MUNICIPAL LIGHT AND POWER PLANT NO.1

SOIL AND GROUNDWATER INVESTIGATION

PREPARED FOR

MUNICIPAL LIGHT AND POWER
1200 EAST 1ST AVENUE
ANCHORAGE, ALASKA

Prepared By

RZA-AGRA
711 "H" Street, Suite 450
Anchorage, Alaska

JANUARY, 1992

A-1272

RZA-AGRA
Engineering & Environmental Services

AGRA
Earth & Environmental Group

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January 17, 1992 A-1271

Municipal Light and Power
1200 East 1st Avenue
Anchorage, Alaska 99501

Attention: Mr. Peter Smithson

Subject: Final Report for
Municipal Light and Power Plant No. 1
Soil And Ground Water Investigation

Dear Mr. Smithson:

In accordance with your authorization RZA-AGRA has completed a soil and groundwater investigation at the subject site. A draft copy of the report was provided to your office for review on October 22, 1992. The draft copy was returned to RZA-AGRA on January 15, 1992 with comments and edits from ML&P and your contractor (Stone and Webster Engineering Corporation). We have modified the report as requested. The final copy is enclosed.

RZA-AGRA would like to this opportunity to address the report and the comments Stone & Webster provided to ML&P.

1.) It was noted that the water quality data for he PCB is suspect as a result of the sampling technique by RZA-AGRA. We would like to note the sampling procedures were followed as stated in the work plan prepared for this project. Stone and Webster indicated that, bailing wells could produce an artificial head which could result in introducing sediments into the water sample. The sediment in the water could then affect the poly chlorinated biphenyl (PCB) analyses. RZA-AGRA agrees with this analogy. However, the coarse grained soils encountered across the project site allows for a rate of groundwater recharge to the monitoring wells which is greater than can what can be removed by purging the wells with a bailer. Thus, the amount of draw down in the well was minimal. The RZA-AGRA geologist who obtained the water samples indicated the draw down was generally less than one foot. This is less than the maximum of 20% draw down recommended by Stone & Webster. Furthermore, RZA-AGRA was not made aware of the type of analyses to be performed on the samples. In order to follow proper sampling and preservation procedures it is imperative that the sampler knows the type of analyses to be performed on the samples.

2.) Stone & Webster has indicated that the Alaska Department of Environmental Conservation (ADEC) does not have a recommended clean-up level for PCB's in ground water. RZA-AGRA refers you to "Interim Guidance for Surface and Groundwater Cleanup Levels" dated September 26, 1990. In this document the ADEC recommends a cleanup level of 0.0005 parts per million for PCB's .

3.) The ADEC has adopted regulations for non underground storage tank contaminated soil clean-up levels. RZA-AGRA recommends that ML&P and Stone & Webster refer to these regulations. The regulations outlines the types of analyses the ADEC requires on soil samples, the data deliverables requirements and the recommended soil clean-up levels. RZA-AGRA has noted that the report final report prepared by Stone & Webster, did not include all analyses types that the ADEC requests, did nor provide complete data packages from the laboratory as the regulations require and has not addressed the soil clean-up matrix.

The recent documentation from Stone & Webster and ML&P recommends that additional sampling be done at Plant # 1. RZA-AGRA would like to assist ML&P in any additional work to be performed at Plant # 1. However, we would like to be better informed as to the type of analyses to be performed on the samples. This will insure that RZA-AGRA is obtaining and preserving samples in the proper manner. Furthermore we could provide input into the type of analyses to be performed. This would insure that the required samples are being collected to meet the ADEC requirements.

RZA-AGRA appreciates the opportunity to assist ML&P in the evaluation of soil and groundwater conditions at Plant # 1. We are available to provide additional services as needed. Should you have any questions or comments or if we may be of additional assistance please call.

Respectfully Submitted,

RZA-AGRA,

James J. Smith
Environmental Geologist

Enclosure; Final Report - Plant # 1 Soil and Groundwater Investigation

cc: Ron Kuczek, Hank Nikkels, Jess Ibarra; ML&P

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January, 1992

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1. SUMMARY

RZA-AGRA performed a soil and groundwater contamination investigation at the Municipal Light and Power (ML&P) Plant NoFROM.1 in Anchorage, Alaska. This investigation provided information regarding the extent and magnitude of contamination from fuel leakage from ML&P above ground fuel storage tanks. RZA-AGRA performed the field exploration program from September 26 to October 7, 1991. Field exploration included: 1) drilling and sampling 9 soil borings; and 2) installation and sampling of 5 monitoring wells.

2.0 PROJECT BACKGROUND

Prior to the 1964 earthquake, Municipal Light and Power had an above ground fuel tank storage facility south and uphill from the present Plant No.1 site near Ship Creek. Possible slope failure during the earthquake caused the ML&P fuel tanks to rupture. The resulting contamination plume extended down-gradient to the ML&P Plant No.1 site. ML&P requested that RZA-AGRA conduct an soil and groundwater investigation to assess the site contamination.

The following sections present information regarding the Municipal Light and Power (ML&P) Plant No.1 site, its surroundings and hydrogeologic conditions in a regional context. Sections 3.0 and 4.0 present information regarding site specific findings.

2.1 Project Scope

The current scope of this work was to investigate soil and groundwater conditions at the ML&P site to determine contaminated areas.For this project RZA-AGRA, investigated soil and groundwater conditions in the area of the Municipal Light and Power Plant No.1 by:

* Preparation of site specific Quality Assurance/Quality Control Plan and Health & Safety Plan for the project. RZA-AGRA submitted the plans to ML&P prior to beginning field work.

* Drilling and sampling soil borings in the vicinity of the ML&P Plant No.1.

* Field screening soil samples using an OVM, to provide a semi-quantitative measurement of headspace vapors in a 1-liter closed jar.

* Installation and sampling of five groundwater monitoring wells around the ML&P Plant No.1 site.

* Complete sample custody documentation for all soil and water samples taken at the site and transfer to ML&P's custody for laboratory analysis.

* Review of regional reference data and well logs to analyze the findings in a regional text.

* Preparation of this report.

2.2 Site Description

The ML&P Plant No.1 is located just north of downtown Anchorage, at 1200 East 1st Avenue in the Ship Creek lowlands (see Figure 1). The Ship Creek lowlands are located at the northern-most perimeter of the Anchorage bowl which lies between the Chugach Mountains to the east and the Cook Inlet to the west. Ground surface at the ML&P site has been leveled for construction to an approximate elevation of 32-feet, relative to mean sea level.

Surface water bodies in the vicinity of the ML&P site include Ship Creek approximately 200-feet north and the Cook Inlet approximately 1/2-mile to the west. Ship Creek drains west-southwest to the Cook Inlet. Ship Creek is considered a tidal tributary near the ML&P site with an average discharge of 162-cubic feet per second, and has drainage area of approximately 117-square miles (United States Geological Survey, 1987).

The ML&P Plant No.1 has been in operation in approximately its present configuration since the early 1960's. The ML&P site consists of gas turbine power plants, switch yards, and buildings housing an office, control and maintenance facilities. The ML&P Plant No.1 site facilities expanded with the addition of a 4,800 square foot (sqf), warm storage building in 1985. Figure 1 shows the location of ML&P site and its surroundings.

The present investigation has focused on soil and groundwater conditions at the ML&P site, located along the Ship Creek lowlands.

2.3 Regional Geology

Anchorage lies within the Cook Inlet-Susitna lowland physiographic subprovince in south-central Alaska. This lowland subprovince is a structural depression that is bounded on all sides, except the southwest, by mountain ranges. These mountains consist of bedrock with a relatively thin mantle of glacial sediments. The lowland generally is filled with glacial and glaciofluvial sediments up to 1,500-feet thick, overlying deeper tertiary strata. Figure 3 indicates a typical geologic cross-section through the Anchorage Bowl. The map indicates the approximate location of the ML&P Plant No.1 site, and the general stratigraphic variability which alternates from alluvial sand and gravels to marine or lacustrine clayey soils.

The near-surface stratigraphy of the Anchorage area is the product of alternating Quaternary glaciations and interglacial periods (Schmoll & Dobrolovny, 1972). It is generally accepted that Anchorage and adjacent areas have been subjected to at least five major Pleistocene glaciations. Sediments associated with the two youngest glaciations are generally present at or near surface in the Anchorage area. During the warm interglacial period between these two glaciations, the sea level rose and apparently created marine or estuarine conditions in the area. Radiocarbon dating suggest that this interglacial period occurred more than 47,000 years ago. The complex history is recorded in glaciofluvial, glacial-lacustrine, glacial-marine and eolian sediments that are associated with specific landforms such as the Elmendorf Moraine which is approximately 2-miles north-northeast of ML&P site. This moraine marks the northern maximum extent of the most recent Naptowne Glaciation in the Anchorage Bowl (see Figure 3). In the northern part of the Anchorage Bowl, glacial reworking and subsequent marine and fluvial processes formed the present Ship Creek lowlands.

2.4 Regional Hydrogeology

Groundwater in the Anchorage metropolitan area comes from unconfined and deeper confined aquifers. Unconfined aquifers are present in shallow alluvium in the west-northwestern lowlands of Anchorage and in Tertiary and Mesozoic metamorphic rocks exposed in the eastern foothills. Groundwater flow in the unconfined aquifers generally follows topographic and surface drainage patterns. Recharge to the water table occurs throughout the area by deep percolation, inflow from streams and by upward flow from the confined aquifers. Wells in surficial Holocene sand and gravel aquifers of the west-northwestern lowlands yield from 50 to 1,000- gallons per minute (gpm). Discharge occurs by outflow to streams, seeps, pumping, evaportranspiration, and downward flow to confined aquifers.

