LOCKHEED MARTIN

ENVIRONMENTAL RESTORATION PROGRAM

Y/ER-286

Field Characterization Report on Phase I of the Bear Creek Valley Treatability Study, Oak Ridge Y-12 Plant, Oak Ridge, Tennessee

This document has been approved by the Y-12 Plant Technical Information Office for release to the public. Date: 3/31/97

ENERGY SYSTEMS
ER

MANAGED BY
LOCKHEED MARTIN ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

UCN-17560 (6 8-95)

Science Applications International Corporation

contributed to the preparation of this document and should not be considered an eligible contractor for its review.

Y/ER-286

Energy Systems Environmental Restoration Program

Field Characterization Report on Phase I of the Bear Creek Valley Treatability Study, Oak Ridge Y-12 Plant, Oak Ridge, Tennessee

Date Issued—April 1997

Prepared by
Science Applications International Corporation
Oak Ridge, Tennessee
under subcontract 78B-99069C

Prepared for the
U.S. Department of Energy
Office of Environmental Management
under budget and reporting code EW 20

Environmental Management Activities at the
OAK RIDGE Y-12 PLANT
Oak Ridge, Tennessee 37831
managed by
LOCKHEED MARTIN ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-84OR21400

PREFACE

The *Field Characterization Report on Phase I of the Bear Creek Valley Treatability Study, Oak Ridge Y-12 Plant, Oak Ridge, Tennessee* (Y/ER-286) was prepared under the Environmental Restoration Program to support the investigation of the practicality of the use of passive, in situ treatment systems to remove contaminants from the Bear Creek Valley Characterization Area. This work was performed under Work Breakdown Structure (WBS) 1.1.02.41.10.34.20. Results from this report will be used to direct further investigation during Phases II and III.

CONTENTS

TABLES

FIGURES

ABBREVIATIONS

BCK	Bear Creek kilometer
BYBY	Boneyard/Burnyard
Energy Systems	Lockheed Martin Energy Systems, Inc.
GWPP	(Y-12) Groundwater Protection Program
ICP	inductively coupled plasma
PVC	polyvinyl chloride
TDS	total dissolved solids
TSS	total suspended solids
VOA	volatile organic analysis

EXECUTIVE SUMMARY

A treatability study is being performed to investigate the practicability of using passive, in situ treatment systems to remove contaminants from the Bear Creek Valley (BCV) Characterization Area (CA), as outlined in *Bear Creek Valley Characterization Area Technology Demonstration Action Plan* (SAIC 1996a). This draft document is a report of the site characterization results and is part of Phase I of this study. Field activities performed are outlined in *Bear Creek Valley Passive Surface Water Treatment Technology Demonstrations, Phase I, Site Characterization* (SAIC 1996b). The focus of the characterization was to obtain sufficient site-specific data on hydrogeology of NT-1, NT-2, and upper Bear Creek (above its confluence with NT-1) to support selection of groundwater capture and treatment systems in Phases II and III. Groundwater samples from the S-3 Site and NT-1 area were also collected for the principal investigators to test during Phase I laboratory work (SAIC 1996a).

Three contaminant migration pathways were delineated in the S-3 Area. Each is described and briefly characterized by field observations and analysis of surface and groundwater collected within each pathway:

Migration pathway 1: to Bear Creek south of the S-3 site; shown by elevated conductivity, nitrate concentrations, uranium concentrations, and gross alpha and beta activity and by a relatively low pH.

Migration pathway 2: to Bear Creek ~1000 ft southwest of the S-3 site; shown by elevated uranium concentrations and gross alpha and beta activity. Nitrate concentrations were not elevated.

Migration pathway 3: along NT-1 and continuing to NT-2; shown by elevated conductivity, nitrate concentrations, and gross alpha and beta activity. Uranium concentrations are relatively low overall. As this pathway discharges at NT-2 further along stratigraphic strike, it is characterized by elevated conductivity and gross alpha and beta activity.

1. INTRODUCTION

This report describes the results of site characterization activities outlined in Phase I of the *Bear Creek Valley Characterization Area Technology Demonstration Action Plan* (SAIC 1996a). Detailed direction regarding the Sampling and Analysis Plan, the Quality Assurance Project Plan, the Health and Safety Plan, and the Waste Management Plan for the site characterization is presented in the *Bear Creek Valley Passive Surface Water Treatment Technology Demonstrations, Phase I, Site Characterization* (SAIC 1996b). The areas of investigation are shown on Fig. 1.

The scope of Phase I site characterization at Bear Creek, NT-1, and NT-2 included six tasks: (1) surface water field screening, (2) surface water and seep sampling, (3) temporary piezometer installation and groundwater sampling, (4) hydraulic testing, (5) data evaluation, and (6) project support and technical report preparation. The detailed activities of each task are defined in the Sampling and Analysis Plan (Sect. 2) of the *Bear Creek Valley Passive Surface Water Treatment Technology Demonstrations, Phase I, Site Characterization* (SAIC 1996b).

2. APPROACH

The investigation approach for the site characterization was designed to determine the following (SAIC 1996b):

- locate the discrete points of groundwater discharge in tributaries NT-1, NT-2, and Bear Creek adjacent to the S-3 Site through surface water sample collection and in-field screening (Task 1);

- determine contaminant geochemistry of surface water and selected seeps along these reaches (Task 2);

- analyze groundwater field parameters near discharge points and identify locations of groundwater contaminant pathways (Task 3);

- provide site-specific groundwater and geotechnical data for the Phase I laboratory testing of potential treatment media (Task 3); and

- obtain sufficient data on site hydrogeology to support Phase I laboratory testing and location of the groundwater capture and treatment systems in Phases II and III (Task 4).

3. SITE CHARACTERIZATION FIELD ACTIVITIES

The site characterization field activities included Tasks 1 through 4. The results of each task are summarized below.

Surface and groundwater field screen parameters were measured using a Horiba U-10 instrument (specific conductivity, pH, and temperature). Nitrate concentrations were determined in the field using a HACH AccuVac Nitraver 5 Nitrate Test Kit with a measurement range of 0 to 50 ppm.

Surface water for analysis was collected as grab samples using a dipper [for volatile organic analysis (VOA) collection] and a peristaltic pump. Use of the pump allowed filtering of samples in the field with disposable in-line filters.

3.1 TASK 1 AND TASK 2 SURFACE WATER SAMPLING

3.1.1 Field Screening Activities

Surface water grab samples were collected at 73 locations at approximately 50 ft. spacing during a summer baseflow period (June 1996) to find discrete points of groundwater discharge along reaches of Bear Creek, NT-1, and NT-2 (Figs. 2 through 4). Sample collection in NT-1 and NT-2 was upstream from the confluence with Bear Creek of each tributary. Sample collection in Bear Creek was conducted upstream of pooled water caused by a beaver dam at Bear Creek kilometer (BCK) 12.46.

Samples were collected from the main channel of each stream and from identifiable seeps adjacent to the main channels. Recognition of seepage areas was done visually (by noting obvious wet areas) and by observing trends, specific conductivity, pH, and temperature in the main stream. Field analysis of nitrate concentration was also performed at each sample location. Trends in the field parameter measurements for NT-1, NT-2, and Bear Creek are shown in Figs. 2 through 4. Selected locations were sampled and analyzed for uranium (Figs. 5 through 7). These data are also summarized in Tables 1 through 3.

The upper reach of Bear Creek was initially sampled during a dry (summer low flow) period (June 6, 1996). Except for a small pool located at Station BC 135, the creek was dry upstream of Station BC 1030. Initiation of flow coincided with the locations of two seeps adjacent to the stream channel. Data from the previously dry reach were collected at a later date following a rain event (summer high flow period, June 14, 1996) (Fig. 2).

3.1.2 Seep Sampling Activities

Surface water (seep) grab samples were collect from five seep locations (Figs. 2 through 4): Stations BC 1030, BC 1280, NT1 200, NT1 390, and NT2 970. The purpose was to determine surface water contaminant geochemistry in these seeps. The sample locations were at the most active or probably contaminated seeps based on the results of Task 1 field screening. These samples were analyzed for the following: volatile organics, inductively coupled plasma (ICP) metals, radiochemistry (including fluorimetric uranium and tritium), anions, alkalinity, mercury, bicarbonate, and total dissolved solids/total suspended solids (TDS/TSS) (Table 4). Field parameters were also measured at time of collection (Table 5).

3.1.3 Results of Surface Water Sampling and Analysis

Specific conductivity, pH, temperature, and nitrate concentration observed during the screening of surface water and seeps was used to identify discrete points of groundwater discharge at Bear Creek, NT-1, and NT-2. Observations for each stream reach are summarized below.

Bear Creek

- Eight seeps were identified along Bear Creek: BC 600, BC 900, BC 1030, BC 1150, BC 1215, BC 1280, BC 1300, and BC 1330. During summer baseflow (June 6, 1996), stream flow began at Station 1030 (Fig. 2). Following a period of rain prior to June 14, 1996, water was present in the previously dry reach of Bear Creek upstream of Station BC 1030 (summer high flow) and allowed identification of seeps at BC 600 and BC 900.

- In-stream values for pH (7.0 to 7.4) and temperature (16° to 19°C) were similar along the reaches of upper Bear Creek sampled during high and low flow periods. A short reach with significantly higher specific conductivity water was observed between Stations BC 500 and 750 during the high flow period measured on June 14, 1996 (Fig. 2). In-stream values for specific conductance outside this short reach were similar during high and low flow periods (~1.0 mS/cm M).

- In-stream nitrate concentrations were 2 to 3 times higher in the low flow period compared to the high flow period.

- Identified seeps upstream of BC 1030 (summer high flow period only) generally had screening values similar to adjacent in-stream values for specific conductance, pH, and temperature. Identified seeps downstream of and including BC 1030 (summer low flow period only) fit two patterns compared with adjacent in-stream values: (1) similar nitrate concentrations and lower temperature (BC 1030, 1150, and 1330) and (2) nondetectable nitrate concentrations and slightly higher temperature (BC 1215, 1280, and 1300). For seeps below BC 1030, pH values were generally lower than in-stream values.

- Uranium concentrations in seeps upstream of BC 1030 (high flow period) were 2 to 3 times higher than those seeps downstream of and including BC 1030 (low flow period).

No single seep can account for uranium contamination in upper Bear Creek. Contamination is likely derived from more diffuse seepage of groundwater into the channel of Bear Creek above BCK 12.46. Identifiable seeps may define the discharge points of preferential groundwater flow path(s). The occurrence of a groundwater discharge point adjacent to the location where dry weather flow starts in Bear Creek may indicate that this seepage area (BC 1030) is connected to this pathway(s).

NT-1

- Three active seeps were identified in NT-1: NT1 075, NT1 200, and NT1 390.

- Seeps at NT-1 are characterized by higher specific conductivity and nitrate concentrations and lower pH compared to adjacent in-stream values (Fig. 3).

- The in-stream concentration of nitrate increases downstream from ~10 ppm at NT1 500 to >50 ppm at NT1 250 where the concentration exceeded the upper limit of the in-field analytical method (50 ppm). Concentrations of nitrate at seeps NT1 200 and NT1 390 measured in the laboratory were 1800 and 720 ppm, respectively (September 19, 1996). The concentration of nitrate and the specific conductance at seep NT1 390 varied between sampling events (June 4 and September 19, 1996): nitrate concentration increased from 20 to 720 ppm and specific conductance increased from 1.07 to 17.4 mS/cm.

- Coincident with the increase of nitrate concentration, pH of in-stream flow decreases downstream from NT1 390. This is consistent with the additive discharge of groundwater with lower pH from the seeps to NT-1 along this reach.

- Conductivity measured while collecting a surface water sample at Station NT1 390 on September 19, 1996, was significantly higher (17.4 mS/cm) than during the Task 1 field screenings on June 4, 1996 (1.07 mS/cm). The only other surface water sample location with higher measured conductivity was Station NT1 075 (22.3 mS/cm).

No single seep can account for contamination observed in NT-1. However, NT-1 is contaminated by discharge from a zone extending from ~NT1 500 to NT1 50. Within this zone, identifiable seeps are located at sites with higher flux of groundwater discharge (NT1 75, 200, and 390) and may indicate preferential groundwater flow paths. These seeps probably account for a large proportion of the total contaminant influx into NT-1.

NT-2

- Two active seeps were identified in NT-2: NT2 645 and NT2 970.

- Seeps at NT-2 are characterized by higher conductivity and nitrate concentrations and lower pH compared to values measured in the adjacent stream (Fig. 4).

- The in-stream nitrate concentration increases from <20 ppm to >50 ppm between NT2 1000 and NT2 950. This is coincident with the seep at NT2 970 which had nitrate concentration of 1000 ppm on September 12, 1996.

No single seep can account for contamination observed in NT-2. However, this stream is contaminated by discharge from a zone extending from ~NT2 645 to NT2 970. Within this zone, two identifiable seeps are located at sites with higher flux of groundwater discharge (NT2 645 and 970) and indicate preferential groundwater flow paths. Of these two seeps, NT2 970 appears to account for the largest proportion of the total contaminant influx into NT-2.

3.2 PIEZOMETER INSTALLATION AND GROUNDWATER SAMPLING

3.2.1 Field Activities

To identify groundwater contaminant pathways, temporary piezometers were installed adjacent to locations of groundwater discharge recognized in the previous tasks. The piezometers were installed in two phases. The first phase involved installation of 25 temporary piezometers (TPB-01, -02, -04 through -16, and -18 through -27) using push-probe (geoprobe) drilling methods (Fig. 8). In addition, two temporary piezometers P1 and P2 were already located close to NT-1 (Fig. 9). All borings were pushed to refusal (bedrock) and piezometers constructed using 1-in. diameter polyvinyl chloride (PVC) casing with 2-ft screened intervals at total depth (Fig. 9). Groundwater grab samples were collected from each piezometer during the sampling event (summer baseflow period) and field screened for specific conductivity, pH, temperature, and nitrate concentration; most piezometers were also sampled for uranium screening. During this phase, a staged approach was employed to use the results from the initial piezometer screenings to determine the locations of the later ones. Boring information for each push-probe temporary piezometer, including depth to water measured in each on June 24, 1996, is in Table 6. Total depth of piezometers in this stage ranges for 5.8 to 23.3 ft.

In the second phase, four temporary piezometers (GW-834 through -837) were installed using hollow-stem auger drilling methods (Fig. 9). These temporary piezometers were located to intercept contaminated groundwater flow identified from results for the push-probe installed piezometers. All borings were augered to refusal (bedrock) and piezometers constructed using 4-in. diameter PVC casing with 2-ft screened intervals at total depth (Fig. 10). Attempts were unsuccessful to collect shelby tube samples for geotechnical analysis from these borings. The shelby tubes could not be pushed through the sample interval without crushing them. Each piezometer was developed; however, GW-836 was not completely developed due to slow recharge rate. Boring information for each augered temporary piezometer is in Table 7.

Groundwater grab samples were collected from three of the piezometers (GW-834, -835, and -837) and analyzed for the following: volatile organics, ICP metals, radiochemistry (including fluorimetric uranium and tritium), anions, alkalinity, mercury, bicarbonate, and TDS/TSS (Table 8). Field measurements were also recorded at the time of sample collection (Table 9).

To better delineate groundwater contaminant pathways, five additional temporary piezometers (TPB-28 through -32) were installed at the end of the second phase using push probe (air hammer) techniques (Fig. 8). All borings were pushed to refusal (bedrock) and piezometers constructed using 1-in. diameter PVC with 2.1-ft screened intervals at total depth (Fig. 9). Groundwater grab samples were collected from these piezometers for field screening of specific conductivity, pH, and temperature as well as uranium screening.

Each of the push-probe temporary piezometers were sampled in a single event between June 14 and June 26, 1996. Following a heavy rainstorm, the piezometers at NT-1 were sampled on August 2, 1996 for field screening (specific conductivity, pH, and temperature). The highest specific conductivity reading for groundwater (30.3 mS/cm) was observed in TPB-02 (Fig. 8).

Elevated beta/gamma readings were encountered during the boring of GW-836 (~400 cpm). These readings were from soil below the water table brought to the surface on the augers.

Elevated mercury vapor concentration was measured in the soil cuttings from GW-837 (maximum 0.777 mg/ml). These cuttings were left uncovered overnight and mercury vapor concentration dropped below an acceptable value, allowing work to continue.

3.2.2 Groundwater Sampling Results

Screening results of groundwater from the temporary push-probe piezometers were consistent with the screening results from the active seeps (groundwater discharge points) recognized during the surface water screenings. By using a staged approach in installing these piezometers, locations of groundwater contaminant pathways during the summer baseflow period have been delineated. Three principal migration pathways have been identified and are shown in Fig. 11. The screening results from push probe piezometers characterizing these pathways are summarized below:

Migration pathway 1: to Bear Creek south of the S-3 site; shown in TPB-09 and TPB-19 by elevated TDS, nitrate, uranium, and ^{99}Tc concentrations and by a decrease in pH.

Migration pathway 2: to Bear Creek through the area where TPB-07, -08, -15, and -16 are located; shown by elevated uranium concentrations. Nitrate concentrations in these piezometers were not elevated.

Migration pathway 3: to NT-1 and extending to NT-2; shown by elevated TDS and nitrate concentrations in TPB-01, -02, -04, and-24. Uranium concentrations in this pathway were low. This pathway also discharges to NT-2 further along stratigraphic strike. At NT-2, it is characterized by elevated TDS in Piezometer TPB-12.

Augered piezometers are located within one of the three contaminant pathways recognized along NT-1 and Bear Creek (Fig. 11). An evaluation of the analytical results of groundwater collected from the augered piezometers GW-834, -835, and -837 shows the values to be consistent with the push-probe piezometers field screening results. The analytical results are summarized in Table 8.

The analytical results from the seep at Station NT1 200 at NT-1 (Fig. 3) may show a significant exception to the characterization of these contaminant pathways. At this location, uranium concentration is similar to that seen in the temporary piezometers within migration pathways 1 and 2 along Bear Creek whereas results from sampling other seeps and piezometers in the NT-1 pathway indicate that uranium was present in very low concentrations ($< 10\ \mu g/L$). The analytical results from the groundwater seep at NT1 200 are summarized below:

- NT1 200 (in migration pathway 3.): nitrate concentration - 1800 mg/L;
  uranium concentration - 2.1 mg/L;
  gross alpha - 56 pCi/L;
  gross beta - 740 pCi/L;
  Technetium-99 - 15,000 pCi/L.

