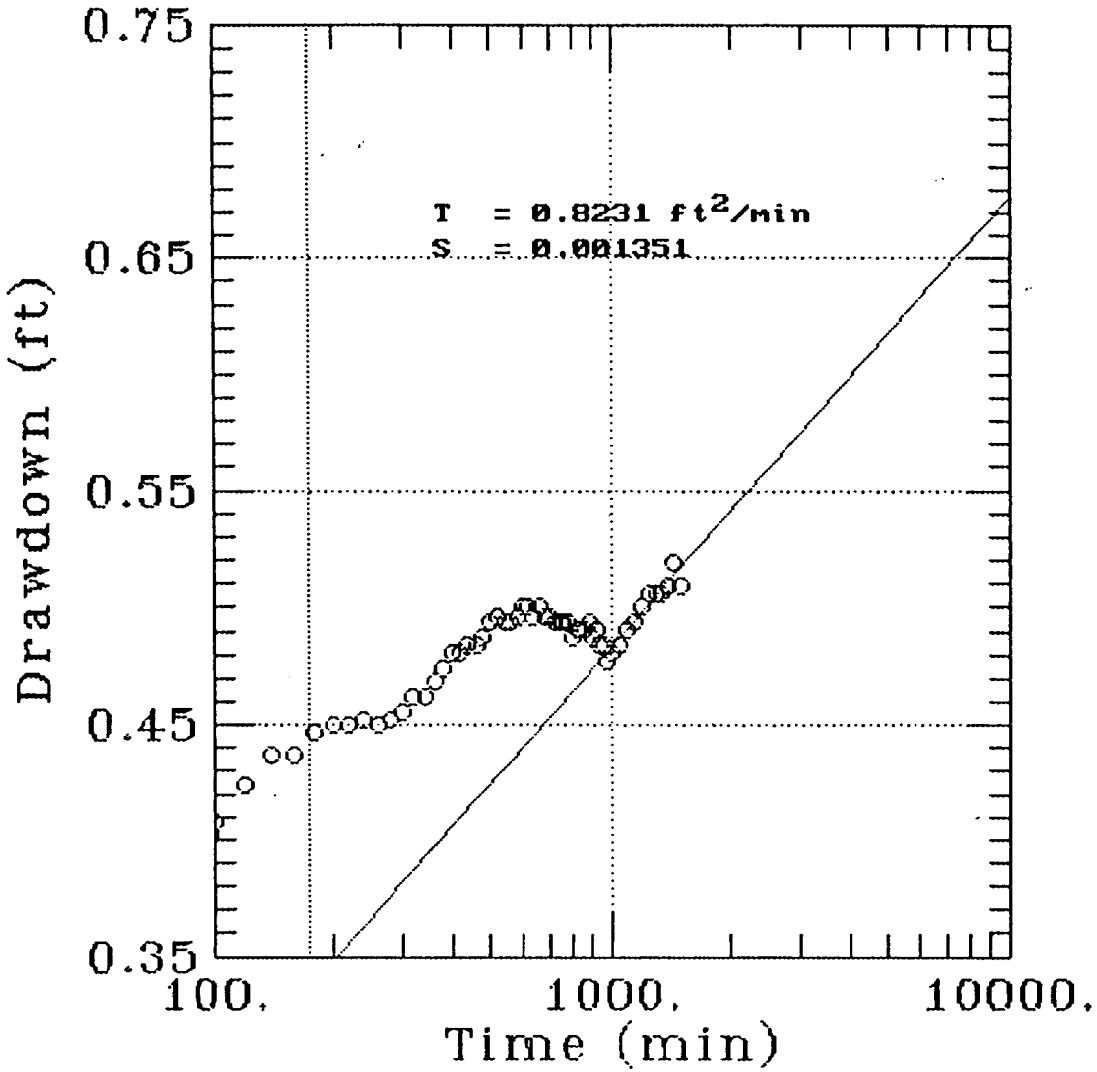
NSB KingsBay IM:Initial Pumping Test/PS2



