Tetra Tech EM Inc.

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April 16, 1999

Mr. Hubert Chan
Remedial Project Manager
Engineering Field Activity West
Naval Facilities Engineering Command
900 Commodore Drive, Building 210
San Bruno, California 94066-2402

CLEAN Contract N62474-94-D-7609
Contract Task Order 219

Subject: **NASA Crows Landing Flight Facility**
UST Cluster 2 Letter Report

Dear Mr. Chan:

This letter report describes installation of two new monitoring well clusters at underground storage tank (UST) Cluster 2, National Aeronautics and Space Administration (NASA) Flight Facility, Crows Landing, California. The two new well clusters (CL2-MW-06 and -07) were installed by Tetra Tech EM Inc. (TtEMI) on behalf of the U.S. Navy to confirm the size and shape of the groundwater contaminant plume at UST Cluster 2. Groundwater contaminants were not detected in samples collected from these wells, thereby confirming previous estimates of the size and shape of the contaminant plume. Design of the site's groundwater cleanup system has now been finalized and construction of the cleanup system is scheduled for summer 1999.

The following sections of this letter report describe construction and sampling of the new well clusters and the sample analytical results. In addition, this letter report summarizes stratigraphic information and groundwater flow evaluations completed for UST Cluster 2.

Well Construction and Sampling

Monitoring well clusters CL2-MW-06 and -07 were installed January 28 and 29, 1999. Both well clusters contain two individual wells: a shallow "A" well screened from 28 to 38 feet below ground surface (bgs), and a deeper "B" well screened from 50 to 60 feet bgs. Both the shallow "A" and deeper "B" wells were installed in the same boring. Figure 1 shows the well locations.

Monitoring well clusters CL2-MW-06 and -07 were sampled on February 11, 1999. All samples were shipped to Applied P & Ch Laboratory in Chino, California for analysis of total purgable petroleum hydrocarbons (TPH-P quantified as gasoline), total extractable petroleum hydrocarbons (TPH-E quantified as diesel, JP-5, or motor oil), benzene, toluene, ethylbenzene, and xylene (BTEX), and methyl-T-butyl ether (MTBE).

contains recycled fiber and is recyclable

Sample Analytical Results

The laboratory analytical report for all samples collected from well clusters CL2-MW-06 and -07 is attached to this letter report. As shown in the analytical report, none of the analytes were detected in any of the samples. Well clusters CL2-MW-06 and -07 were installed near the estimated maximum extent of the groundwater contaminant plume at UST Cluster 2 to provide better detail on the size and shape of the plume (Figure 1). The lack of contaminant detections in groundwater samples collected from well clusters CL2-MW-06 and -07 confirmed the accuracy of the estimated size and shape of the contaminant plume. Consequently, the biosparge injection well groundwater cleanup system design was not altered from earlier designs. In the future, well clusters CL2-MW-06 and -07 will be used to monitor operation and performance of the groundwater cleanup system.

UST Cluster 2 Stratigraphic Summary

All stratigraphic information available for UST Cluster 2 was evaluated as part of the cleanup system design. This stratigraphic evaluation was presented in the Revised Definitive Design for UST Cluster 2 (submitted April 9, 1999) and is summarized in this letter report.

Borehole logs for soil borings completed at UST Cluster 2 indicate that three principal lithologies dominate in the subsurface. These principal lithologies include sandy silt with clay (or silty clay), silty fine-grained sand, and medium-grained sand. Individual lithologic units range from several inches to several feet in thickness and are interbedded randomly. Individual lithologic units are generally lenticular in shape and are not continuous across the site.

The cross section shown in Figure 2 illustrates the interbedded nature of the soil stratigraphy beneath UST Cluster 2. The cross section shows the discontinuous, lenticular shape of most major clay-rich and sand-rich zones. Field borehole logs were simplified to complete this cross section by combining thinly bedded zones of predominantly clay- or sand-rich materials. Consequently, the clay- or sand-rich zones do not necessarily represent single clay- or sand-rich beds, but in many areas are a composite of thinly bedded zones of predominantly clay- or sand-rich materials.