The Upper and Lower Confined Aquifers utilized by Anchorage are restricted to the central lowland areas in thick deposits of Pleistocene glacial outwash and marine sediments. The extent of the confined aquifer system is controlled primarily by the distribution of the principle confining unit, the Bootlegger Cove Formation, overlying the Upper Confined Aquifer. Another, deeper clayey confining bed separates the Upper and Lower Confined Aquifers at a depth ranging from approximately 150 to 200-feet. The majority of the groundwater utilized by Anchorage comes from the confined aquifers.

Natural groundwater flow in the confined aquifers of the west-northwestern lowlands is generally from the east to the west toward Cook Inlet. Pumping alters this natural flow during periods of heavy withdrawal. Recharges occur primarily in the east where the Bootlegger Cove Formation is absent or permeable and the aquifers are exposed to the surface at relatively high elevations. This allows recharge from

stream infiltration and deep percolation. Discharge occurs in the west-northwest, where the Bootlegger Cove Formation is eroded or more permeable, by outflow to estuaries, coastal springs, and the upward flow to the unconfined aquifers. Pumping is also a significant discharge mechanism.

Exchange between the unconfined and confined aquifers is controlled primarily by the Bootlegger Cove Formation and vertical hydraulic difference between the two aquifer systems. The Bootlegger Cove Formation is composed of clay, silt, poorly sorted clayey gravel, and till. The formation is relatively thick (approximately 100 to 120-feet), and impermeable, restricting vertical groundwater flow in the Ship Creek lowlands and in the central lowlands to the south. A typical well log of soil conditions from the Anchorage Bowl is presented in Figure 3.

3.0 FIELD WORK PREPARATIONS

Prior to commencing field operations RZA-AGRA and ML&P representatives discussed the scope of work and procedures for this study. A work plan for the project was prepared by ML&P, dated November 1, 1990. As required, RZA-AGRA prepared and submitted a site specific Quality Assurance/Quality Control Plan and Health & Safety Plan to ML&P on September 23, 1991, prior to commencing field operations. All field personnel were provided copies and were aware of the provisions of the plans. All field personnel and vehicles obtained security clearances for entry into restricted access areas of the ML&P Plant No.1 site.

Proposed boring locations were selected based on locations requested by AML&P, accessibility to drilling sites, and approximate locations of utilities from blueprints provided from ML&P. RZA-AGRA contacted all utilities and located them in the field prior to drilling. Several borings were moved from the proposed locations to avoid utility lines.

Prior to mobilization, the drill rig, augers, and all sampling tools were thoroughly decontaminated by high-pressure washing and steam-cleaning. A storage area for equipment,supplies, and drill cuttings in 55-gallon drums was established inside the Plant fencing, directly behind the main gate guard house at the southwest entrance (see Figure 4).

3.1 Subsurface Exploration

Field drilling began on September 26, 1991. Drilling times and locations were coordinated with ML&P representatives to avoid conflicts with maintenance activities. Ambler drilled nine borings. Ambler and RZA-AGRA installed five monitoring wells around the gas turbine generator building and at upper and lower site gradients (see Figure 4). Drilling was completed on September 30, 1991.

Figure 4 displays locations of soil borings, monitoring wells, maintenance and control buildings, and switchyards. Surveyed elevations of the ground surface of each boring relative to an on site datum of 33.50-feet above mean sea level are shown on the boring logs and Table 3. This elevation was taken from a temporary benchmark on a water utility cover south of the 34 kv switchyard.

Borings were designated by a boring number (i.e. B-1 or B1). All bore logs indicated that the soil types based on the unified ASTM:D 2488 classification, the type of sampling performed, and the results of field OVM screening. Table 2 summarizes this data. The boring logs also detailed the construction of the five monitoring wells.

Soil Borings were drilled by a truck mounted, Mobile B-61 drill rig, equipped with 3'3/8" inside diameter, continuous flight hollow stem auger. Drilling tools and augers were steam cleaned off-site prior to drilling each boring. Drill cuttings were bagged and transported to the on-site storage area. There, they were placed in 55 gallon drums on pallets for ML&P to handle at their discretion. Borings were drilled to depths ranging from 11.5 to 20-feet below ground surface. This depended on the soil and groundwater conditions encountered. Borings B-2, B-3, B-4, B-7, and B-9 were drilled into the top of the confining silt and clay. Borings B-1, B-5, B-6, and B-8 were drilled to at least 4-feet below the groundwater table.

Grab samples were obtained at the surface. Split spoon (2-inch diameter) samples conforming to ASTM:D 1586 were then taken at 5- foot intervals. At least two samples from each boring were collected between the ground surface and the groundwater. One sample was always taken at the groundwater table. Split spoon samples were also taken at 5-foot intervals below the groundwater table to the bottom of the borings. The sampling interval between borings was staggered, so that samples were not obtained from the same elevations (see Table 2).

3.1.1 Soil Sample Handling

Split spoon samplers were decontaminated prior to each use following procedures outlined in the QA/QC plan prepared for this project. Upon sample retrieval, portions of each sample were bottled in laboratory prepared jars for analysis. A second portion of the sample was placed in a clean quart jar with a sealed lid for field screening. All laboratory samples were held in chilled coolers under RZA-AGRA's custody. Samples were then logged into Chain-of-Custody documentation and transferred to ML&P custody for laboratory analyses at their discretion.

3.1.2 Soil Sample Field Screening

All soil samples were screened by headspace analysis using the OVM to detect organic vapor concentrations. Field headspace screening procedures were outlined in the project QA/QC plan. This screening technique proved relatively consistent.

3.2 Monitoring Well Installations

Five monitoring wells were installed at locations selected to determine the direction and gradient of groundwater migration. The wells allowed sampling of the groundwater. Monitoring wells were installed in borings B-2, B-3, B-4, B-7, and B-9. The soil boring logs in Appendix A provide details of the monitoring well construction..

Well depths range from approximately 14.6 to 18.5-feet below the ground surface. Monitoring wells were constructed of two-inch diameter, schedule 40 PVC casing. The casing had 10 to 15-feet of 0.0125-inch slotted well screen installed near the groundwater table. Approximately 3 to 5-feet of the well screen was extended above the groundwater table to allow observation of any free product.

The well screen sections were surrounded by a sand filter pack from 1-foot above the screen to 1/2-foot below the casing bottom. Bentonite seals were placed above the screen section. Flush mounted protective covers were installed in concrete at the ground surface. The top of the well casings were equipped with water-tight locking plugs. The protective casings are clearly labeled "Monitoring Well" to avoid confusion with other plant utilities.

Monitoring wells were developed by bailing to remove silt and increase communication with the surrounding formation. Five well volumes of approximately 20 to 25-gallons were removed with adequate groundwater recharge. Elevations were surveyed for both the ground surface and top of well casing, so accurate water level measurements can be taken. Top of casing elevations are indicated on the boring logs.

3.3 Monitoring Well Sampling

On October 7, 1991, groundwater samples were obtained from the five monitoring wells for laboratory analyses. Prior to disturbing the wells, stabilized groundwater measurements were taken with an electronic water level indicator (0.01-foot accuracy).The standing water was then purged using disposable polyethylene bailers attached to new nylon rope to prevent cross-contamination of samples. Monitoring wells B-2, B-3, and B-9 recharged readily while wells B-4 and B-7 recharged at a slower rate. All wells were developed by removing at least three well volumes before sampling. All water samples plus a duplicate were kept chilled until logged into Chain-of-Custody documentation and transferred to ML&P custody for laboratory analyses at their discretion.

4.0 SITE CONDITIONS

4.1 Soil Conditions

Soil conditions encountered by our subsurface exploration were primarily interlayered strata of sandy gravels and gravelly sands with intermitten fine silts and sands, and sandy clay with gravel. Soil strata was generally observed to have gradational transitions between soil types rather than distinct contacts. Detailed descriptions of the soils (conforming to ASTM: D 2488) encountered at each boring location are provided on the soil boring logs in Appendix A. Two generalized cross-sections indicating major soil transitions and groundwater elevations are shown on Figures 5 and 6.

At all of the boring locations, the ground surface was either paved with asphalt of 3 to 6-inch thickness with approximately 6-inches of sandy gravel fill or solely the 6-inch gravel fill. The transition to native, gravelly sand soils was not distinct at most boring locations.

The shallow native soil conditions were characterized as medium dense to dense, brown, sandy gravel to gravelly sand with intermitten fine silty sand overlying sandy clay with gravel. In borings on the west-northwest section of the site (B-1, B-2, B-3, B-5, and B-8), the shallow silt was grey in color and intermixed with fine gradational sand-pea gravel lenses of a possible fluvial- sand bar deposition. In borings on the east-northeast section of the site (B-4, B-6, B-7, and B-9), the shallow silt was brown in color and intermixed with coarse gradational sand-gravel-cobble lenses of a possible fluvial channel deposition.

Five of the nine borings drilled on the ML&P site intercepted the upper confining clay strata at 14.5 to 18-feet below ground surface (B-2, B-3, B-4, B-7, and B-9). The clay unit was generally stiff, moist, grey to blue-grey, sandy clay with gravel with moderate to high plasticity.

4.2 Groundwater Conditions

Groundwater was encountered in all of the borings. Shallow perched groundwater was noted to be associated with intermitten clayey silt lenses. Soil conditions were generally moderately moist to wet. It is likely that moderate to good surface water infiltration occurs in this area due to limited paved surfaces and structures.

