GROUND-WATER QUALITY, WATER YEAR 1995, AND STATISTICAL ANALYSIS OF GROUND-WATER-QUALITY DATA, WATER YEARS 1994-95, AT THE CHROMIC ACID PIT SITE, U.S. ARMY AIR DEFENSE ARTILLERY CENTER AND FORT BLISS, EL PASO, TEXAS

by Cynthia G. Abeyta and Raymond G. Roybal

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CONVERSION FACTORS AND VERTICAL DATUM

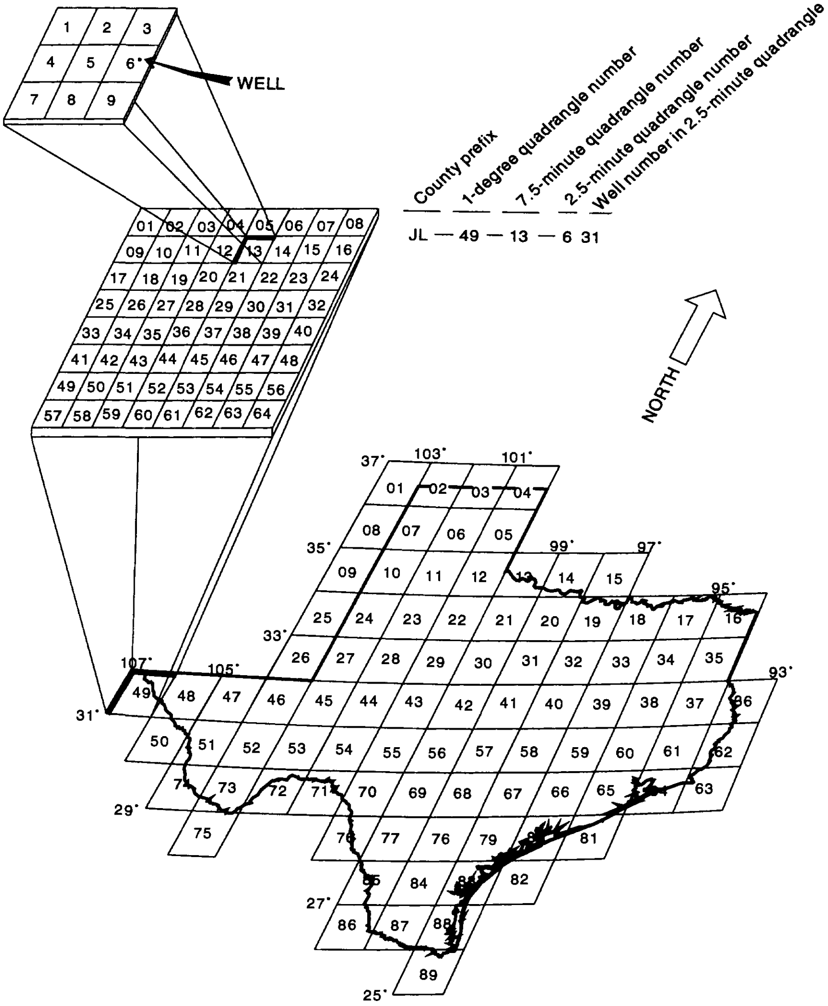
Multiply	By	To obtain
inch	25.40	millimeter
foot	0.3048	meter
yard	0.914	meter
mile	1.609	kilometer
cubic yard	0.7646	cubic meter
gallon	3.785	liter
gallon per minute	0.06309	liter per second

Temperature in degrees Celsius (°C) or degrees Fahrenheit (°F) can be converted as follows:

$$^{\circ}F = 1.8\ (^{\circ}C) + 32$$

$$^{\circ}C = 5/9\ (^{\circ}F - 32)$$

Sea level: In this report sea level refers to the National Geodetic Vertical Datum of 1929--a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.



WELL-NUMBERING SYSTEM

The well-numbering system in Texas was developed by the Texas Water Development Board for use throughout the State. The well number is divided into five segments; in this report the first four segments are divided by hyphens. The first segment is a two-letter prefix that identifies the county. The second segment indicates a 1-degree quadrangle that is assigned a number consisting of two digits ranging from 01 to 89. Each 1-degree quadrangle is divided into 7.5-minute quadrangles that are assigned a two-digit number from 01 to 64; this two-digit number is the third segment of the well number. Each 7.5-minute quadrangle is divided into 2.5-minute quadrangles that are assigned a single-digit number from 1 to 9; this one-digit number is the fourth segment of the well number. Finally, each well within a 2.5-minute quadrangle is given a two-digit number in the order in which it was inventoried, starting with 01; this two-digit number is the fifth segment of the well number. All wells referred to in this report are located on the U.S. Geological Survey El Paso 7.5-minute quadrangle.

GROUND-WATER QUALITY, WATER YEAR 1995, AND STATISTICAL ANALYSIS OF GROUND-WATER-QUALITY DATA, WATER YEARS 1994-95, AT THE CHROMIC ACID PIT SITE, U.S. ARMY AIR DEFENSE ARTILLERY CENTER AND FORT BLISS, EL PASO, TEXAS

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ABSTRACT

The Chromic Acid Pit site is an inactive waste disposal site that is regulated by the Resource Conservation and Recovery Act of 1976. The 2.2-cubic-yard cement-lined pit was operated from 1980 to 1983 by a contractor to the U.S. Army Air Defense Artillery Center and Fort Bliss. The pit, located on the Fort Bliss military reservation in El Paso, Texas, was used for disposal and evaporation of chromic acid waste generated from chrome plating operations. The site was closed in 1989, and the Texas Natural Resources Conservation Commission issued permit number HW-50296 (U.S. Environmental Protection Agency number TX4213720101), which approved and implemented post-closure care for the Chromic Acid Pit site. In accordance with an approved post-closure plan, the U.S. Geological Survey is cooperating with the U.S. Army in monitoring and evaluating ground-water quality at the site. One upgradient ground-water monitoring well (MW1) and two downgradient ground-water monitoring wells (MW2 and MW3), installed adjacent to the chromic acid pit, are monitored on a quarterly basis. Ground-water sampling of these wells by the U.S. Geological Survey began in December 1993.

The ground-water level, measured in a production well located approximately 1,700 feet southeast of the Chromic Acid Pit site, has declined about 29.43 feet from 1982 to 1995. Depth to water at the Chromic Acid Pit site in September 1995 was 284.2 to 286.5 feet below land surface; ground-water flow at the water table is assumed to be toward the southeast.

Ground-water samples collected from monitoring wells at the Chromic Acid Pit site during water year 1995 contained dissolved-solids concentrations of 481 to 516 milligrams per liter. Total chromium concentrations detected above the laboratory reporting limit ranged from 0.0061 to 0.030 milligram per liter; dissolved chromium concentrations ranged from 0.0040 to 0.010 milligram per liter. Nitrate as nitrogen concentrations ranged from 2.1 to 2.8 milligrams per liter; nitrite plus nitrate as nitrogen concentrations ranged from 2.4 to 3.2 milligrams per liter. Water samples from wells MW1 and MW2 were analyzed for volatile organic compounds for the first quarter; no confirmed volatile organic compounds were detected above laboratory reporting limits. Detected chemical concentrations in water from the chromic acid pit monitoring wells during the four sampling periods were below U.S. Environmental Protection Agency-established maximum contaminant levels for public drinking-water supplies. Overall, water-quality characteristics of water from the chromic acid pit ground-water monitoring wells are similar to those of other wells in the surrounding area.

Statistical analyses were performed on 56 of the chemical constituents analyzed for in ground water from the chromic acid pit monitoring wells. Concentrations of chloride, fluoride, sulfate, and potassium were significantly less in water from one or both downgradient wells than in water from the upgradient well. Concentrations of nitrate as nitrogen, nitrite plus nitrate as nitrogen, and dissolved solids were significantly greater in water from the downgradient wells than in water from the upgradient well. Concentrations of nitrate as nitrogen, chloride, and potassium were significantly different in water from the two downgradient wells. Statistical analysis of chemical constituents in water from the chromic acid pit monitoring wells did not appear to indicate a release of hazardous chemicals from the chromic acid pit. There was no indication of ground-water contamination in either downgradient well.

INTRODUCTION

The Chromic Acid Pit site is an inactive waste disposal site that is regulated by the Resource Conservation and Recovery Act of 1976 (RCRA). The cement-lined pit, 2 feet deep by 18 inches wide by 20 feet long (2.2 cubic yards), is located on the U.S. Army Air Defense Artillery Center and Fort Bliss (USAADACENFB) military reservation, in El Paso, Texas (figs. 1 and 2). The chromic acid pit was used for disposal and evaporation of chromic acid waste generated from chrome plating operations. The pit was operated from 1980 to 1983 by a contractor to the USAADACENFB. The chromic acid pit was closed in 1989, and the Texas Water Commission (now the Texas Natural Resource Conservation Commission (TNRCC)) issued permit number HW-50296 (U.S. Environmental Protection Agency (EPA) number TX4213720101), which approved and implemented post-closure care for the Chromic Acid Pit site.

In accordance with an approved post-closure plan, one upgradient and two downgradient ground-water monitoring wells were installed adjacent to the chromic acid pit by a private contractor. In 1993, the U.S. Geological Survey, in cooperation with the U.S. Army, initiated an evaluation of hydrogeologic conditions and ground-water quality at the Chromic Acid Pit site. Quarterly ground-water sampling of the monitoring wells by the U.S. Geological Survey began in December 1993. The hydrogeology at the Chromic Acid Pit site and ground-water characteristics during water year 1994 are presented in a report by Abeyta and Thomas (1996). A water year is the 12-month period October 1 through September 30 and is designated by the calendar year in which it ends. Thus, the year ending September 1994 is called water year 1994.

Purpose and Scope

The primary objectives of this report are to (1) present water-quality data collected on a quarterly basis during water year 1995 from three ground-water monitoring wells located adjacent to the chromic acid pit; and (2) describe the ground-water quality at the Chromic Acid Pit site through analytical results and statistical analysis. The report presents statistical analyses comparing water quality in upgradient well MW1 with that in downgradient wells MW2 and MW3 for the period of record (December 1993 through September 1995). This compilation and statistical analysis of data will result in a better understanding of the ground-water quality at the Chromic Acid Pit site. Data were collected in accordance with TNRCC-approved plans and specifications (Sampling and Analysis Plan for Chromic Acid Pit, U.S. Army Air Defense Artillery Center and Fort Bliss, El Paso, Texas, Final, U.S. Geological Survey, written commun., May 1994) to maintain a consistent monitoring program.

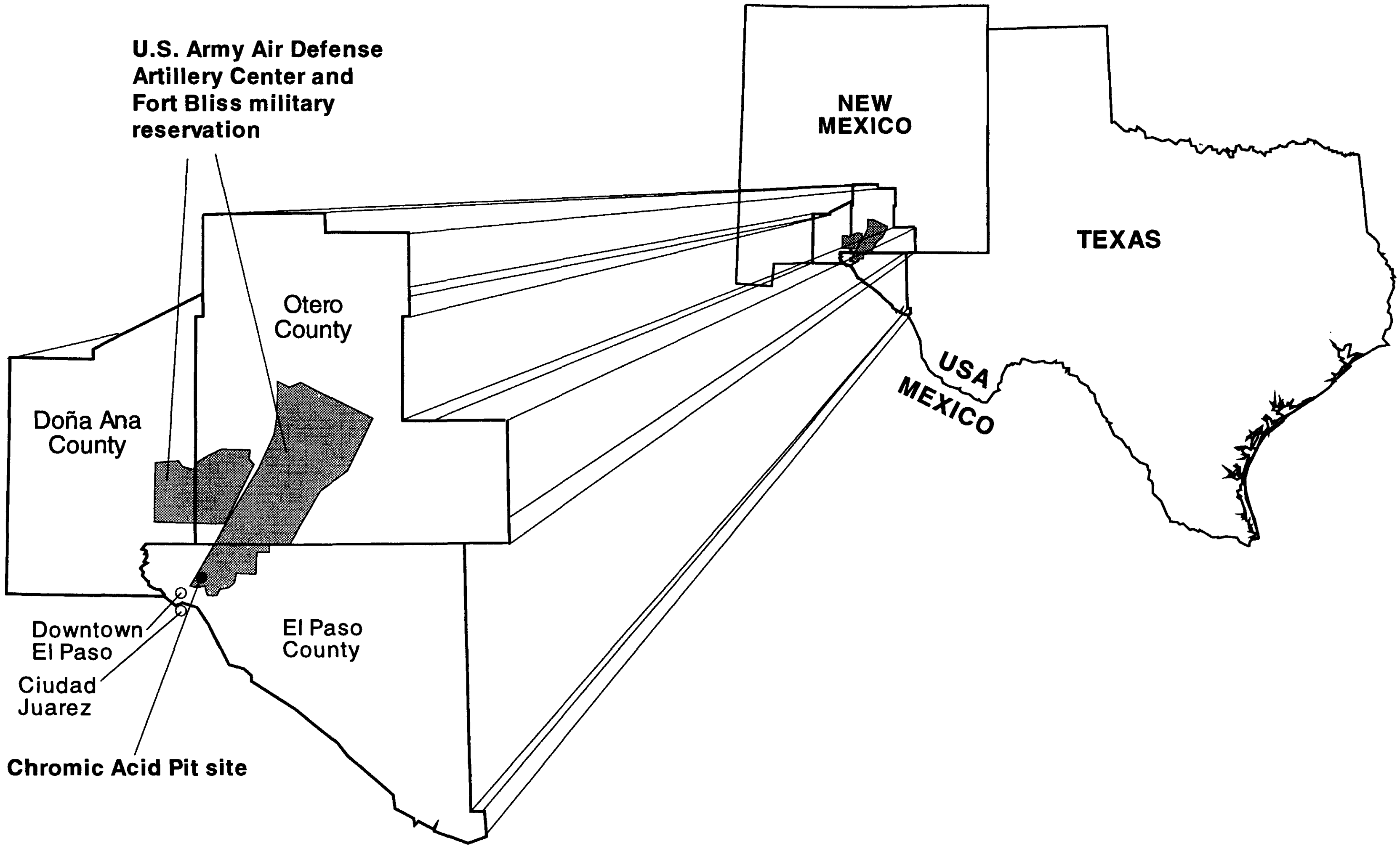
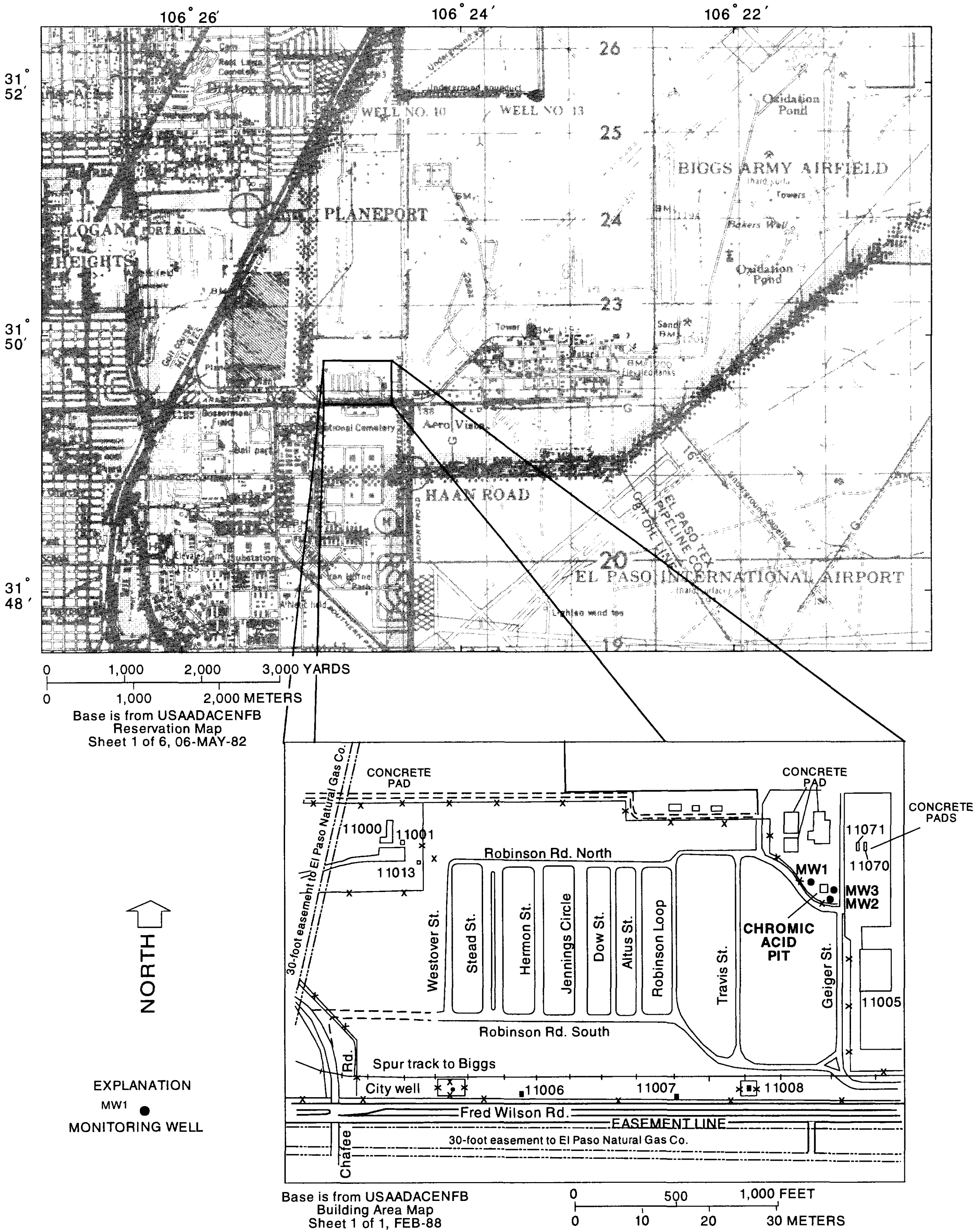


Figure 1.--Location of U.S. Army Air Defense Artillery Center and Fort Bliss military reservation, Texas and New Mexico.



Base is from USAADACENFB
Reservation Map
Sheet 1 of 6, 06-MAY-82

Base is from USAADACENFB
Building Area Map
Sheet 1 of 1, FEB-88

Figure 2.--Location of Chromic Acid Pit site and monitoring wells, U.S. Army Air Defense Artillery Center and Fort Bliss, El Paso, Texas.

