LONGHORN ARMY AMMUNITION PLANT

KARNACK, TEXAS

ADMINISTRATIVE RECORD

VOLUME 1 of 5

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Active Burning Ground and Unlined Evaporation Pond
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RCRA FACILITY INVESTIGATION
-FOR-
ACTIVE BURNING GROUND
-AND-
UNLINED EVAPORATION POND

PHASE I

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

VOLUME I

-PREPARED FOR-
U.S. ARMY ENGINEER DIVISION, HUNTSVILLE
CORPS OF ENGINEERS
HUNTSVILLE, ALABAMA

-PREPARED BY-
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

JULY 1989

EXECUTIVE SUMMARY

The U.S. Army Corps of Engineers (USACE), Huntsville Division, is contracting on behalf of Longhorn Army Ammunition Plant (LHAAP) to assess ground-water contamination beneath the Active Burning Ground (ABG) area of the installation and to investigate all past solid waste management units at the site that may be contributing to the contaminant plume. The work is being performed as a RCRA facility investigation (RFI) under the authority of the Resource Conservation and Recovery Act (RCRA) of 1976 as modified by the Hazardous and Solid Waste Amendments of 1984. This report documents Phase I of the RFI as it was performed by the USACE, Fort Worth District, for the ABG area and for the unlined evaporation pond (UEP), a surface impoundment located within the bounds of the ABG that was closed as a RCRA interim status unit in 1985. This work was performed between May 1987 and September 1988.

The ABG has been used since 1955 for the treatment, storage, and disposal of solid and liquid explosive, pyrotechnic, and combustible solvent wastes by open burning, incineration, evaporation, and burial. Historical waste management units include open burning pits, the UEP, stockpiles of solvent soaked sawdust, and suspected burial pits. Current waste management activities consist of disposing of explosive and explosive-contaminated wastes by burning and are not suspected to be contributing to the ground-water contamination problem beneath the site.

There have been three ground-water contamination investigations performed at the ABG since the potential for ground-water contamination from operation of the UEP was first recognized in 1981. The results of these studies indicated that ground-water beneath the ABG was contaminated with high concentrations of volatile organic compounds (VOCs) and elevated concentrations of barium. However, the results also showed that another source besides the UEP was contributing to ground-water contamination beneath the western portion of the ABG.

Geotechnical investigations for the Phase I RFI consisted of performing a soil gas survey to assist in siting shallow soil borings and additional monitoring wells, drilling and sampling 47 shallow soil borings to verify contaminant source locations, drilling and geophysically logging four deep test borings to define stratigraphy across the site, installing 12 shallow and 3 intermediate depth monitoring wells, slug testing all 15 newly installed wells, and performing one round of water sampling for the 15 new and 10 existing wells at the site. Results of these investigations are presented below.

Ground water beneath the ABG is contaminated with VOCs and elevated concentrations of chlorides, nitrates, and metals. The two most prevalent and highly concentrated contaminants are trichloroethene and methylene chloride, occurring at concentrations as high as 1,400,000 ug/l for TCE and in excess of 17,000,000 ug/l for methylene chloride. Chlorides, nitrates, and the metals barium, cadmium, chromium, mercury, and lead were detected at concentrations exceeding Texas Department of Health drinking water standards.

Two sources were verified as contributing to the VOC contamination at the ABG. These are the UEP and remnants of sawdust pits located around the foundation of the air curtain destructor (ACD). A potential third source is a line of 18 burn pits located in the middle of the burn trench area. No sources have yet been investigated for the other contaminants detected.

For the most part, contamination is confined to a shallow zone of the aquifer underlying the ABG area. Significantly lower concentrations of VOC contaminants were detected in the next lower ground-water zone. Ground water in the shallow zone occurs under unconfined conditions. Regional flow is towards Harrison Bayou, about ¼ mile to the west and north of the ABG, and towards Caddo Lake, about 1 mile to the north of the ABG. However, the direction of flow across the ABG area varies due to a ground-water mound occurring beneath the site. The horizontal hydraulic gradient is extremely low both regionally and at the ABG. Current data are insufficient to determine the vertical hydraulic gradient. The average horizontal velocity for the shallow ground water monitored by the 12 newly installed wells is approximately 1.5 feet per year.

Most of the ABG site, including the identified source areas, is situated on the outcrop of the Wilcox Group, a highly interbedded discontinuous series of clays, sands, and silts. The Harrison Bayou floodplain crosses the western corner of the site. The ABG area is situated over the regional Cypress aquifer, the base of which is defined by the contact between the Wilcox and underlying Midway Groups. A confining bed defining the shallow contaminated zone appears to be continuous within the Wilcox across most of the ABG area, but disappears at the floodplain boundary. Contamination has been identified beyond this point, indicating that Wilcox and floodplain materials are hydraulically connected. Because contamination extends laterally beyond the extent of the confining bed into the floodplain, and because it extends vertically beneath the confining bed into at least the intermediate zone of the aquifer, the base of the uppermost aquifer is defined as the base of the Cypress aquifer, which occurs as deep as 150 feet in the ABG area. Vertical plume definition will require monitoring to this depth.

The contaminant plume has not moved significantly over the past 30 years, extending about 200 feet past the fenced boundary of the ABG in the downgradient directions of the UEP, ACD, and row of 18 burn pits. Closure of the UEP removed the source of contamination for that unit. Although construction of the ACD removed much of the source material in the sawdust pits, some material remains within the water table and continues to contribute to ground-water contamination along the western portion of the site. It appears that any source materials in the burn pits have been removed. There appears to be no immediate threat to surface waters or public water supplies at this time.

Recommendations at this time are to finish defining all possible contaminant sources within the ABG area as well as any others that may be contributing to ground-water contamination beneath the site; to finish characterizing the contaminant plume with respect to hydraulic and chemical properties; to finish defining the horizontal and vertical extent of the contaminant plume; and to investigate whether ground-water contamination has reached the surface waters in the immediate area.

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I.0 INTRODUCTION.

1.1 <u>Scope</u>. The U.S. Army Corps of Engineers (USACE), Fort Worth District, was tasked by the USACE, Huntsville Division, in March 1987 to continue ground-water quality assessment investigations at the Active Burning Ground (ABG) area of Longhorn Army Ammunition Plant (LHAAP) for the purpose of determining the source of organic contamination detected in the ground water underlying the western corner of the site. This report documents all Phase I efforts as required by the scope of work, contained in Appendix A. Phase I was modified several times due to evidence found and results obtained during the course of this investigation. This report addresses all Phase I tasking and these modifications.

1.2 **Authority**. The work described in this report was performed under the authority of the Resource Conservation and Recovery Act (RCRA) of 1976 as modified by the Hazardous and Solid Waste Amendments (HSWA) of 1984. The work was performed by the USACE, Fort Worth District, for the USACE, Huntsville Division, following the scope of work contained in Appendix A. Huntsville Division, in accordance with its Memorandum of Understanding with the U.S. Army Armament, Munitions, and Chemical Command (AMCCOM), prepared the scope of work on behalf of LHAAP.

2.0 BACKGROUND INFORMATION.

2.1 **General**. Longhorn Army Ammunition Plant is a government-owned, contractor-operated industrial installation under the jurisdiction of the U.S. Army Armament, Munitions, and Chemical Command with the primary mission to load, assemble, and pack pyrotechnics, illuminating/signal ammunition, and solid rocket propellant motors. The Longhorn Division of Morton Thiokol, Inc., is the current operating contractor.

2.2 **Location**. Longhorn Army Ammunition Plant is located in Harrison County, Texas, approximately 14 miles northeast of Marshall, Texas, and approximately 40 miles west of Shreveport, Louisiana. The small communities of Karnack and Uncertain, Texas, lie along the western and northern boundaries of LHAAP, respectively. The installation occupies 8,493 acres between State Highway 43 and the western shore of Caddo Lake. A location map is shown on Figure 1.

2.3 **Active Burning Ground**. The ABG is located in the southeast quadrant of LHAAP, as shown on Figure 2. It is a 34.5-acre fenced, secured area that has been in operation since 1955. The area has been used for the treatment, storage, and disposal of solid and liquid explosive, pyrotechnic, and combustible solvent wastes by open burning, incineration, evaporation, and burial. Historical waste management units include open burning pits, an unlined evaporation pond (UEP), stockpiles of solvent soaked sawdust, and suspected burial pits.

Since the closure of the UEP, all ABG waste management activities

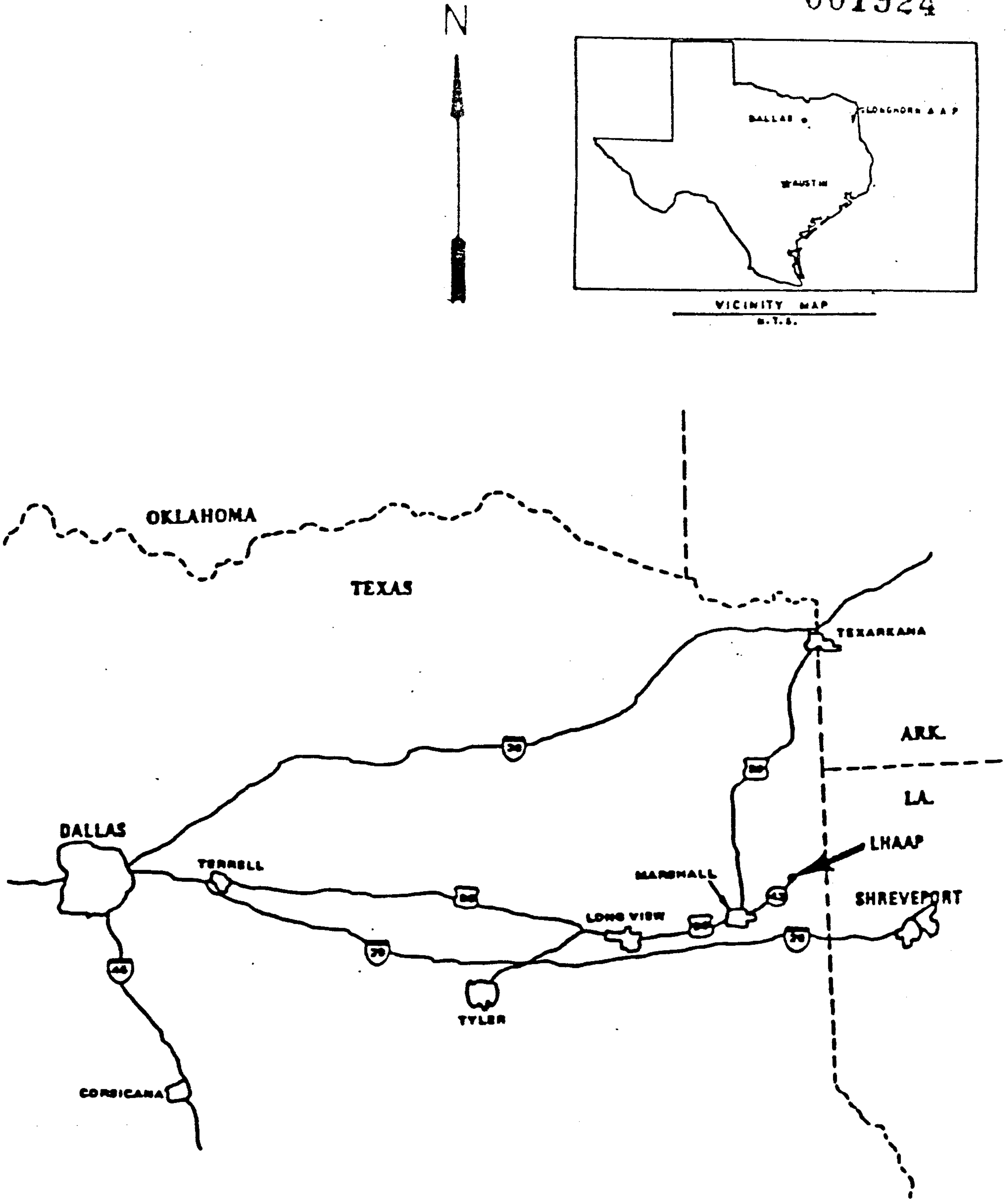


Figure 1. Location Map for Longhorn Army Ammunition Plant (LHAAP).

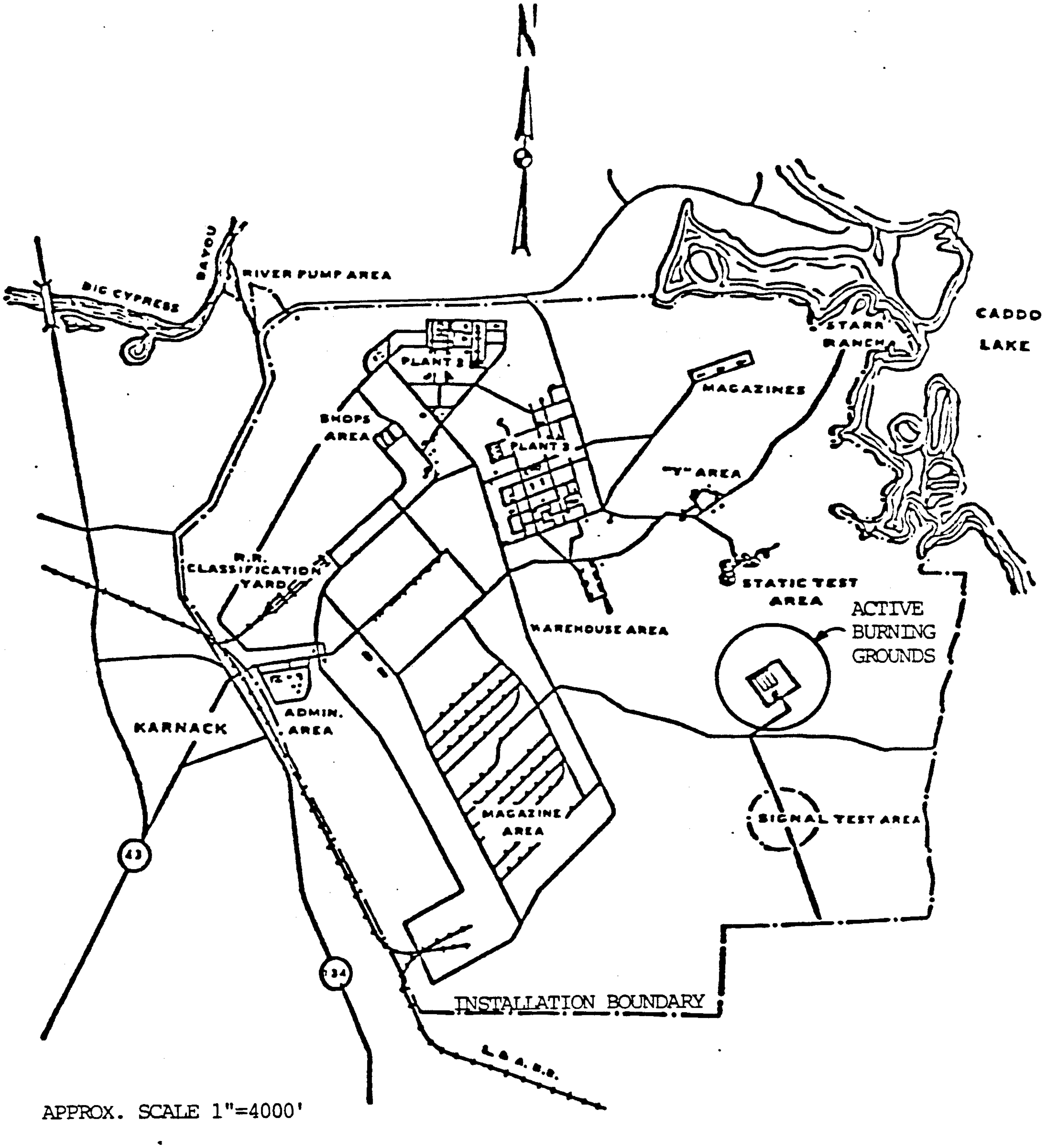


Figure 2. Location Map for Active Burning Grounds.

have been restricted to disposing of explosive and explosive-contaminated wastes by burning. Disposal of these wastes is currently performed using an air curtain destructor (ACD), three open burning cages, and two open burning pans. There is also a washout pad with a covered concrete sump servicing these operations. Two other contained sumps are located at the ACD. Locations of these facilities, as well as the location of the closed UEP, are shown on Figure 3. These ongoing waste management activities are addressed under LHAAP's RCRA Part B and are not suspected to be contributing to any ground-water contamination problem beneath the site.

2.4 Unlined Evaporation Pond. The UEP, located in the northern corner of the ABG, was constructed in 1963. It was originally used as a holding pond to store explosive wastes resulting from the washout of rocket motor casings. However, in 1973 the pond also began receiving wash water containing solvent residues and solids collected from LHAAP operations involving pyrotechnic material preparation and mixing. Wastes received by the UEP contained significant concentrations of several metallic cations such as aluminum, arsenic, barium, cadmium, chromium, iron, lead, magnesium, sodium, strontium, and zinc; nonmetallic anions such as nitrate/nitrite and phosphates; and organic solvents including trichloroethene (TCE), trichloroethane, acetone, ethyl alcohol, methyl ethyl ketone, methylene chloride, and toluene. Sawdust soaked with methylene chloride and other solvents that were used to clean and scour mixers used for mixing illuminants were also

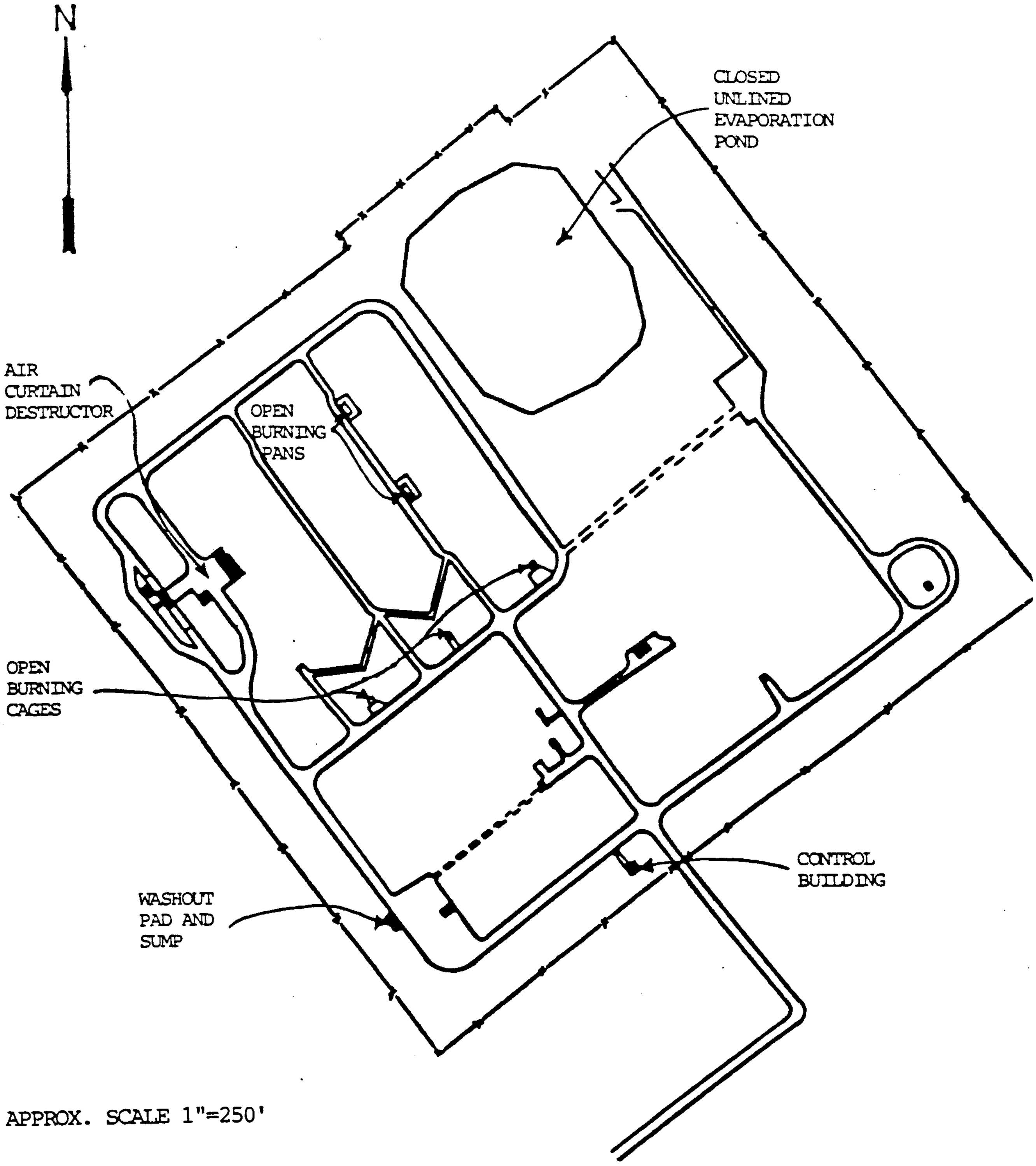


Figure 3. Current Features of Active Burning Grounds.

stockpiled along the southern berms of the UEP.

By 1983, the Army had completed two preliminary studies which indicated that ground water in the ABG area was contaminated with metallic and organic compounds. These studies are documented in the following reports:

- Ground-Water Quality Assessment Plan, Hazardous Waste Special Study No. 32-26-0252-83, USAEHA, 28 March - 1 April 1983.
- Longhorn Army Ammunition Plant Contamination Survey, Morton Thiokol Report No. 16651, prepared by Environmental Protection Systems, Inc., for USATHAMA, Contract No. DAAA09-78-C-3004, June 1984.

As part of the USAEHA study, 13 monitoring wells were installed at the UEP in 1980. Five of these wells (BH-3, BH-4, BH-7, BH-11, and BH-22) still exist at the site. The others were plugged as part of the closure of the UEP in 1985. The USATHAMA contamination survey resulted in the installation of 10 wells (101, 102, 109, 120, 123, 124, 125, 126, 129, and 130) within and around the ABG in 1982. All of these wells still exist, and except for wells 126 and 130, continue to be sampled quarterly by LHAAP. Well locations for these two studies are shown on Sheet 1. Analytical results for the two most prevalent hazardous constituents detected in these wells - methylene chloride and TCE - are summarized on Tables 1 and 2, respectively.

Because operation of the UEP appeared to be responsible for contaminating the ground water at the ABG, the Army ceased operation of the UEP in 1984 and began formal closure activities for the unit as an interim status surface impoundment following RCRA regulations. In 1985, all liquid, sludge, and soil contaminated with barium and

TABLE 1. METHYLENE CHLORIDE CONCENTRATIONS (ug/l) FROM PREVIOUS GROUND-WATER INVESTIGATIONS AND SAMPLING EVENTS

Well No.	USAEHA[a]	USACE[b]		USEPA[c]	LHAAP[d] USACE[e]	USACE[e]	LHAAP[d]						
	3/83	7/84	9/84	11/85	2/86	4/86	5/86	9/86	12/86	3/87	7/87	9/87	1/88
BH-1[f]		ND	1,200										
BH-2[f]		250,000	19,000										
BH-3	22,600	13,000											
BH-4	10,400	18	ND										
BH-5[f]	8,490												
BH-6[f]	14,900	2,000,000	3,300,000										
BH-7		6,000	500										
BH-8[f]		10,000	15										
BH-10[f]		ND	1,900										
BH-11		1,200,000	1,100,000										
BH-22		4,400	3,500										
101					26		7	ND	4	5	7	ND	38
102					26		5	ND	28	6	6	ND	22
109		11,000	ND		21		6	ND	33	6	62	ND	80
120		140,000	300,000		410,000		180,000	370,000	370,000	195,000	110,000	820,000	5,400
123		4,000			26		7	ND	9	28	3	8	10
124		14,000			24		70	ND	7	21	52	ND	ND
125		6,500	1,300		46		ND	ND	7	6	ND	17	ND
126		5,800	ND		15	11							
129		4,200	ND		31		12	6	15	13	41	10	ND
130					15								
C-1			13	ND	13								
C-2			11,000		10	12							
C-3			2,200		17	13							
C-4			10	ND	17								
C-5			5,700	ND	17								
C-6			28		14								
C-7					16								
C-8					14								
C-9					16	14							
C-10					16	13							
Field Blank		26	ND		45	13			8				
Field Blank		23	ND		17								
Trip Blank		13											

ND = Not detected or detected below calibration limits.

[a] Ground-Water Quality Assessment Plan, Hazardous Waste Special Study No. 32-26-0252-83, USAEHA, 28 March - 1 April 1983, as referenced in Groundwater Quality Assessment, Longhorn Army Ammunition Plant, Marshall, Texas: Groundwater Contamination Related to Seepage from an Unlined Evaporation Pond, USACE, 15 March 1985

[b] Groundwater Quality Assessment, Longhorn Army Ammunition Plant, Marshall, Texas: Groundwater Contamination Related to Seepage from an Unlined Evaporation Pond, USACE, 15 March 1985

[c] EPA Groundwater Monitoring Evaluation, Longhorn Army Ammunition Plant (LHAAP), Marshall, Texas, USEPA, 13 January 1986

[d] LHAAP quarterly monitoring program

[e] Groundwater Quality Assessment, Longhorn Army Ammunition Plant, Marshall, Texas: Groundwater Contamination Related to Seepage from an Unlined Evaporation Pond, Addendum, USACE, 8 May 1986

[f] Plugged as part of UEP closure 1984-85.

TABLE 2. TRICHLOROETHENE CONCENTRATIONS (ug/l) FROM PREVIOUS GROUND-WATER INVESTIGATIONS AND SAMPLING EVENTS

Well No.	USAEHA[a]	USACE[b]		USEPA[c]	LHAAP[d] USACE[e]	USACE[e]	LHAAP[d]						
	3/83	7/84	9/84	11/85	2/86	4/86	5/86	9/86	12/86	3/87	7/87	9/87	1/88
BH-1[f]		ND	1,100										
BH-2[f]	198	8,400	6,200										
BH-3	30	ND											
BH-4	140	480	500										
BH-5[f]	39,200												
BH-6[f]	14,000	52,000	120,000										
BH-7		ND	1,600										
BH-8[f]		ND	250										
BH-10[f]		ND	ND										
BH-11		140,000	160,000										
BH-22		ND	1,100										
101					ND		ND	ND	ND	ND	ND	ND	ND
102					ND		ND	ND	ND	ND	7	ND	ND
109		ND	ND		110		110	110	45	140	33	160	120
120		12,000	27,000		29,000		20,000	37,000	22,000	195,000	27,000	50,000	23,000
123		ND			ND		ND	ND	ND	29	ND	4	ND
124		ND			ND		5	ND	ND	15	ND	ND	28
125		ND	ND		4		ND	ND	ND	ND	ND	22	ND
126		ND	ND			ND							
129		11,000	18,000		7,400		3,300	13,000	5,100	5,590	3,500	9,300	4,300
130													
C-1			ND	ND									
C-2			4,700			ND							
C-3			1,300			ND							
C-4			ND	ND									
C-5			2,500	ND									
C-6			ND										
C-7													
C-8													
C-9						ND							
C-10						ND							
Field Blank		ND	ND			ND							
Field Blank		ND	ND										
Trip Blank		ND											

ND = Not detected or detected below calibration limits.

[a] Ground-Water Quality Assessment Plan, Hazardous Waste Special Study No. 32-26-0252-83, USAEHA, 28 March - 1 April 1983, as referenced in Groundwater Quality Assessment, Longhorn Army Ammunition Plant, Marshall, Texas: Groundwater Contamination Related to Seepage from an Unlined Evaporation Pond, USACE, 15 March 1985

[b] Groundwater Quality Assessment, Longhorn Army Ammunition Plant, Marshall, Texas: Groundwater Contamination Related to Seepage from an Unlined Evaporation Pond, USACE, 15 March 1985

[c] EPA Groundwater Monitoring Evaluation, Longhorn Army Ammunition Plant (LHAAP), Marshall, Texas, USEPA, 13 January 1986

[d] LHAAP quarterly monitoring program

[e] Groundwater Quality Assessment, Longhorn Army Ammunition Plant, Marshall, Texas: Groundwater Contamination Related to Seepage from an Unlined Evaporation Pond, Addendum, USACE, 8 May 1986

[f] Plugged as part of UEP closure 1984-85.

exhibiting high COD values, were removed from the pond and were disposed in accordance with EPA regulations. The pond was then backfilled and capped. The Texas Water Commission (TWC) certified in March 1986 that the UEP was clean closed. The unit was replaced with an industrial wastewater treatment facility located elsewhere on LHAAP.

Upon closure of the UEP, LHAAP began a quarterly monitoring program for eight of the remaining wells in the ABG area. Analytical results from this ongoing program are summarized on Tables 1 and 2 for the two most prevalent hazardous constituents detected, which are methylene chloride and TCE, respectively. The Army also implemented a Ground-Water Quality Assessment (GWQA) for contamination caused by past operation of the UEP. The consulting engineering firm Camp Dresser & McKee, Inc. (CDM) performed the GWQA under contract to the USACE, Huntsville Division. Results of this GWQA are contained in the following two documents:

- Groundwater Quality Assessment, Longhorn Army Ammunition Plant, Marshall, Texas: Groundwater Contamination Related to Seepage from an Unlined Evaporation Pond, prepared by Camp Dresser & McKee, Inc. (CDM), for USACE, Huntsville Division, Contract No. DAC87-830-C-0091, March 15, 1985.
- Addendum to Groundwater Quality Assessment, Longhorn Army Ammunition Plant, Marshall, Texas: Groundwater Contamination Related to Seepage from an Unlined Evaporation Pond, prepared by CDM for USACE, Huntsville Division, Contract No. DAC87-830-C-0091, May 8, 1986.

Camp Dresser & McKee, Inc., concluded that the UEP was a secondary source, but not the primary source, of ground-water contamination within the ABG area. During CDM's investigation, organic contamination measured in wells monitoring the UEP unexpectedly decreased to nearly detectable and undetectable concentrations. Laboratory error was ruled out as an explanation for the sudden decrease when the laboratory results were duplicated during subsequent samplings performed by CDM, EPA, and USAEHA. These analyses are shown on Tables 1 and 2. Although several theories were posed to explain this disappearance of ground-water contamination around the UEP, none were satisfactory or could be proven.

Camp Dresser & McKee, Inc., also concluded that the primary source of organics contamination that continues to be detected in wells in the western corner of the ABG is not the UEP, but a source located west of the pond. A major source of inorganic contamination, primarily barium, appears to be located south of the UEP beyond the ABG boundary. Due to contract limitations, these sources were not able to be determined by CDM.

In response to the CDM conclusions, the Army developed a proposal for continued ground-water monitoring and assessment efforts at the ABG. This document, prepared by USACE, Huntsville Division, titled **"U.S. Army Proposal for Additional Groundwater Monitoring at the Closed Unlined Evaporation Pond (UEP), Longhorn Army Ammunition Plant (LHAAP), Marshall, Texas,"** was submitted by LHAAP to the TWC in April 1987. The Army's proposal consisted of a three-phase program, summarized as follows:

o Implement a Compliance Monitoring Program at the Point of

Compliance of the UEP in order to demonstrate that the UEP is no longer a source of ground-water contamination. This will include the installation and quarterly sampling of six new wells.

o Implement a Corrective Action Monitoring Program downgradient of the UEP in order to demonstrate that contaminants in the ground water resulting from operation of the UEP are not present in significant concentrations. This will include the quarterly sampling of four existing wells in addition to the six new wells.

o Continue Ground-Water Quality Assessment investigations in the ABG area in order to determine the source of inorganic contaminants south of the ABG and organic contamination from within the ABG.

In March 1987, Huntsville Division tasked Fort Worth District with the scope of work contained in Appendix A to perform a GWQA investigation at the ABG as described in the Army's proposal to TWC. Included in this scope of work was the installation and one-time sampling of the six compliance monitoring wells at the UEP. Fort Worth District installed these wells, designated as MW-1 through MW-6 on Sheet 1, in August and September 1987. Longhorn AAP incorporated the wells into their quarterly sampling program in May 1988. The installation and sampling of these wells by Fort Worth District have been incorporated into this investigation because the UEP, which received waste after 26 July 1982, meets the definition of a solid waste management unit as it is stated in 31 TAC 335.156(a)(2).

3.0 GEOLOGIC SETTING.

3.1 **Regional.** Longhorn Army Ammunition Plant is situated on an outcrop of the Wilcox Group, which crops out over a large part of the eastern half of Harrison County, as shown on Figure 4. The Wilcox has a maximum thickness of 700 feet, and consists mostly of fine to medium grained sands interbedded with a considerable amount of clay and seams of lignite. Although sand beds up to 50 feet thick are present locally, individual beds are generally lenticular, with lenses of clay, sand, and silt pinching out or grading into each other over very short distances, making correlation difficult.

The Wilcox has been identified by the Texas Water Development Board in Report 27, **"Ground-Water Resources of Harrison County, Texas"**, as the basal unit of the regional Cypress aquifer. The Cypress aquifer outcrops over most of Harrison County and is comprised of, in ascending order, the Wilcox Group, the Carrizo Sand, the Reklaw Formation, and the Queen City Sand. All units are believed to be hydraulically connected. A brief description of each of these units is provided on Figure 5. These units dip to the northwest into the East Texas syncline, while the ground surface generally dips gently to the southeast.

The availability of ground water in Harrison County is largely dependent on the hydrologic characteristics of the units comprising the Cypress aquifer. The Wilcox Group, outcropping in the area of LHAAP, yields small (<50 gpm) to moderate (50-500 gpm) quantities

System	Series	Group	Unit	Approximate maximum thickness (feet)	Character of rocks	Water-bearing properties
Quaternary	Recent and Pleistocene		Alluvium and terrace deposits (undivided)	50	Predominantly clay, silt, and fine sand. Terrace material locally fine to coarse sand.	Yields small quantities of water to a few wells
Tertiary	Eocene	Claiborne	Sparta Sand	25	Fine sand and sandy clay. Limonitic ironstone seams common in outcrop area.	Do.
			Weches Greensand	50	Fine to medium sand, glauconitic and quartzitic, laminar to cross-bedded. Limonitic ironstone seams and concretions common in outcrop area.	Do.
			Queen City Sand	200	Very fine to medium sand, quartzitic, interbedded with silt and clay, laminar to cross-bedded. Contains minor amounts of lignite. Limonitic ironstone seams common in outcrop area	Cypress aquifer
			Reklaw Formation	100	Clay and fine sand, glauconitic and quartzitic, mostly laminar but locally cross-bedded. Locally contains marine fossils. Limonitic ironstone seams common in outcrop area.	
			Carrizo Sand	100	Fine to medium sand interbedded with silt and clay. Laminar to cross-bedded. Limonitic ironstone seams common in outcrop area.	
		Wilcox		700	Fine to medium sand interbedded with considerable amounts of clay. Commonly contains seams of lignite. Limonitic ironstone seams common in outcrop area.	
	Paleocene	Midway		900	Predominantly marine clay; becomes silty in upper part.	Not known to yield fresh water in Harrison County.

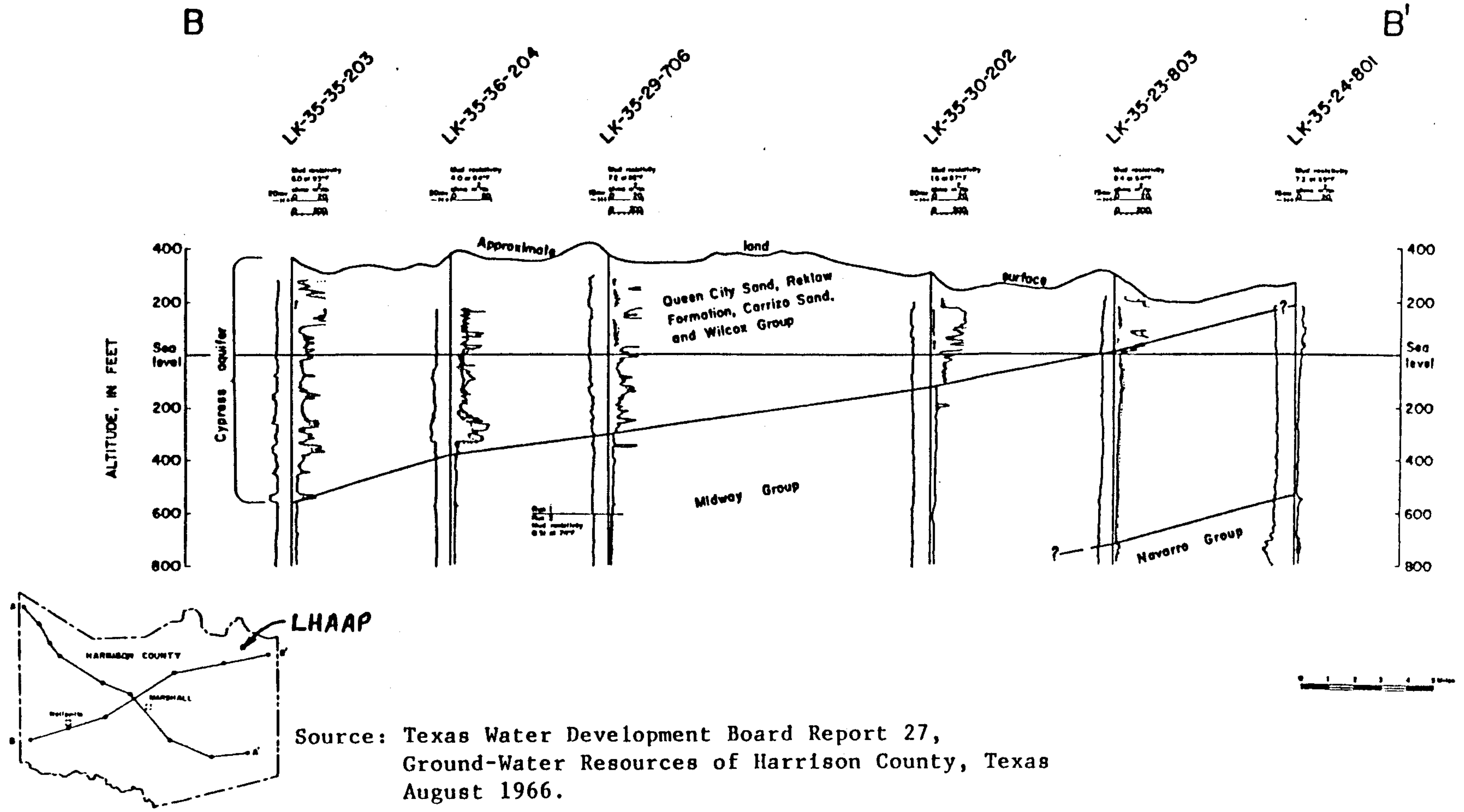
Source: Texas Water Development Board Report 27, Ground-Water Resources of Harrison County, Texas, August 1966

Figure 5. Geologic Units of Harrison County, Texas.

of fresh water to wells throughout the county. As the basal unit of the Cypress aquifer, the Wilcox is also considered as the base of fresh water in the area, conformably overlying the Midway Group, a predominantly calcareous clay that does not yield water but tends to serve as a relatively impermeable basement to the overlying waterbearing Wilcox. The base of the Wilcox, as does the base of overlying units, slopes westward, ranging from el. 193 feet above mean sea level (msl) in the east central part of the county to more than 750 feet below msl in the northwest corner of the county. A geologic section depicting the regional slope is shown on Figure 6. Contoured elevations approximating the base of the Wilcox are shown on Figure 7. In the vicinity of LHAAP, and specifically in the area of the ABG, this bottom elevation of the Wilcox shows to be around el. 50.

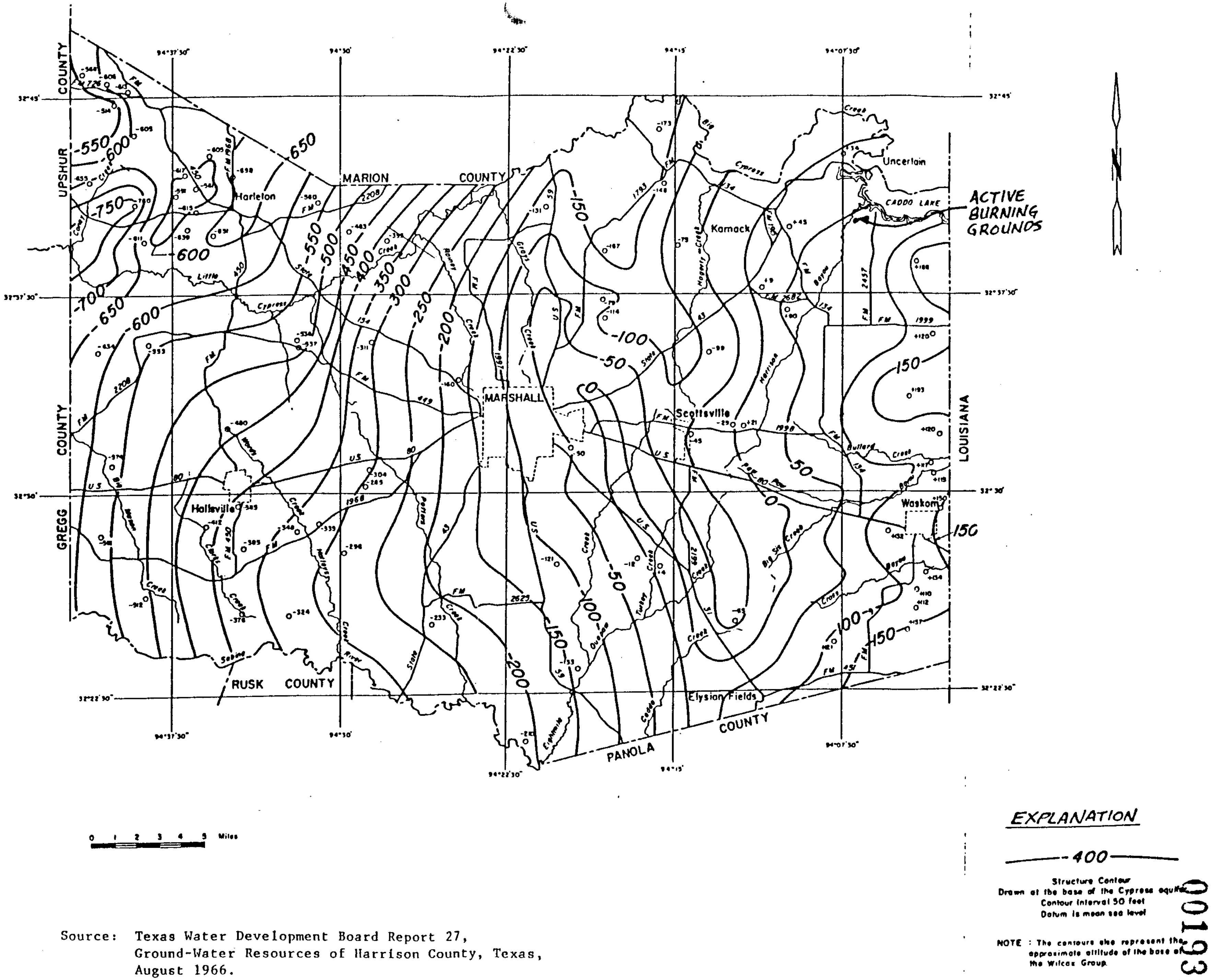
3.2 <u>Active Burning Grounds</u>. The ABG is located in the southeast quadrant of LHAAP, slightly west of the crest of a small topographic divide between Harrison Bayou and Saunders Branch, the two principal drainage basins for the southern part of the installation. The ABG is located approximately ¼ mile east of Harrison Bayou, which drains the site, and approximately 1 mile southwest of Caddo Lake, into which Harrison Bayou flows. The location of the ABG with respect to geology, topography, and surface features is shown on Figure 8.

Most of the fenced area of the ABG is on Wilcox materials. However, there appears to be a contact between the primary materials of the



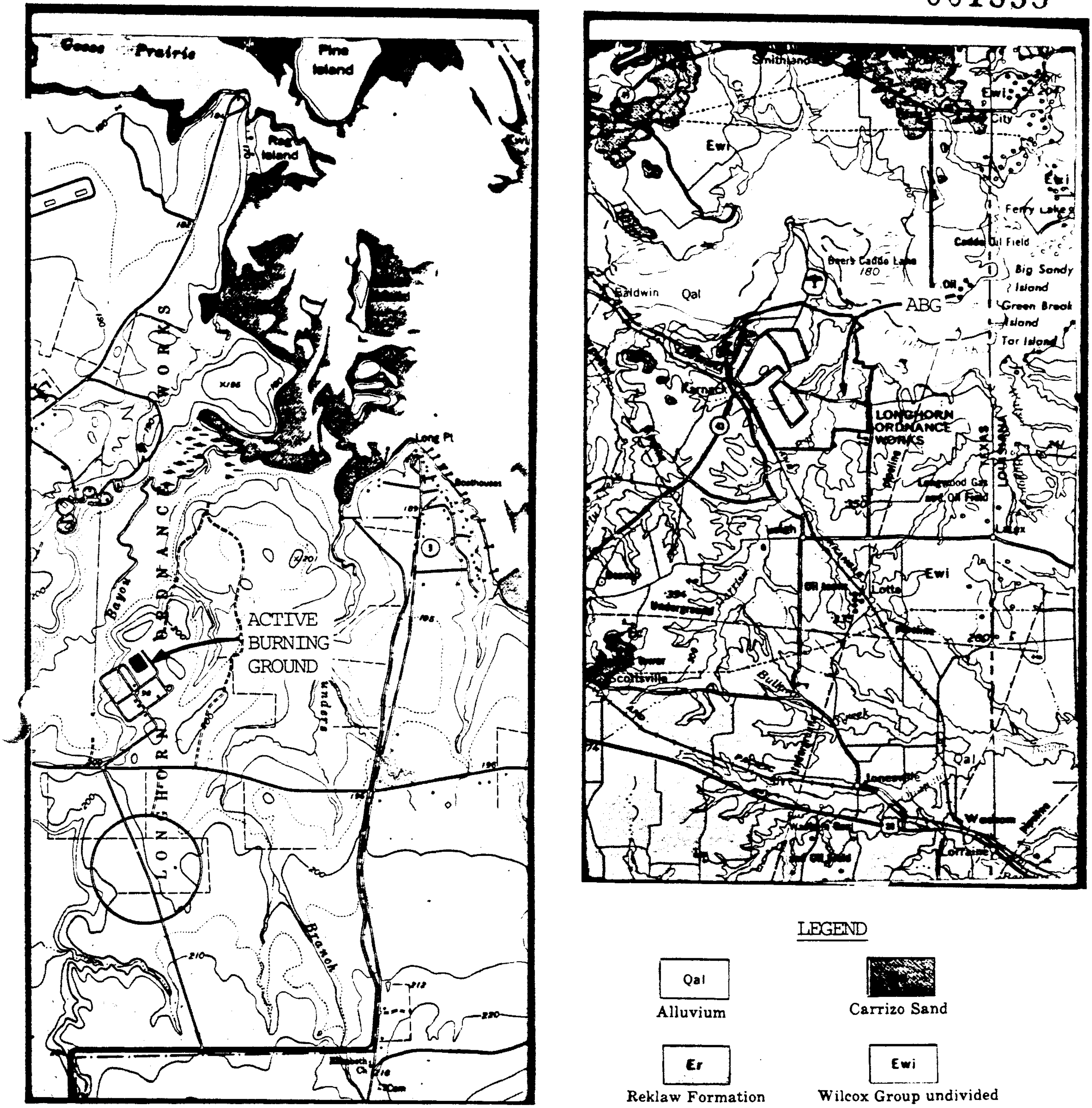
Source: Texas Water Development Board Report 27,
Ground-Water Resources of Harrison County, Texas
August 1966.

Figure 6. Geologic Section Across Harrison County, Texas.



Source: Texas Water Development Board Report 27, Ground-Water Resources of Harrison County, Texas, August 1966.

Figure 7. Approximate Elevation of Base of Cypress Aquifer,



Contour interval 10 feet. Not to scale.

Source: USGS Potters Point Quadrangle,
7.5 minute series, 1978.

Contour interval 100 feet. Scale 1:250,000

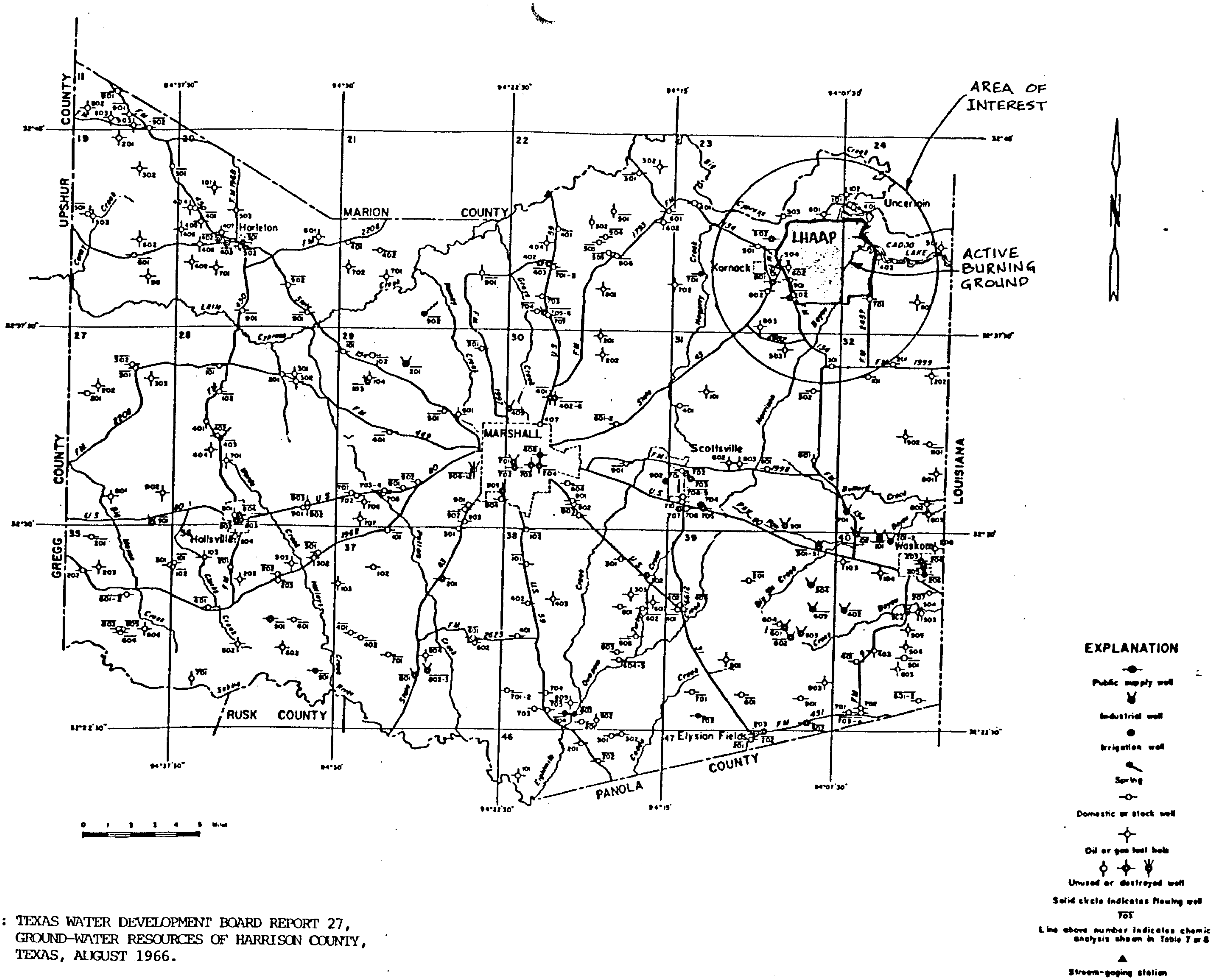
Source: Bureau of Economic Geology,
Geologic Atlas of Texas,
Tyler Sheet, 1965.

Figure 8. Geology and Topography of the ABG Area.

Wilcox and Recent alluvium deposited by Harrison Bayou running somewhere across the western corner of the site. This contact appears to approximate both el. 180 shown on Figure 8, and the 100-year floodplain elevation for Harrison Bayou, shown on Sheet 1.

3.3 **Water Supplies**. There are no water supply wells on LHAAP. Well 602, shown on Figure 9, was constructed on the installation in 1942 as a standby well and is no longer in use. The installation obtains its water supply from Big Cypress Bayou at a pump station located approximately 1 mile northwest of LHAAP. The city of Marshall, Texas, also obtains its water supply from Big Cypress Bayou at a pump station located upstream of LHAAP's.

There are two public supply wells still in use in the area. One, well number 502 on Figure 9, is located in and owned by Caddo Lake State Park. It is completed to a depth of 315 feet (el. -5) and has been in use since 1935. The other public supply well, well number 801 on Figure 9, is owned by the Karnack Water Supply Corporation and services the town of Karnack. It is located approximately ½ mile southeast of town. The well is 430 feet deep (el. -165), and the pump is set at a depth of 200 feet (el. 65). It has been in use since 1942. Two other public water supply wells are shown near LHAAP on Figure 9. These wells, numbers 504 and 902, are owned by the Karnack School and the George Washington Carver School, and are used as standby wells only. Well 504 is 265 feet deep (el. 0) and well 902 is 105 feet deep (el. 135).



SOURCE: TEXAS WATER DEVELOPMENT BOARD REPORT 27,
GROUND-WATER RESOURCES OF HARRISON COUNTY,
TEXAS, AUGUST 1966.

Figure 9. Water Supply Well Location Map, Harrison County, Texas

All other wells in the area of LHAAP are used for stock and domestic purposes. These wells are typically around 250 feet deep, bottoming at approximate el. 0. Well 402, a domestic supply well, is the closest well to the ABG, but due to insufficient supply, is no longer used. The next nearest well to the ABG is well 701, located approximately 2 miles southeast of the ABG. It is a 36-foot deep hand dug well used for domestic purposes.

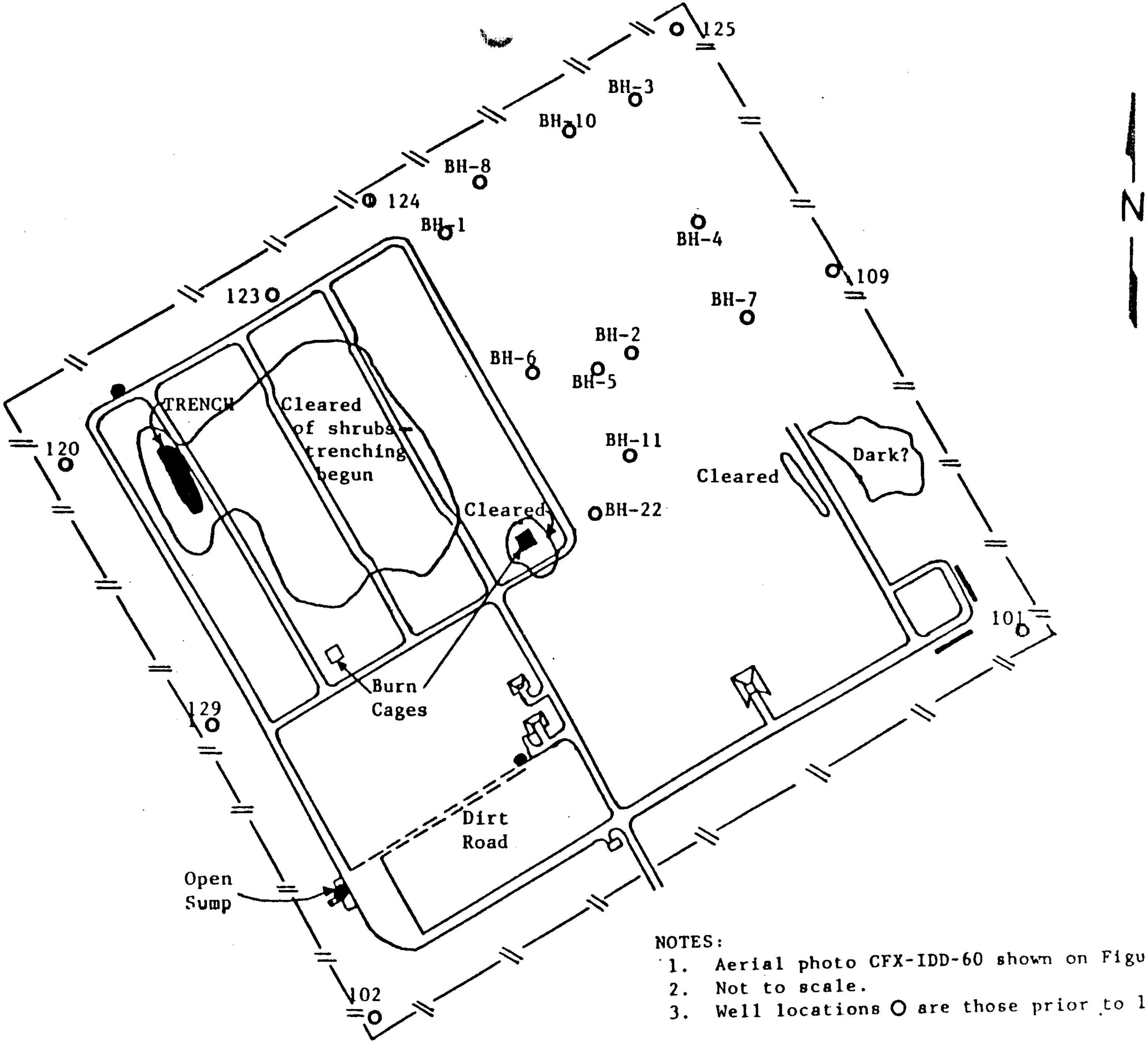
Caddo Lake, which borders the northeastern edge of LHAAP, is created by Caddo Dam on Big Cypress Bayou in Caddo Parrish, Louisiana. The original dam was constructed in 1914 for local navigation purposes and was reconstructed in 1971. The lake provides the municipal water supply for Oil City, Louisiana, and for Mooringsport, Louisiana. Cooling water is also withdrawn from the lake by a steam-electric power plant located near Mooringsport.

Based on these various types of water supplies for the area around LHAAP, ground-water contamination originating at the ABG would pose the biggest threat to Caddo Lake by either discharging directly into Harrison Bayou upstream of the lake or by discharging directly into the lake itself. Ground-water contamination from the ABG poses little to no threat to any of the area's supply wells unless contamination has reached the base of the Cypress aquifer, in which case discharge to surface waters downdip of the site would be bypassed, threatening wells located northwest of the site and constructed at the base of the Cypress aquifer. The two most likely threatened wells in this case are public supply well 502 in Caddo Lake State Park and domestic supply well 503. Both wells are located approximately 4 miles from the ABG.

4.0 INVESTIGATION FOR CONTAMINANT SOURCES.

4.1 Records Search. Aerial photos of the ABG taken in 1954, 1963, 1970, 1978, 1980, and 1985 were reviewed in an attempt to identify possible sources, specifically trenches, that may be causing the ground-water contamination underlying the western corner of the site. Aerial photos taken in 1963 and 1970, shown on Figures 10 through 13, showed possibly three trenches located directly upgradient of the contaminated well 120. The aerial photos showed these trenches to be located immediately beneath where the ACD is now situated. The USACE, Fort Worth District, administered the design and construction of the ACD (Contract No. DACA63-78-B-0010), which was built in 1979 and began operation in 1980. Survey data of the site gathered by the Fort Worth District in 1976 noted the existence of the two westernmost trenches, shown in the aerial photos, as **"wastewater ponds."** Soil borings drilled by the Fort Worth District in 1976 as part of the foundation design analysis identified a **"muck"** layer varying from 1.3 to 4.6 feet in thickness occurring from approximate elevations 173.9 to 178.5 in borings 3A-769, 6D-770, and 8A-771, situated between the two westernmost trenches shown in the photos. A fourth boring, 8A-772, did not encounter any **"muck"** material. These four boring locations are shown on Figure 14. The geologic logs are shown on Sheet 3. The as-builts for the destructor show this **"muck"** layer was removed during construction, but only to the lateral extent of the ACD foundation. The third easternmost trench, visible in both

Figure 10. Aerial Photo (CFX-IDD-60) of Active Burning Grounds, LHAAP, 4-30-63.



NOTES:
1. Aerial photo CFX-IDD-60 shown on Figure 10.
2. Not to scale.
3. Well locations O are those prior to 1987.

Figure 11. Sketch of Active Burning Ground Features from Aerial Photo CFX-IDD-60, 4-30-63.