Groundwater was encountered in the following borings at the noted depths and approximate elevations:

TABLE 1: GROUNDWATER AT TIME OF DRILLING

Boring Number	Depth (feet)	Approximate Elevation(ft)
B-1	6.0	25.72
B-2	6.0	23.19
B-3	6.0	26.85
B-4	6.0	27.51
B-5	6.0	25.84
B-6	6.5	26.72
B-7	5.5	27.70
B-8	8.0	23.56
B-9	8.5	24.67

Due to the silty soil conditions, these groundwater levels may not be representative of stabilized water levels since they are short-term measurements of seepage into the augers during drilling. Longer-term measurements were obtained from the five installed monitoring wells. On October 7, 1991, groundwater sampling was conducted with stabilized water measurements obtained for the following monitoring wells:

TABLE 2: STABILIZED GROUNDWATER ELEVATIONS

Monitoring Well No.	Depth (feet)	Elevation MSL (ft)
B-2	4.2	24.54
B-3	4.5	27.89
B-4	5.5	27.68
B-7	4.2	28.47
B-9	5.7	27.20

The inferred groundwater elevation contours based on these measurements are indicated on Figure 7. Although silty conditions amidst the shallow alluvial soil may slightly mask local variations in groundwater elevation, these inferred contours represent the general trend of groundwater flow towards Ship Creek, west-northwest.

This appears consistent with the regional trends noted in the unconfined aquifers amidst shallow alluvium in the northwestern lowlands of Anchorage. Groundwater flow in the unconfined aquifers in the Anchorage Bowl generally follow surface drainage patterns, which is indicative of the ML&P Plant No.1 site.

Based on the October 7, 1991, measurements, several hydraulic gradients were calculated for the plant site. The first hydraulic gradient was 0.005 ft/ft with a total elevational difference of 0.9-feet between borings B-5 and B-6. The second hydraulic gradient was calculated for the northwest contour transition area (see figure 7), and was found to be 0.012 ft/ft with a total elevational difference of 3.93-feet between boring B-5 and monitoring well B-2.

Groundwater sampling of the five monitoring wells was conducted on October 7, 1991. The water samples correspond to their respective well locations as follows:

Table 4: Groundwater Sampling

Sample No.	Monitoring Well No.
WS-1	MW-9
WS-2	MW-7
WS-3	MW-4
WS-4	MW-3
WS-5	MW-2
WS-6*	MW-3

Remarks: * denotes duplicate sample for quality control.

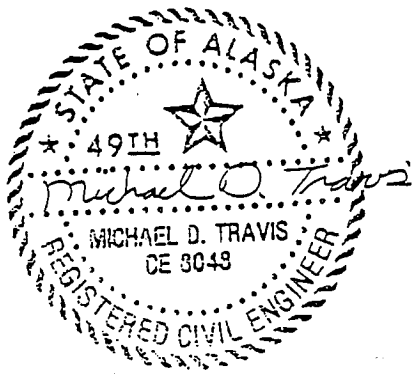
5.0 CLOSURE

RZA-AGRA, has been pleased to be of service to you. If you have any questions regarding the information contained in this report or if we may be of any further assistance, please feel free to contact us.

Respectfully submitted,
RZA-AGRA

Mark W. Rogers
Project Geologist

Michael D. Travis, P.E.
Environmental Services Manager



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PROJECT *ML & P GENERATION PLANT NO. 1* W.O. *A-1271* BORING NO. *B-1*

Elevation reference: *Temporary Bench Mark 33.5 Feet*
Ground surface elevation: *31.72* Casing elevation: *N/A*

AS-BUILT DESIGN

SOIL BORING ONLY;
NO MONITORING WELL INSTALLED.

TESTING

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	OVM READING	GROUND WATER
0	*Loose, moist, brown, SP. Sand with gravel.*	■	S-1			
	Dense, moist, brown, SP. Sand with gravel. Fine sand/gravel with oxidation.	I	S-2	42	2	
5	*Dense, wet, brown to brown-grey, SP → SP-SM. SAND with gravel to SAND with silt and gravel. High diesel odors.*	I	S-3	64	273	ATD
10	*Dense, wet, salt-n-pepper to brown-grey, SM → SP-SM. Silty SAND with gravel to SAND with silt and gravel. Trace diesel odors.*	I	S-4	64	39	
	Boring terminated at approximately 11.5 feet.					
15						
20						
25						
30						

LEGEND

■ Grab Sample

I 2-inch O.D. split-spoon sample

ATD Observed groundwater level (ATD = at time of drilling)

RZA - AGRA
Engineering & Environmental Services
711 "H" Street, Suite 450
Anchorage, Alaska 99501-3442

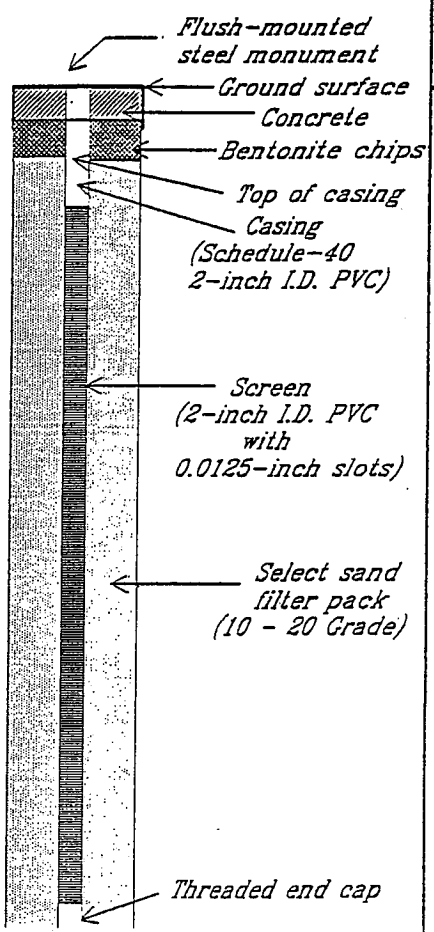
Drilling started: *25 September 1991* Drilling completed: *25 September 1991* Logged by: *MWR*

PROJECT ML & P GENERATION PLANT NO. 1 W.O. A-1271 WELL NO. B-2

Elevation reference: Temporary Bench Mark 33.5 Feet
Ground surface elevation: 29.19 Casing elevation: 28.74

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	OVM READING	GROUND WATER
0	Loose, moist, brown, SP-SM. SAND with silt and gravel. Trace diesel odors.	■	S-1		9	
	Dense, moist, brown to grey-brown, SP-SM. SAND with silt and gravel. Trace diesel odors.	I	S-2	49	6	
5	Loose, wet, brown to grey-brown, SP-SM. SAND with silt and gravel. Pulpy organics and high diesel odors.	I	S-3	17	144	ATD
10	Dense, wet, brown-grey, SP-SM. SAND with silt and gravel. Trace clayey silt and moderate diesel odors.	I	S-4	63	249	
15	Dense, moist, salt-n-pepper to blue-grey, SM→CL. Silty SAND with gravel to sandy lean clay with gravel. Trace diesel odor.	I	S-5	35	55	
	Boring terminated at approximately 18 feet.					
20						
25						
30						

AS-BUILT DESIGN



TESTING

LEGEND

■ Grab Sample

I 2-inch O.D. split-spoon sample

▼ ATD Observed groundwater level (ATD = at time of drilling)

RZA - AGRA
Engineering & Environmental Services

711 "H" Street, Suite 450
Anchorage, Alaska 99501-3442

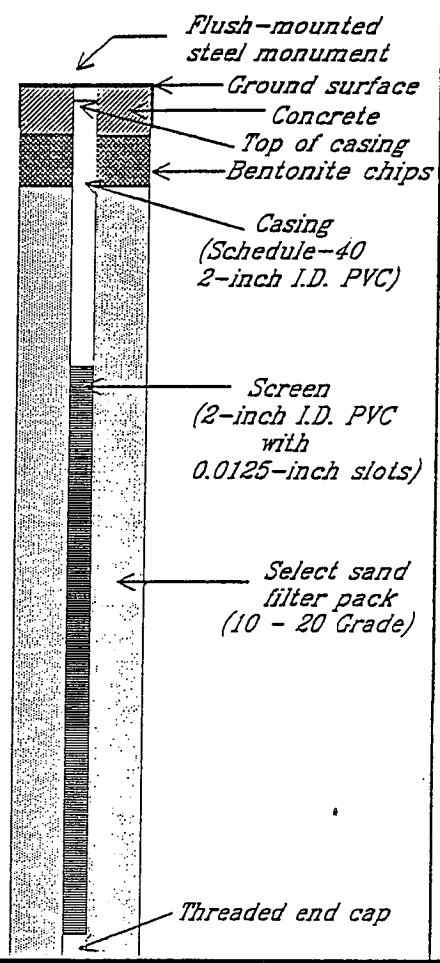
Drilling started: 27 September 1991 Drilling completed: 27 September 1991 Logged by: MWR

PROJECT *ML & P GENERATION PLANT NO. 1* W.O. *A-1271* WELL NO. *B-3*

Elevation reference: *Temporary Bench Mark 33.5 Feet*
Ground surface elevation: *32.85* Casing elevation: *32.39*

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	OVM READING	GROUND WATER
0	*Dense, moist, brown, SP. SAND with gravel. Trace diesel odors.*	■	S-1		40	
	Loose, moist, brown, SP-SM. SAND with silt and gravel. SILT-CLAY with moderate diesel odors.		S-2	24	188	
5	*Brown to grey-brown, SP-SM. SAND with silt and gravel. Same as above. High diesel odors.*		S-3	16	265	ATD
	Loose, wet, brown-grey, SM. Silty SAND with gravel. High diesel odor.		S-4	19	249	
10						
15	*Stiff, moist, brown-grey to grey, SC. Clayey SAND with gravel. Organics and mod diesel odors.*		S-5	37	78	
20	*Stiff, moist, blue-grey, CL. Sandy, lean, CLAY. Fine grad sand/gravel.*		S-6	16	19	
	Sampling terminated at approximately 20 feet.					
25						
30						

AS-BUILT DESIGN



Monitoring well terminated at approximately 18.5 feet.