Federal and State of Texas Regulatory Programs

This report is a part of response actions on Department of Defense installations under the provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, the Superfund Amendment and Reauthorization Act (SARA) of 1986, the RCRA of 1976, the Hazardous and Solid Waste Amendments of 1984, and Executive Order 12316. The SARA confirms that CERCLA is applicable to Federal facilities and defines the process by which Federal agencies are required to initiate remedial actions at their facilities. Compliance procedures taken by the USAADACENFB prior to initiation of ground-water monitoring at the Chromic Acid Pit site are described by Abeyta and Thomas (1996, p. 5-6). These procedures include issuance of Texas permit number HW-50296/EPA permit number TX4213720101 by the TNRCC under provisions of the Texas Health and Safety Code Announcement, Chapter 361-Vernon. The permit authorized the USAADACENFB to perform post-closure care for the 2.2-cubic-yard surface impoundment, identified as the chromic acid pit, according to the Chromic Acid Pit Post-Closure Care Plan of May 1990 (U.S. Army Air Defense Artillery Center and Fort Bliss, written commun., May 1990).

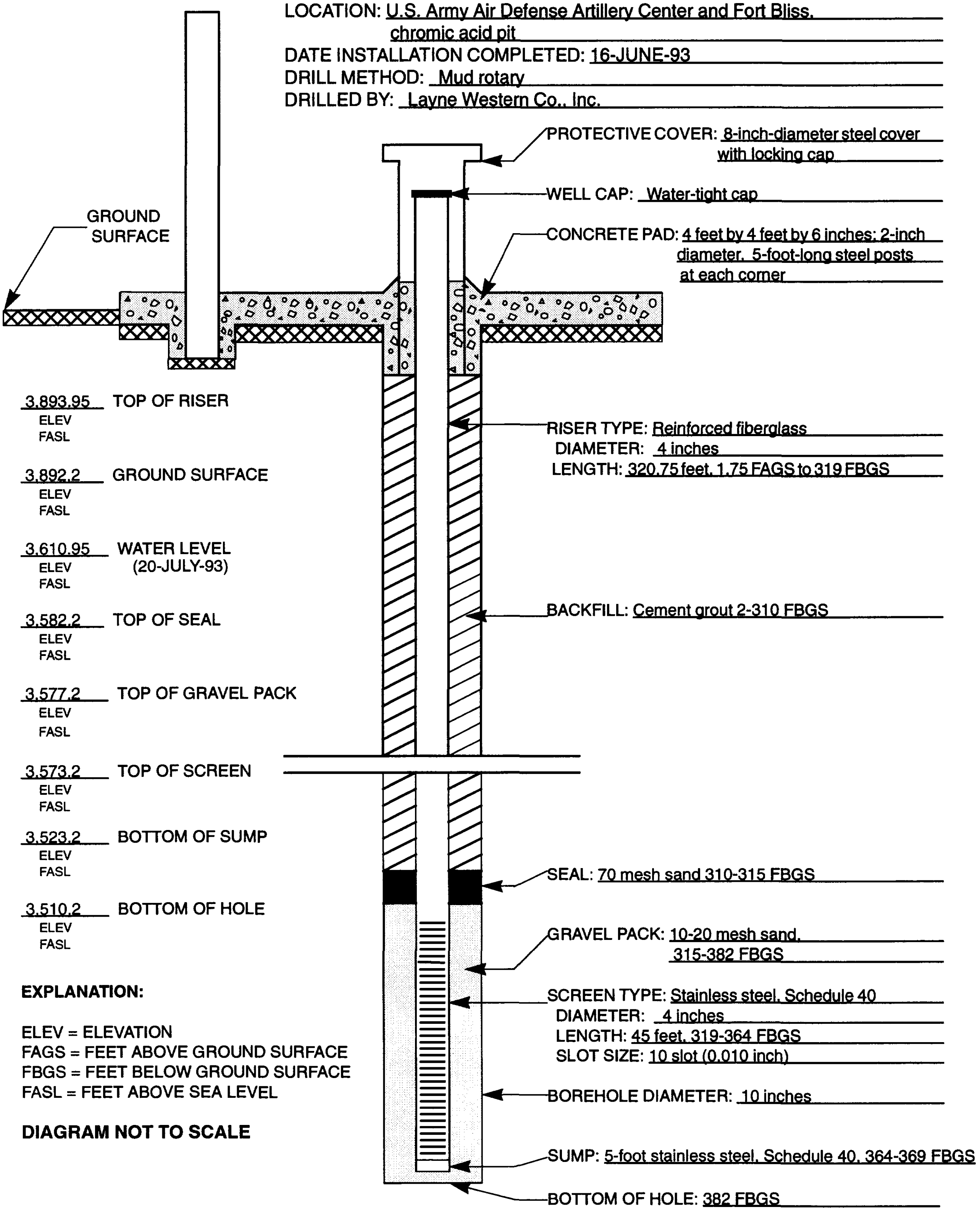
The post-closure care plan for the Chromic Acid Pit site calls for routine maintenance of the site and ground-water monitoring activities. Routine maintenance inspections are conducted by USAADACENFB staff. Ground-water monitoring activities were initiated by construction of three monitoring wells, MW1, MW2, and MW3 (fig. 2), installed by a private contractor and completed in July 1993. These wells were installed in compliance with part 31 of the Texas Administrative Code, Section 335.163 (31 TAC 335.163). Well completion diagrams for these wells are shown in figures 3, 4, and 5.

Ground-Water Sampling and Analysis Plan

Ground-water sampling and analysis procedures for the Chromic Acid Pit site are described in a detailed, TNRCC-approved, site-specific Sampling and Analysis Plan (SAP) (Sampling and analysis plan for chromic acid pit, U.S. Army Air Defense Artillery Center and Fort Bliss, El Paso, Texas, Final, U.S. Geological Survey, written commun., May 1994). This SAP is a supplement to the Texas Water Commission approved May 1990 Sampling and Analysis Plan (Attachment C of TNRCC Permit No. HW-50296, Texas Water Commission, written commun., January 1991). The SAP identifies constituents to be analyzed for in accordance with Section III.D.3 of TNRCC Permit No. HW-50296 and Paul S. Lewis, TNRCC written communication, January 24, 1994. The purpose of the SAP is to ensure that data collected during the quarterly monitoring program are of adequate quality to determine whether hazardous constituents from past disposal practices have contaminated the ground water.

Ground-water samples collected during water year 1995 were measured for temperature, turbidity, pH, and specific conductance, and analyzed for alkalinity, dissolved solids, suspended solids, common ions, nitrates, metals, chromium, total organic carbon, and total organic halides (table 1). For the first quarter of sampling, samples from wells MW1 and MW2 were also analyzed for volatile organic compounds.

WELL NAME: **Chromic acid pit MW1**
WELL NUMBER: **JL-49-13-631**
LOCATION: U.S. Army Air Defense Artillery Center and Fort Bliss, chromic acid pit
DATE INSTALLATION COMPLETED: 16-JUNE-93
DRILL METHOD: Mud rotary
DRILLED BY: Layne Western Co., Inc.



PROTECTIVE COVER: 8-inch-diameter steel cover with locking cap
WELL CAP: Water-tight cap
CONCRETE PAD: 4 feet by 4 feet by 6 inches; 2-inch diameter, 5-foot-long steel posts at each corner
RISER TYPE: Reinforced fiberglass
DIAMETER: 4 inches
LENGTH: 320.75 feet, 1.75 FAGS to 319 FBGS
BACKFILL: Cement grout 2-310 FBGS
SEAL: 70 mesh sand 310-315 FBGS
GRAVEL PACK: 10-20 mesh sand, 315-382 FBGS
SCREEN TYPE: Stainless steel, Schedule 40
DIAMETER: 4 inches
LENGTH: 45 feet, 319-364 FBGS
SLOT SIZE: 10 slot (0.010 inch)
BOREHOLE DIAMETER: 10 inches
SUMP: 5-foot stainless steel, Schedule 40, 364-369 FBGS
BOTTOM OF HOLE: 382 FBGS

ELEV FASL	
3,893.95	TOP OF RISER
3,892.2	GROUND SURFACE
3,610.95	WATER LEVEL (20-JULY-93)
3,582.2	TOP OF SEAL
3,577.2	TOP OF GRAVEL PACK
3,573.2	TOP OF SCREEN
3,523.2	BOTTOM OF SUMP
3,510.2	BOTTOM OF HOLE

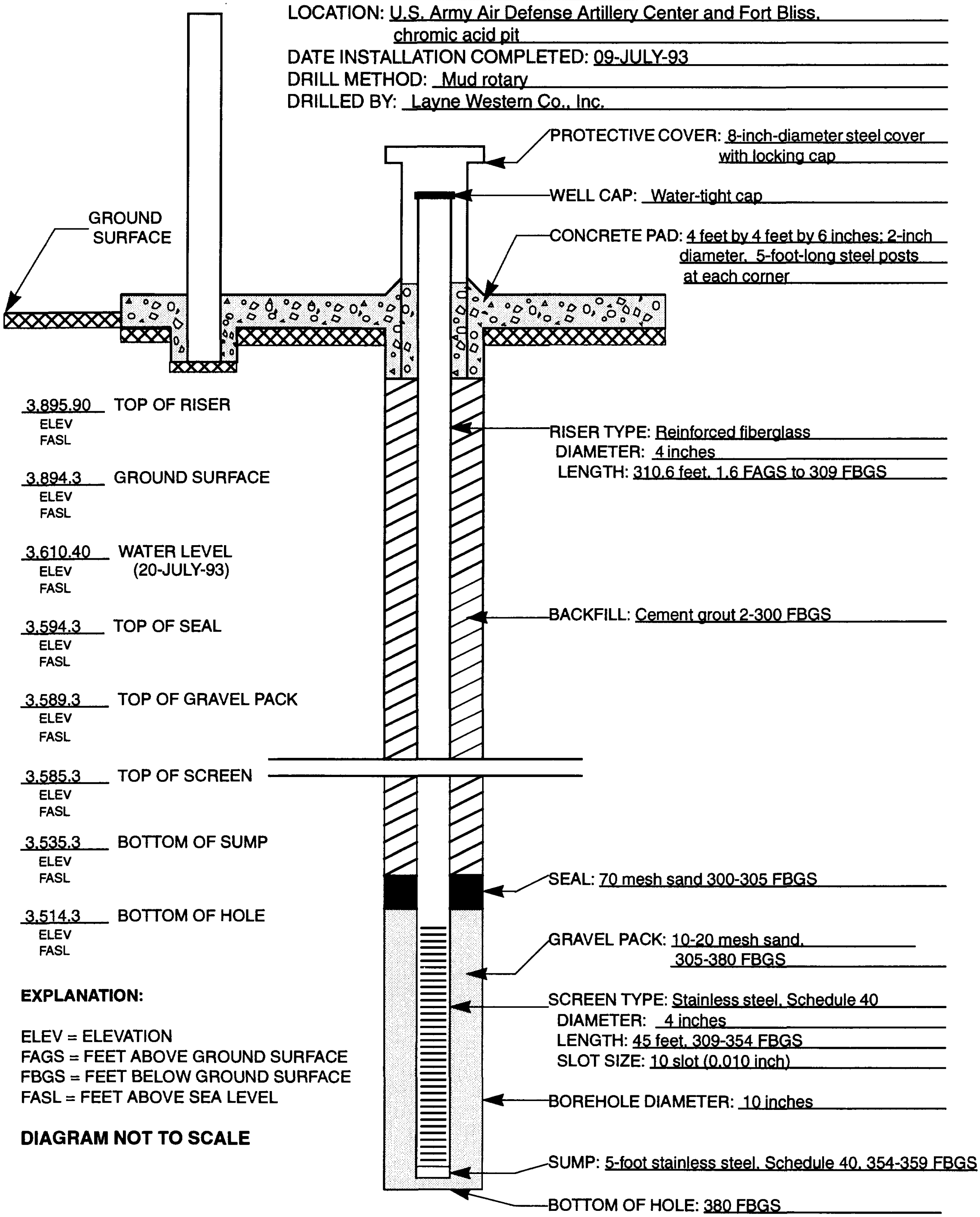
EXPLANATION:

ELEV = ELEVATION
FAGS = FEET ABOVE GROUND SURFACE
FBGS = FEET BELOW GROUND SURFACE
FASL = FEET ABOVE SEA LEVEL

DIAGRAM NOT TO SCALE

Figure 3.--Well completion of chromic acid pit ground-water monitoring well MW1.

WELL NAME: **Chromic acid pit MW2**
WELL NUMBER: **JL-49-13-632**
LOCATION: U.S. Army Air Defense Artillery Center and Fort Bliss, chromic acid pit
DATE INSTALLATION COMPLETED: 09-JULY-93
DRILL METHOD: Mud rotary
DRILLED BY: Layne Western Co., Inc.



PROTECTIVE COVER: 8-inch-diameter steel cover with locking cap
WELL CAP: Water-tight cap
CONCRETE PAD: 4 feet by 4 feet by 6 inches; 2-inch diameter, 5-foot-long steel posts at each corner
RISER TYPE: Reinforced fiberglass
DIAMETER: 4 inches
LENGTH: 310.6 feet, 1.6 FAGS to 309 FBGS
BACKFILL: Cement grout 2-300 FBGS
SEAL: 70 mesh sand 300-305 FBGS
GRAVEL PACK: 10-20 mesh sand, 305-380 FBGS
SCREEN TYPE: Stainless steel, Schedule 40
DIAMETER: 4 inches
LENGTH: 45 feet, 309-354 FBGS
SLOT SIZE: 10 slot (0.010 inch)
BOREHOLE DIAMETER: 10 inches
SUMP: 5-foot stainless steel, Schedule 40, 354-359 FBGS
BOTTOM OF HOLE: 380 FBGS

3,895.90 ELEV FASL	TOP OF RISER
3,894.3 ELEV FASL	GROUND SURFACE
3,610.40 ELEV FASL	WATER LEVEL (20-JULY-93)
3,594.3 ELEV FASL	TOP OF SEAL
3,589.3 ELEV FASL	TOP OF GRAVEL PACK
3,585.3 ELEV FASL	TOP OF SCREEN
3,535.3 ELEV FASL	BOTTOM OF SUMP
3,514.3 ELEV FASL	BOTTOM OF HOLE

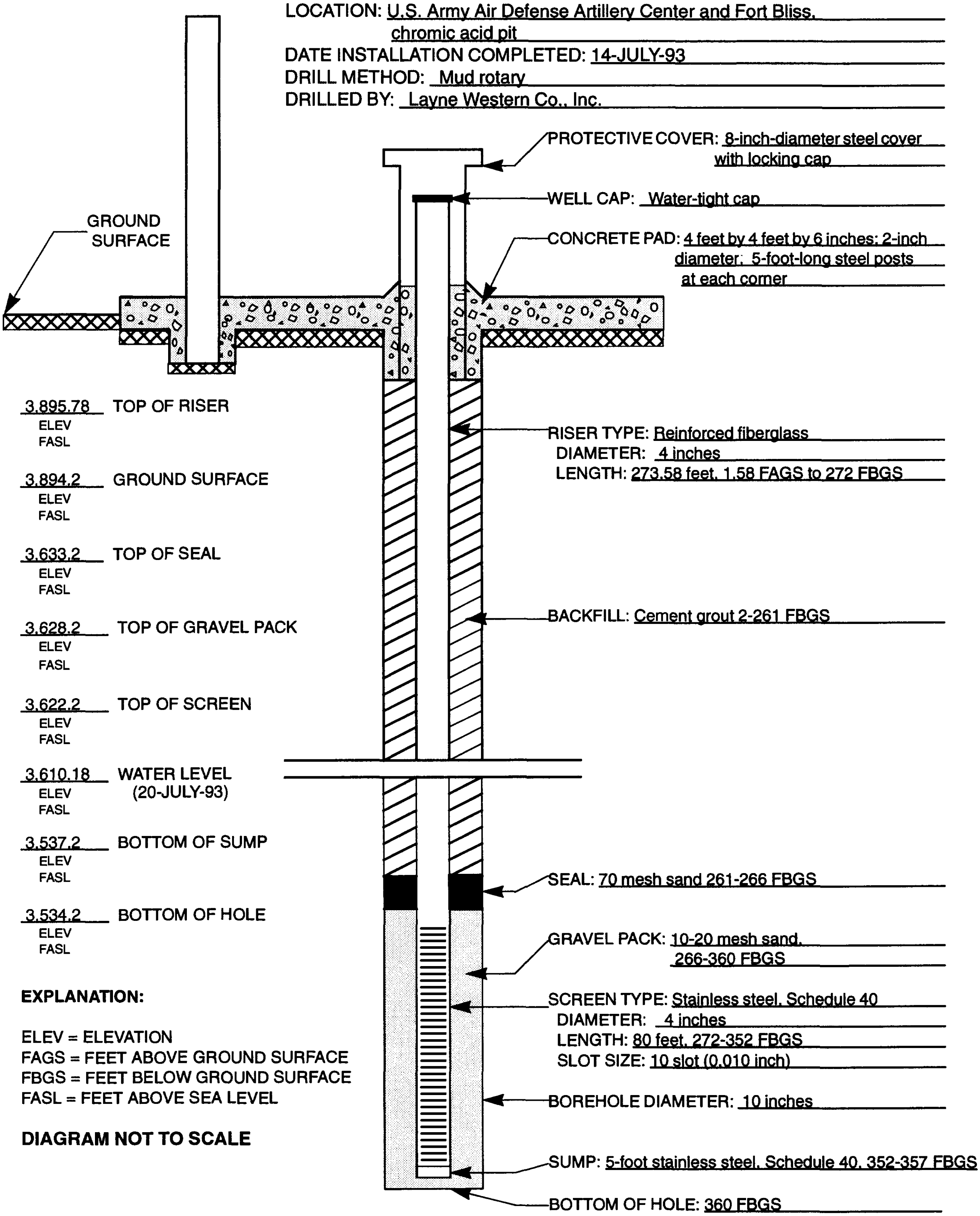
EXPLANATION:

ELEV = ELEVATION
FAGS = FEET ABOVE GROUND SURFACE
FBGS = FEET BELOW GROUND SURFACE
FASL = FEET ABOVE SEA LEVEL

DIAGRAM NOT TO SCALE

Figure 4.--Well completion of chromic acid pit ground-water monitoring well MW2.

WELL NAME: **Chromic acid pit MW3**
WELL NUMBER: **JL-49-13-633**
LOCATION: U.S. Army Air Defense Artillery Center and Fort Bliss, chromic acid pit
DATE INSTALLATION COMPLETED: 14-JULY-93
DRILL METHOD: Mud rotary
DRILLED BY: Layne Western Co., Inc.