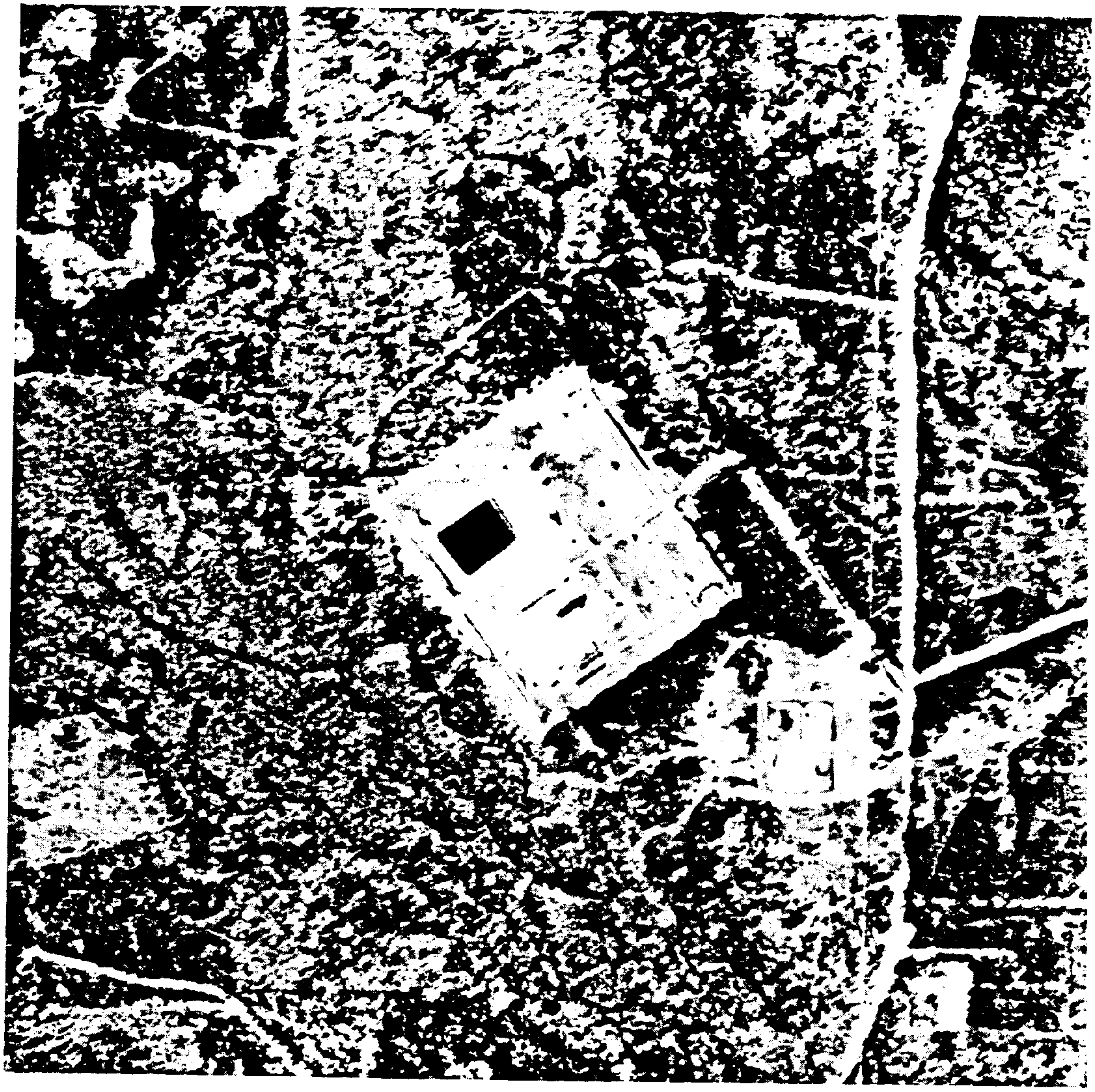
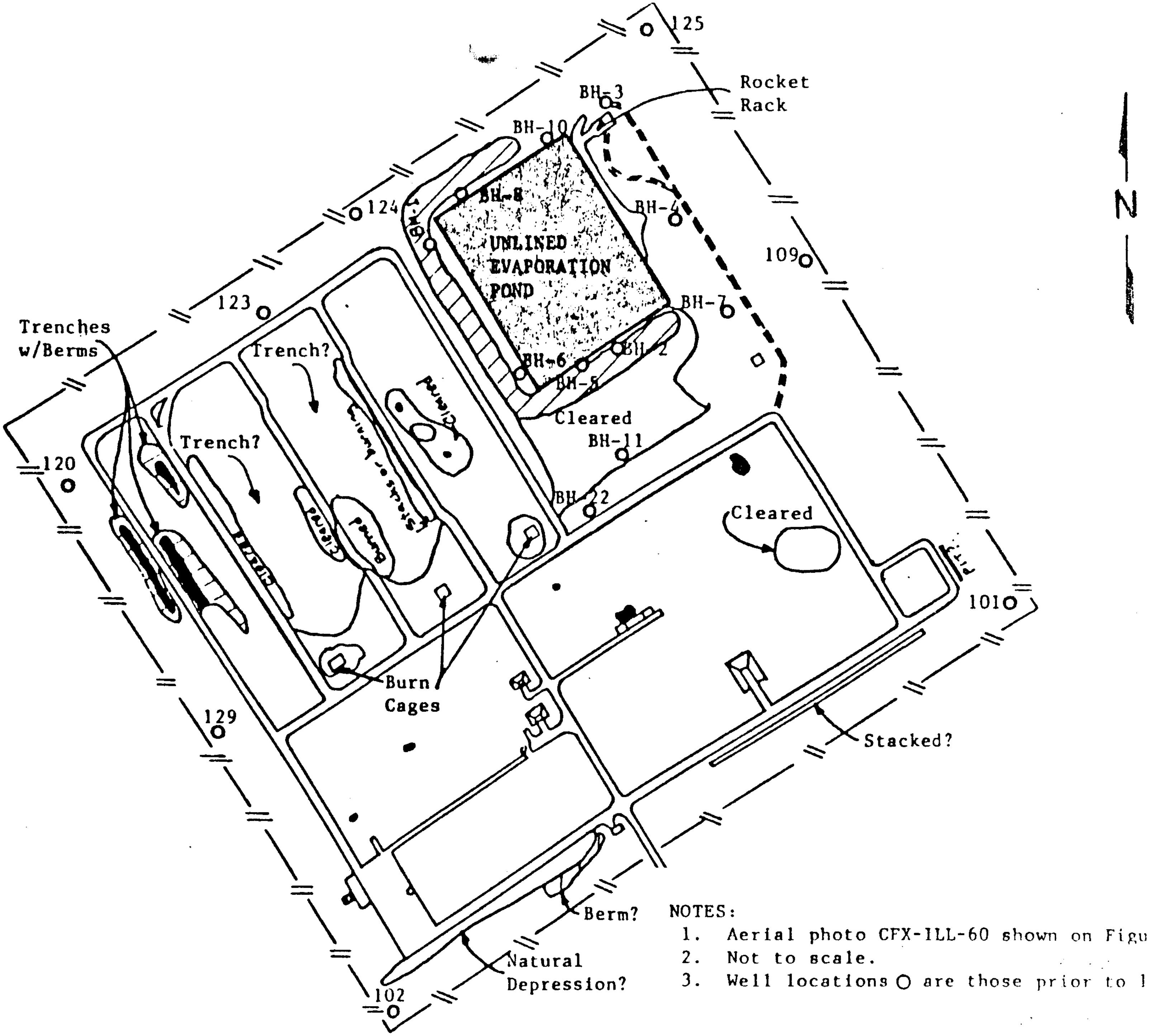


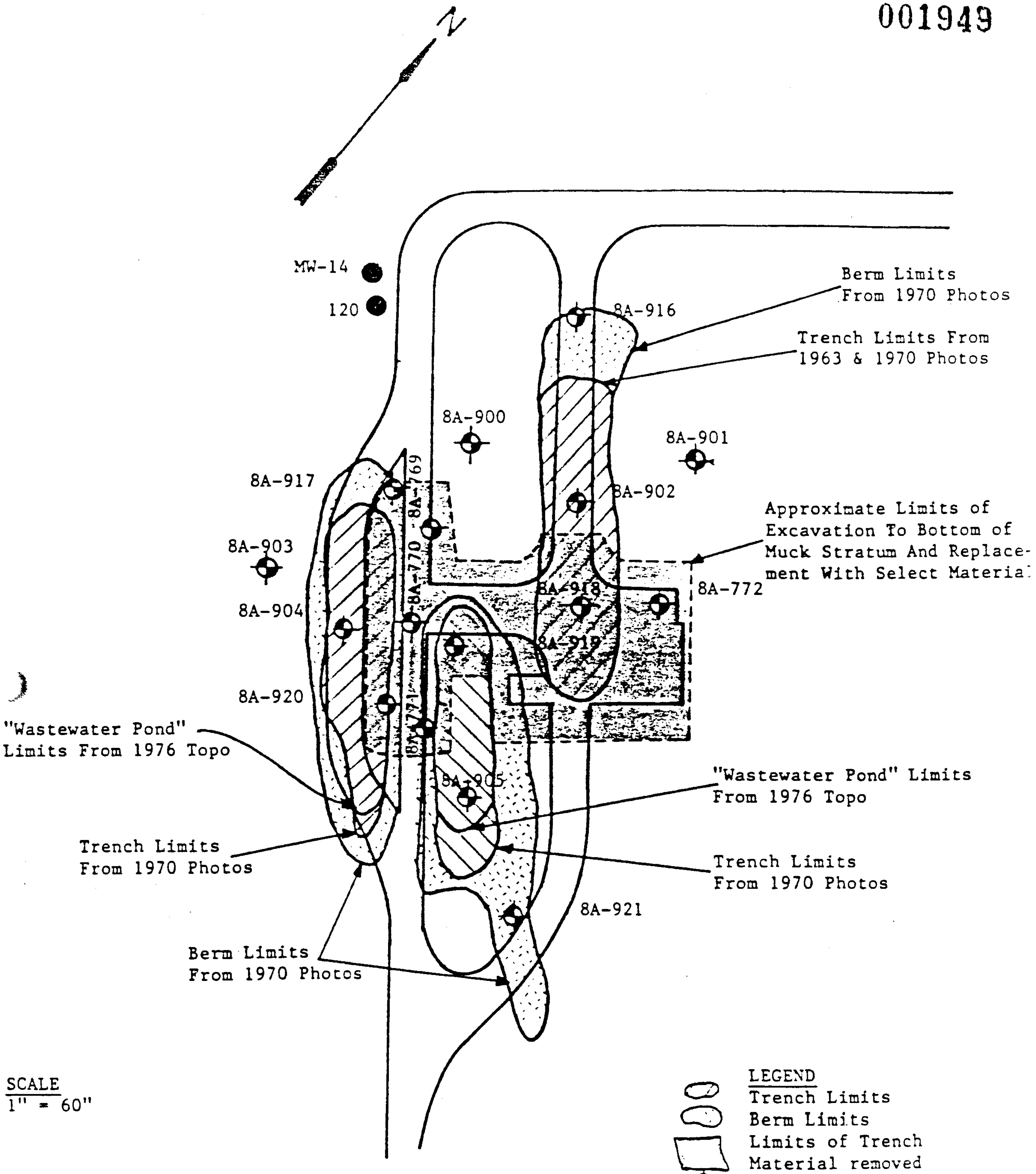
Figure 12. Aerial Photo (CFX-ILL-60) of Active Burning Grounds, LHAAP, 1-30-70.



NOTES:

1. Aerial photo CFX-ILL-60 shown on Figure 12.
2. Not to scale.
3. Well locations ○ are those prior to 1987.

Figure 13. Sketch of Active Burning Ground Features from Aerial Photo CFX-ILL-60, 1-30-70



Notes
1. Base map from Explosive Contaminated Waste Incinerator(AS-BUILT) 22 JUL 1980.
2. For logs of Borings, See Sheets 6 thru 17.
3. Borings 8A-769 thru 8A-872 drilled 1976.
Borings 8A-900 thru 8A-921 drilled 1988.

Figure 14. Trench Detail Beneath Air Curtain Destructor.

aerial photos, is not referenced in the survey data or on the as-builts for the project. This is the oldest of the three trenches, and it may have been buried prior to construction of the ACD. Figure 14 depicts the locations of the three trenches identified in the aerial photos as they relate to the as-builts for the ACD.

Existence of these trenches was further confirmed during a site visit to LHAAP in May 1987 by interviewing two longtime Morton Thiokol, Inc., employees familiar with past operations at the site. They indicated these trenches were used for the disposal of sawdust soaked with methylene chloride and other solvents. These materials were used to clean and scour mixers used for mixing illuminants, as documented in USAEHA Hazardous Waste Special Study No. 39-26-0215-83. The employees said that the trenches were approximately 3 to 4 feet deep and extended along the road to facilitate disposal. Periodically, the trenches were cleaned out and the contents ultimately disposed in the old landfill at LHAAP.

4.2 **Geophysical Investigation**. Prior to confirmation of the exact location of these trenches, plans were made to conduct a geophysical survey in the western corner of the ABG to assist in locating any buried trenches or pits suspected to be the source of contamination for well 120. The USACE Waterways Experiment Station (WES) recommended an electromagnetic (EM) survey to yield the most data by not only locating buried trenches, but possibly assisting in defining the extent of the contaminant plume. However, after visiting the site and seeing the latest evidence indicating the trenches were most likely located beneath the ACD, WES determined that an EM survey would not be productive because the furnace structure and topographic relief would cause too much interference, making reliable interpretation of any geophysical data difficult. Therefore, geophysical survey plans were abandoned and were replaced with plans to conduct a soil gas survey, to be followed by a soil sampling program, to verify the locations of the trenches and any other source materials at the ABG.

4.3 Soil Gas Survey. A soil gas survey was performed at the site by Tracer Research Corporation from Tucson, Arizona, under contract to Fort Worth District, the week of 28 September 1987. The methodology and sampling, analytical, and quality assurance/quality control procedures are detailed in the Tracer Research final report, contained in Appendix B. It was originally anticipated that methylene chloride and TCE would be the two VOCs monitored. However, after the first day of monitoring for both of these VOCs in the vicinity of well 120 where it was known there were high concentrations of both compounds in the ground water, methylene chloride was not detected. Trichloroethene showed up well, however, and appeared to correspond with expected concentration trends in that area. Since ground-water data had shown a reasonably good correlation between methylene chloride and TCE concentrations (see Tables 1 and 2), and because TCE is a VOC more suited to soil gas sampling, the remainder of the survey was spent monitoring only TCE in the soil gas.

Soil gas analyses were performed on-site to allow for tailoring the sampling scheme as the survey progressed. A total of 60 locations were sampled at an approximate depth of 6 feet in the order that they are numbered. These sample locations, the concentrations of TCE detected, and the contoured concentrations of TCE detected are shown on Sheet 4. Contoured concentrations showed five "hot" spots centered at locations SG-07 (TCE = 6,500 ug/l), SG-12 (TCE = 290 ug/l), SG-53 (TCE = 1 ug/l), SG-15 (TCE = 4 ug/l), and SG-39 (TCE = 430 ug/l). The significance of the "hot" spots occurring at locations SG-07, SG-12, and SG-53 was most likely due to them being situated hydraulically downgradient from the trenches beneath the ACD. High concentrations in the vicinity of SG-15, however, were most likely due to another source other than the trenches because available ground-water data, shown on Sheet 1, indicated this location to be upgradient from the ACD. High soil gas concentrations in the vicinity of SG-39 were unexpected. One possible source for these high concentrations could be an abandoned demolition pit shown on an old LHAAP utility map in the area of SG-42. A change in vegetation and a hummocky ground surface that appears to be backfilled material corresponds to a cleared area shown on the 1970 aerial photo (Figures 12 and 13). However, sampling location SG-42, situated in the center of this area, did not yield a high soil gas concentration. Another possible source for the high TCE detected at SG-39 may be the activity associated with the cleared area shown at this location on the 1963 aerial photo (Figures 10 and 11). The configuration of this area on the photo suggests a trench adjacent to the road that was possibly used for disposal.

Three contours showing no detection of TCE in the soil gas were derived from the data obtained at the ABG. One of these contours runs east-west across the southern corner of the site, possibly supporting available ground-water and soil boring data that indicated monitoring wells situated south of the ABG are hydraulically upgradient of the site. The other two detection contours surround the UEP, with relatively low soil gas concentrations detected within these contours. Low concentrations beneath the UEP, known to have been a source for VOC contamination in the past, could either be due to a greater thickness of clay (about 10-15 feet) overlying the ground water than was encountered in the western corner of the ABG, which would tend to prevent high VOC concentrations from reaching the ground surface, or they could reflect a depletion in the source of the VOCs that resulted from closure of the UEP. Soil and ground-water sampling would verify one condition or the other.

4.4 **Shallow Soil Sampling**. A total of 47 shallow soil borings, designated 8A-896 through 8A-921 and 8A-926 through 8A-946, were drilled and sampled during this investigation for the purpose of locating VOC sources of ground-water contamination. Soil boring locations are shown on Sheet 5.

4.4.1 **Field Investigation Procedures**. Drilling and sampling were performed by a Fort Worth District drill crew and geologist following a standard set of procedures. All borings were drilled with a Failing 1500 drill rig. All downhole equipment was steam cleaned prior to drilling each boring. All borings were drilled dry using an 8-inch diameter solid stem flight auger, and were backfilled with a neat cement bentonite grout after a 24-hour water level was obtained.

Safety procedures for all field investigations were designed for handling soils and water contaminated with methylene chloride and TCE. Procedures were detailed on each drill request provided to the driller and geologist. All field personnel had received 40 hours of training in personal protection and safety procedures for hazardous waste management operations. Rubber gloves were worn during periods of prolonged skin contact, and the breathing space around the drill rig was monitored using Drager gas detector tubes for methylene chloride and TCE. Gas detector readings were made for each VOC at least every 10 feet of boring advancement. Field personnel were instructed to shut down operations and leave the area if an average concentration of methylene chloride exceeded 500 ppm over an 8-hour period or an average concentration of TCE exceeded 100 ppm over an 8-hour period.

Two types of soil samples were taken in each boring. Soil samples to be analyzed for the soil classification characteristics grain size distribution, Atterberg limits, and moisture content were taken every foot for the first 10 feet, then every 5 feet or change of material for the remainder of the boring. However, none of the samples taken was ever analyzed because the depths sampled were too shallow to provide useful data for correlation purposes. Soil samples to be analyzed for the chemical concentrations of total metals, explosives, and VOCs were usually taken at an estimated minimum and maximum burial depth for each area of the ABG investigated. These depths were typically 4 and 8 feet, but varied in many of the borings. All soil samples were taken from the flight auger using stainless steel tools.

Prior to taking chemical soil samples, the auger and any handheld tools coming in contact with the sample were washed with a mild detergent, then rinsed with distilled water. Clean, disposable rubber gloves were worn when chemical soil samples were taken. A single chemical soil sample consisted of two 1-liter jar samples. Each jar was filled completely with soil and sealed tightly with a teflon-lined screw lid. One jar was labeled for metals testing. The other jar was labeled for VOCs and explosives testing. Jar labels were filled out in indelible ink, then sealed completely with clear tape when affixed to the jar. Labeled jars were stored inverted on ice until delivered by Fort Worth District personnel to the USACE, Southwestern Division Laboratory (SWDL) in Dallas, Texas. Chain of custody forms were filled out and accompanied all chemical soils to SWDL. All samples were delivered to SWDL within 48 hours of being taken.

4.4.2 ABG Area - First Round Sampling. The data obtained from the soil gas survey, in conjunction with the information obtained from the aerial photos and construction drawings for the ACD, were used

TABLE 3. SHALLOW SOIL BORING DEPTHS AND LOCATION JUSTIFICATIONS

Boring No.	Depth To Be Drilled	Location Justification (TCE Concentration)
8A-896	15 ft	Hot spot SG-12 (290 ug/l).
8A-897	15 ft	High TCE concentration SG-13 (50 ug/l).
8A-898	15 ft	Between hot spots SG-07 (6,500 ug/l) and SG-12 (290 ug/l).
8A-899	15 ft	High TCE concentration SG-55 (45 ug/l).
8A-900	15 ft	High TCE concentration SG-20 (17 ug/l). Vicinity of trenches.
8A-901	15 ft	High TCE concentration SG-18 (2 ug/l). Adjacent to old road where possible dumping occurred.
8A-902	25 ft	Above trench.
8A-903	15 ft	Hot spot SG-07 (6,500 ug/l).
8A-904	15 ft	Above trench.
8A-905	15 ft	Above trench.
8A-906	15 ft	Vicinity of hot spot SG-15 (4 ug/l).
8A-907	15 ft	Hot spot SG-15 (4 ug/l).
8A-908	15 ft	Vicinity of hot spot SG-15 (4 ug/l). Adjacent to old road where possible dumping occurred.
8A-909	15 ft	High TCE concentration SG-40 (1 ug/l). Subsurface data.
8A-910	15 ft	High TCE concentration SG-49 (4 ug/l). Subsurface data.
8A-911	15 ft	Hot spot SG-39 (430 ug/l).
8A-912	15 ft	Demolition pits location.
8A-913	15 ft	Vicinity of demolition pits and hot spot SG-39 (430 ug/l). Subsurface data.
8A-914	15 ft	Subsurface data.
8A-915	15 ft	Subsurface data.

NOTE:

For soil gas sampling locations, see Sheet 4.
For soil boring locations, see Sheet 5.

to site 20 shallow soil borings, designated 8A-896 through 8A-915, at the locations shown on Sheet 5. These borings were sited at these locations in an attempt to locate contaminant sources and to obtain additional subsurface data to be used for siting additional monitoring wells at the ABG. All borings were drilled 15 feet deep, with the exception of 8A-902, located on top of the ACD foundation, which was drilled 25 feet deep in order to penetrate the foundation fill material and still drill 15 feet into in situ soils. Boring depths and justification for their locations are shown on Table 3.

Soil samples to be analyzed for total metals, explosives, and VOC concentrations were taken at 4- and 8-foot depths in each boring except 8A-902, which was sampled after 10 feet of fill had been penetrated. A copy of the drill request detailing decontamination, sampling, sample preservation, sample handling, and safety procedures is provided as Appendix C.

Fifteen of the borings were drilled from 18 March to 4 April 1988. The remaining five borings - 8A-896, 8A-897, 8A-899, 8A-910, and 8A-915 - were drilled from 10-11 May 1988 after wet ground conditions had improved sufficiently to allow the drill rig access to the site. Geologic logs for borings 8A-896 through 8A-915 are shown on Sheets 6 through 10.

A total of 40 soil samples were taken and analyzed for VOCs, total metals, and explosives. All samples were delivered to the SWDL in Dallas, Texas. Volatile organics and explosives analyses were performed by Southwest Laboratory of Oklahoma in Tulsa, Oklahoma, under contract to the SWDL. Metals analyses were performed by the SWDL. The quality assurance/quality control plan for soil sampling and laboratory analyses was prepared by SWDL and is provided as Appendix D. Any variations to sample handling procedures as they are described in this plan were due to site specific conditions and were approved by SWDL before implementation by Fort Worth District personnel. All sample handling procedures followed by Fort Worth field personnel are described in this report.

Analytical results from these 40 soil samples are summarized on Table 4. Volatile organic compounds were detected at concentrations >20 ug/kg in all borings except 8A-906, 8A-909, 8A-910, 8A-912, 8A-913, 8A-914, and 8A-915. The most prevalent VOCs identified were TCE, 1,2-dichloroethene (total), methylene chloride, and 1,1-dichloroethene. Trichloroethene was detected in all borings where VOCs were found, with the exception of boring 8A-914, in which the only VOC detected was methylene chloride. The distribution of these TCE concentrations is shown on Sheet 5 and correspond well with the soil gas survey data. In most cases, VOC concentrations increased with depth. The highest VOC concentrations were detected around and downgradient from the ACD, with the most variety of VOCs occurring where trench materials were actually encountered in borings 8A-902, 8A-904, and 8A-905. Strong odors were frequently noted in the ground water and soil samples.

TABLE 4. SUMMARY OF ANALYTICAL RESULTS FOR CHEMICAL SOIL SAMPLES FROM SHALLOW SOIL BORINGS 8A-896 THROUGH 8A-921

Boring No.	Sample Depth (ft)	Total Barium^a (mg/kg)	VOCs^b (ug/kg)		Explosives^b (ug/g)
8A-896^c	4.0	ND	Trichloroethene	81	ND
	8.0	ND	1,2 Dichloroethane	24	ND
			Trichloroethene	1,400	
8A-897	4.0	31	Trichloroethene	19	ND
	8.0	ND	1,2 Dichloroethene (total)	10	ND
			1,2-Dichloroethane	31	
			Trichloroethene	550	
8A-898	4.0	ND	Methylene Chloride	1,050	ND
			1,2-Dichloroethene	90	
	8.0	ND	Methylene Chloride	123,090	ND
			1,2-Dichloroethene (total)	2,130	
			Trichloroethene	40,660	
8A-899	4.0	110	Trichloroethene	69	ND
	8.0	ND	1,2-Dichloroethene (total)	85	ND
			Trichloroethene	2,840	
8A-900	4.0	22	1,2 Dichloroethene (total)	17	ND
			Trichloroethene	567	
	8.0	ND	Vinyl Chloride	78	ND
			1,1-Dichloroethene	92	
			1,1-Dichloroethane	28	
			1,2-Dichloroethene (total)	1,636	
			1,2-Dichloroethane	157	
			Trichloroethene	2,172	
			Tetrachloroethene	8	
	8.0 Duplicate		1,2-Dichloroethene	1,974	
			Trichloroethene	4,860	

TABLE 4. SUMMARY OF ANALYTICAL RESULTS FOR CHEMICAL SOIL SAMPLES FROM SHALLOW SOIL BORINGS 8A-896 THROUGH 8A-921 (cont'd)

Boring No.	Sample Depth (ft)	Total Barium[a] (mg/kg)	VOCs[b] (ug/kg)		Explosives[b] (ug/g)	
8A-901	4.0	20	1,2-Dichloroethene (total)	8	ND	
			Trichloroethene	9		
	8.0	ND	1,2-Dichloroethene (total)	74	ND	
			Trichloroethene	331		
8A-902	14.0[d]	1,500	1,1-Dichloroethene	750	Tetryl	26.6
			1,1-Dichloroethane	2,539	TNT	5.7
			1,2-Dichloroethene (total)	153,300		
			Trichloroethene	46,910		
			Tetrachloroethene	2,410		
			Toluene	2,450		
	18.0	ND	Methylene Chloride	30,335	ND	
			1,1-Dichloroethene	133		
			1,1-Dichloroethane	110		
			Trichloroethene	42,180		
			1,1,2-Trichloroethane	830		
			4-Methyl-2-Pentanone	698		
			Tetrachloroethene	1,110		
			Toluene	380		
8A-903[c]	4.0	100	1,2-Dichloroethene (total)	16	ND	
			Trichloroethene	220		
	8.0	26	1,2-Dichloroethene (total)	144	ND	
			Trichloroethene	2,079		
8A-904	4.0[d]	120	Vinly Chloride	51	ND	
			Acetone	40		
			1,1-Dichloroethene	6		
			1,2-Dichloroethene (total)	3,628		
			Trichloroethene	86		
	4.0 Duplicate		1,2-Dichloroethene (total)	8,395		
			Chloroform	7		
			Trichloroethene	226		

TABLE 4. SUMMARY OF ANALYTICAL RESULTS FOR CHEMICAL SOIL SAMPLES FROM SHALLOW SOIL BORINGS 8A-896 THROUGH 8A-921 (cont'd)

Boring No.	Sample Depth (ft)	Total Barium[a] (mg/kg)	VOCs[b] (ug/kg)		Explosives[b] (ug/g)
8A-904	8.0	87	Methylene Chloride 1,2-Dichloroethene Trichloroethene Styrene	59 69 88 17	ND
8A-905	4.0[d]	1,000	1,2-Dichloroethene (total) Trichloroethene Ethylbenzene	39,840 78,870 10,665	Tetryl 17.4
	8.0	290	1,2-Dichloroethene (total) Trichloroethene Ethylbenzene Styrene	14,645 21,880 1,390 16,660	Tetryl 9.5
8A-906	4.0	56	ND		ND
	8.0	63	ND		ND
8A-907[c]	4.0	71	Trichloroethene	14	ND
	8.0	130	Trichloroethene	103	ND
8A-908	4.0	82	Trichloroethene	14	ND
	8.0	93	Trichloroethene	270	ND
8A-909	4.0	160	Trichloroethene	16	ND
	8.0	420	ND		ND
8A-910	4.0	290	Trichloroethene	15	ND
	8.0	150	ND		ND
8A-911[c]	4.0	70	1,2-Dichloroethene (total) Trichloroethene	1,219 2,279	ND

TABLE 4. SUMMARY OF ANALYTICAL RESULTS FOR CHEMICAL SOIL SAMPLES FROM SHALLOW SOIL BORINGS 8A-896 THROUGH 8A-921 (cont'd)

Boring No.	Sample Depth (ft)	Total Barium[a] (mg/kg)	VOCs[b] (ug/kg)	Explosives[b] (ug/g)
8A-911	8.0	120	Methylene Chloride 4,318 1,1-Dichloroethene 14 1,2-Dichloroethene (total) 194 Chloroform 5 Trichloroethene 3,228	ND
8A-912	0.0-1.0	200	e	ND
	1.0-2.0	47	e	ND
	4.0	57	ND	ND
	8.0	49	ND	ND
8A-913	4.0	69	ND	ND
	8.0	62	ND	ND
8A-914	4.0	66	Methylene Chloride 8	ND
	8.0	120	ND	ND
8A-915	4.0	120	ND	ND
	8.0	190	ND	ND

ND = Not detected or detected below calibration limits.

[a] Analyses performed by USACE Southwestern Division Laboratory. Calibration limit for Ba was 20 mg/kg.

[b] Analyses performed by Southwest Laboratory of Oklahoma, under contract to USACE Southwestern Division Laboratory. Calibration limits for specific VOCs are contained in Appendix E. Explosive cpds analyzed and respective calibration limits were HMX (1.6 ug/g), RDX (1.8 ug/g), tetryl (5.5 ug/g), TNT (0.8 ug/g), and 2,4 DNT (0.8 ug/g).

[c] "Hot" spot from soil gas survey.

[d] Trench material encountered.

[e] Analysis not performed.

Complete analytical results are contained in Appendix E.

However, no measurable amounts of VOCs were detected in the breathing space of the work area except in soil boring 8A-905, which briefly yielded a TCE concentration of 30-40 ppm when 10 feet had been drilled.

Explosives were detected in only two borings, 8A-902 and 8A-905, both of which contained trench material. Explosives identified were tetryl (26.6 ug/g) and TNT (5.7 ug/g) at 14 feet in 8A-902, and only tetryl at both 4 feet (17.4 ug/g) and 8 feet (9.5 ug/g) in 8A-905. These sample locations also showed the highest concentrations of total barium, with 1500 mg/kg occurring at 4 and 8 feet, respectively, in 8A-905. Complete laboratory results for these soil samples are contained in Appendix E. The quality assurance for these results is discussed in Volume 5.

4.4.3 **Air Curtain Destructor Sampling**. Prior to completing these 20 shallow soil borings and receiving laboratory results, six additional soil borings were added to the shallow soil sampling program after trench material was actually encountered in borings 8A-902, 8A-904, and 8A-905 around the ACD. The purpose of siting these additional borings was to determine how much trench material was actually removed during construction of the ACD and the extent of any material still remaining. These six borings, designated 8A-916 through 8A-921, were drilled and sampled by Fort Worth District personnel from 12-17 May 1988 at the locations shown on Sheet 5. Figure 14 shows how these boring locations relate to the construction as-builts that show the extent of **"muck"** removal and to the aerial photos that show the original extent of the trenches.

Each boring was drilled to approximate elevation 165. Borings were drilled dry using an 8-inch diameter solid stem flight auger. Three different depths were sampled in each boring for explosives and VOCs analyses. Sampling depths were designated at the approximate elevations for the top of the trenches (el 176), for the bottom of the trenches (el 172), and for approximately 6 feet below the bottom of the trenches (el 166) to see how far contamination had migrated downward. A copy of the drill request detailing decontamination, sampling, sample preservation, sample handling, and safety procedures is provided as Appendix F. Geologic logs for borings 8A-916 through 8A-921 are shown on Sheets 11 and 12.

A total of 18 soil samples were taken for chemical analysis. The results of these analyses are summarized on Table 5. It was originally intended that these samples would be analyzed for VOCs and explosives by East Texas Testing Laboratory, Inc., in Longview, Texas, under contract to Morton Thiokol, Inc., for performing soil analyses. Problems with the testing laboratory, however, resulted in transferring the samples to Ana-Lab Corp., in Kilgore, Texas, under contract to Morton Thiokol, Inc., to perform water analyses. Although not requested, East Texas Testing Laboratory, Inc., performed EP toxicity analyses for metals on all 18 samples. None of the samples exceeded the EP toxicity limits specified in 40 CFR 261.24. Volatile organics and explosive analyses were performed by Ana-Lab Corp. It is important to note that units for concentrations were incorrectly

TABLE 5. SUMMARY OF ANALYTICAL RESULTS FOR CHEMICAL SOIL SAMPLES FROM SHALLOW SOIL BORINGS 8A-916 THROUGH 8A-921

Boring No.	Sample Depth (ft)	EP Toxic Metals[a] (mg/l)	VOCs[b] (ug/l)	Explosives[b] (mg/l)
8A-916	9.0[c]	Ba 4.1 Pb 0.09	Benzene 7 Trichloroethene 7	ND
	14.0	Ba 0.22	1,1,1-Trichloroethane 13 1,2-Dichloroethene 89 Trichloroethene 1,800	ND
	20.0	Ba 0.11 Cd 0.01	1,2-Dichloroethane 65 Benzene 7 Methylene Chloride 61 Trichloroethene 640	ND
8A-917	2.0	Ba 0.23	Methylene Chloride 230 Trichloroethene 330	ND
	6.0	Ba 0.22	1,1,1-Trichloroethane 47,000 1,1-Dichloroethane 40 1,1-Dichloroethene 350 Benzene 90 Ethyl Benzene 900 Methylene Chloride 7,200 Tetrachloroethene 1,000 Toluene 10,000 1,2-Dichloroethene 360 Trichloroethene 1,000,000 Xylenes 890	ND
	12.0	Ba 0.23 Cd 0.01 Cr 0.02	1,1,1-Trichloroethane 650 1,1-Dichloroethene 40 1,2-Dichloroethane 130 Methylene Chloride 11,000 Tetrachloroethene 70 1,2-Dichloroethene 1,050 Trichloroethene 24,000	ND
8A-918	16.0	Ba 0.06 Cd 0.01	Methylene Chloride 820 1,2-Dichloroethene 500 Trichloroethene 770	ND
	18.4	Ba 6.1 Cr 0.68	1,1-Dichloroethane 45 1,1-Dichloroethene 40	ND

TABLE 5. SUMMARY OF ANALYTICAL RESULTS FOR CHEMICAL SOIL SAMPLES FROM SHALLOW SOIL BORINGS 8A-916 THROUGH 8A-921 (cont'd)

Boring No.	Sample Depth (ft)	EP Toxic Metals[a] (mg/l)	VOCs[b] (ug/l)		Explosives[b] (mg/l)
8A-918	18.4		1,2-Dichloroethane Ethyl Benzene Methylene Chloride Tetrachloroethene Toluene 1,2-Dichloroethene Trichloroethene Xylenes	340 100 200 160 30 6,600 550 1,200	
	26.0	Ba 0.15	1,1-Dichloroethene 1,2-Dichloroethane Benzene Methylene Chloride Trichloroethene	16 880 1,200 2,200 1,300	ND
8A-919	18.0	Ba 0.40	Trichloroethene	36	ND
	22.0	Ba 0.48	Chloroform Methylene Chloride 1,2-Dichloroethene Trichloroethene	10 880 170 1,200	ND
	28.0	Ba 0.12	Methylene Chloride Trichloroethene	29,000 1,700	ND
8A-920	3.0	Ba 0.11	Methylene Chloride Trichloroethene	510 33	ND
	7.0	Ba 0.06	Benzene	8	ND
	13.0	As 0.02 Ba 0.73 Cd 0.01 Cr 0.48 Pb 0.06 Se 0.01	1,2-Dichloroethene Trichloroethene	140 160	ND
8A-921	12.0	As 0.01 Ba 0.29	2-Chloroethylvinyl, ether Trichloroethene	9 8	ND
	16.0	Ba 0.17 Cd 0.02	ND		ND
	22.0	Ba 0.22	Methylene Chloride Trichloroethene	200 210	ND

TABLE 5. SUMMARY OF ANALYTICAL RESULTS FOR CHEMICAL SOIL SAMPLES FROM SHALLOW SOIL BORINGS 8A-916 THROUGH 8A-921 (cont'd)

ND = Not detected or detected below calibration limits.

[a] Analyses performed by East Texas Testing Laboratory, Inc., under contract to Morton Thiokol, Inc.

[b] Analyses performed by Ana-Lab Corp., under contract to Morton Thiokol, Inc. Note that VOC analyses were performed after shelf life of samples were exceeded. Calibration limits for specific VOCs are contained in Appendix G. Explosive cpds analyzed and respective calibration limits were RDX (0.01 mg/l), HMX (0.01 mg/l), tetryl (0.3 mg/l), 2,4 DNT (0.01 mg/l), 2,6 DNT (0.01 mg/l), and 2,4,6 TNT (0.01 mg/l). Units are those reported by Ana-Lab Corp., possibly reflecting extraction concentrations only.

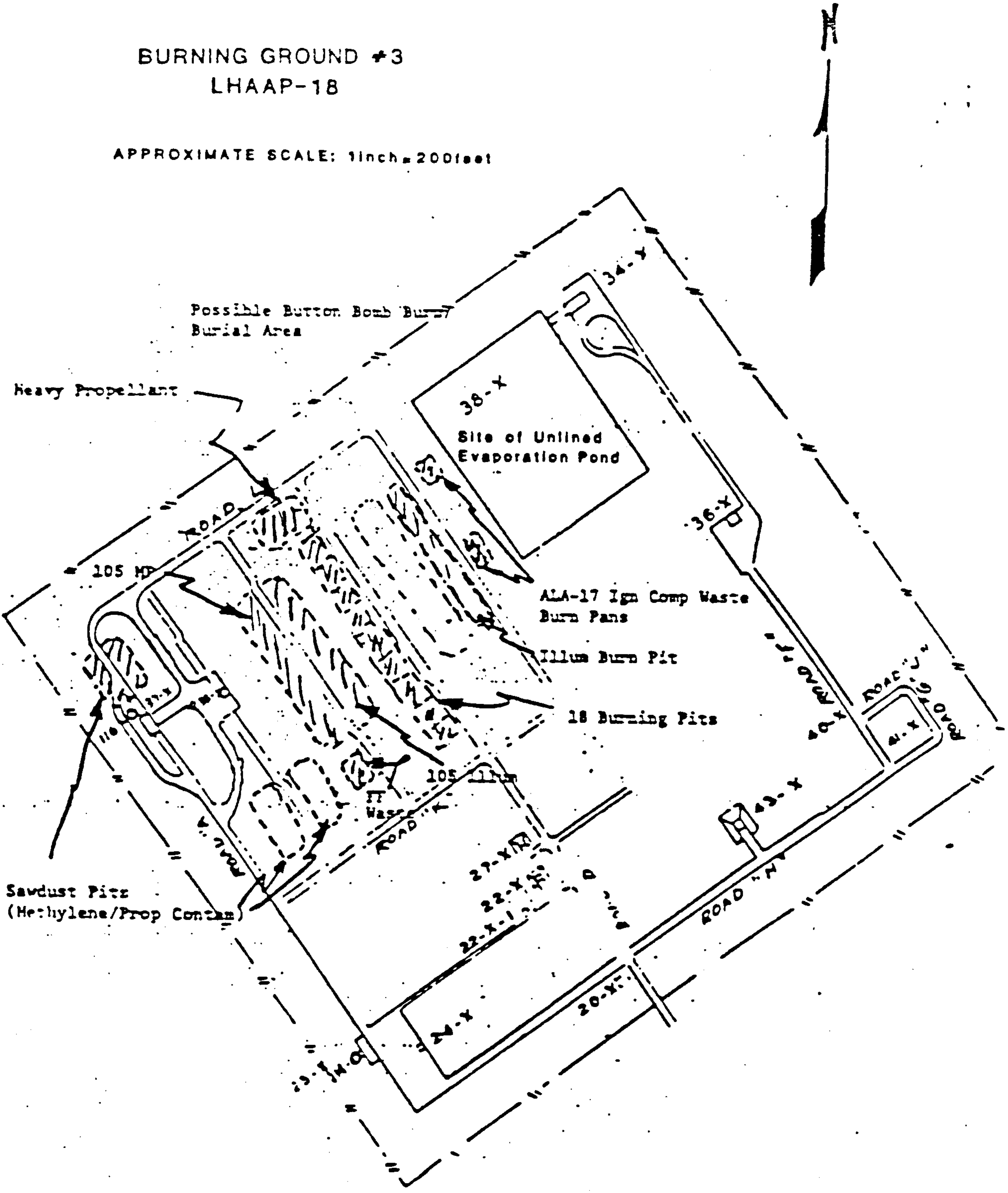
[c] Trench material encountered.

Complete analytical results are contained in Appendix G.

and inexplicably reported as mg/l, possibly reflecting extraction concentrations only. No explosives were detected. It is also important to note that the VOC analyses were performed after the shelf life for VOCs was exceeded. In spite of the reliability of these test results, VOC concentrations were very high, even though no trench material was evident except in boring 8A-916, where traces of material were found at 9 feet. The maximum concentration of TCE reported was 1,000,000 ug/l at 6 feet in 8A-917. The least amount of contamination was found in boring 8A-921, sited on the trench berm limits as determined from the aerial photos. Few VOCs were detected at the upper sampling depths in 8A-921; however, methylene chloride and TCE were detected at 200 ug/l and 210 ug/l, respectively, at 22 feet. Complete analytical results provided to Fort Worth District by Morton Thiokol, Inc., are contained in Appendix G.

4.4.4 __ABG Area - Second Round Sampling__. In September 1987, Fort Worth District installed six monitoring wells, MW-1 through MW-6, at the Point of Compliance around the UEP as required by the scope of work for this investigation. Details of these installations are discussed in **Section 5.0** of this report. On 7 May 1988, Morton Thiokol, Inc., sampled these wells as part of LHAAP's quarterly monitoring program. The samples were analyzed by Ana-Lab Corp., under contract to Morton Thiokol, Inc. The analytical results for MW-1 through MW-6 were provided to Fort Worth District by Morton Thiokol, Inc., and are contained in Appendix H. Four of the six wells showed concentrations of methylene chloride ranging from 300 ug/l to 2,900,000 ug/l. All six of the wells showed concentrations of TCE ranging from 70 ug/l to 60,000 ug/l. These extremely high concentrations of methylene chloride and TCE indicated that ground-water contamination was still present around the UEP.

In order to investigate whether any other sources besides the past operation of the UEP was contributing to the contamination around the pond, 21 additional soil borings, designated 8A-926 through 8A-946, were added to the shallow soil boring program. The borings were sited comparing suspect areas identified in aerial photos with suspect areas identified on the map shown on Figure 15, which shows past solid waste management operations at the ABG as determined by the USAEHA in **"Ground-Water Contamination Survey No. 38-26-0851-88, 18-22 May 1987."** Borings 8A-926 through 8A-934 were sited at 60-foot intervals along the southwestern and southeastern edges of the UEP cap for the purpose of locating any remaining methylene chloride soaked sawdust that was stockpiled along the berms of the UEP during its operation. Borings 8A-935 through 8A-937 were sited along a suspected trench identified in 1980 aerial photos at a location coinciding with the **"Illum Burn Pit"** shown on Figure 15. The remaining nine borings were sited at 50-foot intervals along a suspect area identified as **"Stacks or Burning"** in the 1970 aerial photo sketch shown on Figure 13, which coincides with the line of **"18 Burning Pits"** shown on Figure 15. Boring locations are shown on Sheet 5.



Source: Ground-Water Contamination Survey No.
38-26-0851-88, LHAAP, Marshall, TX,
USAEHA, 18-22 May 1987.

Figure 15. Past Solid Waste Management Units at the ABG.

All 21 soil borings were drilled and sampled from 15-18 August 1988. Each boring was drilled 10 feet deep. Samples to be analyzed for total barium and VOC concentrations were taken at 4 and 10 feet depths in each boring. A copy of the drill request detailing decontamination, sampling, sample preservation, sample handling, and safety procedures is provided as Appendix I. Geologic logs for borings 8A-926 through 8A-946 are shown on Sheets 12 through 17.

A total of 42 soil samples were analyzed for total barium and VOC concentrations. Total barium was selected as an indicator parameter for pyrotechnic wastes. All samples were delivered by Fort Worth District personnel to the SWDL in Dallas, Texas. Volatile organics analyses were performed by Southwest Laboratory of Oklahoma in Tulsa, Oklahoma, under contract to the SWDL. Total barium analyses were performed by the SWDL.

Analytical results for these 42 soil samples are summarized on Table 6. Only the VOCs detected and quantified are shown because many VOCs were tentatively identified at estimated concentrations below detection limits. The tentatively identified and unknown compounds are shown in the complete laboratory results contained in Appendix J.

Volatile organic compounds were detected at concentrations >20 ug/kg in 11 of the 21 borings drilled. These contaminated soil borings are shown on Sheet 5. Of the nine borings sampled around the capped UEP, only borings 8A-930, 8A-931, and 8A-932 detected VOCs. These three locations are closest to the ramp area of the pond. Only trace

TABLE 6 SUMMARY OF ANALYTICAL RESULTS FOR CHEMICAL SOIL SAMPLES FROM SHALLOW SOIL BORINGS 8A-926 THROUGH 8A-946

Boring No.	Sample Depth (ft)	Total Barium[a] (mg/kg)	VOCs[b] (ug/kg)	
8A-926	4.0	92	ND	
	10.0	190	ND	
8A-927	4.0	97	ND	
	10.0	110	ND	
8A-928	4.0	56	ND	
	10.0	110	Acetone[c]	21
8A-929	4.0	50	ND	
	10.0	83	ND	
8A-930	4.0	60		
	10.0	59	1,1- Dichlorothene	6
			Trichloroethene	8
8A-931	4.0	32	Acetone[c]	14
			1,2-Dichloroethene (total)	9
			Trichloroethene	91
	10.0	96	1,1-Dichloroethene	49
			1,1-Dichloroethane	19
			1,2-Dichloroethene (total)	57
			1,1,1-Trichloroethane	13
			Trichloroethene	920E
			Tetrachloroethene	64
	10.0 Duplicate		1,2-Dichloroethene	35
			Trichloroethene	520B
			Tetrachloroethene	44
8A-932	4.0	52	Trichloroethene	8
	10.0	75	ND	

TABLE 6 SUMMARY OF ANALYTICAL RESULTS FOR CHEMICAL SOIL SAMPLES FROM SHALLOW SOIL BORINGS 8A-926 THROUGH 8A-946 (cont'd)

Boring No.	Sample Depth (ft)	Total Barium^a (mg/kg)	VOCs^b (ug/kg)	
8A-933	4.0	79	ND	
	10.0	78	ND	
8A-934	4.0	120	ND	
	10.0	130	ND	
8A-935	4.0	61	ND	
	10.0	85	1,1-Dichloroethene	57
8A-936	4.0	32	ND	
	10.0	85	ND	
8A-937	4.0	36	1,1,1-Trichloroethane	31
			Tetrachloroethene	13
	10	60	1,1-Dichloroethene	14
8A-938	4.0	81	ND	
	10.0	26	ND	
8A-939	4.0	86	Trichloroethene	650E
	4.0 Duplicate		Trichloroethene	85B
	4.0 Duplicate		Trichloroethene	33B
	10.0	72	Trichloroethene	2500BE
8A-940	4.0	51	Methylene Chloride	22,000
			Acetone	33,000
			1,2-Dichloroethene (total)	14,000
			1,2-Dichloroethane	4,600
			Trichloroethene	430,000E
			Tetrachloroethene	4,500
			Toluene	34,000
			Ethylbenzene	2,900

TABLE 6. SUMMARY OF ANALYTICAL RESULTS FOR CHEMICAL SOIL SAMPLES FROM SHALLOW SOIL BORINGS 8A-926 THROUGH 8A-946(cont'd)

Boring No.	Sample Depth (ft)	Total Barium^a (mg/kg)	VOCs^b (ug/kg)	
8A-940	10.0	68	Methylene Chloride	420,000E
			Acetone	20,000
			Chloroform	3,200B
			1,2-Dichloroethane	120,000E
			1,1,1-Trichloroethane	2,200
			Trichloroethene	150,000E
			Tetrachloroethene	16,000
			Toluene	6,700
			Ethylbenzene	18,000
			Xylene (total)	6,100
			1,2-Dichlorobenzene	9,300
8A-941	4.0	67	Trichloroethene	90B
	10.0	140	Acetone^c	46
	10.0 Duplicate		ND	
8A-942	4.0	85	Toluene	690
			Ethylbenzene	3,300E
			Xylene (total)	830
	10.0	170	Acetone^c	150
			1,2-Dichloroethene (total)	140
			Trichloroethene	46B
			Toluene	8
			Ethylbenzene	28
8A-943	4.0	28	Acetone^c	18
	10.0	100	1,2-Dichloroethene (total)	18
			Trichloroethene	19B
8A-944	4.0	29	Acetone	9,900
			Ethylbenzene	1,100
			Styrene	2,100
			Xylene (total)	3,000

TABLE 6. SUMMARY OF ANALYTICAL RESULTS FOR CHEMICAL SOIL SAMPLES FROM SHALLOW SOIL BORINGS 8A-926 THROUGH 8A-946 (cont'd)

Boring No.	Sample Depth (ft)	Total Barium[a] (mg/kg)	VOCs[b] (ug/kg)	
8A-944	10.0	140	Methylene Chloride	4,500
			Carbon Disulfide	13,000
			Trichloroethene	3,800
			Ethylbenzene	7,200
			Styrene	35,000
8A-945	4.0	16	Methylene Chloride	310
			Acetone	1,900E
			Trichloroethene	54
			Tetrachloroethene	110
			Ethylbenzene	70
			Styrene	480
			Xylene (total)	610
	4.0 Duplicate		Acetone	4,700
	10.0	43	Methylene Chloride	16,000
			Trichloroethene	1,700
8A-946	4.0	62	ND	
	10.0	98	ND	

ND = Not detected or detected below calibration limits.

E = Concentration exceeded calibration limits.

B = Possible laboratory blank contamination.

[a] Analyses performed by USACE Southwestern Division Laboratory. Calibration limit for Ba was 1.0 mg/kg.

[b] Analyses performed by Southwest Laboratory of Oklahoma, under contract to USACE Southwestern Division Laboratory. Calibration limits for specific VOCs are contained in Appendix J.

[c] Acetone is common laboratory contaminant, with normal allowable level five times detection limit reported.

Complete analytical results are contained in Appendix J.

(<20 ug/kg) concentrations of solvent-type compounds were detected, except in boring 8A-931, where the concentration of TCE exceeded 920 ug/kg at the 10-foot depth. This concentration is questionable, however, because the method blank run with the duplicate analysis showed possible laboratory blank contamination. No physical evidence of sawdust was found and no methylene chloride was detected in any of these borings, suggesting that if any remnants of stockpiled sawdust do exist, they are most likely under the capped area of the UEP.

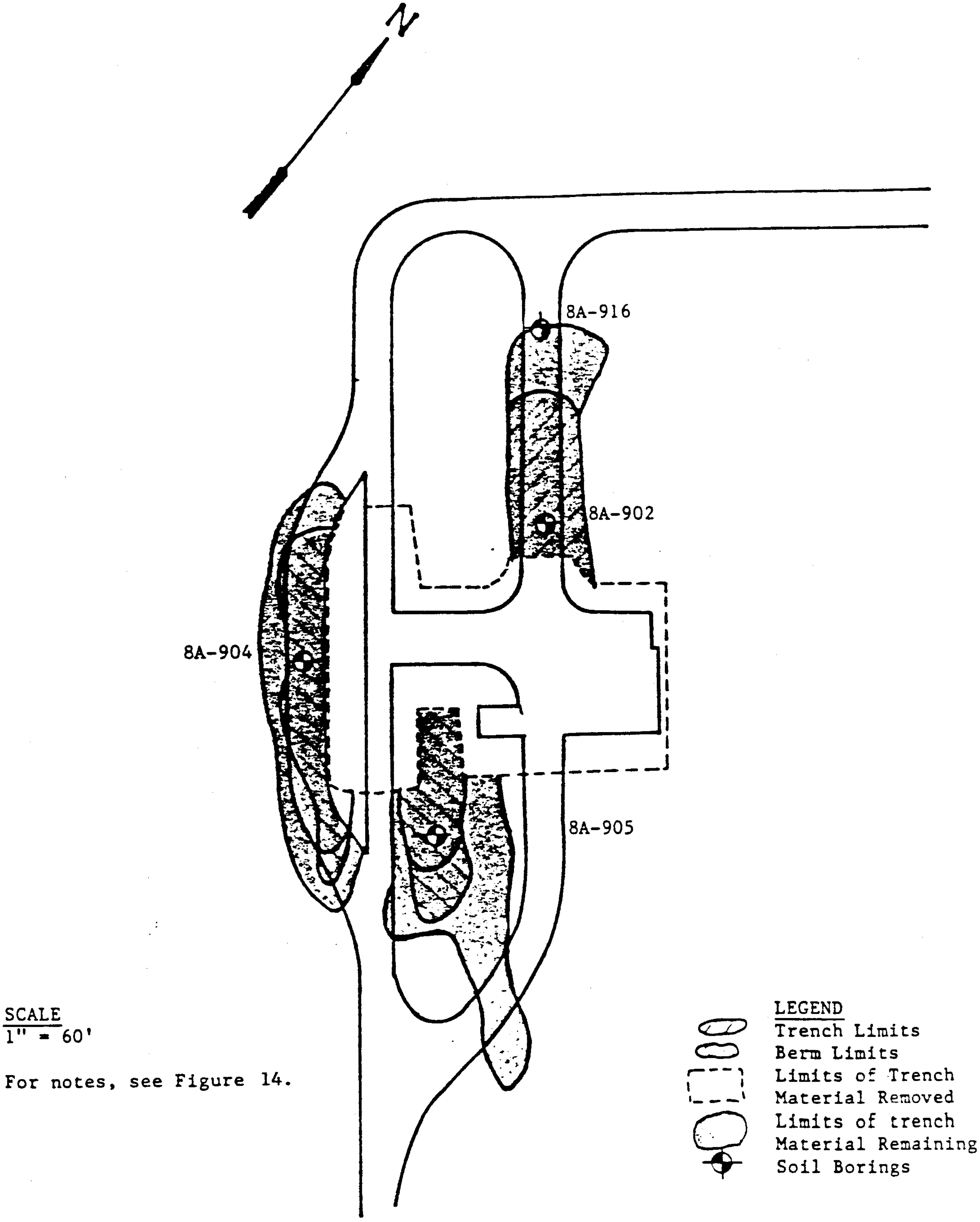
Two of the three borings drilled at the **"Illum Burn Pit"** location showed very low concentrations of VOCs. These two borings were 8A-935 and 8A-937. No physical evidence of the pits was noted. However, boring 8A-937 showed many unidentified compounds detected below calibration limits.

The remaining nine borings drilled along the line of **"18 Burning Pits"** showed the highest concentrations and most varied VOCs detected of the 21 soil borings. All of the borings except 8A-938, 8A-939, and 8A-946 showed backfill material ranging from 0.4 foot thick in 8A-945 up to 6.1 feet thick in 8A-944. Weak to strong odors were noted in all of the borings except 8A-938 and 8A-939. All borings except 8A-938 and 8A-946 showed VOCs present; however, only 4 borings had VOC concentrations >20 ug/kg. Boring 8A-940 had the highest concentrations of VOCs, with methylene chloride exceeding 420,000 ug/kg and TCE exceeding 430,000 ug/kg. Many types of hydrocarbons were also detected in 8A-940, some at concentrations as high as 34,000 ug/kg for toluene, and some unidentified at concentrations estimated as high as 110,000 ug/kg, shown in Appendix J. Borings 8A-942, 8A-944, and 8A-945 showed the same varied range of VOCs and hydrocarbons, with concentrations somewhat less than those detected in 8A-940. Total barium concentrations did not exceed 190 mg/kg, and did not exhibit any pattern with the concentrations of VOCs detected in any of the 21 borings. The quality assurance of these test results is discussed in Volume 5.

4.4.5 **Summary**. Based on these contaminant source investigations, there is a second source at the ABG, besides the past operation of the UEP, that is contributing to the ground-water contamination beneath the site. This source consists of the remnants of three trenches and their berms that are buried around the foundation of the ACD in the western corner of the ABG. Trench remnants encountered from approximate el. 175-177 in borings 8A-902 and 8A-905 consisted of solvent soaked straw, wood shavings, and sawdust in a fill binding material. Trench berm materials were encountered from approximate el. 173-177 in borings 8A-904 and 8A-916 and consisted of traces of these trench materials and other foreign matter. These locations correspond to the original location and extent of the trenches shown in the aerial photos. Because these four borings were the only borings that encountered physical evidence of trench material, it appears safe to assume that the trenches remaining under the foundation of the ACD were removed to the limits of **"muck"** excavation shown on the construction as-builts, leaving the trench remnants beyond the foundation, as shown on Figure 16, as a likely source for ground-water contamination observed in this area.

Three subsurface profiles through this corner of the ABG are shown on Sheet 18 for the purpose of portraying the extent of remnant trench materials and the subsurface conditions where these remnants occur. Free water was encountered at various depths during the drilling in this area, and any attempts to get a 24-hour water level were fruitless because the borings would not stay open overnight. A 3-inch diameter PVC pipe was finally placed in 8A-921 to obtain a 24-hour water level. The ground-water elevation obtained was 177. In most cases, a strong sharp odor was observed in the ground water when it was encountered beneath the ACD. However, no odor was noted in the ground water moving away from the site except in the direction of boring 8A-896, which was a "hot" spot from the soil gas survey.

A potential third contaminant source was identified along the line of **"18 Burning Pits"** shown on Figure 15. Although no physical evidence of burned materials was encountered while drilling borings 8A-938 through 8A-946 along this line of pits, fill material was identified, as well as high concentrations of VOCs and hydrocarbons. The total depth of each of these borings was 10 feet, and no ground water was encountered. However, since the principal recharge to the ground water in this area is infiltration, soil contaminated from past operation of these pits definitely poses the threat of being carried into the ground water underlying the site.



For notes, see Figure 14.

Figure 16. Extent of Contaminant Source Material.

A possible fourth source that could be contributing to ground-water contamination south of the UEP is a suspected trench location adjacent to the west side of the road east of boring 8A-911, suggested by the 1963 aerial photos. High concentrations of VOCs found in soil samples from 8A-911 suggest possible past activity nearby. However the abandoned demolition pit, located immediately south of 8A-911 at boring location 8A-912, which was suspected as a source prior to soil sampling, proved to be an unlikely source after soil samples taken in boring 8A-912 showed no VOCs detected. Soil samples taken for soil classification analyses from the top 2 feet of the boring were later selected for chemical analysis when the geologic log indicated black carbon matter was encountered while drilling. No VOC analyses were performed because the samples had exceeded the shelf life for VOCs. However, the samples were analyzed for total metals and explosives. The maximum concentration for barium detected was 200 mg/kg. No explosives were detected. These results do not eliminate this as a possible source area for VOCs, but because no odor was noted in the samples taken from 8A-912, and soil gas data showed a relatively low concentration of TCE, it appears unlikely that the abandoned demolition pit is a VOC source.

5.0 GROUND-WATER MONITORING.

5.1 **Water Level Data.** Three rounds of water levels were made at the ABG during the course of this investigation. The first round of measurements was made from 7-8 July 1987 for the 25 existing wells at the ABG. Depth to water and depth to the bottom of the well were measured from the top of the PVC well casing in all wells except C-10, where the depths were measured from the top of the protective casing. Measurements were made from these reference points to use the survey data already provided in the CDM reports. However, a comparison of recorded stick-up measurements for the well casings to the stick-up measurements made in the field showed several discrepancies that made the survey data and actual reference points questionable. For several wells (e.g., 101, 102, 125, and 129) it was found that the surveyed elevation for the top of PVC casing was actually the surveyed elevation for the outer protective casing. Recorded stick-ups for the top of PVC on other wells (e.g., 124) were noted as differing from field measurements as much as 1 foot or more. Also, the PVC pipe was cut at an angle or damaged on some wells (e.g., C-2, C-4, and C-10), and in other wells the top of PVC was far enough below the top of the protective casing to make it awkward to take accurate water level measurements consistently.

Because of these discrepancies, the water level elevations determined from the measurements made 7-8 July 1987 became questionable. Previous hydrologic data show a very low hydraulic gradient across the ABG, which makes survey control very critical when plotting a piezometric surface to assist in determining future well locations. Therefore, the water level data obtained in July 1987 were considered bad data and are not presented.

The second round of water level measurements was made from 20-22 April 1988 for the 25 existing wells and the 6 newly installed Compliance Monitoring wells, MW-1 through MW-6. Depth to water in each well was measured from the recently surveyed notched well casing using a Slope Indicator Company Model 51453 water level indicator. The tip of the indicator was thoroughly washed with a mild detergent, then rinsed with distilled water prior to lowering it in each well. Depths to water were recorded to the nearest 0.1 foot and are shown on Table 7. Water level elevations were determined using the most recent Fort Worth District survey data compiled earlier in the month. Contoured elevations of the ground-water surface are presented on Sheet 19.

A third round of water levels was taken on 31 August 1988 for all existing and all newly installed wells except MW-13, which had not yet been installed. Depths were measured in the same manner as during the second round of water level readings and were recorded to the nearest 0.01 foot. Water level readings are shown on Table 7. Although wells MW-7 through MW-15 had not been surveyed yet, the inner well casings had been set level to allow for an accurate measurement from any edge. Water level elevations were determined

TABLE 7. WATER LEVEL DATA

WELL NO.	MEASURING POINT		20-22 APRIL 1988		31 AUGUST 1988	
	NOTCHED CASING	ELEVATION (FT-MSL)	DEPTH (FT)	ELEVATION (FT-MSL)	DEPTH (FT)	ELEVATION (FT-MSL)
BH-3	Well	196.30	21.5	174.8	24.26	172.04
BH-4	Well	197.44	23.0	174.4	24.75	172.69
BH-7	Well	197.24	23.1	174.1	24.27	172.97
BH-11	Well	199.03	25.3	173.7	27.18	171.85
BH-22	Well	199.25	24.3	175.0	25.49	173.76
101	Prot.[a]	197.51	7.0	190.5	9.65	187.86
102	Prot.	194.55	18.5	176.0	20.25	174.30
109	Prot.	197.11	23.6	173.5	24.59	172.52
120	Prot.	183.28	8.4	174.8	11.53	171.75
123	Prot	186.33	11.1	175.2	12.66	173.67
124	Prot.	186.39	10.7	175.7	12.68	173.71
125	Prot.	196.35	21.9	174.4	25.08	171.27
126	Prot.	199.41	26.2	173.2	28.00	171.41
129	Prot.	197.13	21.7	175.4	23.63	173.50
130	Prot.	177.80	5.4	172.4	7.20[b]	170.60
C-1	Prot.	193.80	20.5	173.3	22.79	171.01
C-2	Prot.	176.03	2.8	173.2	6.13	169.90
C-3	Prot.	196.41	23.1	173.3	25.85	170.56
C-4	Prot.	194.74	21.3	173.4	24.49	170.25
C-5	Prot.	180.77	9.4	171.4	12.90	167.87
C-6	Prot.	192.34	22.3	170.0	25.27	167.07
C-7	Prot.	196.72	23.1	173.6	26.07	170.65
C-8	Prot.	192.56	19.1	173.5	21.33	171.23
C-9	Well	202.66	29.9	172.8	31.04	171.62
C-10	Prot.	202.04	28.1	173.9	30.35	171.69
MW-1	Well	199.24	23.8	175.4	25.30	173.94
MW-2	Well	197.00	22.2	174.8	26.66	170.34
MW-3	Well	196.51	23.3	173.2	25.37	171.14
MW-4	Well	197.31	22.6	174.7	25.19	172.12
MW-5	Well	195.21	21.1	174.1	24.34	170.87
MW-6	Well	192.18	18.6	173.6	21.62	170.56
MW-7	Well	188.56	-[c]	-	15.51	173.05
MW-8	Well	186.85	-[c]	-	13.90	172.95
MW-9	Well	184.78	-[c]	-	11.83	172.95
MW-10	Well	177.99	-[c]	-	8.50	169.49
MW-11	Well	177.65	-[c]	-	7.39	170.26
MW-12	Well	178.37	-[c]	-	8.12	170.25
MW-13	Well	176.72	-[c]	-	-[c]	-
MW-14	Well	182.99	-[c]	-	12.48	170.51
MW-15	Well	197.32	-[c]	-	26.56	170.76

[a] Prot. = Protective casing

[b] Recorded 12 Aug 89

[c] Well not installed

upon completion of the final round of surveying in September 1988. Contoured water level elevations for the 31 August 1988 readings are shown on Sheet 20.

5.2 **Survey Data**. Surveying was performed by Fort Worth District survey personnel at three different times. The first survey data were gathered in April 1988 to establish X,Y coordinates and elevations for all 25 existing wells at the ABG and for the 6 newly installed wells MW-1 through MW-6. At this time, a permanent reference mark for taking water level measurements was established on each well by notching the casing with the highest stick-up, painting the notch to make it visible, then surveying this mark to establish a reference elevation for taking all future water level measurements. A second round of surveying was performed in May 1988 to survey and stake eight proposed well locations (MW-7 through MW-14) and four stratigraphic test boring locations (3F-922 through 3F-925). The final round of surveying was performed in September 1988 after all new wells (MW-7 through MW-15) were installed. Coordinates were established to at least the nearest 0.01 foot and are referenced to the State Plane Coordinate System. All elevations were determined to at least the nearest 0.01 foot and are referenced to the National Geodetic Vertical Datum (NGVD) of 1929. Elevations were determined for the reference mark notched on each well casing. For those wells surrounded by a concrete pad (BH-3, BH-4, BH-7, BH-11, BH-22, and C-1 through C-10), **"ground"** elevations were surveyed for the top of the pad. For wells

MW-1 through MW-15, **"ground"** elevations were surveyed for the survey marker installed in the concrete pad. For all other wells, **"ground"** elevation was surveyed for the actual ground surface adjacent to the well. Survey data for all of the ABG monitoring wells and the four stratigraphic test borings are provided in Appendix K.

5.3 **Monitoring Well Installation Procedures**. A total of 15 monitoring wells were installed during this assessment. Twelve of these wells, designated MW-1 through MW-12, were screened at the base of the suspected uppermost saturated zone underlying the ABG area. The other three wells, designated MW-13, MW-14, and MW-15, were installed about 10 feet away from wells C-2, 120, and MW-2, respectively, and were screened in the next deeper saturated zone at each of these locations. Well locations are shown on Sheet 21.

All drilling, sampling, and well installations were performed by a Fort Worth District drill crew and geologist following a standard set of procedures. All borings were drilled with a Failing 1500 drill rig. All downhole equipment was steam cleaned prior to drilling each boring. Borings MW-1 through MW-12 were drilled dry using a 10-inch diameter solid stem flight auger. Borings MW-13 through MW-15 were drilled dry to the depth where casing was set and grouted to seal off the upper saturated zone. The remainder of these borings was augered until the borings began to cave. Each was then completed using a 9-7/8-inch diameter rockbit and a pure bentonite drill mud mixed with nonchlorinated water obtained from the ABG water supply.

Deep wells were completed using a 7-7/8-inch diameter rockbit.

Two types of soil samples were taken in each well boring. Soil samples to be analyzed for the soil classification characteristics grain size distribution, Atterberg limits, and moisture content were taken every foot for the first 10 feet, then once every 5 feet or change of material for the remainder of each boring. Soil samples for chemical analysis were taken at 2- and 10-foot depths in each boring. These samples were analyzed for total metals, explosives, and VOCs, and were taken in the same manner as those chemical samples obtained from the shallow soil borings described earlier.

Upon completion of drilling and sampling, each shallow monitoring well was constructed in accordance with the monitoring well construction detail shown on Figure 17. Deeper wells were constructed in accordance with the detail shown on Figure 18. All well materials were 4-inch I.D. Type 304 stainless steel with flush threaded joints. Well screens were 5 feet long and pre-slotted at a 0.010 inch slot size. The well materials were steam cleaned prior to installation. A manufactured silica sand with a standard sieve size range of 20 to 40 (0.33 to 0.165 inches) was used as a gravel pack, which was placed from the bottom of the boring to 2 feet above the top of the well screen. A 2-foot bentonite seal was placed above the gravel pack, and the remainder of the boring was grouted to the ground surface.

Safety procedures for monitoring well installations were the same as those previously described for the shallow soil sampling program

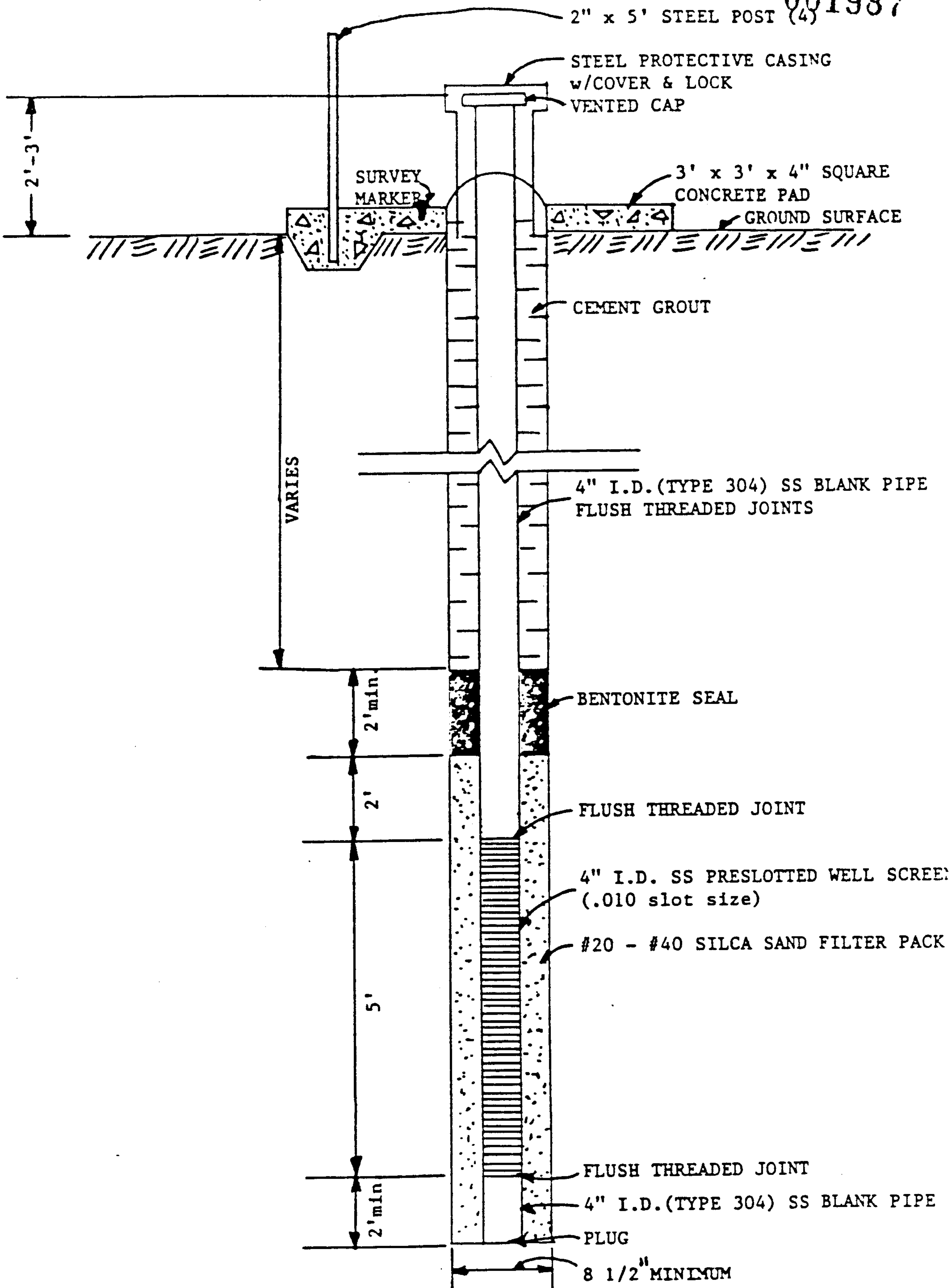


Figure 17. Typical Construction Detail for Shallow Monitoring Well.