UST Cluster 2 Groundwater Flow Summary

Groundwater flow information for UST Cluster 2 was evaluated as part of the cleanup system design. Table 1 shows a summary of groundwater flow direction, gradient, and flow velocity calculations using water elevations measured during eight quarterly monitoring events from May 1996 through March 1998. For comparison, the flow direction, gradient, and flow velocity calculated from water elevations measured during April 1999 are also shown. Table 1 also summarizes vertical gradients calculated from the last four times water elevations were measured at the site.

As shown in Table 1, groundwater flow directions beneath UST Cluster 2 have ranged from 65 to 125 degrees east from north over the past eight quarterly groundwater monitoring events. The average flow direction is 109 degrees east from north. The range and average flow directions correspond to the expected regional flow pattern which, based on surface topography, is west to east, from the Coast Ranges toward the San Joaquin River. The average flow gradient is 0.0039 feet per foot (ft/ft), or about 21 feet per mile, and the average flow velocity is 0.0179 feet per day, or about 6.5 feet per year. Calculations from the April 1999 water elevation measurements indicate a groundwater flow direction of 93 degrees east from north, a gradient of 0.0025 ft/ft, and a flow velocity of 0.0114 feet per day, all similar to historical calculations. Figure 1 illustrates shallow groundwater elevation contours determined from April 1999 water elevations.

Vertical gradients, summarized in Table 1, were calculated from water elevations measured in clustered wells. All clustered wells at UST Cluster 2 include two separate wells completed at different depths, but installed in the same borehole. As shown in Table 1, vertical gradients range from zero (no vertical gradient) to -0.0152 ft/ft (upward) to 0.0305 ft/ft (downward) in the various well clusters. There is no consistent pattern of upward- or downward-directed vertical flow.

Groundwater flow information indicates that pumping from agriculture irrigation wells does not influence groundwater flow at UST Cluster 2. This conclusion is based on the consistent groundwater flow pattern coincident with the expected regional flow pattern. In addition, the lack of any strong, consistent, downward-directed vertical flow suggests that irrigation well pumping from deeper portions of the aquifer does not influence groundwater flow at the site.

Please call me at 303-312-8815 or Neil Bingert at 303-312-8877 if you have any questions regarding this UST Cluster 2 letter report.

Sincerely,

Keith Reamer
Tetra Tech EM Inc. Installation Coordinator

Attachments

cc: Robert Reeves, Regional Water Quality Control Board
Francesca D'Onofrio, California Department of Toxic Substances Control
Jim Simpson, Stanislaus County Department of Environmental Resources
Brian Staab, NASA
Don Chuck, Engineering Field Activity West
NASA Crows Landing Administrative Record, 2 copies

Applied P & Ch Laboratory
13760 Magnolia Ave. Chino CA 91710
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APCL Analytical Report

Submitted to:
Tetra Tech EM Inc.
Attention: Todd Bechtel
1099 18th Street, Ste 1960
Denver CO 80202
Tel: (303)295-1101 Fax: (303)295-2818

Service ID #: 801-991822
Collected by:
Collected on: 02/11/99

Received: 02/13/99
Extracted: 02/15/99
Tested: 02/16/99
Reported: 02/17/99

Sample Description: Water
Project Description: G0069-219C07 Crows Landing

Analysis of Water Samples

Component Analyzed	Method	Unit	PQL	Analysis Result CL2-MW-06A 99-01822-1	CL2-MW-06B 99-01822-2	CL2-MW-07A 99-01822-3	CL2-MW-07B 99-01822-4
GASOLINE + BTXE + MTBE							
Dilution Factor				1	1	1	1
GASOLINE RANGE ORGANICS	M8015V	mg/L	0.05	<0.05	<0.05	<0.05	<0.05
BENZENE	8020	μg/L	0.5	<0.5	<0.5	<0.5	<0.5
ETHYLBENZENE	8020	μg/L	0.5	<0.5	<0.5	<0.5	<0.5
TOLUENE	8020	μg/L	0.5	<0.5	<0.5	<0.5	<0.5
XYLENE (TOTAL)	8020	μg/L	1	<1	<1	<1	<1
METHYL-T-BUTYL ETHER (MTBE)	8020	μg/L	5	<5	<5	<5	<5
Dilution Factor				1	1	1	1
DIESEL RANGE ORGANICS	M8015E	mg/L	0.5	<0.5	<0.5	<0.5	<0.5
JP-5 RANGE ORGANICS	M8015E	mg/L	0.5	<0.5	<0.5	<0.5	<0.5
MOTOR OIL RANGE ORGANICS	M8015E	mg/L	0.5	<0.5	<0.5	<0.5	<0.5