3.3 WATER TABLE MONITORING AND HYDRAULIC TESTING

The purpose of this task was to obtain sufficient data on site hydrogeology to support Phase I laboratory testing and Phases II and III location selection of the groundwater capture and treatment systems (SAIC 1996a).

3.3.1 Water Table Monitoring

Continuous monitoring of water level, specific conductivity, and temperature in GW-834, -835, -836, and -837 began on August 28, 1996, and continued through September 30, 1996 (one month duration). The results of the monitoring are shown on Figs. 12 through 15. Water levels in each piezometer showed responses to precipitation; however, neither water temperature nor specific conductance showed any changes that could be related to precipitation events. Both GW-834 and GW-835 showed rapid increases in water level within a few hours of initiation of precipitation. GW-836 and GW-837 showed more subdued responses. These results indicate that although rapid recharge to shallow groundwater at the S-3 site occurs, the volume of recharge for individual events is not sufficient to result in measurable changes in groundwater chemical parameters.

3.3.2 Pumping Test

A pumping test was performed on November 12, 1996, and is described in detail in Appendix B. The purpose of the test was to characterize the hydraulics of the shallow, unconsolidated zone groundwater interval at this site and estimate the pumping flow rates that could be sustained in GW-835. Before the test started, water level in all the observation piezometers was measured (Fig. 16). During the test, water levels were measured in the pumped piezometer (GW-835) and in nine adjacent observation piezometers (GW-836 and TPB-06, -07, -15, -16, -18, -26, -29, and -30).

The pumping rate during the majority of the test was ~6 L/min. This rate was the maximum possible for pump with the small water column above the pump intake at test initiation (~6.5 ft). The water level in GW-835 appeared to stabilize and remain relatively constant at this pumping rate.

The purpose of the pumping test was to characterize the unconsolidated groundwater interval and estimate the flow rates that the pumped piezometer could sustain with time. Groundwater grab samples were also collected at the beginning, middle, and near end of the test to determine if there was variation in the chemical composition during the period.

Water level responses in piezometers during the pumping test are shown in Fig. B2. With the exception of TPB-18, no response to the pumping of GW-835 was observed in the piezometers. Much of the fluctuation in water levels could most likely be attributed to normal daily variation in the water table. In TPB-18 drawdown of ~0.35 ft was observed 20 minutes after pumping started. As the test progressed the water level in TPB-18 rose to ~0.15 ft below the starting head. This unusual response may indicate a dual storage system. Water levels in piezometers GW-836 and TPB-07, -26, -29, and -30 rose slightly as the test progressed, and these piezometers were apparently not hydraulically connected to GW-835. Based on the results observed, the following conclusions were made (refer to Appendix B for details):

- GW-835 may be capable of producing groundwater at the rate of up to 6 L/min based on the relatively constant water level observed in the piezometer following initial drawdown.

- The screened interval in GW-835 appears to be connected to a highly transmissive zone or interval. The groundwater discharge rate into GW-835 during the test was relatively high and recovery of the water level to pre-test level at termination of the test was very rapid (~5 mins).

- GW-835 is completed in an interval that is probably not in direct hydraulic connection with the observation piezometers. This was shown by the lack of significant change in water levels in the observation piezometers during the test.

- There was little chemical variation in the groundwater collected during the test.

Historical information may explain the heterogeneous nature of the unconsolidated zone in the vicinity of the pumping test. Surface water drainage patterns were altered due to activities at the Y-12 Plant and, specifically, construction of the S-3 Ponds (Sutton 1995). Interpretation of preconstruction aerial photographs shows a section of the original stream channel of Bear Creek to be north of the present channel (Fig. 11). The S-3 Ponds appear to have been constructed over this filled stream channel. The stream channel continued to the southwest from this point and through the site of the pumping test. This trend appears to agree with the interpreted trend of contaminant migration pathway 2. The trace of the original channel then intersects the current channel of Bear Creek in the vicinity of stream flow initiation observed during the summer baseflow period.

It is possible that GW-835 was completed within the original stream channel. Associated fluvial lag deposits and/or coarse fill material could provide the observed interval of high hydraulic transmissivity. Confinement of this relatively high transmissive interval within the original stream channel boundaries could also explain the heterogeneous nature and the lack of response in the nearby observation piezometers.

4. CONCLUSIONS

Field characterization efforts have delineated three primary pathways for contaminated groundwater at the S-3 Site to discharge to surface water (Fig. 11).

- two pathways for uranium-contaminated groundwater to the main stem of Bear Creek adjacent to the former S-3 Ponds. These two pathways were characterized by 4 in. piezometers and are named the GW-835 and GW-837 sites. Groundwater in the shallow pathway to Bear Creek closest to S-3 Ponds (GW-837) also is contaminated with nitrate, ^{99}Tc, and some elevated levels of metals, and groundwater in GW-835 is primarily contaminated with uranium and

- one deeper along strike flow path for uranium, nitrate, PCE, ^{99}Tc, metals, and high TDS contaminated groundwater to NT-1. This deeper along strike flow path extends to NT-2 although, at NT-2, the contaminants are predominately nitrate, elevated TDS, metals, VOCs, and ^{99}Tc.

Permeability and groundwater flow rates in these pathways have not been defined; however piezometers located in the two pathways for uranium to Bear Creek showed lower than expected drawdown during well development indicating that these zones may have relatively higher permeability than the surrounding formation. Single well pumping tests have shown that GW-835 can sustain a pumping rate of up to 6 L/min, whereas GW-837 can only sustain 60 mL/min, and GW-834 a 100 mL/min pumping rate. GW-835 probably intersects a groundwater pathway with relatively high hydraulic conductivity and of limited extent which may be related to the presence of a former stream channel for Bear Creek. This stream channel was apparently filled during construction of the S-3 Ponds and the other facilities in this location and has probably provided a preferential pathway for contaminants to migrate from the S-3 Ponds to Bear Creek.

5. REFERENCES

Kimbrough, C.W., L.W. Long, and L.W. McMahon. 1994. *Environmental Surveillance Procedures Quality Control Program*, Rev. 4, ES/EH/INT-14 (replaces ESH/SUB/87-21706/1) Martin Marietta Energy Systems, Inc., Oak Ridge K-25 Site, Oak Ridge, Tennessee.

SAIC (Science Applications International Corporation). 1996a. *Bear Creek Valley Characterization Area Technology Demonstration Action Plan*, Draft, Y/EN-5479, prepared for Lockheed Martin Energy Systems, Inc., Oak Ridge Y-12 Plant, Oak Ridge, Tennessee, April.

SAIC. 1996b. *Bear Creek Valley Passive Water Treatment Technology Demonstration, Phase I, Site Characterization*, Draft, Y/ER-269, prepared for Lockheed Martin Energy Systems, Inc., Oak Ridge Y-12 Plant, Oak Ridge, Tennessee, June.

Sutton, G.E. 1995. "Distribution of Anthropogenic Fill Material Within Y-12 Plant Area, Oak Ridge, Tennessee," Y-TS-1387.

TABLES

Table 1. Bear Creek surface water screening parameters (collected 6/6/96 and 6/14/96*)

Locations	Sample no.	Conductivity (mS/cm)	pH (su)	Temperature (C)	Nitrate concentration (ppm)	Gross alpha (pCi/L)	Gross beta (pCi/L)	U. Fluor (ppm)
				Stream				
BC 1430	BC1213	1.030	7.10	17.5	9			
BC 1350	BC1212	1.020	7.14	17.7	9			
BC 1300	BC1209	1.010	7.13	17.8	8			
BC 1250	BC1207	1.020	7.07	17.5	8			
BC 1200	BC1205	1.020	7.16	17.1	7			
BC 1150	BC1203	1.050	7.06	16.3	7			
BC 1100	Dry	---	---	---	---			
BC 1050	Dry	---	---	---	---			
BC 1000	BC1214*	1.000	7.40	18.0	3			
BC 950	BC1215*	1.000	7.40	18.0	3			
BC 900	BC1216*	0.990	7.20	17.9	3	133	53.3	0.43
BC 850	BC1217	0.493	7.01	18.1	2			
BC 800	BC1218*	0.990	7.01	18.9	3			
BC 750	BC1219*	1.770	6.99	18.7	3			
BC 700	BC1220*	1.930	7.09	18.5	2			
BC 630	BC1221*	1.970	6.69	18.4	4	149	34.4	0.49
BC 600	BC1222*	1.140	7.09	18.5	3			
BC 550	BC1223*	2.680	7.13	18.9	0			
BC 500	BC1224*	0.633	7.15	19.1	3	126	44.9	0.43

Table 1 (continued)

Locations	Sample no.	Conductivity (mS/cm)	pH (su)	Temperature (C)	Nitrate concentration (ppm)	Gross alpha (pCi/L)	Gross beta (pCi/L)	U. Fluor (ppm)
BC 450	BC1225*	0.630	7.17	19.0	3			
BC 400	BC1226*	0.606	7.21	19.8	3			
BC 350	BC1230*	0.585	7.23	20.0	2			
BC 300	BC1227*	0.550	7.20	20.3	3	67.4	30.2	0.27
BC 250	BC1228*	0.530	7.11	20.9	4			
BC 200	Dry	---	---	---	---			
BC 150	Dry	---	---	---	---			
BC 135	BC1229*	0.501	7.09	20.5	4			
				Seep				
BC 1330	BC1211	0.851	6.97	15.5	8	65	44	0.25
BC 1300	BC1210	1.100	6.96	18.4	0	52	23	0.26
BC 1280	BC1208	0.631	6.93	18.4	0	47	19	0.13
BC 1215	BC1206	0.679	6.84	19.7	0	46	16	0.12
BC 1150	BC1204	0.930	7.06	15.1	3	79	62	0.27
BC 1030	BC1202	1.080	6.70	14.3	3	80	38	0.48
BC 900	BC1216*	0.990	7.20	17.9	3	133	53.3	0.43

Table 2. NT-1 surface water screening parameters (collected 6/4/96)

Locations	Sample no.	Conductivity (mS/cm)	pH (su)	Temperature (C)	Nitrate concentration (ppm)	Gross alpha (pCi/L)	Gross beta (pCi/L)	U.Fluor (ppm)
				Stream				
NT-1 000	N11201	1.370	6.84	22.1	50			
NT-1 050	N11202	1.750	6.54	20.6	50			
NT-1 100	N11203	1.640	6.56	20.3	50			
NT-1 150	N11205	1.470	6.68	20.3	50			
NT-1 200	N11206	1.240	6.66	20.5	50			
NT-1 250	N11208	1.180	6.89	20.5	49			
NT-1 300	N11209	0.960	6.91	20.4	42			
NT-1 350	N11210	0.680	5.83	20.3	30	6.6	37	0.004
NT-1 400	N11211	0.484	7.49	20.8	20			
NT-1 450	N11212	0.436	7.51	21.0	18			
NT-1 500	N11213	0.363	7.71	20.5	12			
NT-1 550	N11214	0.252	7.71	19.4	5			
NT-1 575	N11215	0.244	7.58	18.9	4			
				Seep				
NT-1 075	N11204	22.300	6.08	20.5	50	83	910	0.016
NT-1 200	N11207	4.410	6.01	19.5	50	42	780	0.0017
NT-1 390	N11216	1.070	6.83	17.8	20	6.8	100	0.0049

Table 3. NT-2 surface water screening parameters (collected 6/5/96)

Locations	Sample no.	Conductivity (mS/cm)	pH (su)	Temperature (C)	Nitrate concentration (ppm)	Gross alpha (pCi/L)	Gross beta (pCi/L)	U.Fluor (ppm)
				Stream				
NT-2 000	N21201	0.704	7.43	17.8	45			
NT-2 050	N21202	0.701	7.53	17.5	41			
NT-2 100	N21203	0.697	7.59	17.0	46			
NT-2 150	N21204	0.695	7.60	16.9	50			
NT-2 200	N21205	0.695	7.59	16.7	49			
NT-2 250	N21206	0.695	7.53	16.4	48			
NT-2 300	N21207	0.695	7.55	16.4	46			
NT-2 350	N21208	0.694	7.52	16.1	50			
NT-2 400	N21209	0.694	7.51	16.0	47			
NT-2 450	N21210	0.694	7.46	16.0	50			
NT-2 500	N21211	0.682	7.43	15.9	50			
NT-2 550	N21212	0.687	7.38	16.0	49			
NT-2 600	N21213	0.695	7.43	16.2	50			
NT-2 650	N21214	0.696	7.44	18.9	46			
NT-2 700	N21215	0.726	7.47	19.0	50			
NT-2 750	N21216	0.710	7.32	18.6	50			
NT-2 800	N21217	0.721	7.23	18.5	50			
NT-2 850	N21218	0.672	7.07	18.6	50			
NT-2 900	N21219	0.655	7.04	19.1	48			

Table 3 (continued)

Locations	Sample no.	Conductivity (mS/cm)	pH (su)	Temperature (C)	Nitrate concentration (ppm)	Gross alpha (pCi/L)	Gross beta (pCi/L)	U.Fluor (ppm)
NT-2 950	N21220	0.590	6.91	19.2	50			
NT-2 1000	N21221	0.141	7.38	19.2	17			
NT-2 1120	N21225	0.121	7.34	18.3				
				Seep				
NT-2 645	N21224	3.23	7.08	18.6	50	11	33	0.0023
NT-2 970	N21223	12.6	6.05	15.5	50	49	680	0.0015

Table 4. Analytical results for seeps

Sample no. (location) Collection date	BC1101 (BC 1030) 9/12/96		BC1102 (BC 1280) 9/20/96		NT1101 (NT1 200) 9/19/96		NT1102 (NT1 390) 9/19/96		NT2101 (NT2 970) 9/12/96	
	Filtered	Unfiltered	Filtered	Unfiltered	Filtered	Unfiltered	Filtered	Unfiltered	Filtered	Unfiltered
Analysis										
Bicarbonate, mg/L		384		550		30		412		253
Mercury, mg/L	<0.0002		0.0006		0.0045		<0.0002		<0.000 2	
Aluminum, μg/L	<200	<200	<200	1530	723	110000	707	7210	<200	5170
Boron, μg/L	62.3	5206	94.9	99.3	49.7	420	<20	63.3	<20	55.3
Barium, μg/L	72.1	72.7	285	311	728	958	4340	4910	4290	11000
Calcium, μg/L	153000	153000	164000	170000	360000	>1000000	1100000	1100000	1120	>1000000
Cadmium, μg/L	<20	<20	<20	<20	80.7	846	<20	252	<20	590
Cobalt, μg/L	<20	<20	<20	<20	35.2	601	<20	71.8	<20	171
Chromium, μg/L	<20	<20	<20	69	<20	<20	<20	<20	<20	<20
Copper, μg/L	<30	<30	<30	<30	<30	<300	<300	<300	<300	<300
Iron, μg/L	<200	<200	1610	5150	<200	152	1000	3790	<200	<200
Potassium, μg/L	3820	3870	6150	6560	7730	58400	4960	14900	4820	23800
Magnesium, μg/L	21100	21000	23200	23900	52200	253000	139000	144000	139000	241000
Manganese, μg/L	951	984	5050	5180	11000	100000	5470	52400	5060	100000
Molybdenum, μg/L	<40	<40	<40	<40	<40	<40	<40	<40	<40	<40
Sodium, μg/L	54100	53900	9890	10000	50300	355000	92500	147000	92000	261000
Nickel, μg/L	<40	<40	<40	<40	339	4930	<40	434	<40	1030
Lead, μg/L	<200	<200	<200	<200	<200	<200	<200	<200	<200	<200

Table 4 (continued)

Sample no. (location) Collection date	BC1101 (BC 1030) 9/12/96		BC1102 (BC 1280) 9/20/96		NT1101 (NT1 200) 9/19/96		NT1102 (NT1 390) 9/19/96		NT2101 (NT2 970) 9/12/96	
	Filtered	Unfiltered	Filtered	Unfiltered	Filtered	Unfiltered	Filtered	Unfiltered	Filtered	Unfiltered
Thallium, μg/L	<100	<100	<100	<100	<100	102	<100	<100	<100	114
Vanadium, μg/L	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Zinc, μg/L	27.2	<20	23.8	55.6	22.7	172	<20	98.8	<20	109
Selenium, μg/L	<500	<500	<500	<500	<500	<1000	<500	<500	<500	<1000
Silver, μg/L	24.9	<20	<20	<20	<20	<20	<20	<20	<20	<20
Arsenic, μg/L	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Beryllium, μg/L	<2	<2	<2	<2	<2	35.7	<1.0	<10	<2	<10
Antimony, μg/L	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Lithium, μg/L	<10	<10	174	199	<10	14.1	53.9	13.1	52.9	<10
Phosphorous, μg/L										
Titanium, μg/L	<20	<20	<20	16.7	<20	<20	<20	49.3	<20	<20
Strontium, μg/L	333	327	709	723	1010	3520	4150	2910	4120	4730
Alkalinity, mg/L		400		550		30		410		260
Alpha activity, pC/L		89±14		16±4.9		56±11		170±35		63±16
Beta activity, pC/L		78±12		10±4.8		740±85		1700±200		850±100
Tritium, pC/L		170±580		3130±240		1300±270		370±230		370±230
Fluoride, mg/L		0.902		0.65		57		2.1		
Chloride, mg/L		42		9.5		180		60		58
Nitrite as Nitrogen, mg/L				<0.05		5.8				

Table 4 (continued)

Sample no. (location) Collection date	BC1101 (BC 1030) 9/12/96		BC1102 (BC 1280) 9/20/96		NT1101 (NT1 200) 9/19/96		NT1102 (NT1 390) 9/19/96		NT2101 (NT2 970) 9/12/96	
	Filtered	Unfiltered	Filtered	Unfiltered	Filtered	Unfiltered	Filtered	Unfiltered	Filtered	Unfiltered
Bromide, mg/L										
Nitrate as Nitrogen, mg/L		4.6		4.9		1800		720		1000
Ortho-Phosphate as Phosphorus, mg/L				< 0.12						
Sulfate, mg/L		95		0.94		120		59		3.4
22-Sodium Activity, pC/L		1.1±1.6		0.2±2.3		-0.53±1.7		0.53±1.6		-0.76±2.0
40-Potassium Activity, pC/L		5.6±4.4		320±46		82±45		4±39		39±52
51-Chromium Activity, pC/L		1.3±18		-5±23		-4.3±18		6±16		1.7±19
54-Manganese Activity, pC/L		0.5±1.7		-1±2.3		0.18±1.7		-0.51±1.6		-0.52±1.8
57-Cobalt Activity, pC/L		-0.049±1.4		0.28±1.7		0.91±1.4		0.099±1.2		-0.35±1.2
58-Cobalt Activity, pC/L		0.17±1.8		-0.84±2.5		-0.67±1.8		-0.32±1.6		0.59±2.1
59-Iron Activity, pC/L		1.8±4.2		2.7±5.0		-0.75±3.5		2.6±3.5		-3.4±4.8
60-Cobalt Activity, pC/L		0.53±1.9		-1.1±4.8		2.1±1.8		0.23±1.7		1.9±2.1
65-Zinc Activity, pC/L		1.8±4.1		-4.2±5.0		-0.17±4.3		-1.6±4.2		3.8±5.0
95-Niobium Activity, pC/L		0.53±2.1		-0.34±2.7		0.85±2.1		-0.003±2.0		2.4±2.6
95-Zirconium Activity, pC/L		-0.75±4.9		1.8±5.6		-2.3±4.0		-5.5±4.1		-2.5±5.0
106-Ruthenium Activity, pC/L		7.7±16		-18±21		-5.3±15		-2.1±14		-18±17
125-Antimony Activity, pC/L		-5.3±4.7		2.6±6.3		-3.5±4.7		3.9±4.3		0.41±4.7
134-Cesium Activity, pC/L		-0.33±1.9		0.27±2.6		0.44±1.9		0.17±1.8		-2.5±2.4