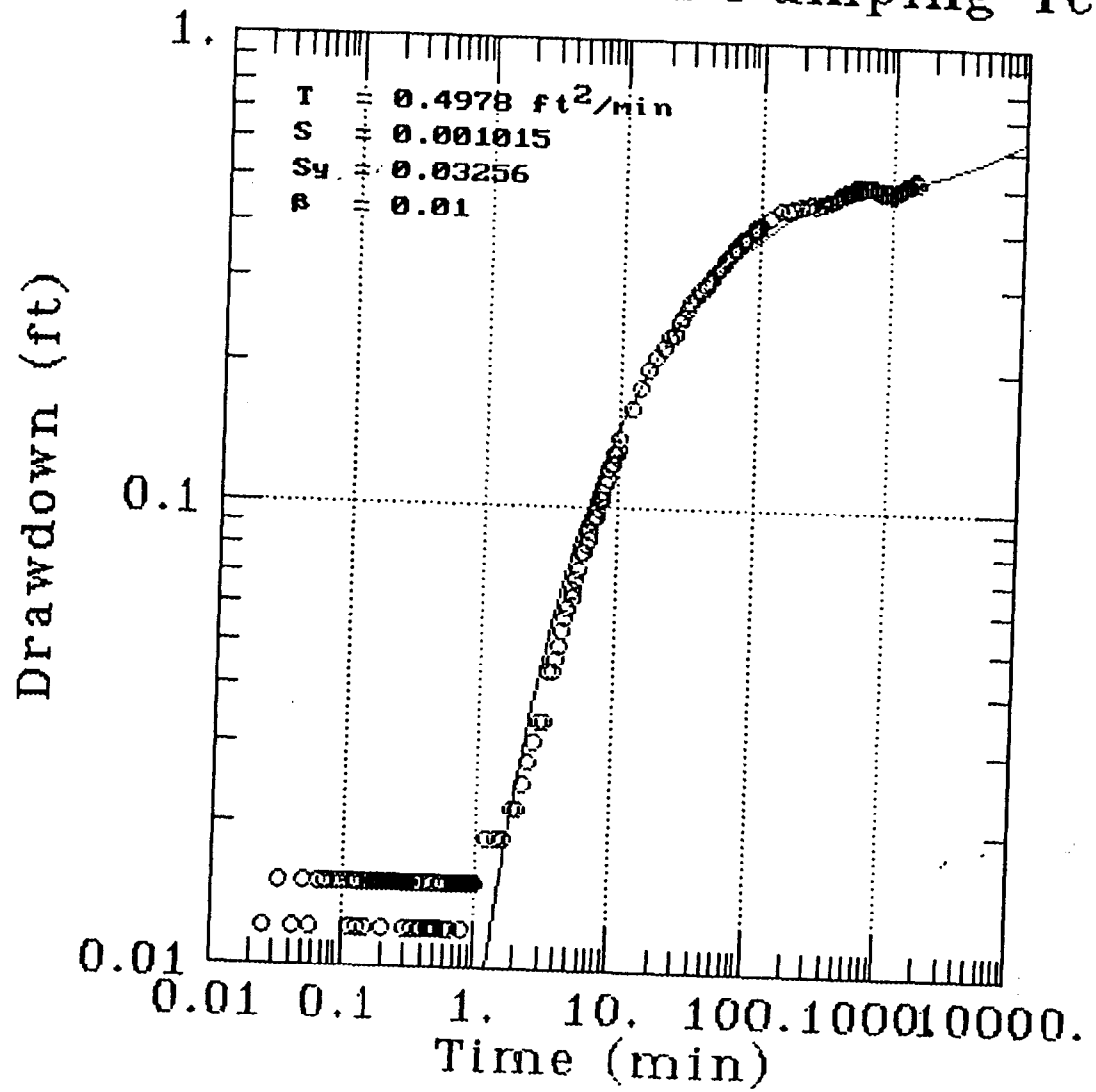
NSB KingsBay IM:Initial Pumping Test/PS3