TESTING

LEGEND

■ Grab Sample

I 2-inch O.D. split-spoon sample

ATD Observed groundwater level (ATD = at time of drilling)

RZA - AGRA
Engineering & Environmental Services
711 "H" Street, Suite 450
Anchorage, Alaska 99501-3442

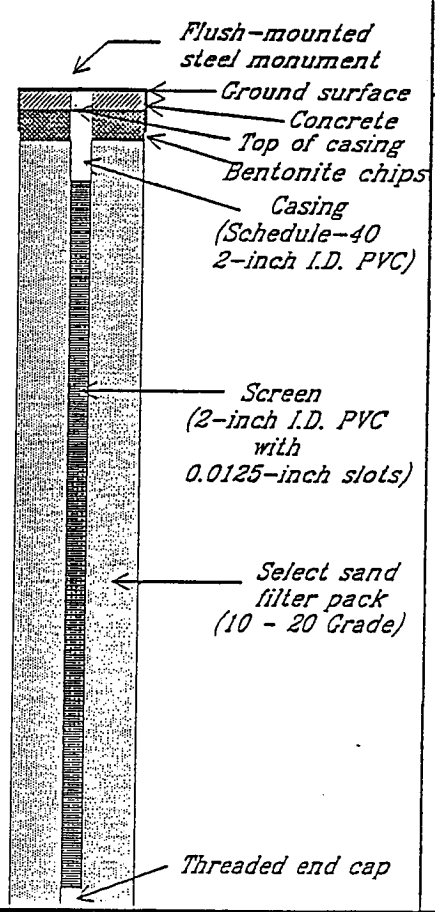
Drilling started: *26 September 1991* Drilling completed: *26 September 1991* Logged by: *MWR*

PROJECT *ML & P GENERATION PLANT NO. 1* W.O. *A-1271* WELL NO. *B-4*

Elevation reference: *Temporary Bench Mark 33.5 Feet*
Ground surface elevation: *33.51* Casing elevation: *33.18*

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	OVM READING	GROUND WATER
0	*Loose, moist, brown, SP. SAND with gravel.*	■	S-1		11	
	Dense, moist, brown to brown-grey, SP-SM. SAND with silt and gravel. Trace diesel odors.		S-2	46	8	
5	*Dense, wet, brown-grey. SP-SM. SAND with silt and gravel. Moderate diesel odor.*		S-3	52	18	ATD
10	*Dense, wet, brown-grey, SP-SM. Silty SAND with gravel. Fine sand/gravel.*		S-4	56	7	
15	*Stiff, moist, brown-grey to blue-grey, SC → CL. Clayey SAND to sandy, lean CLAY. Fine sand.*		S-5	27	5	
	Boring terminated at approximately 17.5 feet.					
20						
25						
30						

AS-BUILT DESIGN



TESTING

LEGEND

■ Grab Sample

I 2-inch O.D. split-spoon sample

▼ ATD Observed groundwater level (ATD = at time of drilling)

RZA - AGRA
Engineering & Environmental Services
711 "H" Street, Suite 450
Anchorage, Alaska 99501-3442

Drilling started: *26 September 1991* Drilling completed: *26 September 1991* Logged by: *MWR*

PROJECT *ML & P GENERATION PLANT NO. 1* W.O. *A-1271* BORING NO. *B-5*

Elevation reference: *Temporary Bench Mark 33.5*
Ground surface elevation: *31.84* Casing elevation: *N/A*

AS-BUILT DESIGN

SOIL BORING ONLY;
NO MONITORING WELL INSTALLED.

TESTING

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	OVM READING	GROUND WATER
0	*Loose, moist, brown, SP. Sand with gravel.*	■	S-1		3	
	Dense, moist, brown, SP → SP-SM. SAND with gravel to SAND with silt and gravel. Clayey silt lenses with trace diesel odors.	I	S-2	72	12	
	Dense, moist, brown-grey, SP-SM. SAND with silt and gravel. Clayey silt lenses with high diesel odors-organics.	I	S-3	26	184	
5						▼ ATD
	Dense, wet, brown to brown-grey, SP-SM. SAND with silt and gravel. Coarse sand/gravel and high diesel odors-sheen.	I	S-4	37	308	
10	*Dense, wet, salt-n-pepper to brown-grey, SM → SP-SM. Silty SAND with gravel to SAND with silt and gravel. High diesel odors-sheen.*	I	S-5	83	290	
	Boring terminated at approximately 11.5 feet.					
15						
20						
25						
30						

LEGEND

■ Grab Sample

I 2-inch O.D. split-spoon sample

▼ ATD Observed groundwater level (ATD = at time of drilling)

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Engineering & Environmental Services
711 "H" Street, Suite 450
Anchorage, Alaska 99501-3442

Drilling started: *27 September 1991* Drilling completed: *27 September 1991* Logged by: *MWR*

PROJECT *ML & P GENERATION PLANT NO. 1* W.O. *A-1271* BORING NO. *B-6*

Elevation reference: *Temporary Bench Mark 33.5 Feet*
Ground surface elevation: *31.84* Casing elevation: *N/A*

AS-BUILT DESIGN

SOIL BORING ONLY;
NO MONITORING WELL INSTALLED.

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	OVM READING	GROUND WATER
0	*Dense, moist, brown, SP. Sand with gravel.*	■	S-1		33	
	Dense, moist, grey-brown, SP-SM. SAND with silt and gravel to SAND with silt and gravel. Fine sand/gravel and trace diesel odors.	I	S-2	73	17	
5	*Dense, wet, brown to brown-grey, SP-SM. SAND with silt and gravel. Clayey-silt with cobbles and high diesel odors-sheen.*	I	S-3	61	202	▼ ATD
10	*Dense, wet, salt-n-pepper to brown-grey, SM → SP-SM. Silty SAND with gravel to SAND with silt and gravel. Trace diesel odors.*	I	S-4	64	51	
	Boring terminated at approximately 11.5 feet.					
15						
20						
25						
30						

TESTING

LEGEND

■ Grab Sample

I 2-inch O.D. split-spoon sample

▼ ATD Observed groundwater level (ATD = at time of drilling)

RZA - AGRA
Engineering & Environmental Services
711 "H" Street, Suite 450
Anchorage, Alaska 99501-3442

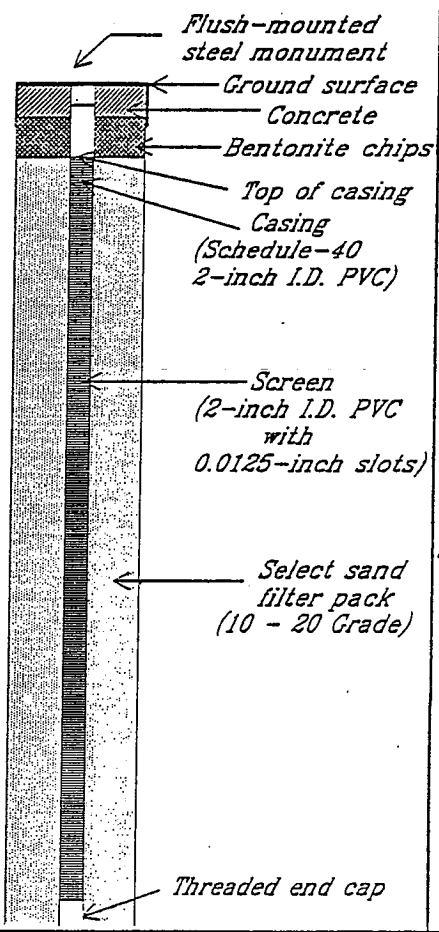
Drilling started: *27 September 1991* Drilling completed: *27 September 1991* Logged by: *MWR*

PROJECT ML & P GENERATION PLANT NO. 1 W.O. A-1271 WELL NO. B-7

Elevation reference: Temporary Bench Mark 33.5 Feet
Ground surface elevation: 33.20 Casing elevation: 32.67

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	OVM READING	GROUND WATER
0	Loose, moist, brown, SP. SAND with gravel.	■	S-1		5	
	Dense, moist, brown to grey-brown, SP. SAND with gravel. Silty sand with clay and trace diesel odors.		S-2	52	--	
5	Dense, wet, grey-brown, SP → SP-SM. SAND with gravel to SAND with silt and gravel. Trace diesel odors.		S-3	80	4	ATD
10	Dense, wet, brown-grey to grey, SM → SP-SM. Silty SAND with gravel to SAND. Fine sand/ gravel and clayey silt.		S-4	67	3	
15	Moist, soft, brown-grey to blue-grey, SC → CL. Clayey SAND with gravel to sandy, lean CLAY.		S-5	8	2	
	Boring terminated at approximately 18 feet.					
20						
25						
30						

AS-BUILT DESIGN



TESTING

LEGEND

■ Grab Sample

I 2-inch O.D. split-spoon sample

▼ ATD Observed groundwater level (ATD = at time of drilling)

RZA - AGRA
Engineering & Environmental Services
711 "H" Street, Suite 450
Anchorage, Alaska 99501-3442

Drilling started: 30 September 1991 Drilling completed: 30 September 1991 Logged by: MWR

PROJECT *ML & P GENERATION PLANT NO. 1* W.O. *A-1271* BORING NO. *B-8*

Elevation reference: *Temporary Bench Mark 33.5 Feet*
Ground surface elevation: *31.56* Casing elevation: *N/A*

AS-BUILT DESIGN

SOIL BORING ONLY;
NO MONITORING WELL INSTALLED.