Table 4 (continued)

Sample no. (location) Collection date	BC1101 (BC 1030) 9/12/96		BC1102 (BC 1280) 9/20/96		NT1101 (NT1 200) 9/19/96		NT1102 (NT1 390) 9/19/96		NT2101 (NT2 970) 9/12/96	
	Filtered	Unfiltered	Filtered	Unfiltered	Filtered	Unfiltered	Filtered	Unfiltered	Filtered	Unfiltered
137-Cesium Activity, pC/L		1.4±1.8		4.5±5.6		0.52±1.8		-0.61±1.6		0.005±2.0
144-Cerium Activity, pC/L		11±11		-9.1±13		-9.7±12		-7.2±9.1		-0.43±9.6
208-Thallium Activity, pC/L		-1.4±3.4		1.9±3.9		1±3.1		0.53±3.4		0.9±4.3
212-Bismuth Activity, pC/L		24±19		2.8±18		13±13		13±13		14±16
212-Lead Activity, pC/L		1.8±5.5		-4.8±6.2		4±5.6		0.19±3.9		1.3±5.4
235 Uranium Activity, pC/L		3.3±4.6		-14±14		13±4.7		2.6±3.9		16±17
Technetium -99, pC/L		17±3.8		-2±2.0		15000 ±1500		5700 ±570		1900 ±190
Total Dissolved Solids, mg/L				620		12000		10000		
Total Strontium, pC/L		0.14±0.80		-0.08±0.62		6.3±1.0		24±3.3		1.3±0.8
Total Suspended Solids, mg/L		6		81		8		69		45
Uranium, μg/g		0.47		0.054		2.1		0.007		<0.002
Chloromethane, μg/L		10		10		10		10		10
Bromomethane, μg/L		10		10		10		10		10
Vinyl chloride, μg/L		10		10		10		10		10
Chloroethane, μg/L		10		10		10		10		10
Trichlorofluoromethane, μg/L		10		10		10		10		10
Methylene chloride, μg/L		10		10		4		7		3
Acetone, μg/L		2		9		8		6		5

Table 4 (continued)

Sample no. (location) Collection date	BC1101 (BC 1030) 9/12/96		BC1102 (BC 1280) 9/20/96		NT1101 (NT1 200) 9/19/96		NT1102 (NT1 390) 9/19/96		NT2101 (NT2 970) 9/12/96	
	Filtered	Unfiltered	Filtered	Unfiltered	Filtered	Unfiltered	Filtered	Unfiltered	Filtered	Unfiltered
1,1,2-Trichloro-1,2,2-trifluoroethane, μg/L		10		10		3		10		12
Carbon disulfide, μg/L		10		10		10		10		10
1,1-Dichloroethene, μg/L		10		10		10		10		10
1,1-Dichloroethane, μg/L		10		10		10		10		10
cis-1,2-Dichloroethene, μg/L		10		10		2		2		10
tran-1,2-Dichloroethene, μg/L		10		10		10		10		10
Chloroform, μg/L		10		10		1		6		5
1,2-Dichloroethane, μg/L		10		10		10		10		10
2-Butanone, μg/L		4		5		10		10		6
1,1,1-Trichloroethane, μg/L		10		10		10		10		10
Carbon tetrachloride, μg/L		10		10		10		10		10
Bromodichloromethane, μg/L		10		10		10		10		10
1,2-Dichloropropane, μg/L		10		10		10		10		10
cis-1,3-Dichloropropene, μg/L		10		10		10		10		10
Trichloroethene, μg/L		10		10		10		10		10
Dibromochloromethane, μg/L		10		10		10		10		10
1,1,2-Trichloroethane, μg/L		10		10		10		10		10
Benzene, μg/L		10		10		10		10		10

Table 4 (continued)

Sample no. (location) Collection date	BC1101 (BC 1030) 9/12/96		BC1102 (BC 1280) 9/20/96		NT1101 (NT1 200) 9/19/96		NT1102 (NT1 390) 9/19/96		NT2101 (NT2 970) 9/12/96	
	Filtered	Unfiltered	Filtered	Unfiltered	Filtered	Unfiltered	Filtered	Unfiltered	Filtered	Unfiltered
trans-1,3-Dichloropropene, μg/L		10		10		10		10		10
Bromoform, μg/L		10		10		10		10		10
4-Methyl-2-pentanone, μg/L		10		10		10		10		10
2-Hexanone, μg/L		10		10		10		10		10
Tetrachloroethene, μg/L		10		10		52		45		10
1,1,2,2-Tetrachloroethane, μg/L		10		10		10		10		10
Toluene, μg/L		10		10		10		10		10
Chlorobenzene, μg/L		10		10		10		10		10
Ethylbenzene, μg/L		10		10		10		10		10
Styrene, μg/L		10		10		10		10		10
Xylene, μg/L		10		10		10		10		10

Table 5. Field measurements from seeps (see Table 4)

Location	Sample no.	Date	Conductivity (mS/cm)	pH (su)	Temperature (°C)
BC 1030	BC1101	9/12/96	0.994	6.61	22.0
BC 1280	BC1102	9/20/96	0.307	6.99	17.1
NT1 200	NT1101	9/19/96	0.522	5.42	20.7
NT1 390	NT1102	9/19/96	17.400	5.23	20.5
NT2 970	NT2101	9/12/96	0.579	5.79	17.8

Table 6. Push probe piezometer boring information

Location	Surface Elevation (AMSL)	Total depth [from TOC (ft)]	Casing stick-up (ft)	TD (BLS) (ft)	Bedrock Elevation (AMSL)	Depth to water [from TOC (ft)] 6/24/96	Depth to water [from BLS (ft)] 6/24/96	Water Table Elevation (AMSL)	Water height (ft) 6/24/96
TPB-1	990.33	16.51	3.57	12.94	977.39	12.16	8.59	981.74	4.35
TPB-2	991.72	20.88	3.08	17.8	973.92	9.50	6.42	985.30	11.38
TPB-3	---	Abandoned	---	---	---	---	---	---	---
TPB-4	990.30	16.64	1.88	14.76	975.54	10.39	8.51	981.79	6.25
TPB-5	991.20	20.42	2.94	17.48	973.72	12.76	9.82	981.38	7.66
TPB-6	998.17	16.64	2.08	14.56	983.61	13.16	11.08	987.09	3.48
TPB-7	996.63	23.46	2.72	20.74	975.89	17.15	14.43	982.20	6.31
TPB-8	988.87	19.63	2.71	16.92	971.95	10.27	7.56	981.31	9.36
TPB-9	1004.51	16.63	2.35	14.28	990.23	10.94	8.59	995.92	5.69
TPB-10	1005.04	25.34	2.04	23.3	981.74	13.20	11.16	993.88	12.14
TPB-11	1003.08	20.42	2.49	17.93	985.15	13.68	11.19	991.89	6.74
TPB-12	975.63	16.02	3.12	12.9	962.73	8.83	5.71	969.92	7.19
TPB-13	969.94	19.99	2.63	17.36	952.58	5.82	3.19	966.75	14.17
TPB-14	971.70	11.68	1.96	9.72	961.98	8.98	7.02	964.68	2.70
TPB-15	997.91	19.85	2.32	17.53	980.38	13.18	10.86	987.05	6.67
TPB-16	998.21	16.58	1.29	15.29	982.92	12.30	11.01	987.20	4.28
TPB-17	---	Abandoned	---	---	---	---	---	---	---
TPB-18	997.30	23.27	2.68	20.59	976.71	14.50	11.82	985.48	8.77
TPB-19	1001.36	13.97	2.79	11.18	990.18	8.68	5.89	995.47	5.29
TPB-20	975.75	14.84	2.52	12.32	963.43	9.36	6.84	968.91	5.48

Table 6 (continued)

Location	Surface Elevation (AMSL)	Total depth [from TOC (ft)]	Casing stick-up (ft)	TD (BLS) (ft)	Bedrock Elevation (AMSL)	Depth to water [from TOC (ft)] 6/24/96	Depth to water [from BLS (ft)] 6/24/96	Water Table Elevation (AMSL)	Water height (ft) 6/24/96
TPB-21	980.97	19.08	2.42	16.66	964.31	17.83	15.41	965.56	1.25
TPB-22	980.13	21.53	2.29	19.24	960.89	17.35	15.06	965.07	4.18
TPB-23	972.76	23.81	2.68	21.13	951.63	10.62	7.94	964.82	13.19
TPB-24	991.53	18.65	2.67	15.98	975.55	11.95	9.28	982.25	6.70
TPB-25	1007.68	16.56	1.41	15.15	992.53	12.15	10.74	996.94	4.41
TPB-26	1000.36	19.85	2.79	17.06	983.30	9.82	7.03	993.33	10.03
TPB-27	998.72	21.53	2.68	18.85	979.87	11.17	8.49	990.23	10.36
TPB-28	1010.69	23.10	3.00	20.10	990.59	15.64[a]	12.64[a]	998.05	7.46[a]
TPB-29	999.88	23.10	3.00	20.10	979.78	14.86[a]	11.86[a]	988.02	8.24[a]
TPB-30	1000.06	22.60	3.50	18.60	981.46	13.08[a]	9.58[a]	990.48	9.52[a]
TPB-31	1007.42	13.30	3.40	9.90	[b]	11.68[a]	8.28[a]	999.14	1.62[a]
TPB-32	1007.29	19.30	3.20	16.10	991.19	14.46[a]	11.26[a]	996.03	4.84[a]

[a] Measurements made 11/6/96. These piezometers were installed in a later phase.
[b] Push probe refusal encountered above bedrock.

Table 7. Augered piezometer boring information

Location	Surface Elevation	Total depth [from TOC (ft)]	Casing stick-up (ft)	TD (BLS) (ft)	Bedrock Elevation (AMSL)	Depth to Water [from TOC (ft)]	Depth to water [from BLS (ft)]	Water Table Elevation (AMSL)	Water height (ft)
GW-834	992.05	19.80	3.00	16.80	975.25	13.90 (8/20/96)	10.90	981.15	5.90
GW-835	998.04	22.10	2.90	19.2	978.84	13.23 (8/14/96)	10.33	987.71	8.87
GW-836	998.04	27.35	3.00	24.35	973.69	16.12 (8/28/96)	13.12	984.92	11.23
GW-837	1005.22	30.90	3.00	27.90	977.32	12.94 (8/19/96)	9.94	995.28	17.96

Table 8. Groundwater analytical results

Sample No. (location)	PA1001 (GW-834)				PA1002 (GW-835)		PA1004 (GW-837)			
Collection date	8/20/96				8/14/96		8/19/96			
	Filtered		Unfiltered		Filtered	Unfiltered	Filtered		Unfiltered	
Analysis	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
Bicarbonate, mg/L			443			426			434	
Mercury, mg/L	0.0002		<0.0002			0.00049	0.00039		0.0012	
Aluminum, μg/L	2760	2670	9860	8210	1220	4550	4690	4630	27900	25500
Boron, μg/L	102	<100	114	<100	108	108	23.1	<100	39.9	<100
Barium, μg/L	>23200	23800	23700	24300	83.5	95.2	483	489	578	587
Calcium, μg/L	>1000000	2629000	>1000000	2662000	163000	163000	>1000000	1647000	>1000000	1681000
Cadmium, μg/L	411	391	427	404	<20	<20	199	184	204	196
Cobalt, μg/L	216	212	222	211	<20	<20	257	250	265	265
Chromium, μg/L	<20	<100	<20	<100	<20	<20	<20	<100	<20	<100
Copper, μg/L	65.2	<200	70.5	<200	<30	<30	58.6	<200	77.2	<200
Iron, μg/L	362	<800	5810	5700	712	4580	207	<800	14300	14300
Potassium, μg/L	29000	26500	32000	28200	6380	7300	43200	38800	47900	42400
Magnesium, μg/L	335000	322000	343000	327000	26000	26400	152000	146000	158000	151000
Manganese, μg/L	>100000	145000	>100000	147000	1120	1160	100000	157000	>100000	159000
Molybdenum, μg/L	<40	<200	<40	<200	<40	<40	<40	<200	<40	<200
Sodium, μg/L	506000	494000	516000	500000	17400	17300	695000	677000	705000	688000
Nickel, μg/L	1660	1710	1710	1750	<40	<40	2130	2130	2140	2210
Lead, μg/L	<200	<800	<200	<800	<200	<200	<200	<800	<200	<800
Thallium, μg/L	136	<500	139	<500	<100	<100	143	<500	169	<500
Vanadium, μg/L	<10	<50	<10	<50	<10	<10	<10	<50	<10	<50

Table 8 (continued)

Sample No. (location)	PA1001 (GW-834)				PA1002 (GW-835)		PA1004 (GW-837)			
Collection date	8/20/96				8/14/96		8/19/96			
	Filtered		Unfiltered		Filtered	Unfiltered	Filtered		Unfiltered	
Analysis	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
Zinc, μg/L	33.5	<100	44.8	<100	<20	<20	97.6	<100	119	105
Selenium, μg/L	<500	<3000	<500	<3000	<500	<500	<500	<3000	<500	<3000
Silver, μg/L	<20	<80	<20	<80	<20	<20	<20	<80	<20	<80
Arsenic, μg/L	<100	<500	<100	<500	<100	<100	<100	<500	<100	<500
Beryllium, μg/L	2	<5.0	2.5	<5.0	<1.0	<1.0	2.9	<5.0	4.5	<5
Antimony, μg/L	<100	<500	100	<500	<100	<100	<100	<500	<100	<500
Lithium, μg/L	41.8	<50	50.5	<50	30.6	32.4	119	93.8	143	124
Phosphorous, μg/L	547	<2000	668	<2000	<300	<300	562	<2000	724	<2000
Titanium, μg/L	<20	<80	189	96.2	<20	124	<20	<80	244	161
Strontium, μg/L	660	6770	6670	6850	488	490	2390	2440	2450	2500
Alkalinity, mg/L			420			310.1			410	
Alpha activity, pC/L			210±56			370±45			790±120	
Beta activity, pC/L			9000±1000			280±34			4300±500	
Tritium, pC/L			1500±280			-46±150			1100±250	
Fluoride, mg/L			4.8			0.4			4.9	
Chloride, mg/L			260			28			320	
Nitrite as Nitrogen, mg/L			8.3			0.2			7.3	
Bromide, mg/L			NA			NA			NA	
Nitrate as Nitrogen, mg/L			2300			29			1400	

Table 8 (continued)

Sample No. (location)	PA1001 (GW-834)				PA1002 (GW-835)		PA1004 (GW-837)			
Collection date	8/20/96				8/14/96		8/19/96			
	Filtered		Unfiltered		Filtered	Unfiltered	Filtered		Unfiltered	
Analysis	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
Ortho-Phosphate as Phosphorus, mg/L			<5.0			<0.12			<5.0	
Sulfate, mg/L			14			150			390	
22-Sodium Activity, pC/L			1.1±1.9			1.5±2.1			-1.5±2.5	
40-Potassium Activity, pC/L			52±47			50±52			42±49	
51-Chromium Activity, pC/L			-1.2±15			8.1±19			9.7±15	
54-Manganese Activity, pC/L			0.85±1.9			1.6±2.2			-0.095±2.0	
57-Cobalt Activity, pC/L			-0.57±1.5			0.84±1.5			0.31±1.3	
58-Cobalt Activity, pC/L			-1.2±1.8			-1.4±2.1			0.49±2.0	
59-Iron Activity, pC/L			0.9±3.3			-0.7±4.8			3±4.2	
60-Cobalt Activity, pC/L			2.3±2.0			-1.7±3.8			2.9±3.6	
65-Zinc Activity, pC/L			-0.63±4.5			-0.55±4.4			1±5.2	
95-Niobium Activity, pC/L			3.6±2.1			-0.5±2.3			2.7±2.3	
95-Zirconium Activity, pC/L			-1.9±4.0			-3.3±4.7			-1.6±4.4	
106-Ruthenium Activity, pC/L			-2.2±16			13±18			3.9±17	
125-Antimony Activity, pC/L			-0.78±5.1			-2.9±5.6			2.4±5.2	
134-Cesium Activity, pC/L			-1.2±2.0			-0.52±2.4			1.2±2.2	
137-Cesium Activity, pC/L			-0.77±2.2			-0.064±3.8			-2.4±3.6	
144-Cerium Activity, pC/L			1.3±12			-3.5±12			-2.1±10	

Table 8 (continued)

Sample No. (location)	PA1001 (GW-834)				PA1002 (GW-835)		PA1004 (GW-837)			
Collection date	8/20/96				8/14/96		8/19/96			
	Filtered		Unfiltered		Filtered	Unfiltered	Filtered		Unfiltered	
Analysis	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
208-Thallium Activity, pC/L			4.5±4.4			3.4±4.0			3.1±3.6	
212-Bismuth Activity, pC/L			13±14			13±16			1.8±16	
212-Lead Activity, pC/L			18±5.6			6.4±5.7			12±5.0	
235 Uranium Activity, pC/L			7.8±5.0			5±18			20±5.0	
Technetium -99, pC/L			22000 ±2200			150±16			10000 ±1000	
Total Dissolved Solids, mg/L						690			11000	
Total Strontium, pC/L			-2.4±?			0.4±1.1			360±?	
Total Suspended Solids, mg/L			190			9				
Uranium, μg/g			0.0037			1.7			2.6	
Unknown, μg/L			65						60	
Acetaldoxime, μg/L			6							
1,2-Ethanediol, Dinitrate, μg/L			16							
1,5-Pentanediol, Dinitrate, μg/L			10							
Chloromethane, μg/L			10 U			10 U			3 J	
Bromomethane, μg/L			4 J			10 U			2 J	
Vinyl chloride, μg/L			10 U			10 U			10 U	
Chloroethane, μg/L			10 U			10 U			10 U	
Trichlorofluoromethane, μg/L			10 U			10 U			10 U	
Methylene chloride, μg/L			14			10 U			18	