PQL: Practical Quantitation Limit. MDL: Method Detection Limit. CRDL: Contract Required Detection Limit
N.D.: Not Detected or less than the practical quantitation limit. "-": Analysis is not required.
J: Reported between PQL and MDL.
Listed Dilution Factors (DF) are relative to the method default DF. All unlisted DFs are 1.0

Respectfully submitted,

Dominic Lau
Laboratory Director
Applied P & Ch Laboratory

Table 1

NASA Crows Landing
UST Cluster 2 Groundwater Flow Summary

Flow Direction, Gradient, and Velocity Summary

DATE	WATER ELEVATION (feet above msl)			FLOW DIRECTION (degrees from North)	GRADIENT (ft/ft)	FLOW VELOCITY (ft/d)
	CL2-MW-03	CL2-MW-04	MW6			
May-96	84.9	85.39	85.24	65	0.0021	0.0096
Aug-96	85.78	86.37	85.53	120	0.0033	0.0151
Nov-96	86.91	87.52	86.72	117	0.0032	0.0146
Feb-97	88.08	88.86	87.64	125	0.0047	0.0215
May-97	87.31	88.2	87.14	112	0.0044	0.0201
Aug-97	86.95	87.83	86.67	117	0.0047	0.0215
Nov-97	87.69	88.39	87.49	116	0.0036	0.0164
Mar-98	91.39	92.6	91.48	98	0.0054	0.0247
			AVERAGE	109	0.0039	0.0179
Apr-99	89.08	89.66	98.19	93	0.0025	0.0114

msl = mean sea level
ft/ft = feet per foot
ft/d = feet per day
For flow velocity calculation:

Average hydraulic conductivity (from slug test results) = 1.37 ft/d
Assumed effective porosity = 0.30

Vertical Gradient Summary

WELL PAIR	WATER ELEVATION (feet above msl)			VERTICAL GRADIENT (ft/ft)
	DATE	SHALLOW	DEEP	
CL2-MW-6A/6B	Apr-99	88.92	88.99	-0.0032
CL2-MW-7A/7B	Apr-99	88.91	88.98	-0.0032
CL2-MP-1A/1B	Aug-97	87.05	87.05	0
	Nov-97	87.74	87.76	-0.0015
	Mar-98	91.32	91.33	-0.0008
	Apr-99	89.26	89.23	0.0023
CL2-MP-2A/2B	Aug-97	86.95	86.97	-0.0016
	Nov-97	87.63	87.62	0.0008
	Mar-98	91.13	91.32	-0.0152
	Apr-99	89.17	89.08	0.0072
CL2-MP-3A/3B	Aug-97	86.95	86.96	-0.0008
	Nov-97	88.04	87.64	0.0305
	Mar-98	90.99	90.73	0.0198
	Apr-99	89.21	89.19	0.0015

Vertical gradient is calculated by dividing the difference in water level elevations by the distance between the center of well screen elevations. Positive vertical gradient values indicate downward-directed vertical flow. Negative vertical gradient values indicate upward-directed vertical flow.