TESTING

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	OVM READING	GROUND WATER
0	*Loose, moist, brown, SP-SM. SAND with silt and gravel.*	■	S-1		1	
	Dense, moist, brown to grey-brown, SP-SM → SM. SAND with silt and gravel to silty SAND with gravel.	I	S-2	28	2	
5	*Dense, wet, brown to grey-brown, SM → CL. Silty SAND with gravel to clayey SAND with gravel. Oxidized sand/gravel lenses with trace diesel odors.*	I	S-3	40	13	ATD
10	*Dense, wet, brown to brown-grey, SM → SP-SM. Slity sand with gravel to SAND with silt and gravel. Coarse sand/gravel with high diesel odor-sheen.*	I	S-4	95	276	
	Dense, wet, brown-grey, SP-SM. Sand with silt and gravel. Clayey-silt lenses with high diesel odors.	I	S-5	40	147	
15	*Boring terminated at approximately 13.5 feet.*					
20						
25						
30						

LEGEND

■ Grab Sample

I 2-inch O.D. split-spoon sample

▼ ATD Observed groundwater level (ATD = at time of drilling)

RZA - AGRA
Engineering & Environmental Services
711 "H" Street, Suite 450
Anchorage, Alaska 99501-3442

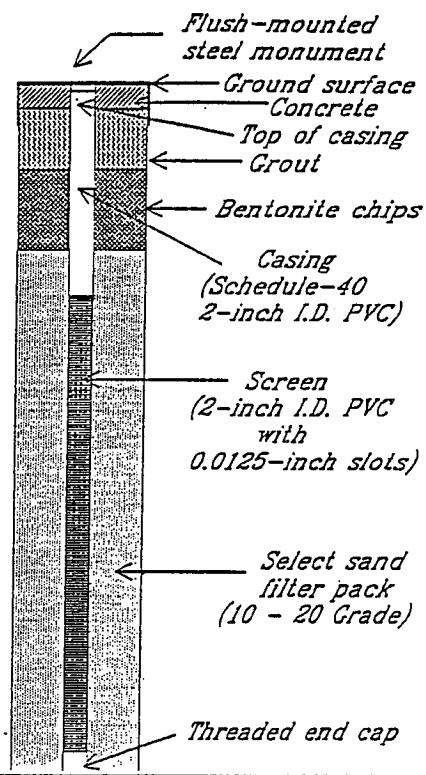
Drilling started: *25 September 1991* Drilling completed: *25 September 1991* Logged by: *MWR*

PROJECT ML & P GENERATION PLANT NO. 1 W.O. A-1271 WELL NO. B-9

Elevation reference: Temporary Bench Mark 33.5 Feet
Ground surface elevation: 33.17 Casing elevation: 32.90

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	OVM READING	GROUND WATER
0	Loose, moderate moist, brown, SP-SM. Sand with silt and gravel.	■	S-1		11	
	Brown, SP-SM. SAND with silt and gravel. Same as above.	I	S-2	22		
5	Firm, moist, brown to brown-grey, SM → SC. Silty SAND to clayey SAND with gravel. Trace diesel odors.	I	S-3	15	50	
	Stiff, wet, brown-grey to grey, SC → CL. Clayey SAND with gravel to sandy, lean CLAY with gravel. Moderate diesel odors.	I	S-4	19	15	ATD
10	Medium dense, wet, grey-brown, SP-SM. SAND with silt and gravel. Trace diesel odors.	I	S-5	32	78	
15	Stiff, moist, blue-grey, CL. Sandy, lean, CLAY with gravel.	I	S-6	16	19	
	Sampling terminated at approximately 16.5 feet.					
20						
25						
30						

AS-BUILT DESIGN



Monitoring well terminated at approximately 14.8 feet.

TESTING

LEGEND

■ Grab Sample

I 2-inch O.D. split-spoon sample

▼ ATD Observed groundwater level (ATD = at time of drilling)

RZA - AGRA
Engineering & Environmental Services
711 "H" Street, Suite 450
Anchorage, Alaska 99501-3442

Drilling started: 25 September 1991 Drilling completed: 25 September 1991 Logged by: MWR

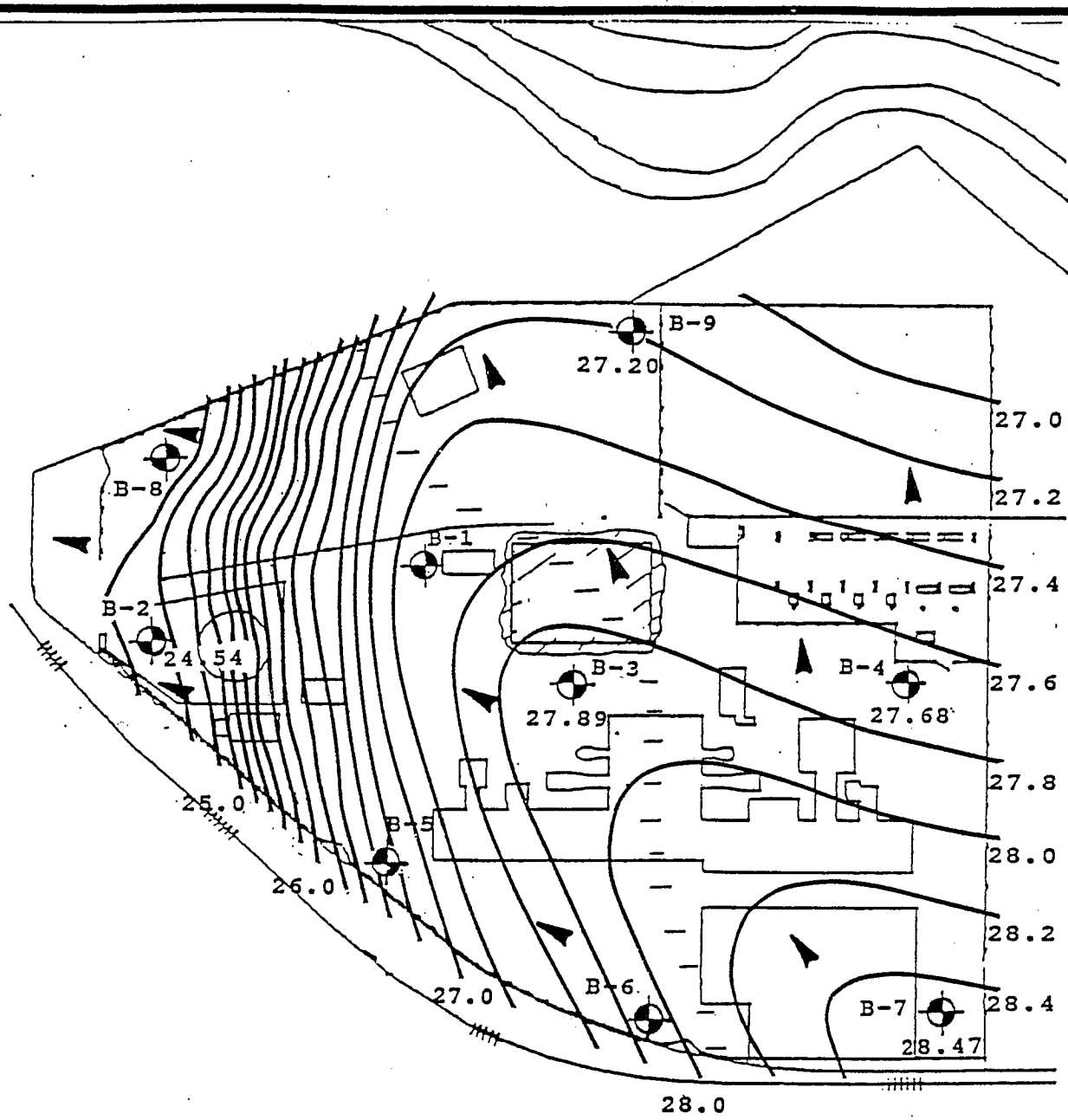
TABLE 3

SUMMARY OF SOIL BORINGS AND FIELD HEADSPACE DATA

BORING NUMBER	GROUND SURFACE ELEVATION	SAMPLE NUMBER	APPROX. DEPTH (FT)	HEADSPACE RESULTS (PPM)	ASTM CLASS D: 2488
B-1	31.72	S-1	0.0-0.5	2.0	SP
		S-2	1.5-3.0	---	SP
		S-3	5.0-6.5	273.	SP→SP-SM.
		S-4	10.0-11.5	39.	SM→SP-SM.
B-2	29.19	S-1	0.0-0.5	9.0	SP-SM
		S-2	2.5-4.0	6.0	SP-SM
		S-3	5.0-6.5	144.	SP-SM
		S-4	10.0-11.5	249.	SP-SM
		S-5	15.0-16.5	55.	SM→CL.
B-3	32.85	S-1	0.0-0.5	40.	SP
		S-2	2.5-4.0	188.	SP-SM
		S-3	5.0-6.5	265.	SP-SM
		S-4	8.5-10.0	249.	SM
		S-5	13.5-15.0	78.	SC
		S-6	18.5-20.0	19.	CL
B-4	33.51	S-1	0.0-0.5	11.	SP
		S-2	1.0-2.5	8.0	SP-SM
		S-3	5.0-6.5	18.	SP-SM
		S-4	10.0-11.5	7.0	SM
		S-5	15.0-16.5	5.0	SC→CL.
B-5	31.84	S-1	0.0-0.5	3.0	SP
		S-2	1.0-2.5	12.	SP→SP-SM.
		S-3	3.5-5.0	184.	SP-SM
		S-4	6.0-7.5	308.	SP-SM
		S-5	10.0-11.5	290.	SM→SP-SM.
B-6	33.22	S-1	0.0-0.5	33.	SP
		S-2	2.5-4.0	17.	SP-SM
		S-3	5.0-6.5	202.	SP-SM
		S-4	10.0-11.5	51.	SM→SP-SM.
B-7	33.20	S-1	0.0-0.5	5.0	SP
		S-2	2.5-4.0	---	SP
		S-3	5.0-6.5	4.0	SP→SP-SM.
		S-4	10.0-11.5	3.0	SM→SP-SM.
		S-5	15.0-16.5	2.0	SC→CL