Table 8 (continued)

Sample No. (location)	PA1001 (GW-834)				PA1002 (GW-835)		PA1004 (GW-837)			
Collection date	8/20/96				8/14/96		8/19/96			
	Filtered		Unfiltered		Filtered	Unfiltered	Filtered		Unfiltered	
Analysis	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
Acetone, µg/L			12			9 BJ			43	
1,1,2-Trichloro-1,2,2-trifluoroethane, µg/L			10 U			5 J			3 J	
Carbon disulfide, µg/L			10 U			10 U			10 U	
1,1-Dichloroethene, µg/L			10 U			10 U			10 U	
1,1-Dichloroethane, µg/L			10 U			10 U			10 U	
cis-1,2-Dichloroethene, µg/L			6 J			10 U			3 J	
tran-1,2-Dichloroethene, µg/L			10 U			10 U			10 U	
Chloroform, µg/L			9 J			10 U			7 J	
1,2-Dichloroethane, µg/L			10 U			10 U			10 U	
2-Butanone, µg/L			**4 BJ**			**3 BJ**			**8 BJ**	
1,1,1-Trichloroethane, µg/L			10 U			10 U			1 J	
Carbon tetrachloride, µg/L			10 U			10 U			10 U	
Bromodichloromethane, µg/L			10 U			10 U			10 U	
1,2-Dichloropropane, µg/L			10 U			10 U			10 U	
cis-1,3-Dichloropropene, µg/L			10 U			10 U			10 U	
Trichloroethene, µg/L			10 U			10 U			10 U	
Dibromochloromethane, µg/L			10 U			10 U			10 U	
1,1,2-Trichloroethane, µg/L			10 U			10 U			10 U	
Benzene, µg/L			10 U			10 U			10 U	

Table 8 (continued)

Sample No. (location)	PA1001 (GW-834)				PA1002 (GW-835)		PA1004 (GW-837)			
Collection date	8/20/96				8/14/96		8/19/96			
	Filtered		Unfiltered		Filtered	Unfiltered	Filtered		Unfiltered	
Analysis	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
trans-1,3-Dichloropropene, μg/L			10 U			10 U			10 U	
Bromoform, μg/L			10 U			10 U			10 U	
4-Methyl-2-pentanone, μg/L			10 U			10 U			2 J	
2-Hexanone, μg/L			10 U			10 U			10 U	
Tetrachloroethene, μg/L			2 J			4 J			14	
1,1,2,2-Tetrachloroethane, μg/L			10 U			10 U			10 U	
Toluene, μg/L			10 U			10 U			10 U	
Chlorobenzene, μg/L			10 U			10 U			10 U	
Ethylbenzene, μg/L			10 U			10 U			10 U	
Styrene, μg/L			10 U			10 U			10 U	
Xylene, μg/L			10 U			10 U			10 U	
Ethane 1,2-Dichloro-1,1,2-tr, μg/L						4.03				

Table 9. Groundwater field measurements (see Table 8)

Location	Sample no.	Date	Conductivity (mS/cm)	pH (su)	Temperature (°C)
GW-834	PA1001	8/20/96	16.5	5.48	23.8
GW-835	PA1002	8/14/96	1.12	6.41	22.6
GW-837	PA1004	8/19/96	11.9	5.38	26.4

Table 10. Migration pathway summary chemical characteristics

Migration pathway	Sample location	Nitrate (mg/L)	Uranium (μg/g)	Gross alpha (pCi/L)	Gross beta (pCi/L)	Technetium (pCi/L)
1	GW-837	1400	2.6	790	4300	10,000
2	GW-835	29	1.7	370	280	150
3	GW-834	2300	0.0037	210	9000	22,000
3 (cont.)	TPB-12, -13, -20	2- >50	<0.003-0.037	97-1581	78-824	N/A

FIGURES

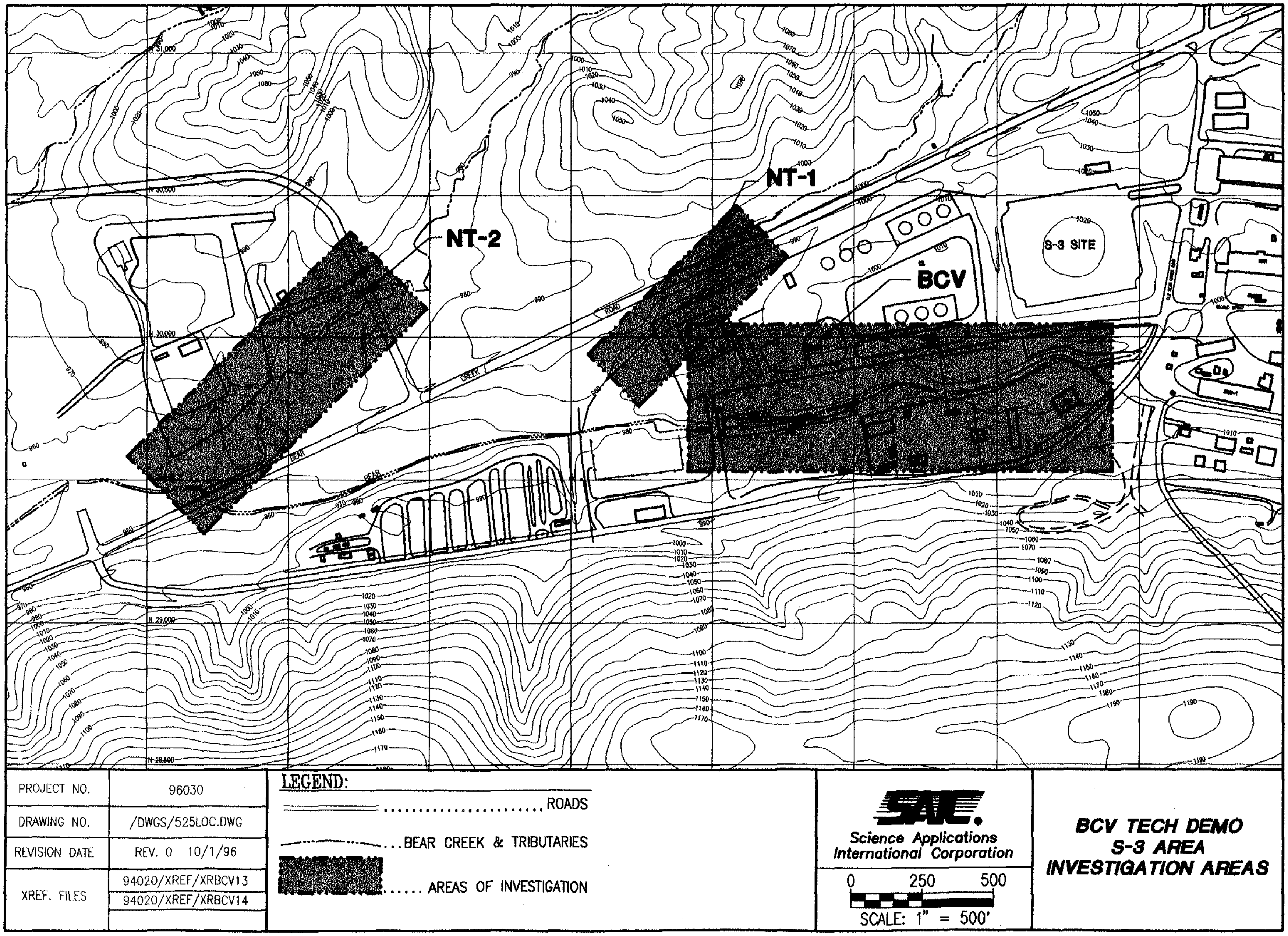
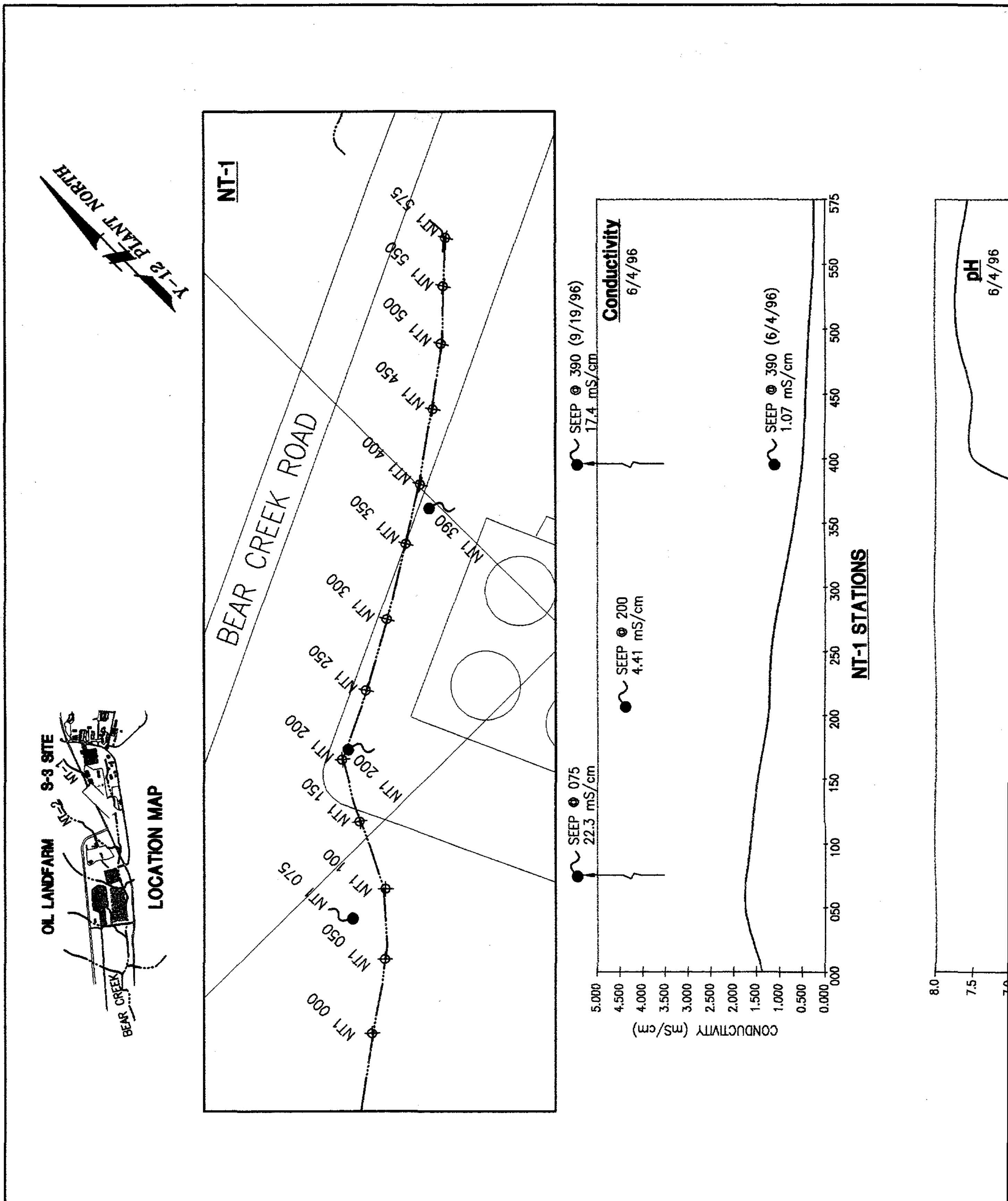


Fig. 1. Areas of investigation.


Y-12 PLANT NORTH
OIL LANDFARM
S-3 SITE
NT-1
NT-2
BEAR CREEK
LOCATION MAP
NT-1
BEAR CREEK ROAD
NT1 000
NT1 050
NT1 075
NT1 100
NT1 150
NT1 200
NT1 200
NT1 250
NT1 300
NT1 350
NT1 390
NT1 400
NT1 450
NT1 500
NT1 550
NT1 575
Conductivity
6/4/96
SEEP @ 075
22.3 mS/cm
SEEP @ 200
4.41 mS/cm
SEEP @ 390 (9/19/96)
17.4 mS/cm
SEEP @ 390 (6/4/96)
1.07 mS/cm
CONDUCTIVITY (mS/cm)
5.000
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
000
050
100
150
200
250
300
350
400
450
500
550
575
NT-1 STATIONS
pH
6/4/96
8.0
7.5

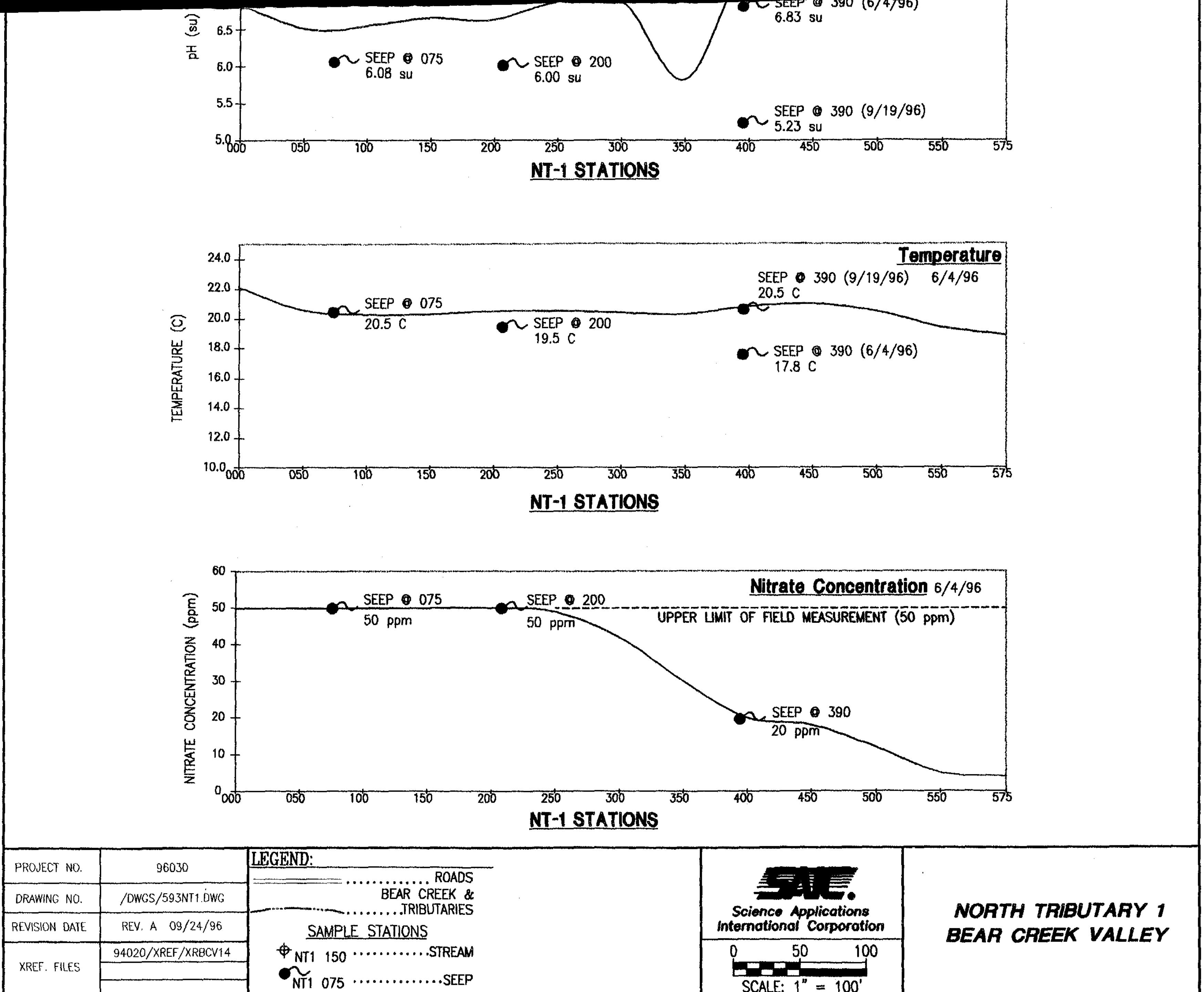


Fig. 3. North Tributary 1 (NT-1) surface water sample locations and field screening results.