PROTECTIVE COVER: 8-inch-diameter steel cover with locking cap
WELL CAP: Water-tight cap
CONCRETE PAD: 4 feet by 4 feet by 6 inches; 2-inch diameter; 5-foot-long steel posts at each corner
RISER TYPE: Reinforced fiberglass
DIAMETER: 4 inches
LENGTH: 273.58 feet, 1.58 FAGS to 272 FBGS
BACKFILL: Cement grout 2-261 FBGS
SEAL: 70 mesh sand 261-266 FBGS
GRAVEL PACK: 10-20 mesh sand, 266-360 FBGS
SCREEN TYPE: Stainless steel, Schedule 40
DIAMETER: 4 inches
LENGTH: 80 feet, 272-352 FBGS
SLOT SIZE: 10 slot (0.010 inch)
BOREHOLE DIAMETER: 10 inches
SUMP: 5-foot stainless steel, Schedule 40, 352-357 FBGS
BOTTOM OF HOLE: 360 FBGS

ELEV FASL	
3,895.78	TOP OF RISER
3,894.2	GROUND SURFACE
3,633.2	TOP OF SEAL
3,628.2	TOP OF GRAVEL PACK
3,622.2	TOP OF SCREEN
3,610.18	WATER LEVEL (20-JULY-93)
3,537.2	BOTTOM OF SUMP
3,534.2	BOTTOM OF HOLE

EXPLANATION:

ELEV = ELEVATION
FAGS = FEET ABOVE GROUND SURFACE
FBGS = FEET BELOW GROUND SURFACE
FASL = FEET ABOVE SEA LEVEL

DIAGRAM NOT TO SCALE

Figure 5.--Well completion of chromic acid pit ground-water monitoring well MW3.

Table 1.--Analytical constituents and methods used for quarterly ground-water monitoring at the Chromic Acid Pit site, water year 1995

Property or constituent and units	Method number[1]
Field tests:	
Temperature, degrees Celsius	E170.1
Turbidity, nephelometric turbidity units	E180.1
pH, standard units	E150.1
Specific conductance, microsiemens per centimeter at 25 degrees Celsius	E120.1
Alkalinity - carbonate, bicarbonate, calcium carbonate, milligrams per liter	A403
Dissolved solids, milligrams per liter	E160.1
Suspended solids, milligrams per liter	E160.2
Common anions: chloride, fluoride, nitrate, orthophosphate, sulfate, milligrams per liter	E300 or A429
Cations: calcium, magnesium, potassium, sodium (total and dissolved), milligrams per liter	SW6010
Nitrite plus nitrate as nitrogen, milligrams per liter	E353.2
Metals:	
Aluminum, antimony, arsenic, barium, beryllium, cadmium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, selenium, silver, thallium, vanadium, zinc (total and dissolved), milligrams per liter	SW6010
Chromium (total and dissolved), milligrams per liter	SW7191
Total organic carbon, milligrams per liter	SW9060
Total organic halides, micrograms per liter	SW9020
Volatile organic compounds, micrograms per liter[2]	SW8240

[1] Method numbers preceded by A are from:

Standard methods for the examination of water and wastewater, 16th edition (American Public Health Association and others, 1985).

Method numbers preceded by E are from:

Methods for chemical analysis of water and wastes, EPA Manual 600/4-79-020 (U.S. Environmental Protection Agency, 1983 - with additions),

Inductively coupled plasma-atomic emission spectrometer method for trace element analysis of water and wastes, 40 CFR 261, Appendix C (U.S. Environmental Protection Agency, 1986a), and

Methods for organic chemical analysis of municipal and industrial wastewater, 40 CFR 136, Appendix A (U.S. Environmental Protection Agency, 1986b).

Method numbers preceded by SW are from:

Test methods for evaluating solid waste, physical/chemical methods, SW-846, 3d edition (U.S. Environmental Protection Agency, 1986c).

[2] Volatile organic compounds were analyzed for only in water samples collected from wells MW1 and MW2 the first quarter, December 1994.

GROUND-WATER QUALITY

The Chromic Acid Pit site quarterly ground-water monitoring program began in December 1993. Data collected during water year 1995 are presented in the following sections. Data collected at the Chromic Acid Pit site prior to December 1994 are described in a report by Abeyta and Thomas (1996). These data provide information needed to define the quality of ground water in the uppermost aquifer adjacent to the Chromic Acid Pit site.

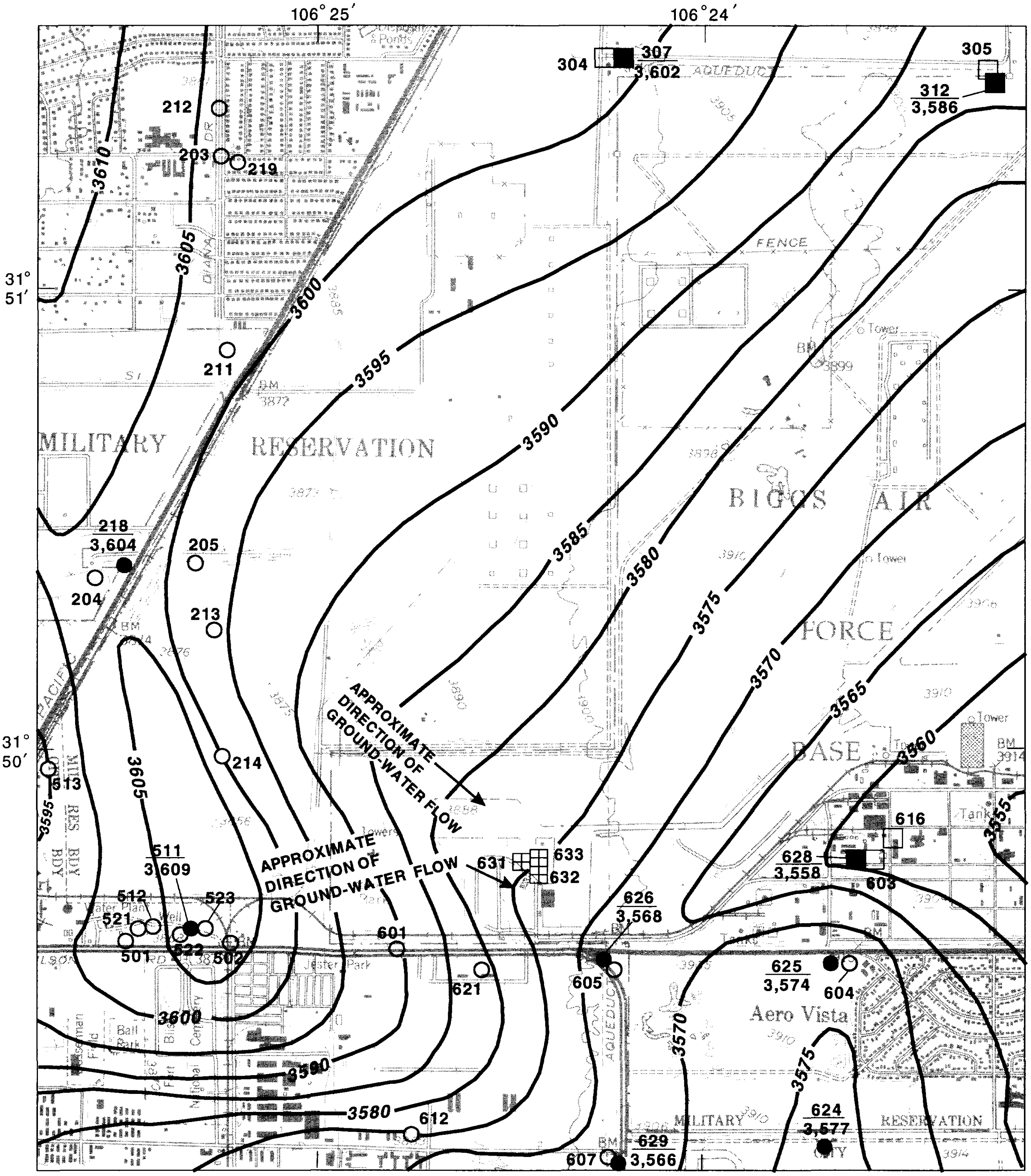
Data-Collection Procedures

Ground-water samples were collected from wells MW1, MW2, and MW3 (figs. 3-5) in December 1994 and March, June, and September 1995 by U.S. Geological Survey personnel. Well MW1 characterizes the chemistry of ground water hydraulically upgradient from the chromic acid pit (fig. 6). This water is considered not to be affected by potential leakage from the chromic acid pit, and well MW1 is referred to in this report as the background or upgradient well. Wells MW2 and MW3 are located hydraulically downgradient from the chromic acid pit and are assumed to represent the chemistry of ground water passing below the chromic acid pit.

Quarterly field activities included purging and sampling the monitoring wells. Ground-water monitoring well MW1 was purged and sampled first, followed by wells MW2 and MW3. Prior to purging each well, the water level was measured to the nearest 0.01 foot with respect to the established survey point on top of each well casing. A water sample from the top of the water column was collected in each well using dedicated translucent Teflon bailers to examine for the presence of floating hydrocarbons. No visible immiscible layers were observed during any of the quarterly sampling events. Each well was purged prior to sampling using a stainless steel submersible piston pump (Bennett model 1800-7) with a 500-foot Teflon water-discharge tube. Compressed nitrogen gas was used to operate automatic reciprocating-piston motors that generate power for operating the double-acting piston fluid pump.

Prior to purging and sampling each well, the outside of the water-discharge line was washed with a solution of potable water and laboratory-grade detergent, rinsed with deionized water, and allowed to air dry. The inside of the water-discharge line was decontaminated with approximately 35 gallons of deionized water. After decontamination, approximately 8 gallons of American Society of Testing and Materials (ASTM) Type II reagent water was pumped through the water-discharge line and chased with deionized water to collect the equipment blank. The ASTM Type II reagent water was collected as the equipment blank prior to purging each well. Temperature, turbidity, pH, and specific conductance of the purged ground water were measured routinely during purging. Wells were purged until a minimum of 3.5 well volumes of water were removed and the temperature, turbidity, pH, and specific conductance had stabilized.

Upon completion of purging, each well was immediately sampled. The appropriate sample bottles were filled from the Teflon discharge line; the samples were preserved immediately. Duplicate-, matrix-spike, and matrix-spike-duplicate sample bottles were filled immediately after their respective environmental sample was collected. Sample bottles for particular analytes were filled in the following order: (1) volatile organics (collected first quarter only); (2) total organic halides; (3) total organic carbon; (4) metals; (5) nitrates and common ions; and (6) field properties. All equipment coming into contact with the water sample was decontaminated prior to sampling using a solution of potable water and laboratory-grade detergent and a rinse water of ASTM Type II reagent water; the equipment was air dried on a clean, well-ventilated, uncontaminated surface.



Base from U.S. Geological Survey, 1:24,000 quadrangle: El Paso, Texas

EXPLANATION

—3600— WATER-LEVEL CONTOUR--Shows elevation at which water level would have stood in tightly cased wells. Datum is sea level

629/3,566 ● CITY OF EL PASO WELL--Top number is last three digits of State well number JL-49-13; bottom number is elevation of water level, in feet above sea level

214 ○ CITY OF EL PASO WELL--Number is last three digits of State well number JL-49-13; water-level data not available for period December 1994 to February 1995

307/3,602 ■ U.S. ARMY WELL--Top number is last three digits of State well number JL-49-13; bottom number is elevation of water level, in feet above sea level

616 ☐ U.S. ARMY WELL--Number is last three digits of State well number JL-49-13; water-level data not available for period December 1994 to February 1995

633 ⊞ U.S. ARMY WELL--Chromic acid pit monitoring wells MW1 (631), MW2 (632), and MW3 (633). Number is last three digits of State well number JL-49-13. Water-level data not used to construct contour

Figure 6.--Elevation of the potentiometric surface and direction of ground-water flow in the vicinity of the Chromic Acid Pit site, El Paso, Texas, December 1994 to February 1995 (modified from water-level map, El Paso Water Utilities, written commun., 1995).

Chain-of-custody procedures were followed to ensure that samples were collected, protected, stored, handled, analyzed, and disposed of properly by authorized personnel (Sampling and Analysis Plan for Chromic Acid Pit, U.S. Army Air Defense Artillery Center and Fort Bliss, El Paso, Texas, Final, U.S. Geological Survey, written commun., May 1994, p. 68-71). The U.S. Geological Survey team leader who collected the sample in the field had initial custody of the samples. The analytical laboratory, Quanterra Environmental Services (formerly Rocky Mountain Analytical Laboratory), Arvada, Colorado, was the ultimate recipient of the samples.

Purged water from the monitoring wells was stored in 55-gallon steel drums placed next to each well and classified by U.S. Geological personnel according to Title 30 TAC 335 Subchapter R. The containerized water was labeled appropriately and stored at the Chromic Acid Pit site until analytical data for that quarter's samples were received and reviewed by U.S. Geological Survey staff. After review of the quarterly analytical data, the purged water was determined to be uncontaminated. These determinations were based on comparison of analytes identified and EPA-defined maximum contamination levels (MCL's) for drinking water (U.S. Environmental Protection Agency, 1994). The purged water was then properly disposed of by USAADACENFB personnel at an authorized facility. The steel drums were then reused for the next quarterly sampling event.

Quality Assurance/Quality Control and Review of Analytical Data

The objective of Quality Assurance/Quality Control (QA/QC) is to monitor the overall sampling program for all environmentally related data collection and analyses to ensure that all data produced are suitable for evaluation and interpretation of ground-water quality at the Chromic Acid Pit site. Detailed QA objectives and goals for accuracy, precision, completeness, representativeness, and comparability and QC objectives and goals for production and documentation of quality data are defined in the SAP for the chromic acid pit (U.S. Geological Survey, written commun., May 1994).

The field QA/QC program was developed to ensure and validate that inconsistencies in protocols did not introduce error into the data collection process. Field QC checks were introduced into the sample collection procedures to (1) identify whether inconsistencies occurred, and (2) minimize the potential for interference or introduction of nonenvironmental contaminants during sample collection, storage, transport, and/or equipment decontamination. Applicable QA/QC samples were collected and analyzed during all field sampling activities at the Chromic Acid Pit site. The following protocols were followed for collection of QA/QC field samples:

> **Equipment blanks** were collected, one at each well, and analyzed for the same parameters as the environmental samples. These samples were collected by pumping ASTM Type II reagent water through the sampling equipment (Bennett pump and tubing) and into the appropriate sample bottle. Equipment blanks for soluble metals were run through a filtering apparatus in the field.
>
> **Field duplicates** were collected, one at each well, and analyzed for the same parameters as the environmental samples. The number of field duplicates equaled the total number of environmental samples. Each field-duplicate bottle was filled immediately after filling of its respective environmental sample bottle. Collection procedures for field duplicates were identical to those for the environmental samples.

Matrix-spike and matrix-spike-duplicate (MS/MSD) samples were collected, one per quarter, rotating sampling locations between monitoring wells MW1, MW2, and MW3. The MS/MSD sample bottles (where collected) were filled immediately after filling the respective field-duplicate sample bottle. Collection procedures for MS/MSD samples were identical to those for the environmental samples. The filled and preserved MS/MSD sample bottles were sent to the laboratory where they were spiked with known concentrations of analytes. The MS/MSD pair was analyzed for the same parameters as its respective environmental sample.

Trip blanks were prepared using ASTM Type II reagent water shipped to the site with the sample bottles and handled as a sample. One trip blank per sampling day was prepared for volatile organic compound (collected first quarter only) and total organic halide analyses. Trip blanks were analyzed for volatile organic compounds (first quarter only) and total organic halides.

Ambient-conditions blanks were prepared on site using ASTM Type II reagent water. One ambient-conditions blank per sampling day was collected for volatile organic compound (collected first quarter only) and total organic halide analyses. A bottle of the ASTM Type II water was left open at the sampling location and then poured into its respective sample bottle after its respective environmental sample, sample duplicate, MS, and MSD samples were collected. Ambient-conditions blanks were analyzed for volatile organic compounds (first quarter only) and total organic halides.

The laboratory QA/QC program was evaluated relative to QA/QC sample data. The accuracy of laboratory analytical data was evaluated by the following:

Standard methods used that, whenever possible, are recognized and considered as standard by the scientific community. EPA methods generally were used.

Calibration standards obtained from the National Institute of Standards and Technology EPA repository, or other reliable commercial sources.

Audit samples evaluating laboratory performance on EPA Water Supply and Water Pollution samples to maintain EPA certification.

Surrogate spikes for volatile and semivolatile organic compounds where recovery of organic surrogate analytes should be within three standard deviations of the laboratory-established average recovery of the surrogate analyte.

Known laboratory control samples where recovery of analytes should be within three standard deviations of the laboratory-established average recovery of the analyte. For multiple-analyte samples, 80 percent of the analytes should be within control limits. In-house control limits were used.

Recovery of analytes where recovery should be within three standard deviations of the laboratory-established average recovery of the analyte. For multiple-analyte methods, 95 percent of the analytes should be within control limits.

The precision of analytical data was evaluated by submitting duplicate samples. These samples included duplicate-environmental samples (given a fictitious well number), MS, and MSD samples. Analytical results for these samples should be within established control limits as defined in the SAP for the Chromic Acid Pit site (U.S. Geological Survey, written commun., May 1994).

Completeness was evaluated by dividing the number of valid data obtained by the total number of samples analyzed, and multiplying by 100 to obtain the percentage of analytical data associated with acceptable QC criteria. If 95 percent or greater of the analytical data were in control, then the sample batch was determined to be in control.

Representativeness of field data was evaluated by: (1) use of standard methods of measurement and sample collection; (2) collection of sufficient size or amount of sample; (3) documentation of reasons for use of nonstandard techniques; and (4) adherence to chain-of-custody procedures. Representativeness of laboratory analytical data was evaluated by: (1) use of preservation techniques to minimize sample degradation that may occur between sample collection and sample analysis; (2) prescribed holding times; (3) field and laboratory blank analyses to determine whether samples have been contaminated; and (4) matrix spikes used to determine the presence of matrix effects.

Comparability of field and laboratory measurements were evaluated by using standard methods of measurement and analysis and consistent reporting units. Comparability in the laboratory was also evaluated by traceable materials for calibration and QC.

Upon completion of analyses and review of analytical and QA/QC results, the laboratory submitted quarterly laboratory analytical results reports to the U.S. Geological Survey. The quarterly data were reviewed and data that did not meet the QA/QC objectives were identified. Quarterly laboratory analytical results and QA/QC data-validation results were submitted by the U.S. Geological Survey to the USAADACENFB. The USAADACENFB reviewed the information and submitted laboratory analytical results reports and QA/QC data-validation reports to the TNRCC. These reports are available to the public at the USAADACENFB, Directorate of Environment, El Paso, Texas, and the TNRCC Records Center, Austin, Texas.

Quarterly QA/QC analytical data collected during sampling at the Chromic Acid Pit site are not presented in this report; they may be reviewed at the locations mentioned above. Environmental-sample data from chromic acid pit ground-water monitoring wells for water year 1995 are presented in the following sections of this report. Environmental-sample data for those wells that did not meet the QA/QC objectives are still reported in the data tables but are qualified. Qualified data are flagged data that may have been noncompliant but were usable.