TABLE 3 CONTINUED

BORING	GROUND SURFACE ELEVATION	SAMPLE	APPROX. DEPTH (FEET)	HEADSPACE RESULTS (PPM-V)	ASTM CLASS D: 2488
B-8	31.56	S-1	0.0-0.5	1.0	SP-SM
		S-2	1.0-2.5	2.0	SP-SM→SM.
		S-3	5.0-6.5	13.	SM→SC
		S-4	9.0-10.5	276.	SM→SP-SM.
		S-5	12.0-13.5	147.	SP-SM
B-9	33.17	S-1	0.0-1.0	11.	SP-SM
		S-2	2.5-4.0	---	SP-SM
		S-3	5.0-7.0	50.	SM→SC
		S-4	7.5-9.0	15.	SC→CL
		S-5	10.0-12.0	---	SP-SM
		S-6	15.0-16.5	3.0	CL



LEGEND

Monitoring Well

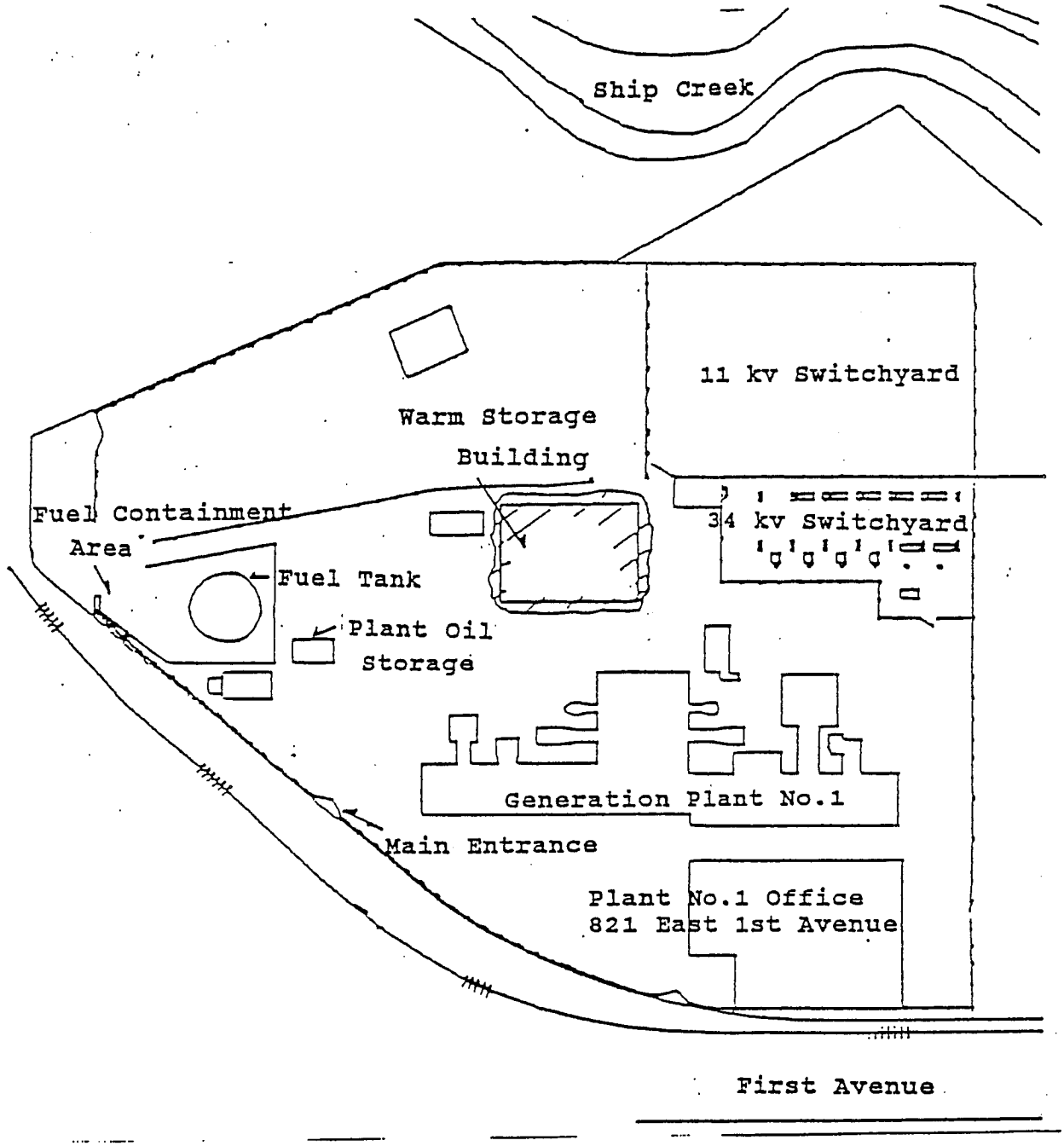
24.54 Stabilized Groundwater Elevation At The Time Of Measurement

.....Inferred Groundwater Elevation Contour

.....Inferred Direction Of Groundwater Migration

NORTH

RZA-AGRA ENGINEERING & ENVIRONMENTAL SERVICES *711 H STREET* *SUITE 450* *ANCHORAGE, ALASKA 99501-3442*	W.O. A-1271 DESIGN MWR DRAWN PSG DATE JANUARY 1992 SCALE 1"=100'	MUNICIPAL LIGHT & POWER PLANT NO. 1 ANCHORAGE, ALASKA INFERRED GROUNDWATER ELEVATION CONTOURS FIGURE 7

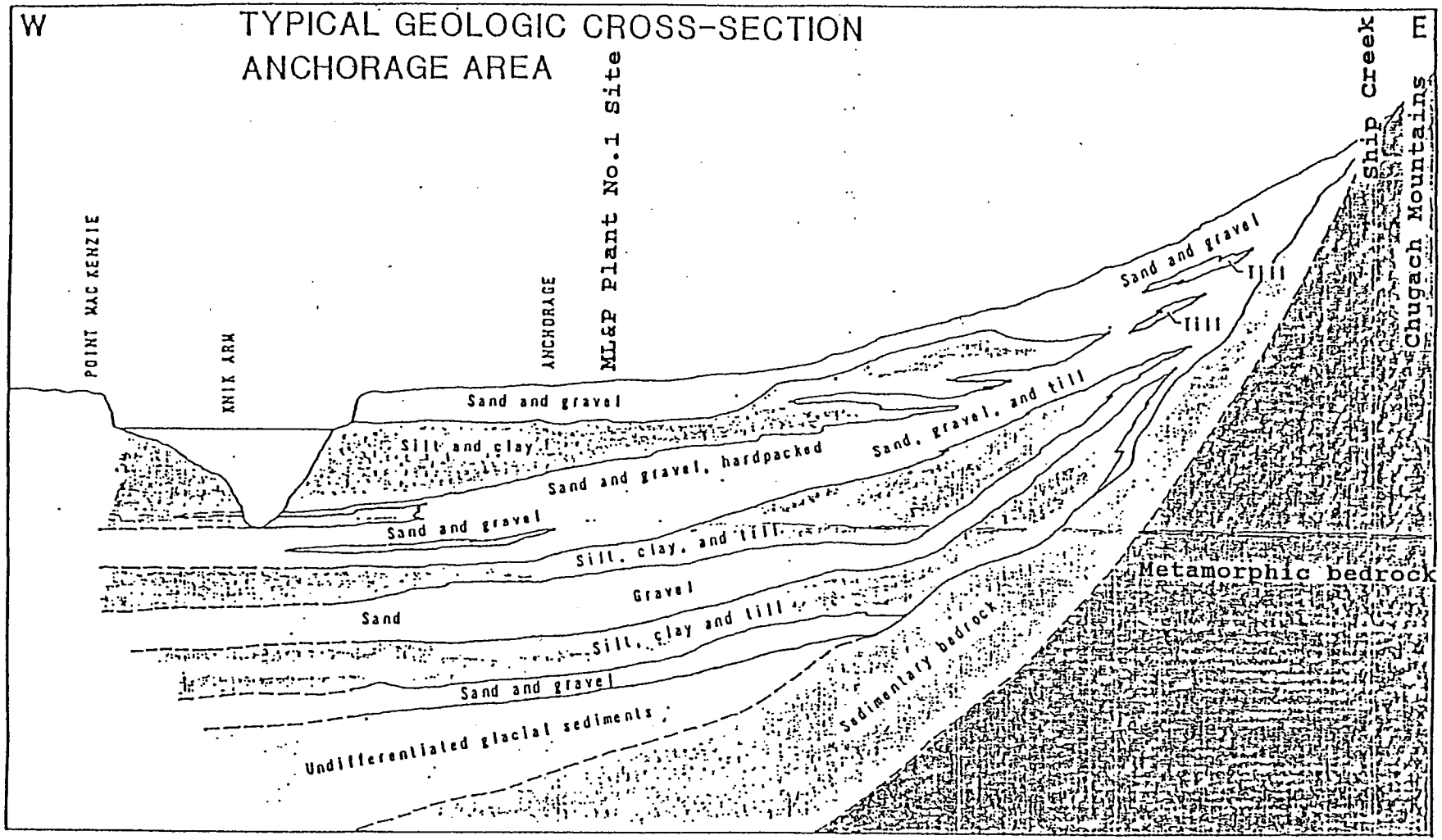


HORIZONTAL SCALE (FEET)

0 100 200

NORTH

RZA-AGRA ENGINEERING & ENVIRONMENTAL SERVICES *711 H STREET* *SUITE 450* *ANCHORAGE, ALASKA 99501-3442*	W.O. A-1271 DESIGN MWR DRAWN PSG DATE OCTOBER 1991 SCALE 1"=100'	MUNICIPAL LIGHT & POWER PLANT NO. 1 ANCHORAGE, ALASKA CURRENT LAYOUT PLAN FIGURE 2



Anchorage area. FROM FREETHEY AND SCULLY, 1980.