NSB KingsBay IM:Initial Pumping Test/PS3

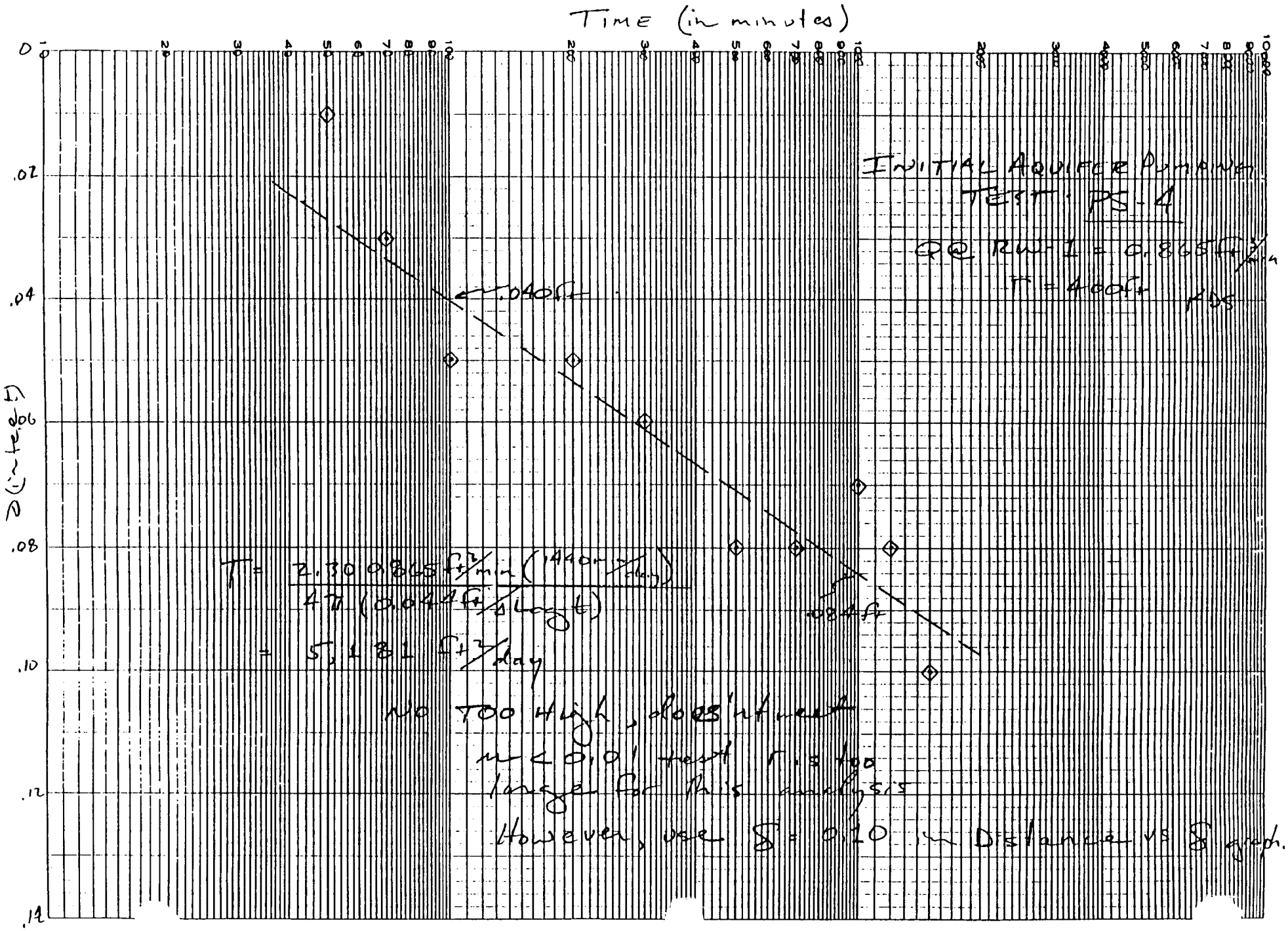


NSB KingsBay IM:Initial Pumping Test/PS3



NO. 341-L310 DIETZGEN GRAPH PAPER
SEMI-LOGARITHMIC
3 CYCLES X 10 DIVISIONS PER INCH

DIETZGEN CORPORATION
MADE IN U.S.A.