Depth to Ground Water

The primary source of ground water in the vicinity of the Chromic Acid Pit site is the unconsolidated and semiconsolidated sedimentary deposits of the Hueco Bolson. Wells completed in the Hueco Bolson supply water for the City of El Paso, Ciudad Juarez (fig. 1), Fort Bliss military reservation, private industries, and agricultural areas. Wells discharging large amounts of water usually are drilled at least 200 feet into water-yielding material. City of El Paso and Fort Bliss municipal wells completed in the Hueco Bolson range in depth from about 600 feet to greater than 1,200 feet. Hydraulic characteristics of the Hueco Bolson vary significantly because of the nonuniform nature of the individual beds (Alvarez and Buckner, 1980). On a regional scale, the Hueco Bolson can be considered a single aquifer, but on a local scale the rate and volume of water flowing through individual beds probably vary considerably. Hydraulic characteristics of the Hueco Bolson are presented in the report by Abeyta and Thomas (1996).

A relatively thick unsaturated zone of approximately 280 feet overlies the aquifer of the Hueco Bolson deposits in the vicinity of the Chromic Acid Pit site. A deep water table prevails for all of the study area. Extensive ground-water development by the City of El Paso and Fort Bliss encompasses the Chromic Acid Pit site (fig. 6).

Ground-water levels have been declining in the El Paso area. Water pumped from wells in the vicinity of the Chromic Acid Pit site is mostly for municipal use. The production well currently under operation nearest the study area is El Paso Water Utilities (EPWU) well JL-49-13-626 located approximately 1,700 feet southeast of the Chromic Acid Pit site (fig. 6). This well is completed well below the water table and when in use pumps at a rate of 1,350 to 1,575 gallons per minute (El Paso Water Utilities, written commun., 1993). Depth to water at EPWU production well JL-49-13-626 is 331.99 feet below land surface (January 1995) (Rodger Sperka, El Paso Water Utilities, oral commun., 1996). EPWU ground-water monitoring data for EPWU well JL-49-13-626 show a water-level decline of 29.43 feet from December 1982 to January 1995 and a decline of 5.09 feet from December 1993 to January 1995.

Depth to water at the Chromic Acid Pit site in September 1995 was 284.2 to 286.5 feet below land surface (chromic acid pit monitoring wells MW1, MW2, and MW3; table 2). Ground-water monitoring data for the Chromic Acid Pit site show a water-level decline of about 1 foot from September 1994 to September 1995. Water-level contours interpolated from water-level elevations measured in City of El Paso and U.S. Army municipal wells in the vicinity of the Chromic Acid Pit site indicate that in December 1994 the potentiometric surface was lower by about 34 feet (3,609 feet minus 3,575 feet) than those measured in the chromic acid pit monitoring wells (fig. 6; table 2). This head difference is due to the difference in well completion; the chromic acid pit ground-water monitoring wells are completed at or near the water table, and the production wells are completed more than 200 feet below the water table.

The direction of ground-water flow at the water table beneath the Chromic Acid Pit site is assumed to be to the southeast (figs. 7-10). Although water-level data at the chromic acid pit monitoring wells indicate a relatively flat local hydraulic gradient at the water table (figs. 7-10), the direction of ground-water flow at the water table was assumed to follow the regional gradient reported for wells completed more than 200 feet deeper (fig. 6). The chromic acid pit wells were completed as RCRA monitoring wells where the screen should straddle the water table. The screen in chromic acid pit monitoring well MW3 straddles the water table; the water levels in MW1 and MW2 were above the screen by approximately 35 and 23 feet, respectively (using September 1995 water-level data, table 2, and figs. 3-5). The difference in pressure head in each well, due to well completion at different depths and the close proximity of the wells to each other, could account for the small variation in water level, which is generally only tenths to hundreths of a foot among the three wells (table 2) and portrays a relatively flat hydraulic gradient (figs. 3-5 and 7-10).

Table 2.--Water-level data for chromic acid pit monitoring wells MW1, MW2, and MW3

Well number (fig. 2)	Elevation of top of fiberglass casing (feet above sea level)	Elevation of ground surface (feet above sea level)	Date measured	Depth to water (feet below top of fiberglass casing)	Depth to water (feet below land surface)	Water-level altitude (feet above sea level)
MW1	3,893.95	3,892.2	07-DEC-93	284.92	283.1	3,609.03
			08-MAR-94	284.30	282.5	3,609.65
			07-JUNE-94	284.10	282.3	3,609.85
			13-SEPT-94	284.97	283.2	3,608.98
			05-DEC-94	284.69	282.9	3,609.26
			07-MAR-95	284.46	282.7	3,609.49
			13-JUNE-95	285.45	283.6	3,608.50
			13-SEPT-95	286.02	284.2	3,607.93
MW2	3,895.90	3,894.3	09-DEC-93	286.90	285.3	3,609.00
			09-MAR-94	286.39	284.8	3,609.51
			08-JUNE-94	286.17	284.6	3,609.73
			14-SEPT-94	287.03	285.4	3,608.87
			06-DEC-94	286.94	285.3	3,608.96
			08-MAR-95	286.89	285.3	3,609.01
			14-JUNE-95	287.48	285.9	3,608.42
			14-SEPT-95	288.09	286.5	3,607.81
MW3	3,895.78	3,894.2	10-DEC-93	286.87	285.3	3,608.91
			10-MAR-94	286.50	284.9	3,609.28
			09-JUNE-94	286.22	284.6	3,609.56
			15-SEPT-94	286.88	285.3	3,608.90
			07-DEC-94	286.88	285.3	3,608.90
			09-MAR-95	286.66	285.1	3,609.12
			15-JUNE-95	287.45	285.8	3,608.33
			13-SEPT-95	287.97	286.4	3,607.81

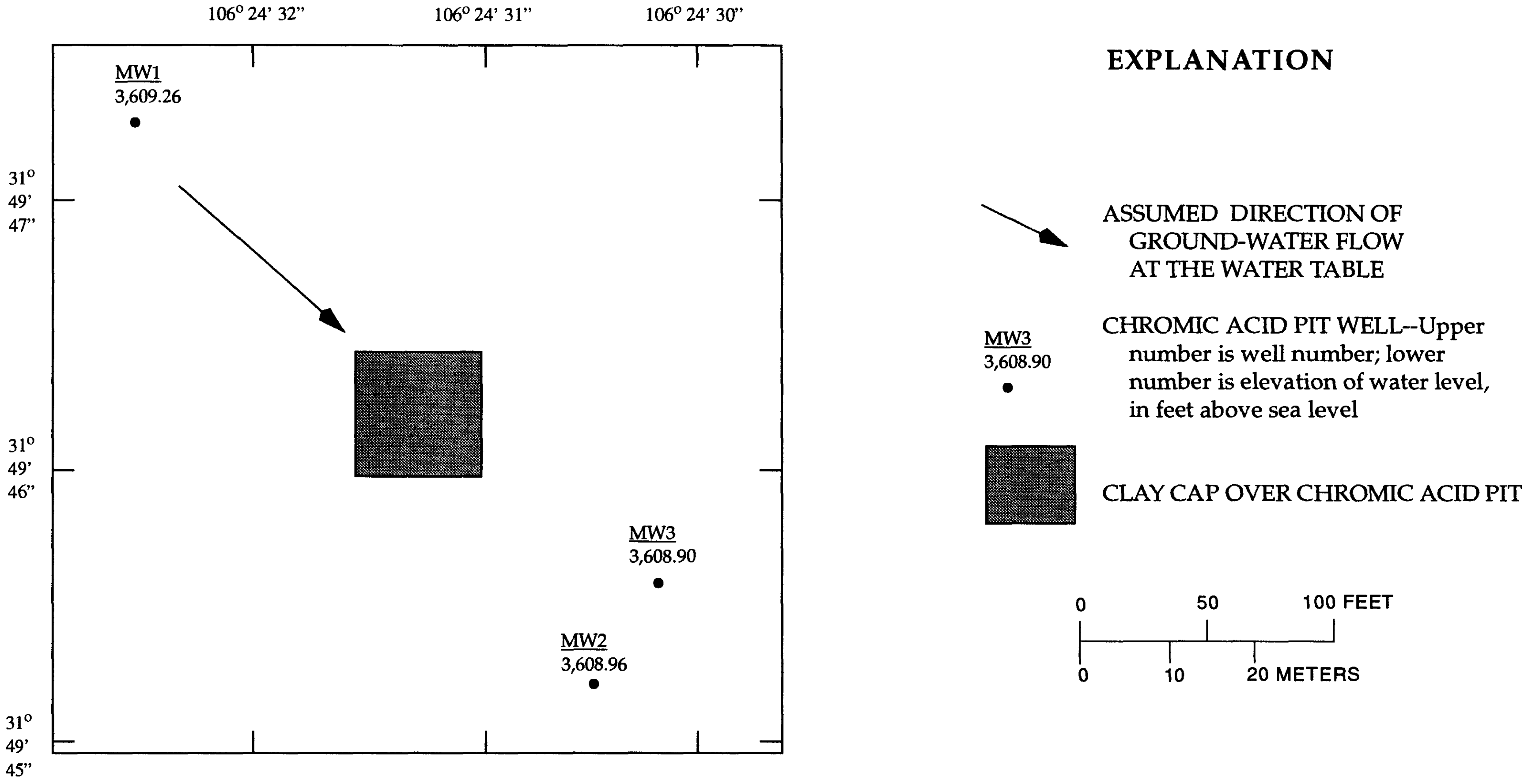


Figure 7.--Water-table elevation, December 1994, and direction of ground-water flow in the vicinity of the chromic acid pit.

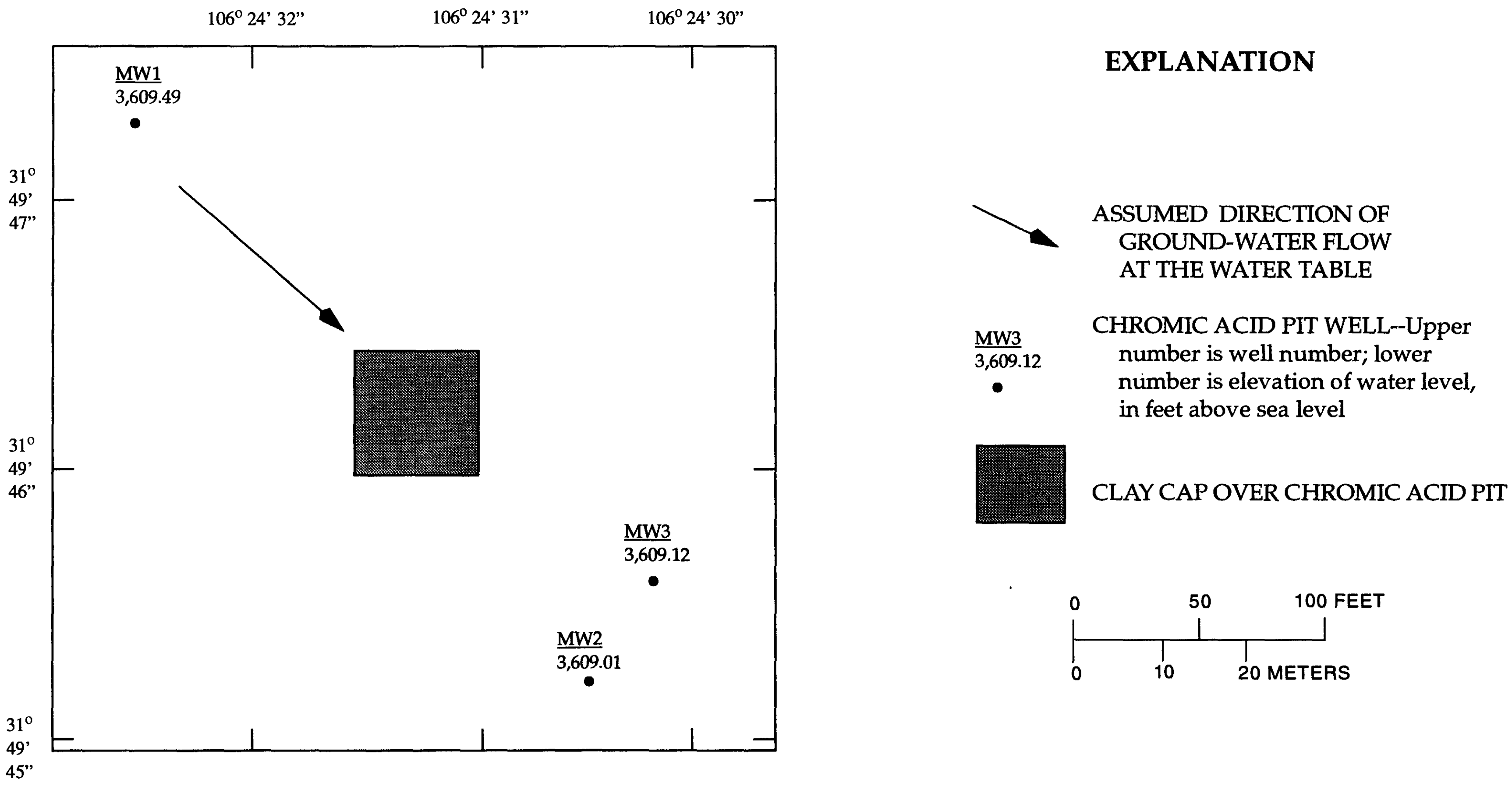


Figure 8.--Water-table elevation, March 1995, and direction of ground-water flow in the vicinity of the chromic acid pit.

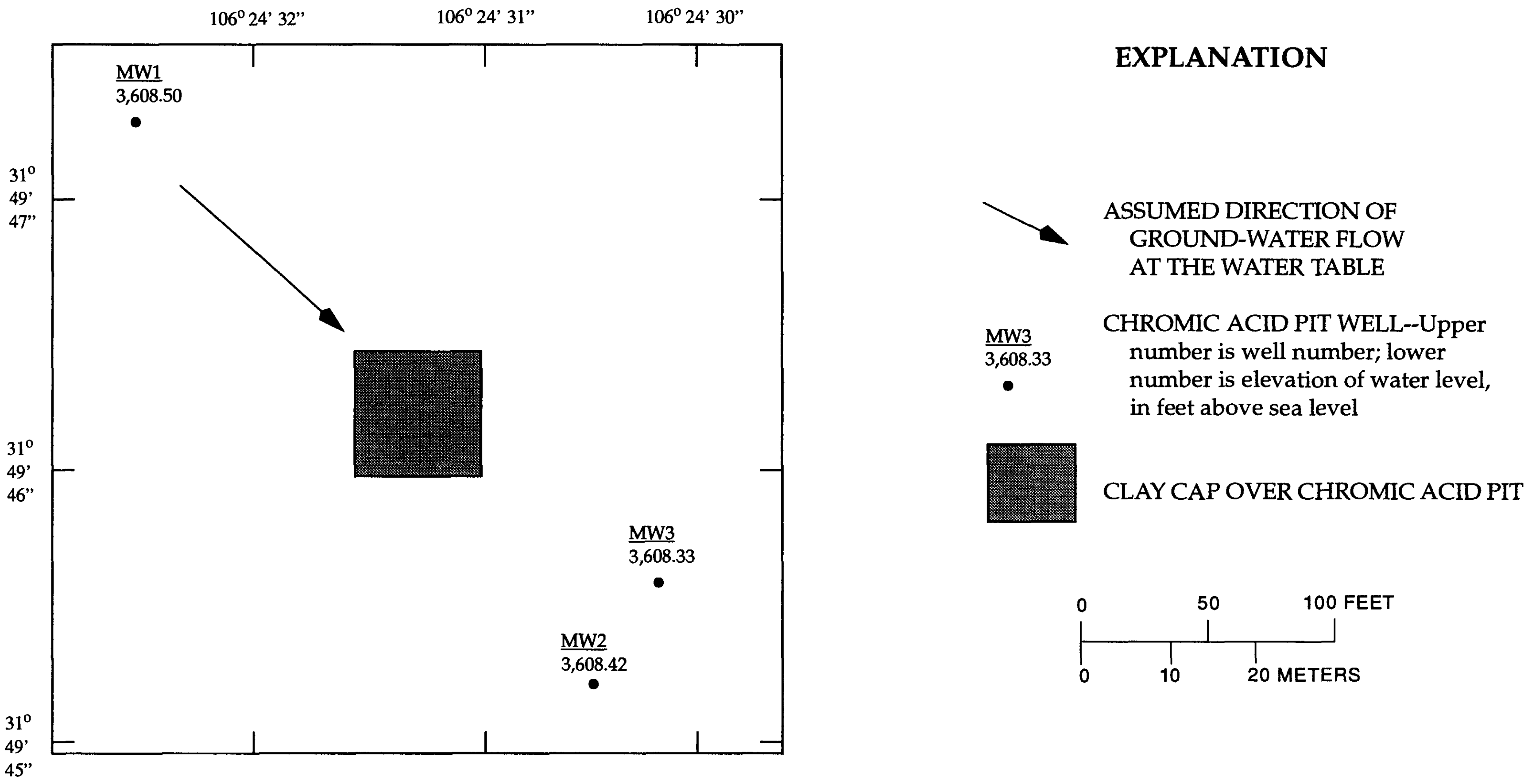


Figure 9.--Water-table elevation, June 1995, and direction of ground-water flow in the vicinity of the chromic acid pit.