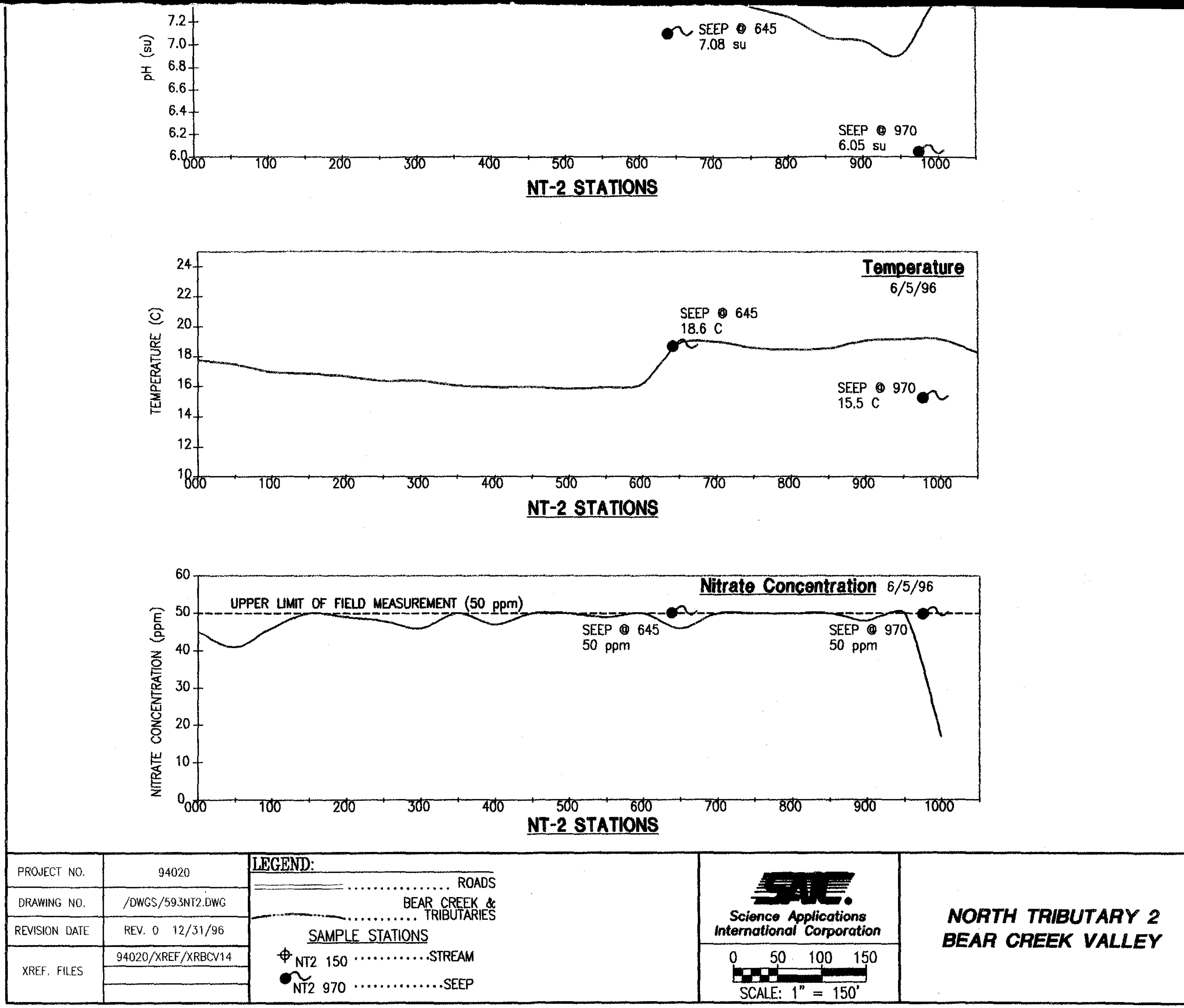
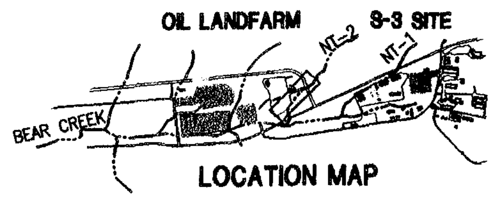
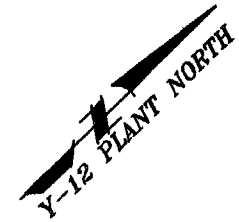
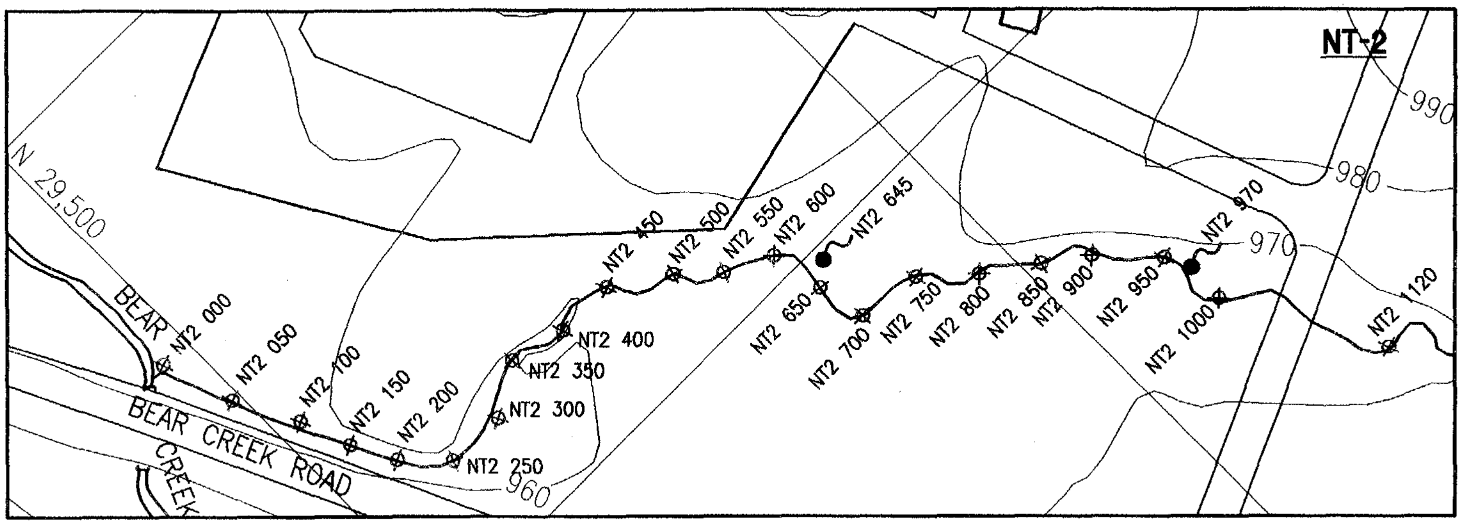
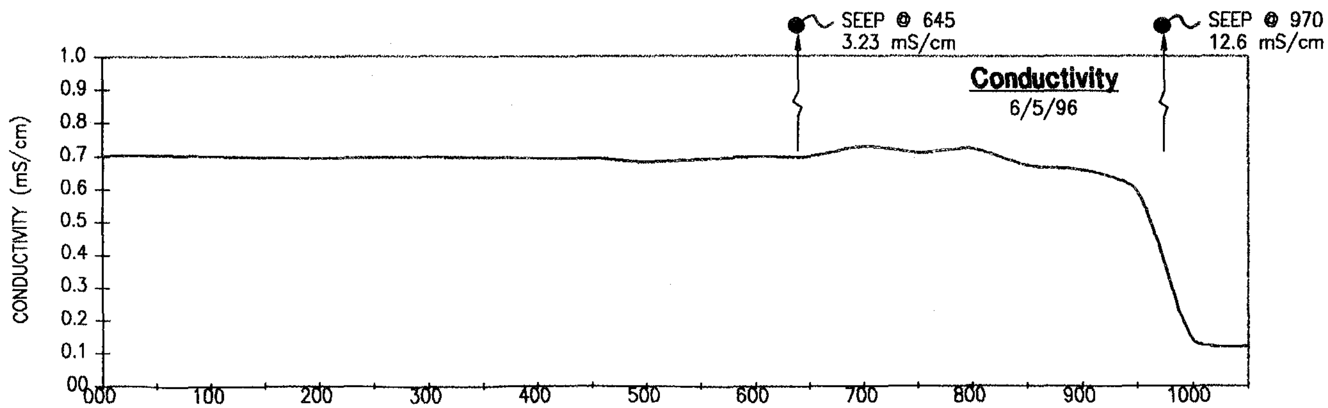


Fig. 4. North Tributary 2 (NT-2) surface water sample locations and field screening results.









NT-2 STATIONS

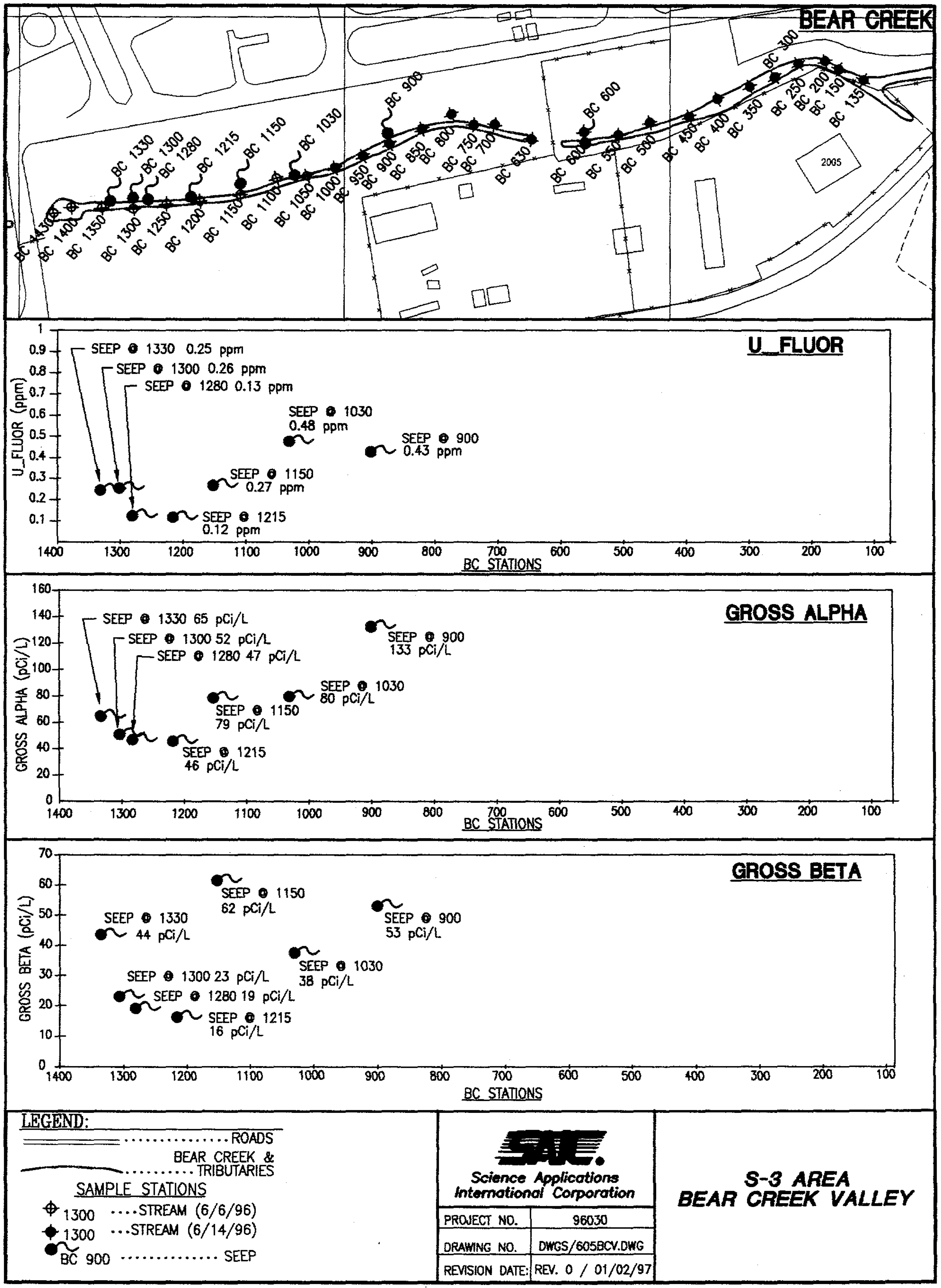


Fig. 5. Bear Creek surface water uranium screening results.

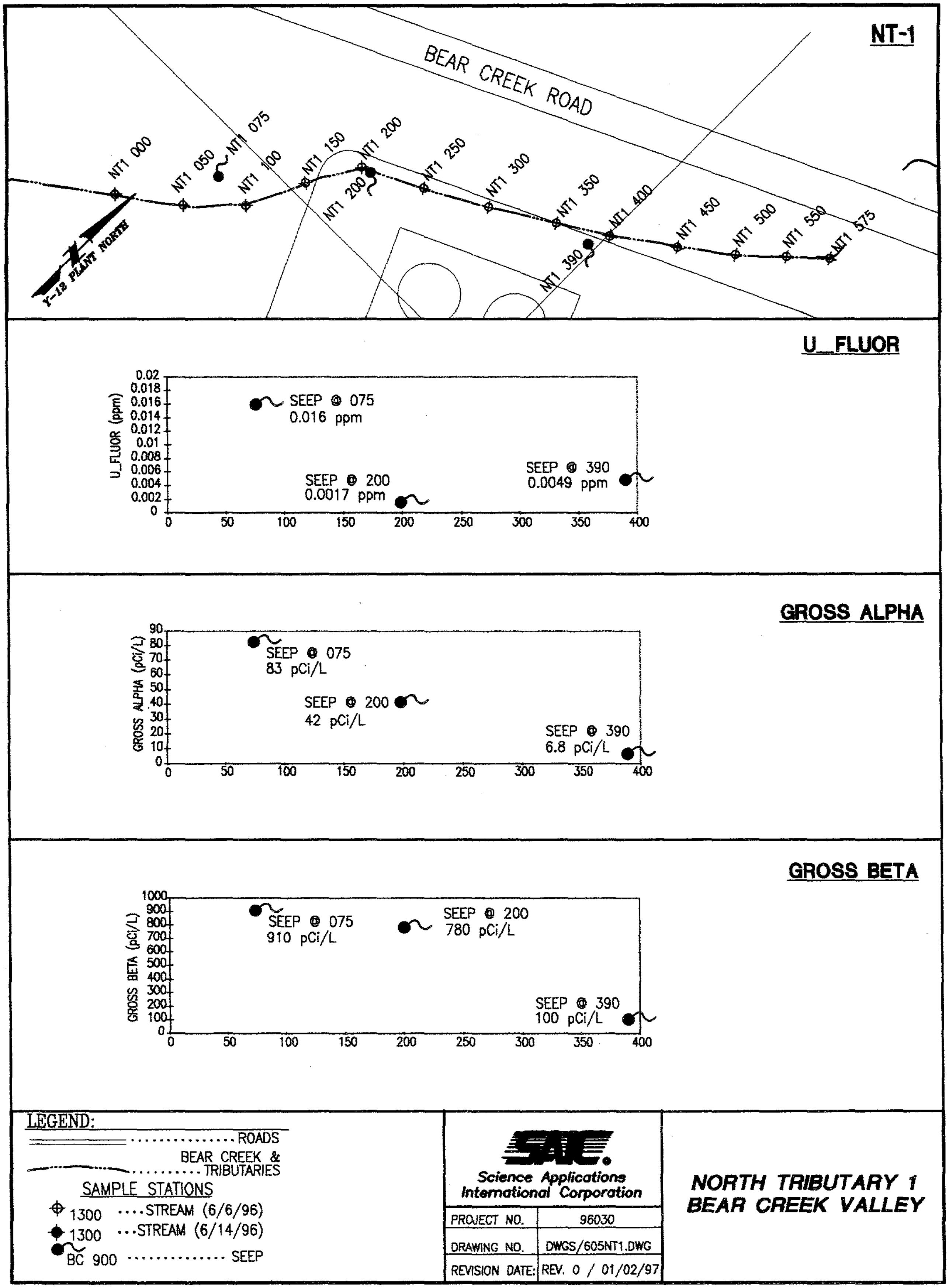


Fig. 6. North Tributary 1 (NT-1) surface water uranium screening results.