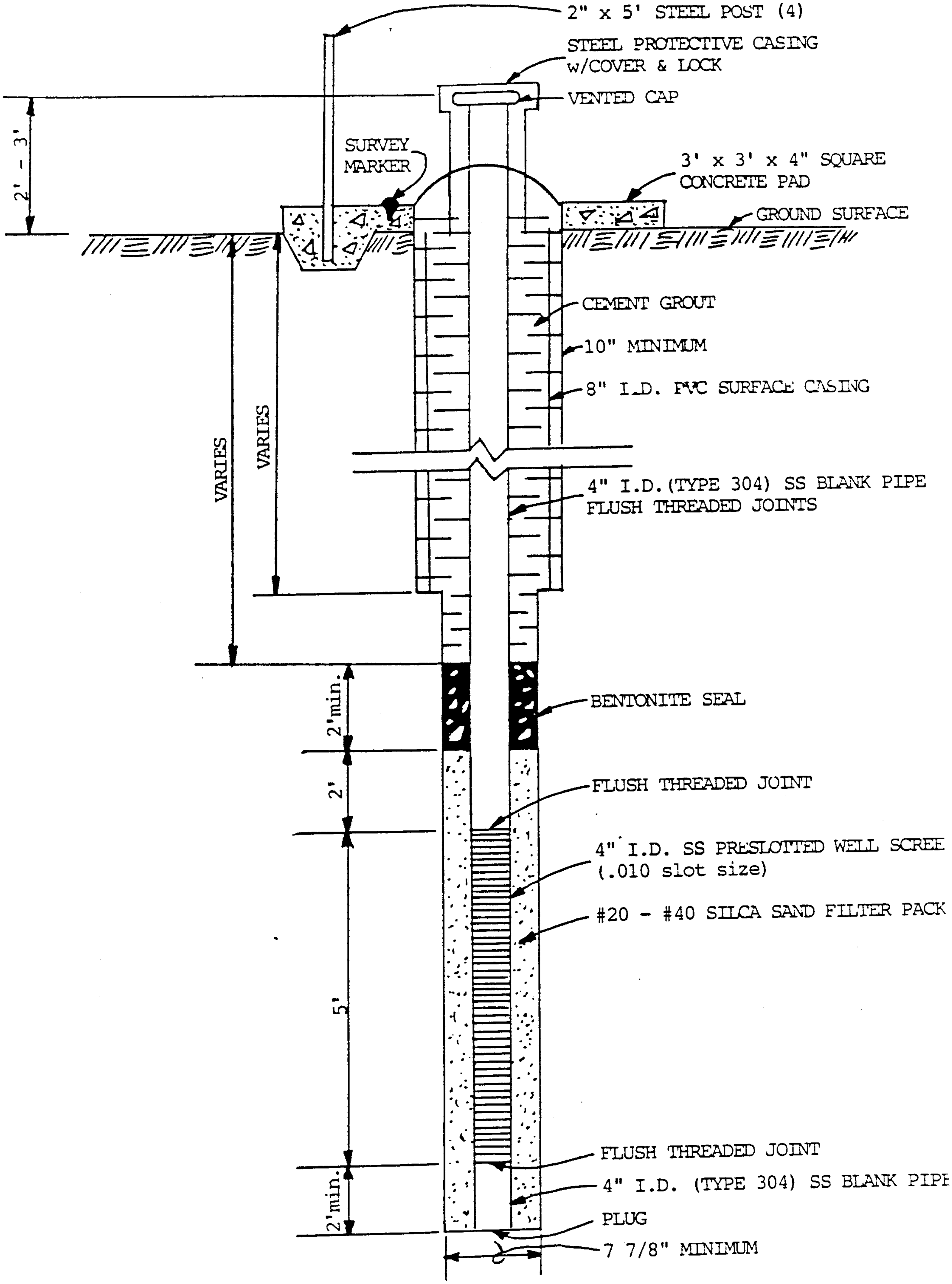


Figure 18. Typical Construction Detail for Deep Monitoring Well

except that gas detector readings were made not only for every 10 feet of boring advancement, but also for surging and bailing performed during well development, which began 48 hours after grouting. Each well was developed using a surge block and bailer which were steam cleaned prior to introduction to the well. Development lasted a minimum of 4 hours, or until the water was clear and free of sediment. Water removed from the well was discharged far enough away to prevent it from running back down the borehole.

After development, each well was equipped with a dedicated 3-foot long 2-inch O.D. stainless steel bailer suspended from the vent hole of the well cap on a teflon-coated stainless steel cable. Each bailer was thoroughly washed with a mild detergent, then rinsed with distilled water prior to installation.

Each well was finished at the ground surface by grouting a lockable 5-foot long 6-inch diameter protective steel casing over the well head. A 3- by 3-foot square concrete pad 4 inches thick was placed around the well. The pad is sloped to direct drainage away from the well. It has a steel post in each corner and a survey marker embedded in the surface. Each survey marker was later stamped with the well number and surveyed marker elevation. Protective posts and well casings were painted, and each protective casing was marked with the well number.

5.4 <u>Installation of Wells MW-1 through MW-6</u>. Six ground-water monitoring wells, MW-1 through MW-6, were installed around the closed

UEP to implement a Compliance Monitoring Program at the Point of Compliance for the UEP, and to implement a Corrective Action Monitoring Program downgradient of the UEP, as proposed in the document "U.S. **Army Proposal for Additional Groundwater Monitoring at the Closed Unlined Evaporation Pond (UEP), Longhorn Army Ammunition Plant, Marshall, Texas,"** prepared by the USACE, Huntsville Division, February 1987, and submitted by LHAAP to the TWC on 27 April 1987. The wells were installed at the proposed locations and were constructed in accordance with the proposed well construction detail, shown on Figure 17. Wells were to be screened at depths approximating the depths previously monitored by USAEHA wells that were removed during closure of the UEP, although construction details for these wells are not available. Boring logs showed all of the USAEHA wells drilled to a depth of 50 feet. The personal communication cited by CDM in the CDM report states that the USAEHA wells screened the top 10 feet of the water table, which is considerably higher than the final 50-foot depths of the well borings.

Examination of the USAEHA boring logs for well borings BH-1 through BH-11 consistently showed various types of clay encountered at approximate el. 150. Because both USATHAMA wells, screened at shallow depths, and USAEHA wells, screened at unknown depths but penetrating to 50 feet, had shown contamination above this clay stratum, it was decided to treat this clay as a possible aquiclude and screen the materials lying immediately above it. Available boring logs and well installation details for the USAEHA and USATHAMA wells are contained in Appendix L.

The six wells were installed from 24 August to 30 September 1987. A copy of the drill request detailing decontamination, sampling, well installation, and safety procedures is provided as Appendix M. After the installation of the first two wells, MW-1 and MW-2, it became necessary to drill an exploratory soil boring, MW-1A, for the purpose of positively identifying the target clay and the soils immediately overlying it. Boring MW-1A was drilled at the location shown on Sheet 21 in a direction believed to be upgradient from the UEP. The boring was augered dry to a depth of 53.0 feet. Soil samples for soil classification analysis were taken every change of material, and the boring was immediately grouted upon completion. A very silty, sandy, low to medium plasticity clay was encountered from 40.2 to 44.0 feet, and a medium to high plasticity clay occurred from 44.0 feet to the bottom of the boring. The occurrence of these clays at these depths agreed well enough with the USAEHA logs and the materials encountered in MW-1 and MW-2 to continue using the clays they identified at approximate el. 150 as the bottom of the MW wells being installed. Geologic logs for soil boring MW-1A and well borings MW-1 through MW-6 are provided in Appendix N. Well installation details are provided in Appendix O and are summarized on Table 8. No unusual conditions were noted during development of any of the wells.

A total of 16 soil samples were taken to be analyzed for VOCs,

TABLE 8.

SUMMARY OF MONITORING WELL INSTALLATION DATA[a] FOR MW-1 THROUGH MW-15

Well No.	Survey Marker Elevation[b] (ft msl)	Total Boring Depth (ft)	Depth to Top of Screen (ft)	Depth to Top of Sand (ft)	Depth to Top of Bentonite (ft)	Top of Well Pipe Elevation (ft msl)
MW-1	197.73	38.0	31.0	28.8	25.2	199.24
MW-2	195.18	40.4	33.4	31.0	27.0	197.00
MW-3	194.02	46.0	39.0	36.5	31.0	196.51
MW-4	195.77	43.0	36.0	33.2	29.1	197.31
MW-5	193.34	40.8	33.8	31.5	27.2	195.21
MW-6	190.26	45.8	38.8	36.4	32.2	192.18
MW-7	186.62	25.0	18.0	15.0	11.5	188.56
MW-8	185.47	32.0	24.0	11.0	8.0	186.85
MW-9	182.58	27.0	20.0	11.0	8.0	184.78
MW-10	176.23	34.5	26.5	21.5	18.0	177.99
MW-11	176.52	11.6	4.6	2.6	0.6	177.65
MW-12	176.77	28.8	20.8	18.8	16.0	178.37
MW-13	174.64	46.0	38.0	36.0	32.0	176.72
MW-14	180.93	51.0	43.0	40.0	36.0	182.99
MW-15	195.70	69.5	61.5	59.5	57.0	197.32

[a] For well installation details, see Appendix O.
[b] For survey data, see Appendix K.

total metals, and explosives concentrations. Samples were taken at the 2- and 10-foot depths in each boring, as well as at the depth where free water was encountered in borings MW-3 through MW-6. All samples were delivered by Fort Worth District personnel to SWDL in Dallas, Texas, where the total metals analyses were performed. Volatile organics and explosive analyses were performed by Southwest Laboratory of Oklahoma in Tulsa, Oklahoma, under contract to SWDL.

Analytical results from these 16 soil samples are summarized on Table 9. No volatile organics were detected in any of the well borings. Total barium concentrations were low, ranging from no detection (<20 mg/kg) to a maximum concentration of 73 mg/kg in boring MW-5. Very low concentrations of the explosive HMX were found at both the 2- and 10-foot sampling depths in MW-1 and MW-2, with a maximum concentration of 0.31 ug/g. The explosive RDX was the only other explosive detected, which was found at a concentration of 0.22 ug/g at 2 feet in MW-3. Complete analytical results are contained in Appendix P, and quality assurance is discussed in Volume 5.

5.5 **Deep Stratigraphic Test Borings**. Before siting additional monitoring well locations to monitor the contaminant plume underlying the western corner of the ABG, three deep stratigraphic test borings were drilled and geophysically logged to determine if there was enough stratigraphic correlation across this area to define a confining bed above which to screen the new wells. Only two wells, 120 and C-2, were located downgradient from the ACD, and neither boring had encountered any type of impermeable material before reaching their

TABLE 9. SUMMARY OF ANALYTICAL RESULTS FOR CHEMICAL SOIL SAMPLES FROM WELL BORINGS MW-1 THROUGH MW-6

Boring No.	Sample Depth (ft)	Total Barium[a] (mg/kg)	VOCs[b] (ug/kg)	Explosives[b] (ug/g)
MW-1	2.0	27	ND	HMX 0.31
	10.0	27	ND	HMX 0.21
MW-2	2.0	27	ND	HMX 0.28
	10.0	58	ND	HMX 0.18
MW-3	2.0	21	ND	RDX 0.22
	10.0	ND	Acetone[c] 28	ND
	15.0	ND	Acetone[c] 20	ND
MW-4	2.0	ND	ND	ND
	10.0	31	Acetone[c] 38	ND
	15.0	26	Acetone[c] 33	ND
MW-5	2.0	73	ND	ND
	10.0	57	Acetone[c] 19	ND
	17.0	68	Acetone[c] 34	ND
MW-6	2.0	68	Acetone[c] 12	ND
	10.0	59	Acetone[c] 28	ND
	18.0	29	Acetone[c] 26	ND

ND = Not detected or detected below calibration limits.

[a] Analyses performed by USACE Southwestern Division Laboratory. Calibration limit for Ba was 20.0 mg/kg.

[b] Analyses performed by Southwest Laboratory of Oklahoma, under contract to USACE Southwestern Division Laboratory. Calibration limits for specific VOCs are contained in Appendix P. Explosive cpds analyzed and respective calibration limits were TNT (0.05 ug/g), 2,4 DNT (0.05 ug/g), 2,6 DNT (0.05 ug/g), RDX (0.05 ug/g), HMX (0.05 ug/g), and tetryl (0.05 ug/g).

[c] Acetone is a common lab contaminant, with normal allowable level five times detection limit reported.

Complete analytical results are contained in Appendix P.

final depths of 24.0 (el. 156) and 32.0 feet (el. 142), respectively. It also appeared likely that a contact between the Wilcox Group and Recent alluvium runs northeast-southwest somewhere across the western corner of the ABG, with the ACD situated on Wilcox and most of the downgradient area situated in alluvium. The test borings would help define this contact and how the stratigraphy of the Wilcox and alluvium relate with respect to contaminant movement in the ground water.

Three deep stratigraphic test borings, designated 3F-922 through 3F-924, were drilled from 20-26 May 1988 at the locations shown on Sheet 21. Drilling and logging were performed by a Fort Worth District drill crew and geologist following a standard set of procedures. All borings were drilled with a Failing 1500 drill rig. All downhole equipment was steam cleaned prior to drilling each boring. Borings were drilled with a 4½-inch diameter fishtail drill bit. A pure bentonite drill mud mixed with nonchlorinated water from the ABG water supply was kept under good circulation to avoid cross-contaminating any lower saturated zones. No samples were taken, but stratigraphy was logged from the drill cuttings and drilling action. All stratigraphic test borings were drilled into clay shale. When drilling was complete, a resistivity and gamma log were run in each boring. Spontaneous potential logs were not run because of equipment problems. Then each boring was backfilled in accordance with TWC requirements for plugging abandoned water wells, as stated in 31 TAC 287.49. Each boring was backfilled to within 10 feet of the ground surface with a thick bentonite mud pumped through the drill rods and placed from the bottom of the boring up, displacing all drill fluid upward and out of the borehole. The top 10 feet of the boring were then grouted with a neat bentonite cement grout. After backfilling, each boring was staked to be surveyed at a later time.

A copy of the drill request for borings 3F-922, 3F-923, and 3F-924 is provided as Appendix Q. Geologic logs are shown on Sheet 22. Resistivity and gamma logs for each of the test borings are shown on Sheets 23 through 27. The geophysical logs agreed fairly well with the stratigraphy described from the drill cuttings. At least two saturated permeable zones were identified in each of the borings, with a third deeper zone occurring in 3F-922. The uppermost saturated zone consisted of a variable thickness of interbedded sandy silts and silty sands. Of primary concern was to identify a confining clay beneath this zone. This clay was found from el. 157-142 in 3F-922, from el. 165-149 in 3F-923, and from el. 148-142 in 3F-924, overlying a 20- to 30-foot thick sand occurring in each boring. A second confining clay was found in boring 3F-922, overlying a third permeable zone approximately 18 feet thick (el. 109-91). A second confining layer was not encountered in borings 3F-923 and 3F-924. Instead, the second saturated zones were underlain by a very sandy clay. All borings bottomed into clay shale. Clay shale was encountered at el. 71 in 3F-922, at el. 34 in 3F-923, and el. 25 in 3F-924.

A fourth stratigraphic test boring, 3F-925, was drilled and geophysically logged after analyses of ground-water samples from newly installed wells MW-1 through MW-6 showed extremely high concentrations of methylene chloride and TCE still present around the closed UEP. Because ground-water contamination had now been identified as still being present around the pond, it became necessary to expand the investigation to include the UEP area of the ABG to delineate the plume underlying this corner of the site. Existing wells showing contamination around the UEP are screened in the uppermost saturated zone. Therefore, it became necessary to begin screening in the next deeper permeable zone to assess the vertical extent of contamination. Test boring 3F-925 was drilled and geophysically logged to define this second zone and any additional confining beds, as well as provide deep stratigraphic information to determine any correlation across the entire ABG site.

Boring 3F-925 was drilled and logged from 23-24 August 1988 at the location shown on Sheet 21. The geologic log is shown on Sheet 22. The resistivity and gamma logs are shown with the stratigraphy on both Sheets 24 and 26. As with test borings 3F-922, 3F-923, and 3F-924, stratigraphy logged from the drill cuttings agreed fairly well with the information shown by the geophysical logs for 3F-925. The upper clay confining bed encountered in exploratory boring MW-1A and well borings MW-2 and MW-4 was identified in 3F-925 as occurring from el. 156-146. This was underlain by a second permeable zone about 22 feet thick, logged as silty sand and sandy silt, occurring from el. 146-124. A thin high plasticity clay layer was described as occurring from el. 124-122, underlain by about 35 feet of sandy clay and sandy silt. Clay shale was encountered at el. 87.

5.6 **Installation of Wells MW-7 Through MW-15**. Eight new wells, MW-7 through MW-14, were installed downgradient of the ACD to monitor the contaminant plume originating from the remnant trenches beneath the structure. The downgradient direction was determined from the 20-22 April 1988 water level data which showed ground water flowing to the west and to the north of the ACD, as shown on Sheet 19. Wells MW-7 through MW-12 were sited at the proposed locations shown on Sheet 19 for the purpose of determining the lateral extent of the contamination already identified in the upper interbedded saturated zone screened by wells 120 and 129. Based on the geology map shown on Figure 8, the contact between the Wilcox and floodplain alluvium roughly follows the contour of the 100-year floodplain shown on sheet 19, which indicates that wells MW-7, MW-8, and MW-9 would be constructed in the primary materials of the Wilcox, the same materials in which the trench materials are buried, while wells MW-10, MW-11, and MW-12 would be located in the alluvium of the floodplain, screened in either Wilcox or alluvial materials.

Wells MW-7 through MW-12 were screened at the base of the uppermost saturated zone as it was identified in test borings 3F-922, 3F-923, and 3F-924. Well location MW-7 was selected to define the southernmost extent of the plume using the **"No Detection"** contour derived from the soil gas survey, shown on Sheet 28. Well location MW-8 was selected for being directly downgradient from contaminated well 129, and well location MW-9 was selected for being directly downgradient from the contamination source. Well location MW-10 is directly downgradient from the contamination source in a more northerly direction than MW-9, and is situated halfway between the source and well C-2, which has not shown contamination since it was installed in July 1984. Well MW-11 was sited halfway between the source and well 123 with the intention of defining the northernmost extent of the plume, since 123 has not shown contamination since July 1984. And well MW-12 was sited as the closest well to the source located downgradient in the floodplain with the intention of determining if the uppermost saturated zone of the Wilcox and the alluvium are hydraulically connected.

Wells MW-13 and MW-14, installed at the locations shown on Sheet 21, were screened in the second deeper permeable zone identified in test borings 3F-922, 3F-923, and 3F-924. Well MW-13 was installed 10 feet away from well C-2 to determine if the contaminant plume has been moving beneath C-2, which would account for C-2 not showing any contamination when it is located downgradient from the contaminant source. Well MW-14 was installed 10 feet away from well 120 to determine the vertical extent of contamination at a known contaminated location, since well 120 has consistently shown the highest concentrations of methylene chloride in this area of the ABG.

A ninth well, MW-15, located in the UEP area of the ABG, was also screened in the second deeper permeable zone as it was identified in test boring 3F-925. Well MW-15 was installed 10 feet away from well MW-2, the most contaminated well in this area of the ABG, to determine if contamination occurring in MW-2 extends downward into this new saturated zone.

The nine new monitoring wells were installed from 29 June to 16 September 1988. Copies of the drill requests detailing decontamination, sampling, well installation, and safety procedures are provided in Appendix R. Estimated well depths shown on the drill requests were determined using the geophysical data obtained from the deep stratigraphic test borings, the stratigraphic data from the well borings of existing wells at the ABG contained in Appendix L and the surveyed elevations of the proposed well locations shown in Appendix K. (Note that survey data shown in Appendix K for well locations MW-12, MW-13, and MW-14 are for originally proposed locations further north and west of well C-2, not shown on Sheet 19. These proposed shallow well locations were later changed to the cluster well locations discussed here and shown on Sheet 21 after the May 1988 water analyses for the LHAAP quarterly monitoring program had been received. The drill requests for these wells address the actual installation locations shown on Sheet 21). Geologic logs for well borings MW-7 through MW-15 are provided in Appendix N. Well installation details are provided in Appendix O. No unusual conditions were noted for any of the wells during development.

The target confining clay for well MW-7 was encountered approximately 11 feet shallower than was anticipated. This boring was originally drilled to a depth of 36 feet at the proposed surveyed location listed in Appendix K. The medium to high plasticity clay first encountered at 21 feet was never penetrated, indicating that this was most likely the target confining clay, so the boring was backfilled with a neat bentonite cement grout and redrilled to a depth of only 25 feet at the location shown on Sheet 21. The target confining clays for wells MW-8 and MW-9 were encountered close to the anticipated depths. A weak odor was noted in MW-9 directly downgradient of the contaminant source. No confining clay was encountered at the anticipated depths in borings MW-10, MW-11, and MW-12. However, these borings were not drilled much deeper than the estimated well depths shown on the drill request. A weak odor was noted in MW-12 when free water was encountered.

Deeper wells MW-13 and MW-14 were cased off in questionable confining bed materials. The upper saturated zone in MW-13 was cased off in a 2-foot thick medium to high plasticity clay encountered at el. 147-145 that appeared comparable to the 3-foot thick plastic clay logged at el. 148-145 in test boring 3F-924. The well was completed in an underlying fine-grained sand. Well MW-14 was originally drilled to a depth of 39 feet at a location on the other side of well 120 before it was backfilled with a thick bentonite drill mud and redrilled at the location shown on Sheet 21. The boring was backfilled and offset after a thin low plasticity clay was penetrated at el. 155-153 and no other confining materials were encountered. Backfilling was performed in the same manner as followed for the stratigraphic test borings to prevent cross-contamination of the upper and lower zones. The upper saturated zone of the new well boring was cased off in the 1.7 feet thick low plasticity clay encountered at el. 155-153, and the well was completed in an underlying fine to medium grained sand. A weak odor was noted to a depth of 32.8 feet, about 5 feet below the questionable confining layer.

Well boring MW-15 encountered about 6.5 feet of medium to high plasticity clay at the anticipated el. 155. This clay was slightly thinner than that logged in test boring 3F-925, but correlated well with other well borings around the UEP. Some odor was noted while drilling from el. 170-149, but no measurable amounts were detected during monitoring. The well was completed in an underlying very silty fine-grained sand.

A total of 18 soil samples were taken for chemical analysis while drilling well borings MW-7 through MW-15. Samples were taken at 2- and 10-foot depths in each boring and were analyzed for total metals, VOCs, and explosives in accordance with the quality assurance/quality control plan contained in Appendix D. Samples were delivered by Fort Worth District personnel to the SWDL in Dallas, Texas, where total metals analyses were performed. Volatile organics and explosives analyses were performed by Southwest Laboratory of Oklahoma, in Tulsa Oklahoma, under contract to SWDL. Analytical results for chemical soil analyses are summarized on Table 10. Complete results are contained in Appendix S.

Very little contamination was detected in any of the soil samples taken. The maximum concentration of total barium detected was 200 mg/kg in well boring MW-14. Well boring MW-12 also showed a similar concentration of 180 mg/kg of total barium at 2 feet. All other samples ranged from below detection to less than 100 mg/kg total barium. Volatile organics were detected in only three of the well borings-MW-10, MW-11, and MW-12. Borings MW-10 and MW-11 showed low concentrations of TCE at the 10-foot depth, with a trace of 1,2-dichloroethane also occurring in MW-11. Boring MW-12 showed 33 ug/kg of TCE at 2 feet, and 670 ug/kg of methylene chloride at 10 feet. No other VOCs were detected. Also, no explosives were detected in any of the borings. The quality assurance for these analyses is discussed in Volume 5.

5.7 **Slug Testing and Water Sampling**. Each of the 15 new wells, MW-1 through MW-15, were slug tested and sampled from 18-30 September 1988. An additional 10 existing wells were also sampled at this time. These wells were C-2, C-3, C-4, C-5, 109, 120, 123, 124, 125, and 129, which were selected because they are downgradient from both the closed UEP and the trenches beneath the ACD, and would therefore best define the contaminant plume(s) emanating from these sources.

Requests for slug testing and water sampling were originally prepared to perform each as a separate event. The order of wells

TABLE 10. SUMMARY OF ANALYTICAL RESULTS FOR CHEMICAL SOIL SAMPLES FROM WELL BORINGS MW-7 THROUGH MW-15

Boring No.	Sample Depth (ft)	Total Barium[a] (mg/kg)	VOCs[b] (ug/kg)	Explosives[b] (ug/g)
MW-7	2.0	23	ND	ND
	10.0	96	ND	ND
MW-8	2.0	28	ND	ND
	10.0	20	ND	ND
MW-9	2.0	51	ND	ND
	10.0	29	ND	ND
MW-10	2.0	ND	ND	ND
	10.0	ND	Trichloroethene 44	ND
MW-11	2.0	43	ND	ND
	10.0	ND	1,2-Dichloroethane 14 Trichloroethene 140	ND
MW-12	2.0	180	Trichloroethene 33	ND
	10.0	34	Methylene Chloride 670	ND
MW-13	2.0	11	Acetone[c] 44	ND
	10.0	15	Acetone[c] 23	ND
MW-14	2.0	200	Acetone[c] 31	ND
	10.0	28	ND	ND
MW-15	2.0	70	Acetone[c] 13	ND
	10.0	92	ND	ND

ND = Not detected or detected below calibration limits.

[a] Analyses performed by USACE Southwestern Division Laboratory. Calibration limit for Ba was 20.0 Mg/kg.

[b] Analyses performed by Southwest Laboratory of Oklahoma, under contract to USACE Southwestern Division Laboratory. Calibration limits for specific VOCs are contained in Appendix S. Explosive cpds analyzed and respective calibration limits were HMX (1.6 ug/g), RDX (1.8 ug/g), tetryl (5.5 ug/g), TNT (0.8 ug/g), 2,4 DNT (0.8 ug/g), and 2,6 DNT (0.8 ug/g).

[c] Acetone is a common lab contaminant, with normal allowable level five times detection limit reported.

Complete analytical results are contained in Appendix S.

to be slug tested and the order of wells to be sampled were specified in each request in an increasing order of likely contamination to prevent cross-contaminating the wells. However, time constraints required that both slug testing and sampling be performed simultaneously, and muddy ground conditions necessitated doing those wells that could be accessed with the drill rig first.

5.7.1 Slug Testing. In most cases, slug testing was performed first, then the well was purged and sampled. Slug testing was performed by a Fort Worth District drill crew and geologist following a standard set of procedures for a slug withdrawal test developed from pp 299-304 of Geological Survey Water-Supply Paper 1536-I, **"Methods of Determining Permeability, Transmissibility, and Drawdown."** These procedures are shown on Figure 19. The data sheet for recording field measurements is shown on Figure 20.

Slug testing was performed using a steam cleaned 10-foot bailer operated by a Failing 1500 drill rig. Procedures specified removing one bailer volume of water from the well and recording the recharge rate until at least 85 percent recovery had occurred. This did not work well in practice, however, because recovery of this small volume of water was too quick to record at least 10 minutes of measurements. Therefore, slug test procedures were modified in the field to remove as much water as possible from the well prior to recording the recharge. This method allowed for recording more complete recovery data and also served as purging the well for water sampling. If a well was

SLUG TEST PROCEDURES

1. Decontaminate bailer and length of sandline equivalent to well depth by steam cleaning using a nonphosphate detergent and rinsing with distilled water.

2. Decontaminate water level indicator probe and length of cable equivalent to well depth by thoroughly rinsing with distilled water.

3. Measure depth to bottom of the well (BOW) to nearest 0.01 foot using marked top of well casing as reference.

4. Measure static water level (SWL) to nearest 0.01 foot. Record time.

5. Compute 100 percent recovery water level (100 RWL) for fast recharging wells and 85 percent recovery water level (85 RWL) for slow recharging wells.

100 RWL = SWL
85 RWL = BOW - (0.85 x RWL), where RWL = BOW-SWL

6. Put bailer in bottom of the well.

7. Record water level with bailer in well (BWL). Record time.

8. Begin slug test when BWL = SWL. Remove bailer. Note time (t_0) and immediate water level (WL) after water is removed.

9. Record water level measurements every minute for the first 10 minutes, every 5 minutes for the next 20 minutes, then every 10 minutes for the next 30 minutes. If the well has not reached 85 percent recovery after 1 hour from t_0, continue to read water levels at 20-minute increments for the next 2 hours, then every hour until complete.

10. Stop recording water levels after 100 percent recovery (100 RWL) is achieved in fast recharging wells, or 85 percent recovery (85 RWL) is achieved in slow recharging wells.

11. Record amount of water bailed from the well. Either calculate using $V = \pi r^2 L$, or measure amount collected.

12. Under "**Remarks,**" note any problems or unusual characteristics while testing.

13. Person performing slug test should initial the data sheet.

Figure 19. Slug Test Procedures.

SLUG TEST
FIELD DATA SHEET

PROJECT:

1.	DATE					
2.	WELL No.					
3.	Csg dia/Type					
4.	BCN					
5.	SWL					
6.	SWL Time					
7.	100 RWL					
8.	85 RWL					
9.	BWL					
10.	BWL Time					
11.	Amt Bailed					
12.	SLUG TEST	→	→	→	→	→
	t_0/WL					
	every minute	→	→	→	→	→
	t_1/WL					
	t_2/WL					
	t_3/WL					
	t_4/WL					
	t_5/WL					
	t_6/WL					
	t_7/WL					
	t_8/WL					
	t_9/WL					
	t_{10}/WL					
	every 5 minutes	→	→	→	→	→
	t_{11}/WL					
	t_{12}/WL					
	t_{13}/WL					
	t_{14}/WL					
	every 10 minutes	→	→	→	→	→
	t_{15}/WL					
	t_{16}/WL					
	t_{17}/WL					
	every 20 minutes	→	→	→	→	→
	t_{18}/WL					
	t_{19}/WL					
	t_{20}/WL					
	t_{21}/WL					
	t_{22}/WL					
	t_{23}/WL					
13.	REMARKS					
14.	INITIALS					

Figure 20. Slug Test Field Data Sheet.

sampled prior to slug testing, the "**DEPTH TO WATER**" measurement recorded prior to purging was used as the static water level ("**SWL**") measurement for the slug test. All water removed from the wells was contained in 55-gallon drums, then was hauled to a sump specified by Morton Thiokol, Inc., personnel for their later collection and treatment. Breathing space around the well was monitored for methylene chloride and TCE during each slug test using Dräger tubes. Slug testing procedures provided to the field personnel are detailed on the request for slug testing contained in Appendix T.

Slug test recovery data were recorded using a Slope Indicator Company Model 51453 water level indicator. Complete field data are provided in Appendix U. Water level recovery time was relatively slow in all wells except MW-14 and MW-15, ranging from 80 minutes up to 6 hours. Wells MW-14 and MW-15 recharged quickly, in 40 minutes and 10 minutes, respectively, which was anticipated because these wells were screened in the next lower sandier unit. Quick recharge was also anticipated in MW-13, which was screened in a deeper sandier zone, but recovery time was slow, taking 2 hours and 20 minutes to reach 100 percent recovery. An odor was noted in only two of the wells tested, MW-1 and MW-2, and was noted as being very strong; however the odors were not strong enough to be measured by the monitoring equipment.

5.7.2 **Water Sampling**. A total of 25 wells were sampled by Fort Worth District personnel following a set of procedures developed in accordance with the guidelines specified in the USEPA publication "RCRA **Ground-Water Monitoring Technical Enforcement Guidance Document.**" All procedures are detailed on the water sampling request contained in Appendix V. Because wells could not be sampled in the order specified on the water sampling request, special care was taken for decontaminating all downhole and laboratory equipment following the procedures listed on Figure 21 prior to sampling each well.

A **Water Sampling Field Data Sheet**, shown on Figure 22, was developed to record all field measurements made during sampling. Instructions for sampling and filling out the **Field Data Sheet** are provided on Figure 23. Water well depths and depths to screened intervals were provided to the field personnel to spot any anomalous readings.

Prior to obtaining water samples, it was necessary to purge each well a minimum of 3 casing volumes of standing water. The well depth and the depth to water was measured in each well to calculate the volume of water to be purged. The volume of standing water in the well was calculated using a rough conversion of 1 foot = 1 gallon for 4-inch diameter wells, and 1 foot = ½ gallon for 2-inch diameter wells. The total volume to be purged was calculated by multiplying this number of gallons by 3. Each well was purged at least three times or until dry. Breathing space was monitored during purging and water sampling using both methylene chloride and TCE Dräger tubes. Purging of 4-inch diameter wells was accomplished using a 10-foot long bailer operated by a Failing 1500 drill rig. Two-inch diameter

DECONTAMINATION PROCEDURES

1. Water level measuring equipment shall be decontaminated prior to each use by thoroughly rinsing with distilled water.

2. Purging equipment shall be decontaminated prior to each use by steam cleaning with a nonphosphate detergent, then thoroughly rinsing with distilled water.

3. Water sampling equipment and laboratory equipment shall be decontaminated prior to each use using the following procedures:

   a. Thoroughly wash with a nonphosphate detergent.

   b. Rinse with tap water.

   c. Rinse with dilute hydrochloric acid (10 parts distilled water to 1 part HCl).

   d. Rinse with distilled water.

   e. Rinse with pesticide grade hexane.

   f. Rinse with pesticide grade methanol.

Figure 21. Decontamination Procedures for Ground-Water Sampling.

WATER SAMPLING
FIELD DATA SHEET

PROJECT:

A.	PURGING —					
1.	DATE					
2.	WELL NO.					
3.	CSG DIA/TYPE					
4.	TOTAL DEPTH					
5.	DEPTH TO WATER					
6.	WATER IN FT.					
7.	GALS. TO PURGE					
8.	START TIME					
9.	STOP TIME					
10.	AMT. BAILED					
B	SAMPLING —					
1.	DATE					
2.	DEPTH TO WATER					
3.	BAILER TYPE					
4.	START TIME					
5.	MEASUREMENTS					
	pH					
	TEMP °C					
	COND. µS					
6.	STOP TIME					
7.	MEASUREMENTS					
	pH					
	TEMP °C					
	COND µS					
8.	RECHARGE					
9.	SAMPLE TYPES					
10.	DUPLICATES					
11.	TRAVEL BLANKS					
12.	EQUIP BLANKS					
13.	COOLER NO.					
14.	STRAP NO.					
15.	BUS BILL NO.					
	REMARKS					
	INITIALS					

Figure 22. Water Sampling Field Data Sheet.

GROUND-WATER SAMPLING PROCEDURES

1. Calibrate field instruments.

2. Begin taking water samples after water level has recovered in well.

3. Record depth to water prior to sampling.

4. Record time begin sampling.

5. Record type of sampler (e.g., dedicated stainless steel, dedicated PVC, portable teflon, etc).

6. Collect samples in the following order:

   a. pH/conductivity/temperature - collect in clean beaker. Measure immediately at time of collection. Recorded value of pH and conductivity should be an average of four readings. Discard sample.

   b. Volatile organics (VOCs) - Overfill three 40 ml glass vials. No air or bubbles in sample. No agitation.

   c. Total organic halides (TOX) - Overfill two glass liter bottles. Preservative to be added in laboratory.

   d. Metals - Overfill one plastic liter bottle. Preservative to be added in laboratory.

   e. Nitrite/Nitrate - Overfill one plastic liter bottle. Preservative to be added in laboratory.

   f. Chloride - Overfill one plastic liter bottle.

   g. Explosives - Overfill two glass liter bottles.

   h. pH/Conductive/Temperature - Collect in clean beaker and measure as in Step a. Also fill one glass liter bottle for laboratory measurements.

7. Record time at end of sampling.

8. Describe recharge rate (e.g., immediate, fast, slow, etc).

9. Record number of each type of sample container taken. For example: three vials, four liter glass, and three liter plastic would be 3/4/3. Don't count the glass liter bottle taken for ph/conductivity/temperature because this sample will be discarded prior to shipment. However, do include duplicates and blanks.

10. Record the parameter for duplicates, travel blanks, or equipment blanks when taken.

11. Shipping information should be filled out after samples are preserved.

12. Under "Remarks," note any problems with the well structure or unusual characteristics while sampling.

13. Person collecting the samples should initial the data sheet.

Figure 23. Procedures for Ground-Water Sampling

wells were purged using their dedicated bailers. Four-inch diameter PVC wells C-2, C-3, C-4, and C-5 were purged using a portable 3-foot long 2-inch diameter teflon bailer suspended on a teflon coated stainless steel cable. Purged water from all 25 wells was collected in 55-gallon drums, then hauled to a sump specified by Morton Thiokol, Inc., personnel for their later collection and treatment. Purging procedures are listed on Figure 24.

If a well was sampled after slug testing, it was considered sufficiently purged for sampling if it bailed dry during the slug test and recharged too slowly to allow for three purgings in a single day. The well was then sampled after it recovered. Only 8 of the 25 wells sampled required purging a minimum of 3 times. These wells were 125, 129, C-2, C-3, C-4, C-5, MW-14, and MW-15. Wells 125 and 129 both purged dry, but recovered in a sufficient amount of time to continue purging the required minimum 3 casing volumes prior to sampling. The other six wells did not purge dry and recharged quickly.

Water samples were taken after the water level had recovered in the well. If a well purged dry and recovered slowly, sampling did not begin until the next day. All wells except C-2, C-3, C-4, and C-5 were sampled with dedicated bailers following the procedures listed on Figure 23. In all cases, efforts were made to sample each well opposite the well screen and not in the sump.

Field measurements for pH, temperature, and conductivity were made at both the beginning and end of sampling for each well. Each

PURGING PROCEDURES

1. Decontaminate bailer and length of sandline equivalent to well depth by steam cleaning using a nonphosphate detergent and rinsing with distilled water.

2. Decontaminate water level indicator by thoroughly rinsing with distilled water.

3. Measure depth to bottom of the well to the nearest 0.01 foot using marked top of well casing as reference.

4. Measure depth to water to nearest 0.01 foot.

5. Calculate standing column of water in feet by subtracting depth to water from total depth of well.

6. Calculate number of gallons to be bailed by multiplying standing column of water by 3.

7. Begin bailing. Record start time.

8. Stop bailing when three casing volumes of water have been removed or the well goes dry, whichever occurs first. Record stop time.

9. Record approximate amount of water bailed.

Figure 24. Purging Procedures for Ground-Water Sampling.

of these parameters was measured four times and the average value was recorded. Samples were then taken in the following order of parameters: VOCs, total organic halogens (TOX), metals, nitrites/nitrates, chloride, and explosives. Numbers and types of containers for each parameter are shown on Table 11. Appropriate duplicate, travel, and equipment blanks were also taken in accordance with quality assurance procedures described in the Quality Assurance/Quality Control Plan in Appendix D. To ensure that the proper number and types of blanks were taken or prepared, a schedule for quality assurance samples was drawn up prior to sampling. This schedule is shown on Table 12. Quality assurance procedures for field samples are listed on Figure 25.

Complete water sampling field data are provided in Appendix W. New monitoring wells MW-1 through MW-15 showed no silt during purging and sampling, although MW-6 was slightly milky in color. On the other hand, several of the existing wells sampled did show silt during purging and sampling. These wells were 109, 123, 124, 125, 129, and C-5, with wells 124 and 129 exhibiting the worst silt and sand conditions during purging. A milky white, yellow, or gray color was noted about the water from several of the wells. Odors were noted in only three of the wells sampled. Wells MW-1 and MW-2 exhibited very strong solvent odors during purging and sampling, but not strong enough to measure, and well C-2 had a salty odor.

All samples were preserved in accordance with the procedures

TABLE 11. SAMPLE CONTAINER AND PRESERVATION PLAN

VIALS			
3	40 ml	VOCs	4°C, Full
GLASS			
2	Liter	TOX	Full, pH < 2 w/ H_2SO_4, 1 ml Sodium Sulfite
2	Liter	Explosives	4°C
1	Liter	pH/Cond/Temp	Dispose
PLASTIC			
1	Liter	Metals (As, Ba, Cd, Cr, Pb, Hg, Ni, Se, Ag, Zn)	pH < 2 w/ HNO_3
1	Liter	Nitrite/Nitrate	pH < 2 w/ H_2SO_4
1	Liter	Chloride	4°C

TABLE 12. SAMPLING PLAN FOR DUPLICATES, TRAVEL BLANKS, AND EQUIPMENT BLANKS

	PARAMETER					
WELL NO.	VOCs	TOX	Metals	N/N	Cl	Expl.
MW-1	D					
MW-2		D				
MW-3				D		
MW-4			D			
MW-5					D	
MW-6						D
MW-7	T					
MW-8			E			
MW-9			E			
MW-10	D					
MW-11		D				
MW-12			D			
MW-13				D		
MW-14					D	
MW-15						D
C-2			T			
C-3	E					
C-4	D					
C-5		D				
109			D			
120				D		
123					D	
124						D
125	T					
129						

D = duplicate
T = travel blank
E = equipment blank

DUPLICATE, TRAVEL, AND EQUIPMENT BLANK PROCEDURES

1. The sampling pattern for duplicates, travel blanks, and equipment blanks is shown on the attached table.

2. A duplicate sample consists of the same number and type of containers as taken for the original sample for a specific parameter. Duplicates are taken, preserved, and labeled in the same manner as the original sample, but have the word "duplicate" included on the label.

3. Travel blanks for a specific parameter consist of distilled water placed in the required number and types of containers for that parameter. These are placed in the ice chest prior to sampling a well. Travel blanks are then preserved and labeled in the same manner as the original sample, but have the words "travel blank" included on the label.

4. Equipment blanks for a specific parameter are taken from either the bailer used to purge a well or the portable bailer used to sample a well. An equipment blank is made after the equipment has been decontaminated but before the equipment is used at the well. The bailer is rinsed with distilled water. The rinsate is collected directly off the bailer in the number and types of containers specified for the parameter. Travel blanks are then preserved and labeled in the same manner as the original sample, but have the words "EQUIPMENT BLANK" included on the label. Specify either "PURGER" or "SAMPLER" on the label, also.

5. All blanks should be appropriately noted on the Field Data Sheet for the well where they are taken.

6. A separate Field Data Form and Chain of Custody record should be filled out for blanks taken at each well.

Figure 25. Quality Assurance Procedures for Field Samples.

described in the Quality Assurance/Quality Control Plan. Sample preservations were done in a temporary laboratory set up by Fort Worth District personnel on LHAAP. Preservation procedures are listed on Figure 26. All samples were kept on ice from the time they were taken until they were delivered by Fort Worth District personnel to the SWDL in Dallas, Texas.

Prior to sending samples to the laboratory, all documentation was completed for each sampled well following the recordkeeping procedures listed on Figure 27. This documentation consisted of completing the data listed on the **Water Sampling Field Data Sheet**, summarizing this data on a **Ground-Water Monitoring Well Data Form**, and completing and signing the **Chain of Custody Form**. The **Ground-Water Monitoring Well Data Form** was designed as a permanent record of the pertinent data recorded for each well sampling event. A copy of this form is shown on Figure 28. Completed forms for the round of water sampling are provided in Appendix X. The **Chain of Custody Form** was developed to show the numbers and types of containers in each shipment, as well as the parameters to be analyzed. A copy of this form is shown on Figure 29. Completed forms are provided in Appendix Y.

A copy of each the **Monitoring Well Data Form** and the **Chain of Custody Form** was enclosed with the appropriate water samples in an ice chest prior to shipping samples to the laboratory. Shipping procedures, detailed on Figure 30, were designed to deliver water samples to the laboratory within 24 hours of being taken. All samples

SAMPLE PRESERVATION PROCEDURES

1. Keep all samples packed in ice until delivered to SWD Laboratory.

2. Preserve samples at a laboratory set up on-site.

3. Preserve water samples in the following manner for the parameters specified.

   a. Volatile Organic Compounds (VOCs) - No bubbles or air space in vials. Keep on ice at 4°C.

   b. Total Organic Halides (TOX) - No bubbles or air space in bottles. Add enough sulfuric acid (H_2SO_4) to bring pH to <2. Add 1 ml sodium sulfite solution.

   c. Metals (As, Ba, Cd, Cr, Pb, Hg, Ni, Se, Ag, Zn) - Add enough nitric acid (HNO_3) to bring pH to <2.

   d. Nitrite/Nitrate - Add enough sulfuric acid (H_2SO_4) to bring pH to <2.

   e. Chloride - Keep on ice at 4°C.

   f. Explosives - Keep on ice at 4°C.

   g. pH/Conductivity/Temperature - Make readings same as for the field. Record on Field Data Form. Discard sample after all other samples for well have been properly preserved.

4. Complete labels showing sample has been preserved and sign.

Figure 26. Preservation Procedures for Ground-Water Samples.

RECORDKEEPING PROCEDURES

1. Three forms will be filled out for each well sampled. These are Field Data Sheet, Field Data Form, and Chain of Custody Form.

2. Copies of each form will be distributed in the following manner:

   a. Field Data Sheet - One field copy
      - One copy to CESWF-ED-GG

   b. Field Data Form - One field copy
      - One copy to CESWF-ED-GG
      - One copy to CESWD-ED-GL

   c. Chain of Custody Form - One field copy
      - One copy to CESWF-ED-GG
      - One copy to CESWD-ED-GL

3. All bus tickets will be kept in the field.

Figure 27. Recordkeeping Procedures for Ground-Water Sampling.

GROUND WATER MONITORING WELL
FIELD DATA FORM

Location ______________ Date ______________

Site ______________ Type of sample ______________

Well number ________ Csg diameter ________ Csg type ________

Rate of recharge ______________

Riser elevation ______________

Depth to water from top of casing ______________ Time of measurement ______________

Depth to water at time of sampling ______________ Time of sampling ______________

Water table ______________ Measuring device ______________

pH ______________ Time of measurement ______________

Meter type and model ______________

Conductivity, umhos/cm ______________ Time of measurement ______________

Meter type and model ______________ Temperature ______________

Chest # ________ Strap # ________ Bus bill ________

Notes concerning condition of well, odor , color, and any problems:

Sample collector ______________

Figure 28. Ground-Water Monitoring Well Data Form.

GROUND WATER MONITORING WELL
CHAIN OF CUSTODY FORM

FORT WORTH DISTRICT, CORPS OF ENGINEERS

Location ______________________ Date ______________________

Site ______________________ Well number ______________________

Number of containers in shipment:

	glass	plastic
liter	______	______
vial	______	______

volatile organics
----
regular detection limits ______
0.5 ppb detection limits ______

Parameters sampled:

pH ______
conductivity ______
TOC ______
Hardness as CaCO3 ______
metals, total * ______
COD ______
hexavalent chromium ______
alkalinity ______
chloride ______
sulfate ______
TOX ______
nitrate ______
volatile organics ______
semi-organics ______
total hydrocarbons ______
BTX ______
EXPLOSIVES ______

* As, Ba, Be, Cd, Cr, Pb, Hg, Ni, Se, Ag, Zn, Fe, Mn, Mg, K, Na, Ca, Cu

* ______ (all of the above)

CUSTODY RECORD
signature and title

Relinquished by	Received by	Date	Time

Figure 29. Chain of Custody Form for Water Samples.

SHIPPING PROCEDURES

1. Pack all containers securely in ice chest, one well per chest. Include blanks for that well number.

2. Fill chest completely with ice.

3. Record chest number, strap number, and bus bill number on Field Data Sheet and Field Data Form. Fill out and sign Chain of Custody Form.

4. Make two copies of Field Data form and Chain of Custody Form.

5. Enclose a sealed plastic bag containing one copy each of Field Data Form and Chain of Custody Form in ice chest.

6. Close chest and secure with shipping strap.

7. Apply appropriate labels for shipping. Ship ice chests by bus each night to SWD Lab. Call SWD the following morning to tell them how many ice chests were sent.

Figure 30. Shipping Procedures for Ground-Water Samples.

were delivered by Fort Worth District personnel within 48 hours of being taken.

5.8 **Water Sampling Results.** A total of 25 well samples were analyzed for total metals, chlorides, total organic halogens (TOX), nitrates, VOCs, and explosives in accordance with the EPA test methods cited in the Quality Assurance/Quality Control Plan contained in Appendix D. Three duplicates were taken and analyzed for each of these six parameters. Three equipment blanks and three travel blanks were also taken and were analyzed for VOCs and total metals. The distribution of QA/QC samples is presented on Table 12.

Total metals, chloride, and nitrate analyses were performed by SWDL. Volatile organics, TOX, and explosives analyses were performed by Southwest Laboratory of Oklahoma, under contract to SWDL. Quality assurance samples were analyzed by Southwest Laboratory of Oklahoma and Controls for Environmental Pollution, Inc., in Santa Fe, NM, also under contract to the SWDL. Laboratory results for all analyses are contained in Appendix Z, and quality assurance is discussed in Volume 5.

Complete water quality results are summarized on Table 13. This table includes the three readings for pH, conductivity and temperature made during sampling, with the first reading made at the beginning of sampling, the second reading made at the end of sampling, and the third reading made in the laboratory while preserving the samples. Equipment problems with the pH meter required using pH paper several times to make a reading. These readings are noted. Each pH,

TABLE 13. SUMMARY OF ANALYTICAL RESULTS FOR WATER SAMPLES[a]

Well No. (Sample No.)		MW-1 (8-1391)	MW-2 (8-1392)	MW-3 (8-1415)	MW-4 (8-1416)	MW-5 (8-1417)	MW-6 (8-1393)
pH	1	6.7	6.2	6.0	6.5	5.4	6.4
	2	6.8	6.3	6.1	6.6	5.5	6.4
	3	6.8	6.6	6.2	6.8	5.7	6.4
Conductivity (umhos/cm)	1	2480	2380	1867	3180	1501	2380
	2	2440	2480	1850	3180	1510	2040
	3	2700	2550	1864	3280	1517	2210
Temperature (°C)	1	22	22	23	22	21	23
	2	22	22.5	24	25	21	23
	3	18	14	24	21	23	15
Chloride (mg/1)		930	890	540	750	420:490.0	980
TOX (mg/1)		4030	3644.0:1300	259.0	502.0	178.9	2747.0
Nitrates (mg/1)		2.7	3.1	3.2: <2.0	<0.2	4.2	<0.2
Total Metals (ug/1)							
Ag		<5.0	<5.0	<5.0	<5.0:<50	<5.0	<5.0
As		<1.0	<1.0	<1.0	<1.0:<2	<1.0	3.0
Ba		2200	3600	1900	270:<1000	2000	1800
Cd		<5.0	<5.0	<5.0	<5.0:40	<5.0	<5.0
Cr		5.8	8.0	27	9.8:100	18	7.5
Hg		0.42	0.42	0.42	<0.1:<2	0.42	<0.1
Pb		14	16	16	12:<100	10	17
Ni		33	38	24	75:110	44	42
Se		0.6	<0.4	<0.4	<0.4:<2	<0.4	<0.4
Zn		63	100	45	65:60	70	48
Explosives (ug/1)[d]		ND	ND	ND	ND	ND	ND
VOCs (ug/1)							
Methylene Chloride		4,200,000E:4,820,000	17,000,000E	19BJ	58B	14B	88B
Acetone		< 100,000:NA	<100,000	<39	<83	<10	<10
1,2-Dichloroethene (total)		< 50,000:NA	<50,000	32	120	31	15
1,2-Dichloroethane		< 50,000:<28,000	<50,000	<19	<42	4J	<5
Trichloroethene		200,000:165,000	1,400,000	550	1100	150	91
Tetrachloroethene		< 50,000:<41,000	17,000J	<19	<42	<5	<5
Remarks		Very strong odor milky white color	Very strong odor milky white color	Milky yellow color	Slightly milky white color	Slightly milky white color	Slight odor milky white color

For footnotes, see last page of Table 13.

TABLE 13. SUMMARY OF ANALYTICAL RESULTS FOR WATER SAMPLES[a] (cont'd)

Well No. (Sample No.)		MW-7 (8-1418)	Travel Blank (8-1419)	MW-8 (8-1480)	Equip Blank (8-1481)	MW-9 (8-1426)	Equip Blank (8-1427)	MW-10 (8-1428)	MW-11 (8-1465)
pH	1	_b		5.2		6b		6b	4.3
	2	_b		5.2		5.5 - 6b		6 - 6.5b	4.3
	3	6.5 - 7b		6 - 6.5b		6b		6.5b	4.3
Conductivity (umhos/cm)	1	1472		857		212		995	309
	2	1487		849		204		992	288
	3	1492		890		210		962	316
Temperature (°C)	1	22		20.5		20		20	26
	2	21.5		21		22		21	25
	3	18		24		22.5		20.5	24.5
Chloride (mg/l)		280		200		43		310	40
TOX (mg/l)		169.5		1,608.0		9.2		2.0	3.2:0.8
Nitrates (mg/l)		0.25		6.1		0.85		<0.2	<0.2
Total Metals (ug/l)									
Ag		<5.0		<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
As		<1.0		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Ba		110		470	<5.0	130	14	640	67
Cd		<5.0		<5.0	<5.0	<5.0	<5.0	24	<5.0
Cr		15		12	<5.0	7.5	<5.0	7.0	8.2
Hg		0.42		<0.1	<0.1	<0.1	<0,1	<0.1	<0.1
Pb		<1.0		16	8.8	14	<1.0	20	13
Ni		23		20	11	12.8	<5.0	28	18
Se		<0.4		<0.4	<0.4	0.5	<0.4	<0.4	<0.4
Zn		29		200	10	64	32	130	30
xplosives (ug/l)[d]		ND		ND		ND		ND	ND
OCs (ug/l)									
ethylene Chloride		<250	18B	<480		5,900		120B:<2,800	<13
cetone		810	<10	<960		<1,000		<10: NA	<25
,2-Dichloroethene (total)		<250	<5	<480		<500		< 5: NA	16
,2-Dichloroethane		<250	<5	<480		<500		< 5: <2,800	52
richloroethene		7,600	10B	13,000		11,000		61: ND	770B
etrachloroethene		<250	<5	<480		<1,000		< 5: <4,100	<13
emarks		Milky white color				Slightly cloudy.			

r footnotes, see last page of Table 13.

TABLE 13. SUMMARY OF ANALYTICAL RE[illegible]TS FOR WATER SAMPLES[a] (cont'd)

Well No. (Sample No.)		MW-12 (8-1483)	MW-13 (8-1466)	MW-14 (8-1482)	MW-15 (8-1394)	C-2 (8-1459)	Travel Blank (8-1460)	C-3 (8-1461)	Equip Blank (8-1462)
pH	1	5.7	7.3	6.1	6.3	6.1		6.1	
	2	_b	7.3	6.1	6.3	6.1		6.2	
	3	6	6.7	6.5 - 7.0b	6.4	6.3		6.2	
Conductivity (umhos/cm)	1	1172	860	_c	644	758		1068	
	2	1173	859	_c	629	755		1055	
	3	1163	860	1796	694	734		1052	
Temperature (°C)	1	22.5	23.5	23.5	25	19		20	
	2	23.5	22.5	24	22	19		20	
	3	22	19	19	20	18		22	
Chloride (mg/l)		260	240	660:1020.0	120	170		310	
TOX (mg/l)		1.7	0.12	3.6	185.0	0.03		0.24	
Nitrates (mg/l)		2.0	2.4:<2.0	<0.2	<0.2	<0.2		2.3	
Total Metals (ug/l)									
Ag		<5.0:<50	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	
As		<1.0:<2	<1.0	<1.0	4.3	3.0	<1.0	8.8	
Ba		560:1200	280	1300	280	540	<5.0	730	
Cd		24:<10	9.0	20	15	29	<5.0	24	
Cr		9.2:60	6.5	7.5	8.0	7.8	5.0	8.0	
Hg		<0.1:2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Pb		20:220	13	23	28	70	<1.0	28	
Ni		18:90	6.5	16	20	5.8	<5.0	7.8	
Se		<0.4:<2	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	
Zn		120:100	18	110	220	260	9.0	94	
xplosives (ug/l)d		ND	ND	ND	ND:ND	ND		ND	
OCs (ug/l)									
ethylene Chloride		<40	<5	<10	58	3J		<5	10
cetone		<81	<10	<21	<25	<10		<10	<10
,2-Dichloroethene (total)		57	<5	<10	<13	<5		<5	<5
,2-Dichloroethane		<40	<5	<10	<13	<5		<5	<5
richloroethene		1100	1J	250	2J	17		<5	<5
etrachloroethene		<40	<5	<10	<13	<5		<5	<5
marks				Slight odor. Reddish brown color.	Very faint odor. Slightly cloudy yellowish color.	Salty odor. Very dirty.		Dingy gray color.	

footnotes, see last page of Table 13.

TABLE 13. SUMMARY OF ANALYTICAL RESULTS FOR WATER SAMPLES[a] (cont'd)

Well No. (Sample No.)		C-4 (8-1463)	C-5 (8-1464)	109 (8-1420)	120 (8-1479)	123 (8-1421)	124 (8-1422)	125 (8-1423)	Travel Blank (8-1424)	129 (8-1425
pH	1	5.9	6.5	6.6	-b	7.1	5.7	5.9		5.8
	2	5.9	6.5	6.7	-b	7.4b	5.7	5.9		5.8
	3	6.0	6.7	6.7	6b	6-7b	5-5.5b	6.1		6.0
Conductivity (umhos/cm)	1	212	386	3280	5890	3350	62	132		986
	2	209	383	2850	6000	3470	64	110		1006
	3	202	374	2850	6300	3500	66	115		1051
Temperature (°C)	1	18.5	19	23	26	24	21.5	21		21.5
	2	18.5	18.5	22.5	24.5	24	23.0	22		21
	3	19	19	22.5	27	22	20	17		21
Chloride (mg/l)		41	64	760	720	3.9:13.8	5.9	19		290
TOX (mg/l)		0.05	0.03:<0.005	12.7	20:1.0	0.02	0.04	2.0		15.3
Nitrates (mg/l)		<0.2	<0.2	0.26	590:735.0	6.3	<0.2	0.28		14
Total Metals (ug/l)										
Ag		<5.0	<5.0	<5.0:<50	<5.0	<5.0	<5.0	<5.0	ND	<5.0
As		2.5	1.6	<1.0:<2	4.7	<1.0	1.1	<1.0		<1.0
Ba		280	340	1500:2700	580	250	590	420		680
Cd		<5.0	<5.0	<5.0:<10	5.5	<5.0	<5.0	<5.0		<5.0
Cr		6.8	5.8	6.2:120	11	6.2	5.5	8.2		7.5
Hg		<0.1	<0.1	<0.1:<2	<0.1	<0.1	<0.1	<0.1		<0.1
Pb		20	21	18:<100	34	12	47	20		31
Ni		8.5	5.8	5.2:<50	100	5.9	10	<5.0		21
Se		<0.4	<0.4	<0.4:<2	0.5	2.6	0.4	<0.4		<0.4
Zn		92	29	22:40	150	10	46	21		46
xplosives (ug/l)d		ND	ND	ND	ND	ND	ND	ND		ND
OCs (ug/l)										
ethylene Chloride		<5:<2,800	110	9B	310,000	<5	<5	<50	2BJ	<33
etone		<10: NA	<10	<13	< 25,000	<10	<10	<100	<13	<67
2-Dichloroethene (total)		<5: NA	<5	11	< 13,000	<5	<5	<50	<7	4J
2-Dichloroethane		<5:<2,800	<5	<6	< 13,000	<5	<5	<50	<7	35
ichloroethene		9:<1,900	77	190	32,000	<5	80	<50	<7	930
trachloroethene		50:<4,100	<5	<6	< 13,000	<5	<5	2J	<7	4J
marks		Milky white color		Milky yellow color silty	Strong odor like oil or gas	Cloudy	Very silty	Very cloudy silty Yellow/red color		Slight odor Very silty

ompiled from field data in Appendices W and X, and from laboratory data in Appendix Z.

I meter broken. Paper used if available.

nductivity meter broken.

xplosive cpds analyzed and respective calibration limits were HMX (26.0 ug/l),
DX (22.0 ug/l), tetryl (26.0 ug/l), TNT (14.0 ug/l), and 2, 4 DNT (10.0 ug/l).

ND = Not detected or detected below calibration limits

< = Not detected below calibration limits

E = Concentration exceeded calibration limits

B = Possible laboratory blank contamination

J = Estimated concentration below calibration limits

NA = No analysis

conductivity, and temperature reading recorded are the average of four measurements that were made. Also included are the field notes made pertaining to color, odor, and siltation. Duplicate results follow the colon.

5.8.1 Field Parameters. The field parameters pH, conductivity, and temperature did not vary much from the beginning to the end of sampling, indicating that representative formation water was being sampled. The pH of most of the water samples was on the acidic side of 7.0, averaging around 6.1 and ranging from 4.3 in MW-11 to 7.3 in MW-13. Conductivity values were typically around 2,000 umhos/cm, but ranged from 64 umhos/cm (possible equipment problem) in well 124 up to 6,000 umhos/cm in well MW-9. Temperatures were typically around 20°C, but ranged from 18.5°C in well C-4 up to 26°C in wells 120 and MW-11. These parameters remained essentially unchanged when measured a third time during sample preservations in the laboratory on-site, indicating the chemistry of the water samples was fairly stable. The decrease in temperature for the third set of readings was due to the samples being on ice prior to preservation.

5.8.2 Chlorides. Chlorides exceeded the maximum allowable concentration limit of 300 mg/l specified in the Texas Department Health (TDH) Drinking Water Standards in 11 of the wells sampled. Six of these wells, MW-1 through MW-6, are located around the closed UEP, with two more wells, 109 and C-3 located downgradient of the UEP. The other three wells, 120, MW-10, and MW-14, are located downgradient of the ACD. Wells 120 and MW-14 are a cluster well that showed chlorides increasing from 720 mg/l in the shallow well to 1,020 mg/l in the deeper. Chloride concentrations associated with the UEP ranged from 310 mg/l in C-3 downgradient of the pond up to 980 mg/l in MW-6 at the Point of Compliance. Chloride concentrations in other wells sampled were as low as 5.9 mg/l in well 124. Laboratory detection limits for chloride were 5.0 mg/l.

5.8.3 Total Organic Halogens (TOX). For the most part, TOX concentrations were high in wells where high VOC concentrations were detected. The three wells having exceedingly high VOC concentrations were MW-1, MW-2, and well 120. These wells also showed high TOX concentrations of 4,030 mg/l, 3,644 mg/l, and 2,011 mg/l, respectively. The only anomalous TOX concentration noted was in well MW-6, which showed TOX at 2,747 mg/l, but VOC concentrations of only 91 ug/l TCE and 15 ug/l of 1,2-dichloroethene (total).

5.8.4 Nitrates. Nitrates exceeded the maximum allowable concentration of 10 mg/l specified by TDH Drinking Water Standards in only two wells. Well 120, at the ACD, showed an exceptionally high concentration of nitrates at 735 mg/l. The other well high in nitrates was well 129, which had 14 mg/l. All other wells ranged from below the detection limits shown on Table 13 up to 6.0 mg/l for nitrate concentrations.

5.8.5 Total Metals. The 10 metals analyzed in the water samples were silver (Ag), arsenic (As), barium (Ba), cadmium (Cd), chromium (Cr), mercury (Hg), lead (Pb), nickel (Ni), selenuim (Se), and zinc

(Zn). Five metals were detected at concentrations equal to or exceeding the maximum allowable limits specified for drinking water by the TDH. These were Ba, Cd, Cr, Hg, and Pb.

5.8.5.1 **Barium**. Barium was found at concentrations exceeding the TDH limit of 1,000 ug/l in wells MW-1, MW-2, MW-3, MW-5, MW-6, MW-12, MW-14, and 109. The maximum concentration of Ba detected was 3,600 ug/l in MW-2. All wells except MW-12 and MW-14 are located around the UEP or downgradient of the pond. Well MW-14 is the deeper cluster well at the ACD. Well MW-12 is located north of the ACD. Duplicate analyses for Ba in MW-12 were 560 ug/l and 1200 ug/l. Detection limits for Ba were 5.0 and 1000 ug/l, respectively.

5.8.5.2 **Cadmium**. Cadmium exceeded TDH drinking water standards in seven of the wells sampled. The TDH specifies a maximum allowable concentration of 10 ug/l, which was exceeded in wells C-2, C-3, MW-4, MW-10, MW-12, MW-14, and MW-15. The highest concentration of Cd detected was 40 ug/l in a duplicate analysis for MW-4. The other duplicate was below the detection limit of 5.0 ug/l.

5.8.5.3 **Chromium**. Chromium exceeded the TDH limit of 50 ug/l in duplicate analyses for three of the wells sampled. Well MW-4 detected both 9.8 ug/l and 100 ug/l, MW-12 detected 9.2 ug/l and 60 ug/l, and 109 detected 6.2 ug/l and 120 ug/l.