INITIAL AQUIFER PUMPING TEST: PS-4

Q @ RW-1 = 0.865 ft³/min

T = 400 ft ADS

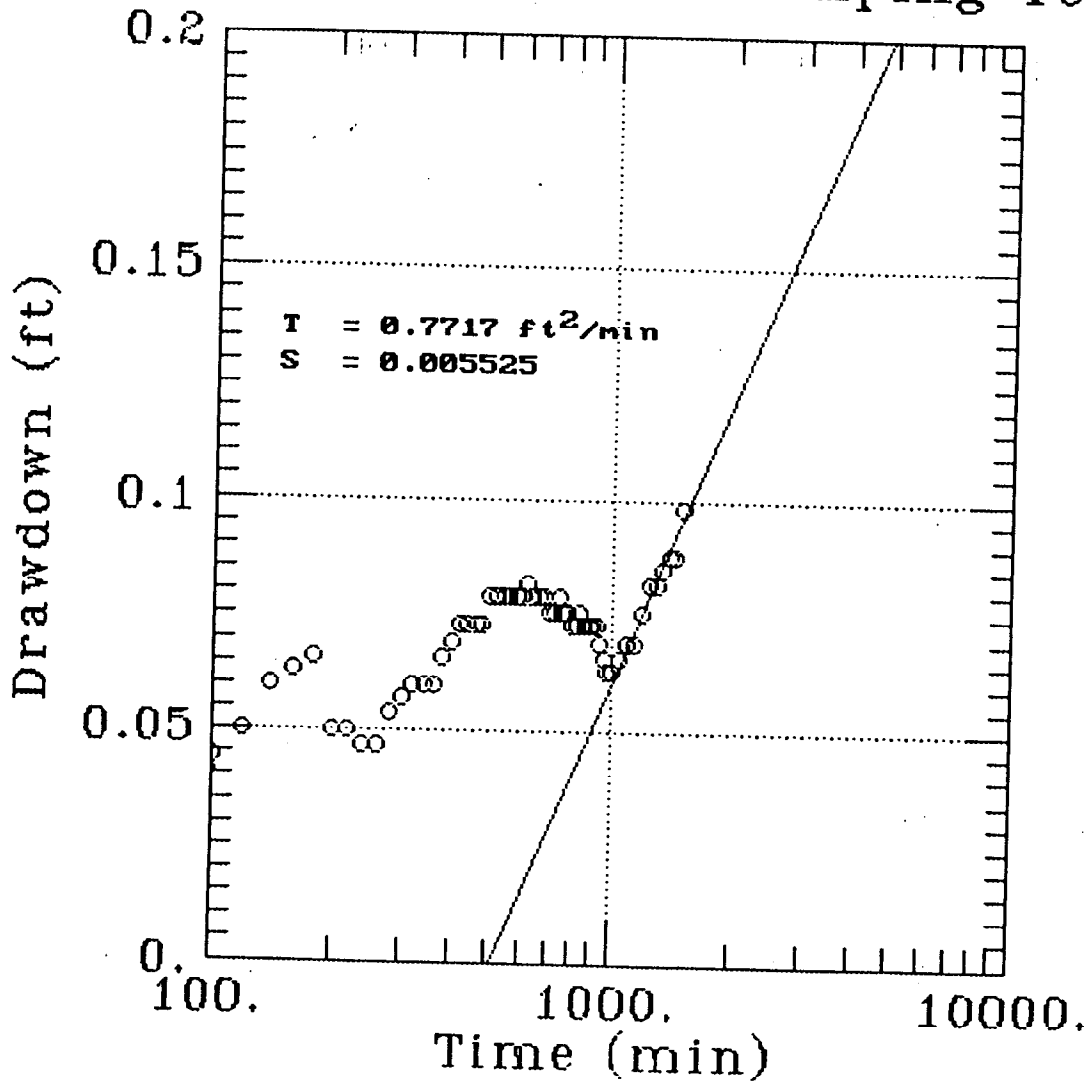
$$T = \frac{2.30\ 0.865\ ft^3/min\ (1440\ min/day)}{4\pi\ (0.044\ ft/\Delta\ Log\ t)}$$