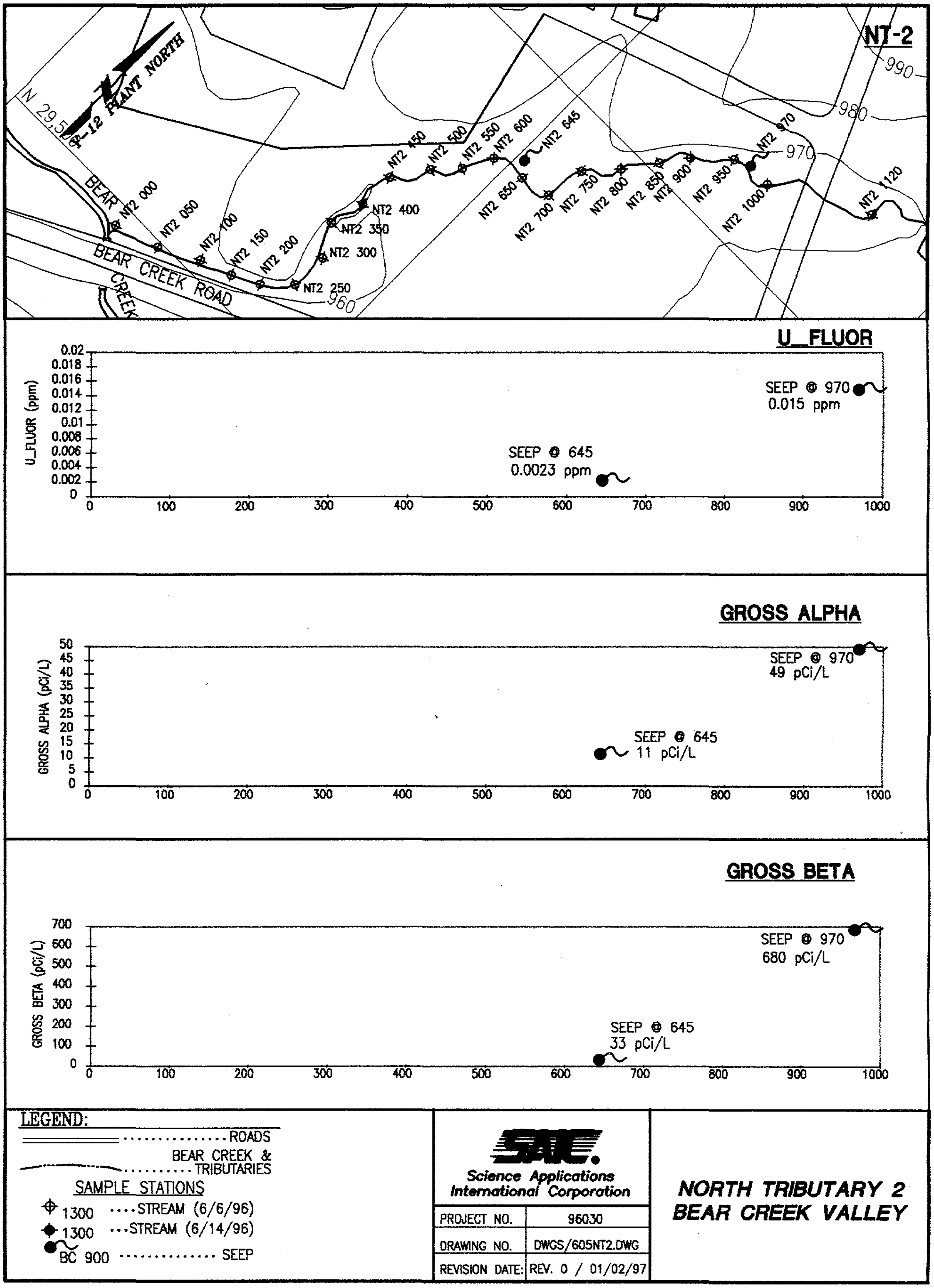
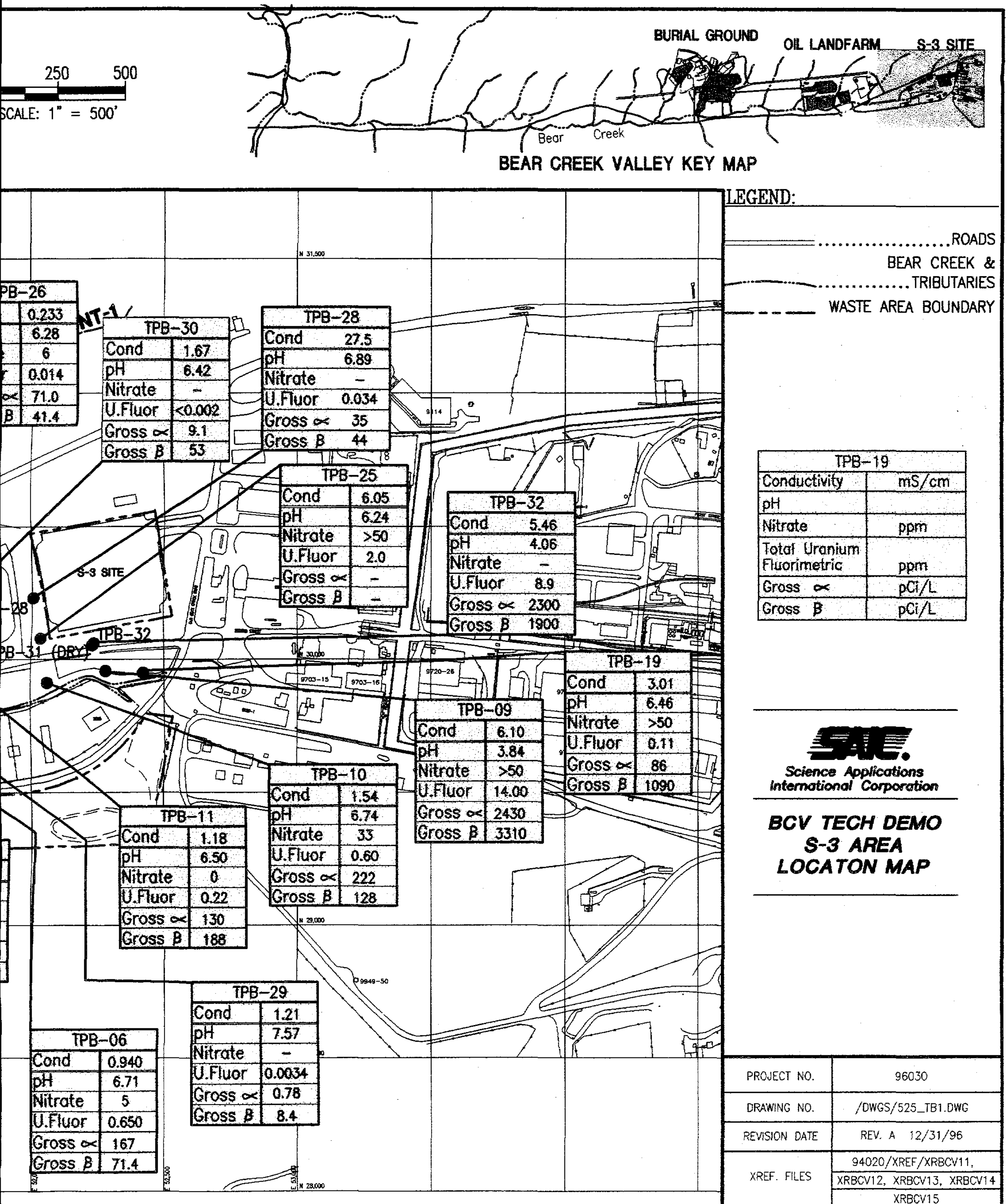
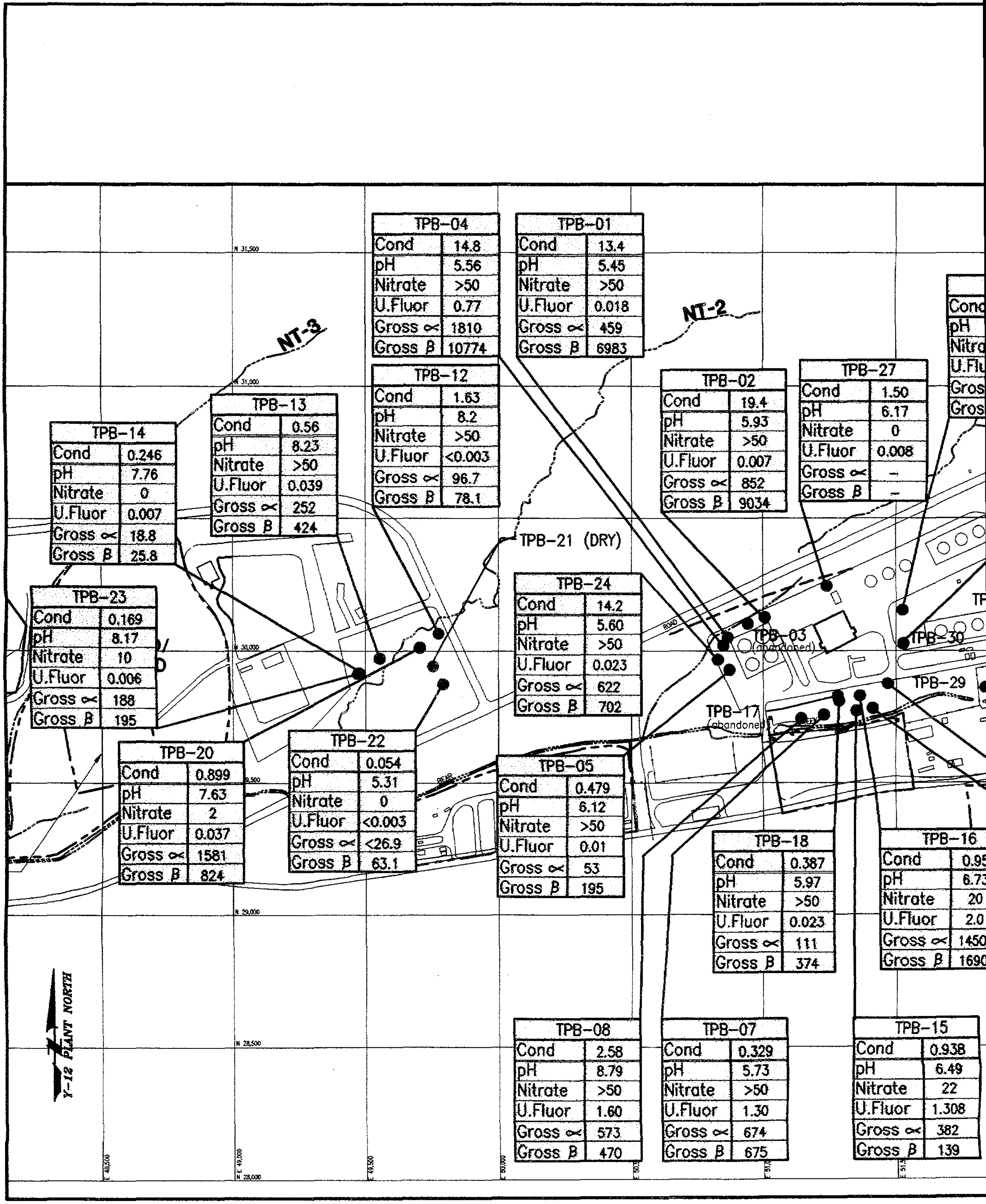


Fig. 7. North Tributary 2 (NT-2) surface water uranium screening results.



ions and groundwater screening results.



SAIC CAD DWG: 94020\DWGS\525_TB1.DWG

Fig. 8. Push probe temporary piezometer loc

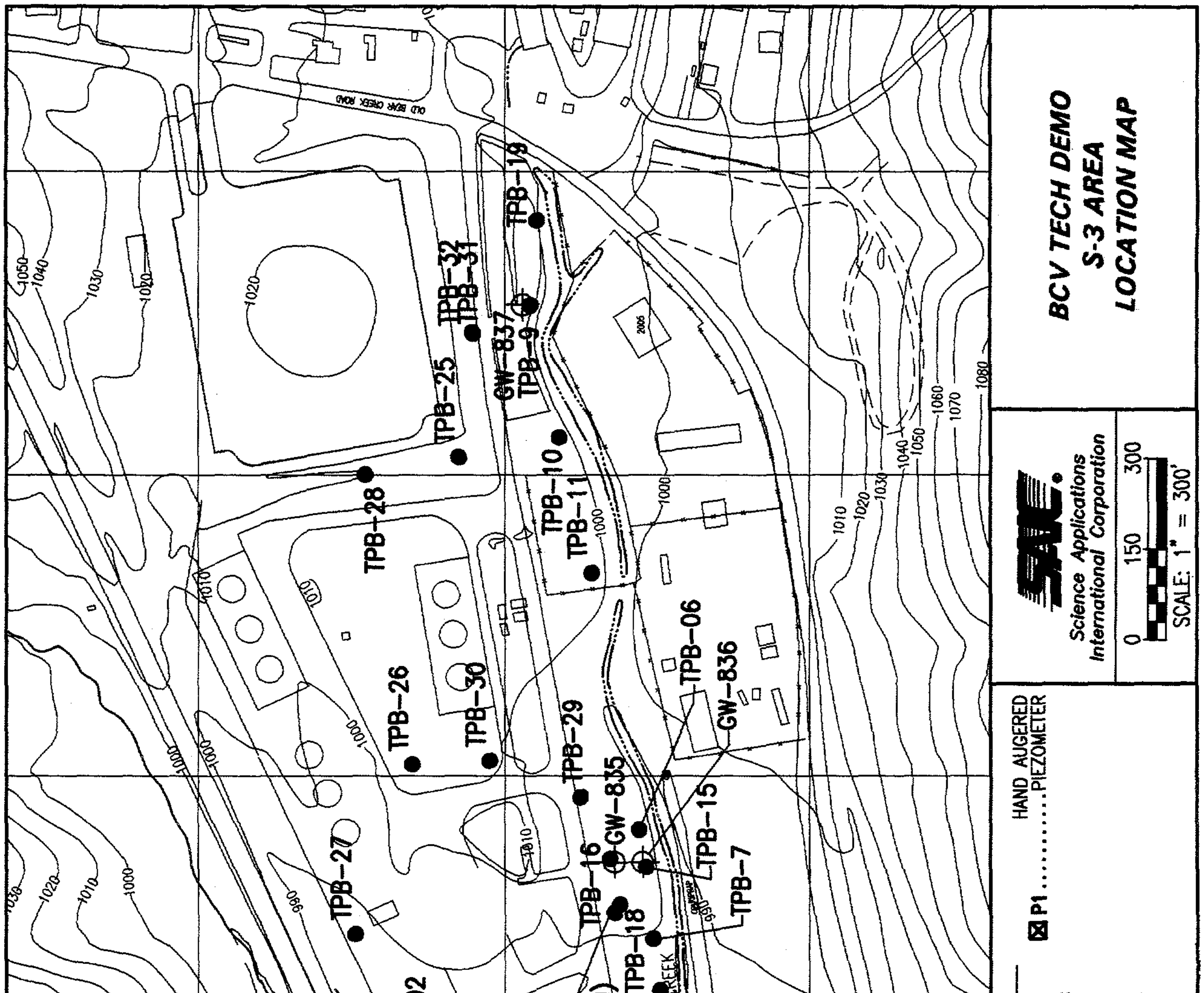


Fig. 9. BCV treatability study S-3 area location map.

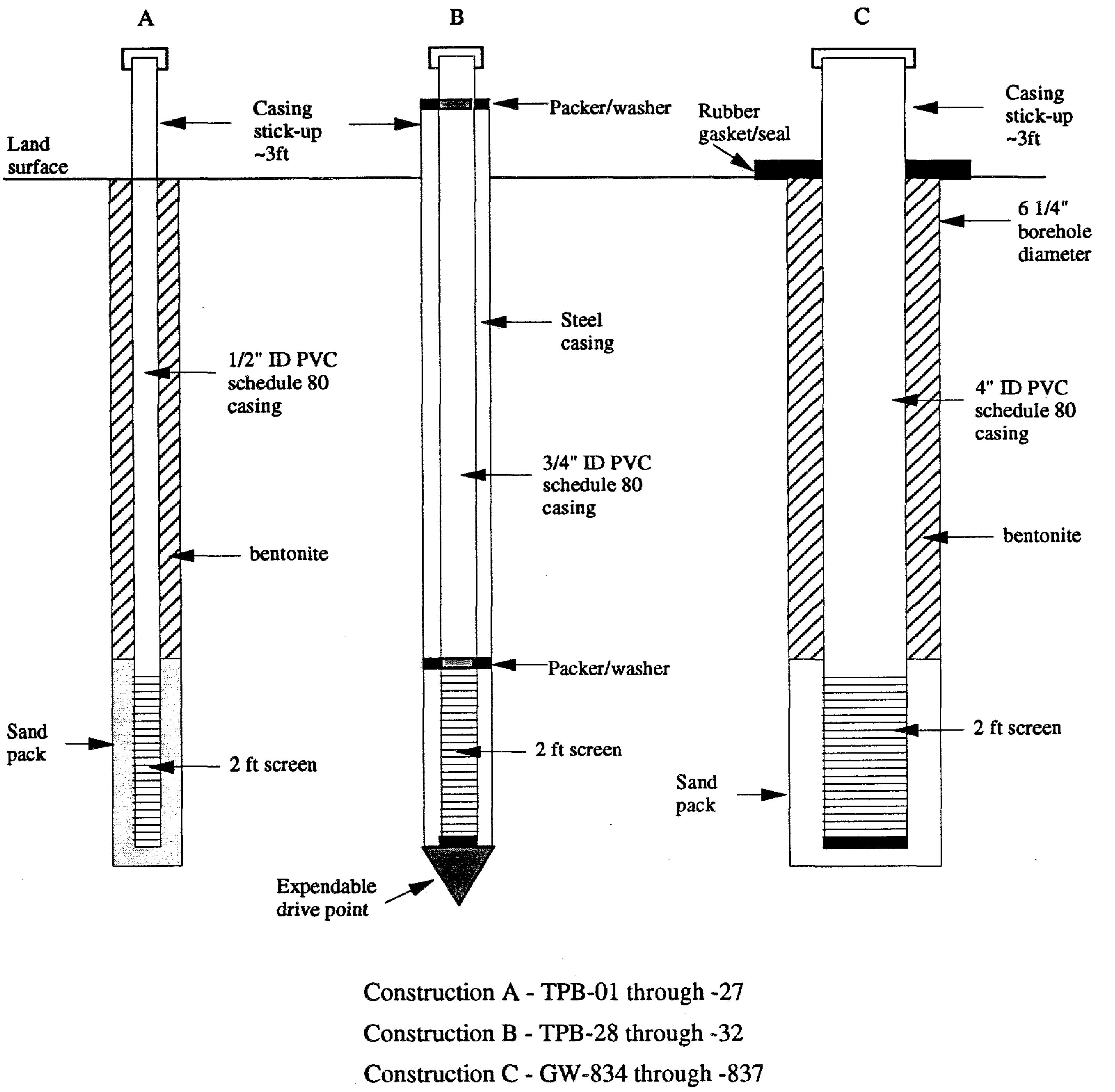


Figure 10. General piezometer construction logs.

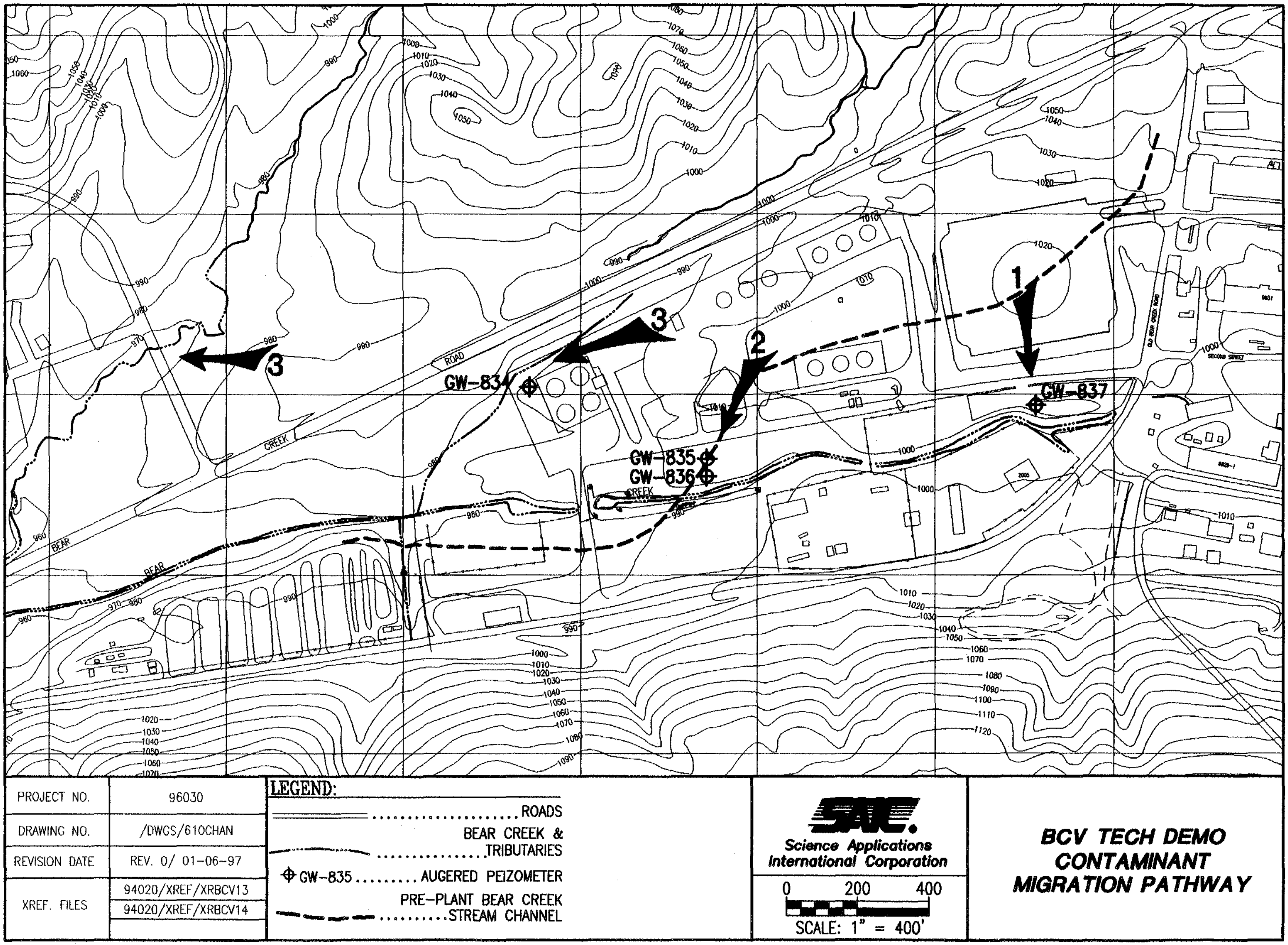


Fig. 11. Contaminant migration pathways.