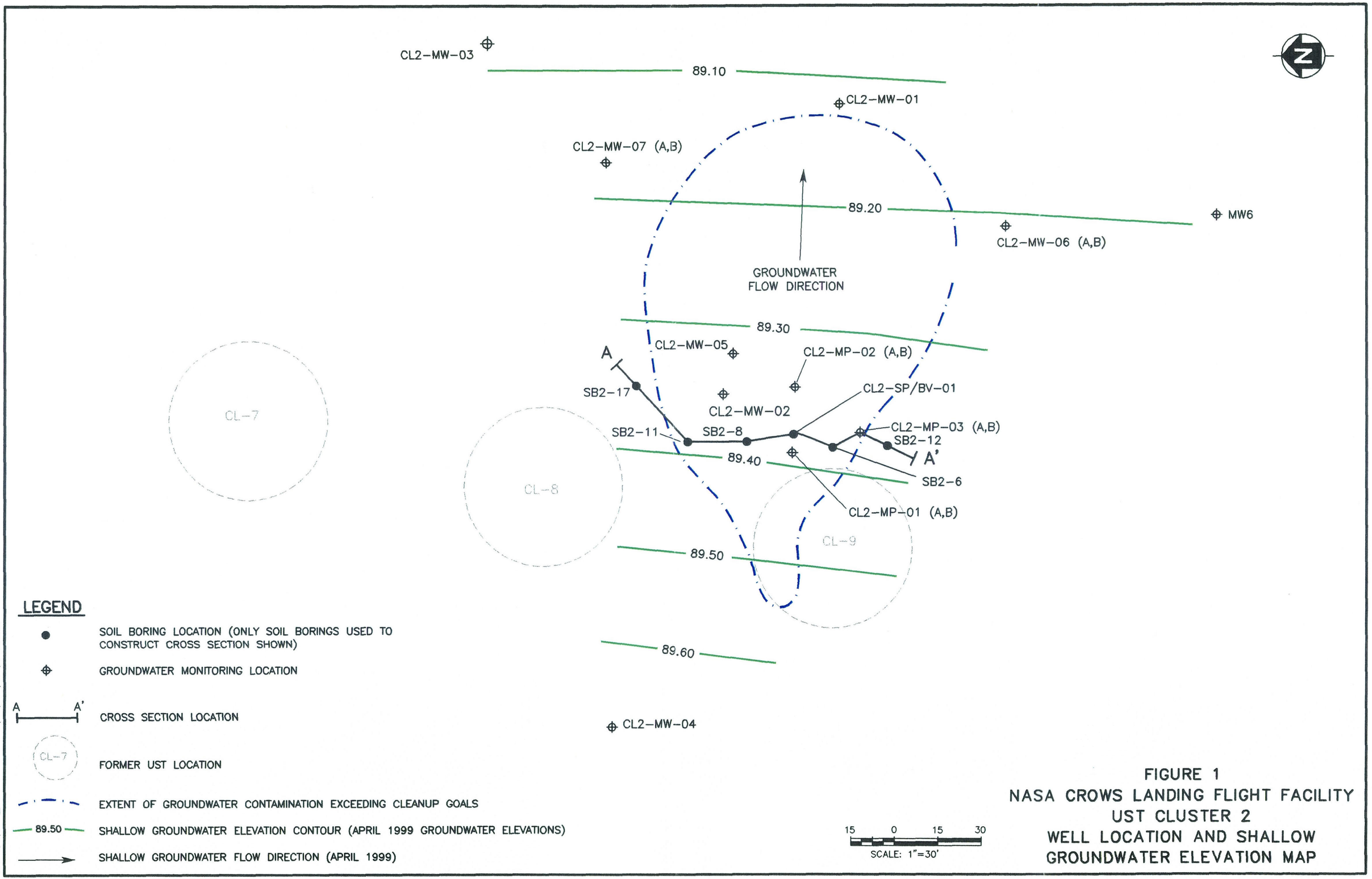
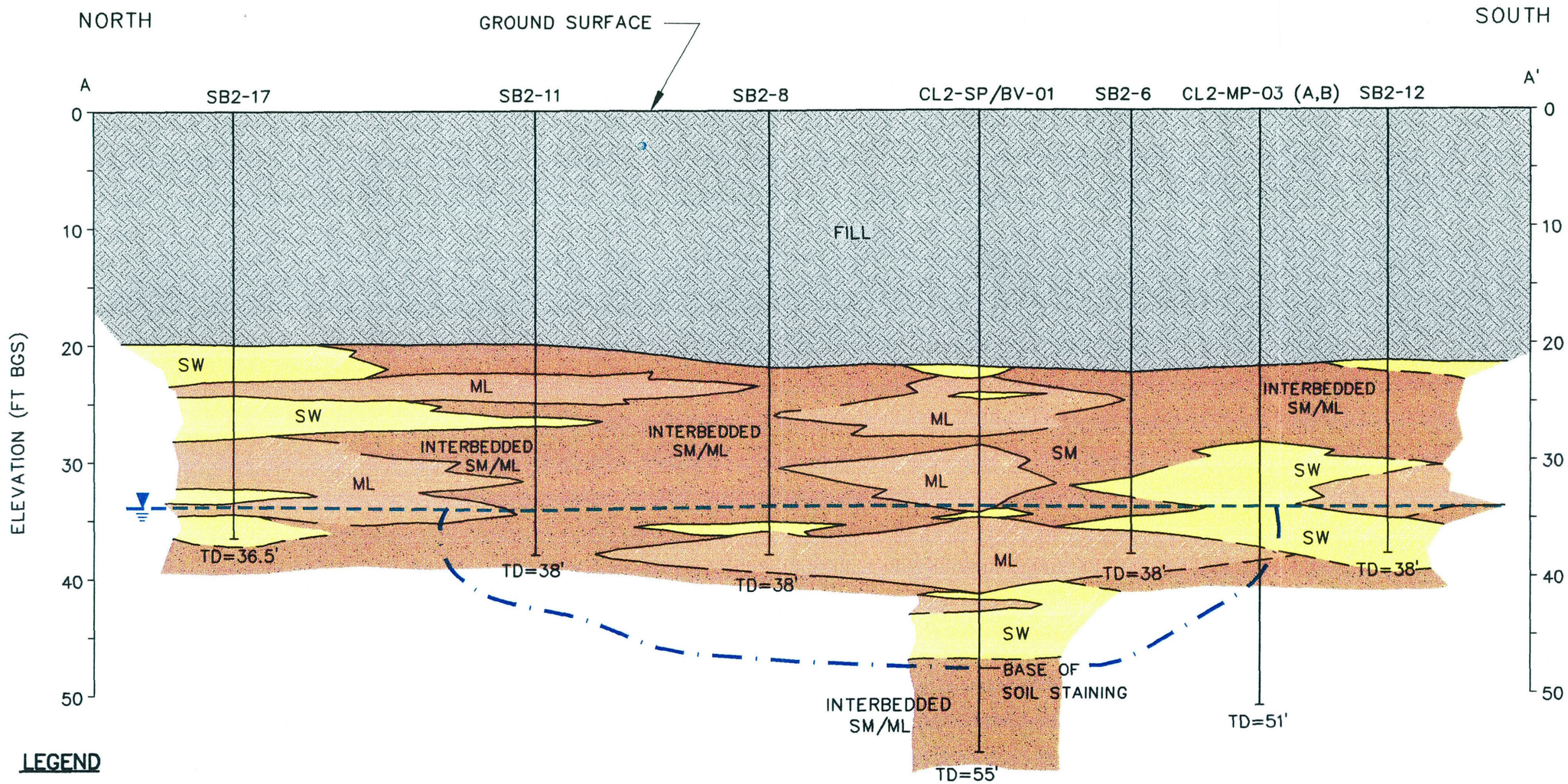