5.8.5.4 **Mercury**. Mercury was detected at the maximum allowable limit for drinking water, 2.0 ug/l, in a duplicate analysis for MW-12. The other analysis was below the detection limit of 0.10 ug/l.

5.8.5.5 **Lead**. The drinking water standard for Pb was exceeded in only two of the wells sampled. Duplicate analyses for well MW-12 showed Pb concentrations of 20 ug/1 and 220 ug/1. Well C-2 detected Pb at 70 ug/1. The maximum allowable concentration for Pb in drinking water is 50 ug/1. Detection limits for Pb were 10 ug/1.

5.8.6 **Explosives**. Specific explosives analyzed for were HMX, RDX, tetryl, TNT, and 2,4 DNT. No explosives were detected above detection limits in any of the water samples analyzed. Detection limits for each explosive are shown on Table 13.

5.8.7 **Volatile Organic Compounds**. As shown on Table 13, the only VOCs detected were trichloroethene (TCE), methylene chloride, 1,2-dichloroethene (total), 1,2-dichloroethane, acetone, and tetrachloroethane.

5.8.7.1 **TCE**. By far, the most prevalent VOC detected was TCE, which was found in 20 of the 25 wells sampled. The five wells showing no TCE were MW-13, MW-15, C-3, 123, and 125. Concentrations detected for TCE in the other 20 wells ranged from 9 ug/1 in C-4 up to 1,400,000 ug/1 in MW-2. Well MW-14 was the only deep cluster well showing TCE contamination, which was at a concentration of 250 ug/1. Well 120, the shallow well clustered with MW-14, showed a concentration of 32,000 ug/1 of TCE. Detection limits for TCE are shown on Table 13.

5.8.7.2 **Methylene Chloride**. Although not as prevalent at TCE, methylene chloride showed the highest VOC concentrations. These concentrations exceeded 17,000,000 ug/1 in MW-2 and exceeded 4,200,000 ug/l in MW-1. Well 120 had the third highest concentration of 310,000 ug/l, which is consistent with LHAAP's past quarterly monitoring results. Other wells detecting methylene chloride were MW-9, MW-15, and C-5, at concentrations of 5,900 ug/l, 58 ug/l, and 110 ug/l, respectively. Well MW-15 is the deep cluster well next to MW-2. Detection limits for methylene chloride are shown on Table 13.

5.8.7.3 **Other VOCs**. The compound 1-2 dichloroethene (total) was detected at low concentrations ranging from 11 ug/l up to 120 ug/l in seven wells, five of which are located around and downgradient of the closed UEP (MW-3, MW-4, MW-5, MW-6, and 109) and two are located downgradient and north of the ACD (MW-12 and MW-11). The compound 1,2-dichloroethane was also detected at very low concentrations of 35 ug/l and 52 ug/l in the two wells 129 and MW-11, respectively. Acetone was detected at 810 ug/l in well MW-7, and tetrachloroethane was found at 50 ug/l in well C-4. Detection limits for each of these compounds are shown on Table 13.

6.0 HYDROGEOLOGICAL CONDITIONS.

6.1 **Ground-Water Flow Direction**. Ground water in the ABG area occurs under unconfined conditions. Depth to ground water varies approximately 2 feet over a 6-month period, from a high elevation of 176.0 recorded in April 1988 (Sheet 19), to a high elevation of 174.30 recorded in August 1988 (Sheet 20). Because recharge of the Wilcox is primarily by infiltration from the surface, these variations in ground-water elevation are most likely due to seasonal fluctuations in rainfall.

Although ground-water elevations vary seasonally, the configuration of the ground-water surface varies little. The ground water is mounded under the southern quadrant of the ABG in an elongated configuration extending from well 102 northward towards the middle of the site. Mounding most likely reflects the ABG as a topographic high (Figure 8), as well as being a potential recharge area due to the lack of vegetation. Ground-water flow is in all directions off this mounded high, as shown on Sheets 19 and 20, with flow directions in the vicinities of the ACD, the old burn trench areas east of the ACD, and the UEP being distorted due to construction activities that have disturbed the natural regime. An inexplicable low occurs in the area of MW-2 that possibly reflects a past activity not yet accounted for.

Regional ground-water flow across the ABG area is towards Harrison Bayou, to the west and north, and towards Caddo Lake, to the northeast. Extrapolation of the scant water level data available in wells far from the ABG can close the lower ground-water elevation contours around the ABG to show these regional trends.

The direction of flow across the source areas in the ABG differ, reflecting their location with respect to the ground-water mound underlying the site. Flow across the buried trenches in the western corner of the site is roughly perpendicular to the 100-year floodplain contour, flowing northwest towards Harrison Bayou. Based on this direction of flow, wells 120, MW-14, MW-12, MW-10, C-2, and MW-13 are located directly downgradient from this source, as shown on Sheet 20. Seasonal variation of ground-water elevations would also place wells MW-9 and MW-11 in the downgradient direction (Sheet 19). Direction of ground-water flow below the line of old burn pits in the center of the old burn trench areas cannot be determined from the April 1988 water level data, but appears to be west towards MW-11 based on the August 1988 data (Sheet 20). Flow direction beneath the UEP, however, is not as straightforward. Ground water flows generally to the north and northeast, but distorted ground-water contours in the vicinity of MW-2 show ground water flowing towards this location within a 400-foot diameter area, encompassing the suspected trench area south of the closed pond (Sheet 20). This low on the April 1988 data is shown centered around well BH-11 (Sheet 19).

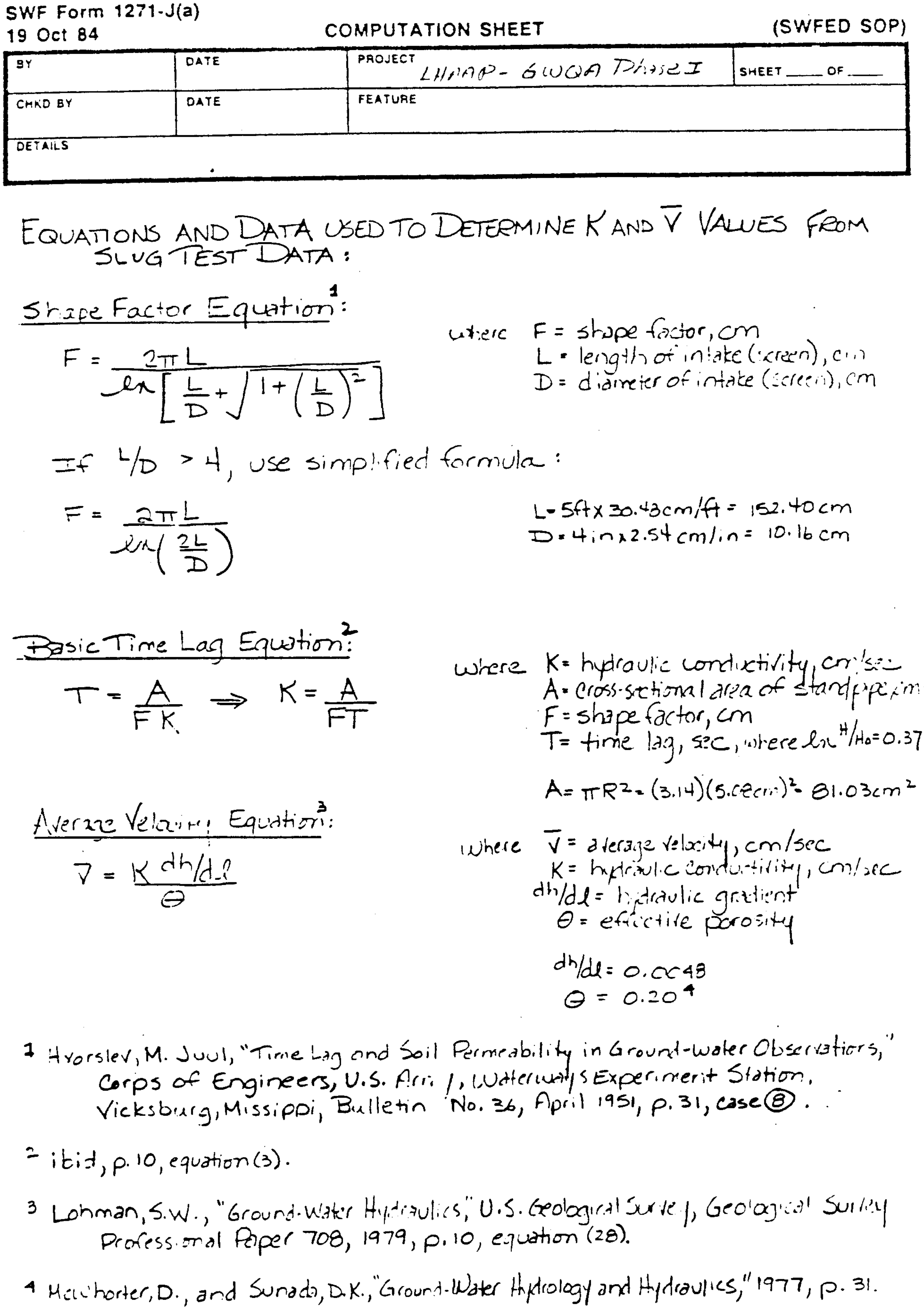
6.2 Ground-Water Gradient. The horizontal hydraulic gradient for ground-water beneath the ABG is extremely low. A representative gradient of .0048 was determined for ground-water flow perpendicular to the least disturbed ground-water contours around the ABG as they are depicted on Sheet 20. Regional gradient, most likely represented by the ground-water contours shown northeast of the site on Sheet 20, is even less, computing to roughly .0025. The less complete April 1988 water level data shown on Sheet 19 yield similar gradients of .0050 and .0018 for the ABG and the regional flow, respectively.

The vertical hydraulic gradient for the site cannot be determined from the data developed from these Phase I investigations. Water level data recorded for the three sets of cluster wells - MW-2 and MW-15, 120 and MW-14, and C-2 and MW-13 - are inconclusive. The water levels recorded for wells MW-2 and MW-15 on 31 August 1988 show a difference in head of 0.42 foot, with MW-15 having the higher head. However, this was 1 day after the installation of MW-15, and it is likely that the well had not yet stabilized from development. Water levels recorded on 18 September 1988 during the slug testing and sampling of MW-2 and MW-15 probably better reflect the stable conditions of the wells, with MW-15 having 2.91 feet of head less than C-2. The same conditions could apply to wells 120 and MW-14. Well MW-14 was installed on 10 August 1988. Water levels recorded on 31 August 1988 showed 1.24 feet of head difference between the two wells, with the greater head in well 120. When measured during sampling almost 1 month later, the two wells differed by 0.15 foot in head, with MW-14 being greater. Well MW-13 was not yet installed when water levels were measured on 31 August 1988, and was therefore newly installed at the time of sampling on 25 September 1988 when the head difference between it and well C-2 was only 0.3 foot.

Concentrations of contaminants detected in water samples from the deeper wells MW-13, MW-14, and MW-15 showed some VOCs present in MW-14 and MW-15, but at very small concentrations relative to those detected in each of their adjacent shallower wells, 120 and MW-2, as shown on Table 13. This indicates that the confining clay separating the two saturated zones in these wells is either a low permeability clay under high vertical hydraulic gradient conditions, or it is a higher permeability clay under low vertical hydraulic gradient conditions. Laboratory classifications made on the confining bed materials sampled from the three deeper well borings classified them as lean sandy silty clay and clayey sand, which would lend support to a low vertical hydraulic gradient. Lower confining bed materials sampled in the shallow well borings around the UEP were classified as either lean clay or clay shale. Lower confining bed materials sampled in well borings MW-7 through MW-9, situated on the outcrop of the Wilcox, all tested as clay shale, with wells MW-7 and MW-9 screened in this material. Lower confining bed materials were not encountered in well borings MW-10, MW-11, and MW-12, situated in the floodplain. Samples analyzed from the bottom of each of these well borings showed a silty sand. Complete laboratory analyses for Atterberg limits, moisture content, and grain size analyses performed on selected samples from well borings MW-1 through MW-15 are contained in Appendix AA.

6.3 Hydraulic Conductivity. Horizontal hydraulic conductivity (K) values for screened materials in wells MW-1 through MW-15 were calculated from the September 1988 slug test data using Hvorslev's time lag method for calculating soil permeability, described in USACE Waterways Experiment Station Bulletin No. 36, **"Time Lag and Soil Permeability in Ground-Water Observations."** The two equations used to arrive at a K value for each well were the shape factor (F) equation for a well screen extended in uniform soil conditions, and the basic time lag (T) equation. Both equations are shown on Figure 31. To determine the T value for computing K, the slug test data were plotted on a semi-logarithmic time versus drawdown plot, with time plotted along the arithmetic axis and drawdown plotted as the ratio of head to initial head (H/H_o) along the logarithmic axis. The T value was then picked where the ln H/H_o = 0.37 when the slope of the data points passed through ln H/H_o = 1. Data plots and K computations for each well are contained in Appendix BB.

The K values calculated for each well are shown on Table 14. Hydraulic conductivities for the 12 shallow wells tested ranged from 1.58 x 10^{-5} cm/sec in MW-9 up to 3.00 x 10^{-4} cm/sec in MW-4. The median K value for these wells was 5.45 x 10^{-5} cm/sec, calculated for MW-6. Because there appears to be no correlation between the K values listed for these 12 wells and the location or types of screened materials, the median K value of 5.45 x 10^{-5} cm/sec is selected to best characterize the hydraulic conductivity of the shallower screened



SWF Form 1271-J(a)
19 Oct 84

COMPUTATION SHEET

(SWFED SOP)

BY	DATE	PROJECT LHAAP- GWQA Phase I	SHEET ____ OF ____
CHKD BY	DATE	FEATURE	
DETAILS			

EQUATIONS AND DATA USED TO DETERMINE K AND $\bar{V}$ VALUES FROM SLUG TEST DATA:

Shape Factor Equation[1]:

$$F = \frac{2\pi L}{\ln\left[\frac{L}{D} + \sqrt{1 + \left(\frac{L}{D}\right)^2}\right]}$$

where F = shape factor, cm
L = length of intake (screen), cm
D = diameter of intake (screen), cm

If $L/D > 4$, use simplified formula:

$$F = \frac{2\pi L}{\ln\left(\frac{2L}{D}\right)}$$

L = 5 ft x 30.48 cm/ft = 152.40 cm
D = 4 in x 2.54 cm/in = 10.16 cm

Basic Time Lag Equation[2]:

$$T = \frac{A}{FK} \Rightarrow K = \frac{A}{FT}$$

where K = hydraulic conductivity, cm/sec
A = cross-sectional area of standpipe, cm²
F = shape factor, cm
T = time lag, sec, where $\ln H/H_o = 0.37$

$A = \pi R^2 = (3.14)(5.08\text{ cm})^2 = 81.03\text{ cm}^2$

Average Velocity Equation[3]:

$$\bar{V} = \frac{K\, dh/dl}{\theta}$$

where $\bar{V}$ = average velocity, cm/sec
K = hydraulic conductivity, cm/sec
dh/dl = hydraulic gradient
θ = effective porosity

$dh/dl = 0.0048$
$\theta = 0.20$[4]

[1] Hvorslev, M. Juul, "Time Lag and Soil Permeability in Ground-water Observations," Corps of Engineers, U.S. Army, Waterways Experiment Station, Vicksburg, Missippi, Bulletin No. 36, April 1951, p. 31, case ⑧.

[2] ibid, p. 10, equation (3).

[3] Lohman, S.W., "Ground-Water Hydraulics," U.S. Geological Survey, Geological Survey Professional Paper 708, 1979, p. 10, equation (28).

[4] McWhorter, D., and Sunada, D.K., "Ground-Water Hydrology and Hydraulics," 1977, p. 31.

Figure 31. Equations Used to Determine Hydraulic Conductivity and Average Velocity Values from Slug Test Data.

TABLE 14. HYDRAULIC CONDUCTIVITY (K) VALUES COMPUTED FROM SLUG TEST DATA

Well No.	K (cm/sec)
MW-1	2.18×10^{-4}
MW-2	5.21×10^{-5}
MW-3	1.91×10^{-4}
MW-4	3.00×10^{-4}
MW-5	1.69×10^{-4}
MW-6	5.45×10^{-5}
MW-7	2.39×10^{-5}
MW-8	2.99×10^{-5}
MW-9	1.58×10^{-5}
MW-10	5.71×10^{-5}
MW-11	1.51×10^{-4}
MW-12	2.58×10^{-5}
MW-13	3.31×10^{-4}
MW-14	4.80×10^{-4}
MW-15	2.40×10^{-3}

NOTE: Slug test calculations are contained in Appendix Z.

materials at the ABG.

The K values for the three deeper wells, which were screened in sandier materials, were higher, ranging from 3.31 x 10^{-4} cm/sec in MW-13 up to 2.40 x 10^{-3} cm/sec in MW-15, with the median, and therefore representative, K values for these deeper screened materials being 4.80 x 10^{-4} cm/sec, calculated for MW-14. The K values for each well that was slug tested are shown on the subsurface profiles on Sheets 23 through 27.

6.4 **Average Velocity.** The average horizontal velocity for the ground water monitored by wells MW-1 through MW-12 at the ABG is 1.31 x 10^{-6} cm/sec. This velocity was calculated using Lohman's average velocity (V) equation, shown on Figure 31, taken from the Geological Survey Professional Paper 708, **"Ground-Water Hydraulics."** The median K value of 5.45 x 10^{-5} cm/sec, as it was determined from the slug test data recorded for these wells, and the hydraulic gradient of .0048, as it was determined from the August 1988 water level data, were used in the equation. An effective porosity of 0.20 was selected from McWhorter and Sunada in **"Ground-Water Hydrology and Hydraulics"** as best reflecting the silty nature of the screened materials in the 12 shallow wells. It is important to note that this average velocity is, at best, only a rough estimate for characterizing the shallow saturated zone because of the heterogeneity of the materials screened for which the slug tests were performed.

Average horizontal velocities for the deeper screened intervals in wells MW-13, MW-14, and MW-15 were not calculated because there is not yet enough data to determine a hydraulic gradient for this deeper saturated zone.

6.5 Contaminant Plume. Sheet 29 shows the extent of TCE contamination in the ground water as it was detected in the 22 shallow wells sampled in September 1988. The concentrations of TCE are contoured to define the contaminant plume underlying the ABG area. Trichloroethene was selected as the parameter to best present plume definition because it was detected in the most number of wells sampled.

Although there are at least two sources contributing to ground-water contamination at the ABG, the contoured concentrations of TCE define a single plume with two separate **"highs,"** each associated with a contaminant source. The highest concentrations of TCE are centered around well MW-2 just southeast of the UEP. The other high TCE concentration contour defines a **"ridge"** beginning at well 120 and running south past wells MW-9 and MW-8, paralleling the 100-year floodplain contour of Harrison Bayou west of the ABG. There are no highs centered over the old line of burn pits, a potential third source identified from the contaminant source investigations.

The configuration of the contaminant plume shows that contaminants that have entered the ground water from past operation of the UEP and the buried trenches over the past 30 years have not moved far downgradient of these sources toward Harrison Bayou and Caddo Lake. The plume appears to be confined to within the ABG boundaries in the northern corner of the site, but may extend further than 200 feet north of the western corner of the site, with high concentrations exceeding 10,000 ug/l of TCE occurring in well MW-8, approximately 250 feet west of the ABG boundary. This well and MW-7, which detected a similar high concentration of TCE, are not located downgradient of the trenches in the western corner of the ABG. Ground-water contours on Sheets 19 and 20 show them both to be situated downgradient of the southern corner of the ABG, which poses the question of whether a contaminant source is in this area. The only solid waste management activity documented for this area of the ABG is the washout pad and sump area, which have been in use for the entire life of the ABG. The southern extent of the contaminant plume has not yet been determined because wells in this area were not sampled during this phase of the RFI.

Although well C-5, located approximately 1,500 feet northeast of the UEP, showed concentrations of methylene chloride at 110 ug/l and TCE at 77 ug/l, there is little reason to suspect contamination from the ABG to extend this far away from the site. There is a possibility that an error in the decontamination procedures used for the portable bailer prior to sampling the well may have caused the contamination in the water sample, or that another source other than the ABG may be contaminating the well. It is also possible that well C-4 is not screened in the shallow contaminated zone, but instead is screened in the next deeper intermediate zone. However, based on the data developed during this phase of the RFI, there is little reason to believe that this well is within the ABG contaminant plume.

The vertical extent of the contaminant plume cannot yet be determined. Samples from wells MW-14 and MW-15 showed that contamination extends vertically down to at least el. 130 at the two known contaminant source locations. The sample obtained from MW-13 showed no contamination, indicating this well to be outside any deeper contaminant plume.

6.6 **Uppermost Aquifer**. The base of the uppermost aquifer underlying the ABG is the base of the regional Cypress aquifer, which is represented as the contact between the overlying Wilcox and the underlying Midway Groups. As shown for the ABG area on Figure 7, this contact occurs at roughly el. 50 and dips to the northwest at about 20 feet per mile. Evidence obtained from the drill cuttings and downhole geophysical logs for the deep stratigraphic test borings drilled at the site suggest this contact occurs anywhere from approximate el. 87 at boring location 3F-925 on the eastern side of the site down to approximate el. 25 at the boring location 3F-924 on the western side of the site, as depicted on Sheets 23 through 27.

Attempts were made during Phase I investigations to define a confining bed in this area that was continuous across the site. It appears that one does not exist. Although well borings did encounter lower permeability materials at the depths anticipated, these materials cannot be conclusively correlated across the entire ABG area to define a shallower uppermost aquifer.

The best correlation of a single confining bed is shown on profile E-E' (Sheet 24), drawn across the entire site along the strike of the Wilcox strata. This upper confining bed identified in test borings 3F-922 and 3F-925, and identified in most of the well borings around the UEP, appears to be continuous for the length of the profile, except at the eastern end where it appears to be pinching out in the direction of well location C-3. This bed is most likely confining the contaminant plume to the screened shallow strata around the UEP. However, as shown by the water sample analyzed from the deeper well MW-15, the bed is not impermeable, and contamination has reached the underlying zone.

The remainder of the vertical section portrayed by profile E-E' illustrates the lenticular and discontinuous nature of the interbedded sandy, silty, clayey strata of the Wilcox Group. The second confining bed identified in test borings 3F-922 and 3F-925 appears to pinch out east of 3F-925, which indicates that the second and third deeper permeable zones identified in 3F-922 are actually a single unit separated by a clay lens at that boring location.

If the confining bed shown on Profile E-E' is indeed continuous for the Wilcox, which comprises most of the ABG site, it loses its continuity at the edge of the Harrison Bayou floodplain as depicted on profiles D-D', F-F', G-G', and H-H' (Sheets 23, 25, 26, and 27). A clear contact between alluvium and Wilcox materials cannot be drawn because the depositional nature of the two are so similar. There is definitely more sand in the shallow alluvial materials sampled, but where these sandy alluvial materials end and the sandy Wilcox materials begin is impossible to tell on the sections. Actually, whether this contact can be determined or not is not so important as the fact that the strata of the entire ABG area, whether alluvial or Wilcox in nature, appear to be hydraulically connected horizontally into the floodplain of the Harrison Bayou and vertically down to the base of the Cypress aquifer, with perhaps locally confining conditions occurring around the UEP only.

6.7 **Potential Contaminant Migration Pathways**. The potential contaminant migration pathways for each of the contaminant sources identified by this phase of the RFI are discussed below.

6.7.1 **UEP**. Ground-water contamination at the UEP has not moved significantly in the past 30 years. The source contributing to the contamination was removed in 1986. However, the plume is still present. The reason it has not moved significantly appears to be the very low hydraulic gradient across the site and the relatively low hydraulic conductivity of the uppermost saturated materials. Although confined locally beneath the ABG by a relatively low permeability clay stratum of the Wilcox, contamination has reached the next lower permeable stratum which may, depending on its hydraulic characteristics, be more conducive to carrying the contaminants away from the site into Harrison Bayou and/or Caddo Lake. The relationship between the structure of the closed UEP and wells MW-2, MW-6, and MW-15 is shown on Sheet 30.

6.7.2 **Buried Trenches.** The source materials contributing to the contaminant plume emanating from the western corner of the ABG still remain in some places around the foundation of the ACD, as shown on Figure 16. These source materials lie in the water table, as shown on Sheet 18, and are actively contributing to the ground-water contamination. The primary route of contaminant migration appears to be along the direction of ground-water flow in this area, as evidenced by the ground-water contours, shown on Sheets 19 and 20, and the configuration of the contaminant **"ridge,"** shown on Sheet 29. Movement of contaminants does not seem to be affected by the change from Wilcox to alluvial materials primarily because the materials are very much alike both physically and hydraulically, as shown by the laboratory and slug test data. What poses some concern is that wells MW-7, MW-8, and MW-9, which are screened in lower K materials, are showing high contaminant concentrations. As in the UEP area, the deeper well MW-14, located adjacent to the source, indicated that contamination has migrated downward into a lower permeability stratum which may hydraulically be more conducive to carrying contaminants more quickly towards Harrison Bayou.

6.7.3 **18 Burn Pits.** It cannot be determined at this time whether the contamination resulting from past operation of these burn pits is contributing to the ground-water contamination at the ABG. It appears that the elevation of the bottom of the pits, as indicated by the bottom of fill material encountered while drilling in this area, occurs approximately 15 feet above the water table. Therefore, contaminants must leach downward before ground-water contamination would occur. Well 124, on the fringe of any plume that may be emanating from the pits, showed a small amount (80 ug/l) of TCE, but this contamination could also be resulting from the UEP. Well 123, more directly downgradient from the pits, showed no contamination. However, wells MW-11 and MW-12, located further downgradient from this potential source, did show contamination, but because they are also located downgradient from the buried trenches, the source of the contaminants detected is inconclusive.

7.0 RECOMMENDATIONS FOR PHASE II TASKING.

7.1 Finish defining the horizontal extent of the contaminant plume by installing eight shallow monitoring wells, MW-16 through MW-23, at the locations shown on Sheet 31. Sample confining and screened materials for soil classification purposes.

7.2 Complete location C-4 as a three-well cluster at the suspected edge of the contaminant plume. Space wells 10 feet apart.

7.2.1 Install well C-4A as a deep well at the base of the uppermost aquifer at the Wilcox/Midway Contact, taking undisturbed samples every 5 feet for visual and laboratory classification. Geophysically log the boring prior to installing the well.

7.2.2 Install well C-4B as either a shallow or intermediate well, depending on the strata identified and correlation obtained from boring C-4A. At this time it is questionable whether C-4 is screened in the shallow contaminated zone or in the deeper intermediate zone, as shown on Sheet 25. Sample confining and screened materials for soil classification purposes.

7.3 Slug test all 10 new wells. Sample all 10 new wells and 8 existing wells C-1, C-5, C-6, C-7, C-8, 102, 126, and 130 to further define the contaminant plume and to site additional wells.

7.4 Measure water levels at least quarterly for a full year to determine seasonal variations in ground-water flow.

7.5 Designate or install at least one upgradient well for the purpose of monitoring elevated concentrations of metals in the ground water at the ABG. At this time, C-7 looks to be a good upgradient location.

7.6 Sample Harrison Bayou for VOCs and metals downgradient of the ABG at the locations designated HB-1 through HB-5 on Sheet 31 to verify if contamination has reached surface waters.

7.7 Drill 12 shallow soil borings, 8A-974 through 8A-975, for the purpose of identifying any additional sources that are contributing to ground-water contamination at the ABG. Boring locations are shown on Figure 32. Boring 8A-974 is located at the suspected trench location shown on the 1963 aerial photos (Figures 10 and 11). Boring 8A-975 is located in an old suspected burn pit shown on the 1970 aerial photos (Figures 12 and 13) that is still visible in the field due to a change in vegetation. These two borings will be used to verify whether any contaminant sources have contributed to the ground-water contamination around the UEP. Location 8A-976 is located adjacent to the sump at the washout pad, and 8A-977 is located along the surface drainage leading away from the sump. These two locations will verify whether sump leakage or overflow may have contributed to the ground-water contamination in this area of the site. Location 8A-978 through 8A-982 are located at old trench and pit locations identified by USAEHA on Figure 14. Locations 8A-983 through 8A-985 are located at locations sampled during the Phase I RFI that showed high VOC concentrations down to depths of 10 feet. Borings should be sampled for chemical analysis down to the water table to verify whether soil contamination, if found, is contributing to ground-water contamination.

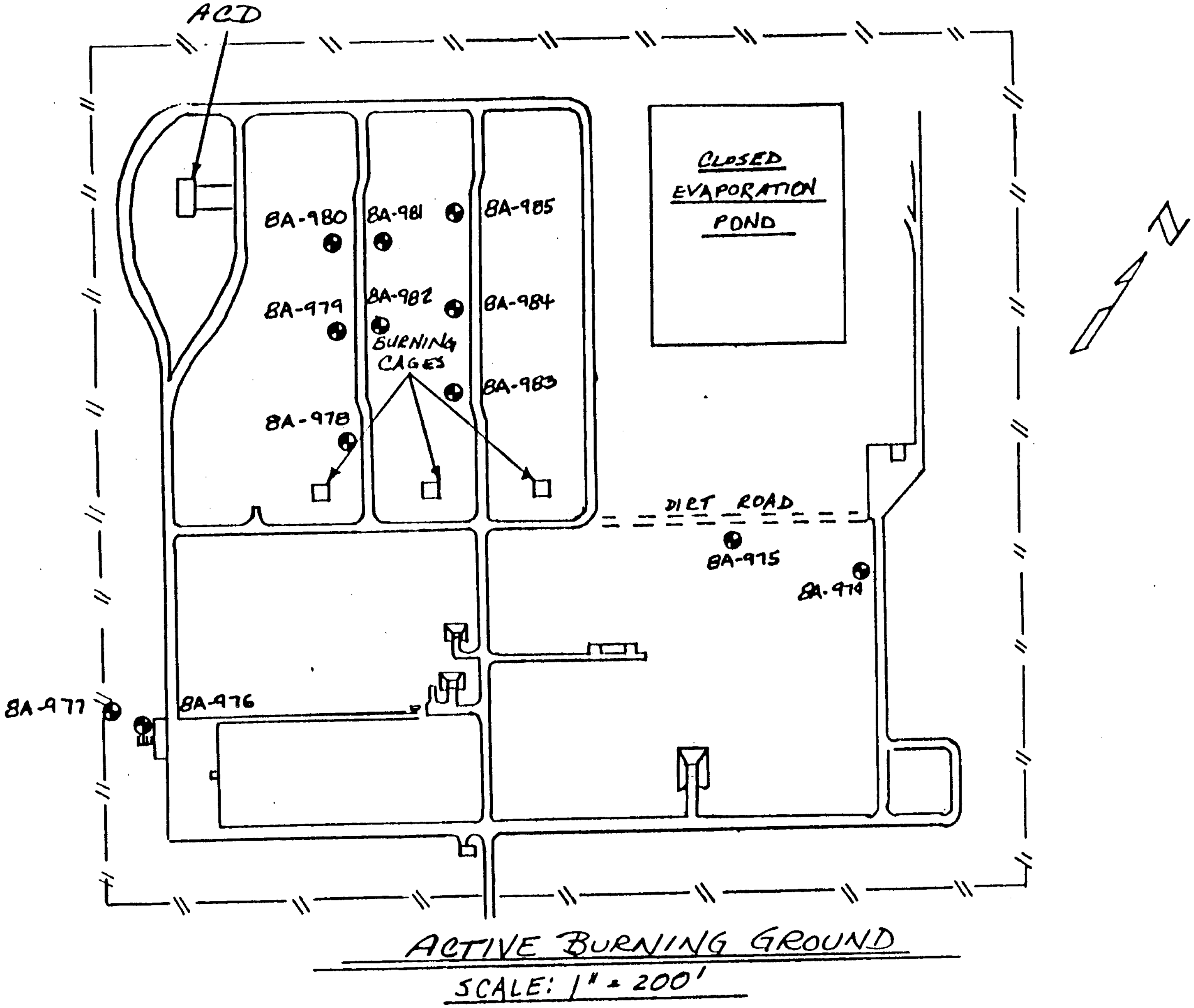


Figure 32. RFI Phase II Proposed Soil Boring Locations.

7.8 Consider plugging these wells for the following reasons:

101 - Water levels are heavily influenced by surface recharge down the well boring. Well is poorly constructed.

125 - Too shallow to monitor UEP contamination. Also poorly constructed with high silting during sampling.

BH-3 - Replaced in 1987 by MW-4.

BH-4 - Replaced in 1987 by MW-3.

BH-11 - Replaced in 1987 by MW-2. Lack of construction details makes water quality data questionable.

BH-22 - Lack of construction details makes water quality data questionable.

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RCRA FACILITY INVESTIGATION
-FOR-
ACTIVE BURNING GROUND
-AND-
UNLINED EVAPORATION POND

PHASE I

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

VOLUME 2
(SHEETS)

-PREPARED BY-
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

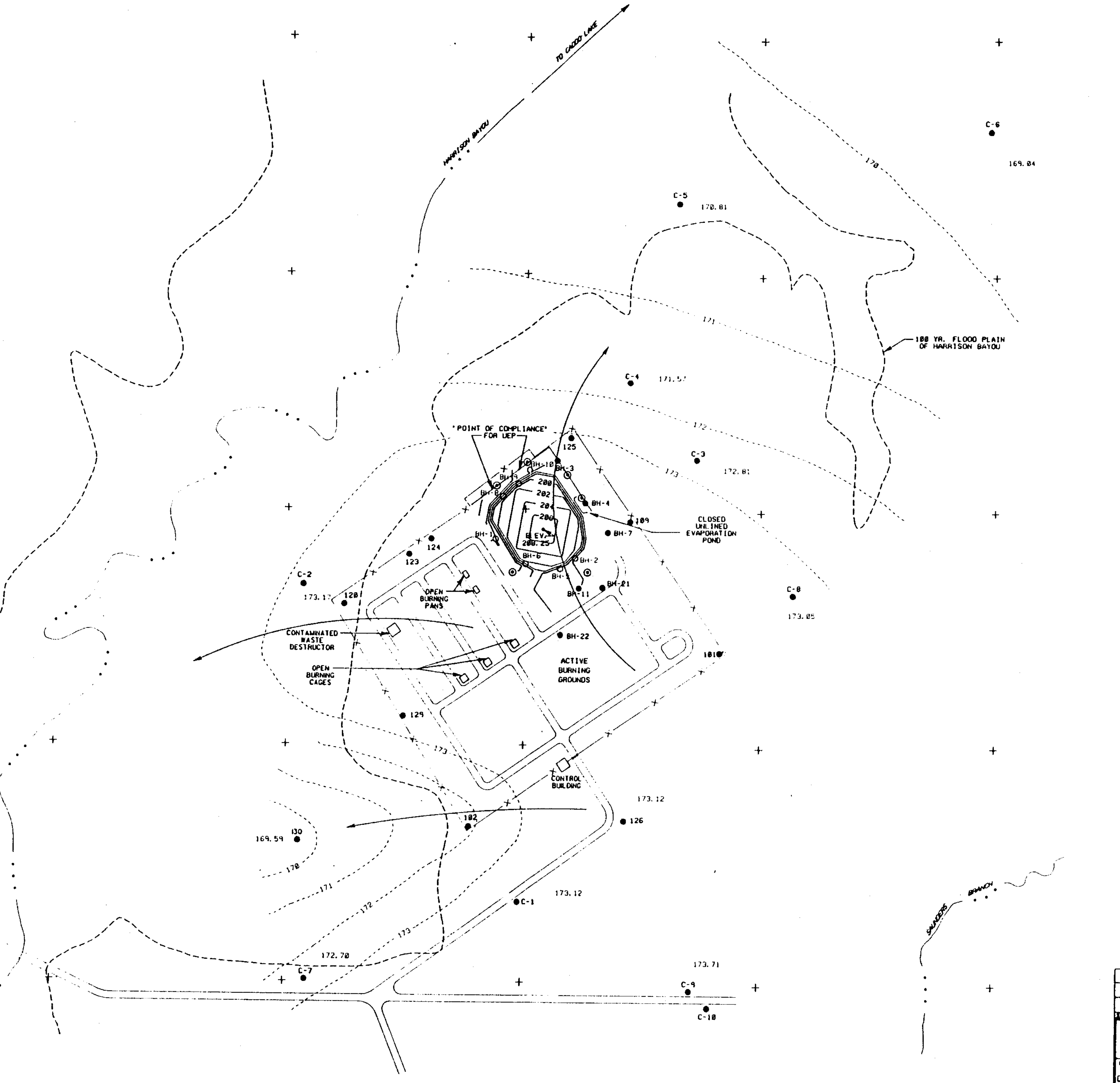
-PREPARED BY-
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

JULY 1989

002058

GROUNDWATER MONITORING WELLS
IN THE
ACTIVE BURNING GROUNDS AREA

*	MEAS. POINT ELEV.	COMP. MON. WELL	CORRECT ACT. MON. WELL
C-1	194.51	NO	NO
C-2	176.57	NO	NO
C-3	197.11	NO	YES
C-4	194.46	NO	YES
C-5	181.56	NO	YES
C-6	193.07	NO	NO
C-7	197.90	NO	NO
C-8	193.30	NO	NO
C-9	204.14	NO	YES
C-10	203.53	NO	NO
BH-3	196.01	NO	NO
BH-4	198.26	NO	NO
BH-7	198.17	NO	YES
BH-11	199.05	NO	NO
BH-21		NO	NO
BH-22		NO	NO
101	197.43	NO	NO
102	194.30	NO	NO
109		NO	NO
120	183.00	NO	NO
123	186.13	NO	NO
124	186.54	NO	NO
125		NO	NO
126	198.66	NO	NO
·129	197.01	NO	NO
130	176.71	NO	NO
XXX	TBD	YES	YES
XXX	TBD	YES	YES
XXX	TBD	YES	YES
XXX	TBD	YES	YES
XXX	TBD	YES	YES
XXX	TBD	YES	YES



LEGEND

- ● EXISTING GROUNDWATER MONITORING WELL
- ○ ABANDONED GROUNDWATER MONITORING WELL
- ⊙ PROPOSED LOCATION FOR ADDITIONAL COMPLIANCE MONITORING WELLS
- 173 GROUNDWATER SURFACE ELEVATIONS (2/18/86)
- ← GROUNDWATER FLOW DIRECTIONS

BH-2	USAEHA WELL DESIGNATION
109	USTHAMA WELL DESIGNATION
C-3	CDM WELL DESIGNATION
MW-2	USACE WELL DESIGNATION

N

200 0 200 400
SCALE IN FEET

NOTE

1. MAP IS PLATE 2 FROM "US ARMY PROPOSAL FOR ADDITIONAL GROUNDWATER MONITORING AT UNLINED EVAPORATION POND (UEP), LONGHORN ARMY AMMUNITION PLANT, MARSHALL, TEXAS", PREPARED BY USACE HUNTSVILLE DIVISION, FEB 1987.

SYMBOL NO	ACTION	DATE	DESCRIPTION OF REVISION

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

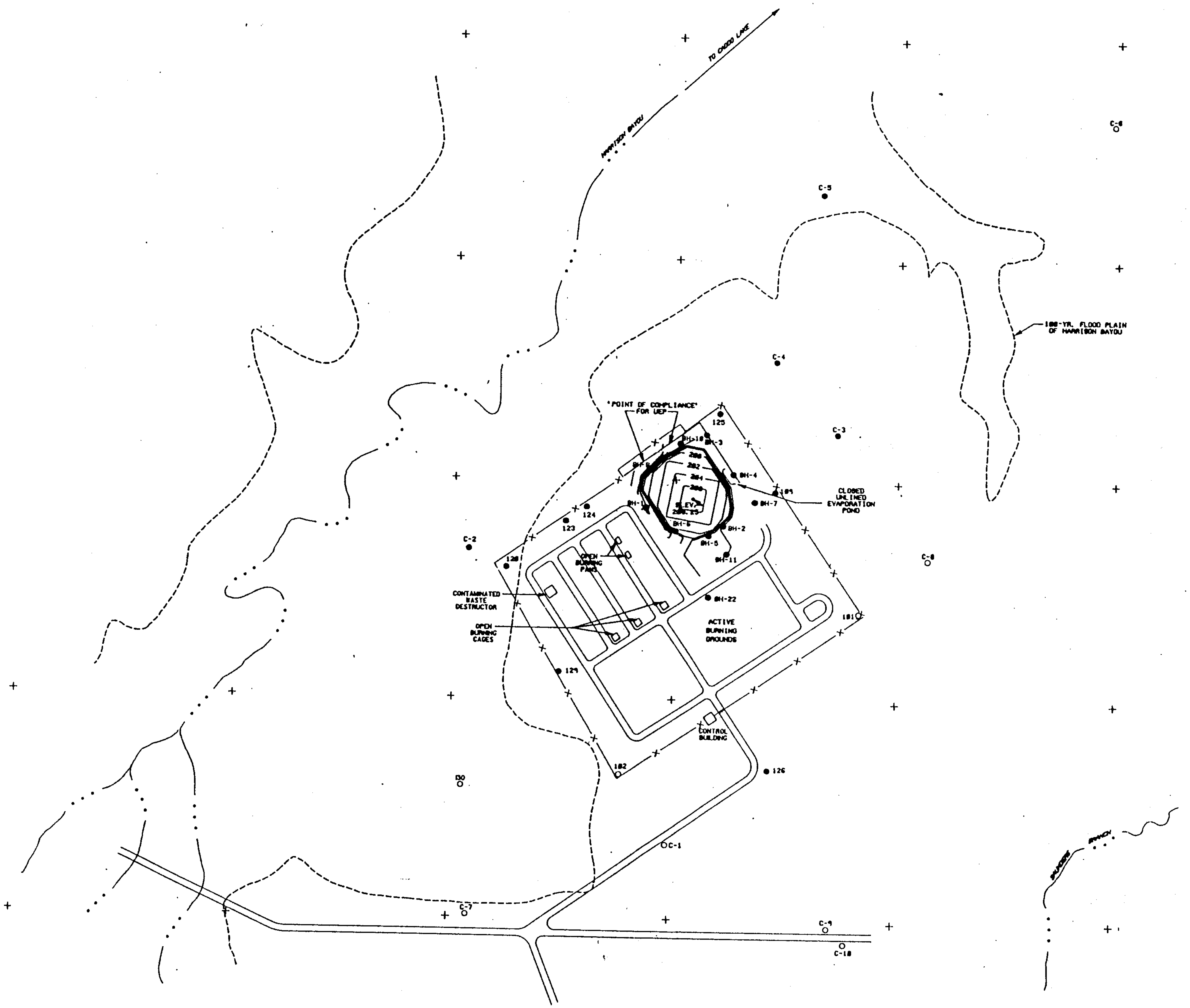
DESIGNED BY: D. FITZGERALD
DRAWN BY: C. KIRBY
REVIEWED BY: R. BEHM

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

RCRA FACILITY INVESTIGATION
ABG AND UEP SITES
PHASE I
PIEZOMETRIC SURFACE MAP 18 FEBRUARY 1986

SUBMITTED BY: ROBERT C. BEHM
ENGINEER:

SOL. NO.
DATED:
CONTR. NO
DRAWING NUMBER
SHEET NO. 1 OF 31
SEQUENCE NO. 1



LEGEND

○ MONITORING WELL
● CONTAMINATED MONITORING WELL
BH-4 USAEHA WELL DESIGNATION
109 USATHAMA WELL DESIGNATION
C-2 USACE (CDM) WELL DESIGNATION

NOTES

1. WELLS DESIGNATED AS CONTAMINATED ARE CONTAMINATED WITH METHYLENE CHLORIDE AND/OR TCE. SEE TABLES 1 AND 2.

2. BASE MAP FROM "US ARMY PROPOSAL FOR ADDITIONAL GROUNDWATER MONITORING AT THE UNLINED EVAPORATION POND (UEP), LONGHORN ARMY AMMUNITION PLANT, MARSHALL, TEXAS", PREPARED BY USACE, HUNTSVILLE DIVISION, FEB 1987.

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SCALE IN FEET

SYMBOL	DESCRIPTION OF REVISION	DATE	APPROVAL

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

RCRA FACILITY INVESTIGATION
ABG AND UEP SITES
PHASE I
EXTENT OF METHYLENE CHLORIDE AND
TCE CONTAMINATION IN PAST WELLS

DESIGNED BY: D.FITZGERALD
DRAWN BY: C. KIRBY
REVIEWED BY: R.BEHM
SUBMITTED BY: ROBERT C. BEHM
ENGINEER:

SOL. NO.
DATED:
CONTR. NO.
DRAWING NUMBER
SHEET NO. 2 of 31
SEQUENCE NO. 2

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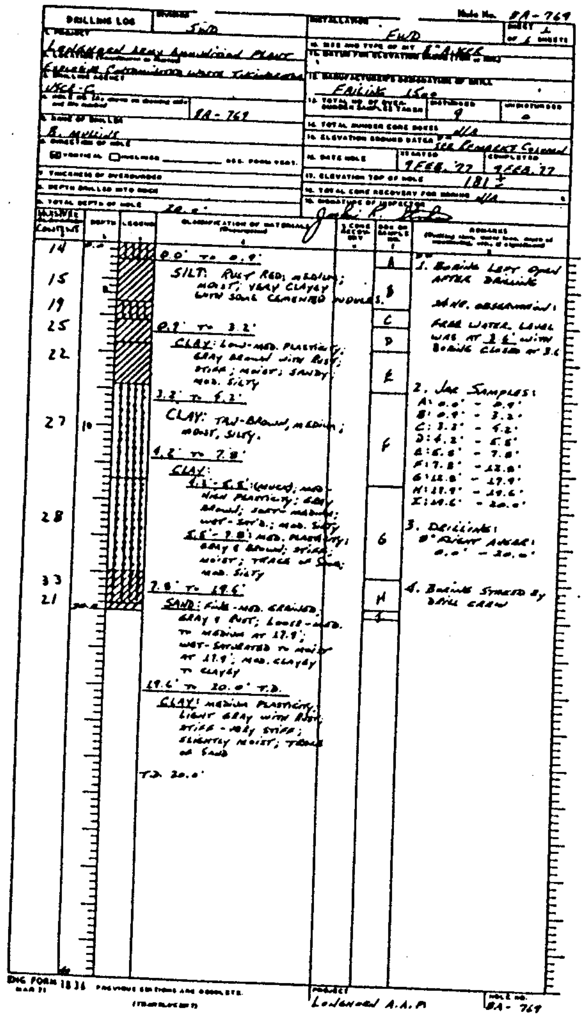


DRILLING LOG — DIVISION: SWD — INSTALLATION: FWD — Hole No. BA-769 — SHEET 1 OF 1 SHEETS

1. PROJECT: Longhorn Army Ammunition Plant
2. LOCATION: Explosive Contaminated Waste Incinerator
3. DRILLING AGENCY: USCE-C
4. HOLE NO.: BA-769
5. NAME OF DRILLER: B. Mullins
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 20.0'
10. SIZE AND TYPE OF BIT: 8" Auger
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 9, UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: N/A
15. ELEVATION GROUND WATER: See Remarks Column
16. DATE HOLE: STARTED 9 FEB. 77, COMPLETED 9 FEB. 77
17. ELEVATION TOP OF HOLE: 181±
18. TOTAL CORE RECOVERY FOR BORING: N/A
19. SIGNATURE OF INSPECTOR

MOISTURE CONTENT: 14, 15, 19, 25, 22, 27, 28, 33, 21

CLASSIFICATION OF MATERIALS:

0.0' to 0.9'
SILT: Rust red; medium; moist; very clayey with some cemented nodules.

0.9' to 3.2'
CLAY: Low-med. plasticity; gray brown with rust; stiff; moist; sandy; mod. silty

3.2' to 4.2'
CLAY: Tan-brown, medium; moist, silty.

4.2' to 7.8'
CLAY:
4.2'-5.5' (mucky); med-high plasticity; gray brown; soft-medium; wet-sat'd.; mod. silty
5.5'-7.8': med. plasticity; gray & brown; stiff; moist; trace of sand; mod. silty

7.8' to 19.6'
SAND: Fine-med. grained, gray & rust; loose-med. to medium at 17.9'; wet-saturated to moist at 17.9'; mod. clayey to clayey

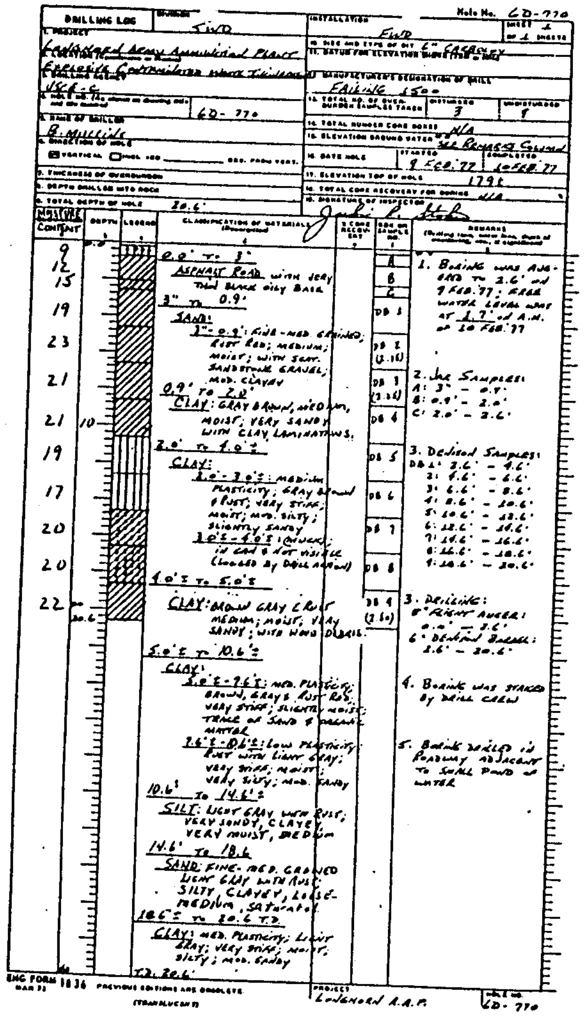
19.6' to 20.0' T.D.
CLAY: medium plasticity; light gray with rust; stiff-very stiff; slightly moist; trace of sand

T.D. 20.0'

SAMPLE NO.: A, B, C, D, E, F, G, H, I

REMARKS:
1. Boring left open after drilling
24 hr. observation: Free water level was at 3.6' with boring closed at 3.6
2. Jar samples:
A: 0.0' - 0.9'
B: 0.9' - 3.2'
C: 3.2' - 4.2'
D: 4.2' - 5.5'
E: 5.5' - 7.8'
F: 7.8' - 12.8'
G: 12.8' - 17.9'
H: 17.9' - 19.6'
I: 19.6' - 20.0'
3. Drilling: 8" Flight Auger: 0.0' - 20.0'
4. Boring staked by drill crew

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) — PROJECT: Longhorn A.A.P. — HOLE NO. BA-769



DRILLING LOG — DIVISION: SWD — INSTALLATION: FWD — Hole No. CD-770 — SHEET 1 OF 1 SHEETS

1. PROJECT: Longhorn Army Ammunition Plant
2. LOCATION: Explosive Contaminated Waste Incinerator
3. DRILLING AGENCY: USCE-C
4. HOLE NO.: CD-770
5. NAME OF DRILLER: B. Mullins
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 20.6'
10. SIZE AND TYPE OF BIT: 6" [illegible]
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 3, UNDISTURBED 9
14. TOTAL NUMBER CORE BOXES: N/A
15. ELEVATION GROUND WATER: See Remarks Column
16. DATE HOLE: STARTED 9 FEB. 77, COMPLETED 10 FEB. 77
17. ELEVATION TOP OF HOLE: 179±
18. TOTAL CORE RECOVERY FOR BORING: N/A
19. SIGNATURE OF INSPECTOR

MOISTURE CONTENT: 9, 12, 15, 19, 23, 21, 21, 19, 17, 20, 20, 22

CLASSIFICATION OF MATERIALS:

0.0' to 3"
ASPHALT ROAD with very thin black oily base

3" to 0.9'
SAND:
3"-0.9': fine-med grained; rust red; medium; moist; with sdst. sandstone gravel; mod. clayey

0.9' to 2.0'
CLAY: Gray brown, medium, moist; very sandy with clay laminations.

2.0' to 4.0'±
CLAY:
2.0'-3.0'±: medium plasticity; gray brown & rust; very stiff; moist; mod. silty; slightly sandy
3.0'±-4.0'± (mucky): in can & not visible (loosed by drill action)

4.0'± to 5.0'±
CLAY: Brown gray & rust medium; moist; very sandy; with wood debris.

5.0'± to 10.6'±
CLAY:
5.0'±-9.6'±: med. plasticity; brown, gray & rust red; very stiff; slightly moist; trace of sand & organic matter
9.6'±-10.6'±: low plasticity; rust with light gray; very stiff; moist; very silty; mod. sandy

10.6' to 14.6'±
SILT: Light gray with rust; very sandy, clayey, very moist, medium

14.6' to 18.6
SAND: Fine-med. grained light gray with rust; silty, clayey, loose-medium, saturated

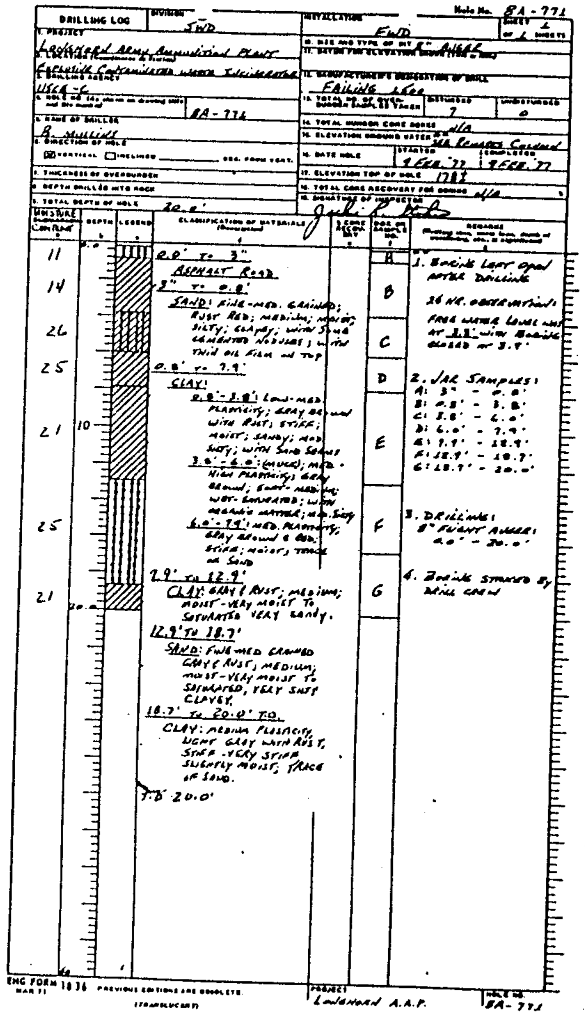
18.6'± to 20.6 T.D.
CLAY: Med. plasticity; light gray; very stiff; moist; silty; mod. sandy

T.D. 20.6'

SAMPLE NO.: A, B, C, DB 1, DB 2 (3.10), DB 3 (3.11), DB 4, DB 5, DB 6, DB 7, DB 8, DB 9 (3.60)

REMARKS:
1. Boring was augered to 2.6' on 9 Feb. 77; free water level was at 1.7' at A.M. of 10 Feb. 77
2. Jar samples:
A: 3" - 0.9'
B: 0.9' - 2.0'
C: 2.0' - 2.6'
3. Denison samples:
DB 1: 2.6' - 4.6'
2: 4.6' - 6.6'
3: 6.6' - 8.6'
4: 8.6' - 10.6'
5: 10.6' - 12.6'
6: 12.6' - 14.6'
7: 14.6' - 16.6'
8: 16.6' - 18.6'
9: 18.6' - 20.6'
3. Drilling:
8" Flight Auger: 0.0' - 2.6'
6" Denison Barrel: 2.6' - 20.6'
4. Boring was staked by drill crew
5. Boring drilled in roadway adjacent to small pond of water

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) — PROJECT: Longhorn A.A.P. — HOLE NO. CD-770



DRILLING LOG — DIVISION: SWD — INSTALLATION: FWD — Hole No. BA-771 — SHEET 1 OF 1 SHEETS

1. PROJECT: Longhorn Army Ammunition Plant
2. LOCATION: Explosive Contaminated Waste Incinerator
3. DRILLING AGENCY: USCE-C
4. HOLE NO.: BA-771
5. NAME OF DRILLER: B. Mullins
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 20.0'
10. SIZE AND TYPE OF BIT: 8" Auger
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 7, UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: N/A
15. ELEVATION GROUND WATER: See Remarks Column
16. DATE HOLE: STARTED 9 FEB. 77, COMPLETED 9 FEB. 77
17. ELEVATION TOP OF HOLE: 178±
18. TOTAL CORE RECOVERY FOR BORING: N/A
19. SIGNATURE OF INSPECTOR

MOISTURE CONTENT: 11, 14, 26, 25, 21, 25, 21

CLASSIFICATION OF MATERIALS:

0.0' to 3"
ASPHALT ROAD

3" to 0.8'
SAND: Fine-med. grained; rust red; medium; moist; silty; clayey; with some cemented nodules; with thin oil film on top

0.8' to 7.9'
CLAY:
0.8'-3.8': low-med. plasticity; gray brown with rust; stiff; moist; sandy; mod. silty; with sand seams
3.8'-6.0' (mucky); med.-high plasticity; gray brown; soft-medium; wet-saturated; with organic matter; mod. silty
6.0'-7.9': med. plasticity; gray brown & red; stiff; moist; trace of sand

7.9' to 12.9'
CLAY: Gray & rust; medium; moist-very moist to saturated very sandy.

12.9' to 18.7'
SAND: Fine-med grained gray & rust, medium; moist-very moist to saturated, very silty clayey.

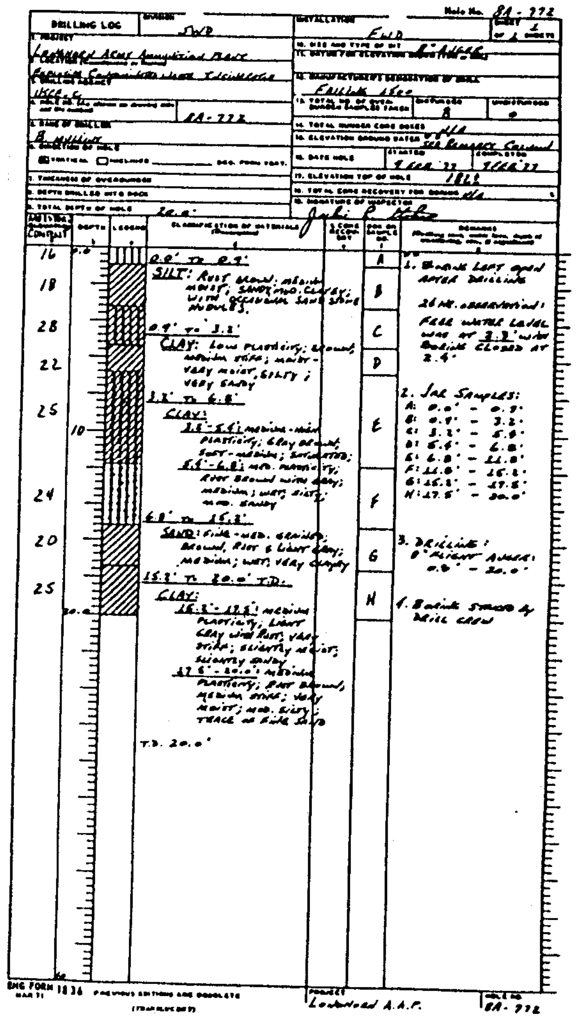
18.7' to 20.0' T.D.
CLAY: Medium plasticity, light gray with rust, stiff-very stiff slightly moist; trace of sand.

T.D. 20.0'

SAMPLE NO.: A, B, C, D, E, F, G

REMARKS:
1. Boring left open after drilling
24 hr. observation: Free water level was at 1.1' with boring closed at 3.9'
2. Jar samples:
A: 3" - 0.8'
B: 0.8' - 3.8'
C: 3.8' - 6.0'
D: 6.0' - 7.9'
E: 7.9' - 12.9'
F: 12.9' - 18.7'
G: 18.7' - 20.0'
3. Drilling: 8" Flight Auger: 0.0' - 20.0'
4. Boring staked by drill crew

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) — PROJECT: Longhorn A.A.P. — HOLE NO. BA-771



DRILLING LOG — DIVISION: SWD — INSTALLATION: FWD — Hole No. BA-772 — SHEET 1 OF 1 SHEETS

1. PROJECT: Longhorn Army Ammunition Plant
2. LOCATION: Explosive Contaminated Waste Incinerator
3. DRILLING AGENCY: USCE-C
4. HOLE NO.: BA-772
5. NAME OF DRILLER: B. Mullins
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 20.0'
10. SIZE AND TYPE OF BIT: 8" Auger
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 8, UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: N/A
15. ELEVATION GROUND WATER: See Remarks Column
16. DATE HOLE: STARTED 9 FEB. 77, COMPLETED 9 FEB. 77
17. ELEVATION TOP OF HOLE: 182±
18. TOTAL CORE RECOVERY FOR BORING: N/A
19. SIGNATURE OF INSPECTOR

MOISTURE CONTENT: 16, 18, 28, 22, 25, 24, 20, 25

CLASSIFICATION OF MATERIALS:

0.0' to 0.9'
SILT: Rust brown; medium; moist; sandy; mod. clayey; with occasional sandstone nodules.

0.9' to 3.2'
CLAY: Low plasticity; brown; medium stiff; moist-very moist, silty; very sandy

3.2' to 6.8'
CLAY:
3.2'-5.4': medium-high plasticity; gray brown; soft-medium; saturated;
5.4'-6.8': med. plasticity; rust brown with gray; medium; wet; silty; mod. sandy

6.8' to 15.3'
SAND: Fine-med. grained; brown, rust & light gray; medium; wet; very clayey

15.3' to 20.0' T.D.
CLAY:
15.3'-17.5': medium plasticity; light gray with rust; very stiff; slightly moist; slightly sandy
17.5'-20.0': medium plasticity; rust brown; medium stiff; very moist; mod. silty; trace of fine sand

T.D. 20.0'

SAMPLE NO.: A, B, C, D, E, F, G, H

REMARKS:
1. Boring left open after drilling
24 hr. observation: Free water level was at 3.3' with boring closed at 2.4'
2. Jar samples:
A: 0.0' - 0.9'
B: 0.9' - 3.2'
C: 3.2' - 5.4'
D: 5.4' - 6.8'
E: 6.8' - 11.8'
F: 11.8' - 15.3'
G: 15.3' - 17.5'
H: 17.5' - 20.0'
3. Drilling: 8" Flight Auger: 0.0' - 20.0'
4. Boring staked by drill crew

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) — PROJECT: Longhorn A.A.P. — HOLE NO. BA-772

NOTES

1. BORING LOGS ARE FROM FORT WORTH DISTRICT FOUNDATION DESIGN ANALYSIS FOR EXPLOSIVE CONTAMINATED WASTE INCINERATOR, MCA PROJECT NO. 971-000, 19 MAY 1977.
2. FOR BORING LOCATIONS, SEE FIGURE 13.