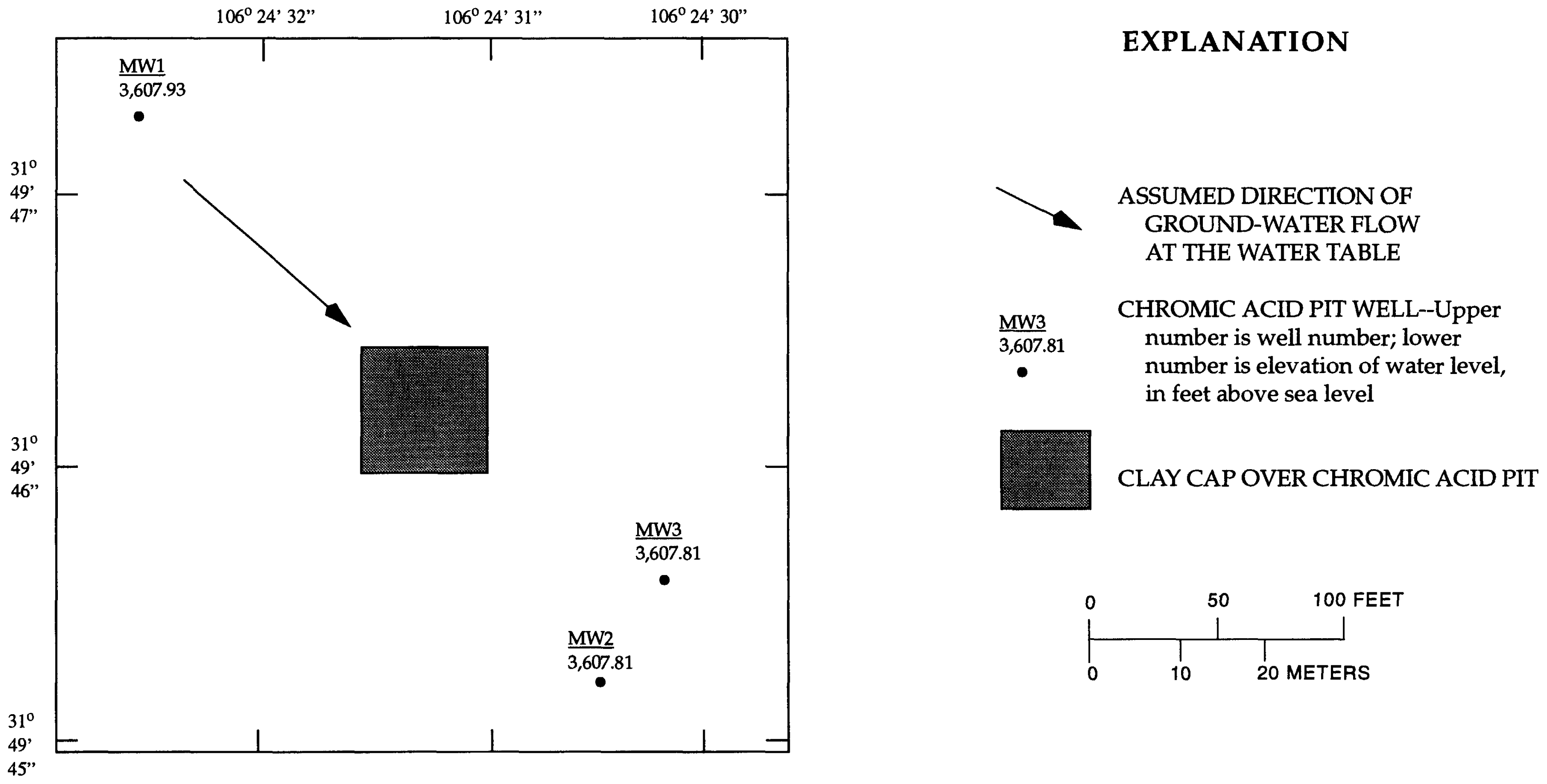


Figure 10.--Water-table elevation, September 1995, and direction of ground-water flow in the vicinity of the chromic acid pit.

Results of Analyses

Water-quality data for water year 1995 resulting from quarterly ground-water monitoring at the Chromic Acid Pit site are presented in tables 3-6; associated data-qualifier codes are presented in table 7. Water temperature of samples from chromic acid pit wells ranged from 19.0 to 23.5 °C. Turbidity of water samples ranged from 0.12 to 5.58 nephelometric turbidity units (NTU's) and were substantially lower than those measured during water year 1994 (Abeyta and Thomas, 1996, p. 41). The presence of drilling mud, possibly still in the formation from installation of the wells (Abeyta and Thomas, 1996, p. 41) had, over time, cleared out considerably during purging.

The pH of water samples from well MW1 ranged from 7.79 to 7.94; from well MW2 ranged from 7.15 to 7.78; and from well MW3 ranged from 7.49 to 7.83. Water in well MW1 was more basic than water from wells MW2 and MW3, which may be due to well completion and development (possibly cement grout getting into the screened interval in well MW1 (Abeyta and Thomas, 1996, p. 41)). Over time, the pH of water from well MW1 approached the pH values of water from wells MW2 and MW3 (tables 3-6). Specific conductance of water from the chromic acid pit wells ranged from 731 to 861 microsiemens per centimeter at 25 °C.

Alkalinity of water samples was measured in the field immediately after sampling. Dissolved carbonate concentrations, calculated from field alkalinity and pH, were zero in water samples from wells MW1, MW2, and MW3. Calculated bicarbonate concentrations in water samples ranged from 161 to 188 milligrams per liter (mg/L) in well MW1, from 220 to 232 mg/L in well MW2, and from 191 to 222 mg/L in well MW3. Alkalinity as calcium carbonate in water samples ranged from 132 to 154 mg/L in well MW1, from 180 to 190 mg/L in well MW2, and from 156 to 182 mg/L in well MW3.

Concentrations of dissolved solids in the three monitoring wells ranged from 481 to 516 mg/L. Suspended-solids concentrations in water samples from the three monitoring wells ranged from not detected (reporting limit of 2.0 mg/L) to 5.2 mg/L; concentrations were smaller than those reported during water year 1994 sampling events (Abeyta and Thomas, 1996, p. 41).

Analyses for common ions included total chloride, fluoride, nitrate, orthophosphate, and sulfate, and total and dissolved calcium, magnesium, potassium, and sodium (tables 3-6). Ground water from the chromic acid pit wells generally contains large relative amounts of sodium and bicarbonate. Nitrate as nitrogen concentrations in water samples ranged from 2.1 to 2.8 mg/L; concentrations of nitrite plus nitrate as nitrogen ranged from 2.4 to 3.2 mg/L (reported values had associated matrix interferences (tables 3 and 6)). Results for some common ions had associated qualifiers (tables 3-6).

Metals identified in concentrations above the laboratory reporting limits in ground-water samples from the chromic acid pit monitoring wells include chromium (total and dissolved), iron (total), manganese (total and dissolved), and zinc (total). Laboratory reporting limits for metals are established from instrument detection limit (IDL) evaluations and represent the level above which reliable data can be routinely obtained. These limits are generally two to five times the IDL (Quanterra Environmental Services, written commun., December 1994). Concentrations of each of these metals were detected in water from background well MW1 (with the exception of total and dissolved manganese) as well as downgradient wells MW2 and MW3, signifying their possible presence in the Hueco Bolson deposits. Dissolved manganese was identified in the December 1994 water sample from well MW2 at a concentration of 0.016 mg/L; total manganese was identified in the March 1995 water sample from MW3 at a concentration of 0.011 mg/L.

Table 3.--Analytical results of quarterly ground-water monitoring at the Chromic Acid Pit site, U.S. Army Air Defense Artillery Center and Fort Bliss, El Paso, Texas, first quarter, December 1994

[Qualifier codes are identified in table 7. --, no data; NTU's, nephelometric turbidity units; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; ND, not detected]

Parameter and units	Method	Reporting limit	Well MW1 result/qualifier	Well MW2 result/qualifier	Well MW3 result/qualifier
Date	--	--	05-DEC-94	06-DEC-94	07-DEC-94
Time	--	--	1620	1245	1110
U.S. Geological Survey sample number	--	--	CAP0117	CAP0215	CAP0315
Laboratory sample number	--	--	039638-0001-SA	039668-0001-SA	039681-0001-SA
Water level, elevation, feet above sea level, prior to pumping	--	0.01	3,609.26	3,608.96	3,608.90
Amount purged prior to sampling, gallons	--	1	220	180	183
Depth sampled, feet below land surface	--	1	325	325	325
Field properties:					
Temperature, degrees Celsius	E170.1	0.1	20.0	21.9	21.4
Turbidity, NTU's	E180.1	1	3.52	4.32	5.58
pH	E150.1	0.1	7.93	7.78	7.75
Specific conductance, µS/cm	E120.1	10.0	802	786	800
Alkalinity, carbonate, mg/L	A403	--	0	0	0
Alkalinity, bicarbonate, mg/L	A403	10	188	226	215
Alkalinity, calcium carbonate, mg/L	A403	10	154	185	176
Dissolved solids, mg/L	E160.1	10.0	481	498	506
Suspended solids, mg/L	E160.2	2.0	5.2	5.2	3.6
Common ions:					
Chloride, total, mg/L	E300	0.50	84.3/M,I	69.3/M,I	72.7/M,I
Fluoride, total, mg/L	E300	0.50	1.5	1.3	1.2
Nitrate as nitrogen, total, mg/L	E300	0.50	2.1/M,I	2.7/M,I	2.5/M,I
Nitrite plus nitrate as nitrogen, total, mg/L	E353.2	0.2	2.6/C	3.1/C	2.8/C
Orthophosphate as phosphorus, total, mg/L	E300	0.50	ND	ND	ND
Sulfate, total, mg/L	E300	0.50	107	107/E	107
Calcium, total, mg/L	SW6010	5.0	25.6	27.4	27.3
Calcium, dissolved, mg/L	SW6010	5.0	26.9	29.4	27.1
Magnesium, total, mg/L	SW6010	5.0	10.3	10.9	10.7
Magnesium, dissolved, mg/L	SW6010	5.0	11.1	12.1	10.8
Potassium, total, mg/L	SW6010	5.0	8.2	7.5	9.4
Potassium, dissolved, mg/L	SW6010	5.0	9.1	8.4	7.7
Sodium, total, mg/L	SW6010	5.0	123	125	131
Sodium, dissolved, mg/L	SW6010	5.0	133	135	121

Table 3.--Analytical results of quarterly ground-water monitoring at the Chromic Acid Pit site, U.S. Army Air Defense Artillery Center and Fort Bliss, El Paso, Texas, first quarter, December 1994--Continued

Parameter and units	Method	Reporting limit	Well MW1 result/qualifier	Well MW2 result/qualifier	Well MW3 result/qualifier
Metals:					
Aluminum, total, mg/L	SW6010	0.20	ND	ND	ND
Aluminum, dissolved, mg/L	SW6010	0.20	ND	ND	ND
Antimony, total, mg/L	SW6010	0.20	ND	ND	ND
Antimony, dissolved, mg/L	SW6010	0.20	ND	ND	ND
Arsenic, total, mg/L	SW6010	0.30	ND	ND	ND
Arsenic, dissolved, mg/L	SW6010	0.30	ND	ND	ND
Barium, total, mg/L	SW6010	0.10	ND	ND	ND
Barium, dissolved, mg/L	SW6010	0.10	ND	ND	ND
Beryllium, total, mg/L	SW6010	0.0020	ND	ND	ND
Beryllium, dissolved, mg/L	SW6010	0.0020	ND	ND	ND
Cadmium, total, mg/L	SW6010	0.0050	ND	ND	ND
Cadmium, dissolved, mg/L	SW6010	0.0050	ND	ND	ND
Chromium, total, mg/L	SW7191	0.0020	0.0067/C	0.0089/C	0.0069/C
Chromium, dissolved, mg/L	SW7191	0.0020	0.0061/C	0.0070/C	0.0099/C,D
Cobalt, total, mg/L	SW6010	0.040	ND	ND	ND
Cobalt, dissolved, mg/L	SW6010	0.040	ND	ND	ND
Copper, total, mg/L	SW6010	0.030	ND/M,H	ND/E,M,H	ND/M,H
Copper, dissolved, mg/L	SW6010	0.030	ND	ND	ND
Iron, total, mg/L	SW6010	0.040	ND	0.080/E	ND
Iron, dissolved, mg/L	SW6010	0.040	ND	ND	ND
Lead, total, mg/L	SW6010	0.20	ND	ND	ND
Lead, dissolved, mg/L	SW6010	0.20	ND	ND	ND
Manganese, total, mg/L	SW6010	0.010	ND	ND	ND
Manganese, dissolved, mg/L	SW6010	0.010	ND	0.016	ND
Molybdenum, total, mg/L	SW6010	0.040	ND	ND	ND
Molybdenum, dissolved, mg/L	SW6010	0.040	ND	ND	ND
Nickel, total, mg/L	SW6010	0.040	ND	ND	ND
Nickel, dissolved, mg/L	SW6010	0.040	ND	ND	ND
Selenium, total, mg/L	SW6010	0.40	ND/M,I	ND/M,I	ND/M,I
Selenium, dissolved, mg/L	SW6010	0.40	ND	ND	ND
Silver, total, mg/L	SW6010	0.030	ND	ND	ND
Silver, dissolved, mg/L	SW6010	0.030	ND	ND	ND
Thallium, total, mg/L	SW6010	5.0	ND/C,M,H	ND/C,M,H	ND/C,M,H
Thallium, dissolved, mg/L	SW6010	5.0	ND/C	ND/C	ND/C
Vanadium, total, mg/L	SW6010	0.040	ND	ND	ND

Table 3.--Analytical results of quarterly ground-water monitoring at the Chromic Acid Pit site, U.S. Army Air Defense Artillery Center and Fort Bliss, El Paso, Texas, first quarter, December 1994--Continued

Parameter and units	Method	Reporting limit	Well MW1 result/qualifier	Well MW2 result/qualifier	Well MW3 result/qualifier
Metals--Continued:					
Vanadium, dissolved, mg/L	SW6010	0.040	ND	ND	ND
Zinc, total, mg/L	SW6010	0.010	ND/L	ND/D,E,L	0.015/D
Zinc, dissolved, mg/L	SW6010	0.010	ND	ND	ND
Total organic carbon, mg/L	SW9060	1.0	13/C,D,E	13/C	10/C
Total organic halogen as chloride, µg/L	SW9020	30.0	ND	ND	ND
Volatile organic compounds:					
Acetone, µg/L	SW8240	10	ND	ND	--
Acetonitrile, µg/L	SW8240	200	ND	ND	--
Acrolein, µg/L	SW8240	100	ND	ND	--
Acrylonitrile, µg/L	SW8240	100	ND	ND	--
Allyl chloride, µg/L	SW8240	10	ND	ND	--
Benzene, µg/L	SW8240	5.0	ND	ND	--
Bromodichloromethane, µg/L	SW8240	5.0	ND	ND	--
Bromoform, µg/L	SW8240	5.0	ND	ND	--
Bromomethane, µg/L	SW8240	10	ND	ND	--
Carbon disulfide, µg/L	SW8240	5.0	ND	ND	--
Carbon tetrachloride, µg/L	SW8240	5.0	ND	ND	--
Chlorobenzene, µg/L	SW8240	5.0	ND	ND	--
Chloroethane, µg/L	SW8240	10	ND	ND	--
Chloroform, µg/L	SW8240	5.0	ND	ND	--
Chloromethane, µg/L	SW8240	10	ND	ND	--
Chloroprene, µg/L	SW8240	5.0	ND	ND	--
Dibromochloromethane, µg/L	SW8240	5.0	ND	ND	--
Dibromomethane, µg/L	SW8240	5.0	ND	ND	--
Dichlorodifluoromethane, µg/L	SW8240	20	ND	ND	--
Ethylbenzene, µg/L	SW8240	5.0	ND	ND	--
Ethyl methacrylate, µg/L	SW8240	20	ND	ND	--
Iodomethane, µg/L	SW8240	5.0	ND	ND	--
Isobutanol, µg/L	SW8240	200	ND	ND	--
Methacrylonitrile, µg/L	SW8240	5.0	ND	ND	--
Methyl methacrylate, µg/L	SW8240	20	ND	ND	--
Methylene chloride, µg/L	SW8240	5.0	ND	ND	--
Propionitrile, µg/L	SW8240	5.0	ND	ND	--
Styrene, µg/L	SW8240	5.0	ND	ND	--
Tetrachloroethene, µg/L	SW8240	5.0	ND	ND	--

Table 3.--Analytical results of quarterly ground-water monitoring at the Chromic Acid Pit site, U.S. Army Air Defense Artillery Center and Fort Bliss, El Paso, Texas, first quarter, December 1994--Concluded

Parameter and units	Method	Reporting limit	Well MW1 result/qualifier	Well MW2 result/qualifier	Well MW3 result/qualifier
Volatile organic compounds--Continued:					
Toluene, µg/L	SW8240	5.0	ND	ND	--
Trichloroethene, µg/L	SW8240	5.0	ND	ND	--
Trichlorofluoromethane, µg/L	SW8240	5.0	ND	ND	--
Vinyl acetate, µg/L	SW8240	10	ND	ND	--
Vinyl chloride, µg/L	SW8240	10	ND	ND	--
Xylenes (total), µg/L	SW8240	5.0	ND	ND	--
cis-1,3-Dichloropropene, µg/L	SW8240	5.0	ND	ND	--
trans-1,3-Dichloropropene, µg/L	SW8240	5.0	ND	ND	--
trans-1,4-Dichloro-2-butene, µg/L	SW8240	5.0	ND	ND	--
1,1,1,2-Tetrachloroethane, µg/L	SW8240	5.0	ND	ND	--
1,1,1-Trichloroethane, µg/L	SW8240	5.0	ND	ND	--
1,1,2,2-Tetrachloroethane, µg/L	SW8240	5.0	ND	ND	--
1,1,2-Trichloroethane, µg/L	SW8240	5.0	ND	ND	--
1,1-Dichloroethane, µg/L	SW8240	5.0	ND	ND	--
1,1-Dichloroethene, µg/L	SW8240	5.0	ND	ND	--
1,2,3-Trichloropropane, µg/L	SW8240	5.0	ND	ND	--
1,2-Dibromo-3-chloro-propane (DBCP), µg/L	SW8240	10	ND	ND	--
1,2-Dibromoethane (EDB), µg/L	SW8240	10	ND	ND	--
1,2-Dichloroethane, µg/L	SW8240	5.0	ND	ND	--
1,2-Dichloroethene (total), µg/L	SW8240	5.0	ND	ND	--
1,2-Dichloropropane, µg/L	SW8240	5.0	ND	ND	--
1,4-Dioxane, µg/L	SW8240	500	ND	ND	--
2-Butanone (MEK), µg/L	SW8240	10	ND	ND	--
2-Hexanone, µg/L	SW8240	10	ND	ND	--
4-Methyl-2-pentanone (MIBK), µg/L	SW8240	10	ND	ND	--
Tentatively identified compounds:					
Siloxane, µg/L	SW8240	--	--	17/X,Y	--

Table 4.--Analytical results of quarterly ground-water monitoring at the Chromic Acid Pit site, U.S. Army Air Defense Artillery Center and Fort Bliss, El Paso, Texas, second quarter, March 1995

[Qualifier codes are identified in table 7. --, no data; NTU's, nephelometric turbidity units; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; ND, not detected]