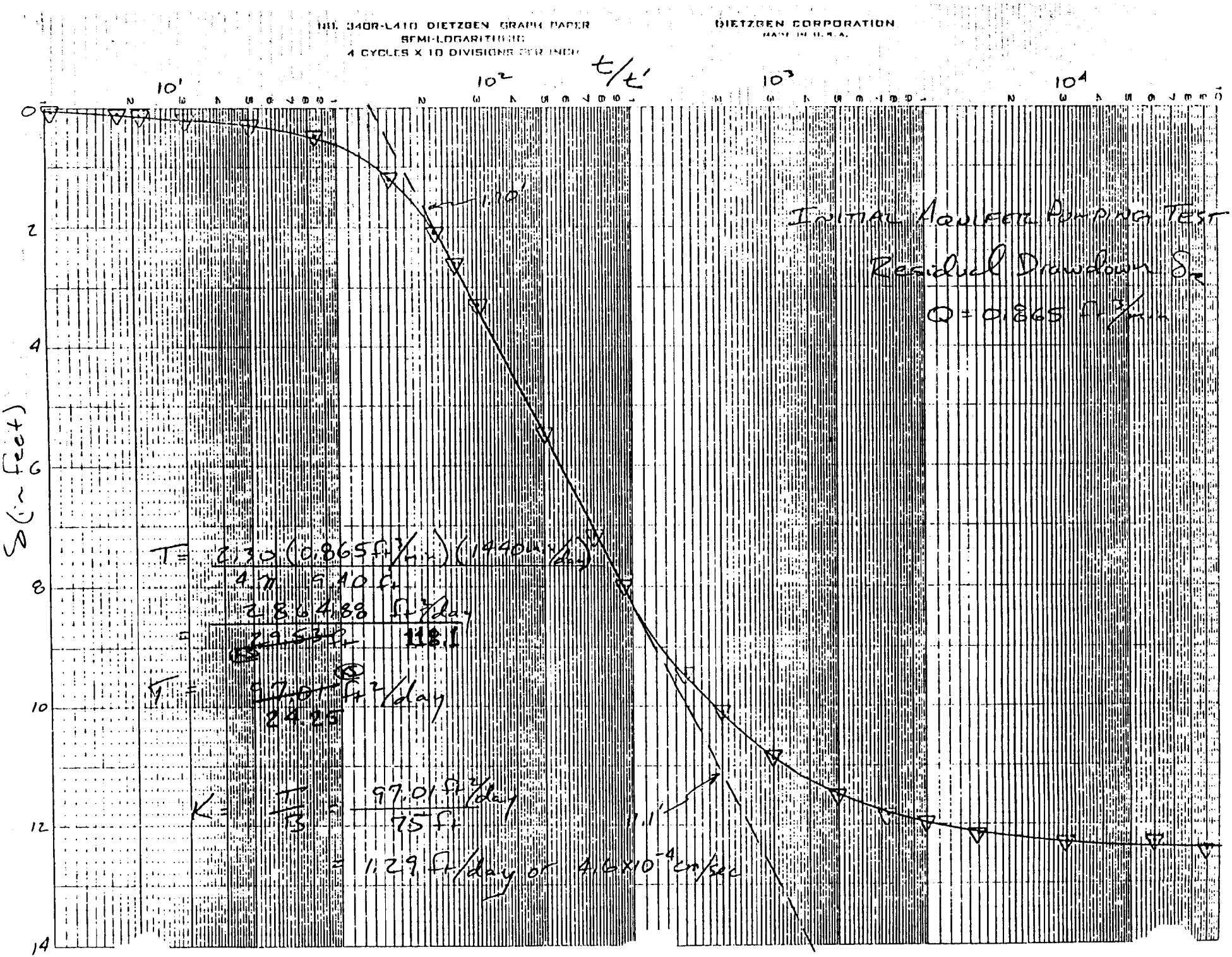
$$= 5{,}181\ ft^2/day$$

NO TOO High, does not meet u < 0.01 test, T is too large for this analysis

However, use S = 0.10 in Distance vs S graph.