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RCRA FACILITY INVESTIGATION
ABG AND UEP SITES
PHASE I
LOGS OF BORINGS
FOUNDATION DESIGN ANALYSIS

DESIGNED BY: D. FITZGERALD
DRAWN BY: C. KIRBY
REVIEWED BY: R. BEHM
SUBMITTED BY: ROBERT C. BEHM
ENGINEER:
SOL. NO.
DATED:
CONTR. NO.
DRAWING NUMBER
SHEET NO. 3 of 31
SEQUENCE NO. 3

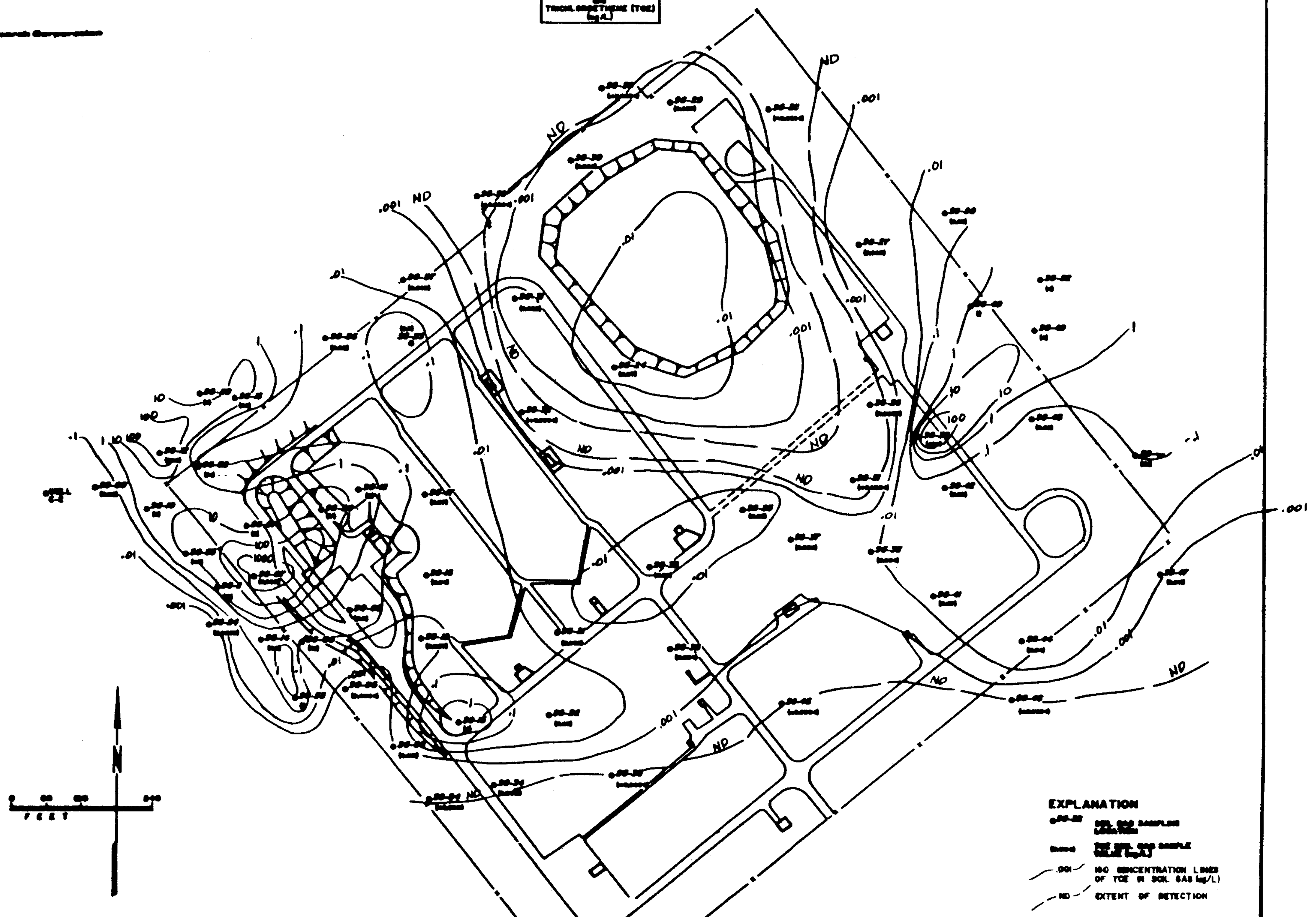
FIGURE 1

LONGHORN ARMY AMMUNITION PLANT

MARSHALL, TEXAS

SAMPLING LOCATIONS and TRICHLOROETHENE (TCE) (ug/L)

Tracer Research Corporation



EXPLANATION

- SOIL GAS SAMPLING LOCATION
- TCE SOIL GAS SAMPLE VALUE (ug/L)
- .001 ISO CONCENTRATION LINES OF TCE IN SOIL GAS (ug/L)
- ND EXTENT OF DETECTION

US ARMY CORPS OF ENGINEERS/LONGHORN-KARNACK, TEXAS

Sample	Depth	Date	[illegible] (ug/l)	TCE (ug/l)
SG01	2.5'	09/20	<0.2	3
SG02	5'	09/20	<0.08	0.2
SG03	5'	09/20	<0.02	0.001
SG04	4'	09/20	<0.008	<0.0001
SG05	3.5'	09/20	<0.02	0.0004
SG06	4.5'	09/20	<0.02	0.1
SG07	4.5'	09/20	<170	6,000
SG08	5'	09/20	<0.08	0.1
SG09	5'	09/20	<0.02	0.02
SG10	2.5'	09/20	<0.3	5
SG11	4'	09/20	<0.3	10
SG12	4'	09/20	<170	300
SG13	5'	09/20	<8	80
SG14	4.5'	09/20	<0.3	0.2
SG15	3.5'	09/20	N/A	4
SG16	4.5'	09/20	N/A	0.04
SG17	5'	09/20	N/A	0.07
SG18	3.5'	09/20	N/A	3
SG19	4.5'	09/20	N/A	0.007
SG20	5'	09/20	N/A	17
SG21	4.5'	09/20	N/A	[illegible]
SG22	4'	09/20	N/A	0.08
SG23	4.5'	09/20	N/A	0.3
SG24	5'	09/20	N/A	0.07
SG25	[illegible]	09/20	N/A	[illegible]
SG26	5'	09/29	N/A	0.0007
SG27	4.5'	09/29	N/A	0.005
SG28	3.5'	09/29	N/A	<0.0004
SG29	5'	09/29	N/A	0.007
SG30	5'	09/29	N/A	0.006
SG31	5'	09/29	N/A	0.002
SG32	5'	09/29	N/A	<0.0004
SG33	5'	09/29	N/A	0.02
SG34	3.5'	09/29	N/A	0.0001
SG35	[illegible]	09/29	N/A	<0.0004
SG36	4.5'	09/29	N/A	[illegible]
SG37	5'	09/29	N/A	[illegible]
SG38	6'	09/29	N/A	0.004
SG39	4.5'	09/29	N/A	[illegible]
SG40	[illegible]	09/29	N/A	1
SG41	5'	09/29	N/A	0.07
SG42	5'	09/29	N/A	[illegible]
SG43	6'	09/29	N/A	[illegible]
SG44	4.5'	09/29	N/A	0.04
SG45	4'	09/29	N/A	<0.0004
SG46	4.5'	09/29	N/A	<0.0004
SG47	5'	09/29	N/A	[illegible]
SG48	4.5'	09/29	N/A	0.1
SG49	3.5'	09/29	N/A	4
SG50	4'	09/29	N/A	[illegible]
SG51	3.5'	10/01	N/A	<0.0004
SG52	4.5'	10/01	N/A	4
[illegible]	5'	10/01	N/A	1
[illegible]	4'	10/01	N/A	[illegible]
[illegible]	5'	10/01	N/A	[illegible]
[illegible]	5'	10/01	N/A	[illegible]
SG57	3.5'	10/01	N/A	[illegible]
[illegible]	3.5'	10/01	N/A	<0.0004
[illegible]	3.5'	10/01	N/A	<0.0004
[illegible]	5'	10/01	N/A	7

Notations:
I interference with adjacent peaks
NA not analyzed

Analyzed by S. [illegible]
Checked by R. [illegible]
Proofed by L. [illegible]

NOTE

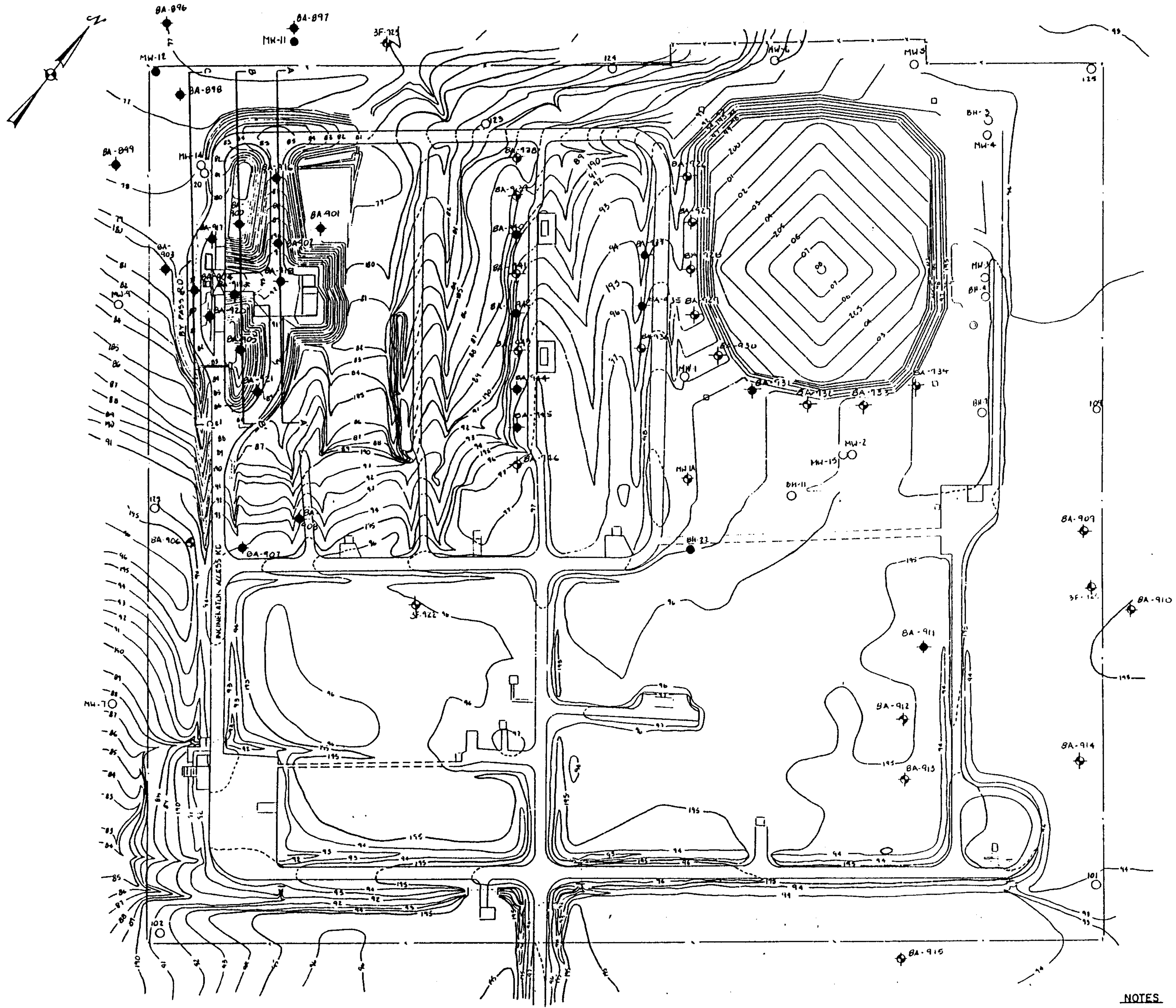
1. SOIL GAS SURVEY PERFORMED BY TRACER RESEARCH CORPORATION, SEPT 1987. BASE MAP AND SAMPLING DATA FROM FINAL REPORT DATED OCT 1987, CONTAINED IN APPENDIX B.

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RCRA FACILITY INVESTIGATION
ABS AND WEP SITES
PHASE I
SOIL GAS SAMPLING LOCATIONS
RESULTS AND CONTOURS

DESIGNED BY: [illegible]
DRAWN BY: C. [illegible]
CHECKED BY: [illegible]
SUBMITTED BY: ROBERT C. BEHM
SHEET NO. 4 OF [illegible]

002062



LEGEND

○ MONITORING WELLS
⊕ SOIL BORING LOCATION
● SOIL CONTAMINATED WITH > 20 ug/L VOCs
195 CONTOUR INTERVAL IN FT-MSL
—·— FENCE
◎ MANHOLE
- - - INFERRED CONTOUR
□ UEP MONUMENTS

NOTES

1. FOR SUBSURFACE PROFILES, SEE SHEET 18.
2. FOR ANALYTICAL RESULTS FOR CONTAMINATED SOIL AND WELL BORINGS, SEE TABLES 5, 6, 7, 10, AND 11.
3. BASE MAP COMPILED FROM FORT WORTH DISTRICT SURVEY DATA AND AS-BUILTS, CONTRACT NO. DACA63-78-B-0010, AND AS-BUILTS CONTRACT NO. DACA87-84-C-0039.

SYMBOL NO.	ACTION	DATE	DESCRIPTION OF REVISION

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

DESIGNED BY: D.FITZGERALD
DRAWN BY: C.KIRBY
REVIEWED BY: R. BEHM

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RCRA FACILITY INVESTIGATION
ABG AND UEP SITES
PHASE I
SOIL CONTAMINATION AND
BORING LOCATION MAP

SUBMITTED BY: ROBERT C. BEHM
ENGINEER:
SOL. NO.
DATED:
CONTR. NO.
DRAWING NUMBER
SHEET NO. 5 OF 31
SEQUENCE NO. 5

002063

Hole No. BA-896

DRILLING LOG

Division: SWD

Installation: FWD

Sheet 1 of 1 sheets

1. Project: LONGHORN AAP.
2. Location: GROUND-WATER QUALITY ASSESSMENT
3. Drilling agency: USCE
4. Hole No.: BA-896
5. Name of driller: T. SILITS
6. Direction of hole: ☒ Vertical ☐ Inclined ____ deg. from vert.
7. Thickness of overburden
8. Depth drilled into rock
9. Total depth of hole: 15.0'
10. Size and type of bit: 8" AUGER
11. Datum for elevation shown
12. Manufacturer's designation of drill: FAILING 1500
13. Total no. of overburden samples taken: Disturbed 11; Undisturbed 0
14. Total number core boxes: N/A
15. Elevation ground water: SEE REMARKS COLUMN
16. Date hole: Started 11 MAY '88; Completed 11 MAY '88
17. Elevation top of hole: 177'±
18. Total core recovery for boring: N/A
19. Signature of inspector: Jackie R. Stokes

Depth: 0.0, 15.0, 20, 40

Classification of materials:

0.0' TO 15.0' T.D.

SAND:

0.0'-4.0': FINE GRAINED; LOOSE-MEDIUM; DRY-DAMP; SILTY TO VERY SILTY FROM 2.0'; BROWN, YELLOWISH BROWN & LIGHT GRAY FROM 2.0'

4.0'-6.0': FINE GRAINED; LIGHT GRAY WITH YELLOWISH BROWN; MEDIUM; MOIST; SILTY

6.0'-15.0': FINE GRAINED; LIGHT GRAY & YELLOWISH BROWN; MEDIUM; SILTY; VERY MOIST-WET TO WET FROM 10.0' TO SATURATED FROM 12.0'

T.D. 15.0'

Box or sample No.: A, B, C, D, E, F, G

Remarks:

1. WATER LEVEL: NOTE: SOME FREE WATER ENTERED DURING DRILLING FROM 6.5'± WITH ABUNDANT WATER FROM 12.0'

24 HR. OBSERVATION: FREE WATER LEVEL WAS AT 5.0' WITH BORING CLOSED IN FROM 5.2'

2. JAR SAMPLES: (SOIL CLASS. ANALYSES)
A: 0.0' - 2.0'
B: 2.0' - 4.0'
C: 4.0' - 6.0'
D: 6.0' - 8.0'
E: 8.0' - 10.0'
F: 10.0' - 12.0'
G: 12.0' - 15.0'
(CHEMICAL ANALYSES)
C-1 & 1A: 4.0'
C-2 & 2A: 8.0'

3. DRILLING: 8" FLIGHT AUGER: 0.0' - 15.0'

4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLORO-ETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. A WEAK ODOR WAS OBSERVED AROUND 4.0'.

5. NOTE: BORING WAS DRILLED AS SHOWN ON LAYOUT.

ENG FORM 1836

Project: LONGHORN AAP.

Hole No.: BA-896

Hole No. BA-897

DRILLING LOG

Division: SWD

Installation: FWD

Sheet 1 of 1 sheets

1. Project: LONGHORN AAP.
2. Location: GROUND-WATER QUALITY ASSESSMENT
3. Drilling agency: USCE
4. Hole No.: BA-897
5. Name of driller: T. SILITS
6. Direction of hole: ☒ Vertical ☐ Inclined ____ deg. from vert.
7. Thickness of overburden
8. Depth drilled into rock
9. Total depth of hole: 15.0'
10. Size and type of bit: 8" AUGER
11. Datum for elevation shown
12. Manufacturer's designation of drill: FAILING 1500
13. Total no. of overburden samples taken: Disturbed 11; Undisturbed 0
14. Total number core boxes: N/A
15. Elevation ground water: SEE REMARKS COLUMN
16. Date hole: Started 11 MAY '88; Completed 11 MAY '88
17. Elevation top of hole: 176.5'±
18. Total core recovery for boring: N/A
19. Signature of inspector: Jackie R. Stokes

Depth: 0.0, 15.0, 20, 40

Classification of materials:

0.0' TO 2.0'

SILT: LOW PLASTICITY; YELLOWISH BROWN; MEDIUM-STIFF; DAMP; VERY SANDY (BORDERS A SILTY SAND)

2.0' TO 5.5'

CLAY: MEDIUM PLASTICITY; GRAY WITH YELLOWISH BROWN; VERY STIFF TO STIFF FROM 4.0'; DAMP TO MOIST FROM 4.0'; SILTY TO VERY SILTY FROM 4.0'

5.5' TO 15.0' T.D.

SAND:

5.5'-11.5': FINE GRAINED; LIGHT GRAY WITH YELLOWISH BROWN; MEDIUM; MOIST TO SATURATED FROM 7.5'; VERY SILTY TO SILTY FROM 7.5'

11.5'-15.0': FINE GRAINED; LIGHT BLUE GRAY; MEDIUM; MOIST; VERY SILTY

T.D. 15.0'

Box or sample No.: A, B, C, D, E, F, G

Remarks:

1. WATER LEVEL: NOTE: FREE WATER ENTERED BORING DURING DRILLING FROM 7.5'±

24 HR. OBSERVATION: FREE WATER LEVEL WAS AT 4.5' WITH BORING CLOSED IN FROM 4.6'

2. JAR SAMPLES: (SOIL CLASS. ANALYSES)
A: 0.0' - 2.0'
B: 2.0' - 4.0'
C: 4.0' - 5.5'
D: 5.5' - 7.5'
E: 7.5' - 9.5'
F: 9.5' - 11.5'
G: 11.5' - 15.0'
(CHEMICAL ANALYSES)
C-1 & 1A: 4.0'
C-2 & 2A: 8.0'

3. DRILLING: 8" FLIGHT AUGER: 0.0' - 15.0'

4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLORO-ETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. NO ODOR WAS DETECTED DURING DRILLING

5. NOTE: BORING WAS DRILLED AS SHOWN ON LAYOUT.

ENG FORM 1836

Project: LONGHORN AAP.

Hole No.: BA-897

Hole No. BA-898

DRILLING LOG

Division: SWD

Installation: FWD

Sheet 1 of 1 sheets

1. Project: LONGHORN AAP.
2. Location: GROUND-WATER QUALITY ASSESSMENT
3. Drilling agency: USCE
4. Hole No.: BA-898
5. Name of driller: T. SILITS
6. Direction of hole: ☒ Vertical ☐ Inclined ____ deg. from vert.
7. Thickness of overburden
8. Depth drilled into rock
9. Total depth of hole: 15.0'
10. Size and type of bit: 8" AUGER
11. Datum for elevation shown
12. Manufacturer's designation of drill: FAILING 1500
13. Total no. of overburden samples taken: Disturbed 12; Undisturbed 0
14. Total number core boxes: N/A
15. Elevation ground water: SEE REMARKS COLUMN
16. Date hole: Started 4 APRIL '88; Completed 4 APRIL '88
17. Elevation top of hole: 176.5'±
18. Total core recovery for boring: N/A
19. Signature of inspector: Jackie R. Stokes

Depth: 0.0, 15.0, 20, 40

Classification of materials:

0.0' TO 3.9'

SILT: LOW-MEDIUM PLASTICITY; GRAY & BROWN; SANDY

0.0'-0.9': SOFT-MEDIUM; WET

0.9'-2.9': MEDIUM-STIFF; MOIST

2.9'-3.9': MEDIUM; WET

3.9' TO 15.0' T.D.

SAND:

3.9'-7.9': FINE GRAINED; LIGHT GRAY WITH YELLOWISH BROWN; MEDIUM; VERY MOIST TO WET; VERY SILTY; WITH SHARP ODOR IN SAMPLES FROM 5.9'

7.9'-15.0': FINE GRAINED; LIGHT GRAY WITH YELLOWISH BROWN; MEDIUM; SATURATED DOWN TO VERY MOIST-WET FROM 9.9'; VERY SILTY; WITH SHARP ODOR

T.D. 15.0'

Box or sample No.: A, B, C, D, E, F, G, H

Remarks:

1. WATER LEVEL: NOTE: ABUNDANT FREE WATER ENTERED DURING DRILLING; 24 HR. LEVEL WAS AT 0.1' WITH BORING CLOSED IN AT 0.6'

2. JAR SAMPLES: (SOIL CLASS. ANALYSES)
A: 0.0' - 0.9'
B: 0.9' - 2.9'
C: 2.9' - 3.9'
D: 3.9' - 5.9'
E: 5.9' - 7.9'
F: 7.9' - 9.9'
G: 9.9' - 11.9'
H: 11.9' - 15.0'
(CHEMICAL ANALYSES)
C-1 & C-1A: 4.0'
C-2 & C-2A: 8.0'

3. DRILLING: 8" FLIGHT AUGER: 0.0' - 15.0'

4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLORO-ETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. NO ODOR WAS DETECTED EXITING BOREHOLE, BUT AN ODOR WAS DETECTED FROM JAR SAMPLES TAKEN FROM 5.9'

5. LOCATION: NOTE: DRILLED AS SHOWN ON LAYOUT.

ENG FORM 1836

Project: LONGHORN AAP.

Hole No.: BA-898

Hole No. BA-899

DRILLING LOG

Division: SWD

Installation: FWD

Sheet 1 of 1 sheets

1. Project: LONGHORN AAP.
2. Location: GROUND-WATER QUALITY ASSESSMENT
3. Drilling agency: USCE
4. Hole No.: BA-899
5. Name of driller: T. SILITS
6. Direction of hole: ☒ Vertical ☐ Inclined ____ deg. from vert.
7. Thickness of overburden
8. Depth drilled into rock
9. Total depth of hole: 15.0'
10. Size and type of bit: 8" AUGER
11. Datum for elevation shown
12. Manufacturer's designation of drill: FAILING 1500
13. Total no. of overburden samples taken: Disturbed 12; Undisturbed 0
14. Total number core boxes: N/A
15. Elevation ground water: SEE REMARKS COLUMN
16. Date hole: Started 11 MAY '88; Completed 11 MAY '88
17. Elevation top of hole: 178'±
18. Total core recovery for boring: N/A
19. Signature of inspector: Jackie R. Stokes

Depth: 0.0, 15.0, 20, 40

Classification of materials:

0.0' TO 7.7'

SILT:

0.0'-1.7': LOW PLASTICITY; REDDISH BROWN; STIFF; DAMP; VERY SANDY

1.7'-7.7': LOW-MEDIUM PLASTICITY; YELLOWISH BROWN WITH LIGHT GRAY TO LIGHT BLUE GRAY WITH YELLOWISH BROWN FROM 3.7'; MEDIUM-STIFF; VERY MOIST TO WET FROM 5.7'±; SANDY; WITH SMALL CARBON STAINS FROM 5.7'

7.7' TO 15.0' T.D.

SAND: FINE GRAINED; YELLOWISH BROWN WITH LIGHT GRAY TO LIGHT BLUE GRAY FROM 11.7'-13.7'; MEDIUM; SATURATED; SILTY TO VERY SILTY FROM 11.7'

T.D. 15.0'

Box or sample No.: A, B, C, D, E, F, G, H

Remarks:

1. WATER LEVEL: NOTE: FREE WATER ENTERED BORING DURING DRILLING FROM 6.0'±; BORING LEFT OPEN

24 HR. OBSERVATION: FREE WATER LEVEL WAS AT 4.7' WITH BORING CLOSED IN AT 5.2'

2. JAR SAMPLES: (SOIL CLASS. ANALYSES)
A: 0.0' - 1.7'
B: 1.7' - 3.7'
C: 3.7' - 5.7'
D: 5.7' - 7.7'
E: 7.7' - 9.7'
F: 9.7' - 11.7'
G: 11.7' - 13.7'
H: 13.7' - 15.0'
(CHEMICAL ANALYSES)
C-1 & 1A: 4.0'
C-2 & 2A: 8.0'

3. DRILLING: 8" FLIGHT AUGER: 0.0' - 15.0'

4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLORO-ETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. NO ODOR WAS DETECTED DURING DRILLING

5. NOTE: BORING WAS DRILLED AS SHOWN ON LAYOUT.

ENG FORM 1836

Project: LONGHORN AAP.

Hole No.: BA-899

NOTE

FOR BORING LOCATIONS, SEE SHEET 5.

SYMBOL	ACTION	DATE	DESCRIPTION OF REVISION

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

DESIGNED BY: D. FITZGERALD

DRAWN BY: C. KIRBY

REVIEWED BY: R. BEHM

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RCRA FACILITY INVESTIGATION
ABG AND UEP SITES
PHASE I

LOGS OF BORINGS

SUBMITTED BY: ROBERT C. BEHM
ENGINEER:

SOL. NO. | DATED:

CONTR. NO.

DRAWING NUMBER

SHEET NO. 6 OF 31

SEQUENCE NO. 6

DRILLING LOG — DIVISION: SWD — INSTALLATION: FWD — SHEET 1 OF 1 SHEETS

1. PROJECT	LONGHORN AAP
2. LOCATION	GROUND-WATER QUALITY ASSESSMENT
3. DRILLING AGENCY	USCE
4. HOLE NO.	BA-900
5. NAME OF DRILLER	T. SUITS
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED
7. THICKNESS OF OVERBURDEN	
8. DEPTH DRILLED INTO ROCK	
9. TOTAL DEPTH OF HOLE	15.0'
10. SIZE AND TYPE OF BIT	8" AUGER
11. DATUM FOR ELEVATION SHOWN	
12. MANUFACTURER'S DESIGNATION OF DRILL	FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED 11 / UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES	N/A
15. ELEVATION GROUND WATER	SEE REMARKS COLUMN
16. DATE HOLE	STARTED 23MAR.88 / COMPLETED 23MAR.88
17. ELEVATION TOP OF HOLE	176.5'±
18. TOTAL CORE RECOVERY FOR BORING	N/A
19. SIGNATURE OF INSPECTOR	Jackie R. Stokes

CLASSIFICATION OF MATERIALS:

0.0' TO 4.0'±
FILL:
0.0'-2.0'±: SAND: FINE GRAINED; REDDISH BROWN; MEDIUM; VERY MOIST; VERY SILTY
2.0'±-4.0'±: SILT: LOW PLASTICITY; LIGHT REDDISH BROWN & DARK GRAYISH BROWN; MEDIUM; VERY MOIST; VERY SANDY
4.0'± TO 6.0'
SILT: LOW-MEDIUM PLASTICITY; LIGHT GRAY; MEDIUM; MOIST-VERY MOIST; CLAYEY; VERY SANDY
6.0' TO 8.0'
CLAY: MEDIUM-HIGH PLASTICITY; GRAY WITH LIGHT RED; MEDIUM-STIFF; DAMP-MOIST; SLIGHTLY SILTY
8.0' TO 15.0' T.D.
SAND: FINE GRAINED; YELLOWISH BROWN WITH GRAY TO GRAY FROM 12.0'±; MEDIUM; SATURATED; VERY SILTY; CONTAINS A WEAK ODOR
T.D. 15.0'

BOX OR SAMPLE NO.: A, B, C, D, E, F, G

REMARKS:

1. WATER LEVEL: NOTE: ABUNDANT FREE WATER IN BORING DURING DRILLING. LEVEL WAS AT 1.0' ON 24MAR.88 AT 1116 HRS. WITH BORING CLOSED AT 1.5'

2. JAR SAMPLES: (SOIL CLASS. ANALYSES)
A: 0.0' - 2.0'
B: 2.0' - 4.0'
C: 4.0' - 6.0'
D: 6.0' - 8.0'
E: 8.0' - 10.0'
F: 10.0' - 12.0'
G: 12.0' - 15.0'
(CHEMICAL ANALYSES)
C-1 & 1A: 4.0'
C-2 & 2A: 8.0'

3. DRILLING: 8" FLIGHT AUGER: 0.0' - 15.0'

4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT & ONLY A WEAK ODOR WAS DETECTED.

5. LOCATION: NOTE: DRILLED AS SHOWN ON LAYOUT.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) — PROJECT: LONGHORN AAP — HOLE NO. BA-900

DRILLING LOG — DIVISION: SWD — INSTALLATION: FWD — SHEET 1 OF 1 SHEETS — Hole No. BA-701

1. PROJECT	LONGHORN AAP
2. LOCATION	GROUND-WATER QUALITY ASSESSMENT
3. DRILLING AGENCY	USCE
4. HOLE NO.	BA-701
5. NAME OF DRILLER	T. SUITS
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED
7. THICKNESS OF OVERBURDEN	
8. DEPTH DRILLED INTO ROCK	
9. TOTAL DEPTH OF HOLE	15.0'
10. SIZE AND TYPE OF BIT	8" AUGER
11. DATUM FOR ELEVATION SHOWN	
12. MANUFACTURER'S DESIGNATION OF DRILL	FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED 11 / UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES	N/A
15. ELEVATION GROUND WATER	SEE REMARKS COLUMN
16. DATE HOLE	STARTED 23MAR.88 / COMPLETED 23MAR.88
17. ELEVATION TOP OF HOLE	180'±
18. TOTAL CORE RECOVERY FOR BORING	N/A
19. SIGNATURE OF INSPECTOR	Jackie R. Stokes

CLASSIFICATION OF MATERIALS:

0.0' TO 2.0'±
SAND FILL: FINE GRAINED; RED; MEDIUM; MOIST; SILTY
2.0'± TO 4.9'
SILT:
2.0'-4.0': LOW PLASTICITY; GRAYISH BROWN; MEDIUM-STIFF; MOIST; VERY SANDY
4.0'-4.9': LOW-MEDIUM PLASTICITY; GRAYISH BROWN; MEDIUM; WET; SLIGHTLY SANDY
4.9' TO 7.0
CLAY: MEDIUM-HIGH PLASTICITY; GRAY; MEDIUM-STIFF; DAMP-MOIST; SLIGHTLY SILTY
7.0' TO 15.0' T.D.
SAND: FINE GRAINED; YELLOWISH BROWN WITH LIGHT GRAY TO GRAY FROM 11.0'; MEDIUM; SATURATED; VERY SILTY; CONTAINS A WEAK ODOR
T.D. 15.0'

BOX OR SAMPLE NO.: A, B, C, D, E, F, G

REMARKS:

1. WATER LEVEL: NOTE: ABUNDANT FREE WATER IN BORING DURING DRILLING. LEVEL WAS AT 3.6' ON 24MAR.88 AT 1310 HRS. WITH BORING CLOSED IN AT 3.0'

2. JAR SAMPLES: (SOIL CLASS. ANALYSES)
A: 0.0' - 2.0'
B: 2.0' - 4.0'
C: 4.0' - 4.9'
D: 4.9' - 7.0'
E: 7.0' - 9.0'
F: 9.0' - 11.0'
G: 11.0' - 15.0'
(CHEMICAL ANALYSES)
C-1 & C-1A: 4.0'
C-2 & C-2A: 8.0'

3. DRILLING: 8" FLIGHT AUGER: 0.0' - 15.0'

4. NOTE: GAS DETECTORS TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT & ONLY A WEAK ODOR WAS DETECTED.

5. LOCATION: NOTE: DRILLED AS SHOWN ON LAYOUT.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) — PROJECT: LONGHORN AAP. — HOLE NO. BA-901

DRILLING LOG — DIVISION: SWD — INSTALLATION: FWD — SHEET 1 OF 1 SHEETS — Hole No. BA-702

1. PROJECT	LONGHORN AAP.
2. LOCATION	GROUND-WATER QUALITY ASSESSMENT
3. DRILLING AGENCY	USCE
4. HOLE NO.	BA-702
5. NAME OF DRILLER	T. SUITS
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED
7. THICKNESS OF OVERBURDEN	
8. DEPTH DRILLED INTO ROCK	
9. TOTAL DEPTH OF HOLE	25.0'
10. SIZE AND TYPE OF BIT	8" AUGER
11. DATUM FOR ELEVATION SHOWN	
12. MANUFACTURER'S DESIGNATION OF DRILL	FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED 9 / UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES	N/A
15. ELEVATION GROUND WATER	SEE REMARKS COLUMN
16. DATE HOLE	STARTED 26MAR.88 / COMPLETED 26MAR.88
17. ELEVATION TOP OF HOLE	190.5'±
18. TOTAL CORE RECOVERY FOR BORING	N/A
19. SIGNATURE OF INSPECTOR	Jackie R. Stokes

CLASSIFICATION OF MATERIALS:

0.0' TO 0.2'
ASPHALT ROADWAY
0.2' TO 0.8'
SAND/GRAVEL BASE
0.8' TO 6.0'±
CLAY FILL: MEDIUM PLASTICITY; LIGHT GRAY WITH RED & YELLOWISH BROWN; VERY STIFF; DAMP; SILTY; SLIGHTLY SANDY
6.0'± TO 9.0'±
SAND FILL: FINE GRAINED; RED; MEDIUM; DAMP-MOIST; SLIGHTLY CLAYEY
9.0'± TO 12.5'
CLAY FILL: LOW PLASTICITY; RED WITH LIGHT GRAY & YELLOW; STIFF; MOIST; VERY SANDY; WITH SMALL POCKETS OF PLASTIC LIGHT GRAY CLAY
12.5' TO 13.5'
SAND/CLAY FILL: DARK BROWN & BLACK; VERY MOIST-WET; WITH SMALL FERRUGINOUS GRAVEL & TRACE OF FOREIGN MATTER; WITH A WEAK ODOR
13.5' TO 14.3'
STRAW/WOOD SHAVINGS FILL: IN A SANDY CLAY BINDER; BROWN-BLACK; SOFT-MEDIUM; WET; WITH STRONG SHARP ODOR
14.3' TO 18.0'
CLAY: MEDIUM PLASTICITY; GRAY TO GRAYISH BROWN FROM 16.0'; STIFF-VERY STIFF; DAMP; SILTY; SLIGHTLY SANDY FROM 16.0'; WITH WEAK ODOR
18.0' TO 20.0'
SILT: LOW PLASTICITY; LIGHT GRAY & YELLOWISH BROWN; MEDIUM-STIFF; MOIST-VERY MOIST; VERY SANDY; WITH WEAK ODOR
20.0' TO 22.0'
SAND: FINE GRAINED; LIGHT GRAY & YELLOWISH BROWN; MEDIUM; VERY MOIST-WET; VERY SILTY; (BORDERS A SANDY SILT); WITH A WEAK ODOR.
22.0' TO 25.0' T.D.
SILT: LOW PLASTICITY; LIGHT GRAY WITH YELLOWISH BROWN; MEDIUM; WET; SANDY; WITH WEAK ODOR.
T.D. 25.0'

BOX OR SAMPLE NO.: NO SAMPLES; A, B, C, D, E, F, G, H, I

REMARKS:

1. WATER LEVEL: NOTE: FREE WATER ENTERED DURING DRILLING FROM WATER LEVEL WAS AT 12.0' AT 0820 HRS. ON 26MAR.88 WITH BORING CLOSED IN AT 12.5'

2. JAR SAMPLES: (SOIL CLASS. ANALYSES)
A: 10.0' - 12.0'
B: 12.0' - 12.5'
C: 12.5' - 13.5'
D: 13.5' - 14.3'
E: 14.3' - 16.0'
F: 16.0' - 18.0'
G: 18.0' - 20.0'
H: 20.0' - 22.0'
I: 22.0' - 25.0'
(CHEMICAL ANALYSES)
C-1 & 1A: 14.0'
C-2 & 2A: 18.0'

3. DRILLING: 8" FLIGHT AUGER: 0.0' - 25.0'
NOTE: NO SAMPLES TAKEN FROM 0.0'-10.0'

4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. A STRONG SHARP ODOR WAS DETECTED WHEN FREE WATER WAS ENCOUNTERED IN DRILLING.

5. LOCATION: NOTE: DRILLED AS SHOWN ON LAYOUT

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) — PROJECT: LONGHORN AAP. — HOLE NO. BA-902

DRILLING LOG — DIVISION: SWD — INSTALLATION: FWD — SHEET 1 OF 1 SHEETS — Hole No. BA-703

1. PROJECT	LONGHORN AAP.
2. LOCATION	GROUND-WATER QUALITY ASSESSMENT
3. DRILLING AGENCY	USCE
4. HOLE NO.	BA-703
5. NAME OF DRILLER	T. SUITS
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED
7. THICKNESS OF OVERBURDEN	
8. DEPTH DRILLED INTO ROCK	
9. TOTAL DEPTH OF HOLE	15.0'
10. SIZE AND TYPE OF BIT	8" AUGER
11. DATUM FOR ELEVATION SHOWN	
12. MANUFACTURER'S DESIGNATION OF DRILL	FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED 13 / UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES	N/A
15. ELEVATION GROUND WATER	SEE REMARKS COLUMN
16. DATE HOLE	STARTED 22MAR.88 / COMPLETED 22MAR.88
17. ELEVATION TOP OF HOLE	180'±
18. TOTAL CORE RECOVERY FOR BORING	N/A
19. SIGNATURE OF INSPECTOR	Jackie R. Stokes

CLASSIFICATION OF MATERIALS:

0.0' TO 3.1'
SILT:
0.0'-2.6': LOW PLASTICITY; REDDISH BROWN TO GRAY FROM 2.0'; MEDIUM-STIFF; MOIST; VERY SANDY
2.6'-3.1': LOW-MEDIUM PLASTICITY; YELLOWISH BROWN WITH LIGHT GRAY; SOFT-VERY SOFT; WET; SANDY
3.1' TO 7.9'
CLAY:
3.1'-5.0': MEDIUM-HIGH PLASTICITY; RED & LIGHT GRAY; STIFF-VERY STIFF; DAMP
5.0'-7.9': LOW-MEDIUM PLASTICITY; YELLOWISH BROWN WITH LIGHT GRAY; MEDIUM-STIFF; MOIST-VERY MOIST; VERY SILTY; SANDY
7.9' TO 15.0' T.D.
SAND: FINE GRAINED; LIGHT GRAY WITH YELLOWISH BROWN; MEDIUM; SATURATED TO VERY MOIST FROM 9.9'; VERY SILTY TO VERY CLAYEY FROM 9.9'
T.D. 15.0'

BOX OR SAMPLE NO.: A, B, C, D, E, F, G, H, I

REMARKS:

1. WATER LEVEL: NOTE: FREE WATER ENTERED BORING DURING DRILLING FROM 2.6'±; BORING LEFT OPEN; WATER LEVEL WAS AT 2.3' ON 23MAR.88 AT 1120 HRS. WITH BORING CLOSED IN AT 2.0'

2. JAR SAMPLES: (SOIL CLASS. ANALYSES)
A: 0.0' - 2.0'
B: 2.0' - 2.6'
C: 2.6' - 3.1'
D: 3.1' - 5.0'
E: 5.0' - 7.0'
F: 7.0' - 7.9'
G: 7.9' - 9.9'
H: 9.9' - 11.9'
I: 11.9' - 15.0'
(CHEMICAL ANALYSES)
C-1 & C-1A: 4.0'
C-2 & C-2A: 8.0'

3. DRILLING: 8" FLIGHT AUGER: 0.0' - 15.0'

4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT & NO ODOR WAS OBSERVED.

5. LOCATION: NOTE: DRILLED AS SHOWN ON LAYOUT.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) — PROJECT: LONGHORN AAP. — HOLE NO. BA-903

NOTE
FOR BORING LOCATIONS, SEE SHEET 5.

SYMBOL	NO.	ACTION	DATE	DESCRIPTION OF REVISION

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RCRA FACILITY INVESTIGATION
ABG AND UEP SITES
PHASE I
LOGS OF BORINGS

DESIGNED BY: D.FITZGERALD
DRAWN BY: C.KIRBY
REVIEWED BY: R.BEHM
SUBMITTED BY: ROBERT C. BEHM
ENGINEER:
SOL. NO.
DATED:
CONTR. NO.
DRAWING NUMBER
SHEET NO. 7 of 31
SEQUENCE NO. 7

002065

DRILLING LOG – HOLE NO. BA-904

DIVISION	SWD
INSTALLATION	FWD
SHEET	1 of 1 SHEETS
1. PROJECT	LONGHORN AAP
2. LOCATION	GROUND-WATER QUALITY ASSESSMENT
3. DRILLING AGENCY	USCE
4. HOLE NO.	BA-904
5. NAME OF DRILLER	T. SUITS
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	
8. DEPTH DRILLED INTO ROCK	
9. TOTAL DEPTH OF HOLE	15.0'
10. SIZE AND TYPE OF BIT	8" AUGER
11. DATUM FOR ELEVATION SHOWN	
12. MANUFACTURER'S DESIGNATION OF DRILL	FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED 13 / UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES	N/A
15. ELEVATION GROUND WATER	SEE REMARKS COLUMN
16. DATE HOLE	STARTED 18MAR'88 / COMPLETED 18MAR.'88
17. ELEVATION TOP OF HOLE	174'±
18. TOTAL CORE RECOVERY FOR BORING	N/A
19. SIGNATURE OF INSPECTOR	Jackie R. Stokes

Depth: 0.0 – 15.0 – 20 – 40

Classification of materials (Description):

0.0' TO 2"
ASPHALT ROADWAY
2" TO 0.9'
GRAVEL/SAND BASE
0.9' TO 3.0'
CLAY FILL: LOW-MEDIUM PLASTICITY; BROWN; STIFF; MOIST; SILTY; WITH TRACE OF SAND; GRAVELLY WITH FERRUGINOUS GRAVEL & CONCRETIONS
3.0' TO 3.6'
SAND FILL: FINE GRAINED; RED; MEDIUM; MOIST; SILTY; WITH CLAY POCKETS
3.6' TO 6.5'
SILT FILL: LOW PLASTICITY; REDDISH BROWN & LIGHT GRAY; MEDIUM; MOIST; SANDY; SLIGHTLY CLAYEY; WITH SMALL AMOUNT OF FOREIGN MATTER
6.5' TO 15.0' T.D.
SAND: FINE GRAINED; LIGHT GRAY WITH BROWN; MEDIUM; MOIST TO SATURATED FROM 7.4'; SILTY; STRONG SHARP ODOR FROM 7.4'; VERY CLAYEY & VERY MOIST FROM 12.1'-15.0' (BORDERS A VERY SANDY CLAY)
T.D. 15.0'

Box or sample no.: A, B, C, D, E, F, G, H, I

Remarks:

1. WATER LEVEL:
NOTE: AUGERED INTO FREE WATER FROM 7.4'±; BORING LEFT OPEN
NOTE: WATER LEVEL WAS AT 2.0' ON 21 MAR. AT 0810 HRS. WITH BORING CLOSED IN AT 2.5'

2. JAR SAMPLES:
(SOIL CLASS. ANALYSES)
A: 2" - 0.9'
B: 0.9' - 3.0'
C: 3.0' - 3.6'
D: 3.6' - 5.6'
E: 5.6' - 6.5'
F: 6.5' - 7.4'
G: 7.4' - 9.4'
H: 9.4' - 12.1'
I: 12.1' - 15.0'
(CHEMICAL ANALYSES)
C-1 & 1A: 4.0'
C-2 & 2A: 8.0'

3. DRILLING:
8" FLIGHT AUGER: 0.0' - 15.0'

4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. A STRONG SHARP ODOR WAS DETECTED WHEN FREE WATER WAS ENCOUNTERED IN DRILLING.

5. LOCATION:
NOTE: DRILLED AS SHOWN ON LAYOUT.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)
PROJECT: LONGHORN AAP. HOLE NO. BA-904

DRILLING LOG – HOLE NO. BA-905

DIVISION	SWD
INSTALLATION	FWD
SHEET	1 of 1 SHEETS
1. PROJECT	LONGHORN AAP
2. LOCATION	GROUND-WATER QUALITY ASSESSMENT
3. DRILLING AGENCY	USCE
4. HOLE NO.	BA-905
5. NAME OF DRILLER	T. SUITS
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	
8. DEPTH DRILLED INTO ROCK	
9. TOTAL DEPTH OF HOLE	15.0'
10. SIZE AND TYPE OF BIT	8" AUGER
11. DATUM FOR ELEVATION SHOWN	
12. MANUFACTURER'S DESIGNATION OF DRILL	FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED 14 / UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES	N/A
15. ELEVATION GROUND WATER	SEE REMARKS COLUMN
16. DATE HOLE	STARTED 22MAR.'88 / COMPLETED 22MAR.'88
17. ELEVATION TOP OF HOLE	180'±
18. TOTAL CORE RECOVERY FOR BORING	N/A
19. SIGNATURE OF INSPECTOR	Jackie R. Stokes

Depth: 0.0 – 15.0 – 20 – 40

Classification of materials (Description):

0.0' TO 5.0'±
FILL:
0.0'-1.4': SAND: FINE GRAINED; REDDISH BROWN; MEDIUM; MOIST; SILTY
1.4'-3.0': SILT: LOW PLASTICITY; YELLOWISH BROWN & GRAY; STIFF; DAMP; VERY SANDY; WITH CARBON STAINS
3.0'-3.4': SAND: FINE GRAINED; GRAYISH BROWN WITH YELLOWISH BROWN; MEDIUM; VERY MOIST - WET; SILTY
3.4'-3.9': CLAY: LOW PLASTICITY; YELLOWISH BROWN & LIGHT GRAY; STIFF; DAMP; VERY SANDY
3.9'-5.0': WOOD SHAVINGS/SAWDUST: WITH SMALL AMOUNT OF SILT BINDER; DARK GRAY; SOFT-VERY SOFT; SATURATED; WITH A VERY STRONG SHARP ODOR
5.0'± TO 7.0'
SILT: LOW PLASTICITY; GRAYISH BROWN; MEDIUM; MOIST; VERY SANDY (NOTE: BORDERS A SILTY SAND); WITH A STRONG SHARP ODOR
7.0' TO 15.0' T.D.
SAND: WITH STRONG SHARP ODOR
7.0'-9.0': FINE GRAINED; GRAYISH BROWN WITH YELLOWISH BROWN; MEDIUM; WET; VERY SILTY
9.0'-10.3': FINE GRAINED; YELLOWISH BROWN; MEDIUM; VERY MOIST-WET; VERY CLAYEY (NOTE: BORDERS A SANDY CLAY)
10.3'-15.0': FINE GRAINED; YELLOWISH BROWN WITH GRAY; MEDIUM; SATURATED; SILTY; GRAY WITH YELLOWISH BROWN FROM 12.3' & WET
T.D. 15.0'

Box or sample no.: A, B, C, D, E, F, G, H, I, J

Remarks:

1. WATER LEVEL:
NOTE: ABUNDANT FREE WATER ENTERED DURING DRILLING FROM 3.9'; BORING LEFT OPEN; BORING HAD CLOSED IN AT 2.4' WITH NO FREE WATER ABOVE.

2. JAR SAMPLES:
(SOIL CLASS. ANALYSES)
A: 0.0' - 1.4'
B: 1.4' - 3.0'
C: 3.0' - 3.4'
D: 3.4' - 3.9'
E: 3.9' - 5.0'
F: 5.0' - 7.0'
G: 7.0' - 9.0'
H: 9.0' - 10.3'
I: 10.3' - 12.3'
J: 12.3' - 15.0'
(CHEMICAL ANALYSES)
C-1 & 1A: 4.0'
C-2 & 2A: 8.0'

3. DRILLING:
8" FLIGHT AUGER: 0.0' - 15.0'

4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNT OF METHYLENE CHLORIDE WAS PRESENT. A READING OF 30-40 PPM OF TRICHLOROETHYLENE WAS PRESENT AT 10.0'; A STRONG SHARP ODOR WAS OBSERVED WHEN FREE WATER WAS ENCOUNTERED.

5. LOCATION:
NOTE: DRILLED AS SHOWN ON LAYOUT.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)
PROJECT: LONGHORN AAP. HOLE NO. BA-905

DRILLING LOG – HOLE NO. BA-906

DIVISION	SWD
INSTALLATION	FWD
SHEET	1 of 1 SHEETS
1. PROJECT	LONGHORN AAP.
2. LOCATION	GROUND-WATER QUALITY ASSESSMENT
3. DRILLING AGENCY	USCE
4. HOLE NO.	BA-906
5. NAME OF DRILLER	T. SUITS
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	
8. DEPTH DRILLED INTO ROCK	
9. TOTAL DEPTH OF HOLE	15.0'
10. SIZE AND TYPE OF BIT	8" AUGER
11. DATUM FOR ELEVATION SHOWN	
12. MANUFACTURER'S DESIGNATION OF DRILL	FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED 11 / UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES	N/A
15. ELEVATION GROUND WATER	SEE REMARKS COLUMN
16. DATE HOLE	STARTED 21MAR.'88 / COMPLETED 21MAR.'88
17. ELEVATION TOP OF HOLE	174.5'±
18. TOTAL CORE RECOVERY FOR BORING	N/A
19. SIGNATURE OF INSPECTOR	Jackie R. Stokes

Depth: 0.0 – 15.0 – 20 – 40

Classification of materials (Description):

0.0' TO 11.0'
CLAY:
0.0'-4.0': MEDIUM-HIGH PLASTICITY; RED WITH LIGHT GRAY; VERY STIFF-HARD; DAMP; WITH TRACE OF SILT & SAND
4.0'-11.0': MEDIUM PLASTICITY; YELLOWISH BROWN & LIGHT GRAY; SLIGHTLY SILTY & SANDY
4.0'-8.0': VERY STIFF-HARD; DAMP
8.0'-9.4': STIFF; MOIST
9.4'-11.0': VERY STIFF; DAMP; WITH CARBON STAINS
11.0' TO 15.0' T.D.
SILT: LOW PLASTICITY; YELLOWISH BROWN & LIGHT GRAY; MEDIUM-STIFF; MOIST; CLAYEY; VERY SANDY; WITH SMALL CARBON STAINS
T.D. 15.0'

Box or sample no.: A, B, C, D, E, F, G

Remarks:

1. WATER LEVEL:
NOTE: NO FREE WATER IN BORING DURING DRILLING; LEVEL WAS AT 11.0' ON 22MAR. AT 1300 HRS

2. JAR SAMPLES:
(SOIL CLASS. ANALYSES)
A: 0.0' - 2.0'
B: 2.0' - 4.0'
C: 4.0' - 6.0'
D: 6.0' - 8.0'
E: 8.0' - 9.4'
F: 9.4' - 11.0'
G: 11.0' - 15.0'
(CHEMICAL ANALYSES)
C-1 & 1A: 4.0'
C-2 & 2A: 8.0'

3. DRILLING:
8" FLIGHT AUGER: 0.0' - 15.0'

4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT & NO ODOR WAS OBSERVED.

5. LOCATION:
NOTE: DRILLED AS SHOWN ON LAYOUT.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)
PROJECT: LONGHORN AAP. HOLE NO. BA-906

DRILLING LOG – HOLE NO. BA-907

DIVISION	SWD
INSTALLATION	FWD
SHEET	1 of 1 SHEETS
1. PROJECT	LONGHORN AAP
2. LOCATION	GROUND-WATER QUALITY ASSESSMENT
3. DRILLING AGENCY	USCE
4. HOLE NO.	BA-907
5. NAME OF DRILLER	T. SUITS
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	
8. DEPTH DRILLED INTO ROCK	
9. TOTAL DEPTH OF HOLE	15.0'
10. SIZE AND TYPE OF BIT	8" AUGER
11. DATUM FOR ELEVATION SHOWN	
12. MANUFACTURER'S DESIGNATION OF DRILL	FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED 11 / UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES	N/A
15. ELEVATION GROUND WATER	SEE REMARKS COLUMN
16. DATE HOLE	STARTED 18MAR.'88 / COMPLETED 18MAR.'88
17. ELEVATION TOP OF HOLE	174'±
18. TOTAL CORE RECOVERY FOR BORING	N/A
19. SIGNATURE OF INSPECTOR	Jackie R. Stokes

Depth: 0.0 – 15.0 – 20 – 40

Classification of materials (Description):

0.0' TO 0.1'
SILT: LOW-MEDIUM PLASTICITY; BROWN; STIFF; DAMP; CLAYEY; SLIGHTLY SANDY
0.1' TO 3.5'
CLAY: MEDIUM-HIGH PLASTICITY; RED WITH BROWN & LIGHT GRAY; STIFF-VERY STIFF; DAMP; SLIGHTLY SANDY TO 2.0'; VERY STIFF FROM 2.0'
3.5' TO 15.0' T.D.
CLAY: MEDIUM PLASTICITY; YELLOWISH BROWN & LIGHT GRAY; VERY STIFF-HARD TO STIFF FROM 11.5'; DAMP TO MOIST FROM 11.5'; SILTY; SLIGHTLY SANDY; WITH SOME CARBON STAINS
T.D. 15.0'

Box or sample no.: A, B, C, D, E, F, G

Remarks:

1. WATER LEVEL:
NOTE: NO FREE WATER ENCOUNTERED DURING DRILLING; BORING LEFT OPEN.
NOTE: NO FREE WATER IN BORING ON 21 MAR.'88.

2. JAR SAMPLES:
(SOIL CLASS. ANALYSES)
A: 0.1 - 2.0'
B: 2.0' - 3.5'
C: 3.5' - 5.5'
D: 5.5' - 7.5'
E: 7.5' - 9.5'
F: 9.5' - 11.5'
G: 11.5' - 15.0'
(CHEMICAL ANALYSES)
C-1 & 1A: 4.0'
C-2 & 2A: 8.0'

3. DRILLING:
8" FLIGHT AUGER: 0.0' - 15.0'

4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT & NO ODOR WAS OBSERVED.

5. LOCATION:
NOTE: DRILLED AS SHOWN ON LAYOUT.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)
PROJECT: LONGHORN AAP. HOLE NO. BA-907

NOTE
FOR BORING LOCATIONS, SEE SHEET 5.

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

RCRA FACILITY INVESTIGATION
ABG AND UEP SITES
PHASE I
LOGS OF BORINGS

DESIGNED BY:	R. FITZGERALD
DRAWN BY:	C. KIRBY
REVIEWED BY:	R. BEHM
SUBMITTED BY:	ROBERT C. BEHM
ENGINEER:	
SOL. NO.	
DATED:	
CONTR. NO	
DRAWING NUMBER	
SHEET NO.	8 of 31
SEQUENCE NO.	8

002066

DRILLING LOG

Hole No. BA-908

DIVISION: SWD
INSTALLATION: FWD
SHEET 1 OF 1 SHEETS
1. PROJECT: Longhorn AAP.
2. LOCATION: GROUND-WATER QUALITY ASSESSMENT
3. DRILLING AGENCY: USCE
4. HOLE NO.: BA-908
5. NAME OF DRILLER: T. SUITS
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 15.0'
10. SIZE AND TYPE OF BIT: 8" AUGER
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 12, UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: N/A
15. ELEVATION GROUND WATER: SEE REMARKS COLUMN
16. DATE HOLE: STARTED 21 MAR. 88, COMPLETED 21 MAR. 88
17. ELEVATION TOP OF HOLE: 195.5'±
18. TOTAL CORE RECOVERY FOR BORING: N/A
19. SIGNATURE OF INSPECTOR: Jackie R. Stokes

CLASSIFICATION OF MATERIALS:

0.0' TO 0.4'
SILT: LOW PLASTICITY; DARK BROWN; MEDIUM-STIFF; MOIST; SANDY
0.4' TO 15.0' T.D.
CLAY:
0.4'-3.3': MEDIUM-HIGH PLASTICITY; RED & LIGHT GRAY; STIFF-VERY STIFF; DAMP; WITH TRACE OF SILT & SAND; WITH SMALL CARBON STAINS
3.3'-15.0': MEDIUM PLASTICITY; YELLOWISH BROWN & LIGHT GRAY; SILTY; SLIGHTLY SANDY; WITH SMALL CARBON STAINS
3.3'-5.3': STIFF; DAMP-MOIST
5.3'-11.3': VERY STIFF; DAMP
11.3'-15.0': STIFF; MOIST
T.D. 15.0'

BOX OR SAMPLE NO.: B, C, D, E, F, G, H

REMARKS:

1. WATER LEVEL: NOTE: NO FREE WATER IN BORING DURING DRILLING; NO FREE WATER IN BORING ON 22 MAR. AT 1100 HRS.
2. JAR SAMPLES: (SOIL CLASS. ANALYSES)
A: 0.0' - 0.4'
B: 0.4' - 2.4'
C: 2.4' - 3.3'
D: 3.3' - 5.3'
E: 5.3' - 7.3'
F: 7.3' - 9.3'
G: 9.3' - 11.3'
H: 11.3' - 15.0'
(CHEMICAL ANALYSES)
C-1 & 1A: 4.0'
C-2 & 2A: 8.0'
3. DRILLING: 8" FLIGHT AUGER: 0.0' - 15.0'
4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT & NO ODOR WAS OBSERVED.
5. LOCATION: NOTE: DRILLED AS SHOWN ON LAYOUT.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)
PROJECT: Longhorn AAP.
HOLE NO.: BA-908

DRILLING LOG

Hole No. BA-909

DIVISION: SWD
INSTALLATION: FWD
SHEET 1 OF 1 SHEETS
1. PROJECT: LONGHORN AAP.
2. LOCATION: GROUND-WATER QUALITY ASSESSMENT
3. DRILLING AGENCY: USCE
4. HOLE NO.: BA-909
5. NAME OF DRILLER: T. SUITS
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 15.0'
10. SIZE AND TYPE OF BIT: 8" AUGER
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 13, UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: N/A
15. ELEVATION GROUND WATER: SEE REMARKS COLUMN
16. DATE HOLE: STARTED 30 MAR. 88, COMPLETED 30 MAR. 88
17. ELEVATION TOP OF HOLE: 194.5'±
18. TOTAL CORE RECOVERY FOR BORING: N/A
19. SIGNATURE OF INSPECTOR: Jackie R. Stokes

CLASSIFICATION OF MATERIALS:

0.0' TO 1.8'
SILT: MEDIUM PLASTICITY; BROWN; MEDIUM; VERY MOIST-WET; SLIGHTLY SANDY
1.8' TO 10.5'
CLAY:
1.8'-3.0': MEDIUM-HIGH PLASTICITY; YELLOWISH BROWN & LIGHT GRAY; STIFF; MOIST; SILTY
3.0'-4.7': MEDIUM-HIGH PLASTICITY; REDDISH BROWN; HARD; DAMP
4.7'-6.7': LOW PLASTICITY; YELLOWISH BROWN & GRAY; MEDIUM-STIFF; MOIST-VERY MOIST; VERY SILTY; SANDY
6.7'-10.5': MEDIUM PLASTICITY; YELLOWISH BROWN & LIGHT GRAY; SILTY; WITH TRACE OF SAND & BLACK CARBON STAINS
10.5' TO 12.2'
SAND: FINE GRAINED; YELLOWISH BROWN & LIGHT GRAY; MEDIUM; MOIST; VERY SILTY
12.2' TO 13.4'
SILT: LOW PLASTICITY; LIGHT GRAY & YELLOWISH BROWN; STIFF; MOIST; VERY SANDY; CLAYEY
13.4' TO 15.0' T.D.
CLAY: MEDIUM-HIGH PLASTICITY; LIGHT GRAY WITH YELLOWISH BROWN; VERY STIFF; DAMP; WITH TRACE OF SILT & SAND.
T.D. 15.0'

BOX OR SAMPLE NO.: A, B, C, D, E, F, G, H, I

REMARKS:

1. WATER LEVEL: NOTE: SOME FREE WATER WAS SEEPING IN FROM 0.0'-1.8' DURING DRILLING; BORING LEFT OPEN 24 HRS.; LEVEL WAS AT 0.9' WITH BORING CLOSED IN AT 1.2'
2. JAR SAMPLES: (SOIL CLASS. ANALYSES)
A: 0.0' - 1.8'
B: 1.8' - 3.0'
C: 3.0' - 4.7'
D: 4.7' - 6.7'
E: 6.7' - 8.7'
F: 8.7' - 10.5'
G: 10.5' - 12.2'
H: 12.2' - 13.4'
I: 13.4' - 15.0'
(CHEMICAL ANALYSES)
C-1 & 1A: 4.0'
C-2 & 2A: 8.0'
3. DRILLING: 8" FLIGHT AUGERS: 0.0' - 15.0'
4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. NO ODOR WAS DETECTED DURING DRILLING.
5. LOCATION: NOTE: DRILLED AS SHOWN ON LAYOUT.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)
PROJECT: LONGHORN AAP.
HOLE NO.: BA-909

DRILLING LOG

Hole No. BA-910

DIVISION: SWD
INSTALLATION: FWD
SHEET 1 OF 1 SHEETS
1. PROJECT: LONGHORN AAP.
2. LOCATION: GROUND-WATER QUALITY ASSESSMENT
3. DRILLING AGENCY: USCE
4. HOLE NO.: BA-910
5. NAME OF DRILLER: T. SUITS
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 15.0'
10. SIZE AND TYPE OF BIT: 8" AUGER
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 12, UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: N/A
15. ELEVATION GROUND WATER: SEE REMARKS COLUMN
16. DATE HOLE: STARTED 10 MAY 88, COMPLETED 10 MAY 88
17. ELEVATION TOP OF HOLE: 195'±
18. TOTAL CORE RECOVERY FOR BORING: N/A
19. SIGNATURE OF INSPECTOR: Jackie R. Stokes

CLASSIFICATION OF MATERIALS:

0.0' TO 1.8'
SILT: LOW-MEDIUM PLASTICITY; BROWN; STIFF; DAMP; SLIGHTLY SANDY-SANDY
1.8' TO 15.0' T.D.
CLAY:
1.8'-3.8': MEDIUM-HIGH PLASTICITY; YELLOWISH BROWN WITH RED & LIGHT GRAY; VERY STIFF-HARD; DAMP; WITH TRACE OF SILT & FINE SAND
3.8'-5.8': MEDIUM-HIGH PLASTICITY; RED WITH LIGHT GRAY; STIFF-VERY STIFF; DAMP-SLIGHTLY MOIST
5.8'-6.5': MEDIUM-HIGH PLASTICITY; REDDISH BROWN; HARD; DAMP; WITH TRACE OF SILT & FINE SAND
6.5'-15.0': MEDIUM PLASTICITY TO LOW PLASTICITY FROM 8.5'; HARD TO VERY STIFF FROM 12.5'; DRY-DAMP TO MOIST FROM 12.5'; SILTY TO VERY SILTY FROM 8.5'; WITH SMALL CARBON STAINS; VERY SANDY FROM 8.5'
T.D. 15.0'

BOX OR SAMPLE NO.: A, B, C, D, E, F, G, H

REMARKS:

1. WATER LEVEL: NOTE: NO FREE WATER IN BORING DURING DRILLING; BORING WAS DRY AFTER 24 HRS.
2. JAR SAMPLES: (SOIL CLASS. ANALYSES)
A: 0.0' - 1.8'
B: 1.8' - 3.8'
C: 3.8' - 5.8'
D: 5.8' - 6.5'
E: 6.5' - 8.5'
F: 8.5' - 10.5'
G: 10.5' - 12.5'
H: 12.5' - 15.0'
(CHEMICAL ANALYSES)
C-1 & 1A: 4.0'
C-2 & 2A: 8.0'
3. DRILLING: 8" FLIGHT AUGERS: 0.0' - 15.0'
4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. NO ODOR WAS DETECTED DURING DRILLING.
5. NOTE: BORING WAS DRILLED AS SHOWN ON LAYOUT.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.
PROJECT: LONGHORN AAP
HOLE NO.: BA-910

DRILLING LOG

Hole No. BA-911

DIVISION: SWD
INSTALLATION: FWD
SHEET OF SHEETS
1. PROJECT: Longhorn AAP
2. LOCATION: GROUND-WATER QUALITY ASSESSMENT
3. DRILLING AGENCY: USCE
4. HOLE NO.: BA-911
5. NAME OF DRILLER: T. SUITS
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 15.0'
10. SIZE AND TYPE OF BIT: 8" AUGER
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 14, UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: N/A
15. ELEVATION GROUND WATER: SEE REMARKS COLUMN
16. DATE HOLE: STARTED 1 APRIL 88, COMPLETED 1 APRIL 88
17. ELEVATION TOP OF HOLE: 194.5'±
18. TOTAL CORE RECOVERY FOR BORING: N/A
19. SIGNATURE OF INSPECTOR: Jackie R. Stokes

CLASSIFICATION OF MATERIALS:

0.0' TO 1.0'
SILT: MEDIUM PLASTICITY; YELLOWISH BROWN; MEDIUM; WET; CLAYEY; MODERATELY SANDY
1.0' TO 15.0' T.D.
CLAY:
1.0'-2.7': MEDIUM-HIGH PLASTICITY; YELLOWISH BROWN WITH LIGHT GRAY; MEDIUM-STIFF; MOIST; SILTY; WITH TRACE OF SAND
2.7'-5.5': MEDIUM-HIGH PLASTICITY; REDDISH BROWN, RED & LIGHT GRAY DOWN TO REDDISH BROWN & RED FROM 4.7'; VERY STIFF-HARD; DAMP
5.5'-7.5': LOW PLASTICITY; LIGHT GRAY & YELLOWISH BROWN; VERY STIFF; DAMP; VERY SANDY
7.5'-8.0': MEDIUM PLASTICITY; LIGHT GRAY WITH YELLOWISH BROWN; STIFF; MOIST; SILTY; SLIGHTLY SANDY
8.0'-10.1': MEDIUM-HIGH PLASTICITY; LIGHT GRAY & YELLOWISH BROWN; HARD; DAMP
10.1'-12.0': MEDIUM PLASTICITY; YELLOWISH BROWN & LIGHT GRAY; STIFF; MOIST; VERY SILTY; MODERATELY SANDY
12.0'-15.0': MEDIUM-HIGH PLASTICITY; YELLOWISH BROWN WITH LIGHT GRAY DOWN TO LIGHT GRAY WITH YELLOWISH BROWN FROM 13.2'; HARD; DAMP; WITH TRACE OF SILT & SAND.
T.D. 15.0'

BOX OR SAMPLE NO.: A, B, C, D, E, F, G, H, I, J

REMARKS:

1. WATER LEVEL: NOTE: FREE WATER ENTERING FROM UPPER 1.0'± DURING DRILLING; LEVEL WAS AT 0.2' ON 4 APRIL 88 WITH BORING CLOSED IN AT 5.0'
2. JAR SAMPLES: (SOIL CLASS. ANALYSES)
A: 0.0' - 1.0'
B: 1.0' - 2.7'
C: 2.7' - 4.7'
D: 4.7' - 5.5'
E: 5.5' - 7.5'
F: 7.5' - 8.0'
G: 8.0' - 10.1'
H: 10.1' - 12.0'
I: 12.0' - 13.2'
J: 13.2' - 15.0'
(CHEMICAL ANALYSES)
C-1 & C-1A: 4.0'
C-2 & C-2A: 8.0'
3. DRILLING: 8" FLIGHT AUGER: 0.0' - 15.0'
4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. NO ODOR WAS DETECTED DURING DRILLING.
5. LOCATION: NOTE: DRILLED AS SHOWN ON LAYOUT.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.
PROJECT: Longhorn AAR
HOLE NO.: BA-911

NOTE
FOR BORING LOCATIONS, SEE SHEET 5.