Parameter and units	Method	Reporting limit	Well MW1 result/qualifier	Well MW2 result/qualifier	Well MW3 result/qualifier
Date	--	--	07-MAR-95	08-MAR-95	09-MAR-95
Time	--	--	1525	1330	1315
U.S. Geological Survey sample number	--	--	CAP1021	CAP2021	CAP3017
Laboratory sample number	--	--	040890-0001-SA	040907-0001-SA	040929-0001-SA
Water level, elevation, feet above sea level, prior to pumping	--	0.01	3,609.49	3,609.01	3,609.12
Amount purged prior to sampling, gallons	--	1	203	174.5	170
Depth sampled, feet below land surface	--	1	325	325	325
Field properties:					
Temperature, degrees Celsius	E170.1	0.1	21.7	21.8	23.5
Turbidity, NTU's	E180.1	1	0.68	0.58	1.76
pH	E150.1	0.1	7.94	7.56	7.65
Specific conductance, µS/cm	E120.1	10.0	818	797	795
Alkalinity, carbonate, mg/L	A403	--	0	0	0
Alkalinity, bicarbonate, mg/L	A403	10	188	222	221
Alkalinity, calcium carbonate, mg/L	A403	10	154	182	181
Dissolved solids, mg/L	E160.1	10.0	485	481	516
Suspended solids, mg/L	E160.2	2.0	ND	ND	ND
Common ions:					
Chloride, total, mg/L	E300	0.50	87.6/M,I	67.7/M,I	68.3/M,I
Fluoride, total, mg/L	E300	0.50	1.5	1.1	1.2
Nitrate as nitrogen, total, mg/L	E300	0.50	2.1	2.7	2.6
Nitrite plus nitrate as nitrogen, total, mg/L	E353.2	0.10	2.4	3.0	2.9
Orthophosphate as phosphorus, total, mg/L	E300	0.50	ND	ND	ND
Sulfate, total, mg/L	E300	0.50	104/M,I	102/M,I	101/M,I
Calcium, total, mg/L	SW6010	5.0	28.5	30.3	29.4
Calcium, dissolved, mg/L	SW6010	5.0	28.6	29.1	27.5
Magnesium, total, mg/L	SW6010	5.0	11.2	11.7	11.1
Magnesium, dissolved, mg/L	SW6010	5.0	11.2	11.2	10.3
Potassium, total, mg/L	SW6010	5.0	8.5	8.0	8.8
Potassium, dissolved, mg/L	SW6010	5.0	8.5	7.9	8.4
Sodium, total, mg/L	SW6010	5.0	131	135	135
Sodium, dissolved, mg/L	SW6010	5.0	130	130	125
Metals:					
Aluminum, total, mg/L	SW6010	0.20	ND	ND	ND
Aluminum, dissolved, mg/L	SW6010	0.20	ND	ND	ND

Table 4.--Analytical results of quarterly ground-water monitoring at the Chromic Acid Pit site, U.S. Army Air Defense Artillery Center and Fort Bliss, El Paso, Texas, second quarter, March 1995--Concluded

Parameter and units	Method	Reporting limit	Well MW1 result/qualifier	Well MW2 result/qualifier	Well MW3 result/qualifier
Metals--Continued:					
Antimony, total, mg/L	SW6010	0.20	ND	ND	ND
Antimony, dissolved, mg/L	SW6010	0.20	ND	ND	ND
Arsenic, total, mg/L	SW6010	0.30	ND	ND	ND
Arsenic, dissolved, mg/L	SW6010	0.30	ND	ND	ND
Barium, total, mg/L	SW6010	0.10	ND	ND	ND
Barium, dissolved, mg/L	SW6010	0.10	ND	ND	ND
Beryllium, total, mg/L	SW6010	0.0020	ND	ND	ND
Beryllium, dissolved, mg/L	SW6010	0.0020	ND	ND	ND
Cadmium, total, mg/L	SW6010	0.0050	ND	ND	ND
Cadmium, dissolved, mg/L	SW6010	0.0050	ND	ND	ND
Chromium, total, mg/L	SW7191	0.0020	0.0095/C	0.011/C	0.016/C
Chromium, dissolved, mg/L	SW7191	0.0020	0.0040/C	0.0082/C	0.0074/C
Cobalt, total, mg/L	SW6010	0.040	ND	ND	ND
Cobalt, dissolved, mg/L	SW6010	0.040	ND	ND	ND
Copper, total, mg/L	SW6010	0.030	ND	ND	ND
Copper, dissolved, mg/L	SW6010	0.030	ND	ND	ND
Iron, total, mg/L	SW6010	0.040	0.082/D	ND	0.14
Iron, dissolved, mg/L	SW6010	0.040	ND	ND	ND
Lead, total, mg/L	SW6010	0.20	ND	ND	ND
Lead, dissolved, mg/L	SW6010	0.20	ND	ND	ND
Manganese, total, mg/L	SW6010	0.010	ND	ND	0.011
Manganese, dissolved, mg/L	SW6010	0.010	ND	ND	ND
Molybdenum, total, mg/L	SW6010	0.040	ND	ND	ND
Molybdenum, dissolved, mg/L	SW6010	0.040	ND	ND	ND
Nickel, total, mg/L	SW6010	0.040	ND	ND	ND
Nickel, dissolved, mg/L	SW6010	0.040	ND	ND	ND
Selenium, total, mg/L	SW6010	0.40	ND/M,I	ND/M,I	ND/M,I
Selenium, dissolved, mg/L	SW6010	0.40	ND	ND	ND
Silver, total, mg/L	SW6010	0.030	ND	ND	ND
Silver, dissolved, mg/L	SW6010	0.030	ND	ND	ND
Thallium, total, mg/L	SW6010	5.0	ND/C	ND/C	ND/C
Thallium, dissolved, mg/L	SW6010	5.0	ND/C	ND/C	ND/C
Vanadium, total, mg/L	SW6010	0.040	ND	ND	ND
Vanadium, dissolved, mg/L	SW6010	0.040	ND	ND	ND
Zinc, total, mg/L	SW6010	0.010	0.012/D	ND	0.011/D
Zinc, dissolved, mg/L	SW6010	0.010	ND	ND	ND
Total organic carbon, mg/L	SW9060	1.0	ND/C	ND/C	ND/C
Total organic halogen as chloride, µg/L	SW9020	30.0	ND	ND	ND

Table 5.--Analytical results of quarterly ground-water monitoring at the Chromic Acid Pit site, U.S. Army Air Defense Artillery Center and Fort Bliss, El Paso, Texas, third quarter, June 1995

[Qualifier codes are identified in table 7. --, no data; NTU's, nephelometric turbidity units; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; ND, not detected]

Parameter and units	Method	Reporting limit	Well MW1 result/qualifier	Well MW2 result/qualifier	Well MW3 result/qualifier
Date	--	--	13-JUNE-95	14-JUNE-95	15-JUNE-95
Time	--	--	1600	1330	1225
U.S. Geological Survey sample number	--	--	CAP1025	CAP2025	CAP3023
Laboratory sample number	--	--	042742-0001-SA	042786-0001-SA	042827-0001-SA
Water level, elevation, feet above sea level, prior to pumping	--	0.01	3,608.50	3,608.42	3,608.33
Amount purged prior to sampling, gallons	--	1	216	180	175
Depth sampled, feet below land surface	--	1	320	325	320
Field properties:					
Temperature, degrees Celsius	E170.1	0.1	21.5	21.7	20.1
Turbidity, NTU's	E180.1	1	1.09	3.00	2.44
pH	E150.1	0.1	7.86	7.15	7.83
Specific conductance, µS/cm	E120.1	10.0	731	794	777
Alkalinity, carbonate, mg/L	A403	--	0	0	0
Alkalinity, bicarbonate, mg/L	A403	10	186	220	222
Alkalinity, calcium carbonate, mg/L	A403	10	153	180	182
Dissolved solids, mg/L	E160.1	10.0	494	491	491
Suspended solids, mg/L	E160.2	2.0	ND	ND	2.4
Common ions:					
Chloride, total, mg/L	E300	0.50	87.9/M,I	68.5/M,I	68.7/M,I
Fluoride, total, mg/L	E300	0.50	1.5	1.4	1.3
Nitrate as nitrogen, total, mg/L	E300	0.50	2.1	2.7	2.7
Nitrite plus nitrate as nitrogen, total, mg/L	E353.2	0.10	2.4	3.0	3.0
Orthophosphate as phosphorus, total, mg/L	E300	0.50	ND/M	ND/M	ND/M
Sulfate, total, mg/L	E300	0.50	106	103	104
Calcium, total, mg/L	SW6010	5.0	28.2	28.1	28.4
Calcium, dissolved, mg/L	SW6010	5.0	28.6	28.5	29.9
Magnesium, total, mg/L	SW6010	5.0	10.7	11.0	10.5
Magnesium, dissolved, mg/L	SW6010	5.0	11.3	11.3	11.5
Potassium, total, mg/L	SW6010	5.0	8.6	7.0	8.9
Potassium, dissolved, mg/L	SW6010	5.0	9.3	7.6	9.3
Sodium, total, mg/L	SW6010	5.0	128	120	129
Sodium, dissolved, mg/L	SW6010	5.0	131	123	136
Metals:					
Aluminum, total, mg/L	SW6010	0.20	ND	ND	ND
Aluminum, dissolved, mg/L	SW6010	0.20	ND	ND	ND

Table 5.--Analytical results of quarterly ground-water monitoring at the Chromic Acid Pit site, U.S. Army Air Defense Artillery Center and Fort Bliss, El Paso, Texas, third quarter, June 1995--Concluded

Parameter and units	Method	Reporting limit	Well MW1 result/qualifier	Well MW2 result/qualifier	Well MW3 result/qualifier
Metals--Continued:					
Antimony, total, mg/L	SW6010	0.20	ND	ND	ND
Antimony, dissolved, mg/L	SW6010	0.20	ND	ND	ND
Arsenic, total, mg/L	SW6010	0.30	ND	ND	ND
Arsenic, dissolved, mg/L	SW6010	0.30	ND	ND	ND
Barium, total, mg/L	SW6010	0.10	ND	ND	ND
Barium, dissolved, mg/L	SW6010	0.10	ND	ND	ND
Beryllium, total, mg/L	SW6010	0.0020	ND	ND	ND
Beryllium, dissolved, mg/L	SW6010	0.0020	ND	ND	ND
Cadmium, total, mg/L	SW6010	0.0050	ND	ND	ND
Cadmium, dissolved, mg/L	SW6010	0.0050	ND	ND	ND
Chromium, total, mg/L	SW7191	0.0020	0.0078/C	0.030/C	0.012/C
Chromium, dissolved, mg/L	SW7191	0.0020	0.0082/C	0.0084/C	0.0084/C
Cobalt, total, mg/L	SW6010	0.040	ND	ND	ND
Cobalt, dissolved, mg/L	SW6010	0.040	ND	ND	ND
Copper, total, mg/L	SW6010	0.030	ND	ND	ND
Copper, dissolved, mg/L	SW6010	0.030	ND	ND	ND
Iron, total, mg/L	SW6010	0.040	0.055/D,E,R	0.20	0.15
Iron, dissolved, mg/L	SW6010	0.040	ND	ND	ND
Lead, total, mg/L	SW6010	0.20	ND	ND	ND
Lead, dissolved, mg/L	SW6010	0.20	ND	ND	ND
Manganese, total, mg/L	SW6010	0.010	ND	ND	ND
Manganese, dissolved, mg/L	SW6010	0.010	ND	ND	ND
Molybdenum, total, mg/L	SW6010	0.040	ND	ND	ND
Molybdenum, dissolved, mg/L	SW6010	0.040	ND	ND	ND
Nickel, total, mg/L	SW6010	0.040	ND	ND	ND
Nickel, dissolved, mg/L	SW6010	0.040	ND	ND	ND
Selenium, total, mg/L	SW6010	0.40	ND	ND	ND
Selenium, dissolved, mg/L	SW6010	0.40	ND	ND	ND
Silver, total, mg/L	SW6010	0.030	ND	ND	ND
Silver, dissolved, mg/L	SW6010	0.030	ND	ND	ND
Thallium, total, mg/L	SW6010	5.0	ND/C	ND/C	ND/C
Thallium, dissolved, mg/L	SW6010	5.0	ND/C	ND/C	ND/C
Vanadium, total, mg/L	SW6010	0.040	ND	ND	ND
Vanadium, dissolved, mg/L	SW6010	0.040	ND	ND	ND
Zinc, total, mg/L	SW6010	0.010	0.012	ND	ND
Zinc, dissolved, mg/L	SW6010	0.010	ND	ND	ND
Total organic carbon, mg/L	SW9060	1.0	ND/C	ND/C	ND/C
Total organic halogen as chloride, mg/L	SW9020	30.0	ND	ND	ND

Table 6.--Analytical results of quarterly ground-water monitoring at the Chromic Acid Pit site, U.S. Army Air Defense Artillery Center and Fort Bliss, El Paso, Texas, fourth quarter, September 1995

[Qualifier codes are identified in table 7. --, no data; NTU's, nephelometric turbidity units; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; ND, not detected]

Parameter and units	Method	Reporting limit	Well MW1 result/qualifier	Well MW2 result/qualifier	Well MW3 result/qualifier
Date	--	--	13-SEPT-95	14-SEPT-95	13-SEPT-95
Time	--	--	1200	1245	1740
U.S. Geological Survey sample number	--	--	CAP1031	CAP2029	CAP3027
Laboratory sample number	--	--	044615-0001-SA	044640-0001-SA	044640-0001-SA
Water level, elevation, feet above sea level, prior to pumping	--	0.01	3,607.93	3,607.81	3,607.81
Amount purged prior to sampling, gallons	--	1	220	180	181
Depth sampled, feet below land surface	--	1	320	320	300
Field properties:					
Temperature, degrees Celsius	E170.1	0.1	19.7	19.0	21.3
Turbidity, NTU's	E180.1	1	0.32	0.90	0.12
pH	E150.1	0.1	7.79	7.23	7.49
Specific conductance, µS/cm	E120.1	10.0	861	822	838
Alkalinity, carbonate, mg/L	A403	--	0	0	0
Alkalinity, bicarbonate, mg/L	A403	10	161	232	191
Alkalinity, calcium carbonate, mg/L	A403	10	132	190	156
Dissolved solids, mg/L	E160.1	10.0	499	497	516
Suspended solids, mg/L	E160.2	2.0	ND	ND	ND
Common ions:					
Chloride, total, mg/L	E300	0.50	85.6	68.3	70.3
Fluoride, total, mg/L	E300	0.50	1.6	1.4	1.4
Nitrate as nitrogen, total, mg/L	E300	0.50	2.2	2.8	2.7
Nitrite plus nitrate as nitrogen, total, mg/L	E353.2	0.20	[1]2.4/C,M,H	3.2/C,M,H	3.1/C,M,H
Orthophosphate as phosphorus, total, mg/L	E300	0.50	ND	ND	ND
Sulfate, total, mg/L	E300	0.50	107	103	104
Calcium, total, mg/L	SW6010	5.0	30.3	28.9	27.6
Calcium, dissolved, mg/L	SW6010	5.0	29.5	27.4	28.2
Magnesium, total, mg/L	SW6010	5.0	12.1	11.1	10.3
Magnesium, dissolved, mg/L	SW6010	5.0	11.6	10.8	10.8
Potassium, total, mg/L	SW6010	5.0	8.9	8.1	8.4
Potassium, dissolved, mg/L	SW6010	5.0	8.4	7.5	8.5
Sodium, total, mg/L	SW6010	5.0	133	133	127
Sodium, dissolved, mg/L	SW6010	5.0	128	124	130
Metals:					
Aluminum, total, mg/L	SW6010	0.20	0.032/j,D	ND	ND
Aluminum, dissolved, mg/L	SW6010	0.20	ND	ND	ND
Antimony, total, mg/L	SW6010	0.20	ND	ND	ND

Table 6.--Analytical results of quarterly ground-water monitoring at the Chromic Acid Pit site, U.S. Army Air Defense Artillery Center and Fort Bliss, El Paso, Texas, fourth quarter, September 1995--Concluded

Parameter and units	Method	Reporting limit	Well MW1 result/qualifier	Well MW2 result/qualifier	Well MW3 result/qualifier
Metals--Continued:					
Antimony, dissolved, mg/L	SW6010	0.20	ND	ND	ND
Arsenic, total, mg/L	SW6010	0.30	ND	ND	ND
Arsenic, dissolved, mg/L	SW6010	0.30	ND	ND	ND
Barium, total, mg/L	SW6010	0.10	0.045/j	ND	ND
Barium, dissolved, mg/L	SW6010	0.10	0.043/j	ND	ND
Beryllium, total, mg/L	SW6010	0.0020	ND	ND	ND
Beryllium, dissolved, mg/L	SW6010	0.0020	ND	ND	ND
Cadmium, total, mg/L	SW6010	0.0050	ND	ND	ND
Cadmium, dissolved, mg/L	SW6010	0.0050	ND	ND	ND
Chromium, total, mg/L	SW7191	0.0050	0.0061/C	ND[2]/g,C	ND[2]/g,C
Chromium, dissolved, mg/L	SW7191	0.0050	[2]0.0039/j,g,C	0.010/C	0.0093/C
Cobalt, total, mg/L	SW6010	0.040	ND	ND	ND
Cobalt, dissolved, mg/L	SW6010	0.040	ND	ND	ND
Copper, total, mg/L	SW6010	0.030	ND	ND	ND
Copper, dissolved, mg/L	SW6010	0.030	0.023/j,D	ND	ND
Iron, total, mg/L	SW6010	0.040	0.048	0.054	0.095
Iron, dissolved, mg/L	SW6010	0.040	ND	ND	ND
Lead, total, mg/L	SW6010	0.20	ND	ND	ND
Lead, dissolved, mg/L	SW6010	0.20	ND	ND	ND
Manganese, total, mg/L	SW6010	0.010	ND	ND	ND
Manganese, dissolved, mg/L	SW6010	0.010	ND	ND	ND
Molybdenum, total, mg/L	SW6010	0.040	ND	ND	ND
Molybdenum, dissolved, mg/L	SW6010	0.040	ND	ND	ND
Nickel, total, mg/L	SW6010	0.040	ND	ND	ND
Nickel, dissolved, mg/L	SW6010	0.040	ND	ND	ND
Selenium, total, mg/L	SW6010	0.40	ND/M,H	ND/M,H	ND/M,H
Selenium, dissolved, mg/L	SW6010	0.40	ND	ND	ND
Silver, total, mg/L	SW6010	0.030	ND	ND	ND
Silver, dissolved, mg/L	SW6010	0.030	ND	ND	ND
Thallium, total, mg/L	SW6010	5.0	ND/C	ND/C	ND/C
Thallium, dissolved, mg/L	SW6010	5.0	0.18/j,C	ND/C	ND/C
Vanadium, total, mg/L	SW6010	0.040	0.012/j	ND	ND
Vanadium, dissolved, mg/L	SW6010	0.040	0.010/j	ND	ND
Zinc, total, mg/L	SW6010	0.010	0.0054/j,D	ND	0.10/b,D,E,L
Zinc, dissolved, mg/L	SW6010	0.010	ND	ND	ND
Total organic carbon, mg/L	SW9060	1.0	1.0/C	ND/C	ND/C
Total organic halogen as chloride, mg/L	SW9020	30.0	ND	ND	ND

[1] Laboratory reporting limit is 0.40 mg/L

[2] Laboratory reporting limit is 0.010 mg/L.