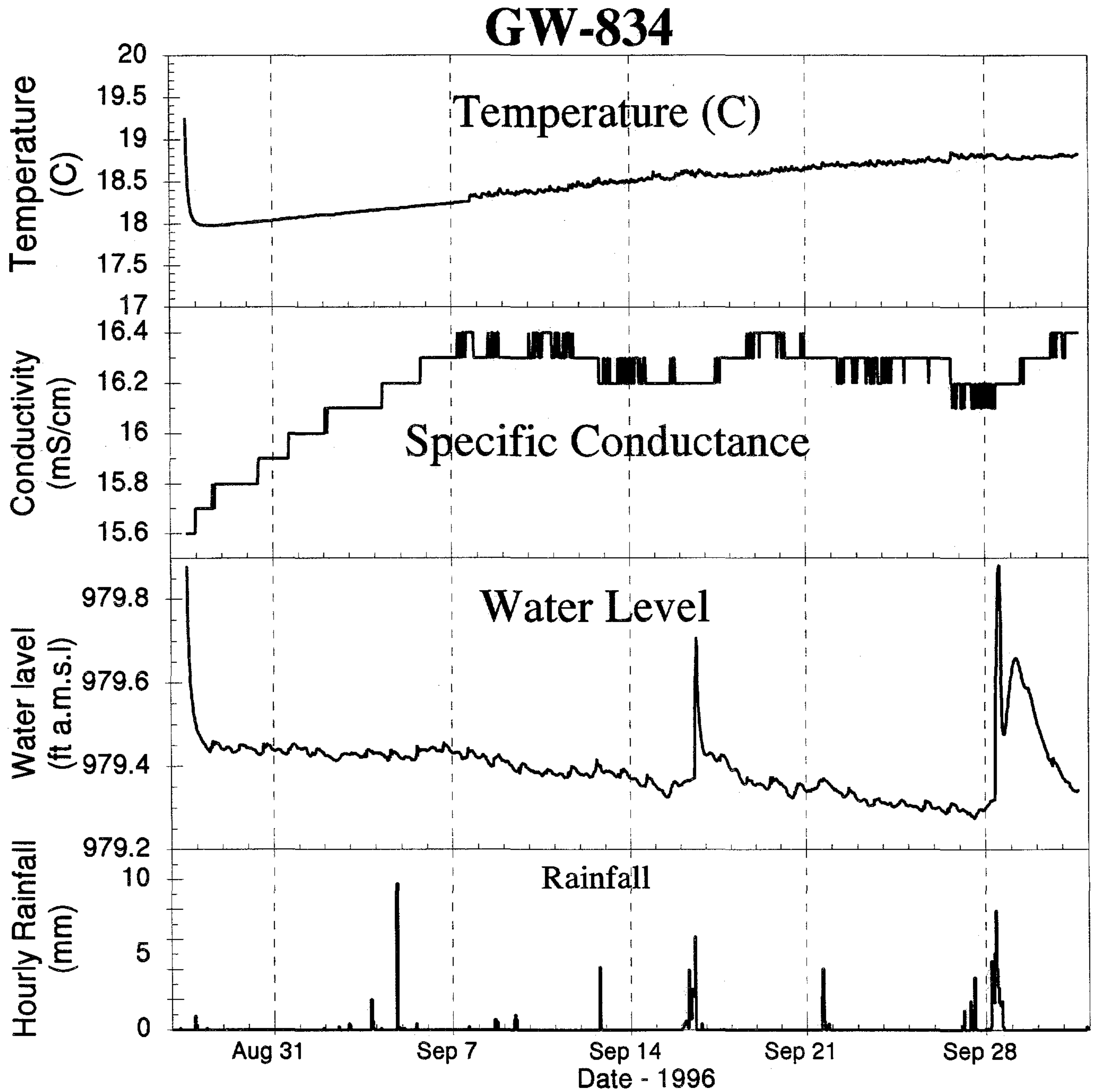


Fig. 12. GW-834 continuous water level, temperature, and conductivity monitoring.

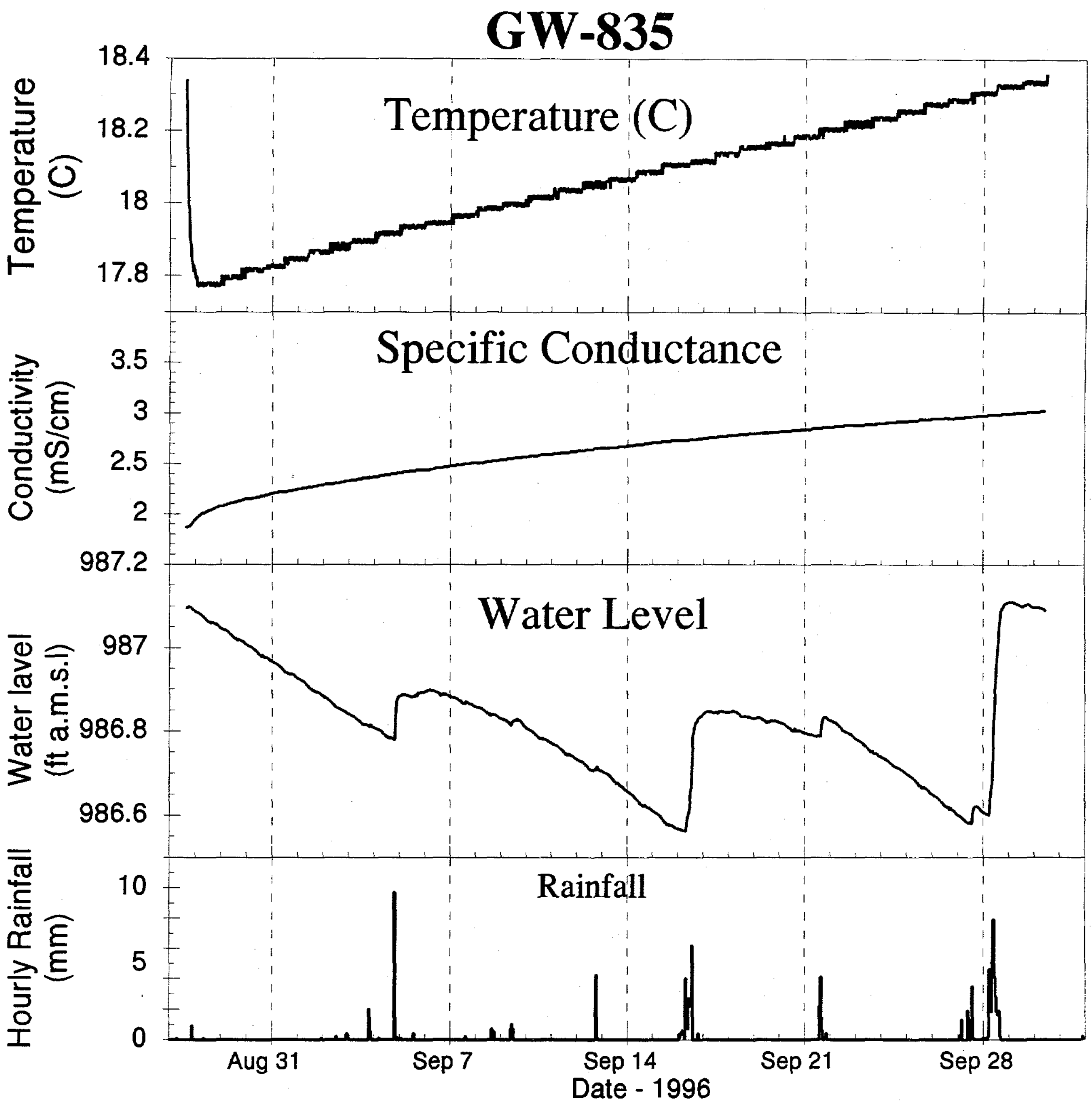


Fig. 13. GW-835 continuous water level, temperature, and conductivity monitoring.

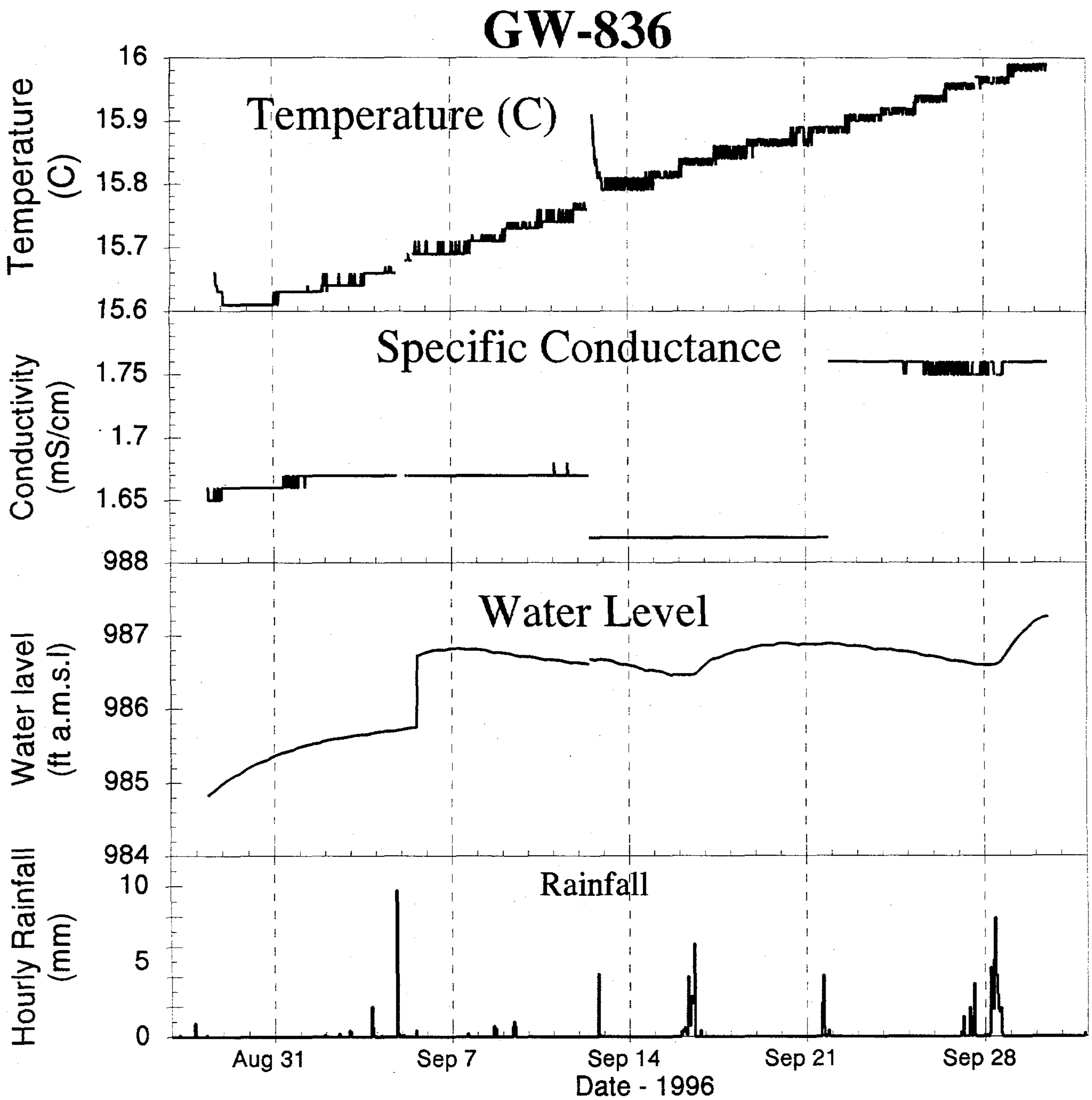


Fig. 14. GW-836 continuous water level, temperature, and conductivity monitoring.

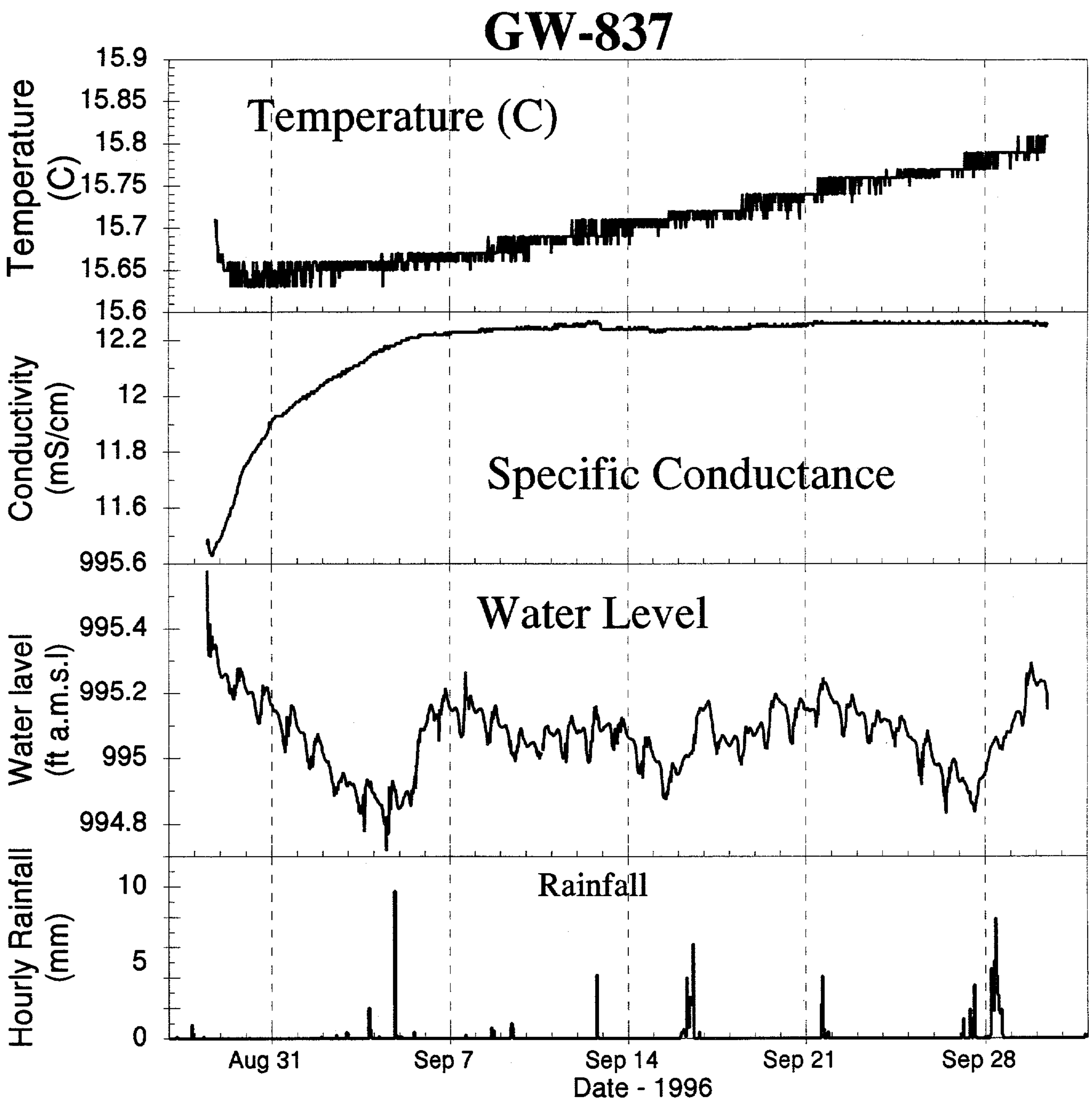


Fig. 15. GW-837 continuous water level, temperature, and conductivity monitoring.

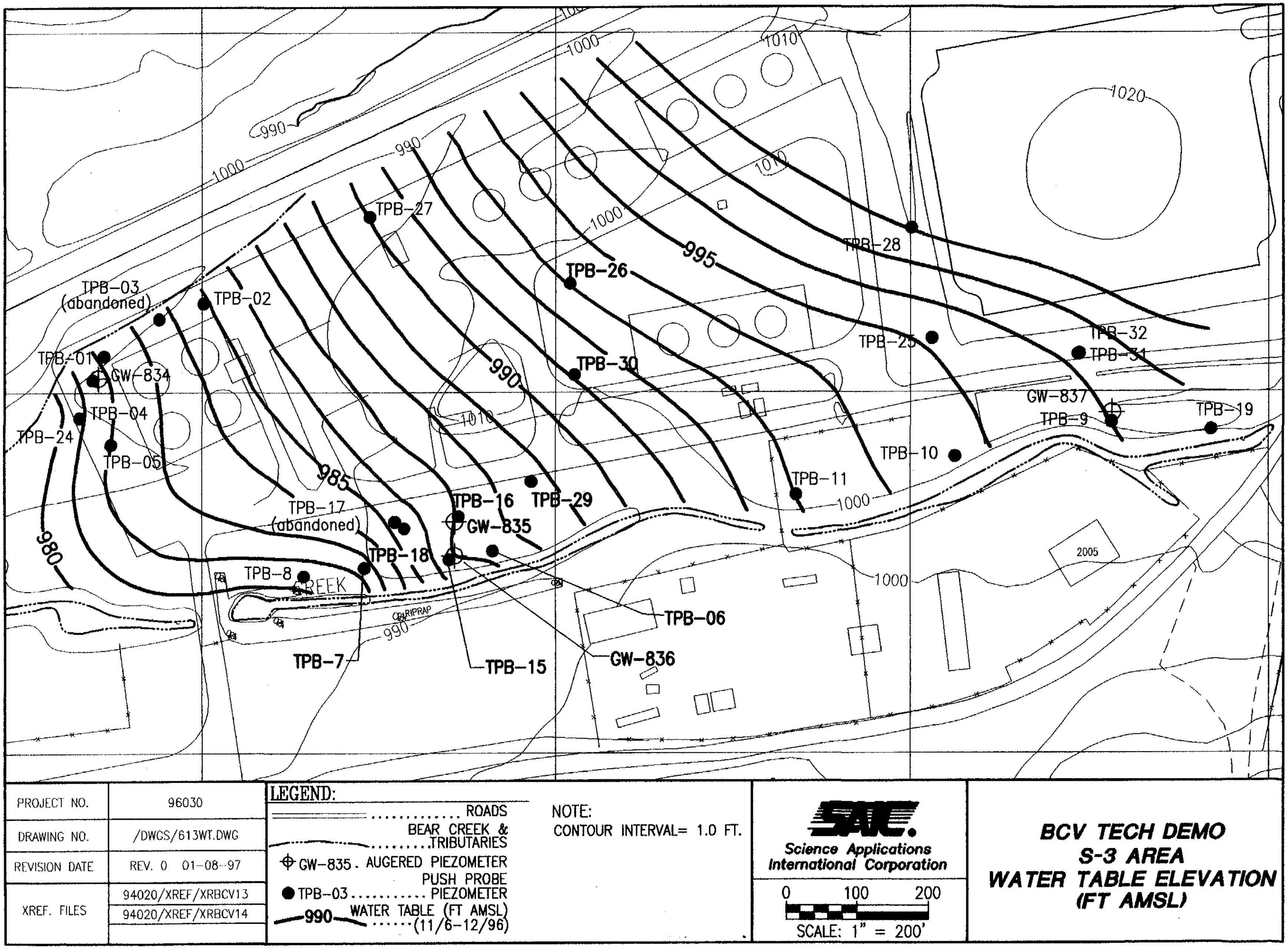


Fig. 16. BCV treatability study S-3 area water table elevation (ft amsl).