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

DESIGNED BY: D. FITZGERALD
DRAWN BY: C. IOKEY
REVIEWED BY: R. BEHM

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RCRA FACILITY INVESTIGATION
ABG AND UEP SITES
PHASE I
LOGS OF BORINGS

SUBMITTED BY: ROBERT C. BEHM
ENGINEER:
SOL. NO.
DATED:
CONTR. NO.
DRAWING NUMBER
SHEET NO. 9 OF 31
SEQUENCE NO. 9

002067

Hole No. BA-912

DRILLING LOG
Division: SWD
Installation: FWD
Sheet 1 of 1 sheets
1. Project: LONGHORN AAP.
2. Location: GROUND-WATER QUALITY ASSESSMENT
3. Drilling agency: USCE
4. Hole No.: BA-912
5. Name of driller: T. SUITS
6. Direction of hole: ☒ Vertical ☐ Inclined ____ deg. from vert.
7. Thickness of overburden:
8. Depth drilled into rock:
9. Total depth of hole: 15.0'
10. Size and type of bit: 8" AUGER
11. Datum for elevation shown (TBM or MSL):
12. Manufacturer's designation of drill: FAILING 1500
13. Total no. of overburden samples taken: Disturbed 13 / Undisturbed 0
14. Total number core boxes: N/A
15. Elevation ground water: SEE REMARKS COLUMN
16. Date hole: Started 31 MAR.'88 / Completed 31 MAR.'88
17. Elevation top of hole: 195'±
18. Total core recovery for boring: N/A %
19. Signature of inspector: Jackie R.

Classification of materials (Description):

0.0' TO 2.0'
SILT:
0.0'-1.0': MEDIUM PLASTICITY; BLACK; SOFT-MEDIUM; SATURATED; WITH ABUNDANT BLACK CARBON MATTER
1.0'-2.0': MEDIUM-HIGH PLASTICITY; YELLOWISH BROWN; SOFT-MEDIUM; SATURATED; CLAYEY; WITH BLACK CARBON MATTER
2.0' TO 15.0' T.D.
CLAY:
2.0'-3.4': MEDIUM-HIGH PLASTICITY; LIGHT GRAY WITH RED & BROWN; MEDIUM; WET; SILTY
3.4'-6.5': MEDIUM-HIGH PLASTICITY; LIGHT GRAY & RED & BROWN DOWN TO REDDISH BROWN WITH LIGHT GRAY FROM 5.4'; HARD; DAMP
6.5'-8.5': LOW-MEDIUM PLASTICITY; YELLOWISH BROWN WITH LIGHT GRAY; STIFF; MOIST; SANDY
8.5'-10.5': MEDIUM-HIGH PLASTICITY; YELLOWISH BROWN & LIGHT GRAY; VERY STIFF; DAMP; WITH TRACE OF FINE SAND
10.5'-12.5': LOW-MEDIUM PLASTICITY; YELLOWISH BROWN WITH LIGHT GRAY; STIFF; MOIST; SANDY
12.5'-15.0': MEDIUM-HIGH PLASTICITY; YELLOWISH BROWN WITH LIGHT GRAY; VERY STIFF; DAMP; SLIGHTLY SILTY; WITH SMALL CARBON STAINS.
T.D. 15.0'

Box or sample no.: A, B, C, D, E, F, G, H, I

Remarks:

1. WATER LEVEL:
NOTE: FREE WATER ENTERING FROM UPPER 3.0'± DURING DRILLING; 24 HR. LEVEL WAS AT 0.3' ON 1 APRIL WITH BORING CLOSED IN AT 0.8'

2. JAR SAMPLES:
(SOIL CLASS. ANALYSES)
A: 0.0' - 1.0'
B: 1.0' - 2.0'
C: 2.0' - 3.4'
D: 3.4' - 5.4'
E: 5.4' - 6.5'
F: 6.5' - 8.5'
G: 8.5' - 10.5'
H: 10.5' - 12.5'
I: 12.5' - 15.0'
(CHEMICAL ANALYSES)
C-1 & 1A: 4.0'
C-2 & 2A: 8.0'

3. DRILLING:
8" FLIGHT AUGER: 0.0' - 15.0'

4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. NO ODOR WAS DETECTED DURING DRILLING.

5. LOCATION:
NOTE: DRILLED AS SHOWN ON LAYOUT.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)
Project: LONGHORN AAP.
Hole No.: BA-912

Hole No. BA-913

DRILLING LOG
Division: SWD
Installation: FWD
Sheet 1 of 1 sheets
1. Project: LONGHORN AAP.
2. Location: GROUND-WATER QUALITY ASSESSMENT
3. Drilling agency: USCE
4. Hole No.: BA-913
5. Name of driller: T. SUITS
6. Direction of hole: ☒ Vertical ☐ Inclined ____ deg. from vert.
7. Thickness of overburden:
8. Depth drilled into rock:
9. Total depth of hole: 15.0'
10. Size and type of bit: 8" AUGER
11. Datum for elevation shown (TBM or MSL):
12. Manufacturer's designation of drill: FAILING 1500
13. Total no. of overburden samples taken: Disturbed 13 / Undisturbed 0
14. Total number core boxes: N/A
15. Elevation ground water: SEE REMARKS COLUMN
16. Date hole: Started 31 MAR.88 / Completed 31 MAR.88
17. Elevation top of hole: 194.5'±
18. Total core recovery for boring: N/A %
19. Signature of inspector: Jackie R.

Classification of materials (Description):

0.0' TO 2.0'
SILT: LOW-MEDIUM PLASTICITY; GRAYISH BROWN; MEDIUM; VERY MOIST-WET; SANDY
2.0' TO 15.0' T.D.
CLAY:
2.0'-3.2': MEDIUM-HIGH PLASTICITY; LIGHT GRAY, RED & REDDISH BROWN; MEDIUM-STIFF; VERY MOIST; SILTY
3.2'-4.7': MEDIUM-HIGH PLASTICITY; GRAY WITH RED; VERY STIFF-HARD; DAMP
4.7'-7.3': LOW-MEDIUM PLASTICITY; YELLOWISH BROWN WITH LIGHT GRAY; STIFF; MOIST; SANDY
7.3'-13.1': MEDIUM-HIGH PLASTICITY; LIGHT GRAY WITH YELLOWISH BROWN; HARD; DAMP; WITH TRACE OF FINE SAND; SILTY FROM 11.3' WITH CARBON STAINS
13.1'-15.0': LOW PLASTICITY; YELLOWISH BROWN WITH LIGHT GRAY; STIFF; DAMP-MOIST; VERY SANDY
T.D. 15.0'

Box or sample no.: A, B, C, D, E, F, G, H, I

Remarks:

1. WATER LEVEL:
NOTE: FREE WATER ENTERING FROM UPPER 2.0'± DURING DRILLING; 24 HR. LEVEL WAS AT 0.6' ON 1 APRIL WITH BORING CLOSED IN AT 0.9'

2. JAR SAMPLES:
(SOIL CLASS. ANALYSES)
A: 0.0' - 2.0'
B: 2.0' - 3.2'
C: 3.2' - 4.7'
D: 4.7' - 6.7'
E: 6.7' - 7.3'
F: 7.3' - 9.3'
G: 9.3' - 11.3'
H: 11.3' - 13.1'
I: 13.1' - 15.0'
(CHEMICAL ANALYSES)
C-1 & 1A: 4.0'
C-2 & 2A: 8.0'

3. DRILLING:
8" FLIGHT AUGER: 0.0' - 15.0'

4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. NO ODOR WAS DETECTED DURING DRILLING.

5. LOCATION:
NOTE: DRILLED AS SHOWN ON LAYOUT.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)
Project: LONGHORN AAP.
Hole No.: BA-913

Hole No. BA-914

DRILLING LOG
Division: SWD
Installation: FWD
Sheet 1 of 1 sheets
1. Project: LONGHORN AAP.
2. Location: GROUND-WATER QUALITY ASSESSMENT
3. Drilling agency: USCE
4. Hole No.: BA-914
5. Name of driller: T. SUITS
6. Direction of hole: ☒ Vertical ☐ Inclined ____ deg. from vert.
7. Thickness of overburden:
8. Depth drilled into rock:
9. Total depth of hole: 15.0'
10. Size and type of bit: 8" AUGER
11. Datum for elevation shown (TBM or MSL):
12. Manufacturer's designation of drill: FAILING 1500
13. Total no. of overburden samples taken: Disturbed 11 / Undisturbed 0
14. Total number core boxes: N/A
15. Elevation ground water: SEE REMARKS COLUMN
16. Date hole: Started 29 MAR'88 / Completed 29 MAR'88
17. Elevation top of hole: 194.5'±
18. Total core recovery for boring: N/A %
19. Signature of inspector: Jackie R.

Classification of materials (Description):

0.0' TO 3.4'
SILT: MEDIUM-HIGH PLASTICITY; BROWN; SOFT-MEDIUM; WET; CLAYEY; LIGHT GRAYISH BROWN FROM 2.0'
3.4' TO 15.0' T.D.
CLAY:
3.4'-5.4': MEDIUM-HIGH PLASTICITY; LIGHT GRAY WITH RED & YELLOWISH BROWN; HARD; DAMP; SLIGHTLY SILTY; WITH SMALL CARBON STAINS
5.4'-9.4': MEDIUM PLASTICITY; LIGHT GRAY WITH YELLOWISH BROWN; HARD; DAMP; SLIGHTLY SILTY; WITH TRACE OF SAND; WITH SMALL CARBON STAINS
9.4'-11.4': LOW-MEDIUM PLASTICITY; LIGHT GRAY WITH YELLOWISH BROWN; STIFF; DAMP-MOIST; SILTY; SANDY; WITH SMALL CARBON STAINS
11.4'-15.0': MEDIUM-HIGH PLASTICITY; LIGHT GRAY WITH YELLOWISH BROWN; STIFF-VERY STIFF; DAMP-MOIST; SILTY
T.D. 15.0'

Box or sample no.: A, B, C, D, E, F, G

Remarks:

1. WATER LEVEL:
NOTE: SOME FREE WATER SEEPING IN DURING DRILLING FROM UPPER 3.0'±; LEVEL WAS AT 0.3' ON 30 MAR.88 AT 1320 HRS WITH BORING CLOSED IN AT 0.8'; NOTE: SOME PRECIPITATION WAS RECEIVED OVERNIGHT.

2. JAR SAMPLES:
(SOIL CLASS. ANALYSES)
A: 0.0' - 2.0'
B: 2.0' - 3.4'
C: 3.4' - 5.4'
D: 5.4' - 7.4'
E: 7.4' - 9.4'
F: 9.4' - 11.4'
G: 11.4' - 15.0'
(CHEMICAL ANALYSES)
C-1 & 1A: 4.0'
C-2 & 2A: 8.0'

3. DRILLING:
8" FLIGHT AUGER: 0.0' - 15.0'

4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. NO ODOR WAS DETECTED DURING DRILLING.

5. LOCATION:
NOTE: DRILLED AS SHOWN ON LAYOUT.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)
Project: LONGHORN AAP.
Hole No.: BA-914

Hole No. BA-915

DRILLING LOG
Division: SWD
Installation: FWD
Sheet 1 of 1 sheets
1. Project: LONGHORN AAP.
2. Location: GROUND-WATER QUALITY ASSESSMENT
3. Drilling agency: USCE
4. Hole No.: BA-915
5. Name of driller: T. SUITS
6. Direction of hole: ☒ Vertical ☐ Inclined ____ deg. from vert.
7. Thickness of overburden:
8. Depth drilled into rock:
9. Total depth of hole: 15.0'
10. Size and type of bit: 8" AUGER
11. Datum for elevation shown (TBM or MSL):
12. Manufacturer's designation of drill: FAILING 1500
13. Total no. of overburden samples taken: Disturbed 12 / Undisturbed 0
14. Total number core boxes: N/A
15. Elevation ground water: SEE REMARKS COLUMN
16. Date hole: Started 10 MAY'88 / Completed 10 MAY'88
17. Elevation top of hole: 195.5'±
18. Total core recovery for boring: N/A %
19. Signature of inspector: Jackie R.

Classification of materials (Description):

0.0' TO 1.5'
SILT: LOW PLASTICITY; BROWN; STIFF; DAMP; VERY SANDY
1.5' TO 15.0' T.D.
CLAY:
1.5'-3.5': MEDIUM-HIGH PLASTICITY; DARK GRAY WITH YELLOWISH BROWN; STIFF-VERY STIFF; DAMP-MOIST; SLIGHTLY SILTY
3.5'-5.5': LOW-MEDIUM PLASTICITY; REDDISH BROWN WITH GRAY; HARD; DAMP; SLIGHTLY SANDY
5.5'-7.0': LOW PLASTICITY; YELLOWISH BROWN; STIFF; MOIST; VERY SANDY
7.0'-8.0': MEDIUM-HIGH PLASTICITY; LIGHT GRAY WITH YELLOWISH BROWN; MEDIUM-STIFF; VERY MOIST; VERY SILTY; WITH TRACE OF SAND
8.0'-9.7': MEDIUM-HIGH PLASTICITY; YELLOWISH BROWN WITH LIGHT GRAY; HARD; DAMP; WITH SMALL CARBON STAINS
9.7'-15.0': MEDIUM PLASTICITY TO LOW PLASTICITY FROM 11.7'; YELLOWISH BROWN WITH LIGHT GRAY; VERY STIFF; DAMP; VERY SILTY; SLIGHTLY SANDY TO VERY SANDY FROM 11.7'
T.D. 15.0'

Box or sample no.: A, B, C, D, E, F, G, H

Remarks:

1. WATER LEVEL:
NOTE: NO FREE WATER IN BORING DURING DRILLING; BORING WAS DRY AFTER 24 HRS.

2. JAR SAMPLES:
(SOIL CLASS. ANALYSES)
A: 0.0' - 1.5'
B: 1.5' - 3.5'
C: 3.5' - 5.5'
D: 5.5' - 7.0'
E: 7.0' - 8.0'
F: 8.0' - 9.7'
G: 9.7' - 11.7'
H: 11.7' - 15.0'
(CHEMICAL ANALYSES)
C-1 & 1A: 4.0'
C-2 & 2A: 8.0'

3. DRILLING:
8" FLIGHT AUGER: 0.0' - 15.0'

4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. NO ODOR WAS DETECTED DURING DRILLING.

5. NOTE: BORING WAS DRILLED AS SHOWN ON LAYOUT.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)
Project: LONGHORN AAP.
Hole No.: BA-915

NOTE
FOR BORING LOCATIONS, SEE SHEET 5.

Symbol	Zone	Description of revision	Date	Approval

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RCRA FACILITY INVESTIGATION
ABG AND UEP SITES
PHASE I
LOGS OF BORINGS

Designed by: D. FITZGERALD
Drawn by: C. KIRBY
Reviewed by: R. BEHM
Submitted by: ROBERT C. BEHM, Engineer
Sol. No.:
Dated:
Contr. No.:
Drawing number:
Sheet No. 10 of 31
Sequence No. 10

002068

Hole No. BA-916

DRILLING LOG | DIVISION SWD | INSTALLATION FWD | SHEET 1 OF 1 SHEETS
1. PROJECT Longhorn AAP
2. LOCATION (Coordinates or Station) Ground-Water Quality Assessment
3. DRILLING AGENCY USCE
4. HOLE NO. (As shown on drawing title and file number) BA-916
5. NAME OF DRILLER T. Suits
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE 21.0'
10. SIZE AND TYPE OF BIT 8" Auger
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 11 UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES N/A
15. ELEVATION GROUND WATER See Remarks Column
16. DATE HOLE: STARTED 12 MAY 88 COMPLETED 12 MAY 88
17. ELEVATION TOP OF HOLE 166'±
18. TOTAL CORE RECOVERY FOR BORING N/A %
19. SIGNATURE OF INSPECTOR Jackie R. Stokes

ELEVATION | DEPTH: 0.0, 20, 21.0, 40 | LEGEND | CLASSIFICATION OF MATERIALS (Description) | % CORE RECOVERY | BOX OR SAMPLE NO.: 8" AUGER, A, B, C, D, E | REMARKS

0.0' To 0.3'
ASPHALT SURFACE
0.3' To 0.9'
GRAVEL BASE
0.9' To 9.0'
CLAY/SAND FILL: VERY STIFF, LOW-MEDIUM PLASTICITY CLAY WITH FINE GRAINED SAND; LIGHT GRAY, YELLOWISH BROWN & RED; DAMP
9.0' To 10.8'
SAND/CLAY FILL: FINE GRAINED SAND WITH MEDIUM CLAY; GRAY; VERY MOIST-WET; WITH ROOTS & TRACE OF STRAW/HAY & MEDIUM-STRONG ODOR
10.8' To 15.7'
CLAY:
10.8'-13.7': MEDIUM PLASTICITY; GRAY; VERY SILTY; MEDIUM; VERY MOIST; WITH CARBON MATTER & ROOTS
13.7'-15.7': LOW-MEDIUM PLASTICITY; LIGHT GRAY & YELLOWISH BROWN; STIFF-VERY STIFF; DAMP; SANDY; VERY SILTY (BORDERS A SILT)
15.7' To 21.0' T.D.
SAND:
15.7'-17.0': FINE GRAINED; LIGHT GRAY & YELLOWISH BROWN; MEDIUM; VERY MOIST; VERY SILTY
17.0'-21.0': FINE GRAINED; YELLOWISH BROWN & LIGHT GRAY; MEDIUM; SATURATED; SLIGHTLY SILTY
T.D. 21.0'

1. WATER LEVEL:
NOTE: FREE WATER ENTERED BORING DURING DRILLING FROM 12.0'± - 13.7'± & 15.7'-21.0'
24 HR. OBSERVATION: FREE WATER LEVEL WAS AT 9.1' WITH BORING CLOSED IN FROM 11.2'

2. JAR SAMPLES:
(SOIL CLASS. ANALYSES)
A: 9.0' - 10.8
B: 10.8' - 13.7'
C: 13.7' - 15.7'
D: 15.7' - 17.0'
E: 17.0' - 21.0'
(CHEMICAL ANALYSES)
C-1 & 1A: 10.0
C-2 & 2A: 14.0'
C-3 & 3A: 20.0'

3. DRILLING:
8" FLIGHT AUGER: 0.0' - 21.0'

4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. A MEDIUM-STRONG ODOR WAS OBSERVED FROM 9.0'

5. NOTE: BORING WAS DRILLED AS SHOWN ON LAYOUT.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. | PROJECT Longhorn AAP. | HOLE NO. BA-916

Hole No. BA-917

DRILLING LOG | DIVISION SWD | INSTALLATION FWD | SHEET 1 OF 1 SHEETS
1. PROJECT Longhorn AAP.
2. LOCATION (Coordinates or Station) Ground-Water Quality Assessment
3. DRILLING AGENCY USCE
4. HOLE NO. (As shown on drawing title and file number) BA-917
5. NAME OF DRILLER T. Suits
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE 13.0'
10. SIZE AND TYPE OF BIT 8" Auger
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 11 UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES N/A
15. ELEVATION GROUND WATER See Remarks Column
16. DATE HOLE: STARTED 13 MAY 88 COMPLETED 13 MAY 88
17. ELEVATION TOP OF HOLE 178.5'±
18. TOTAL CORE RECOVERY FOR BORING N/A %
19. SIGNATURE OF INSPECTOR Jackie R. Stokes

ELEVATION | DEPTH: 0.0, 13.0, 20, 40 | LEGEND | CLASSIFICATION OF MATERIALS (Description) | % CORE RECOVERY | BOX OR SAMPLE NO.: 8" AUGER, A, B, C, D, E | REMARKS

0.0' To 4.0'
SAND FILL:
0.0'-0.6': FINE GRAINED; BROWN; MEDIUM; DAMP; VERY SILTY
0.6'-1.1': FINE GRAINED; RED; MEDIUM; DAMP; SLIGHTLY SILTY
1.1'-4.0': FINE GRAINED, RED, MEDIUM SAND WITH PLASTIC GRAY CLAY SEAMS; VERY MOIST
4.0' To 5.1'
CLAY: MEDIUM-HIGH PLASTICITY; DARK BLUE GRAY WITH YELLOWISH BROWN; VERY STIFF; DAMP; WITH TRACE OF SILTY SAND & A WEAK ODOR
5.1' To 6.5'
SILT: LOW PLASTICITY; YELLOWISH BROWN WITH LIGHT GRAY; MEDIUM STIFF; VERY MOIST; VERY SANDY; WITH A WEAK ODOR
6.5' To 13.0' T.D.
SAND:
6.5'-9.2': FINE GRAINED; REDDISH BROWN; MEDIUM; VERY MOIST-WET; SILTY; WITH A WEAK ODOR
9.2'-13.0': FINE GRAINED; LIGHT GRAY WITH YELLOWISH BROWN; MEDIUM; SATURATED; SILTY; WITH A WEAK ODOR
T.D. 13.0'

1. WATER LEVEL:
NOTE: FREE WATER ENTERED BORING DURING DRILLING FROM 7.0'± - 13.0'
24 HR. OBSERVATION: FREE WATER LEVEL WAS AT 1.4' WITH BORING CLOSED IN AT 1.7'

2. JAR SAMPLES:
(SOIL CLASS. ANALYSES)
A: 2.0' - 4.0'
B: 4.0' - 5.1'
C: 5.1' - 6.5'
D: 6.5' - 9.2'
E: 9.2' - 13.0'
(CHEMICAL ANALYSES)
C-1 & 1A: 2.0'
C-2 & 2A: 6.0'
C-3 & 3A: 12.0'

3. DRILLING:
8" FLIGHT AUGER: 0.0' - 13.0'

4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. A WEAK ODOR WAS OBSERVED FROM 4.0'-13.0'

5. NOTE: BORING WAS OFFSET 10' N35°W DUE TO UNDERGROUND UTILITIES.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. | PROJECT Longhorn AAP. | HOLE NO. BA-917

Hole No. BA-918

DRILLING LOG | DIVISION SWD | INSTALLATION FWD | SHEET 1 OF 1 SHEETS
1. PROJECT Longhorn AAP.
2. LOCATION (Coordinates or Station) Ground-Water Quality Assessment
3. DRILLING AGENCY USCE
4. HOLE NO. (As shown on drawing title and file number) BA-918
5. NAME OF DRILLER T. Suits
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE 27.0'
10. SIZE AND TYPE OF BIT 8" Auger
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 10 UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES N/A
15. ELEVATION GROUND WATER See Remarks Column
16. DATE HOLE: STARTED 17 MAY 88 COMPLETED 17 MAY 88
17. ELEVATION TOP OF HOLE 192'±
18. TOTAL CORE RECOVERY FOR BORING N/A %
19. SIGNATURE OF INSPECTOR Jackie R. Stokes

ELEVATION | DEPTH: 0.0, 20, 27.0, 40 | LEGEND | CLASSIFICATION OF MATERIALS (Description) | % CORE RECOVERY | BOX OR SAMPLE NO.: 8" AUGER, A, B, C, D | REMARKS

0.0' To 0.5'
CONCRETE SURFACE
0.5' To 0.8'
GRAVEL BASE
0.8' To 13.5'±
SAND/CLAY FILL: FINE GRAINED SAND & VERY STIFF LOW-MEDIUM PLASTICITY CLAY; DAMP-MOIST; REDDISH BROWN, YELLOWISH BROWN & LIGHT GRAY
13.5'± To 16.6'
SAND: (MEDIUM-STRONG ODOR)
13.5'-16.0': FINE GRAINED; LIGHT GRAY & YELLOWISH BROWN; MEDIUM; DAMP; SILTY; ROOT ZONE
16.0'-16.6': FINE GRAINED; YELLOWISH BROWN; MOIST; MEDIUM; CLAYEY; WITH CARBON MATTER & FERRUGINOUS NODULES
16.6' To 18.2'
CLAY: MEDIUM-HIGH PLASTICITY; YELLOWISH BROWN & GRAY; VERY STIFF; DAMP; SLIGHTLY SILTY; WITH CARBON STAINS & A STRONG SHARP ODOR
18.2' To 27.0' T.D.
SAND: FINE GRAINED; YELLOWISH BROWN WITH BLUE GRAY; SATURATED; MEDIUM; VERY SILTY; WITH A STRONG SHARP ODOR
T.D. 27.0'

1. WATER LEVEL:
NOTE: FREE WATER ENTERED BORING DURING AUGERING FROM 18.2'±
24 HR. OBSERVATION: BORING HAD CLOSED IN AT 11.2' WITH NO FREE WATER ABOVE.

2. JAR SAMPLES:
(SOIL CLASS. ANALYSES)
A: 16.0' - 16.6
B: 16.6' - 18.2'
C: 18.2' - 23.2'
D: 23.2' - 27.0'
(CHEMICAL ANALYSES)
C-1 & 1A: 16.0'
C-2 & 2A: 18.4'
C-3 & 3A: 26.0'

3. DRILLING:
8" FLIGHT AUGER: 0.0' - 27.0'

4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. A STRONG ODOR WAS DETECTED FROM 13.5'±

5. NOTE: BORING WAS DRILLED AS SHOWN ON LAYOUT.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. | PROJECT Longhorn AAP. | HOLE NO. BA-918

Hole No. BA-919

DRILLING LOG | DIVISION SWD | INSTALLATION FWD | SHEET 1 OF 1 SHEETS
1. PROJECT Longhorn AAP.
2. LOCATION (Coordinates or Station) Ground-Water Quality Assessment
3. DRILLING AGENCY USCE
4. HOLE NO. (As shown on drawing title and file number) BA-919
5. NAME OF DRILLER T. Suits
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE 29.0'
10. SIZE AND TYPE OF BIT 8" Auger
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 11 UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES N/A
15. ELEVATION GROUND WATER See Remarks Column
16. DATE HOLE: STARTED 16 MAY 88 COMPLETED 16 MAY 88
17. ELEVATION TOP OF HOLE 193.5'±
18. TOTAL CORE RECOVERY FOR BORING N/A %
19. SIGNATURE OF INSPECTOR Jackie R. Stokes

ELEVATION | DEPTH: 0.0, 20, 29.0, 40 | LEGEND | CLASSIFICATION OF MATERIALS (Description) | % CORE RECOVERY | BOX OR SAMPLE NO.: 8" AUGER, A, B, C, D, E | REMARKS

0.0' To 15.0'±
SAND/CLAY FILL: FINE GRAINED SAND & VERY STIFF LOW-MEDIUM PLASTICITY CLAY; DAMP-MOIST; WITH CARBON STAINS FROM 10.0'±; VERY SANDY FROM 13.5'±
15.0'± To 19.9'
SAND: FINE GRAINED; LIGHT GRAY & YELLOWISH BROWN; MEDIUM; DAMP-MOIST; SILTY; ROOT ZONE; WITH A STRONG SHARP ODOR
19.9' To 21.0'
CLAY: LOW-MEDIUM PLASTICITY; LIGHT GRAY & YELLOWISH BROWN; STIFF; MOIST; SILTY; SANDY; WITH STRONG SHARP ODOR
21.0' To 29.0' T.D.
SAND: FINE GRAINED; LIGHT GRAY & YELLOWISH BROWN; MEDIUM; SATURATED TO VERY MOIST FROM 27.6'; SILTY TO VERY CLAYEY FROM 27.6'; WITH A STRONG SHARP ODOR
T.D. 29.0'

1. WATER LEVEL:
NOTE: FREE WATER ENTERED BORING DURING AUGERING FROM 21.0'± - 29.0'
24 HR. OBSERVATION: BORING HAD CLOSED IN AT 13.6' WITH NO FREE WATER ABOVE.

2. JAR SAMPLES:
(SOIL CLASS. ANALYSES)
A: 18.0 - 19.9
B: 19.9' - 21.0'
C: 21.0' - 26.0'
D: 26.0' - 27.6'
E: 27.6' - 29.0'
(CHEMICAL ANALYSES)
C-1 & 1A: 18.0'
C-2 & 2A: 22.0'
C-3 & 3A: 28.0'

3. DRILLING:
8" FLIGHT AUGER: 0.0' - 29.0'

4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. A STRONG SHARP ODOR WAS DETECTED FROM 15.0'±

5. NOTE: BORING WAS DRILLED AS SHOWN ON LAYOUT.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. | PROJECT Longhorn AAP. | HOLE NO. BA-919

NOTE
FOR BORING LOCATIONS, SEE SHEET 5.

SYMBOL	DESCRIPTIONS OF REVISIONS	DATE	APPROVAL

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

DESIGNED BY: D. FITZGERALD
DRAWN BY: C. KIRBY
REVIEWED BY: R. BEHM
SUBMITTED BY: ROBERT C. BEHM
ENGINEER:

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

RCRA FACILITY INVESTIGATION
ABG AND UEP SITES
PHASE I
LOGS OF BORINGS

SOL. NO.
DATED:
CONTR. NO.
DRAWING NUMBER
SHEET NO. 11 of 31
SEQUENCE NO. 11

002069

Hole No. BA-920

DRILLING LOG	DIVISION SWD	INSTALLATION FWD	SHEET 1 OF 1 SHEETS
1. PROJECT Longhorn AAP.		10. SIZE AND TYPE OF BIT 8" AUGER	
2. LOCATION Ground-Water Quality Assessment		11. DATUM FOR ELEVATION SHOWN	
3. DRILLING AGENCY USCE		12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500	
4. HOLE NO.	BA-920	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED 12 / UNDISTURBED 0
5. NAME OF DRILLER T. Suits		14. TOTAL NUMBER CORE BOXES N/A	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ___ DEG. FROM VERT.		15. ELEVATION GROUND WATER See Remarks Column	
7. THICKNESS OF OVERBURDEN		16. DATE HOLE	STARTED 16 MAY 88 / COMPLETED 16 MAY 88
8. DEPTH DRILLED INTO ROCK		17. ELEVATION TOP OF HOLE 191.5'±	
9. TOTAL DEPTH OF HOLE 14.0'		18. TOTAL CORE RECOVERY FOR BORING N/A	
		19. SIGNATURE OF INSPECTOR Jackie R. Stokes	

ELEVATION | DEPTH | LEGEND | CLASSIFICATION OF MATERIALS (Description) | % CORE RECOVERY | BOX OR SAMPLE NO. | REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)

Depth: 0.0 — 14.0 — 20 — 40

Box or sample no.: 8" AUGER; A; B; C; D; E; F

Classification of materials:

0.0' To 4.8'
FILL:
0.0'-0.6': SILT: LOW PLASTICITY; YELLOWISH BROWN; STIFF; DAMP; SANDY
0.6'-1.0': GRAVEL: FINE; LOOSE; VERY MOIST
1.0'-1.4': CLAY: MEDIUM PLASTICITY; RED & REDDISH BROWN; STIFF-VERY STIFF; DAMP; SANDY
1.4'-4.8': SAND: FINE GRAINED; REDDISH BROWN; MEDIUM; VERY MOIST; VERY CLAYEY

4.8' To 5.9'
SAND: FINE GRAINED; GRAY WITH YELLOWISH BROWN; MEDIUM; MOIST; CLAYEY; WITH A WEAK ODOR

5.9' To 8.0'
CLAY:
5.9'-6.9': MEDIUM-HIGH PLASTICITY; BLUE GRAY WITH RED; VERY STIFF-HARD; DAMP; WITH A WEAK ODOR
6.9'-8.0': LOW PLASTICITY; YELLOWISH BROWN WITH BLUE GRAY; STIFF-VERY STIFF; DAMP; VERY SILTY; SANDY

8.0' To 14.0' T.D.
SAND:
8.0'-10.0': FINE GRAINED; LIGHT GRAY WITH YELLOWISH BROWN; MEDIUM; VERY MOIST-WET; VERY SILTY; WITH A WEAK ODOR
10.0'-14.0': FINE GRAINED; LIGHT BLUE GRAY; MEDIUM; SATURATED; SLIGHTLY SILTY; WITH A WEAK ODOR.

T.D. 14.0'

Remarks:

1. WATER LEVEL:
NOTE: FREE WATER ENTERED BORING DURING DRILLING FROM 8.0'-14.0'
24-HR. OBSERVATION: FREE WATER LEVEL WAS AT 5.0' WITH BORING CLOSED AROUND 3" PVC PIPE AT 1.0'; PVC PIPE WAS PLACED TO 12.0'

2. JAR SAMPLES:
(SOIL CLASS. ANALYSES)
A: 3.0' - 4.8'
B: 4.8' - 5.9'
C: 5.9' - 6.9'
D: 6.9' - 8.0'
E: 8.0' - 10.0'
F: 10.0' - 14.0'
(CHEMICAL ANALYSES)
C-1 & 1A: 3.0'
C-2 & 2A: 7.0'
C-3 & 3A: 13.0'

3. DRILLING:
8" FLIGHT AUGER: 0.0' - 14.0'

4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. A WEAK ODOR WAS OBSERVED FROM 4.8'-14.0'

5. NOTE: BORING WAS DRILLED AS SHOWN ON LAYOUT.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE | PROJECT Longhorn AAP. | HOLE NO. BA-920

Hole No. BA-921

DRILLING LOG	DIVISION SWD	INSTALLATION FWD	SHEET 1 OF 1 SHEETS
1. PROJECT Longhorn AAP.		10. SIZE AND TYPE OF BIT 8" AUGER	
2. LOCATION Ground-Water Quality Assessment		11. DATUM FOR ELEVATION SHOWN	
3. DRILLING AGENCY USCE		12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500	
4. HOLE NO.	BA-921	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED 12 / UNDISTURBED 0
5. NAME OF DRILLER T. Suits		14. TOTAL NUMBER CORE BOXES N/A	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ___ DEG. FROM VERT.		15. ELEVATION GROUND WATER See Remarks Column	
7. THICKNESS OF OVERBURDEN		16. DATE HOLE	STARTED 12 MAY 88 / COMPLETED 12 MAY 88
8. DEPTH DRILLED INTO ROCK		17. ELEVATION TOP OF HOLE 188'±	
9. TOTAL DEPTH OF HOLE 23.0'		18. TOTAL CORE RECOVERY FOR BORING N/A	
		19. SIGNATURE OF INSPECTOR Jackie R. Stokes	

ELEVATION | DEPTH | LEGEND | CLASSIFICATION OF MATERIALS (Description) | % CORE RECOVERY | BOX OR SAMPLE NO. | REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)

Depth: 0.0 — 20 — 23.0 — 40

Box or sample no.: 8" AUGER; A; B; C; D; E; F

Classification of materials:

0.0' To 5.8'±
CLAY/SAND FILL: VERY STIFF, LOW-MEDIUM PLASTICITY CLAY WITH FINE GRAINED SAND; RED, YELLOWISH BROWN & LIGHT GRAY; DAMP

5.8'± To 7.8'±
SAND: FINE GRAINED; GRAY; MEDIUM; DAMP; VERY SILTY; WITH CARBON STAINS

7.8'± To 10.2'±
SILT: MEDIUM PLASTICITY; REDDISH BROWN & LIGHT GRAY; MEDIUM; VERY MOIST; MODERATELY SANDY

10.2'± To 11.8'
SILT: LOW-MEDIUM PLASTICITY; LIGHT GRAY & YELLOWISH BROWN; VERY STIFF; DRY-DAMP; SANDY

11.8' To 14.0'
CLAY: MEDIUM-HIGH PLASTICITY; DARK GRAY WITH YELLOWISH BROWN; VERY STIFF-HARD; DAMP; WITH OCCASIONAL SANDY SILT LAMINATION

14.0' To 14.9'
SILT: LOW PLASTICITY; LIGHT GRAY WITH YELLOWISH BROWN; STIFF; DAMP-MOIST; VERY SANDY

14.9' To 21.0'
SAND: FINE GRAINED; LIGHT GRAY WITH YELLOWISH BROWN; MEDIUM; SATURATED; MODERATELY SILTY

21.0' To 21.7'
CLAY: MEDIUM PLASTICITY; YELLOWISH BROWN & LIGHT BLUE GRAY; STIFF; MOIST; VERY SILTY; SLIGHTLY SANDY

21.7' To 23.0' T.D.
SILT: LOW PLASTICITY; LIGHT GRAY WITH YELLOWISH BROWN; STIFF; DAMP; SANDY; WITH LIGHT GREEN SILTY CLAY LAMINATIONS

T.D. 23.0'

Remarks:

1. WATER LEVEL:
NOTE: FREE WATER ENTERED BORING DURING DRILLING FROM 15.0'±-21.0'.
24 HR. OBSERVATION: FREE WATER LEVEL WAS AT 11.5' WITH BORING CLOSED IN AT 12.0'

2. JAR SAMPLES:
(SOIL CLASS. ANALYSES)
A: 12.0' - 14.0'
B: 14.0' - 14.9'
C: 14.9' - 19.9'
D: 19.9' - 21.0'
E: 21.0' - 21.7'
F: 21.7' - 23.0'
(CHEMICAL ANALYSES)
C-1 & 1A: 12.0'
C-2 & 2A: 16.0'
C-3 & 3A: 22.0'

3. DRILLING:
8" FLIGHT AUGER: 0.0' - 23.0'

4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. NO ODOR WAS DETECTED DURING DRILLING.

5. NOTE: BORING WAS DRILLED AS SHOWN ON LAYOUT.

6. NOTE: 3" PVC PIPE WAS PLACED IN BORING TO 18.0' FOR 24 HR WATER LEVEL.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE | PROJECT Longhorn AAP. | HOLE NO. BA-921

Hole No. BA-926

DRILLING LOG	DIVISION SWD	INSTALLATION FWD	SHEET 1 OF 1 SHEETS
1. PROJECT Longhorn AAP.		10. SIZE AND TYPE OF BIT 8" AUGER	
2. LOCATION Ground-Water Quality Assessment		11. DATUM FOR ELEVATION SHOWN	
3. DRILLING AGENCY USCE		12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500	
4. HOLE NO.	BA-926	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED 11 / UNDISTURBED 0
5. NAME OF DRILLER T. Suits		14. TOTAL NUMBER CORE BOXES N/A	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ___ DEG. FROM VERT.		15. ELEVATION GROUND WATER See Remarks Column	
7. THICKNESS OF OVERBURDEN		16. DATE HOLE	STARTED 15 AUG 88 / COMPLETED 15 AUG 88
8. DEPTH DRILLED INTO ROCK		17. ELEVATION TOP OF HOLE 193'±	
9. TOTAL DEPTH OF HOLE 10.0'		18. TOTAL CORE RECOVERY FOR BORING N/A	
		19. SIGNATURE OF INSPECTOR Jackie R. Stokes	

ELEVATION | DEPTH | LEGEND | CLASSIFICATION OF MATERIALS (Description) | % CORE RECOVERY | BOX OR SAMPLE NO. | REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)

Depth: 0.0 — 10.0 — 20 — 40

Box or sample no.: A; B; C; D; E; F; G

Classification of materials:

0.0' To 0.8'
CLAY FILL: MEDIUM PLASTICITY; GRAYISH BROWN; VERY STIFF; DAMP; SLIGHTLY SILTY & SANDY

0.8' To 2.1'
SILT: LOW PLASTICITY; LIGHT BROWN & YELLOWISH BROWN; STIFF; DAMP; VERY SANDY

2.1' To 10.0' T.D.
CLAY:
2.1'-3.1': LOW-MEDIUM PLASTICITY; YELLOWISH BROWN & LIGHT GRAY; HARD; DAMP; SILTY; SLIGHTLY SANDY; WITH OCCASIONAL CARBON STAIN
3.1'-4.0': MEDIUM-HIGH PLASTICITY; GRAY WITH RED; HARD; DAMP; WITH TRACE OF SILT & SAND
4.0'-10.0': MEDIUM-HIGH PLASTICITY DOWN TO MEDIUM PLASTICITY FROM 6.0'; GRAY WITH YELLOWISH BROWN; VERY STIFF; DAMP; SLIGHTLY SILTY TO TRACE OF SILT & SAND FROM 6.0'; WITH FERRUGINOUS STAINS, & SCATTERED CARBON STAINS FROM 6.0'

T.D. 10.0'

Remarks:

1. WATER LEVEL:
NOTE: NO FREE WATER IN BORING DURING DRILLING & DRY AFTER 24 HRS.

2. JAR SAMPLES:
(SOIL CLASSIFICATION)
A: 0.0' - 0.8'
B: 0.8' - 2.1'
C: 2.1' - 3.1'
D: 3.1' - 4.0'
E: 4.0' - 6.0'
F: 6.0' - 8.0'
G: 8.0' - 10.0'
(CHEMICAL SAMPLES)
C-1 & 1A: 4.0'
C-2 & 2A: 10.0'

3. DRILLING:
8" FLIGHT AUGER: 0.0' - 10.0'
NOTE: BORING WAS GROUTED AFTER 24 HR. WATER LEVEL OBSERVATION.

4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. NO ODOR WAS DETECTED DURING DRILLING.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE | PROJECT Longhorn AAP. | HOLE NO. BA-926

Hole No. BA-927

DRILLING LOG	DIVISION SWD	INSTALLATION FWD	SHEET 1 OF 1 SHEETS
1. PROJECT Longhorn AAP.		10. SIZE AND TYPE OF BIT 8" AUGER	
2. LOCATION Ground-Water Quality Assessment		11. DATUM FOR ELEVATION SHOWN	
3. DRILLING AGENCY USCE		12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500	
4. HOLE NO.	BA-927	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED 10 / UNDISTURBED 0
5. NAME OF DRILLER T. Suits		14. TOTAL NUMBER CORE BOXES N/A	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ___ DEG. FROM VERT.		15. ELEVATION GROUND WATER See Remarks Column	
7. THICKNESS OF OVERBURDEN		16. DATE HOLE	STARTED 15 AUG 88 / COMPLETED 15 AUG 88
8. DEPTH DRILLED INTO ROCK		17. ELEVATION TOP OF HOLE 195'±	
9. TOTAL DEPTH OF HOLE 10.0'		18. TOTAL CORE RECOVERY FOR BORING N/A	
		19. SIGNATURE OF INSPECTOR Jackie R. Stokes	

ELEVATION | DEPTH | LEGEND | CLASSIFICATION OF MATERIALS (Description) | % CORE RECOVERY | BOX OR SAMPLE NO. | REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)

Depth: 0.0 — 10.0 — 20 — 40

Box or sample no.: A; B; C; D; E; F

Classification of materials:

0.0' To 0.9'
SAND: FINE GRAINED; LIGHT BROWN & GRAYISH BROWN; MEDIUM; DAMP; VERY SILTY

0.9' To 2.0'
CLAY: MEDIUM PLASTICITY; GRAY WITH RED & LIGHT BROWN; HARD; DAMP; SLIGHTLY SANDY

2.0' To 4.0'
SILT: LOW PLASTICITY; LIGHT BROWN; HARD; DRY-DAMP; SANDY

4.0' To 6.0'
CLAY: MEDIUM-HIGH PLASTICITY; GRAY WITH BROWN; HARD; DAMP; WITH TRACE OF SILT & FINE SAND

6.0' To 10.0' T.D.
SILT:
6.0'-8.0': LOW PLASTICITY; LIGHT GRAYISH BROWN; MEDIUM; VERY MOIST; VERY SANDY
8.0'-10.0': LOW-MEDIUM PLASTICITY; LIGHT GRAY & YELLOWISH BROWN; MEDIUM-STIFF; MOIST-VERY MOIST; CLAYEY & SANDY

T.D. 10.0'

Remarks:

1. WATER LEVEL:
NOTE: NO FREE WATER IN BORING DURING DRILLING & DRY AFTER 24 HRS.

2. JAR SAMPLES:
(SOIL CLASSIFICATION)
A: 0.0 - 0.9'
B: 0.9' - 2.0'
C: 2.0' - 4.0'
D: 4.0' - 6.0'
E: 6.0' - 8.0'
F: 8.0' - 10.0'
(CHEMICAL SAMPLES)
C-1 & 1A: 4.0'
C-2 & 2A: 10.0'

3. DRILLING:
8" FLIGHT AUGER: 0.0' - 10.0'
NOTE: BORING WAS GROUTED AFTER 24 HR. WATER LEVEL OBSERVATION.

4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. NO ODOR WAS DETECTED DURING DRILLING.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE | PROJECT Longhorn AAP. | HOLE NO. BA-927

NOTE
FOR BORING LOCATIONS, SEE SHEET 5.

SYMBOL	DESCRIPTION OF REVISION	DATE	APPROVAL

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

DESIGNED BY: D. FITZGERALD
DRAWN BY: C. IRBY
REVIEWED BY: R. BEHM

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RCRA FACILITY INVESTIGATION
ABG AND UEP SITES
PHASE I
LOGS OF BORINGS

SUBMITTED BY: ROBERT C. BEHM
ENGINEER:

SOL. NO. | DATED:
CONTR. NO.
DRAWING NUMBER | SHEET NO. 12 OF 31 | SEQUENCE NO. 12

002070

Hole No. BA-928

DRILLING LOG	DIVISION SWD	INSTALLATION FWD	SHEET 1 OF 1 SHEETS

1. PROJECT: LONGHORN AAP
2. LOCATION (Coordinates or Station): GROUND-WATER QUALITY ASSESSMENT
3. DRILLING AGENCY: USCE
4. HOLE NO. (As shown on drawing title and file number): BA-928
5. NAME OF DRILLER: T. SUITS
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN:
8. DEPTH DRILLED INTO ROCK:
9. TOTAL DEPTH OF HOLE: 10.0'
10. SIZE AND TYPE OF BIT: 8" AUGER
11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 10, UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: N/A
15. ELEVATION GROUND WATER: SEE REMARKS COLUMN
16. DATE HOLE: STARTED 15 AUG '88, COMPLETED 15 AUG '88
17. ELEVATION TOP OF HOLE: 195' ±
18. TOTAL CORE RECOVERY FOR BORING: N/A %
19. SIGNATURE OF INSPECTOR:

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	0.0 10.0 20		0.0' TO 0.8' CLAY FILL: LOW-MEDIUM PLASTICITY; RED & BROWN; STIFF; DAMP-MOIST; SILTY; SLIGHTLY SANDY 0.8' TO 1.4' SAND: FINE GRAINED; LIGHT BROWN; MEDIUM; DAMP; VERY SILTY 1.4' TO 10.0' T.D. CLAY: 1.4'-5.5': MEDIUM PLASTICITY; LIGHT BROWN WITH RED; HARD; DRY-DAMP; SILTY; SLIGHTLY SANDY; WITH SCATTERED CARBON STAINS 5.5'-10.0': MEDIUM-HIGH PLASTICITY; LIGHT GRAY & YELLOWISH BROWN WITH RED; HARD; DAMP; WITH TRACE OF SILT & SAND; WITH ABUNDANT CARBON STAINS T.D. 10.0'		A B C D E F	1. WATER LEVEL: NOTE: NO FREE WATER IN BORING DURING DRILLING & DRY AFTER 24 HRS. 2. JAR SAMPLES: (SOIL CLASSIFICATION) A: 0.0' - 0.8' B: 0.8' - 1.4' C: 1.4' - 3.4' D: 3.4' - 5.5' E: 5.5' - 7.5' F: 7.5' - 10.0' (CHEMICAL SAMPLES) C-1 & 1A: 4.0' C-2 & 2A: 10.0' 3. DRILLING: 8" FLIGHT AUGER: 0.0' - 10.0' NOTE: BORING WAS GROUTED AFTER 24 HR. WATER LEVEL OBSERVATION. 4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. NO ODOR WAS DETECTED DURING DRILLING.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE — PROJECT: LONGHORN AAP — HOLE NO. BA-928

Hole No. BA-929

DRILLING LOG	DIVISION SWD	INSTALLATION FWD	SHEET 1 OF 1 SHEETS

1. PROJECT: LONGHORN AAP.
2. LOCATION (Coordinates or Station): GROUND-WATER QUALITY ASSESSMENT
3. DRILLING AGENCY: USCE
4. HOLE NO. (As shown on drawing title and file number): BA-929
5. NAME OF DRILLER: T. SUITS
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN:
8. DEPTH DRILLED INTO ROCK:
9. TOTAL DEPTH OF HOLE: 10.0'
10. SIZE AND TYPE OF BIT: 8" AUGER
11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 11, UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: N/A
15. ELEVATION GROUND WATER: SEE REMARKS COLUMN
16. DATE HOLE: STARTED 15 AUG '88, COMPLETED 15 AUG '88
17. ELEVATION TOP OF HOLE: 196' ±
18. TOTAL CORE RECOVERY FOR BORING: N/A %
19. SIGNATURE OF INSPECTOR:

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	0.0 10.0 20		0.0' TO 0.5' CLAY FILL: LOW PLASTICITY; REDDISH BROWN-BROWN; STIFF-VERY STIFF; DAMP; SILTY & SANDY 0.5' TO 2.5' SAND: FINE GRAINED; REDDISH BROWN-BROWN; MEDIUM; DAMP; VERY SILTY; (BORDERS A SANDY SILT) 2.5' TO 10.0' T.D. CLAY: 2.5'-4.0': LOW PLASTICITY; YELLOWISH BROWN WITH RED; VERY STIFF; DAMP; VERY SILTY; SANDY 4.0'-5.0': MEDIUM PLASTICITY; RED WITH LIGHT BROWN; VERY STIFF-HARD; DAMP; WITH SAND LAMINATIONS 5.0'-7.0': MEDIUM-HIGH PLASTICITY; RED WITH LIGHT GRAY; VERY STIFF-HARD; DAMP 7.0'-10.0' T.D.: LOW PLASTICITY; YELLOWISH BROWN WITH LIGHT GRAY; MEDIUM; MOIST-VERY MOIST; VERY SANDY & SILTY T.D. 10.0'		A B C D E F G	1. WATER LEVEL: NOTE: NO FREE WATER IN BORING DURING DRILLING & DRY AFTER 24 HRS. 2. JAR SAMPLES: (SOIL CLASSIFICATION) A: 0.0' - 0.5' B: 0.5' - 2.5' C: 2.5' - 4.0' D: 4.0' - 5.0' E: 5.0' - 7.0' F: 7.0' - 9.0' G: 9.0' - 10.0' (CHEMICAL SAMPLES) C-1 & 1A: 4.0' C-2 & 2A: 10.0' 3. DRILLING: 8" FLIGHT AUGER: 0.0' - 10.0' NOTE: BORING WAS GROUTED AFTER 24 HR. WATER LEVEL OBSERVATION. 4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. NO ODOR WAS DETECTED DURING DRILLING.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE — PROJECT: LONGHORN AAP. — HOLE NO. BA-929

Hole No. BA-930

DRILLING LOG	DIVISION SWD	INSTALLATION FWD	SHEET 1 OF 1 SHEETS

1. PROJECT: LONGHORN AAP.
2. LOCATION (Coordinates or Station): GROUND-WATER QUALITY ASSESSMENT
3. DRILLING AGENCY: USCE
4. HOLE NO. (As shown on drawing title and file number): BA-930
5. NAME OF DRILLER: T. SUITE
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN:
8. DEPTH DRILLED INTO ROCK:
9. TOTAL DEPTH OF HOLE: 10.0'
10. SIZE AND TYPE OF BIT: 8" AUGER
11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 10, UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: N/A
15. ELEVATION GROUND WATER: SEE REMARKS COLUMN
16. DATE HOLE: STARTED 15 AUG '88, COMPLETED 15 AUG '88
17. ELEVATION TOP OF HOLE: 198' ±
18. TOTAL CORE RECOVERY FOR BORING: N/A %
19. SIGNATURE OF INSPECTOR:

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	0.0 10.0 20		0.0' TO 1.2' SAND: FINE GRAINED; BROWN; MEDIUM; DAMP; VERY SILTY 1.2' TO 8.8' CLAY: 1.2'-3.2': LOW PLASTICITY; REDDISH BROWN; VERY STIFF; DAMP; VERY SILTY; SANDY 3.2'-4.8': MEDIUM PLASTICITY; RED WITH LIGHT GRAY; HARD; DAMP; WITH SAND LAMINATIONS 4.8'-6.8': MEDIUM-HIGH PLASTICITY; RED; HARD; DAMP 6.8'-8.8': LOW-MEDIUM PLASTICITY; YELLOWISH BROWN WITH LIGHT GRAY; STIFF; DAMP-MOIST; VERY SILTY; SANDY 8.8' TO 10.0' T.D. SILT: LOW PLASTICITY; YELLOWISH BROWN; MEDIUM; VERY MOIST; VERY SANDY (BORDERS A SILTY SAND) T.D. 10.0'		A B C D E F	1. WATER LEVEL: NOTE: NO FREE WATER IN BORING DURING DRILLING & DRY AFTER 24 HRS. 2. JAR SAMPLES: (SOIL CLASSIFICATION) A: 0.0' - 1.2' B: 1.2' - 3.2' C: 3.2' - 4.8' D: 4.8' - 6.8' E: 6.8' - 8.8' F: 8.8' - 10.0' (CHEMICAL SAMPLES) C-1 & 1A: 4.0' C-2 & 2A: 10.0' 3. DRILLING: 8" FLIGHT AUGER: 0.0' - 10.0' NOTE: BORING WAS GROUTED AFTER 24 HR. WATER LEVEL OBSERVATION 4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. NO ODOR WAS DETECTED DURING DRILLING.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE — PROJECT: LONGHORN AAP. — HOLE NO. BA-930

Hole No. BA-931

DRILLING LOG	DIVISION SWD	INSTALLATION FWD	SHEET 1 OF 1 SHEETS

1. PROJECT: LONGHORN AAP.
2. LOCATION (Coordinates or Station): GROUND-WATER QUALITY ASSESSMENT
3. DRILLING AGENCY: USCE
4. HOLE NO. (As shown on drawing title and file number): BA-931
5. NAME OF DRILLER: T. SUITE
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN:
8. DEPTH DRILLED INTO ROCK:
9. TOTAL DEPTH OF HOLE: 10.0'
10. SIZE AND TYPE OF BIT: 8" AUGER
11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 11, UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: N/A
15. ELEVATION GROUND WATER: SEE REMARKS COLUMN
16. DATE HOLE: STARTED 15 AUG '88, COMPLETED 15 AUG '88
17. ELEVATION TOP OF HOLE: 198' ±
18. TOTAL CORE RECOVERY FOR BORING: N/A %
19. SIGNATURE OF INSPECTOR:

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	0.0 10.0 20		0.0' TO 0.9' CLAY FILL: LOW-MEDIUM PLASTICITY; BROWN WITH RED; VERY STIFF; DAMP; SLIGHTLY SILTY & SANDY 0.9' TO 2.2' SILT: LOW PLASTICITY; YELLOWISH BROWN; STIFF; DRY; VERY SANDY (BORDERS A SILTY SAND) 2.2' TO 10.0' T.D. CLAY: 2.2'-3.9': MEDIUM PLASTICITY; YELLOWISH BROWN WITH RED; HARD; DAMP; WITH TRACE OF SAND 3.9'-8.8': MEDIUM-HIGH PLASTICITY; LIGHT GRAY WITH RED TO YELLOWISH BROWN & RED AT 5.9'; HARD; DAMP; WITH TRACE OF FINE SAND FROM 5.9' 8.8'-10.0': LOW-MEDIUM PLASTICITY; YELLOWISH BROWN & LIGHT GRAY; MEDIUM-STIFF; VERY MOIST; VERY SILTY; SANDY T.D. 10.0'		A B C D E F G	1. WATER LEVEL: NOTE: NO FREE WATER IN BORING DURING DRILLING & DRY AFTER 24 HRS. 2. JAR SAMPLES: (SOIL CLASSIFICATION) A: 0.0' - 0.9' B: 0.9' - 2.2' C: 2.2' - 3.9' D: 3.9' - 5.9' E: 5.9' - 7.9' F: 7.9' - 8.8' G: 8.8' - 10.0' (CHEMICAL SAMPLES) C-1 & 1A: 4.0' C-2 & 2A: 10.0' 3. DRILLING: 8" FLIGHT AUGER: 0.0' - 10.0' NOTE: BORING WAS GROUTED AFTER 24 HR. WATER LEVEL OBSERVATION. 4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. NO ODOR WAS DETECTED DURING DRILLING.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE — PROJECT: LONGHORN AAP. — HOLE NO. BA-931

NOTE
FOR BORING LOCATIONS, SEE SHEET 5.

SYMBOL	APPR. NO.	ACTION	DATE	DESCRIPTION OF REVISIONS

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

DESIGNED BY: D. FITZGERALD
DRAWN BY: C. KIRBY
REVIEWED BY: R. BEHM

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RCRA FACILITY INVESTIGATION
ABG AND UEP SITES
PHASE I
LOGS OF BORINGS

SUBMITTED BY: ROBERT C. BEHM
ENGINEER:
SOL. NO.
DATED:
CONTR. NO.
DRAWING NUMBER
SHEET NO. 13 of 31
SEQUENCE NO. 13

002071

Hole No. BA-932

DRILLING LOG	DIVISION SWD	INSTALLATION FWD	SHEET 1 OF 1 SHEETS

1. PROJECT: LONGHORN AAP.
2. LOCATION (Coordinates or Station): GROUND-WATER QUALITY ASSESSMENT
3. DRILLING AGENCY: USCE
4. HOLE NO. (As shown on drawing title and file number): BA-932
5. NAME OF DRILLER: T. SUITS
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN:
8. DEPTH DRILLED INTO ROCK:
9. TOTAL DEPTH OF HOLE: 10.0'
10. SIZE AND TYPE OF BIT: 8" AUGER
11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 10 UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: N/A
15. ELEVATION GROUND WATER: SEE REMARKS COLUMN
16. DATE HOLE: STARTED 16 AUG '88 COMPLETED 16 AUG '88
17. ELEVATION TOP OF HOLE: 197' ±
18. TOTAL CORE RECOVERY FOR BORING: N/A %
19. SIGNATURE OF INSPECTOR: Jackie R.

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	0.0 10.0 20		0.0' TO 0.2' SILT FILL: LOW PLASTICITY; LIGHT BROWN; MEDIUM; MOIST; VERY SANDY 0.2' TO 1.0' CLAY FILL: MEDIUM PLASTICITY; RED WITH BROWN; HARD; DAMP; SLIGHTLY SANDY 1.0' TO 3.0' SILT: LOW PLASTICITY; GRAYISH BROWN; STIFF; DAMP; VERY SANDY; (BORDERS A SILTY SAND) 3.0' TO 10.0' T.D. CLAY: 3.0'-4.9': LOW-MEDIUM PLASTICITY; YELLOWISH BROWN WITH RED; STIFF-VERY STIFF; DAMP; VERY SILTY; WITH TRACE OF SAND 4.9'-7.0': MEDIUM-HIGH PLASTICITY; LIGHT GRAY WITH RED & YELLOWISH BROWN; HARD; DAMP; WITH TRACE OF FINE SAND 7.0'-10.0': MEDIUM PLASTICITY; YELLOWISH BROWN & LIGHT GRAY; HARD; DAMP; MODERATELY SILTY & SANDY T.D. 10.0'		A B C D E F	1. WATER LEVEL: NOTE: NO FREE WATER IN BORING DURING DRILLING & DRY AFTER 24 HRS. 2. JAR SAMPLES: (SOIL CLASSIFICATION) A: 0.2' - 1.0' B: 1.0' - 3.0' C: 3.0' - 4.9' D: 4.9' - 7.0' E: 7.0' - 9.0' F: 9.0' - 10.0' (CHEMICAL SAMPLES) C-1 & 1A: 4.0' C-2 & 2A: 10.0' 3. DRILLING: 8" FLIGHT AUGER: 0.0' - 10.0' NOTE: BORING WAS GROUTED AFTER 24 HR. WATER LEVEL OBSERVATION. 4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. NO ODOR WAS DETECTED DURING DRILLING.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT LONGHORN AAP. HOLE NO. BA-932

Hole No. BA-933

DRILLING LOG	DIVISION SWD	INSTALLATION FWD	SHEET 1 OF 1 SHEETS

1. PROJECT: LONGHORN AAP.
2. LOCATION (Coordinates or Station): GROUND-WATER QUALITY ASSESSMENT
3. DRILLING AGENCY: USCE
4. HOLE NO. (As shown on drawing title and file number): BA-933
5. NAME OF DRILLER: T. SUITS
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN:
8. DEPTH DRILLED INTO ROCK:
9. TOTAL DEPTH OF HOLE: 10.0'
10. SIZE AND TYPE OF BIT: 8" AUGER
11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 11 UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: N/A
15. ELEVATION GROUND WATER: SEE REMARKS COLUMN
16. DATE HOLE: STARTED 16 AUG '88 COMPLETED 16 AUG '88
17. ELEVATION TOP OF HOLE: 196' ±
18. TOTAL CORE RECOVERY FOR BORING: N/A %
19. SIGNATURE OF INSPECTOR: Jackie R.

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	0.0 10.0 20		0.0' TO 0.2' SILT FILL: LOW PLASTICITY; LIGHT BROWN; MEDIUM; MOIST; VERY SANDY 0.2' TO 1.5' CLAY FILL: MEDIUM PLASTICITY; GRAYISH BROWN; VERY STIFF; DAMP; SILTY; SLIGHTLY SANDY 1.5' TO 2.5' SILT: LOW PLASTICITY; GRAYISH BROWN; STIFF; DAMP; VERY SANDY; WITH CARBON STAINS 2.5' TO 10.0' T.D. CLAY: 2.5'-4.5': LOW-MEDIUM PLASTICITY; YELLOWISH BROWN WITH RED; STIFF-VERY STIFF; DAMP; MODERATELY SILTY & SANDY; WITH SCATTERED CARBON STAINS 4.5'-7.7': MEDIUM-HIGH PLASTICITY; LIGHT GRAY WITH RED & YELLOWISH BROWN; HARD; DAMP; WITH TRACE OF FINE SAND 7.7'-10.0': MEDIUM PLASTICITY; YELLOWISH BROWN & LIGHT GRAY; HARD; DAMP; SLIGHTLY SILTY & SANDY T.D. 10.0'		A B C D E F G	1. WATER LEVEL: NOTE: NO FREE WATER IN BORING DURING DRILLING & DRY AFTER 24 HRS. 2. JAR SAMPLES: (SOIL CLASSIFICATION) A: 0.2' - 1.5' B: 1.5' - 2.5' C: 2.5' - 4.5' D: 4.5' - 6.5' E: 6.5' - 7.7' F: 7.7' - 9.7' G: 9.7' - 10.0' (CHEMICAL SAMPLES) C-1 & 1A: 4.0' C-2 & 2A: 10.0' 3. DRILLING: 8" FLIGHT AUGER: 0.0' - 10.0' NOTE: BORING WAS GROUTED AFTER 24 HR. WATER LEVEL OBSERVATION. 4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. NO ODOR WAS DETECTED DURING DRILLING.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT LONGHORN AAP. HOLE NO. BA-933

Hole No. BA-934

DRILLING LOG	DIVISION SWD	INSTALLATION FWD	SHEET 1 OF 1 SHEETS

1. PROJECT: LONGHORN AAP.
2. LOCATION (Coordinates or Station): GROUND-WATER QUALITY ASSESSMENT
3. DRILLING AGENCY: USCE
4. HOLE NO. (As shown on drawing title and file number): BA-934
5. NAME OF DRILLER: T. SUITS
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN:
8. DEPTH DRILLED INTO ROCK:
9. TOTAL DEPTH OF HOLE: 10.0'
10. SIZE AND TYPE OF BIT: 8" AUGER
11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 10 UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: N/A
15. ELEVATION GROUND WATER: SEE REMARKS COLUMN
16. DATE HOLE: STARTED 16 AUG '88 COMPLETED 16 AUG '88
17. ELEVATION TOP OF HOLE: 195' ±
18. TOTAL CORE RECOVERY FOR BORING: N/A %
19. SIGNATURE OF INSPECTOR: Jackie R.

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	0.0 10.0 20		0.0' TO 0.2' SILT FILL: LOW PLASTICITY; LIGHT BROWN; MEDIUM; MOIST; VERY SANDY 0.2' TO 1.0' CLAY FILL: MEDIUM PLASTICITY; LIGHT GRAY WITH YELLOWISH BROWN; VERY STIFF-HARD; DAMP; MODERATELY SILTY & SANDY 1.0' TO 3.0' SILT: LOW PLASTICITY; LIGHT GRAY & YELLOWISH BROWN; STIFF; DAMP; SANDY; CLAYEY 3.0' TO 10.0' T.D. CLAY: 3.0'-9.0': MEDIUM-HIGH PLASTICITY; GRAY WITH RED; HARD; DAMP; WITH TRACE OF FINE SAND; WITH CARBON STAINS 9.0'-10.0': LOW PLASTICITY; LIGHT GRAY WITH YELLOWISH BROWN; MEDIUM-STIFF; VERY MOIST; VERY SILTY; SLIGHTLY SANDY T.D. 10.0'		A B C D E F	1. WATER LEVEL: NOTE: NO FREE WATER IN BORING DURING DRILLING & DRY AFTER 24 HRS. 2. JAR SAMPLES: (SOIL CLASSIFICATION) A: 0.2' - 1.0' B: 1.0' - 3.0' C: 3.0' - 5.0' D: 5.0' - 7.0' E: 7.0' - 9.0' F: 9.0' - 10.0' (CHEMICAL SAMPLES) C-1 & 1A: 4.0' C-2 & 2A: 10.0' 3. DRILLING: 8" FLIGHT AUGERS: 0.0' - 10.0' NOTE: BORING WAS GROUTED AFTER 24 HR. WATER LEVEL OBSERVATION. 4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. NO ODOR WAS DETECTED DURING DRILLING.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT LONGHORN AAP. HOLE NO. BA-934

Hole No. BA-935

DRILLING LOG	DIVISION SWD	INSTALLATION FWD	SHEET 1 OF 1 SHEETS

1. PROJECT: LONGHORN AAP.
2. LOCATION (Coordinates or Station): GROUND-WATER QUALITY ASSESSMENT
3. DRILLING AGENCY: USCE
4. HOLE NO. (As shown on drawing title and file number): BA-935
5. NAME OF DRILLER: T. SUITS
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN:
8. DEPTH DRILLED INTO ROCK:
9. TOTAL DEPTH OF HOLE: 10.0'
10. SIZE AND TYPE OF BIT: 8" AUGER
11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 9 UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: N/A
15. ELEVATION GROUND WATER: SEE REMARKS COLUMN
16. DATE HOLE: STARTED 16 AUG '88 COMPLETED 16 AUG '88
17. ELEVATION TOP OF HOLE: 195' ±
18. TOTAL CORE RECOVERY FOR BORING: N/A %
19. SIGNATURE OF INSPECTOR: Jackie R.