Table 7.--Data-qualifier codes used to qualify water-quality data

[TIC, tentatively identified compound]

Data-qualifier code	Definition
A	Reported results may be less than the actual value or possibility of a false non-detect because the sample was extracted or analyzed after the required analytical holding-time limits[1].
B	Associated surrogate-recovery sample results did not meet the frequency or quality-control acceptance criteria.
b	Compound is also detected in the blank (laboratory qualifier code).
C	Reported results did not meet the project-reporting limits[2].
D	Associated field-duplicate sample results did not meet the frequency (discussed in the Quality Assurance/Quality Control and Review of Analytical Data section of this report) or quality-control acceptance criteria[3].
E	Associated equipment blank results did not meet the frequency or quality-control acceptance criteria.
F	Associated ambient-conditions blank results did not meet the frequency or quality-control criteria.
G	Associated trip blank results did not meet the frequency or quality-control criteria.
g	Reporting limit raised due to matrix interference (laboratory qualifier code).
H	Reported value may be biased high because the quality-control results are substantially greater than the quality-control limits[4].
I	Reported value may be biased low because the quality-control results are substantially less than the quality-control limits.
J	Associated laboratory duplicate-control sample results did not meet the frequency or quality-control acceptance criteria.
j	Result is detected below the reporting limit or is an estimated concentration (laboratory qualifier code).
K	Associated laboratory single-control sample results did not meet the frequency or quality-control acceptance criteria.
L	Associated method blank results did not meet the frequency or quality-control acceptance criteria.
M	Associated matrix spike or matrix-spike duplicate sample results did not meet the frequency or quality-control acceptance criteria.
N	Instrument tuning, calibration, internal standards, or performance results did not meet the frequency or quality-control acceptance criteria.
O	Problems with inductively coupled plasma analysis such as interelemental interferences or serial dilution. (This qualifier is to be used only with inorganic data.)
P	Reported result was more than the highest calibration of method limits or exceeded the instrument's linear range.
Q	Reported result was less than the lowest calibration, target-detection, reporting, or method limits or was below the instrument's linear range.
R	Problems in the sampling or analysis process such as field or laboratory contamination of a sample.
S	The sample result (positive or not detected) is considered conditionally rejected because of serious deficiencies in the ability to analyze the sample, or the quality-control acceptance criteria were substantially outside the required limits. Resampling or reanalysis may be necessary to verify the presence or absence of the constituent.

Table 7.--Data-qualifier codes used to qualify water-quality data--Concluded

Data-qualifier code	Definition
T	The reported positive sample result is considered not reliable because of substantial contamination in the associated blanks on the basis of the following criteria: (1) concentration of analyte that is a common laboratory organic contaminant has a concentration less than 10 times the concentration in the associated blank, or (2) other analytes have concentrations less than 5 times the concentration in the associated blank.
t	Sample diluted due to the concentration of target compounds (laboratory qualifier code).
U	The reported positive sample result is considered an estimated quantity or questionable because: (1) there were analysis problems, (2) the quality-control or confirmation acceptance criteria were not met, or (3) the amount reported is less than or more than the calibration or method-detection limits[5,6].
V	The reported not-detected (ND) sample result is questionable because of analysis problems or quality-control acceptance criteria were not met.
W	The identification of a TIC is questionable and the reported positive result for the TIC is strictly an estimated value because normal analysis and quality-control acceptance criteria do not apply directly for the reported TIC result. (This data-qualifier code is to be used only with TIC data.)
X	The identification of a TIC is questionable and the reported positive result is considered not reliable because this TIC was also detected in an associated quality-control blank. (This data-qualifier code is to be used only with TIC data.)
Y	The identification of a TIC is questionable and the reported positive result is considered as conditionally rejected because this TIC is considered a common laboratory contaminant. (This data-qualifier code is to be used only with TIC data.)
Z	This data qualifier code is used for specific analytical results that have data-quality problems not covered or represented in this list. If this code is used, some explanation is needed to describe the specific data-quality problem.

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[1] Holding time: period of time during which a sample can be stored after collection and preservation. Holding-time limits are listed in table 1.5.2.1 of the Sampling and Analysis Plan (U.S. Geological Survey, written commun., May 1994).

[2] Project-reporting limit: the minimum signal level required to quantitatively identify a specific analyte by a specific procedure at a confidence level that is greater than 97 percent. Limits are listed in table 1.8.2.1 of the Sampling and Analysis Plan (U.S. Geological Survey, written commun., May 1994).

[3] Quality-control acceptance criteria: predefined requirements set to monitor that the data generated are precise and accurate. Criteria are listed in table 1.8.3.1 of the Sampling and Analysis Plan (U.S. Geological Survey, written commun., May 1994).

[4] Quality-control limits: limits for assessing accuracy by use of matrix-spike and matrix-spike duplicate samples. Limits are listed in table 1.13.2.1 of the Sampling and Analysis Plan (U.S. Geological Survey, written commun., May 1994).

[5] Calibration limit: the frequency of calibration and calibration verification and the concentration of calibration standards are determined by the manufacturer's guidelines, the analytical method, or the requirements of special contracts.

[6] Method-detection limit: minimum concentration of a substance that can be measured and reported using a specific method.

Concentrations of total chromium, detected above the laboratory reporting limit, ranged from 0.0061 to 0.030 mg/L; concentrations of dissolved chromium ranged from 0.0040 to 0.010 mg/L. Concentrations of total iron in water samples ranged from not detected (laboratory reporting limit of 0.040 mg/L) to 0.20 mg/L. Concentrations of total zinc ranged from not detected (laboratory reporting limit of 0.010 mg/L) to 0.10 mg/L (some reported values for total zinc did not meet field-duplicate and/or equipment blank and method blank QA/QC requirements (tables 3-6)). Some reported results, whether detected at or above the reporting limits or not, had data qualifiers; some reported values did not meet field-duplicate QA/QC requirements (tables 3-6). Detected chemical concentrations in water from the chromic acid pit monitoring wells during the four sampling periods were below EPA-identified maximum contaminant levels (table 8) for public drinking-water supplies.

The chromic acid pit ground-water monitoring wells were completed with a 5-foot stainless steel sump and stainless steel wire-wrap screen (figs. 3-5). The composition of the stainless steel water-well casing and sump, assuming the use of type 304 stainless steel (not specified by the contractor who completed the wells), is as follows (Driscoll, 1986):

Chromium - 18 percent minimum;
Nickel - 8 percent minimum;
Manganese - 2 percent maximum;
Carbon - 0.08 percent maximum; and
Iron - balance.

Driscoll (1986) described type 304 stainless steel as having excellent corrosion resistance and as being the most widely used stainless steel material for water-well screens. Monitoring well MW3 contains 80 feet of stainless steel screen, and wells MW1 and MW2 contain 45 feet each.

Although the type of stainless steel material assumed to be used may be resistant to corrosion, detected concentrations of chromium, iron, and manganese may be partly due to the chemical leaching of the screen and sump material, as well as the stainless steel pump used in purging and sampling of the wells. Total metal concentrations detected above the laboratory reporting limits (Quanterra Environmental Services, written commun., December 1994; March, July, September, and October 1995) in equipment blanks collected during the second year of quarterly sampling included: (1) chromium detected in 2 of 12 equipment-blank samples at concentrations of 0.0022 and 0.0023 mg/L; (2) zinc detected in 9 of 12 equipment-blank samples ranging from 0.011 to 0.50 mg/L; (3) iron detected in 2 of 12 equipment-blank samples at concentrations of 0.15 and 0.19 mg/L; (4) copper detected in 1 of 12 equipment-blank samples at a concentration of 0.27 mg/L; and (5) cadmium detected in 1 of 12 equipment-blank samples at a concentration of 0.0051 mg/L. Unless qualified with the code E (table 7) in tables 3-6, the detection of these metals in the equipment blanks was within acceptable QA/QC limits.

Total organic carbon concentrations were detected (laboratory reporting limit of 1.0 mg/L) twice in upgradient well MW1 and once each in downgradient wells MW2 and MW3 (4 of the 12 total water samples); concentrations were 13 and 1.0 mg/L in water from MW1 and 13 and 10 mg/L in water from wells MW2 and MW3, respectively. One of the analyses for water samples from well MW1 did not meet the QA/QC criteria for equipment-blank and duplicate samples (table 3). Concentrations of total organic halides were not detected above the laboratory reporting limit (30.0 μg/L) in any of the monitoring wells during the water year 1995 sampling rounds.

Table 8.--Summary of maximum contaminant levels for selected water-quality constituents and properties for public water-supply systems[1]

[--, no data; mg/L, milligrams per liter]

Constituent	Maximum contaminant level[2]	Secondary maximum contaminant level[3]
pH (standard units)	--	Less than 6.5 and greater than 8.5
Aluminum, total	--	0.05-0.2 mg/L
Antimony, total	0.006 mg/L	--
Arsenic, total	0.05 mg/L	--
Barium, total	2 mg/L	--
Beryllium, total	0.004 mg/L	--
Cadmium, total	0.005 mg/L	--
Chloride, total	--	250 mg/L
Chromium, total	0.1 mg/L	--
Copper, total	--	1.0 mg/L
Cyanide, total	0.2 mg/L	--
Dissolved solids	--	500 mg/L
Fluoride, total	4.0 mg/L	2.0 mg/L
Iron, total	--	0.3 mg/L
Manganese, total	--	0.05 mg/L
Mercury, total	0.002 mg/L	--
Nickel, total	0.1 mg/L	--
Nitrite plus nitrate, total	10 mg/L	--
Nitrate as nitrogen, total	10 mg/L	--
Nitrite as nitrogen, total	1 mg/L	--
Selenium, total	0.05 mg/L	--
Silver, total	--	0.1 mg/L
Sulfate, total	--	250 mg/L
Thallium, total	0.002 mg/L	--
Zinc, total	--	5.0 mg/L

[1] Public water-supply system: A system for the provision of piped water to the public for human consumption, if such system has at least 15 service connections or regularly serves at least 25 individuals daily at least 60 days of the year.

[2] Maximum contaminant level: Maximum permissible level of a contaminant in water that is delivered to the free-flowing outlet of the ultimate user of a public water system. Maximum contaminant levels are those levels set by the U.S. Environmental Protection Agency (1994) in the National Primary Drinking Water Regulations. These regulations deal with contaminants that may have a substantial direct impact on the health of the consumer and are enforceable by Federal law.

[3] Secondary maximum contaminant level: Advisable maximum level of a contaminant in water that is delivered to a free-flowing outlet of the ultimate user of a public water system. Secondary maximum contaminant levels are those levels proposed by the U.S. Environmental Protection Agency (1994) in the National Secondary Drinking Water Regulations. These regulations deal with contaminants that may not have a substantial direct impact on the health of the consumer, but their presence in excessive quantities may affect the aesthetic qualities of the water and may discourage the use of a drinking-water supply by the public.

Ground-water samples collected from monitoring wells MW1 and MW2 during the first quarter of water year 1995 were analyzed for the volatile organic compounds listed in Appendix IX (U.S. Environmental Protection Agency, 1993, Appendix IX). No volatile organic compounds were detected above the laboratory reporting limits during the December 1994 sampling round with the exception of the tentatively identified volatile compounds reported as siloxanes (table 3). Siloxanes are common laboratory and field artifacts or contaminants whose sources include silicon-based grease in the field or laboratory plus the liquid phase coating on gas chromatography columns, as well as other laboratory equipment. Siloxanes may be present, however, in environmental samples from spills of silicone oils or lubricating oils with siloxane additives (Quanterra Environmental Services, written commun., December 29, 1994). The siloxane compounds were tentatively identified in a water sample from well MW2 at a concentration of 17 μg/L. The siloxane compounds were also tentatively identified in the ambient blank for well MW2 at a concentration of 7.5 μg/L. The tentative identification of this compound is strictly an estimate based on the laboratory detection of an unknown compound through gas chromatograph/mass spectrometer (GC/MS) analysis. The mass spectrum of chromatographic peaks generated by the GC/MS analysis was compared to a library of reference spectra, which was then reviewed by an analyst who tentatively identified the compound on the basis of available information. The tentatively identified compound (TIC) was quantified on the basis of total ionization peak area relative to an internal laboratory standard. Because this TIC was also tentatively identified in the associated ambient blank (Quanterra Analytical Services, written commun., December 29, 1994), the samples were assumed to have been contaminated during collection. Overall, chemical concentrations in water from the chromic acid pit monitoring wells were similar to those in other wells in the vicinity (tables 3-6; Abeyta and Thomas, 1996, table 10).

STATISTICAL ANALYSIS OF WATER-QUALITY DATA

Hypothesis tests were performed on water-quality data for chromic acid pit ground-water monitoring wells MW1, MW2, and MW3 to determine whether water quality at either downgradient, or compliance, well (MW2 and MW3) was significantly different than that at the background well (MW1). Water-quality data used in the hypothesis tests were for samples collected on a quarterly basis (eight quarters total) between December 7, 1993, and September 13, 1995 (tables 3-6; Abeyta and Thomas, 1996, tables 11-14).

Sufficient background and compliance data were available for statistical analysis after a minimum of four water samples were collected from each well over the 12-month period beginning December 1993. Samples were collected at four intervals (December, March, June, and September) during each year to assure that independent samples were obtained (because most statistical procedures are based on the assumption of independence).

Because the list of constituents to be analyzed was modified after the first quarterly sampling event (Abeyta and Thomas, 1996, p. 6), the number of samples at each well varied from seven to eight. Duplicate and other QC samples are not included in the sample set because they are not considered to be independent measurements.

Procedure

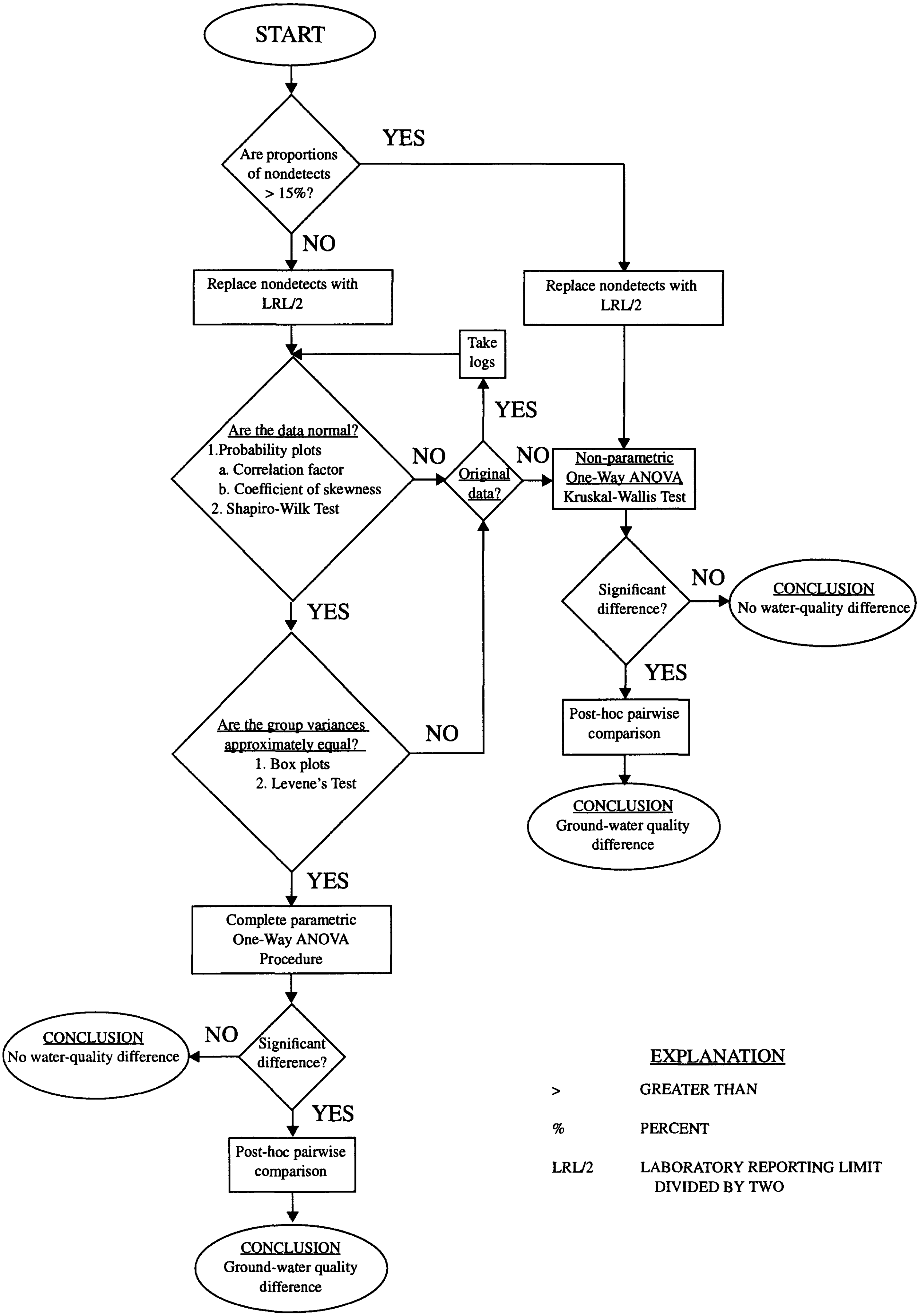
The procedure for the hypothesis tests followed the flow chart shown in figure 11. Water-quality data for MW1, MW2, and MW3 were examined to determine whether the proportion of nondetect values for each water-quality constituent was greater than or equal to 15 percent. If the proportion of nondetect values was greater than or equal to 15 percent then a nonparametric hypothesis test was performed. If the proportion of nondetect values was less than 15 percent then a parametric hypothesis test was performed if it met the criteria described below. For both nonparametric and parametric hypothesis tests all nondetect values in the data were replaced with a value equal to the laboratory reporting limit divided by two.

The nonparametric hypothesis-test procedure is based on taking the ranks of a variable and analyzing these ranks instead of the original values. The Statistical Analysis System (SAS) Institute NPAR1WAY procedure (SAS Institute, Inc., 1990b, p. 1195-1210) was used to perform the hypothesis test. This procedure determines whether the distribution of a variable has the same location parameter across different groups, using a one-way analysis of variance on the ranked data, and computes the Kruskal-Wallis test statistic, which was used to judge the outcome of the hypothesis test. If the Kruskal-Wallis test statistic indicated a significant difference among wells MW1, MW2, and MW3, then pairwise hypothesis tests were performed between MW1, MW2, and MW3. The SAS Institute NPAR1WAY procedure (SAS Institute, Inc., 1990b, p. 1195-1210) was used to compute the Wilcoxon-Rank-Sum test statistic. This test statistic was used to judge whether water quality at either downgradient well was significantly different than that at the background well.