NORTH

SOURCE

FREETHY & SCULLY, 1980
WATER RESOURCES OF THE
COOK INLET BASINE, ALASKA:
USGS ATLAS HA-20

RZA-AGRA
ENGINEERING & ENVIRONMENTAL SERVICES

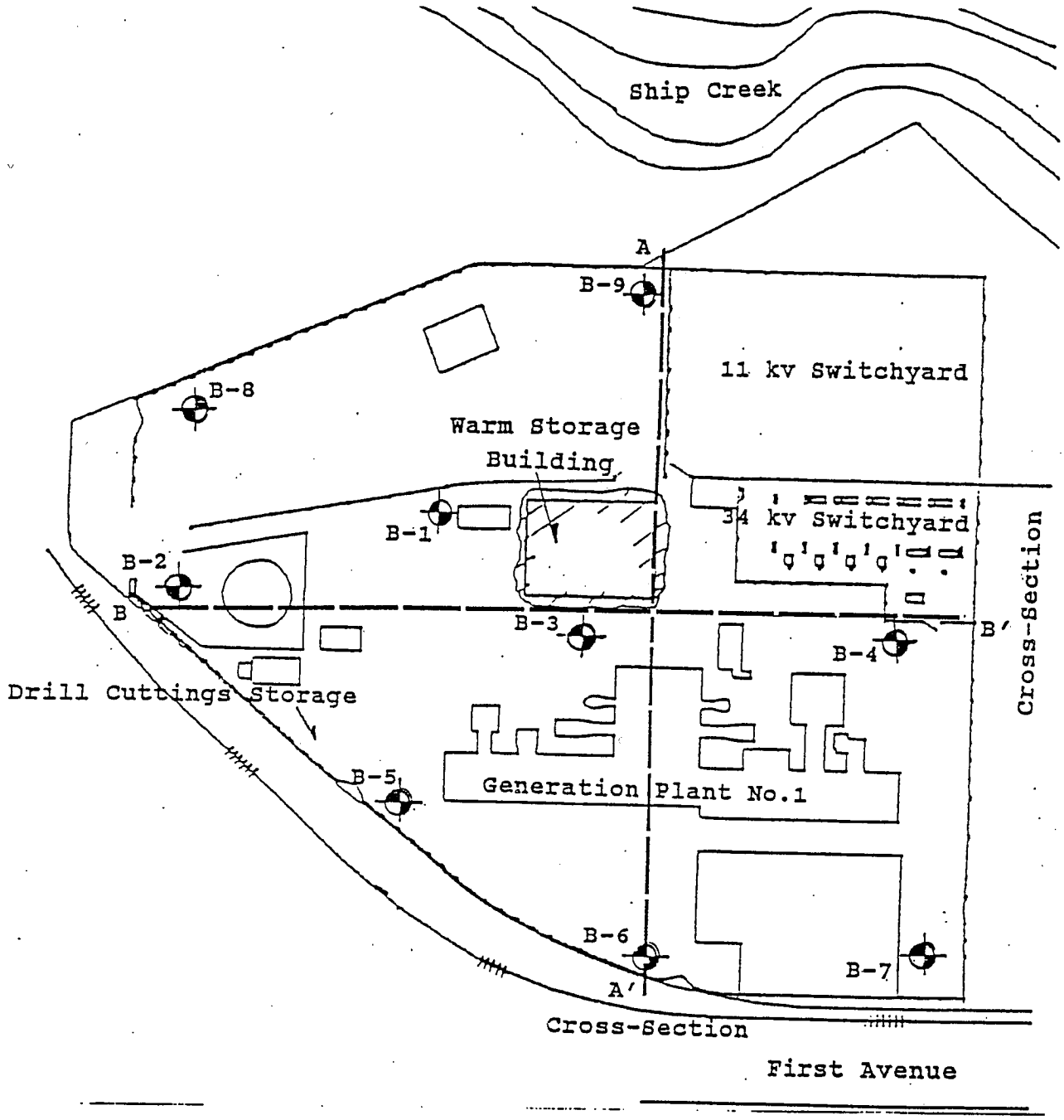
711 H STREET
SUITE 450
ANCHORAGE, ALASKA 99501-3442

W.O.	A-1271
DESIGN	MWR
DRAWN	PSG
DATE	OCTOBER 1991
SCALE	NOT TO SCALE

MUNICIPAL LIGHT & POWER PLANT NO. 1
ANCHORAGE, ALASKA

SCHEMATIC GEOLOGIC CROSS-SECTION OF
THE ANCHORAGE AREA

FIGURE 3



LEGEND

MONITORING WELL / SOIL BORING

Cross-Section

HORIZONTAL SCALE (FEET)

0 100 200

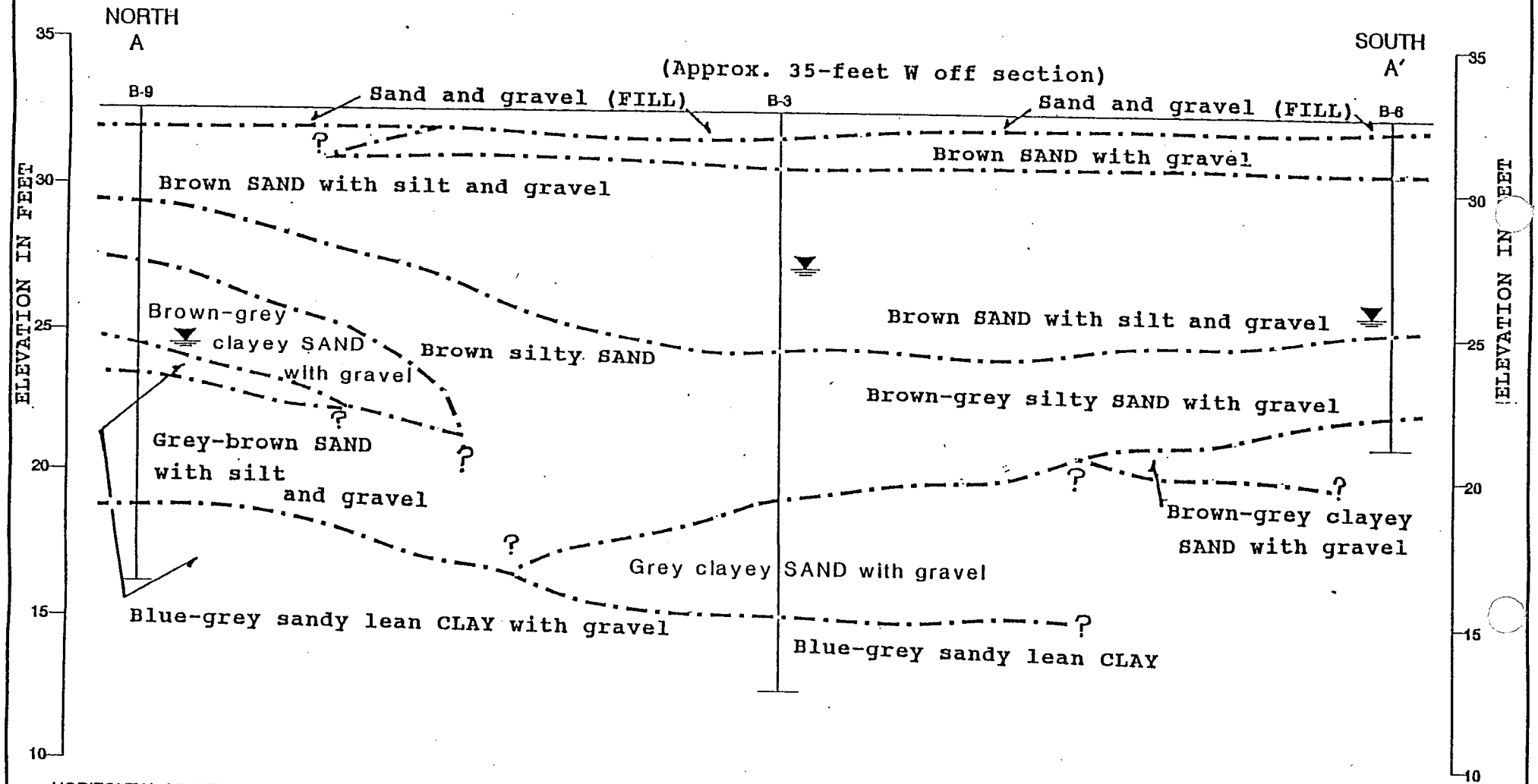
NORTH

RZA-AGRA ENGINEERING & ENVIRONMENTAL SERVICES 711 H STREET SUITE 450 ANCHORAGE, ALASKA 99501-3442	W.O. A-1271 DESIGN MWR DRAWN PSG DATE OCTOBER 1991 SCALE 1"=100'