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	0.0 10.0 20		0.0' TO 10.0' T.D. CLAY: 0.0'-2.0': LOW PLASTICITY; REDDISH BROWN; VERY STIFF; DAMP; SILTY; SANDY 2.0'-4.0': LOW-MEDIUM PLASTICITY; YELLOWISH BROWN WITH LIGHT GRAY; HARD; DRY; SANDY 4.0'-10.0': MEDIUM PLASTICITY; LIGHT GRAY WITH RED DOWN TO YELLOWISH BROWN WITH LIGHT GRAY FROM 6.0'; HARD; DAMP; WITH TRACE OF SAND. T.D. 10.0'		A B C D E	1. WATER LEVEL: NOTE: NO FREE WATER IN BORING DURING DRILLING & DRY AFTER 24 HRS. 2. JAR SAMPLES: (SOIL CLASSIFICATION) A: 0.0' - 2.0' B: 2.0' - 4.0' C: 4.0' - 6.0' D: 6.0' - 8.0' E: 8.0' - 10.0' (CHEMICAL SAMPLES) C-1 & 1A: 4.0' C-2 & 2A: 10.0' 3. DRILLING: 8" FLIGHT AUGER: 0.0' - 10.0' NOTE: BORING WAS GROUTED AFTER 24 HR. WATER LEVEL OBSERVATION. 4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. NO ODOR WAS DETECTED DURING DRILLING.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT LONGHORN AAP. HOLE NO. BA-935

NOTE
FOR BORING LOCATIONS, SEE SHEET 5.

SYMBOL	DESCRIPTION OF REVISION	DATE	APPROVAL

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

DESIGNED BY: D. FITZGERALD
DRAWN BY: C. KIRBY
REVIEWED BY: R. BEHM

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RCRA FACILITY INVESTIGATION
ABG AND UEP SITES
PHASE I
LOGS OF BORINGS

SUBMITTED BY: ROBERT C. BEHM
ENGINEER:
SOL. NO.
DATED:
CONTR. NO.
DRAWING NUMBER
SHEET NO. 14 of 31
SEQUENCE NO. 14

002072

Hole No. 8A-936

DRILLING LOG	DIVISION SWD
INSTALLATION FWD	SHEET 1 OF 1 SHEETS
1. PROJECT Longhorn AAP	10. SIZE AND TYPE OF BIT 8" AUGER
2. LOCATION (Coordinates or Station) GROUND-WATER QUALITY ASSESSMENT	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY USCE	12. MANUFACTURER'S DESIGNATION OF DRILL FAILING 1500
4. HOLE NO. (As shown on drawing title and file number) 8A-936	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 9, UNDISTURBED 0
5. NAME OF DRILLER T. SUITS	14. TOTAL NUMBER CORE BOXES N/A
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER SEE REMARKS COLUMN
7. THICKNESS OF OVERBURDEN	16. DATE HOLE: STARTED 16 AUG '88, COMPLETED 16 AUG '88
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE 196'±
9. TOTAL DEPTH OF HOLE 10.0'	18. TOTAL CORE RECOVERY FOR BORING N/A %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	0.0 10.0 20 40		0.0' To 10.0' T.D. CLAY: 0.0' - 2.0': LOW PLASTICITY; REDDISH BROWN; VERY STIFF; DAMP; SANDY; SILTY 2.0' - 4.0': LOW-MEDIUM PLASTICITY; LIGHT GRAY & RED; HARD; DRY; SANDY 4.0' - 10.0': MEDIUM PLASTICITY; YELLOWISH BROWN WITH LIGHT GRAY; HARD; DAMP; WITH TRACE OF SAND; WITH CARBON STAINS T.D. 10.0'		A B C D E	1. WATER LEVEL: NOTE: NO FREE WATER IN BORING DURING DRILLING & DRY AFTER 24 HRS. 2. JAR SAMPLES: (SOIL CLASSIFICATION) A: 0.0' - 2.0' B: 2.0' - 4.0' C: 4.0' - 6.0' D: 6.0' - 8.0' E: 8.0' - 10.0' (CHEMICAL SAMPLES) C-1 & 1A: 4.0' C-2 & 2A: 10.0' 3. DRILLING: 8" FLIGHT AUGER: 0.0' - 10.0' NOTE: BORING WAS GROUTED AFTER 24 HR. WATER LEVEL OBSERVATION. 4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. NO ODOR WAS DETECTED DURING DRILLING.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE
PROJECT Longhorn AAP.
HOLE NO. 8A-936

Hole No. 8A-937

DRILLING LOG	DIVISION SWD
INSTALLATION SWD	SHEET 1 OF 1 SHEETS
1. PROJECT Longhorn AAP.	10. SIZE AND TYPE OF BIT 8" AUGER
2. LOCATION (Coordinates or Station) GROUND-WATER QUALITY ASSESSMENT	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY USCE	12. MANUFACTURER'S DESIGNATION OF DRILL FAILING 1500
4. HOLE NO. (As shown on drawing title and file number) BA-937	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 11, UNDISTURBED 0
5. NAME OF DRILLER T. SUITS	14. TOTAL NUMBER CORE BOXES N/A
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER SEE REMARKS COLUMN
7. THICKNESS OF OVERBURDEN	16. DATE HOLE: STARTED 16 AUG '88, COMPLETED 16 AUG '88
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE 194'±
9. TOTAL DEPTH OF HOLE 10.0'	18. TOTAL CORE RECOVERY FOR BORING N/A %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	0.0 10.0 20		0.0' To 0.9' SILT: LOW PLASTICITY; BROWN; STIFF; DAMP; SANDY; CLAYEY 0.9' To 10.0' T.D. CLAY: 0.9' - 3.6': LOW PLASTICITY; YELLOWISH BROWN TO LIGHT BROWN FROM 2.9'; VERY STIFF-HARD; DAMP TO DRY FROM 2.9'; SILTY; SANDY 3.6' - 5.6': MEDIUM-HIGH PLASTICITY; RED & LIGHT GRAY; HARD; DAMP; WITH FINE SAND LAMINATIONS & CARBON STAINS 5.6' - 7.0': LOW-MEDIUM PLASTICITY; LIGHT GRAY & YELLOWISH BROWN; VERY STIFF-HARD; DAMP; SANDY 7.0' - 10.0': MEDIUM-HIGH PLASTICITY; LIGHT GRAY & YELLOWISH BROWN; HARD; DAMP; SLIGHTLY SILTY; (MEDIUM PLASTICITY; SILTY; WITH TRACE OF SAND FROM 9.0') T.D. 10.0'		A B C D E F G	1. WATER LEVEL: NOTE: NO FREE WATER IN BORING DURING DRILLING & DRY AFTER 24 HRS. 2. JAR SAMPLES: (SOIL CLASSIFICATION) A: 0.0' - 0.9' B: 0.9' - 2.9' C: 2.9' - 3.6' D: 3.6' - 5.6' E: 5.6' - 7.0' F: 7.0' - 9.0' G: 9.0' - 10.0' (CHEMICAL SAMPLES) C-1 & 1A: 4.0' C-2 & 2A: 10.0' 3. DRILLING: 8" FLIGHT AUGER: 0.0' - 10.0' NOTE: BORING WAS GROUTED AFTER 24 HR. WATER LEVEL OBSERVATION. 4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. NO ODOR WAS DETECTED DURING DRILLING.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE
PROJECT Longhorn AAP.
HOLE NO. 8A-937

Hole No. 8A-938

DRILLING LOG	DIVISION SWD
INSTALLATION FWD	SHEET 1 OF 1 SHEETS
1. PROJECT Longhorn AAP.	10. SIZE AND TYPE OF BIT 8" AUGER
2. LOCATION (Coordinates or Station) GROUND-WATER QUALITY ASSESSMENT	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY USCE	12. MANUFACTURER'S DESIGNATION OF DRILL FAILING 1500
4. HOLE NO. (As shown on drawing title and file number) BA-938	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 11, UNDISTURBED 0
5. NAME OF DRILLER T. SUITS	14. TOTAL NUMBER CORE BOXES N/A
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER SEE REMARKS COLUMN
7. THICKNESS OF OVERBURDEN	16. DATE HOLE: STARTED 17 AUG '88, COMPLETED 17 AUG '88
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE 186'±
9. TOTAL DEPTH OF HOLE 10.0'	18. TOTAL CORE RECOVERY FOR BORING N/A %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	0.0 10.0 20		0.0' To 7.3' CLAY: 0.0' - 0.4': MEDIUM PLASTICITY; GRAYISH BROWN; VERY STIFF; DAMP; SLIGHTLY SILTY & SANDY 0.4' - 6.4': MEDIUM PLASTICITY; LIGHT GRAY WITH YELLOWISH BROWN; HARD; DAMP; SLIGHTLY SANDY 6.4' - 7.3': LOW-MEDIUM PLASTICITY; LIGHT GRAY & YELLOWISH BROWN; VERY STIFF; DAMP; SILTY; SANDY 7.3' To 10.0' T.D. SAND: FINE GRAINED; LIGHT GRAY & YELLOWISH BROWN; MEDIUM; DAMP; VERY SILTY (BORDERS A SANDY SILT) T.D. 10.0'		A B C D E F G	1. WATER LEVEL: NOTE: NO FREE WATER IN BORING DURING DRILLING & DRY AFTER 24 HRS. 2. JAR SAMPLES: (SOIL CLASSIFICATION) A: 0.0' - 0.4' B: 0.4' - 2.4' C: 2.4' - 4.4' D: 4.4' - 6.4' E: 6.4' - 7.3' F: 7.3' - 9.3' G: 9.3' - 10.0' (CHEMICAL SAMPLES) C-1 & 1A: 4.0' C-2 & 2A: 10.0' 3. DRILLING: 8" FLIGHT AUGER: 0.0' - 10.0' NOTE: BORING WAS GROUTED AFTER 24 HR. WATER LEVEL OBSERVATION. 4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. NO ODOR WAS DETECTED DURING DRILLING.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE
PROJECT Longhorn AAP.
HOLE NO. 8A-938

Hole No. 8A-939

DRILLING LOG	DIVISION SWD
INSTALLATION FWD	SHEET 1 OF 1 SHEETS
1. PROJECT Longhorn AAP.	10. SIZE AND TYPE OF BIT 8" AUGER
2. LOCATION (Coordinates or Station) GROUND-WATER QUALITY ASSESSMENT	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY USCE	12. MANUFACTURER'S DESIGNATION OF DRILL FAILING 1500
4. HOLE NO. (As shown on drawing title and file number) 8A-939	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 10, UNDISTURBED 0
5. NAME OF DRILLER T. SUITS	14. TOTAL NUMBER CORE BOXES N/A
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER SEE REMARKS COLUMN
7. THICKNESS OF OVERBURDEN	16. DATE HOLE: STARTED 17 AUG '88, COMPLETED 17 AUG '88
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE 188'±
9. TOTAL DEPTH OF HOLE 10.0'	18. TOTAL CORE RECOVERY FOR BORING N/A %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	0.0 10.0 20		0.0' To 0.3' SILT: LOW PLASTICITY; BROWN; STIFF; DAMP; VERY SANDY (BORDERS A SILTY SAND) 0.3' To 10.0' T.D. CLAY: 0.3' - 4.3': MEDIUM PLASTICITY; LIGHT GRAY WITH YELLOWISH BROWN; VERY STIFF-HARD; DAMP; MODERATELY SILTY; WITH TRACE OF SAND. 4.3' - 8.3': MEDIUM-HIGH PLASTICITY; YELLOWISH BROWN WITH LIGHT GRAY; HARD; DAMP; SILTY; WITH SCATTERED CARBON STAINS FROM 6.3' 8.3' - 10.0': MEDIUM PLASTICITY; LIGHT GRAY WITH YELLOWISH BROWN; STIFF-VERY STIFF; MOIST-DAMP; MODERATELY SILTY; WITH TRACE OF SAND & SCATTERED CARBON STAINS. T.D. 10.0'		A B C D E F	1. WATER LEVEL: NOTE: NO FREE WATER IN BORING DURING DRILLING & DRY AFTER 24 HRS. 2. JAR SAMPLES: (SOIL CLASSIFICATION) A: 0.0' - 0.3' B: 0.3' - 2.3' C: 2.3' - 4.3' D: 4.3' - 6.3' E: 6.3' - 8.3' F: 8.3' - 10.0' (CHEMICAL SAMPLES) C-1 & 1A: 4.0' C-2 & 2A: 10.0' 3. DRILLING: 8" FLIGHT AUGER: 0.0' - 10.0' NOTE: BORING WAS GROUTED AFTER 24 HR. WATER LEVEL OBSERVATION. 4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. NO ODOR WAS DETECTED DURING DRILLING.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE
PROJECT Longhorn AAP.
HOLE NO. 8A-939

NOTE
FOR BORING LOCATIONS, SEE SHEET 5.

SYMBOL	DESCRIPTION OF REVISION	DATE	APPROVAL

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

RCRA FACILITY INVESTIGATION
ABG AND UEP SITES
PHASE I

LOGS OF BORINGS

DESIGNED BY: B. FITZGERALD
DRAWN BY: C. KIRBY
REVIEWED BY: R. BEHM
SUBMITTED BY: ROBERT C. BEHM
ENGINEER:
SOL. NO.
DATED:
CONTR. NO.
DRAWING NUMBER
SHEET NO. 15 of 31
SEQUENCE NO. 15

002073

Hole No. BA-940

DRILLING LOG
DIVISION: SWD
INSTALLATION: FWD
SHEET 1 OF 1 SHEETS
1. PROJECT: LONGHORN AAP.
2. LOCATION (Coordinates or Station): GROUND-WATER QUALITY ASSESSMENT
3. DRILLING AGENCY: USCE
4. HOLE NO. (As shown on drawing title and file number): BA-940
5. NAME OF DRILLER: T. SILITS
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 10.0'
10. SIZE AND TYPE OF BIT: 8" AUGER
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 13 | UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: N/A
15. ELEVATION GROUND WATER: SEE REMARKS COLUMN
16. DATE HOLE: STARTED 17 AUG. 88 | COMPLETED 17 AUG. 88
17. ELEVATION TOP OF HOLE: 190'±
18. TOTAL CORE RECOVERY FOR BORING: N/A %
19. SIGNATURE OF INSPECTOR: Jackie R.

ELEVATION (a) | DEPTH (b) | LEGEND (c) | CLASSIFICATION OF MATERIALS (Description) (d) | % CORE RECOVERY (e) | BOX OR SAMPLE NO. (f) | REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)

Depth: 0.0, 10.0, 20

Classification of materials:

0.0' TO 0.3'
SAND FILL: FINE GRAINED; REDDISH BROWN; MEDIUM; DAMP; SILTY; GRAVELLY
0.3' TO 0.8'
CLAY FILL: MEDIUM-HIGH PLASTICITY; RED WITH BROWN & LIGHT GRAY; VERY STIFF-HARD; DAMP; WITH TRACE OF SILT & SAND.
0.8' TO 1.5'
SILT FILL: LOW PLASTICITY; GRAYISH BROWN; MEDIUM; DAMP; VERY SANDY
1.5' TO 10.0' T.D.
CLAY:
1.5'-6.0': MEDIUM-HIGH PLASTICITY DOWN TO MEDIUM PLASTICITY FROM 4.0'; LIGHT GRAY & RED; HARD; DAMP; SLIGHTLY SANDY FROM 4.0'; CONTAINS A STRONG SHARP ODOR.
6.0'-8.9': MEDIUM-HIGH PLASTICITY; LIGHT GRAY & YELLOWISH BROWN; VERY STIFF-HARD; DAMP; WITH TRACE OF SILT & SAND; CONTAINS A STRONG SHARP ODOR.
8.9'-10.0': LOW-MEDIUM PLASTICITY; LIGHT GRAY & YELLOWISH BROWN; STIFF; DAMP-MOIST; VERY SILTY; SANDY; CONTAINS A STRONG SHARP ODOR.
T.D. 10.0'

Box or sample no.: A, B, C, D, E, F, G, H, I

Remarks:

1. WATER LEVEL:
NOTE: NO FREE WATER IN BORING DURING DRILLING & DRY AFTER 24 HRS.

2. JAR SAMPLES:
(SOIL CLASSIFICATION)
A: 0.0' - 0.3'
B: 0.3' - 0.8'
C: 0.8' - 1.5'
D: 1.5' - 3.5'
E: 3.5' - 4.0'
F: 4.0' - 6.0'
G: 6.0' - 8.0'
H: 8.0' - 8.9'
I: 8.9' - 10.0'
(CHEMICAL SAMPLES)
C-1 & 1A: 4.0'
C-2 & 2A: 10.0'

3. DRILLING:
8" FLIGHT AUGERS: 0.0' - 10.0'
NOTE: BORING WAS GROUTED AFTER 24 HR. WATER LEVEL OBSERVATION.

4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. A STRONG SHARP ODOR WAS DETECTED FROM 1.5'-10.0'

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.
PROJECT: LONGHORN AAP.
HOLE NO.: BA-940

Hole No. BA-941

DRILLING LOG
DIVISION: SWD
INSTALLATION: FWD
SHEET 1 OF 1 SHEETS
1. PROJECT: LONGHORN AAP.
2. LOCATION (Coordinates or Station): GROUND-WATER QUALITY ASSESSMENT
3. DRILLING AGENCY: USCE
4. HOLE NO. (As shown on drawing title and file number): BA-941
5. NAME OF DRILLER: T. SILITS
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 10.0'
10. SIZE AND TYPE OF BIT: 8" AUGER
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 12 | UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: N/A
15. ELEVATION GROUND WATER: SEE REMARKS COLUMN
16. DATE HOLE: STARTED 17 AUG. 88 | COMPLETED 17 AUG. 88
17. ELEVATION TOP OF HOLE: 192'±
18. TOTAL CORE RECOVERY FOR BORING: N/A %
19. SIGNATURE OF INSPECTOR: Jackie R.

ELEVATION (a) | DEPTH (b) | LEGEND (c) | CLASSIFICATION OF MATERIALS (Description) (d) | % CORE RECOVERY (e) | BOX OR SAMPLE NO. (f) | REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)

Depth: 0.0, 10.0, 20

Classification of materials:

0.0' TO 0.9'
CLAY FILL: LOW-MEDIUM PLASTICITY; RED & BROWN; VERY STIFF; DAMP; SANDY; CONTAINS A WEAK ODOR.
0.9' TO 1.5'
CLAY FILL: MEDIUM PLASTICITY; YELLOWISH BROWN; HARD; DAMP; WITH TRACE OF SILT & SAND; CONTAINS A WEAK ODOR.
1.5' TO 2.0'
SAND FILL: FINE GRAINED; GRAYISH BROWN; MEDIUM; DAMP; SILTY; CONTAINS A WEAK ODOR.
2.0' TO 10.0' T.D.
CLAY:
2.0'-4.0': MEDIUM PLASTICITY; YELLOWISH BROWN; STIFF-VERY STIFF; DAMP; SILTY; SLIGHTLY SANDY; CONTAINS A WEAK ODOR.
4.0'-10.0': MEDIUM-HIGH PLASTICITY; LIGHT GRAY & YELLOWISH BROWN & RED DOWN TO YELLOWISH BROWN & LIGHT GRAY FROM 6.0'; VERY STIFF-HARD; DAMP; SILTY; WITH TRACE OF SAND; CONTAINS A WEAK ODOR.
T.D. 10.0'

Box or sample no.: A, B, C, D, E, F, G

Remarks:

1. WATER LEVEL:
NOTE: NO FREE WATER IN BORING DURING DRILLING & DRY AFTER 24 HRS.

2. JAR SAMPLES:
(SOIL CLASSIFICATION)
A: 0.0' - 0.9'
B: 0.9' - 1.5'
C: 1.5' - 2.0'
D: 2.0' - 4.0'
E: 4.0' - 6.0'
F: 6.0' - 8.0'
G: 8.0' - 10.0'
(CHEMICAL SAMPLES)
C-1 & 1A: 4.0'
C-2 & 2A: 10.0'

3. DRILLING:
8" FLIGHT AUGER: 0.0' - 10.0'
NOTE: BORING WAS GROUTED AFTER 24 HR. WATER LEVEL OBSERVATION.

4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. A WEAK ODOR WAS DETECTED IN SOIL SAMPLES FROM 0.0'-10.0'

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.
PROJECT: LONGHORN AAP.
HOLE NO.: BA-941

Hole No. BA-942

DRILLING LOG
DIVISION: SWD
INSTALLATION: FWD
SHEET 1 OF 1 SHEETS
1. PROJECT: LONGHORN AAP.
2. LOCATION (Coordinates or Station): GROUND-WATER QUALITY ASSESSMENT
3. DRILLING AGENCY: USCE
4. HOLE NO. (As shown on drawing title and file number): BA-942
5. NAME OF DRILLER: T. SILITS
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 10.0'
10. SIZE AND TYPE OF BIT: 8" AUGER
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 11 | UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: N/A
15. ELEVATION GROUND WATER: SEE REMARKS COLUMN
16. DATE HOLE: STARTED 18 AUG. 88 | COMPLETED 15 AUG. 88
17. ELEVATION TOP OF HOLE: 193'±
18. TOTAL CORE RECOVERY FOR BORING: N/A %
19. SIGNATURE OF INSPECTOR: Jackie R.

ELEVATION (a) | DEPTH (b) | LEGEND (c) | CLASSIFICATION OF MATERIALS (Description) (d) | % CORE RECOVERY (e) | BOX OR SAMPLE NO. (f) | REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)

Depth: 0.0, 10.0, 20

Classification of materials:

0.0' TO 0.6'
SAND FILL: FINE GRAINED; REDDISH BROWN; MEDIUM; DAMP; GRAVELLY; VERY SILTY
0.6' TO 1.6'
CLAY FILL: MEDIUM PLASTICITY; YELLOWISH BROWN WITH RED & LIGHT GRAY; VERY STIFF; DAMP; SLIGHTLY SILTY; WITH SAND POCKETS
1.6' TO 3.6'
SAND FILL: FINE GRAINED; GRAYISH BROWN; MEDIUM; DAMP; SILTY; CONTAINS A WEAK ODOR.
3.6' TO 5.4'
CLAY FILL: LOW-MEDIUM PLASTICITY; YELLOWISH BROWN & RED; STIFF; MOIST; SILTY & SANDY; WITH CARBON STAINS; CONTAINS A WEAK TO MODERATELY STRONG ODOR.
5.4' TO 10.0' T.D.
CLAY:
5.4'-9.4': MEDIUM PLASTICITY; LIGHT GRAY, RED & YELLOWISH BROWN; VERY STIFF; DAMP; SLIGHTLY SILTY & SANDY; CONTAINS A WEAK ODOR.
9.4'-10.0': MEDIUM-HIGH PLASTICITY; YELLOWISH BROWN & LIGHT GRAY; HARD; DAMP; CONTAINS A WEAK ODOR.
T.D. 10.0'

Box or sample no.: A, B, C, D, E, F, G

Remarks:

1. WATER LEVEL:
NOTE: NO FREE WATER IN BORING DURING DRILLING & DRY AFTER 24 HRS.

2. JAR SAMPLES:
(SOIL CLASSIFICATION)
A: 0.0' - 0.6'
B: 0.6' - 1.6'
C: 1.6' - 3.6'
D: 3.6' - 5.4'
E: 5.4' - 7.4'
F: 7.4' - 9.4'
G: 9.4' - 10.0'
(CHEMICAL SAMPLES)
C-1 & 1A: 4.0'
C-2 & 2A: 10.0'

3. DRILLING:
8" FLIGHT AUGER: 0.0' - 10.0'
NOTE: BORING WAS GROUTED AFTER 24 HR. WATER LEVEL OBSERVATION.

4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. A WEAK TO MODERATELY STRONG ODOR WAS DETECTED IN SOIL SAMPLES FROM 1.6'-10.0'

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.
PROJECT: LONGHORN AAP.
HOLE NO.: BA-942

Hole No. BA-943

DRILLING LOG
DIVISION: SWD
INSTALLATION: FWD
SHEET 1 OF 1 SHEETS
1. PROJECT: LONGHORN AAP.
2. LOCATION (Coordinates or Station): GROUND-WATER QUALITY ASSESSMENT
3. DRILLING AGENCY: USCE
4. HOLE NO. (As shown on drawing title and file number): BA-943
5. NAME OF DRILLER: T. SILITS
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 10.0'
10. SIZE AND TYPE OF BIT: 8" AUGER
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 11 | UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: N/A
15. ELEVATION GROUND WATER: SEE REMARKS COLUMN
16. DATE HOLE: STARTED 18 AUG. 88 | COMPLETED 18 AUG. 88
17. ELEVATION TOP OF HOLE: 194'±
18. TOTAL CORE RECOVERY FOR BORING: N/A %
19. SIGNATURE OF INSPECTOR: Jackie R.

ELEVATION (a) | DEPTH (b) | LEGEND (c) | CLASSIFICATION OF MATERIALS (Description) (d) | % CORE RECOVERY (e) | BOX OR SAMPLE NO. (f) | REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)

Depth: 0.0, 10.0, 20

Classification of materials:

0.0' TO 1.0' (FILL)
CLAY: MEDIUM PLASTICITY; RED, YELLOWISH BROWN & LIGHT GRAY; HARD; DAMP; SLIGHTLY SILTY & SANDY
1.0' TO 2.1'
SAND FILL: FINE GRAINED; LIGHT BROWN; MEDIUM; DAMP; SILTY
2.1' TO 10.0' T.D.
CLAY:
2.1'-3.6': MEDIUM-HIGH PLASTICITY; YELLOWISH BROWN WITH LIGHT GRAY; STIFF-VERY STIFF; DAMP-MOIST; WITH SCATTERED CARBON STAINS; WITH TRACE OF SILT & SAND; CONTAINS A MODERATELY STRONG ODOR.
3.6'-5.6': LOW PLASTICITY; YELLOWISH BROWN WITH LIGHT GRAY & RED; STIFF; MOIST; VERY SILTY & SANDY; CONTAINS A WEAK ODOR.
5.6'-7.0': MEDIUM-HIGH PLASTICITY; YELLOWISH BROWN & LIGHT GRAY; STIFF-VERY STIFF; DAMP-MOIST; SLIGHTLY SILTY; CONTAINS A WEAK ODOR.
7.0'-8.1': MEDIUM-HIGH PLASTICITY; LIGHT GRAY WITH YELLOWISH BROWN; HARD; DAMP; CONTAINS A WEAK ODOR.
8.1'-10.0': MEDIUM PLASTICITY; YELLOWISH BROWN WITH LIGHT GRAY; STIFF; MOIST; SLIGHTLY SILTY & SANDY; WITH SCATTERED CARBON STAINS; CONTAINS A WEAK ODOR
T.D. 10.0'

Box or sample no.: A, B, C, D, E, F, G

Remarks:

1. WATER LEVEL:
NOTE: NO FREE WATER IN BORING DURING DRILLING & DRY AFTER 24 HRS.

2. JAR SAMPLES:
(SOIL CLASSIFICATION)
A: 0.0' - 1.0'
B: 1.0' - 2.1'
C: 2.1' - 3.6'
D: 3.6' - 5.6'
E: 5.6' - 7.0'
F: 7.0' - 8.1'
G: 8.1' - 10.0'
(CHEMICAL SAMPLES)
C-1 & 1A: 4.0'
C-2 & 2A: 10.0'

3. DRILLING:
8" FLIGHT AUGER: 0.0' - 10.0'
NOTE: BORING WAS GROUTED AFTER 24 HR. WATER LEVEL OBSERVATION.

4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. A WEAK TO MODERATELY STRONG ODOR WAS DETECTED IN SOIL SAMPLES FROM 2.1'-10.0'

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.
PROJECT: LONGHORN AAP.
HOLE NO.: BA-943

NOTE
FOR BORING LOCATIONS, SEE SHEET 5.

SYMBOL	DESCRIPTION OF REVISION	DATE	APPROVAL

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

DESIGNED BY: D. FITZGERALD
DRAWN BY: C. KIRBY
REVIEWED BY: R. BEHM

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RCRA FACILITY INVESTIGATION
ABG AND UEP SITES
PHASE I

LOGS OF BORINGS

SUBMITTED BY: ROBERT C. BEHM
ENGINEER:
SOL. NO.
DATED:
CONTR. NO.
DRAWING NUMBER
SHEET NO. 16 OF 31
SEQUENCE NO. 16
CONTR. NO.

002074

DRILLING LOG — Hole No. BA-944

DIVISION	SWD
INSTALLATION	FWD
SHEET	1 of 1 SHEETS
1. PROJECT	LONGHORN AAP
2. LOCATION	GROUND-WATER QUALITY ASSESSMENT
3. DRILLING AGENCY	USCE
4. HOLE NO.	BA-944
5. NAME OF DRILLER	T. SUITS
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	
8. DEPTH DRILLED INTO ROCK	
9. TOTAL DEPTH OF HOLE	10.0'
10. SIZE AND TYPE OF BIT	8" AUGER
11. DATUM FOR ELEVATION SHOWN	
12. MANUFACTURER'S DESIGNATION OF DRILL	FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED 12 / UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES	N/A
15. ELEVATION GROUND WATER	SEE REMARKS COLUMN
16. DATE HOLE	STARTED 18 AUG 88 / COMPLETED 18 AUG 88
17. ELEVATION TOP OF HOLE	176'±
18. TOTAL CORE RECOVERY FOR BORING	N/A
19. SIGNATURE OF INSPECTOR	

DEPTH: 0.0 — 10.0 — 20

CLASSIFICATION OF MATERIALS (Description)

0.0' TO 5.0'
CLAY FILL:
0.0'-1.0': MEDIUM-HIGH PLASTICITY; RED & REDDISH BROWN; VERY STIFF; DAMP; WITH TRACE OF SILT & SAND; CONTAINS A WEAK ODOR.
1.0'-2.0': LOW-MEDIUM PLASTICITY; GRAY WITH RED; VERY STIFF; DAMP; WITH SAND POCKETS; CONTAINS A WEAK ODOR.
2.0'-3.4': LOW PLASTICITY; YELLOWISH BROWN WITH LIGHT GRAY; STIFF-VERY STIFF; DAMP; VERY SANDY; CONTAINS A MODERATELY STRONG ODOR.
3.4'-5.0': MEDIUM PLASTICITY; LIGHT GRAY WITH YELLOWISH BROWN; MEDIUM-STIFF; MOIST-VERY MOIST; SILTY; WITH TRACE OF SAND; WITH SCATTERED CARBON STAINS; CONTAINS A MODERATELY STRONG ODOR.
5.0' TO 6.1'
SAND FILL: FINE-MEDIUM GRAINED; GRAYISH BROWN; MEDIUM; VERY MOIST; CLAYEY; WITH CARBON MATTER; CONTAINS A MODERATELY STRONG-STRONG ODOR.
6.1' TO 10.0' T.D.
CLAY:
6.1'-9.3': MEDIUM-HIGH PLASTICITY; LIGHT GRAY & YELLOWISH BROWN; STIFF-VERY STIFF; DAMP-MOIST; SILTY; WITH TRACE OF SAND; CONTAINS A MODERATELY STRONG ODOR.
9.3'-10.0': LOW PLASTICITY; YELLOWISH BROWN WITH LIGHT GRAY; MEDIUM; VERY MOIST; VERY SANDY (BORDERS A CLAYEY SAND); CONTAINS A WEAK ODOR.
T.D. 10.0'

BOX OR SAMPLE NO.: A, B, C, D, E, F, G, H

REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)

1. WATER LEVEL:
NOTE: NO FREE WATER IN BORING DURING DRILLING & DRY AFTER 24 HRS.

2. JAR SAMPLES:
(SOIL CLASSIFICATION)
A: 0.0' - 1.0'
B: 1.0' - 2.0'
C: 2.0' - 3.4'
D: 3.4' - 5.0'
E: 5.0' - 6.1'
F: 6.1' - 8.1'
G: 8.1' - 9.3'
H: 9.3' - 10.0'
(CHEMICAL SAMPLES)
C-1 & 1A: 4.0'
C-2 & 2A: 10.0'

3. DRILLING:
8" FLIGHT AUGER: 0.0' - 10.0'
NOTE: BORING WAS GROUTED AFTER 24 HR. WATER LEVEL OBSERVATION.

4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. A WEAK TO STRONG ODOR WAS DETECTED IN SOIL SAMPLES FROM 0.0'-10.0'.

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE

PROJECT: LONGHORN AAP. HOLE NO. BA-944

DRILLING LOG — Hole No. BA-945

DIVISION	SWD
INSTALLATION	FWD
SHEET	1 of 1 SHEETS
1. PROJECT	LONGHORN AAP.
2. LOCATION	GROUND-WATER QUALITY ASSESSMENT
3. DRILLING AGENCY	USCE
4. HOLE NO.	BA-945
5. NAME OF DRILLER	T. SUITS
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	
8. DEPTH DRILLED INTO ROCK	
9. TOTAL DEPTH OF HOLE	10.0'
10. SIZE AND TYPE OF BIT	8" AUGER
11. DATUM FOR ELEVATION SHOWN	
12. MANUFACTURER'S DESIGNATION OF DRILL	FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED 11 / UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES	N/A
15. ELEVATION GROUND WATER	SEE REMARKS COLUMN
16. DATE HOLE	STARTED 18 AUG. 88 / COMPLETED 18 AUG. 88
17. ELEVATION TOP OF HOLE	176'±
18. TOTAL CORE RECOVERY FOR BORING	N/A
19. SIGNATURE OF INSPECTOR	

DEPTH: 0.0 — 10.0 — 20

CLASSIFICATION OF MATERIALS (Description)

0.0' TO 0.4'
CLAY FILL: MEDIUM-HIGH PLASTICITY; YELLOWISH BROWN, LIGHT GRAY & RED; VERY STIFF; DAMP
0.4' TO 3.4'
CLAY:
0.4'-1.4': LOW-MEDIUM PLASTICITY; YELLOWISH BROWN & LIGHT GRAY; STIFF-VERY STIFF; DAMP; SILTY; MODERATELY SANDY; WITH CARBON STAINS & A MODERATELY STRONG ODOR.
1.4'-3.4': LOW PLASTICITY; YELLOWISH BROWN & LIGHT GRAY; STIFF; DAMP; VERY SILTY; VERY SANDY; (BORDERS A SANDY SILT); CONTAINS A MODERATELY STRONG ODOR.
3.4' TO 6.2'
SAND: FINE GRAINED; YELLOWISH BROWN WITH LIGHT GRAY; MEDIUM; MOIST-VERY MOIST; SILTY; CONTAINS A MODERATELY STRONG ODOR
6.2' TO 10.0' T.D.
CLAY: LOW PLASTICITY; YELLOWISH BROWN & LIGHT GRAY; STIFF; MOIST; SANDY; VERY SILTY (BORDERS A SANDY SILT); CONTAINS A MODERATELY STRONG ODOR.
T.D. 10.0'

BOX OR SAMPLE NO.: A, B, C, D, E, F, G

REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)

1. WATER LEVEL:
NOTE: NO FREE WATER IN BORING DURING DRILLING & DRY AFTER 24 HRS.

2. JAR SAMPLES:
(SOIL CLASSIFICATION)
A: 0.0' - 0.4'
B: 0.4' - 1.4'
C: 1.4' - 3.4'
D: 3.4' - 5.4'
E: 5.4' - 6.2'
F: 6.2' - 8.2'
G: 8.2' - 10.0'
(CHEMICAL SAMPLES)
C-1 & 1A: 4.0'
C-2 & 2A: 10.0'

3. DRILLING:
8" FLIGHT AUGER: 0.0' - 10.0'
NOTE: BORING WAS GROUTED AFTER 24 HR. WATER LEVEL OBSERVATION.

4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. A MODERATELY STRONG ODOR WAS DETECTED IN SOIL SAMPLES FROM 0.4' - 10.0'.

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE

PROJECT: LONGHORN AAP. HOLE NO. BA-945

DRILLING LOG — Hole No. BA-946

DIVISION	SWD
INSTALLATION	FWD
SHEET	1 of 1 SHEETS
1. PROJECT	LONGHORN AAP.
2. LOCATION	GROUND-WATER QUALITY ASSESSMENT
3. DRILLING AGENCY	USCE
4. HOLE NO.	BA-946
5. NAME OF DRILLER	T. SUITS
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	
8. DEPTH DRILLED INTO ROCK	
9. TOTAL DEPTH OF HOLE	10.0'
10. SIZE AND TYPE OF BIT	8" AUGER
11. DATUM FOR ELEVATION SHOWN	
12. MANUFACTURER'S DESIGNATION OF DRILL	FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED 10 / UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES	N/A
15. ELEVATION GROUND WATER	SEE REMARKS COLUMN
16. DATE HOLE	STARTED 18 AUG. 88 / COMPLETED 18 AUG. 88
17. ELEVATION TOP OF HOLE	177'±
18. TOTAL CORE RECOVERY FOR BORING	N/A
19. SIGNATURE OF INSPECTOR	

DEPTH: 0.0 — 10.0 — 20

CLASSIFICATION OF MATERIALS (Description)

0.0' TO 0.4'
SILT; LOW PLASTICITY; BROWN; STIFF; DAMP; VERY SANDY; WITH A WEAK ODOR.
0.4' TO 10.0' T.D.
CLAY:
0.4'-2.5'; LOW PLASTICITY; YELLOWISH BROWN WITH RED; STIFF; DAMP; VERY SILTY; SANDY; CONTAINS A WEAK ODOR.
2.5'-10.0': MEDIUM PLASTICITY; LIGHT GRAY & RED; HARD; DRY-DAMP; MODERATELY SANDY; YELLOWISH BROWN & LIGHT GRAY & DAMP FROM 4.5'.
T.D. 10.0'

BOX OR SAMPLE NO.: A, B, C, D, E, F

REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)

1. WATER LEVEL:
NOTE: NO FREE WATER IN BORING DURING DRILLING & DRY AFTER 24 HRS.

2. JAR SAMPLES:
(SOIL CLASSIFICATION)
A: 0.0' - 0.4'
B: 0.4' - 2.5'
C: 2.5' - 4.5'
D: 4.5' - 6.5'
E: 6.5' - 8.5'
F: 8.5' - 10.0'
(CHEMICAL SAMPLES)
C-1 & 1A: 4.0'
C-2 & 2A: 10.0'

3. DRILLING:
8" FLIGHT AUGER: 0.0' - 10.0'
NOTE: BORING WAS GROUTED AFTER 24 HR. WATER LEVEL OBSERVATION.

4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. A WEAK ODOR WAS DETECTED IN SOIL SAMPLES FROM 0.0'-2.5'.

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE

PROJECT: LONGHORN AAP. HOLE NO. BA-946

NOTE
FOR BORING LOCATIONS, SEE SHEET 5.

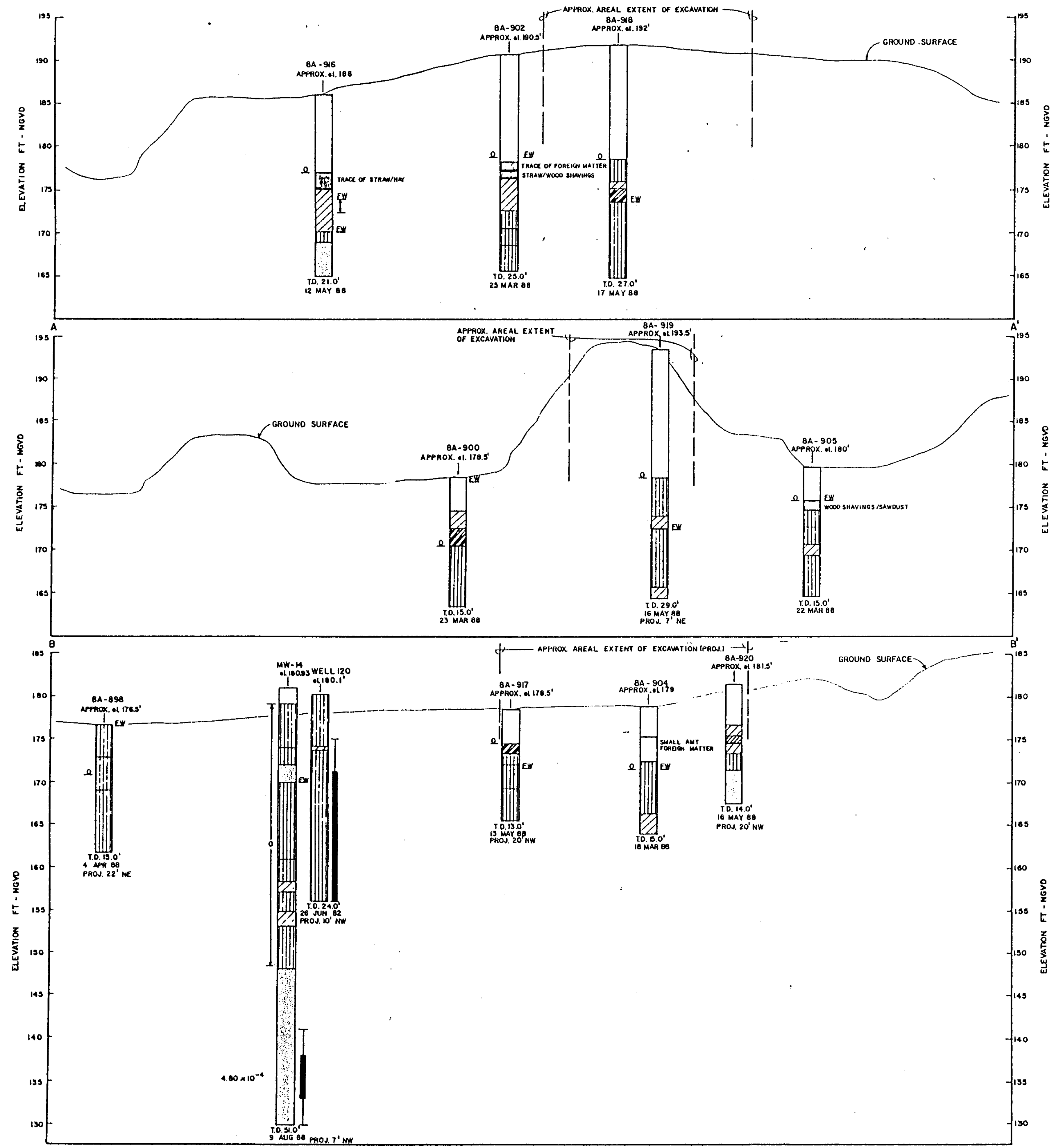
SYMBOL	DESCRIPTION	DATE	APPROVAL

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RCRA FACILITY INVESTIGATION
ABG AND UEP SITES
PHASE I
LOGS OF BORINGS

DESIGNED BY: D. FITZGERALD
DRAWN BY: C. KIRBY
REVIEWED BY: R. BEHM
SUBMITTED BY: ROBERT C. BEHM
ENGINEER:
SOL. NO.
DATED:
CONTR. NO
DRAWING NUMBER
SHEET NO 17 of 31
SEQUENCE NO. 17

002075



STRATIGRAPHIC SYMBOLS

- ▨ SANDY CLAY AND SILTY CLAY
- ▨ FAT CLAY
- ░ SAND
- ▨ CLAYEY SAND
- ▥ SILTY SAND AND SANDY SILT
- ▥ SILT
- ▥ CLAYEY SILT
- ▥ SANDY CLAYEY SILT
- ░ GRAVEL
- ░ SANDSTONE AND CEMENTED SAND
- ▤ SHALE
- ☐ FILL
- ▩ SOURCE MATERIAL

LEGEND

FW	FREE WATER ENCOUNTERED DURING DRILLING
O	ODOR ENCOUNTERED DURING DRILLING
⊤ ⊥	LIMITS OF ODOR AND/OR FREE WATER IF NOT TO T.D.
▼	WATER LEVEL MEASURED 31 AUGUST 1988
⌶	WELL GRAVEL PACK INTERVAL
▮	WELL SCREEN INTERVAL

GENERAL NOTES

1. STRATIGRAPHIC SYMBOLS ARE IN ACCORDANCE WITH DESCRIPTION OF MATERIALS ON THE FIELD LOGS.
2. THE BORING NUMBER AND ELEVATION ARE SHOWN AT THE TOP OF THE LOG. THE ELEVATION IS THE SURVEYED TOP OF CONCRETE PAD OR SURVEY MARKER.
3. TOTAL DEPTH OF BORING AND DATE COMPLETED ARE SHOWN AT THE BOTTOM OF THE LOG.
4. ASSUME THAT ONCE O AND/OR FW ARE ENCOUNTERED, THE BORING EXHIBITED AN ODOR AND/OR THE BORING MADE WATER UNTIL T.D. WAS REACHED UNLESS OTHERWISE NOTED.
5. FOR 3F BORINGS, RESISTIVITY LOGS ARE SHOWN TO THE RIGHT OF THE BORING. THE RESISTIVITY CALIBRATION IS SHOWN IN OHMS(Ω) AT THE BOTTOM OF THE LOG. THE GAMMA LOG IS SHOWN TO THE LEFT OF THE BORING. THE COUNT RATE AND TIME CONSTANT ARE SHOWN AT THE BOTTOM OF THE LOG.
6. FOR LOGS OF BA BORINGS, SEE SHEETS 6 THROUGH 17.
7. FOR LOGS OF 3F BORINGS, SEE SHEET 22.
8. FOR LOGS OF USAEHA, USTHAMA, AND USACE(CDM) WELL BORINGS, SEE APPENDIX
9. FOR LOGS OF MW WELL BORINGS, SEE APPENDIX N.
10. FOR WELL INSTALLATION DETAILS FOR USTHAMA AND USACE(CDM) WELLS, SEE APPENDIX L . THERE ARE NO WELL INSTALLATION DETAILS FOR USAEHA WELLS.
11. FOR WELL INSTALLATION DETAILS FOR MW WELLS, SEE APPENDIX O.
12. HYDRAULIC CONDUCTIVITY VALUES DETERMINED FOR WELLS MW-1 THRU MW-15 ARE SHOWN OPPOSITE THE WELL SCREEN IN CM/SEC.

NOTES

1. APPROXIMATE LIMITS OF EXCAVATION ARE FOR AIR CURTAIN DESTRUCTOR AS SHOWN ON CONSTRUCTION AS-BUILTS, USACE, FORT WORTH DISTRICT, CONTRACT NO. DACA63-78-B-0010.
2. FOR BORING LOCATIONS, SEE SHEET 5.

20 0 20 40
HORIZONTAL SCALE IN FEET

5 0 5 10
VERTICAL SCALE IN FEET

SYMBOL | DESCRIPTION | DATE | APPROVAL — DESCRIPTION OF REVISION

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

DESIGNED BY: D. FITZGERALD
DRAWN BY: C. KIRBY
REVIEWED BY: R. BEHM

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

RCRA FACILITY INVESTIGATION
ABG AND UEP SITES
PHASE I

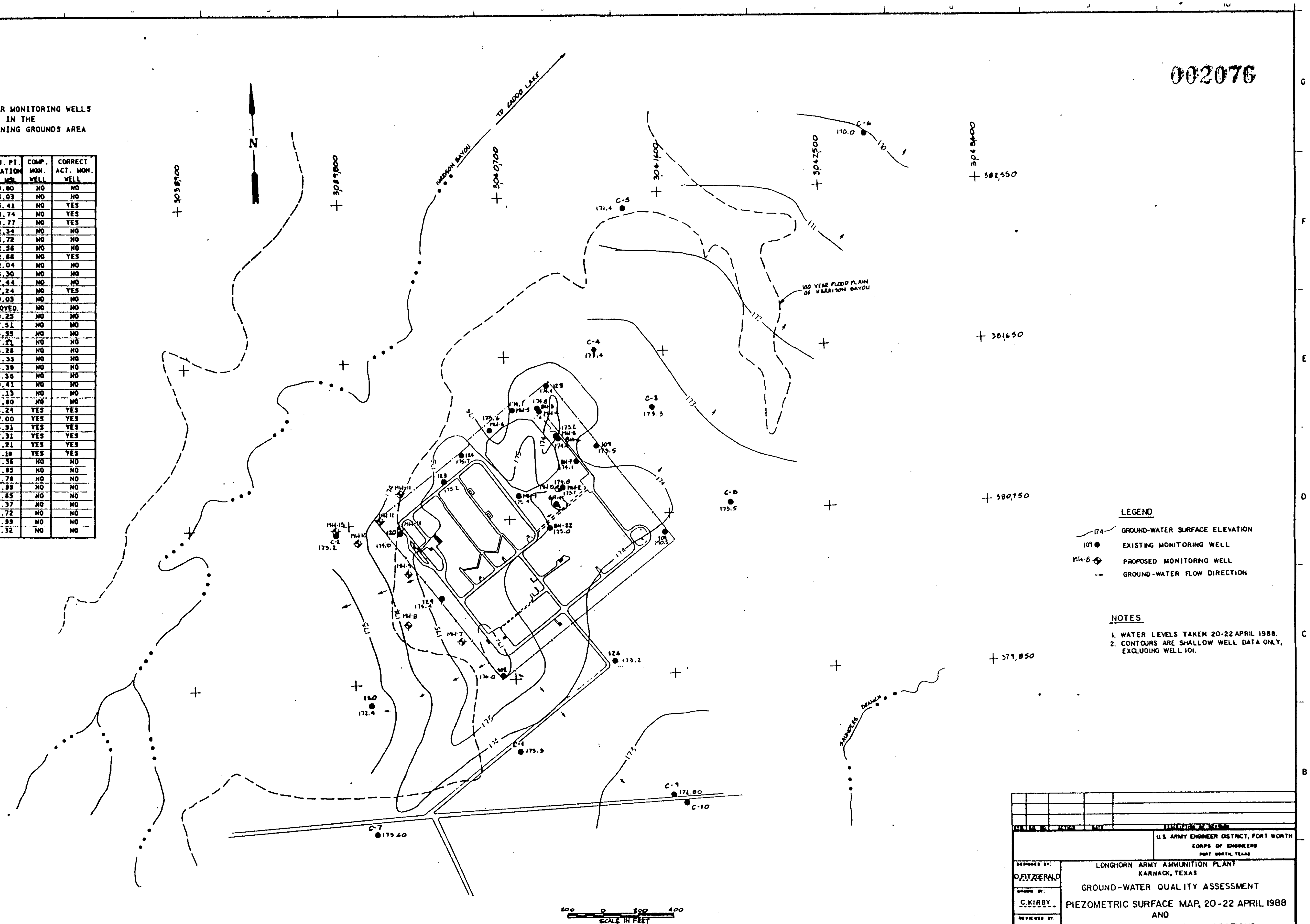
SUBSURFACE PROFILES A-A', B-B', AND C-C'

SUBMITTED BY: ROBERT C. BEHM
ENGINEER:
SOL. NO.
DATED:
CONTR. NO.
DRAWING NUMBER
SHEET NO. 18 of 31
SEQUENCE NO. 18

002076

GROUNDWATER MONITORING WELLS
IN THE
ACTIVE BURNING GROUNDS AREA

WELL NO.	MEAS. PT. ELEVATION FT. MSL	COMP. MON. WELL	CORRECT ACT. MON. WELL
C-1	193.80	NO	NO
C-2	178.03	NO	NO
C-3	196.41	NO	YES
C-4	194.74	NO	YES
C-5	180.77	NO	YES
C-6	192.34	NO	NO
C-7	196.72	NO	NO
C-8	192.56	NO	NO
C-9	202.88	NO	YES
C-10	202.04	NO	NO
BH-3	196.30	NO	NO
BH-4	197.44	NO	NO
BH-7	197.24	NO	YES
BH-11	188.03	NO	NO
BH-21	REMOVED.	NO	NO
BH-22	188.25	NO	NO
101	197.51	NO	NO
102	194.55	NO	NO
108	197.11	NO	NO
120	183.28	NO	NO
123	186.33	NO	NO
124	188.39	NO	NO
125	196.36	NO	NO
128	188.41	NO	NO
129	197.13	NO	NO
130	177.80	NO	NO
MW-1	188.24	YES	YES
MW-2	187.00	YES	YES
MW-3	196.51	YES	YES
MW-4	187.31	YES	YES
MW-5	195.21	YES	YES
MW-6	192.10	YES	YES
MW-7	188.58	NO	NO
MW-8	186.85	NO	NO
MW-9	184.78	NO	NO
MW-10	177.99	NO	NO
MW-11	177.65	NO	NO
MW-12	178.37	NO	NO
MW-13	176.72	NO	NO
MW-14	182.99	NO	NO
MW-15	187.32	NO	NO



LEGEND

174 GROUND-WATER SURFACE ELEVATION
101 ● EXISTING MONITORING WELL
MW-8 ◈ PROPOSED MONITORING WELL
→ GROUND-WATER FLOW DIRECTION

NOTES

1. WATER LEVELS TAKEN 20-22 APRIL 1988.
2. CONTOURS ARE SHALLOW WELL DATA ONLY, EXCLUDING WELL 101.

SYMBOL	DESCRIPTION	DATE	APPROVAL

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

DESIGNED BY: D.FITZGERALD
DRAWN BY: C.KIRBY
REVIEWED BY: R.BEHM

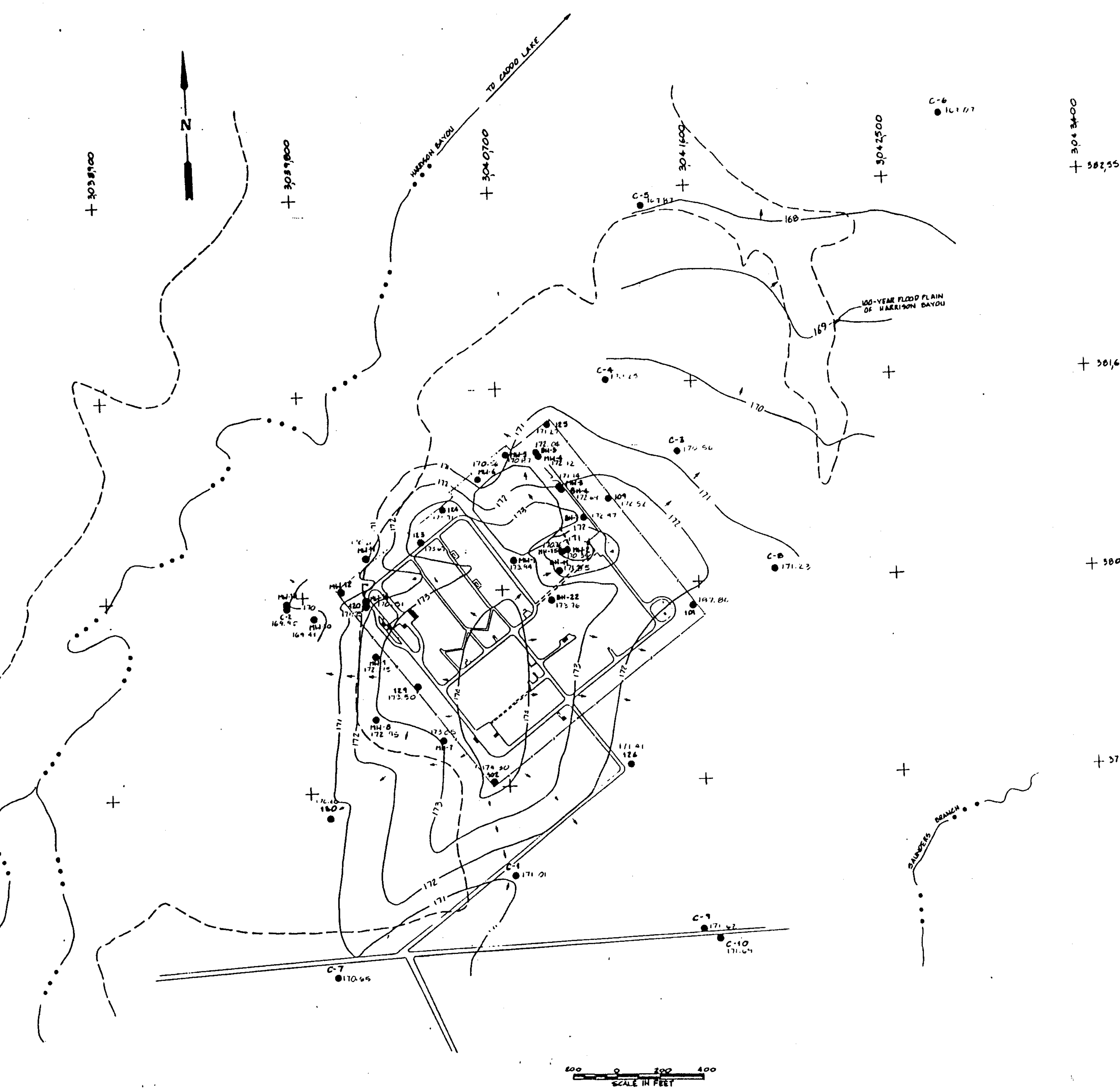
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
GROUND-WATER QUALITY ASSESSMENT
PIEZOMETRIC SURFACE MAP, 20-22 APRIL 1988
AND
PROPOSED WELL LOCATIONS

SUBMITTED BY: ROBERT C. BEHM
ENGINEER:
SOL. NO.
DATED:
CONTR. NO
DRAWING NUMBER
SHEET NO. 19 of 31
SEQUENCE NO. 19

002077

GROUNDWATER MONITORING WELLS
IN THE
ACTIVE BURNING GROUNDS AREA

WELL NO.	MEAS. PT. ELEVATION FT. MSL	COMP. MON. WELL	CORRECT ACT. MON. WELL
C-1	193.80	NO	NO
C-2	176.03	NO	NO
C-3	196.41	NO	YES
C-4	194.74	NO	YES
C-5	180.77	NO	YES
C-6	192.34	NO	NO
C-7	198.72	NO	NO
C-8	192.58	NO	NO
C-9	202.66	NO	YES
C-10	202.04	NO	NO
BH-3	196.30	NO	NO
BH-4	197.44	NO	NO
BH-7	197.24	NO	YES
BH-11	198.03	NO	NO
BH-21	REMOVED.	NO	NO
BH-22	198.25	NO	NO
101	197.51	NO	NO
102	194.55	NO	NO
108	197.11	NO	NO
120	183.28	NO	NO
123	186.33*	NO	NO
124	186.39	NO	NO
125	196.35	NO	NO
126	195.41	NO	NO
129	197.13	NO	NO
130	177.80	NO	NO
MW-1	199.24	YES	YES
MW-2	197.00	YES	YES
MW-3	196.51	YES	YES
MW-4	197.31	YES	YES
MW-5	195.21	YES	YES
MW-6	192.18	YES	YES
MW-7	188.56	NO	NO
MW-8	186.85	NO	NO
MW-9	184.78	NO	NO
MW-10	177.39	NO	NO
MW-11	177.65	NO	NO
MW-12	178.37	NO	NO
MW-13	178.72	NO	NO
MW-14	182.99	NO	NO
MW-15	197.32	NO	NO



LEGEND

—174— GROUND-WATER SURFACE ELEVATION

109 ● MONITORING WELL

→ GROUND-WATER FLOW DIRECTION

NOTES

1. WATER LEVELS TAKEN 31 AUGUST 1988.
2. CONTOURS ARE SHALLOW WELL DATA ONLY, EXCLUDING WELL 101.

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

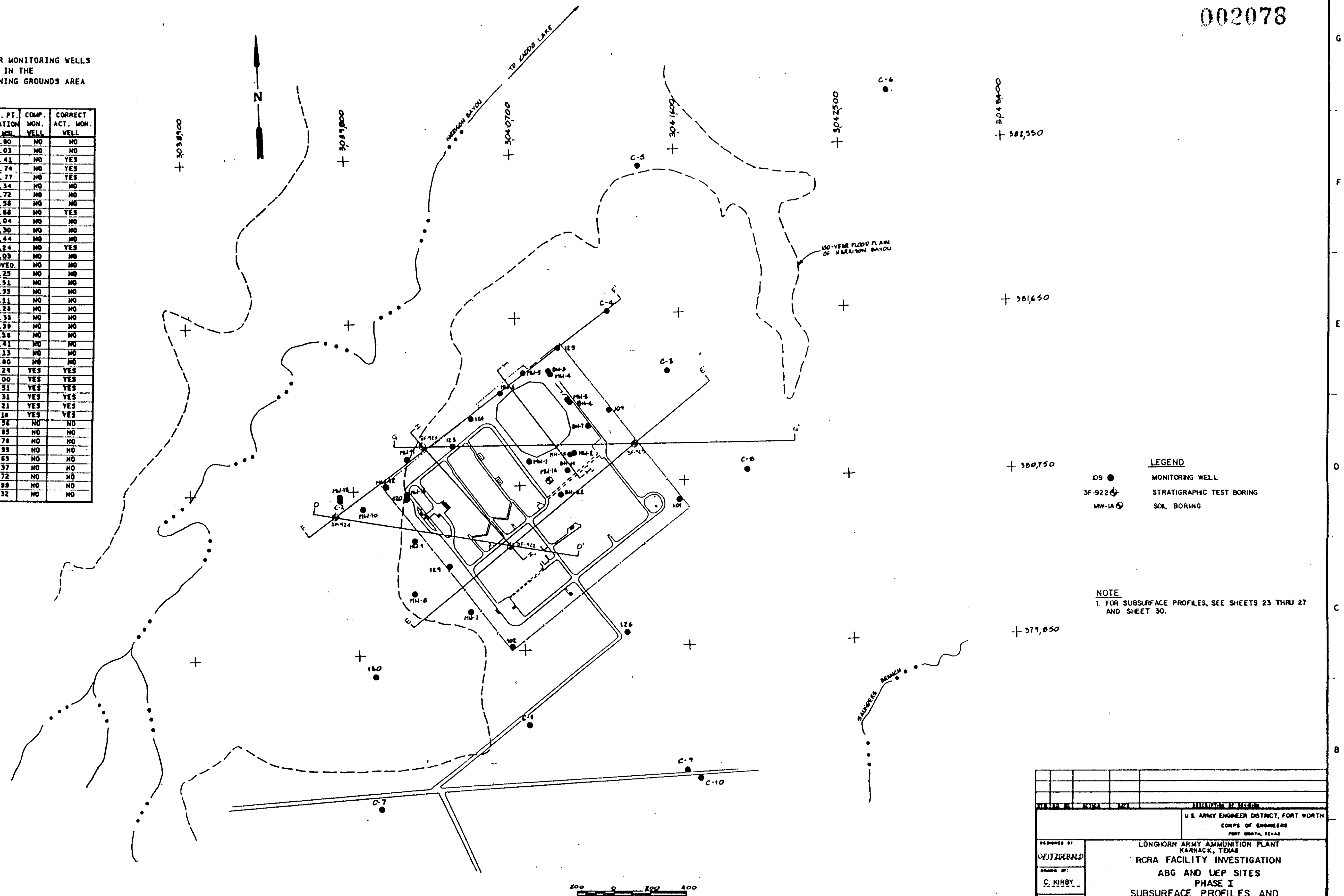
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RCRA FACILITY INVESTIGATION
ABG AND UEP SITES
PHASE I
PIEZOMETRIC SURFACE MAP
31 AUGUST 1988

DESIGNED BY:	D. FITZGERALD
DRAWN BY:	C. KIRBY
REVIEWED BY:	R. BEHM
SUBMITTED BY:	ROBERT C. BEHM
ENGINEER:	
SOL. NO.	
DATED:	
CONTR. NO.	
DRAWING NUMBER	
SHEET NO.	20 of 31
SEQUENCE NO.	20

002078

GROUNDWATER MONITORING WELLS
IN THE
ACTIVE BURNING GROUNDS AREA

WELL NO.	MEAS. PT. ELEVATION FT. MSL	COMP. MON. WELL	CORRECT ACT. MON. WELL
C-1	193.80	NO	NO
C-2	176.03	NO	NO
C-3	196.41	NO	YES
C-4	194.74	NO	YES
C-5	180.77	NO	YES
C-6	192.34	NO	NO
C-7	196.72	NO	NO
C-8	192.58	NO	NO
C-9	202.86	NO	YES
C-10	202.04	NO	NO
BH-3	196.30	NO	NO
BH-4	197.44	NO	NO
BH-7	197.24	NO	YES
BH-11	198.03	NO	NO
BH-21	REMOVED.	NO	NO
BH-22	198.25	NO	NO
101	197.51	NO	NO
102	194.55	NO	NO
108	197.11	NO	NO
120	183.28	NO	NO
123	186.33	NO	NO
124	186.39	NO	NO
125	196.38	NO	NO
128	195.41	NO	NO
129	197.13	NO	NO
130	177.80	NO	NO
MW-1	199.24	YES	YES
MW-2	197.00	YES	YES
MW-3	196.51	YES	YES
MW-4	197.31	YES	YES
MW-5	195.21	YES	YES
MW-6	192.18	YES	YES
MW-7	188.56	NO	NO
MW-8	186.85	NO	NO
MW-9	184.78	NO	NO
MW-10	177.99	NO	NO
MW-11	177.65	NO	NO
MW-12	178.37	NO	NO
MW-13	176.72	NO	NO
MW-14	182.99	NO	NO
MW-15	197.32	NO	NO



NOTE
1. FOR SUBSURFACE PROFILES, SEE SHEETS 23 THRU 27 AND SHEET 30.