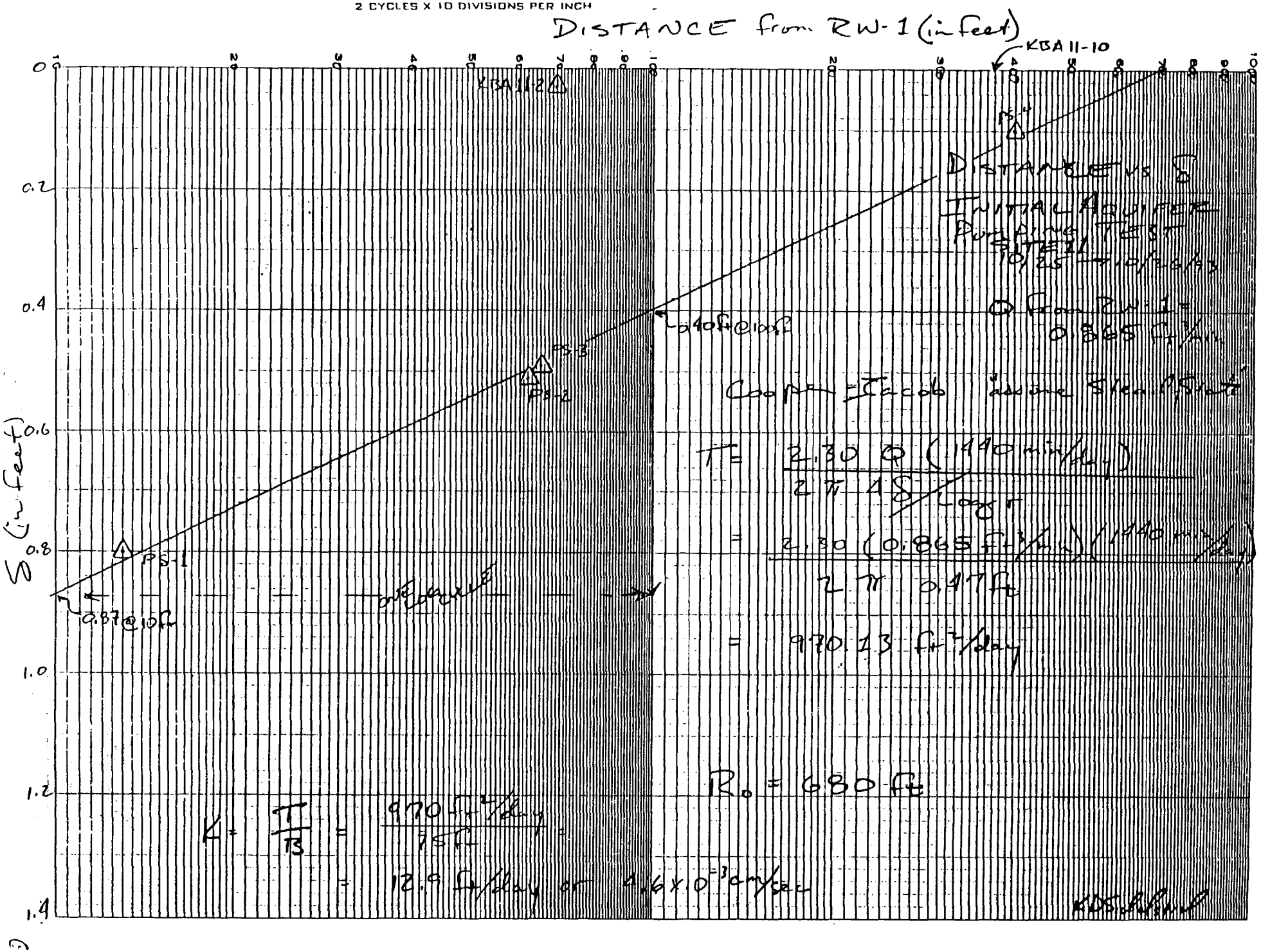
NSB KingsBay IM:Initial Pumping Test/PS4