MUNICIPAL LIGHT & POWER PLANT NO. 1
ANCHORAGE, ALASKA

SITE AND EXPLORATION PLAN

FIGURE 4



HORIZONTAL SCALE (FEET)

0 50 100

VERTICAL SCALE (FEET)

0 5 10

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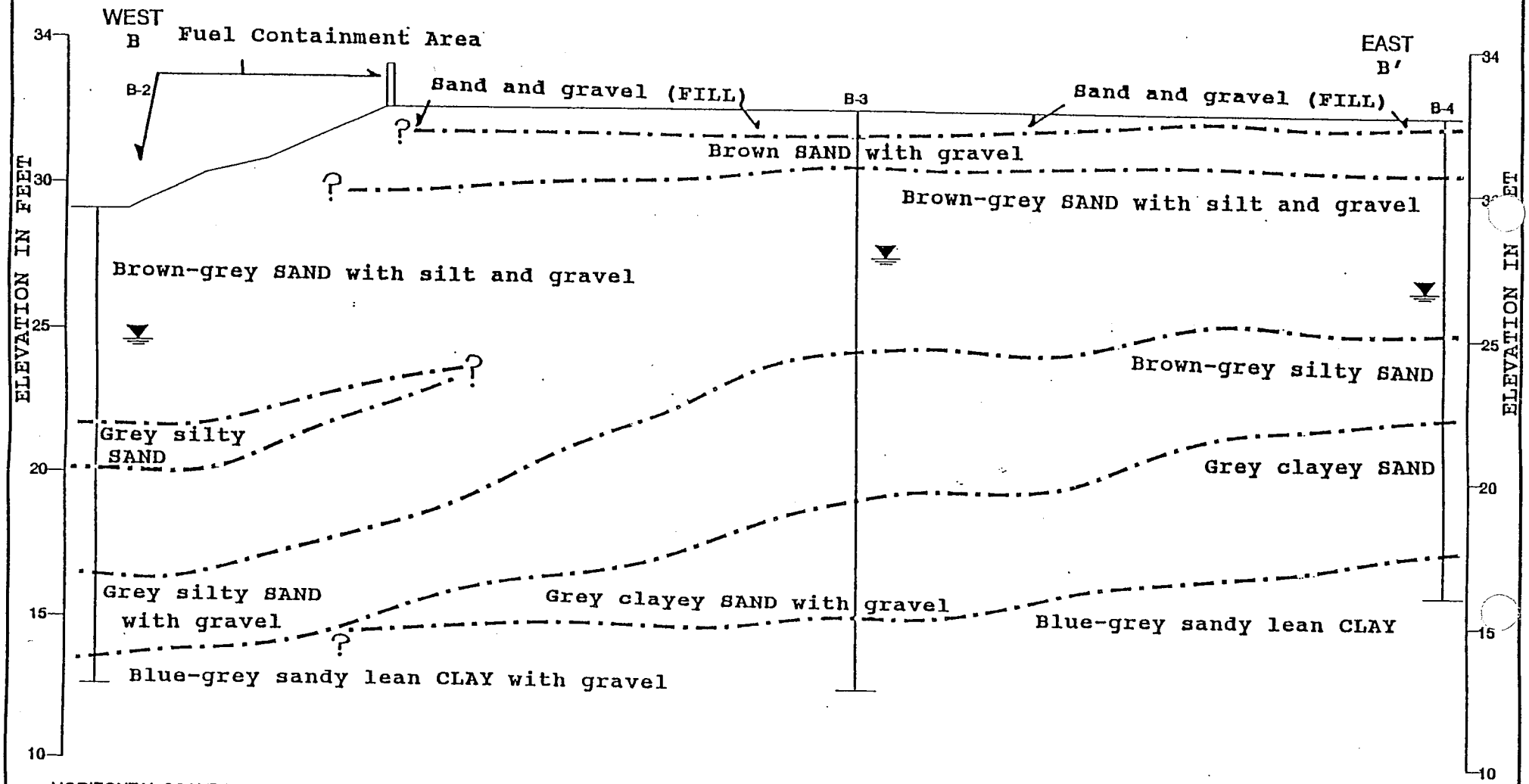
711 H STREET
SUITE 450
ANCHORAGE, ALASKA 99501-3442

W.O.	A-1271
DESIGN	MWR
DRAWN	PSG
DATE	OCTOBER 1991
SCALE	AS NOTED

MUNICIPAL LIGHT & POWER PLANT NO. 1
ANCHORAGE, ALASKA

GENERALIZED SUBSURFACE CROSS-SECTION A-A'

FIGURE 5



HORIZONTAL SCALE (FEET)

0 50 100

VERTICAL SCALE (FEET)

0 5 10

RZA-AGRA
ENGINEERING & ENVIRONMENTAL SERVICES

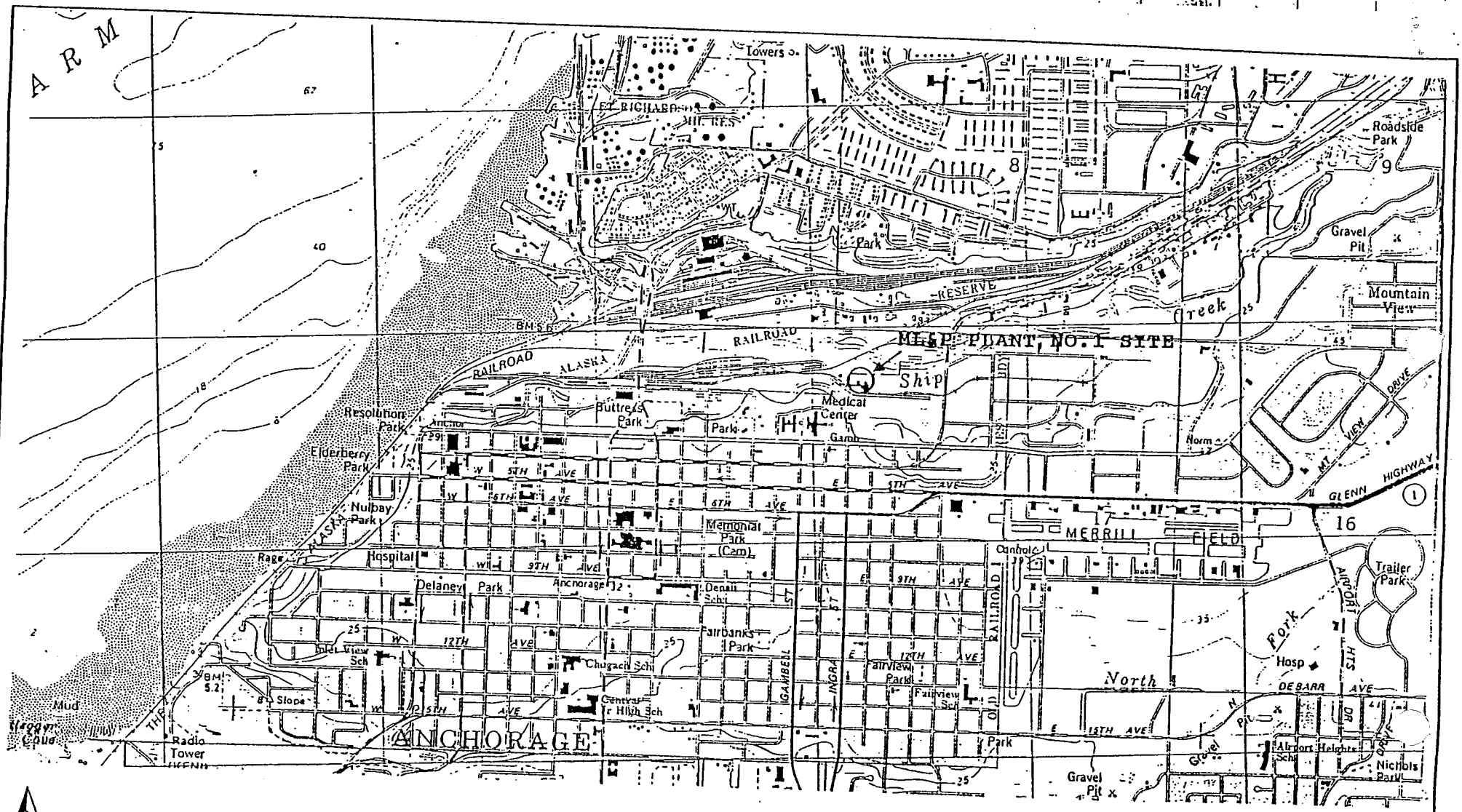
711 H STREET
SUITE 450
ANCHORAGE, ALASKA 99501-3442

W.O.	A-1271
DESIGN	MWR
DRAWN	PSG
DATE	OCTOBER 1991
SCALE	AS NOTED

MUNICIPAL LIGHT & POWER PLANT NO. 1
ANCHORAGE, ALASKA

GENERALIZED SUBSURFACE CROSS-SECTION B-B'

FIGURE 6



SOURCE

USGS 7.5 MINUTE SERIES
TOPOGRAPHIC QUADRANGLE
ANCHORAGE (A-8)
NW, ALASKA

CONTOUR INTERVAL IN METERS

RZA-AGRA
ENGINEERING & ENVIRONMENTAL SERVICES

711 H STREET
SUITE 450
ANC[illegible]SKA 99501-3112

W.O.	A-1271
DESIGN	MWR
DRAWN	PSG
DATE	OCTOBER 1991
SCALE	AS NOTED

MUNICIPAL LIGHT & POWER PLANT NO. 1
ANCHORAGE, ALASKA

SITE VICINITY MAP

FIGURE 1