	U.S. ARMY ENGINEER DISTRICT, FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS
DESIGNED BY: D.FITZGERALD	LONGHORN ARMY AMMUNITION PLANT KARNACK, TEXAS RCRA FACILITY INVESTIGATION ABG AND UEP SITES PHASE I SUBSURFACE PROFILES AND WELL LOCATION MAP
DRAWN BY: C. KIRBY	
REVIEWED BY: R. BEHM	
SUBMITTED BY: ROBERT C. BEHM ENGINEER:	SOL. NO. DATED: CONTR. NO DRAWING NUMBER SHEET NO. 21 of 31 SEQUENCE NO. 21

DRILLING LOG — Hole No. 3F-922

DIVISION	SWD
INSTALLATION	FWD
SHEET	1 of 3 sheets
1. PROJECT	LONGHORN AAP (STRATIGRAPHIC TEST
2. LOCATION	BORINGS FOR GROUND-WATER QUALITY ASSESS.)
3. DRILLING AGENCY	USCE
4. HOLE NO.	3F-922
5. NAME OF DRILLER	T. SUITS
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	
8. DEPTH DRILLED INTO ROCK	
9. TOTAL DEPTH OF HOLE	201.0'
10. SIZE AND TYPE OF BIT	8" AUGER; 4½" FISHTAIL
11. DATUM FOR ELEVATION SHOWN	
12. MANUFACTURER'S DESIGNATION OF DRILL	FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED 2; UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES	N/A
15. ELEVATION GROUND WATER	SEE REMARKS COLUMN
16. DATE HOLE	STARTED 18 MAY '88; COMPLETED 20 MAY '88
17. ELEVATION TOP OF HOLE	195.98
18. TOTAL CORE RECOVERY FOR BORING	N/A
19. SIGNATURE OF INSPECTOR	Jackie R. Stokes

Depth: 0.0 … 50 … 100 … 150 … 201.0

0.0' TO 3.0'±
SILT: LOW PLASTICITY; LIGHT GRAY & YELLOWISH BROWN; VERY STIFF; DAMP; VERY SANDY

3.0'± TO 15.0'±
CLAY:
3.0'±-6.0'±: MEDIUM-HIGH PLASTICITY; RED & LIGHT GRAY; VERY STIFF
6.0'±-11.0'±: MEDIUM PLASTICITY; LIGHT GRAY & YELLOWISH BROWN; SILTY
11.0'±-15.0'±: LOW PLASTICITY; LIGHT GRAY & YELLOWISH BROWN; VERY SILTY; SANDY

15.0'± TO 25.0'±
SILT: LOW PLASTICITY; YELLOWISH BROWN WITH LIGHT GRAY; SANDY

25.0'± TO 28.0'±
CLAY: LOW-MEDIUM PLASTICITY; LIGHT GRAY WITH YELLOWISH BROWN; SANDY

28.0'± TO 42.0'±
SILT: LIGHT GRAY WITH YELLOWISH BROWN; LOW PLASTICITY; SANDY; CLAYEY FROM 39.0'±

42.0'± TO 58.0'±
CLAY: MEDIUM-HIGH PLASTICITY; LIGHT BLUE GRAY WITH YELLOWISH BROWN STREAKS; VERY SILTY FROM 54.0'±

58.0'± TO 71.0'±
SAND: FINE GRAINED; YELLOWISH BROWN; SILTY; WITH ABUNDANT CARBON MATTER. WITH FEW VERY FINE "PEA GRAVEL" AT 63.0'± WITH PARTIAL LOSS OF DRILL FLUIDS

71.0'± TO 87.0'±
CLAY: DARK BROWN & REDDISH BROWN; PLASTIC SLIGHTLY SILTY

87.0'± TO 105.0'±
SAND/SILT: LIGHT GRAY; INTERBEDDED LAYERS OF SILTY SAND & SANDY SILT

105.0'± TO 125.0'±
CLAY: LIGHT BLUE GRAY; PLASTIC; SLIGHTLY SILTY

125.0'± TO 201.0' T.D.
CLAY SHALE: BLUE GRAY; PLASTIC; MORE INDURATED THAN ABOVE; WITH TWO MODERATELY HARD THIN CEMENTED LAYERS FROM 143.5'-143.8' & 167.5'-167.8' (FERRUGINOUS SANDSTONE?); HAD TO USE ROCKBIT

143.5'-143.8': ROCK LAYER

167.5'-167.8': ROCK LAYER

T.D. 201.0'

8" AUGER — 4½" FISHTAIL — 4½" ROCKBIT — 4½" FISHTAIL — 4½" ROCKBIT — 4½" FISHTAIL

REMARKS

1. WATER LEVEL: NOTE: DRILL FLUID SETTLED OVERNIGHT TO 17.0' NOTE: BORING WAS BACKFILLED AFTER DRILLING WITH A THICK BENTONITE MUD.

2. NOTE: NO SAMPLES WERE TAKEN

3. DRILLING: 8" FLIGHT AUGER: 0.0' - 10.0' NOTE: SET 6" PVC CASING TO 10.0' 4½" FISHTAIL: 10.0' - 143.5' 4½" ROCKBIT: 143.5' - 143.8' 4½" FISHTAIL: 143.8' - 167.5' 4½" ROCKBIT: 167.5' - 167.8' 4½" FISHTAIL: 167.8' - 201.0' NOTE: BENTONITE DRILL MUD WAS USED IN BORING NOTE: LOST PARTIAL DRILL FLUID AT 63.0'

4. NOTE: RESISTIVITY & GAMMA LOGS WERE RUN IN BORING ON 20 MAY.

5. BORING LOCATION: NOTE: BORING WAS MOVED APPROX. 400' S53°E OF MAP LOCATION.

6. NOTE: NO ODOR WAS DETECTED DURING DRILLING.

7. NOTE: BORING WAS LOGGED BY DRILL CUTTINGS & DRILLING ACTION.

DRILLING LOG — Hole No. 3F-923

DIVISION	SWD
INSTALLATION	FWD
SHEET	1 of 2 sheets
1. PROJECT	LONGHORN AAP (STRATIGRAPHIC TEST
2. LOCATION	BORINGS FOR GROUND-WATER QUALITY ASSESS.)
3. DRILLING AGENCY	USCE
4. HOLE NO.	3F-923
5. NAME OF DRILLER	T. SUITS
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	
8. DEPTH DRILLED INTO ROCK	
9. TOTAL DEPTH OF HOLE	152.0'
10. SIZE AND TYPE OF BIT	8" AUGER; 4½" FISHTAIL
11. DATUM FOR ELEVATION SHOWN	
12. MANUFACTURER'S DESIGNATION OF DRILL	FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED 0; UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES	N/A
15. ELEVATION GROUND WATER	SEE REMARKS COLUMN
16. DATE HOLE	STARTED 23 MAY 88; COMPLETED 24 MAY 88
17. ELEVATION TOP OF HOLE	175.97
18. TOTAL CORE RECOVERY FOR BORING	N/A
19. SIGNATURE OF INSPECTOR	Jackie R. Stokes

Depth: 0.0 … 50 … 100 … 150 … 152.0

0.0' TO 1.7'
SAND: FINE GRAINED; YELLOWISH BROWN & LIGHT GRAY; MEDIUM; MOIST; VERY SILTY

1.7' TO 3.6'
SILT: LOW-MEDIUM PLASTICITY; LIGHT GRAY & YELLOWISH BROWN; STIFF; MOIST; SANDY

3.6' TO 11.0'±
SAND: FINE GRAINED; LIGHT BLUE GRAY WITH YELLOWISH BROWN; MEDIUM; WET; VERY SILTY

11.0'± TO 27.0'±
CLAY: YELLOWISH BROWN WITH LIGHT GRAY; PLASTIC; SILTY

27.0'± TO 31.0'±
SILT: LIGHT BLUE GRAY; VERY SANDY; WITH CARBON MATTER

31.0'± TO 52.0'±
SAND: FINE GRAINED; LIGHT GRAY; VERY CARBONACEOUS; WITH LIGNITE; GRAVELLY FROM 47.0' WITH FINE "PEA GRAVEL" & PARTIAL LOSS OF DRILL FLUIDS

52.0'± TO 90.0'±
SAND/SILT: LIGHT GRAY & GRAYISH BROWN; INTERBEDDED; WITH CLAYEY SILT SEAMS; WITH CARBON MATTER; CLAYEY AT 70.0'±

90.0'± TO 142.0'±
CLAY: LIGHT BLUE GRAY; VERY SANDY; SILTY; WITH CARBON MATTER

142.0'± TO 152.0' T.D.
CLAY SHALE: DARK GRAY; SLIGHTLY SILTY; PLASTIC

T.D. 152.0'

8" AUGER — 4½" FISHTAIL

REMARKS

1. WATER LEVEL: NOTE: SOME FREE WATER IN BORING AT 3.6'± NOTE: BORING WAS BACKFILLED AFTER DRILLING WITH A THICK BENTONITE MUD.

2. NOTE: NO SAMPLES WERE TAKEN

3. DRILLING: 8" FLIGHT AUGER: 0.0' - 10.0' NOTE: SET 6" PVC CASING TO 10.0' 4½" FISHTAIL: 10.0' - 152.0' NOTE: BENTONITE DRILL MUD WAS USED IN BORING NOTE: LOST PARTIAL DRILL FLUID AT 47.0'

4. NOTE: RESISTIVITY & GAMMA LOGS WERE RUN IN BORING ON 24 MAY.

5. NOTE: BORING WAS DRILLED AS SHOWN ON LAYOUT.

6. NOTE: NO ODOR WAS DETECTED DURING DRILLING.

7. NOTE: BORING WAS LOGGED BY DRILL CUTTINGS & DRILLING ACTION.

DRILLING LOG — Hole No. 3F-924

DIVISION	SWD
INSTALLATION	FWD
SHEET	1 of 2 sheets
1. PROJECT	LONGHORN AAP (STRATIGRAPHIC TEST
2. LOCATION	BORINGS FOR GROUND-WATER QUALITY ASSESS.)
3. DRILLING AGENCY	USCE
4. HOLE NO.	3F-924
5. NAME OF DRILLER	T. SUITS
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	
8. DEPTH DRILLED INTO ROCK	
9. TOTAL DEPTH OF HOLE	175.0'
10. SIZE AND TYPE OF BIT	8" AUGER; 4½" FISHTAIL
11. DATUM FOR ELEVATION SHOWN	
12. MANUFACTURER'S DESIGNATION OF DRILL	FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED 0; UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES	N/A
15. ELEVATION GROUND WATER	UNDETERMINED
16. DATE HOLE	STARTED 25 MAY '88; COMPLETED 26 MAY '88
17. ELEVATION TOP OF HOLE	176.10
18. TOTAL CORE RECOVERY FOR BORING	N/A
19. SIGNATURE OF INSPECTOR	Jackie R. Stokes

Depth: 0.0 … 50 … 100 … 150 … 175.0

0.0' TO 0.7'
SILT: LOW PLASTICITY; LIGHT BROWN; HARD; DRY; SANDY.

0.7' TO 5.5'
CLAY:
0.7'-4.0': MEDIUM PLASTICITY; LIGHT GRAY WITH YELLOWISH BROWN; HARD; DAMP; SLIGHTLY SILTY
4.0'-5.5': LOW PLASTICITY; YELLOWISH BROWN WITH LIGHT GRAY; HARD; DAMP; SANDY

5.5' TO 13.0'±
SILT; LOW PLASTICITY; YELLOWISH BROWN & LIGHT GRAY; STIFF TO MEDIUM FROM 7.0'±; DAMP TO WET FROM 7.0'±; VERY SANDY

13.0'± TO 28.0'±
SAND: FINE GRAINED; LIGHT GRAY WITH YELLOWISH BROWN TO YELLOWISH BROWN WITH LIGHT GRAY FROM 17.0'± TO LIGHT GRAY FROM 23.0'±; SILTY TO VERY SILTY FROM 17.0'±; CARBONACEOUS FROM 23.0'±

28.0'± TO 34.0'±
CLAY:
28.0'±-31.0'±: PLASTIC; LIGHT GRAY; SLIGHTLY SILTY
31.0'±-34.0'±: SANDY; LIGHT GRAY; WITH CARBON MATTER

34.0'± TO 53.0'±
SAND: FINE GRAINED; LIGHT GRAY; VERY CARBONACEOUS; WITH LIGNITE

53.0'± TO 60.0'±
SANDSTONE/GRAVEL(?): CUTTINGS WERE YELLOWISH BROWN FERRUGINOUS SANDSTONE WITH FEW VERY FINE QUARTZ GRAVEL; CARBONACEOUS; DRILLED AS IF CEMENTED

60.0'± TO 66.0'±
SAND: FINE GRAINED; LIGHT GRAY; WITH SILT SEAMS; WITH CARBON MATTER

66.0'± TO 151.0'±
CLAY: LIGHT BLUE GRAY; VERY SANDY; SILTY; WITH CARBON MATTER; WITH SANDY SILT SEAMS

151.0'± TO 175.0' T.D.
CLAY SHALE: DARK GRAY; PLASTIC.

168.0'-169.0': MOD. HARD ROCK LAYER; DIFFICULT TO CUT WITH FISHTAIL BIT; FERRUGINOUS SANDSTONE(?)

T.D. 175.0'

8" AUGER — 4½" FISHTAIL

REMARKS

1. WATER LEVEL: NOTE: MATERIAL WAS WET FROM 7.0'±-8.0' DURING AUGERING; BORING WAS BACKFILLED AFTER DRILLING WITH A THICK BENTONITE MUD.

2. NOTE: NO SAMPLES WERE TAKEN

3. DRILLING: 8" FLIGHT AUGER: 0.0' - 10.0' NOTE: SET 6" PVC CASING TO 10.0' 4½" FISHTAIL: 10.0' - 175.0' NOTE: BENTONITE DRILL MUD WAS USED IN BORING.

4. NOTE: RESISTIVITY & GAMMA LOGS WERE RUN IN BORING ON 27 MAY 88

5. NOTE: BORING WAS DRILLED AS SHOWN ON LAYOUT.

6. NOTE: NO ODOR WAS DETECTED DURING DRILLING.

7. NOTE: BORING WAS LOGGED BY DRILL CUTTINGS & DRILLING ACTION.

DRILLING LOG — Hole No. 3F

DIVISION	SWD
INSTALLATION	FWD
SHEET	1 of 2 sheets
1. PROJECT	LONGHORN AAP
2. LOCATION	GROUND-WATER QUALITY ASSESSMENT
3. DRILLING AGENCY	USCE
4. HOLE NO.	3F-925
5. NAME OF DRILLER	T. SUITS
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	
8. DEPTH DRILLED INTO ROCK	
9. TOTAL DEPTH OF HOLE	167.2'
10. SIZE AND TYPE OF BIT	8" AUGER; 4½" FISHTAIL
11. DATUM FOR ELEVATION SHOWN	
12. MANUFACTURER'S DESIGNATION OF DRILL	FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED 0; UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES	N/A
15. ELEVATION GROUND WATER	UNDETERMINED
16. DATE HOLE	STARTED 23 AUG '88; COMPLETED 24 AUG '88
17. ELEVATION TOP OF HOLE	194.93'
18. TOTAL CORE RECOVERY FOR BORING	N/A
19. SIGNATURE OF INSPECTOR	Jackie R. Stokes

Depth: 0.0 … 50 … 100 … 150 … 167.2

0.0' TO 2.2'±
SILT: LOW PLASTICITY; LIGHT GRAY & YELLOWISH BROWN; VERY STIFF; DAMP; VERY SANDY

2.2'± TO 15.0'±
CLAY:
2.2'±-6.0'±: MEDIUM-HIGH PLASTICITY; LIGHT GRAY & RED BROWN TO LIGHT RED WITH GRAY FROM 5.0'; VERY STIFF-HARD; DAMP
6.0'±-15.0'±: MEDIUM TO LOW PLASTICITY FROM 8.0'±; YELLOWISH BROWN WITH LIGHT GRAY; STIFF; MOIST; SILTY TO VERY SILTY FROM 8.0'±; VERY SANDY FROM 8.0'±

15.0'± TO 39.0'±
SILT: LOW PLASTICITY; YELLOWISH BROWN WITH LIGHT GRAY; SANDY; WITH SILTY SAND SEAMS

39.0'± TO 49.0'±
CLAY: MEDIUM-HIGH PLASTICITY; LIGHT BLUE GRAY WITH YELLOWISH BROWN;

49.0'± TO 71.0'±
SAND/SILT: SILTY SAND & SANDY SILT; GRAY; WITH ABUNDANT CARBON MATTER; WITH SOME WEAK CEMENTATION

71.0'± TO 73.0'±
CLAY: MEDIUM-HIGH PLASTICITY; LIGHT BLUE GRAY;

73.0'± TO 108.0'±
CLAY/SILT: PREDOMINANTLY LOW PLASTICITY WITH SOME THIN PLASTIC SEAMS; SANDY; LIGHT BLUE GRAY WITH YELLOWISH BROWN

108.0'± TO 167.2' T.D.
CLAY SHALE: BLUE GRAY-GRAY; PLASTIC; WITH THREE CEMENTED LAYERS AS INDICATED BELOW

138.0'-139.0': HARD WHITISH GRAY SANDSTONE

158.0'-158.4': MODERATELY HARD WHITISH GRAY SANDSTONE (CUT WITH FISHTAIL BIT)

167.0'-167.2' T.D.: HARD WHITISH GRAY SANDSTONE

T.D. 167.2'

8" AUGER — 4½" FISHTAIL — 4½" ROCKBIT — 4½" FISHTAIL

REMARKS

1. WATER LEVEL: NOTE: WATER LEVEL UNDETERMINED. NOTE: BORING WAS BACKFILLED AFTER DRILLING & E-LOGGING WITH A THICK BENTONITE DRILL MUD.

2. NOTE: NO SAMPLES WERE TAKEN.

3. DRILLING: 8" FLIGHT AUGER: 0.0' - 11.0' NOTE: SET 6" PVC PIPE TO 11.0' 4½" FISHTAIL BIT: 11.0' - 138.0' 4½" ROCKBIT: 138.0' - 139.0' 4½" FISHTAIL BIT: 139.0' - 167.2' NOTE: BENTONITE DRILL MUD WAS USED IN BORING.

4. NOTE: RESISTIVITY & GAMMA LOGS WERE RUN IN BORING ON 24 AUG. 88.

5. NOTE: BORING WAS DRILLED AS SURVEYED & STAKED.

6. NOTE: NO ODOR WAS DETECTED DURING DRILLING.

7. NOTE: BORING WAS LOGGED BY DRILL CUTTINGS & DRILLING ACTION.

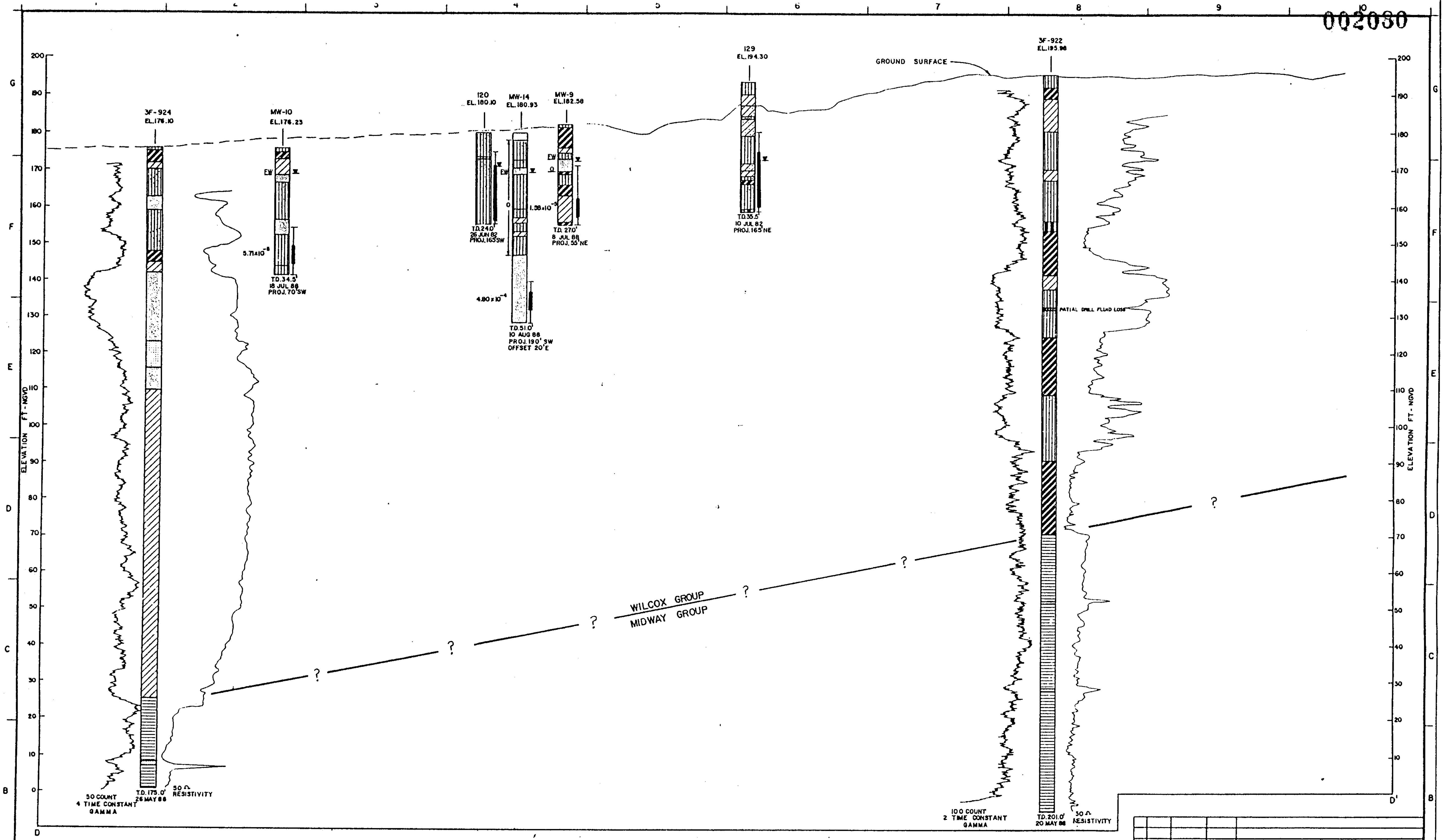
NOTE
1. FOR BORING LOCATIONS, SEE SHEET 21.
2. FOR DOWNHOLE GEOPHYSICAL LOGS, SEE SHEET 23 THRU 27.

SYMBOL	DESCRIPTION OF REVISION	DATE	APPROVAL

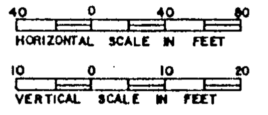
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RCRA FACILITY INVESTIGATION
ABG AND UEP SITES
PHASE I
LOGS OF BORINGS
STRATIGRAPHIC TEST BORINGS

DESIGNED BY: D. FITZGERALD
DRAWN BY: C. HIRBY
REVIEWED BY: R. BEHM
SUBMITTED BY: ROBERT C. BEHM
ENGINEER:
SOL. NO.
DATED:
CONTR NO
DRAWING NUMBER
SHEET NO. 22 of 31
SEQUENCE NO. 22



NOTES
1. FOR LEGEND, STRATIGRAPHIC SYMBOLS, AND GENERAL NOTES, SEE SHEET 18.
2. FOR BORING LOCATIONS, SEE SHEET 21.



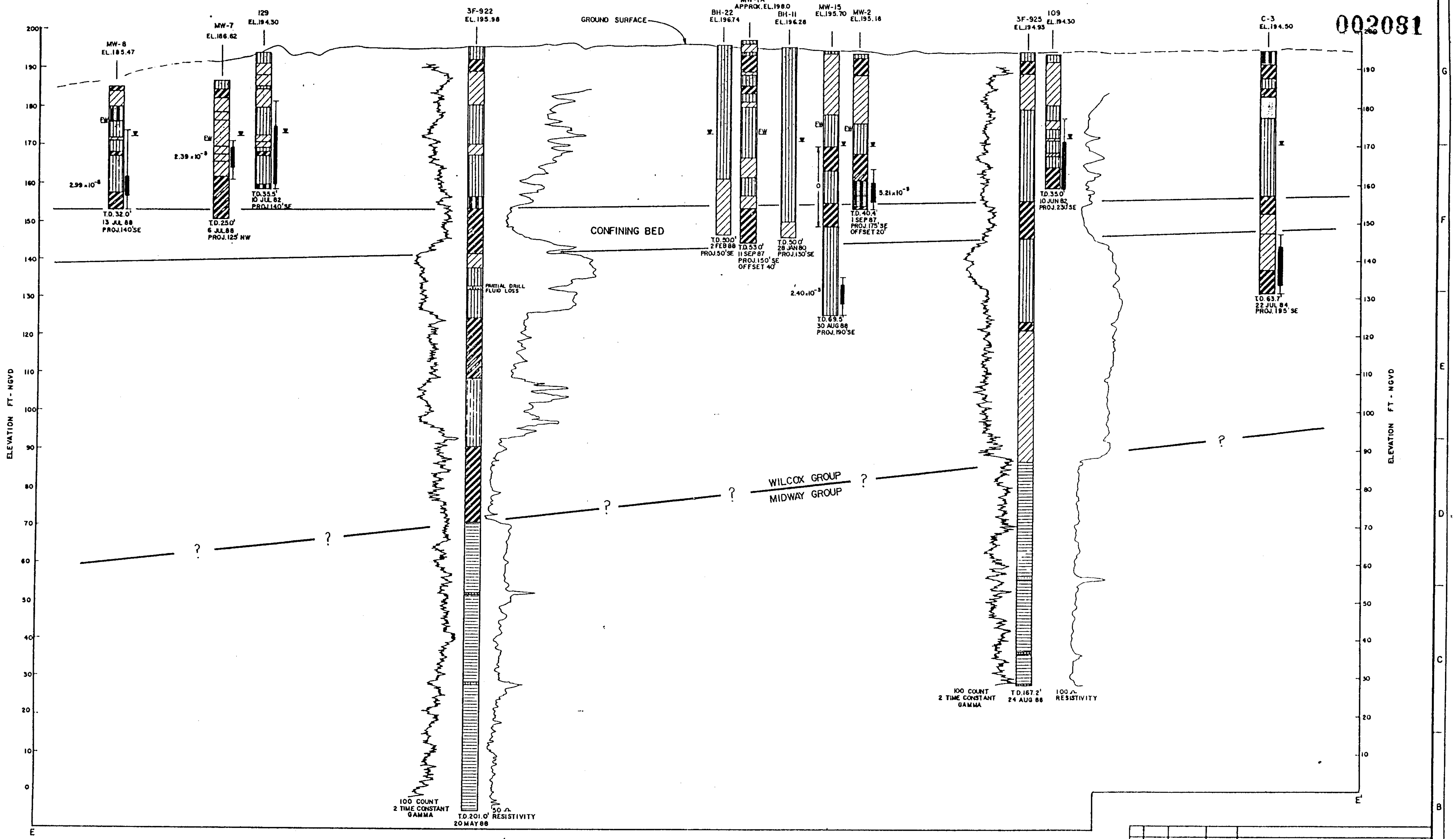
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

DESIGNED BY: D.FITZGERALD
DRAWN BY: C. KIRBY
REVIEWED BY: R. BEHM

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

RCRA FACILITY INVESTIGATION
ABG AND UEP SITES
PHASE I
SUBSURFACE PROFILE D-D'

SUBMITTED BY: ROBERT C. BEHM
ENGINEER:
SOL. NO.
DATED:
CONTR. NO.
DRAWING NUMBER
SHEET NO. 23 of 31
SEQUENCE NO. 23



NOTES

1. LOG SHOWN FOR MW-7 WAS FROM ORIGINALLY DRILLED LOCATION APPROXIMATELY 10' SE OF LOCATION SHOWN. WELL WAS CONSTRUCTED IN NEW BORING WHERE T.D. WAS 25.0'.
2. FOR LEGEND, STRATIGRAPHIC SYMBOLS, AND GENERAL NOTES, SEE SHEET 18.
3. FOR BORING LOCATIONS, SEE SHEET 21.

60 0 60 120
HORIZONTAL SCALE IN FEET

10 0 10 20
VERTICAL SCALE IN FEET

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

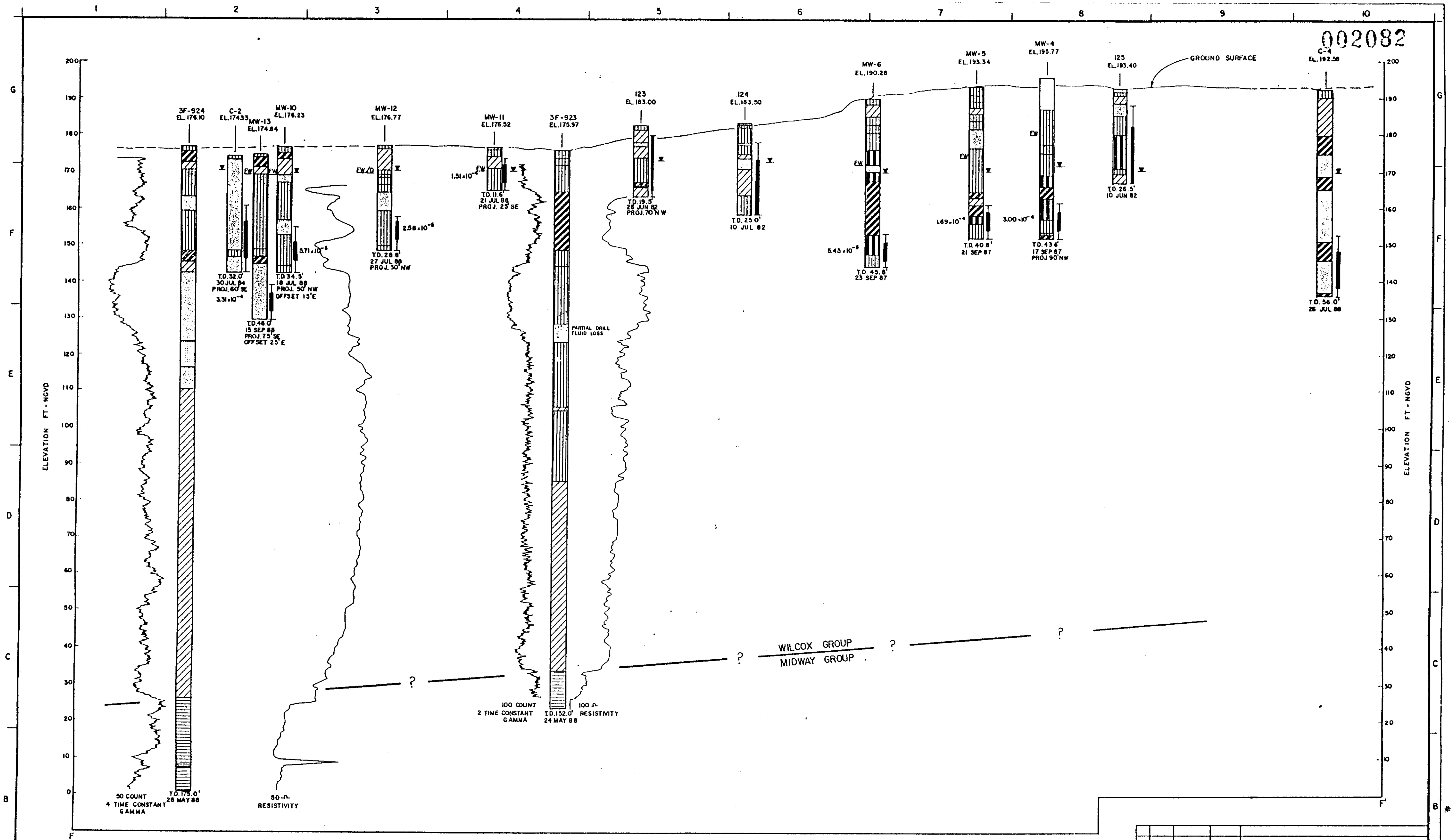
DESIGNED BY: D.FITZGERALD
DRAWN BY: C. KIRBY
REVIEWED BY: R. BEHM

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

RCRA FACILITY INVESTIGATION
ABG AND UEP SITES
PHASE I
SUBSURFACE PROFILE E - E'

SUBMITTED BY: ROBERT C. BEHM
ENGINEER:
SOL. NO.
DATED:
CONTR. NO.
DRAWING NUMBER
SHEET NO. 24 of 31
SEQUENCE NO. 24

002082



NOTES
1. FOR LEGEND, STRATIGRAPHIC SYMBOLS, AND GENERAL NOTES, SEE SHEET 18.
2. FOR BORING LOCATIONS, SEE SHEET 21.

60 0 60 120
HORIZONTAL SCALE IN FEET

10 0 10 20
VERTICAL SCALE IN FEET

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

DESIGNED BY: D.FITZGERALD
DRAWN BY: C. KIRBY
REVIEWED BY: R. BEHM

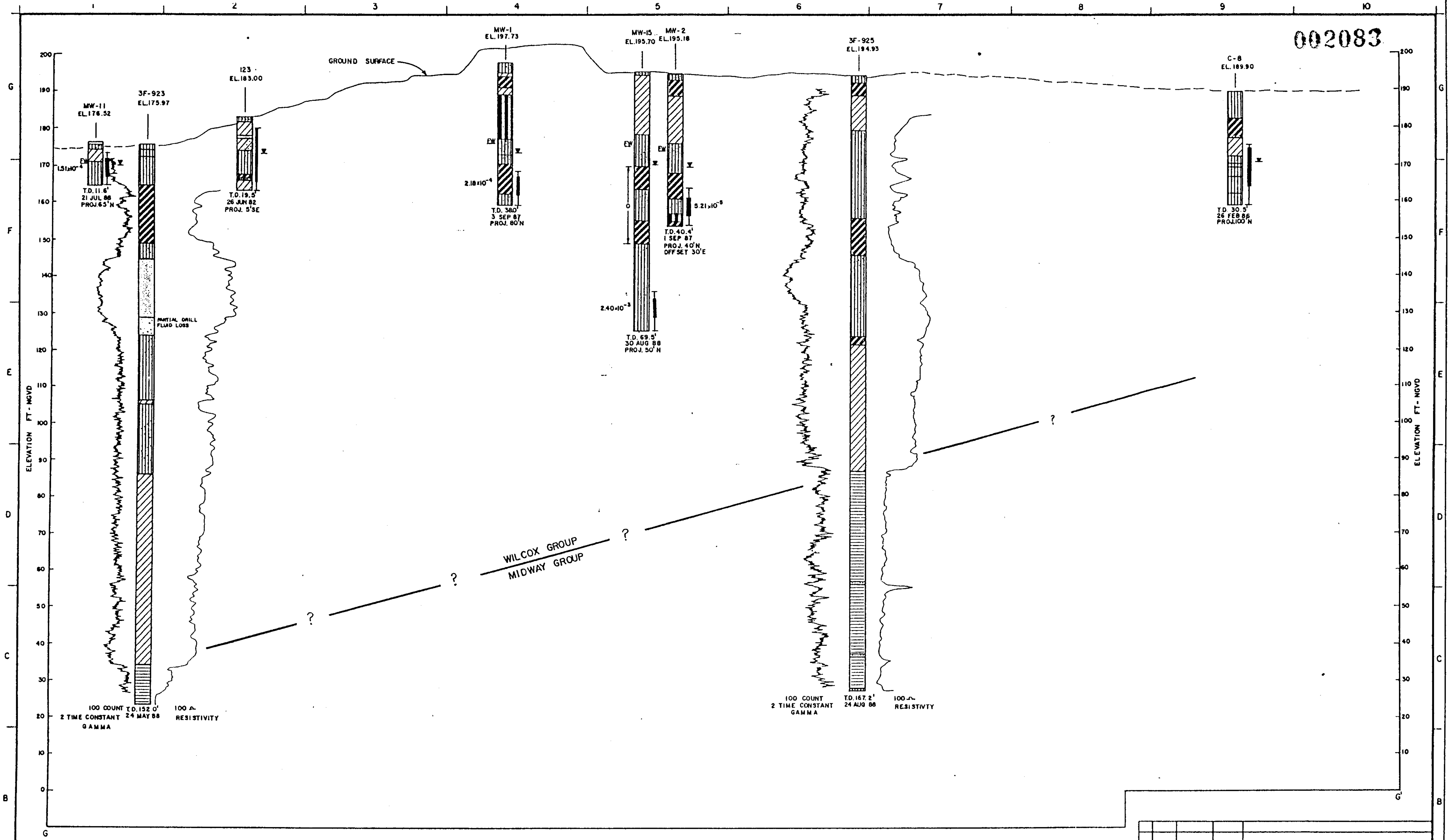
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

RCRA FACILITY INVESTIGATION
ABG AND UEP SITES
PHASE I
SUBSURFACE PROFILE F - F'

SUBMITTED BY:
ROBERT C. BEHM
ENGINEER:

SOL. NO.
DATED:
CONTR. NO.
DRAWING NUMBER
SHEET NO. 25 OF 31
SEQUENCE NO. 25

002083



NOTES
1. FOR LEGEND, STRATIGRAPHIC SYMBOLS, AND GENERAL NOTES, SEE SHEET 18.
2. FOR BORING LOCATIONS, SEE SHEET 21.

60 0 60 120
HORIZONTAL SCALE IN FEET

10 0 10 20
VERTICAL SCALE IN FEET

SYM.	DESCRIPTION	DATE	APPROVAL	DESCRIPTION OF REVISION

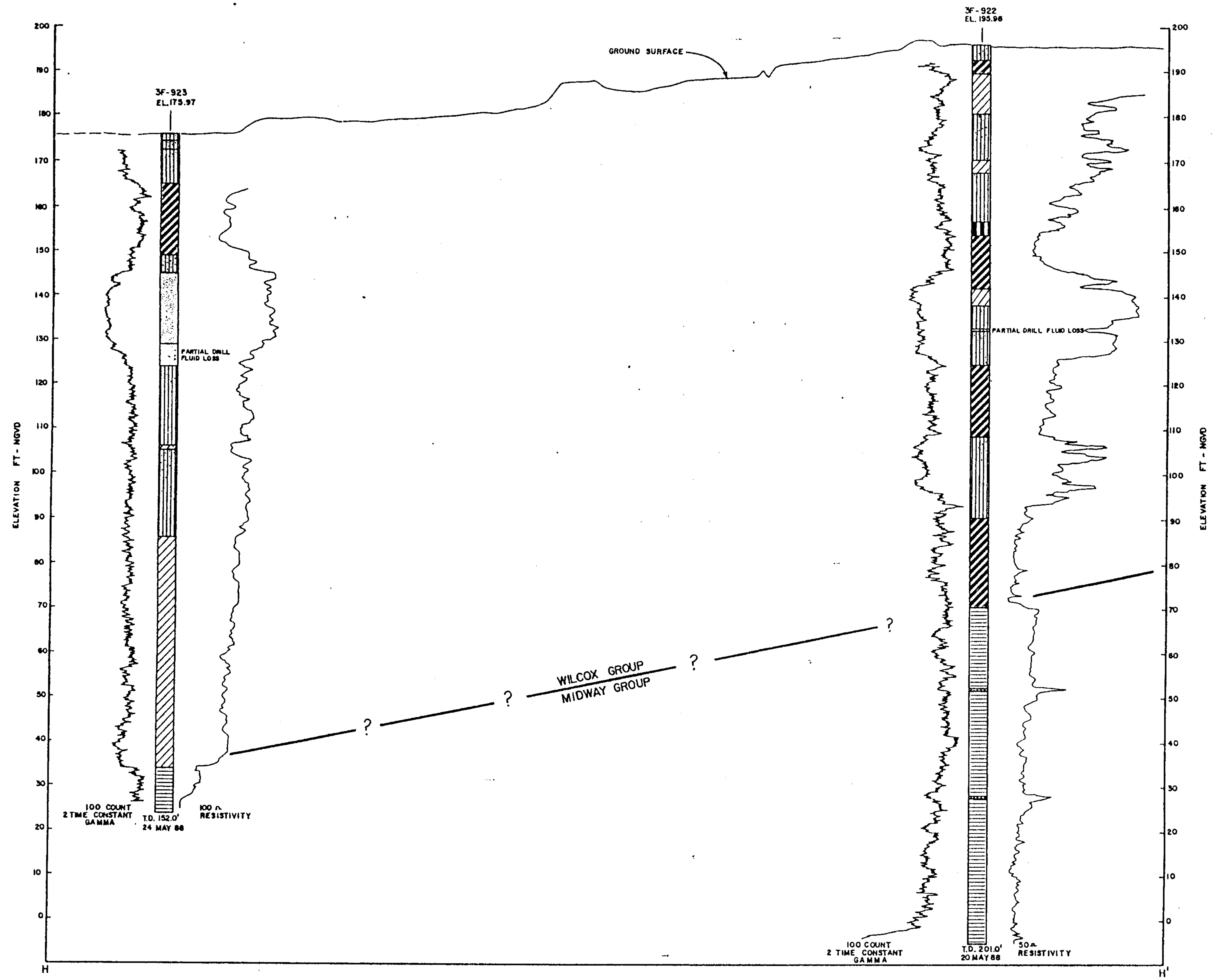
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

DESIGNED BY: D.FITZGERALD
DRAWN BY: C.KIRBY
REVIEWED BY: R.BEHM

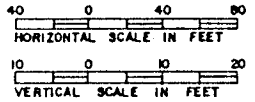
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RCRA FACILITY INVESTIGATION
ABG AND UEP SITES
PHASE I
SUBSURFACE PROFILE G-G'

SUBMITTED BY: ROBERT C. BEHM
ENGINEER:
SOL. NO.
DATED:
CONTR. NO.
DRAWING NUMBER
SHEET NO. 26 of 31
SEQUENCE NO. 26

002084



NOTES
1. FOR LEGEND, STRATIGRAPHIC SYMBOLS, AND GENERAL NOTES, SEE SHEET 18.
2. FOR BORING LOCATIONS, SEE SHEET 21.



U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

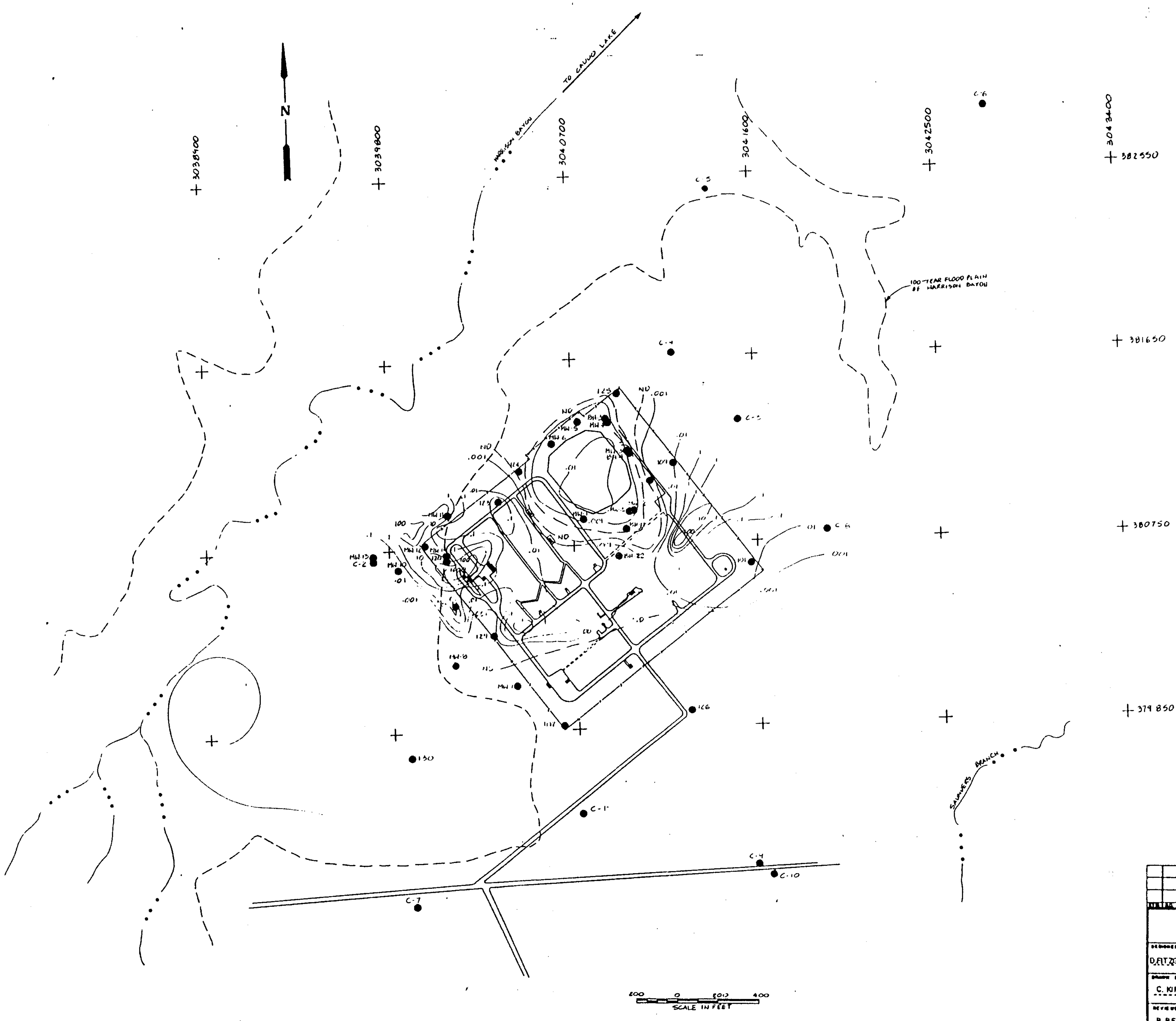
DESIGNED BY: D.FITZGERALD
DRAWN BY: C.KIRBY
REVIEWED BY: R.BEHM

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

RCRA FACILITY INVESTIGATION
ABG AND UEP SITES
PHASE I
SUBSURFACE PROFILE H - H'

SUBMITTED BY:
ROBERT C. BEHM
ENGINEER:

SOL. NO.
DATED:
CONTR. NO.
DRAWING NUMBER
SHEET NO. 27 of 31
SEQUENCE NO. 27



LEGEND

125 ●	MONITORING WELL
.01	ISO CONCENTRATION LINES OF TRICHLOROETHENE IN SOIL GAS (ug/L)
ND	EXTENT OF TRICHLOROETHENE DETECTION IN SOIL GAS

NOTES

1. SOIL GAS SURVEY PERFORMED SEPT 1987.
2. REFER TO SHEET 4 FOR SAMPLING LOCATIONS AND CONCENTRATIONS.

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

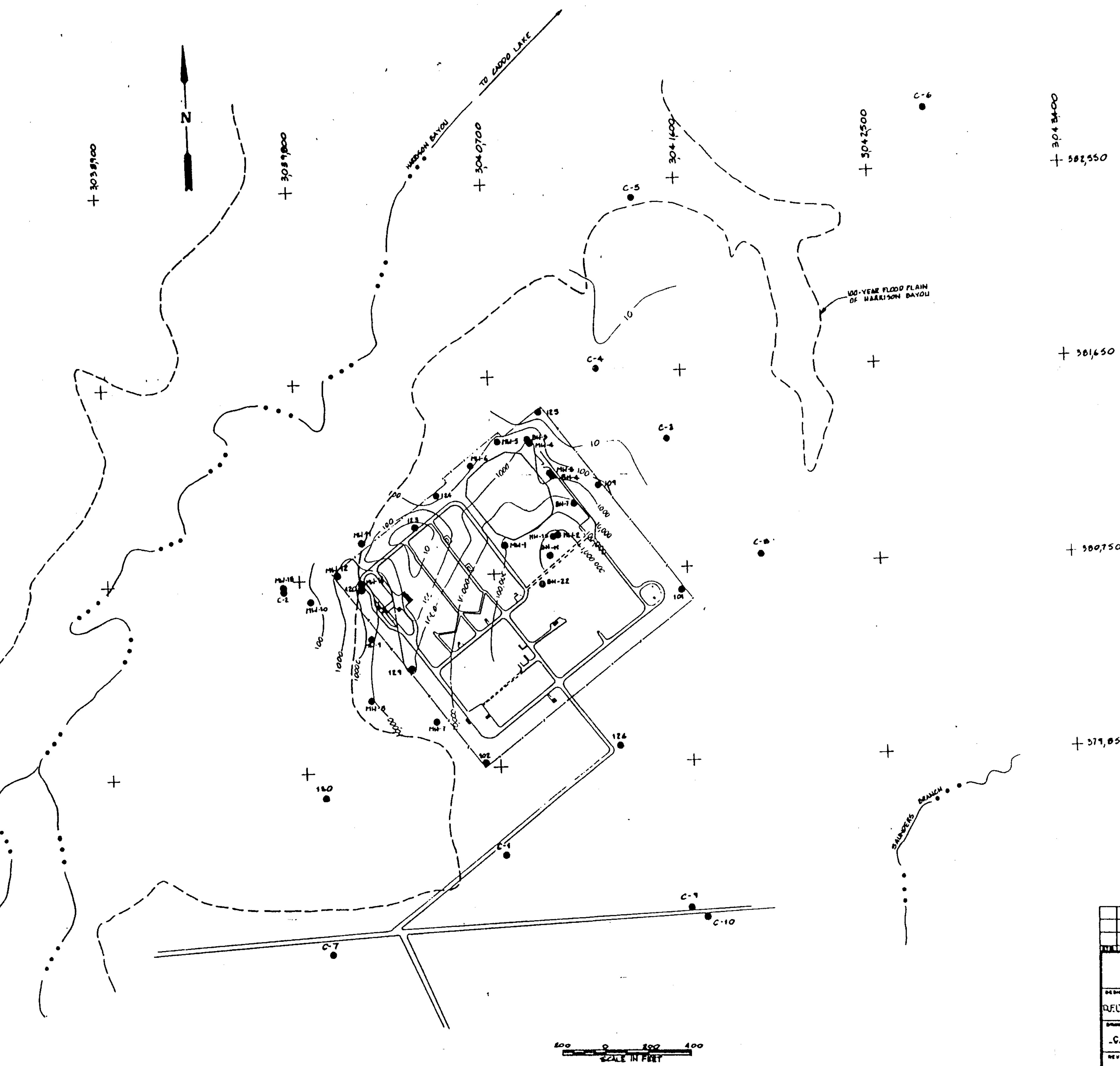
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RCRA FACILITY INVESTIGATION
ABG AND UEP SITES
PHASE I
SOIL GAS CONTOURS AND WELL LOCATIONS

DESIGNED BY: D. FITZGERALD
DRAWN BY: C. KIRBY
REVIEWED BY: R. BEHM
SUBMITTED BY: ROBERT C. BEHM
ENGINEER:
SOL. NO.
DATED:
CONTR. NO
DRAWING NUMBER
SHEET NO. 28 OF 31
SEQUENCE NO. 28

002086

GROUNDWATER MONITORING WELLS
IN THE
ACTIVE BURNING GROUNDS AREA

WELL NO.	MEAS. PT. ELEVATION FT. MSL	COMP. MON. WELL	CORRECT ACT. MON. WELL
C-1	193.80	NO	NO
C-2	176.03	NO	NO
C-3	196.41	NO	YES
C-4	194.74	NO	YES
C-5	180.77	NO	YES
C-6	192.34	NO	NO
C-7	198.72	NO	NO
C-8	192.58	NO	NO
C-9	202.66	NO	YES
C-10	202.04	NO	NO
BH-3	198.30	NO	NO
BH-4	197.44	NO	NO
BH-7	197.24	NO	YES
BH-11	199.03	NO	NO
BH-21	REMOVED.	NO	NO
BH-22	199.25	NO	NO
101	197.51	NO	NO
102	194.55	NO	NO
108	197.11	NO	NO
120	183.28	NO	NO
123	188.33	NO	NO
124	188.39	NO	NO
125	196.35	NO	NO
126	185.41	NO	NO
129	187.13	NO	NO
130	177.80	NO	NO
MW-1	199.24	YES	YES
MW-2	187.00	YES	YES
MW-3	196.51	YES	YES
MW-4	197.31	YES	YES
MW-5	195.21	YES	YES
MW-6	192.18	YES	YES
MW-7	188.56	NO	NO
MW-8	186.85	NO	NO
MW-9	184.78	NO	NO
MW-10	177.99	NO	NO
MW-11	177.65	NO	NO
MW-12	178.37	NO	NO
MW-13	176.72	NO	NO
MW-14	182.99	NO	NO
MW-15	197.32	NO	NO



TCE AND METHYLENE CHLORIDE CONCENTRATIONS FOR MONITORING WELLS SAMPLED 19-27 SEPTEMBER 1988

WELL NUMBER SAMPLED	TRICHLOROETHENE ug/l	METHYLENE CHLORIDE ug/L
MW-1	200,000	4,200,000E
MW-2	1,400,000	17,000,000E
MW-3	330	198J
MW-4	1,100	38B
MW-5	130	14B
MW-6	91	88B
MW-7	7,600	2300U
MW-8	13,000	4800U
MW-9	11,000	5,900
MW-10	61	120B
MW-11	770E	13U
MW-12	1,300	40U
MW-13	13	5U
MW-14	250	10U
MW-15	33	5B
C-2	17	3J
C-3	5U	5U
C-4	9	5U
C-5	77	11B
109	190	9B
120	32,000	310,000
123	5U	5U
124	80	3B
125	50U	50U
129	930	33U

E = Concentration exceeds calibration range of instrument used for analysis

B = Probable blank contamination

J = Estimated value less than sample quantitation limit but greater than zero

U = Compound analyzed for but not detected below this quantitation limit

LEGEND

—100—	ISO CONCENTRATION LINES OF TRICHLOROETHENE IN GROUND WATER (ug/L)
109●	MONITORING WELL

NOTES
1. SAMPLING PERFORMED 19-27 SEPTEMBER 1988.
2. REFER TO APPENDIX Z FOR COMPLETE ANALYTICAL DATA.

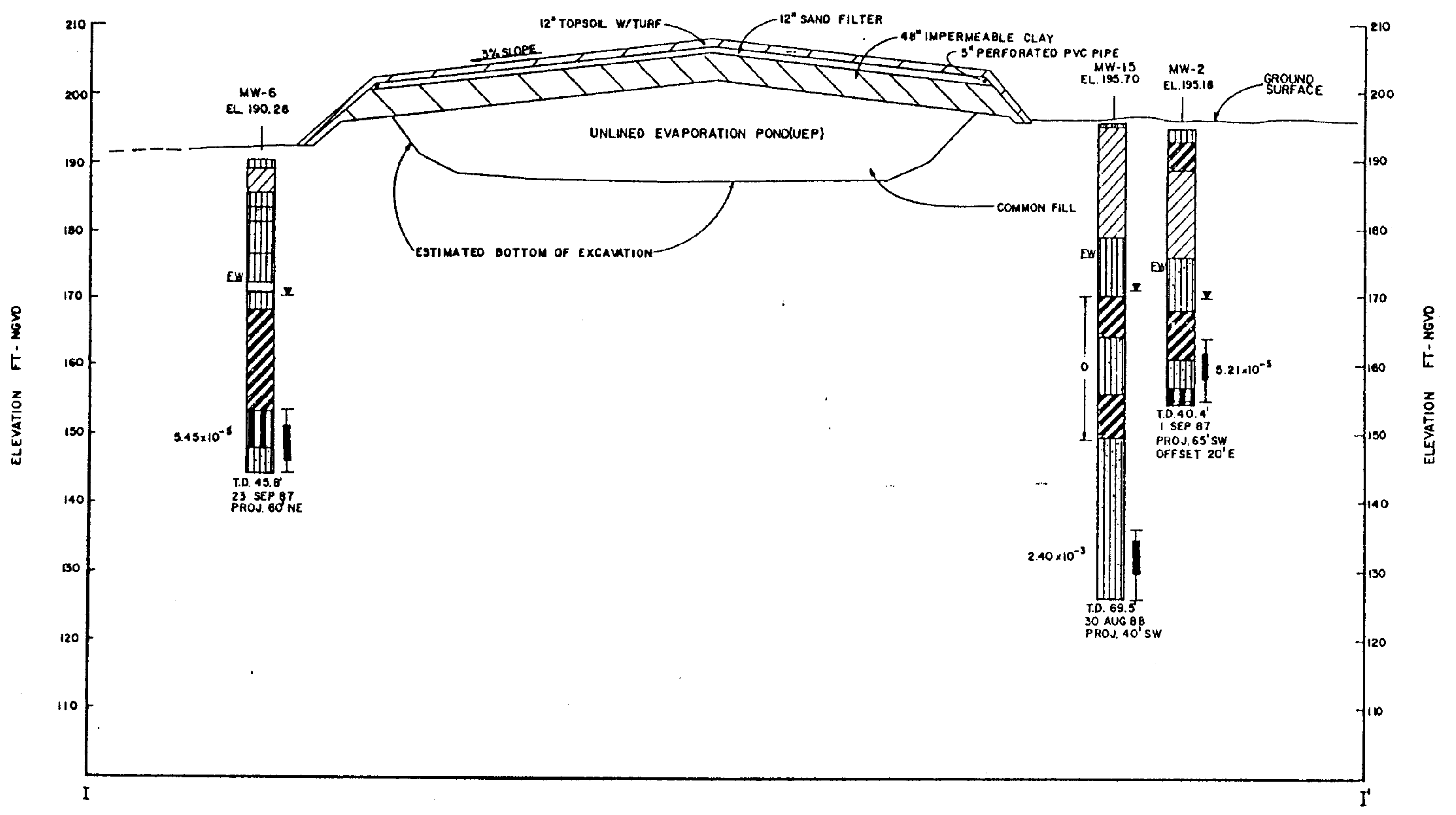
REVISIONS

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

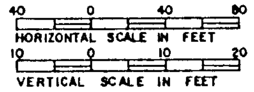
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RCRA FACILITY INVESTIGATION
ABG AND UEP SITES
PHASE I
EXTENT OF TRICHLOROETHENE IN SHALLOW GROUND WATER

DESIGNED BY: D.FITZGERALD
DRAWN BY: C. KIRBY
REVIEWED BY: R. BEHM
SUBMITTED BY: ROBERT C. BEHM
ENGINEER:
SOL. NO.
DATED:
CONTR. NO.
DRAWING NUMBER
SHEET NO. 29 of 31
SEQUENCE NO. 29

002087



NOTES
1. FOR LEGEND, STATIGRAPHIC SYMBOLS, AND GENERAL NOTES, SEE SHEET 18.
2. UEP DETAILS ARE AS SHOWN ALONG THE BASELINE SECTION ON THE CONSTRUCTION AS-BUILTS, USACE, FORT WORTH DISTRICT, CONTRACT NO. DACA63-85-C-0262.
3. FOR BORING LOCATIONS, SEE SHEET 21.



SYMBOL	DESCRIPTION	DATE	APPROVAL	DESCRIPTION OF REVISION

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

DESIGNED BY: D. FITZGERALD
DRAWN BY: C. KIRBY
REVIEWED BY: R. BEHM

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

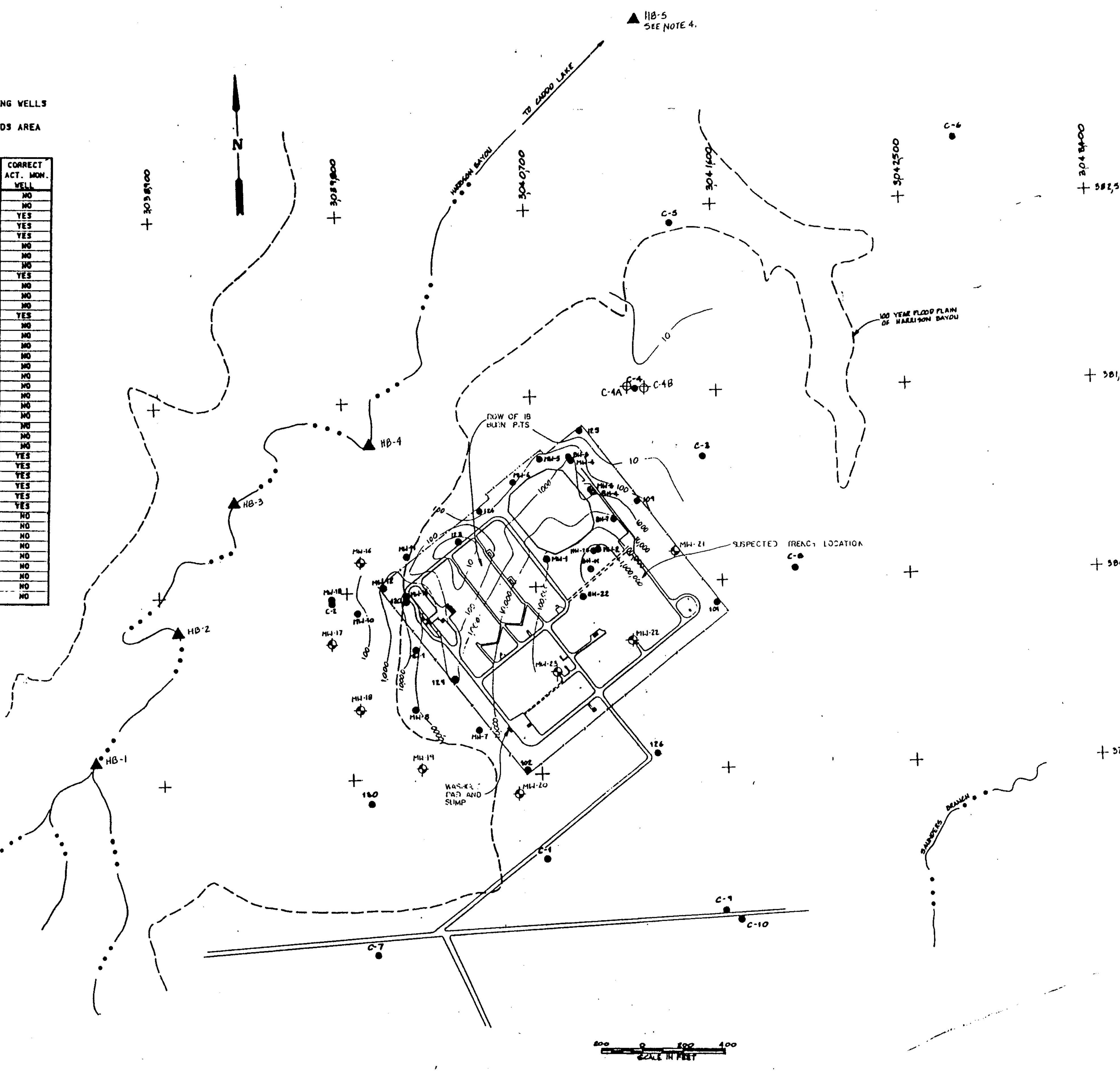
RCRA FACILITY INVESTIGATION
ABG AND UEP SITES
PHASE I
SUBSURFACE PROFILE I-I'

SUBMITTED BY: ROBERT C. BEHM
ENGINEER:
SOL. NO.
DATED:
CONTR. NO.
DRAWING NUMBER
SHEET NO. 30 of 31
SEQUENCE NO. 30

002088

GROUNDWATER MONITORING WELLS
IN THE
ACTIVE BURNING GROUNDS AREA

WELL NO.	MEAS. PT. ELEVATION FT. MSL	COMP. MON. WELL	CORRECT ACT. MON. WELL
C-1	183.80	NO	NO
C-2	178.03	NO	NO
C-3	196.41	NO	YES
C-4	184.74	NO	YES
C-5	180.77	NO	YES
C-6	182.34	NO	NO
C-7	196.72	NO	NO
C-8	182.58	NO	NO
C-9	202.86	NO	YES
C-10	202.04	NO	NO
BH-3	186.30	NO	NO
BH-4	187.44	NO	NO
BH-7	187.24	NO	YES
BH-11	188.03	NO	NO
BH-21	REMOVED.	NO	NO
BH-22	188.25	NO	NO
101	187.51	NO	NO
102	189.55	NO	NO
109	187.11	NO	NO
120	183.28	NO	NO
123	186.33	NO	NO
124	186.39	NO	NO
125	186.38	NO	NO
126	188.41	NO	NO
129	197.13	NO	NO
130	177.80	NO	NO
MW-1	189.24	YES	YES
MW-2	187.00	YES	YES
MW-3	186.51	YES	YES
MW-4	187.31	YES	YES
MW-5	185.21	YES	YES
MW-6	182.18	YES	YES
MW-7	188.58	NO	NO
MW-8	186.85	NO	NO
MW-9	184.78	NO	NO
MW-10	177.99	NO	NO
MW-11	177.85	NO	NO
MW-12	178.37	NO	NO
MW-13	176.72	NO	NO
MW-14	182.99	NO	NO
MW-15	187.32	NO	NO



TCE AND METHYLENE CHLORIDE CONCENTRATIONS FOR MONITORING WELLS SAMPLED 19-27 SEPTEMBER 1988

WELL NUMBER SAMPLED	TRICHLOROETHENE ug/l	METHYLENE CHLORIDE ug/l
MW-1	200,000	4,300,000E
MW-2	1,400,000	17,000,000E
MW-3	550	198J
MW-4	1,100	58B
MW-5	150	14B
MW-6	91	88B
MW-7	7,600	250U
MW-8	13,000	480U
MW-9	11,000	5,900
MW-10	61	120B
MW-11	770E	13U
MW-12	1,200	40U
MW-13	1J	5U
MW-14	250	10U
MW-15	2J	5B
C-2	17	3J
C-3	5U	5U
C-4	9	5U
C-5	77	110
109	190	9B
120	32,000	310,000
123	5U	5U
124	80	5U
125	50U	50U
129	930	33U

E = Concentration exceeds calibration range of instrument used for analysis

B = Probable blank contamination

J = Estimated value less than sample quantitation limit but greater than zero

U = Compound analyzed for but not detected below this quantitation limit

LEGEND

100	ISO CONCENTRATION LINES OF TRICHLOROETHENE IN GROUND WATER
109 ●	MONITORING WELL
MW-16 ⊕	PROPOSED MONITORING WELL LOCATION
HB-2 ▲	PROPOSED SURFACE WATER SAMPLING LOCATION

NOTES

1. SAMPLING PERFORMED 19-27 SEPTEMBER 1988.
2. REFER TO APPENDIX L FOR COMPLETE ANALYTICAL DATA.
3. FOR PIEZOMETRIC SURFACE MAP, SEE SHEET 20.
4. HB-5 IS LOCATED APPROXIMATELY 3000 FEET DOWNSTREAM OF HB-4.

SYMBOL	DESCRIPTION	DATE	APPROVAL

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

DESIGNED BY: D. FITZGERALD
DRAWN BY: C. KIRBY
REVIEWED BY: R. BEHM

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RCRA FACILITY INVESTIGATION
ABG AND UEP SITES
PHASE I
PROPOSED PHASE II
SAMPLING & MONITORING WELL LOCATIONS

SUBMITTED BY: ROBERT C. BEHM
ENGINEER:
SOL. NO.
DATED:
CONTR. NO.
DRAWING NUMBER
SHEET NO. 31 of 31
SEQUENCE NO. 31