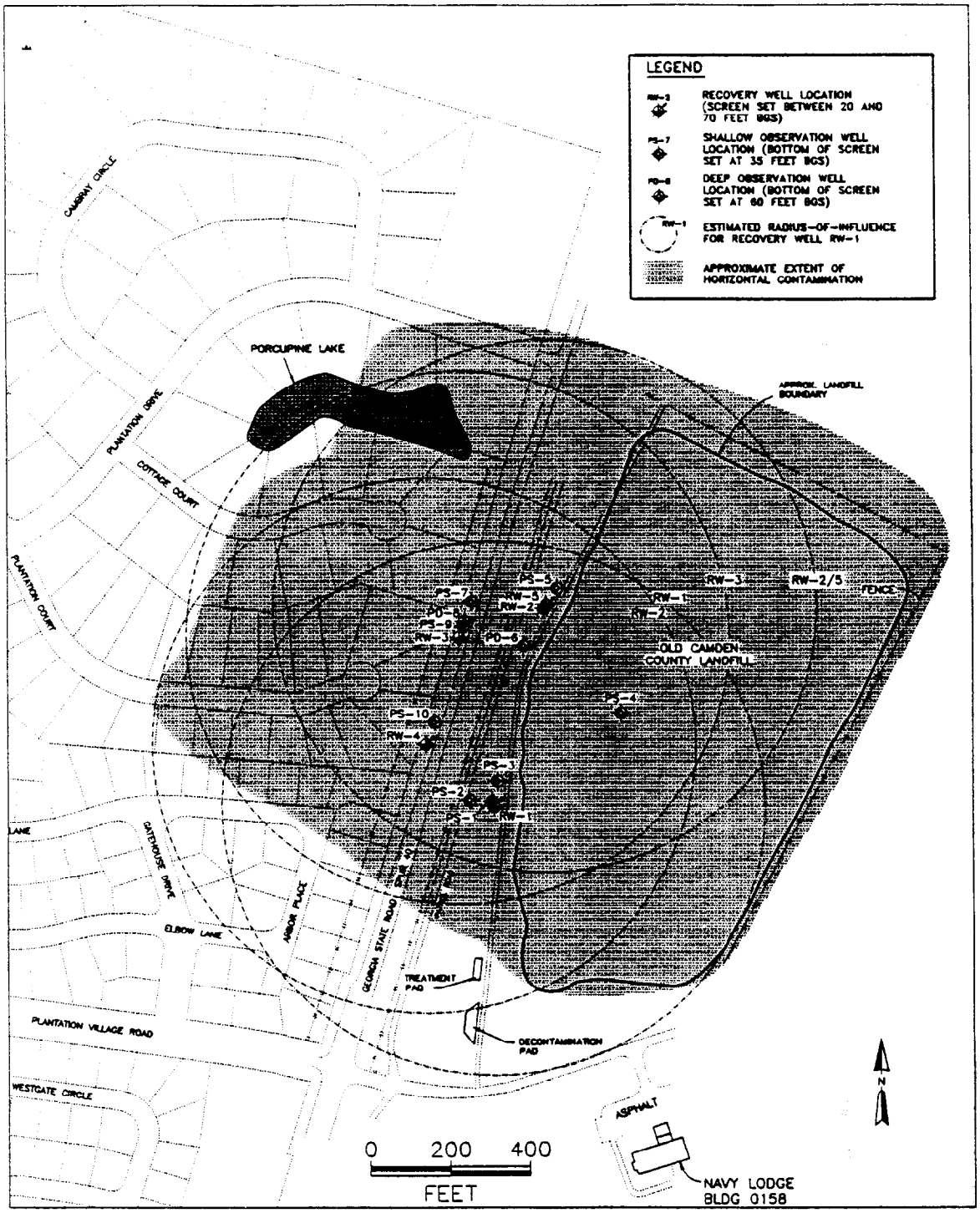



NO. 340R-L410 DIETZGEN GRAPH PAPER
SEMI-LOGARITHMIC
4 CYCLES X 10 DIVISIONS PER INCH
DIETZGEN CORPORATION
MADE IN U.S.A.
t/t'
10¹
10²
10³
10⁴
s (in feet)
0
2
4
6
8
10
12
14
1.10'
1.1'
INITIAL AQUIFER PUMPING TEST
Residual Drawdown S_R
Q = 0.865 ft³/min
T = 2.30 (0.865 ft³/min)(1440 min/day) / 4π (5.40 ft)
= 2804.88 ft²/day / 67.95 ft
= 41.3
T = 97.01 ft²/day / 24.25
K = T/B = 97.01 ft²/day / 75 ft
= 1.29 ft/day or 4.6×10⁻⁴ cm/sec

NO. 341-L210 DIETZGEN GRAPH PAPER
SEMI-LOGARITHMIC
2 CYCLES X 10 DIVISIONS PER INCH

DIETZGEN CORPORATION
MADE IN U.S.A.





CHEM\MAPS\3-948.dwg

DWN: NLW	PROJECT NO.: 08503	TITLE: PROJECTED ESTIMATE OF RADIUS-OF-INFLUENCE SURROUNDING RECOVERY WELLS	IM TECHNICAL MEMORANDUM
CHKD: KDS	FIGURE NO.: APP.E		NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
DATE: 03/20/94			