The parametric hypothesis-test procedure requires that two assumptions about the data be satisfied: (1) the data or the log-transformed data for MW1, MW2, and MW3 must fit a normal distribution; and (2) the variances for the data or the log-transformed data at MW1, MW2, and MW3 must be approximately equal. The SAS Institute UNIVARIATE procedure (SAS Institute, Inc., 1990a, p. 617-634) calculates the Shapiro-Wilk statistic, which was used to test the MW1, MW2, and MW3 data and the log-transformed MW1, MW2, and MW3 data for normality. The SAS Institute Levene's Test (SAS Institute, Inc., written commun., 1995) was used to test the MW1, MW2, and MW3 data and the log-transformed MW1, MW2, and MW3 data for homogeneous variances. The SAS Institute ANOVA procedure (SAS Institute, Inc., 1990b, p. 209-244) was used to perform the hypothesis test; an F statistic was computed and used to judge the outcome of the hypothesis test. If the F statistic indicated a significant difference among wells MW1, MW2, and MW3, then pairwise hypothesis tests were performed between wells MW1, MW2, and MW3. The SAS Institute TTEST procedure (SAS Institute, Inc., 1990b, p. 1633-1640) was used to compute the t statistic, which was used to judge whether water quality at either downgradient well was significantly different from water quality at the background well. If either of the two assumptions about the data was not satisfied, the nonparametric test was performed.

Results

Results of hypothesis tests on water-quality data for 56 chemical constituents at wells MW1, MW2, and MW3 are summarized in table 9. Significant differences were determined at the 95-percent confidence level. This means that, on average, 1 time in 20 a significant difference will be determined when there is no significant difference. No calculation for the number of times a real significant difference will go undetected has been made.



EXPLANATION

>	GREATER THAN
%	PERCENT
LRL/2	LABORATORY REPORTING LIMIT DIVIDED BY TWO

Figure 11.--Methods used for statistical analysis of water-quality data.

Table 9.--Results of statistical testing of chemical data for the U.S. Army Air Defense Artillery Center and Fort Bliss, chromic acid pit, El Paso, Texas, December 1993 through September 1995[1]

[Note: Field properties collected December 1993-September 1995 and volatile and semivolatile organic compounds previously collected were not tested. >, greater than; <, less than]

Chemical parameter tested	Number of obser-vations	Greater than 15 percent of observations are nondetects?		Normal distribution?		Log values form a normal distribution?		Variances homogeneous?		Log value variances homogeneous?		Kruskal-Wallis test results		ANOVA test results		Pairwise test results
		YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	SIGNIF-ICANT	NOT SIGNIF-ICANT	SIGNIF-ICANT	NOT SIGNIF-ICANT	
Dissolved solids	8		X	X				X						X		MW3 > MW1 MW2 > MW1
Suspended solids	8	X											X			
Common ions:																
Chloride, total	8		X	X		X			X	X				X		MW3 > MW2 MW1 > MW3 MW1 > MW2
Fluoride, total	8		X		X		X					X				MW1 > MW2 MW1 > MW3
Nitrate as nitrogen, total	8		X		X		X					X				MW2 > MW3 MW2 > MW1 MW3 > MW1
Nitrite plus nitrate as nitrogen, total	8		X	X				X						X		MW3 > MW1 MW2 > MW1
Orthophosphate as phosphorus, total	8	X											X			
Sulfate, total	8		X		X		X					X				MW1 > MW2
Calcium, total	7		X	X				X							X	
Calcium, dissolved	7		X		X		X						X			
Magnesium, total	7		X	X				X							X	
Magnesium, dissolved	7		X		X		X						X			
Potassium, total	7		X	X				X						X		MW3 > MW2 MW1 > MW2
Potassium, dissolved	7		X	X				X							X	
Sodium, total	7		X	X		X			X		X		X			
Sodium, dissolved	7		X		X		X						X			

Table 9.--Results of statistical testing of chemical data for the U.S. Army Air Defense Artillery Center and Fort Bliss, chromic acid pit, El Paso, Texas, December 1993 through September 1995[1]--Continued

Chemical parameter tested	Number of observations	Greater than 15 percent of observations are nondetects?		Normal distribution?		Log values form a normal distribution?		Variances homogeneous?		Log value variances homogeneous?		Kruskal-Wallis test results		ANOVA test results		Pairwise test results
		YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	SIGNIFICANT	NOT SIGNIFICANT	SIGNIFICANT	NOT SIGNIFICANT	
Metals:																
Aluminum, total	7	X											X			
Aluminum, dissolved	7	X											X			
Antimony. total	8	X											X			
Antimony, dissolved	8	X											X			
Arsenic, total	8	X											X			
Arsenic, dissolved	8	X											X			
Barium, total	8	X											X			
Barium, dissolved	8	X											X			
Beryllium, total	8	X											X			
Beryllium, dissolved	8	X											X			
Cadmium, total	8	X											X			
Cadmium, dissolved	8	X											X			
Chromium, total	8		X		X	X				X					X	
Chromium, dissolved	8		X	X				X							X	
Cobalt, total	8	X											X			
Cobalt, dissolved	8	X											X			
Copper, total	8	X											X			
Copper, dissolved	8	X											X			
Iron, total	7		X		X	X				X					X	
Iron, dissolved	7	X											X			
Lead, total	8	X											X			
Lead, dissolved	8	X											X			
Manganese, total	7	X											X			

Table 9.--Results of statistical testing of chemical data for the U.S. Army Air Defense Artillery Center and Fort Bliss, chromic acid pit, El Paso, Texas, December 1993 through September 1995[1]--Concluded

Chemical parameter tested	Number of observations	Greater than 15 percent of observations are nondetects?		Normal distribution?		Log values form a normal distribution?		Variances homogeneous?		Log value variances homogeneous?		Kruskal-Wallis test results		ANOVA test results		Pairwise test results
		YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	SIGNIFICANT	NOT SIGNIFICANT	SIGNIFICANT	NOT SIGNIFICANT	
Metals--Continued:																
Manganese, dissolved	7	X											X			
Molybdenum, total	7	X											X			
Molybdenum, dissolved	7	X											X			
Nickel, total	8	X											X			
Nickel, dissolved	8	X											X			
Selenium, total	8	X											X			
Selenium, dissolved	8	X											X			
Silver, total	8	X											X			
Silver, dissolved	8	X											X			
Thallium, total	8	X											X			
Thallium, dissolved	8	X											X			
Vanadium, total	8	X											X			
Vanadium, dissolved	8	X											X			
Zinc, total	8	X											X			
Zinc, dissolved	8	X											X			
Total organic carbon	7	X											X			
Total organic halides	7	X											X			

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[1] Refer to tables 3-7 and Abeyta and Thomas, 1996, tables 11-15 for data and associated data-qualifier codes.

Significant differences were detected between ground water in the downgradient wells and ground water in the background well for the following chemical constituents: dissolved solids, chloride, fluoride, nitrate as nitrogen, nitrite plus nitrate as nitrogen, sulfate, and potassium. The concentrations of chloride, fluoride, sulfate, and potassium were significantly less in water from one or both downgradient wells MW2 and MW3 than in water from background well MW1. Concentrations of dissolved solids, nitrate as nitrogen, and nitrite plus nitrate as nitrogen were significantly greater in water from one or both downgradient wells MW2 and MW3 than in water from background well MW1. The concentration of nitrate as nitrogen in water from downgradient well MW2 was significantly greater than in water from downgradient well MW3. Concentrations of chloride and potassium in water from downgradient well MW3 were significantly greater than in water from downgradient well MW2. For all other laboratory-analyzed chemical constituents, no significant differences were detected at the 95-percent confidence level between water in the downgradient wells and water in the background well or between water in one downgradient well and water in the other downgradient well.

The significant differences among concentrations of dissolved solids, chloride, fluoride, sulfate, and potassium in water from the background well and in the downgradient wells are assumed to be due in part to incomplete well development (Abeyta and Thomas, 1996, p. 41 and 63). Although monitoring wells MW2 and MW3 have cleared up through purging, they initially contained significant amounts of drill mud and sediment prior to the initial sampling event. The significant difference of dissolved-solids concentrations may also be due in part to chemical reactions that could occur as a consequence of any leakage of cement grout into the screened interval in MW1 (Abeyta and Thomas, 1996, p. 41). Existing data indicate that concentrations of nitrate in ground water in the vicinity of the Chromic Acid Pit site are variable and range in concentration from 1.2 to 12 mg/L (Abeyta and Thomas, 1996, p. 37 and table 10).

Although significant differences were identified in concentrations of dissolved solids, chloride, fluoride, sulfate, potassium, nitrate as nitrogen, and nitrite plus nitrate as nitrogen between water samples from background well MW1 and those from downgradient wells MW2 and MW3, these differences do not appear to be associated with release of contaminants from the chromic acid pit. Therefore, data collected and analyzed during the first 2 years of quarterly monitoring of ground water at the Chromic Acid Pit site indicate no contamination due to potential leakage from the chromic acid pit.

SUMMARY

Ground-water-quality conditions of the Chromic Acid Pit site on the USAADACENFB military reservation were evaluated. The chromic acid pit, located in El Paso, Texas, is a 2.2-cubic-yard concrete pit used from 1980 to 1983 for disposal of chromic acid waste generated from chrome plating operations. The RCRA-regulated chromic acid pit was closed in 1989 and is currently under post-closure care in accordance with TNRCC permit number HW-50296 (EPA number TX4213720101). Post-closure care requirements include routine maintenance of the site, conducted by USAADACENFB staff, and quarterly ground-water monitoring activities, conducted by the U.S. Geological Survey. Ground-water monitoring activities were initiated by installation of three monitoring wells by a private contractor. Ground-water monitoring well MW1 was installed hydraulically upgradient from the chromic acid pit; monitoring wells MW2 and MW3 were installed hydraulically downgradient from the chromic acid pit. The U.S. Geological Survey began quarterly ground-water monitoring at the site in December 1993 in accordance with a detailed, site-specific SAP.

Municipal wells of the City of El Paso and Fort Bliss are drilled at least 200 feet into water-yielding material of the Hueco Bolson sedimentary deposits. These wells range in depth from about 600 feet to greater than 1,200 feet below land surface. An unsaturated zone of approximately 280 feet overlies the aquifer of the Hueco Bolson deposits in the area of the Chromic Acid Pit site. Ground-water levels measured in a production well located approximately 1,700 feet southeast of the Chromic Acid Pit site indicate a decline of 29.43 feet from December 1982 to January 1995 and a decline of 5.09 feet from December 1993 to January 1995. Direction of ground-water flow at the water table beneath the Chromic Acid Pit site is assumed to be toward the southeast. Depths to water as measured in the chromic acid pit ground-water monitoring wells indicate a decline of about 1 foot from September 1994 to September 1995.

During water year 1995, water samples from the chromic acid pit ground-water monitoring wells were collected quarterly and measured for temperature, turbidity, pH, and specific conductance, and analyzed for alkalinity, common ions, metals, total organic carbons, total organic halides, and volatile organic compounds (first quarter only). Water temperature ranged from 19.0 to 23.5 °C. Turbidity values ranged from 0.12 to 5.58 NTU's and were significantly lower than those measured during water year 1994 sampling rounds. The pH of water samples from background well MW1 ranged from 7.79 to 7.94 and of water samples from downgradient wells MW2 and MW3 ranged from 7.15 to 7.83. Water in well MW1 was more basic than water from wells MW2 and MW3, possibly due to cement grout getting into the screened interval in well MW1. Over time, the pH of water from well MW1 has approached pH values of water from wells MW2 and MW3. Specific conductance of water from the chromic acid pit wells ranged from 731 to 861 microsiemens per centimeter at 25 °C.

Dissolved carbonate concentration in water samples, calculated from field alkalinity and pH, was zero in water from wells MW1, MW2, and MW3. Calculated bicarbonate concentration in water samples ranged from 161 to 188 mg/L in well MW1, from 220 to 232 mg/L in well MW2, and from 191 to 222 mg/L in well MW3. Alkalinity as calcium carbonate in water samples ranged from 132 to 154 mg/L in well MW1, from 180 to 190 mg/L in well MW2, and from 156 to 182 mg/L in well MW3.

Dissolved-solids concentrations in water samples ranged from 481 to 516 mg/L. Suspended-solids concentrations ranged from not detected (reporting limit of 2.0 mg/L) to 5.2 mg/L. Analyses for common ions included total chloride, fluoride, nitrate, orthophosphate, sulfate, and total and dissolved calcium, magnesium, potassium, and sodium. Ground water at the Chromic Acid Pit site generally contains relatively large amounts of sodium and bicarbonate. Nitrate as nitrogen concentrations in water samples ranged from 2.1 to 2.8 mg/L; concentrations of nitrite plus nitrate as nitrogen ranged from 2.4 to 3.2 mg/L.

Concentrations of metals identified above the laboratory reporting limits in ground-water samples from the chromic acid pit monitoring wells included chromium, iron, manganese, and zinc. These metals, with the exception of manganese, were identified in water from background well MW1 as well as downgradient wells MW2 and MW3, signifying background occurrence of these metals possibly in the Hueco Bolson deposits. Total chromium concentrations detected above the laboratory reporting limit ranged from 0.0061 to 0.030 mg/L; dissolved chromium concentrations ranged from 0.0040 to 0.010 mg/L. The wells were completed with stainless steel screens and sumps, which are alloys of chromium, nickel, manganese, carbon, and iron, possibly also contributing to concentrations of these metals in the water samples.

Total organic carbon was detected twice in upgradient well MW1 at concentrations of 13 and 1.0 mg/L and once each in downgradient wells MW2 and MW3 at concentrations of 13 and 10 mg/L, respectively (one sample from MW1 had associated QA/QC qualifiers). Total organic halides were not detected above the laboratory reporting limit of 30.0 µg/L. No volatile organic compounds were detected above laboratory reporting limits. Tentatively identified volatile organic compounds reported as siloxane were identified in water samples from downgradient well MW2 at a concentration of 17 µg/L. The tentative identification of siloxane is strictly an estimate. Compounds of siloxane are common laboratory and field artifacts or contaminants. Siloxane was also tentatively identified in the associated ambient blank, indicating possible contamination of environmental samples with this compound during field collection. Overall, chemical concentrations in water from the chromic acid pit monitoring wells were similar to those from other wells in the vicinity. Detected chemical concentrations in water from the chromic acid pit monitoring wells during the four sampling periods were below EPA-identified maximum contaminant levels for public drinking-water supplies.

Statistical analysis of water-quality data for 56 chemical constituents at wells MW1, MW2, and MW3 indicated significant differences between ground water in downgradient wells MW2 and MW3 and ground water in background well MW1 for dissolved solids, chloride, fluoride, nitrate as nitrogen, nitrite plus nitrate as nitrogen, sulfate, and potassium. Chloride, fluoride, sulfate, and potassium were significantly less in water from one or both downgradient wells MW2 and MW3 than in water from background well MW1, possibly due in part to incomplete well development. Dissolved solids, nitrate as nitrogen, and nitrite plus nitrate as nitrogen concentrations were significantly greater in water from one or both downgradient wells MW2 and MW3 than in water from background well MW1. Nitrate as nitrogen concentrations in water from downgradient well MW2 were significantly greater than in water from downgradient well MW3. Concentrations of chloride and potassium in water from downgradient well MW3 were significantly greater than in water from downgradient well MW2. Differences in dissolved-solids concentrations may be due in part to chemical reactions that could occur as a consequence of possible leakage of cement grout into the screened interval in MW1. Existing data indicate that concentrations of nitrate in ground water in the vicinity of the Chromic Acid Pit site are variable and range in concentration from 1.2 to 12 mg/L. Statistical analysis indicated no significant differences for all other laboratory-analyzed chemical constituents, at the 95-percent confidence level, between water from the downgradient wells and water from the background well or between water from one downgradient well and water from the other downgradient well. Differences detected through statistical analysis of chemical constituents of water in chromic acid pit monitoring wells MW1, MW2, and MW3 do not appear to indicate a release of hazardous chemicals from the chromic acid pit. There is no indication of ground-water contamination in either of the downgradient wells.

REFERENCES

Abeyta, C.G., and Thomas, C.L., 1996, Hydrogeology and ground-water quality of the Chromic Acid Pit site, U.S. Army Air Defense Artillery Center and Fort Bliss, El Paso, Texas: U.S. Geological Survey Water-Resources Investigations Report 96-4035, 69 p.

Alvarez, H.J., and Buckner, A.W., 1980, Ground-water development in the El Paso region, Texas, with emphasis on the resources of the lower El Paso Valley: Texas Department of Water Resources Report 246, 346 p.

American Public Health Association and others, 1985, Standard methods for the examination of water and wastewater (16th ed.): Washington, D.C., American Public Health Association, 1268 p.

Driscoll, F.G., 1986, Groundwater and wells (2d ed.): Johnson Filtration Systems, Inc., St. Paul, Minn., 1089 p.

SAS Institute, Inc., 1990a, SAS Procedures Guide, Version 6, (3d ed.): SAS Institute, Inc., Cary, N.C., 705 p.

_____1990b, SAS/STAT User's Guide, Version 6 (4th ed.): SAS Institute, Inc., Cary, N.C., 1686 p.

Texas Natural Resources Conservation Commission, 1993, 30 TAC 330, Municipal solid waste: Texas Register, Austin, Tex., 194 p. plus updates through December 1993.

U.S. Environmental Protection Agency, 1983, Methods for chemical analysis of water and wastes: U.S. Environmental Protection Agency Manual 600/4-79-020.

_____1986a, Inductively coupled plasma-atomic emission spectrometer method for trace element analysis of water and wastes: Federal Register, 40 CFR 261, App. C, July 1, 1986.

_____1986b, Methods for organic chemical analysis of municipal and industrial wastewater: Federal Register, 40 CFR 136, App. A, July 1, 1986.

_____1986c, Test methods for evaluating solid waste, physical/chemical methods, SW-846 (3d ed.): U.S. Environmental Protection Agency.

_____1989, Statistical analysis of ground-water monitoring data at RCRA facilities (interim final guidance): U.S. Environmental Protection Agency, Office of Solid Waste, February 1989.

_____1992, Statistical analysis of ground-water monitoring data at RCRA facilities (Draft addendum to interim final guidance): U.S. Environmental Protection Agency, Office of Solid Waste, July 1992, 84 p. and appendices.

_____1993, Code of Federal regulations, Title 40, Environment, Part 264, Appendix IX, Ground-water monitoring list: Federal Register, July 1, 1993.

_____1994, Summary of EPA finalized national primary drinking water regulations: U.S. Environmental Protection Agency, July 1994, 7 p.

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