FIGURE 1
NASA CROWS LANDING FLIGHT FACILITY
UST CLUSTER 2
WELL LOCATION AND SHALLOW
GROUNDWATER ELEVATION MAP



LEGEND

LITHOLOGIC CONTACT, DASHED WHERE INFERRED

FILL — EXCAVATION FILL MATERIAL, CLEAN NATIVE SOIL FROM EXCAVATION STOCKPILE FROM GROUND SURFACE TO ABOUT 9 FEET BELOW GROUND SURFACE, IMPORTED GRAVEL TO BASE OF EXCAVATION.

ML — SILTY CLAYS AND CLAYEY SILTS WITH LOW PERMEABILITY.

SM — FINE-GRAINED SILTY SANDS OR THINLY BEDDED COMBINATIONS OF SILTY SANDS WITH CLAYS OR SILTY SANDS WITH SANDS WITH MODERATE PERMEABILITY.

SW — SANDS WITH HIGH PERMEABILITY.

WATER TABLE SURFACE

EXTENT OF GROUNDWATER CONTAMINATION EXCEEDING CLEANUP GOALS.

5' 0 5' 10'
SCALE: 1" = 10'

FIGURE 2
NASA CROWS LANDING FLIGHT FACILITY
UST CLUSTER 2
CROSS SECTION A-A'

FILE NAME: R:\069\219C\1001\X-SEC1.DEG
DATE: 04/15/99 DMF DN