APPENDIX A
WELL DEVELOPMENT REPORTS
(GW-834, -835, and -837)

ORNL-DWG 90M-13756

Y-12 PLANT GROUNDWATER PROTECTION PROGRAM	WELL NO. GW-834
WELL DEVELOPMENT ACTIVITY/PROGRESS REPORT	PAGE 1 of 2

LOCATION: S3 Ponds	DATE: START: 8-15-96
BAILERS: G. Shillings/J. Gallaher - Highland Drilling Co	FINISH: 8-16-96
HELPERS: NA	
DRILL: NA	LOGGED BY: Timothy Coffey - SAIC

DATE	TIME		ACTIVITY/COMMENTS
	START	FINISH	
8-15-96	0928	0944	Arrive at GW-834 site. Don personal protective equipment (PPE).
	0944	0948	Enter exclusion zone. Uncap well, organic vapors in casing
			headspace = 0.0 ppm. Measure water level at 10.8 ft below
			ground surface (BGS). Calculate a well volume of 3.8 gallons.
	0948	0953	Commence bailing the well. Bail 4 gallons of water out of the well;
			water sample is turbid. Breathing zone analysis (BZA) while
			bailing = 0.0 ppm.
	0953	0959	Screen water sample. Readings: pH = 5.8, conductance
			= 7600 μmhos/cm, temperature = 20.5°C.
	0959	1002	Continue bailing the well. Bail another 2 gallons of water out of the
			well; water sample is turbid (silty). The well is nearly dry.
	1002	1007	Screen water sample. Readings: pH = 5.6, conductance
			= 12,300 μmhos/cm, temperature = 19.2°C.
	1007	1033	Wait for well to recharge.
	1033	1036	Continue bailing the well. Bail another 2 gallons of water out of the
			well; water sample is turbid. Well is now dry.

96-001MS(H)/082296

ORNL-DWG 90M-13757

Y-12 PLANT GROUNDWATER PROTECTION PROGRAM	WELL NO. GW-834
WELL DEVELOPMENT ACTIVITY/PROGRESS REPORT continued	PAGE 2 of 2

DATE	TIME		ACTIVITY/COMMENTS
	START	FINISH	
8-15-96	1036	1040	Screen water sample. Readings: pH = 5.5, conductance
(cont.)			= 13,000 µmhos/cm, temperature = 20.0°C. Plan to let well
			recharge overnight and finish development tomorrow. Leave
			bailer and water handling equipment within the exclusion zone.
	1040	1051	Y-12 Plant RADCON representative, D.M. Smith, scans
			instruments and personnel out of the exclusion zone. Depart site.
8/16/96	0655	0721	Arrive at GW-834 site. Don PPE, and enter exclusion zone.
	0721	0724	Commence bailing the well. Bail 3.5 gallons of water out of the
			well; water sample is slightly turbid.
	0724	0732	Screen water sample. Readings: pH = 5.6, conductance
			= 13,300 µmhos/cm, temperature = 18.5°C.
	0732	0736	Continue bailing the well. Bail another 2 gallons of water out of the
			well; water sample is turbid. Well is nearly dry.
	0736	0742	Screen water sample. Readings: pH = 5.6, conductance
			= 12,900 µmhos/cm, temperature = 18.1°C. Terminate
			development.
	0742	0803	Decontaminate bailer and water handling equipment. D.M. Smith
			scans equipment and personnel out of the exclusion zone. Depart
			site.
			Development of GW-834 is complete.

ORNL-DWG 90M-13612

Y-12 PLANT GROUNDWATER PROTECTION PROGRAM

MONITORING WELL DEVELOPMENT PROGRESS

WELL NO. GW-834

LOCATION: S3 Ponds

ONE WELL VOLUME: 3.8 GALLONS

WELL INSTALLATION COMPLETION DATE: 7-11-96

DATE	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	pH	DISSOLVED SOLIDS (µS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
8-15-96	4	Turbid	5.8	7600	4	1.1	
8-15-96	2	Turbid (Silty)	5.6	12,300	6	1.6	
8-15-96	2	Turbid	5.5	13,000	8	2.1	1.
8-16-96	3.5	Slightly Turbid	5.6	13,300	11.5	3.0	
8-16-96	2	Turbid	5.6	12,900	13.5	3.6	1.
RESULTS AT END OF DEVELOPMENT		Turbid	5.6	12,900	13.5	3.6	

COMMENTS:

1. Well bailed to dryness.

96-001MS(H)/082896

ORNL-DWG 90M-13755

Y-12 PLANT GROUNDWATER PROTECTION PROGRAM

MONITORING WELL DEVELOPMENT SUMMARY

WELL NO. GW-834

METHOD OF DEVELOPMENT: 4-liter bailer

DEVELOPMENT OBSERVED BY: Timothy Coffey - SAIC

DEVELOPMENT DATE:
START: 8-15-96
FINISH: 8-16-96

ONE WELL VOLUME: 3.8 GALLONS

TOTAL GALLONS PUMPED: 13.5 TOTAL WELL VOLUMES PUMPED: 3.6

INITIAL pH: 5.8 FINAL pH: 5.6

INITIAL SPECIFIC CONDUCTANCE: 7600 μmhos/cm FINAL: 12,900 μmhos/cm

DESCRIPTION OF INITIAL TURBIDITY: Turbid

DESCRIPTION OF FINAL TURBIDITY: Turbid

FINAL MEASURED TURBIDITY: Not Analyzed

WELL APPROVED BY: W.K. Jago - HSEA

ODOR OF WATER: None discernable

WATER DISCHARGED TO:
- ☐ GROUND SURFACE
- ☐ TANK TRUCK
- ☐ STORM SEWERS
- ☒ STORAGE TANKS
- ☐ DRUMS
- ☐ OTHER ____

INITIAL PRE-DEVELOPMENT WATER DEPTH: 10.8 ft BGS on 8-15-96

DEVELOPMENT OBSERVATIONS: Well is a moderate to fair producer. Well always gave more than 1 well volume prior to drying up. Water cleared up fairly well, however, the last (sediment-laden) sample was turbid due to the higher ratio of sediments to water as the well dried up.

OBSERVER SIGNATURE: [signature]

DATE: 8-16-96

96-001MS(H)/082296

Y-12 PLANT GWPP DEVELOPMENT WATER FIELD SCREENING/DISPOSAL SHEET

WELL NO. GW-834 SITE: S3 Ponds

APPROX. VOLUME OF DEVELOPMENT WATER: 13.5 gallons

CALIBRATION OF INSTRUMENTS (check those instruments calibrated to manufacturer's specifications):

Instrument	Checked		Model
pH meter	X	(model)	Horiba Model U-7
Sp. Cond. meter	X	(model)	YSI S-C-T Meter Model 33
Organic vapor meter	X	(model)	Century/Foxboro OVA Model 128
Beta/gamma meter	X	(model)	Ludlum Model 3 Survey Meter with G-M Pancake Probe
Alpha meter	X	(model)	Ludlum Model 12 Count Ratemeter with Scintillation Tube Probe

FIELD SCREENING RESULTS:

Date	Time	pH	Sp. Cond.	Organic Vapors*	Beta/ Gamma	Alpha
8-15-96	0953	5.8	7600 µmhos/cm	NA	40 cpm	0 cpm
8-15-96	1002	5.6	12,300 µmhos/cm	NA	40 cpm	0 cpm
8-15-96	1033	5.5	13,000 µmhos/cm	NA	40 cpm	0 cpm
8-16-96	0724	5.6	13,300 µmhos/cm	NA	40 cpm	0 cpm
8-16-96	0736	5.6	12,900 µmhos/cm	NA	50 cpm	0 cpm
		(4.0-10.5)	(<1000 µmhos/cm)	(<5 ppm)	(<100 cpm)	(<500 cpm)

*No headspace analysis, all development water contained.

Weather: 8-15-96: Clear.
8-16-96: Early a.m. fog, then clear.

Temp.: 8-15-96: Upper-60s to low-70s°F
8-16-96: Mid- to upper-60s°F

DISPOSITION: Drill-site Disposal ______ Containerization X

(Labeled?) Y/n (Y circled)

Describe: Development water placed in 330-gal. P-T Tank.

On-site Geologist (print): Timothy Coffey - SAIC

Signature:

Date: 8-16-96

96-001MS(H)/082296

Y-12 PLANT GROUNDWATER PROTECTION PROGRAM

EQUIPMENT DECONTAMINATION INSPECTION SUMMARY

WELL NO. GW-834

INSTALLATION ☐
P&A ☐
DEVELOPMENT ☒

LOCATION: S3 Ponds

DATE: START: 8-15-96

DECONTAMINATION CREW: G. Shillings

FINISH: 8-16-96

EQUIPMENT	DECON DATE	INSPECTION DATE	INSPECTION (PASS/FAIL)	INSPECTOR'S INITIALS
DRILL RIG ______ (Mast, Chassis, Cables, Carousel, Hoses, Etc.)	NA	—	—	—
DRILLING TOOLS (Pipe Wrenches, Hand Tools, Lifting Bells, Clevis, Chains, Etc.)	NA	—	—	—
DOWN HOLE TOOLS (Drilling Rods, Stabilizers, Washover Pipe, Bits, Etc.)	NA	—	—	—
WELL CONSTRUCTION MATERIALS (Casing, Screen, Centralizers, Etc.)	NA	—	—	—
WORKOVER RIG ______ (Mast, Chassis, Cables, Hoses, Etc.)	NA	—	—	—
DEVELOPMENT TOOLS (Tubing, Bailers, Pumps, Etc.)	8-15-96	8-15-96	Pass	TJC
OTHER EQUIPMENT OR RE-INSPECTIONS (SPECIFY)				

COMMENTS:

ORNL-DWG 90M-13756

Y-12 PLANT GROUNDWATER PROTECTION PROGRAM	WELL NO. GW-835
WELL DEVELOPMENT ACTIVITY/PROGRESS REPORT	PAGE 1 of 3

LOCATION: S3 Ponds	DATE: START: 8-13-96
BAILER: G. Shillings - Highland Drilling Co.	FINISH: 8-13-96
HELPERS: NA	
DRILL: NA	LOGGED BY: Timothy Coffey - SAIC

DATE	TIME		ACTIVITY/COMMENTS
	START	FINISH	
8-13-96	0808	0825	Arrive at GW-835 site. This is the first of four wells to be
			developed; discuss project with Y-12 Plant Health-Physics
			representative D.M. Smith (a small exclusion zone will be
			established around each well, and work will be controlled by RWP
			96-H-0155).
	0825	0850	S. Jones (HSEA) conducts a short project-specific health & safety
			briefing. Items worth mentioning include:
			• Work must stop if beta/gamma counts reach 100 cpm.
			• Headspace analyses for water samples (for disposal) will not
			be required because all development water is to be contained.
	0850	0854	Don personal protective equipment (PPE) consisting of Level D
			hooded Tyvek/Sardnex, rubber gloves, plastic and rubber boots,
			and eye protection.
	0854	0859	Enter exclusion zone. Uncap well, organic vapors: in casing
			headspace = 36 ppm (max), in breathing zone = 0 ppm. Measure
			water level at 10.4 ft below ground surface (BGS). Calculate a
			well volume of 6.0 gallons.
	0859	0908	Commence bailing the well. Bail 4 gallons of water out of the well;
			water sample is turbid (silty). Breathing zone analysis (BZA) while
			bailing = 0.0 ppm.

ORNL-DWG 90M-13757

Y-12 PLANT GROUNDWATER PROTECTION PROGRAM

WELL NO. GW-835

WELL DEVELOPMENT ACTIVITY/PROGRESS REPORT continued

PAGE 2 of 3

DATE	TIME START	TIME FINISH	ACTIVITY/COMMENTS
8-13-96	0908	0914	Screen water sample. Readings: pH = 6.5, conductance =
(cont.)			1350 µmhos/cm, temperature = 15.0°C.
	0914	0920	Continue bailing the well. Bail another 4 gallons of water out of the
			well; water sample is turbid (water is beginning to clear slightly).
			BZA while bailing = 0.0 ppm.
	0920	0926	Screen water sample. Readings: pH = 6.5, conductance
			= 1200 µmhos/cm, temperature = 19.°0 C. (temperature
			instrument, YSI meter, is acting strangely; reading is jumping).
	0926	0930	Continue bailing the well. Bail another 4 gallons of water out of the
			well; water sample is turbid.
	0930	0934	Screen water sample. Readings: pH = 6.5, conductance
			= 1100 µmhos/cm, temperature = 19.2°C (jumpy again).
	0934	0938	Continue bailing the well. Bail another 4 gallons of water out of the
			well; water sample is turbid.
	0938	0942	Screen water sample. Readings: pH = 6.5, conductance
			= 1010 µmhos/cm, temperature = 19.0°C (jumpy).
	0942	0948	Continue bailing the well. Bail another 8 gallons of water out of the
			well; water sample is moderately turbid (water has cleared a great
			deal since beginning development).
	0948	0953	Screen water sample. Readings: pH = 6.6, conductance
			= 910 µmhos/cm, temperature = 19.0°C.

96-001MS(H)/082296

Y-12 PLANT GROUNDWATER PROTECTION PROGRAM

WELL NO. GW-835

WELL DEVELOPMENT ACTIVITY/PROGRESS REPORT continued

DATE	TIME START	TIME FINISH	ACTIVITY/COMMENTS
8-13-96	0953	0959	Continue bailing the well. Bail another 8 gallons of water out of the
(cont.)			well; water sample is moderately turbid. First sign that well is
			beginning to dry up; water level has dropped significantly.
	0959	1004	Screen water sample. Readings: pH = 6.5, conductance
			= 980 µmhos/cm, temperature = 19.0°C.
	1004	1011	Continue bailing the well. Bail another 8 gallons of water out of the
			well; water sample is slightly turbid. Water continues to clear, while
			water level continues to drop.
	1011	1015	Screen water sample. Readings: pH = 6.6, Conductance
			= 890 µmhos/cm, temperature = 19.0°C.
	1015	1023	Continue bailing the well. Bail another 8 gallons of water out of the
			well; water sample is slightly turbid.
	1023	1027	Screen water sample. Readings: pH = 6.6, conductance
			= 890 µmhos/cm, temperature = 19.0°C.
	1027	1055	S. Jones (HSEA) terminates development of GW-835: have
			removed 8.0 well volumes, parameters have stabilized and water
			has cleared significantly. Decontaminate bailer and other water
			handling items. D.M. Smith scans equipment and personnel out
			of the exclusion zone.
	1055	1101	Pack up equipment. Depart site.
			Development of GW-835 is complete.

ORNL-DWG 90M-13612

Y-12 PLANT GROUNDWATER PROTECTION PROGRAM

MONITORING WELL DEVELOPMENT PROGRESS

WELL NO. GW-835

LOCATION: S3 Ponds

ONE WELL VOLUME: 6.0 GALLONS

WELL INSTALLATION COMPLETION DATE: 7-11-96

DATE	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	pH	DISSOLVED SOLIDS (µS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
8-13-96	4	Turbid (silty)	6.5	1350	4	0.7	
8-13-96	4	Turbid	6.5	1200	8	1.3	
8-13-96	4	Turbid	6.5	1100	12	2.0	
8-13-96	4	Turbid	6.5	1010	16	2.7	
8-13-96	8	Moderately Turbid	6.6	910	24	4.0	
8-13-96	8	Moderately Turbid	6.5	980	32	5.3	
8-13-96	8	Slightly Turbid	6.6	890	40	6.7	
8-13-96	8	Slightly Turbid	6.6	890	48	8.0	
RESULTS AT END OF DEVELOPMENT		Slightly Turbid	6.6	890	48	8.0	

COMMENTS:

96-001MS(H)/082096

ORNL-DWG 90M-13755

Y-12 PLANT GROUNDWATER PROTECTION PROGRAM

MONITORING WELL DEVELOPMENT SUMMARY

WELL NO. GW-835

METHOD OF DEVELOPMENT: 4-liter bailer

DEVELOPMENT OBSERVED BY: Timothy Coffey - SAIC

DEVELOPMENT DATE:
START: 8-13-96
FINISH: 8-13-96

ONE WELL VOLUME: 6.0 GALLONS

TOTAL GALLONS PUMPED: 48 TOTAL WELL VOLUMES PUMPED: 8.0

INITIAL pH: 6.5 FINAL pH: 6.6

INITIAL SPECIFIC CONDUCTANCE: 1350 µmhos/cm FINAL: 890 µmhos/cm

DESCRIPTION OF INITIAL TURBIDITY: Turbid (silty)

DESCRIPTION OF FINAL TURBIDITY: Slightly Turbid

FINAL MEASURED TURBIDITY: Not Analyzed

WELL APPROVED BY: W.K. Jago - HSEA

ODOR OF WATER: None Discernable

WATER DISCHARGED TO:
- ☐ GROUND SURFACE
- ☐ STORM SEWERS
- ☐ DRUMS
- ☐ TANK TRUCK
- ☒ STORAGE TANKS
- ☐ OTHER ______

INITIAL PRE-DEVELOPMENT WATER DEPTH: 10.4 ft BGS on 8-13-96

DEVELOPMENT OBSERVATIONS: Well is an excellent producer, as judged by inability to dry the well up. The well water cleared significantly during development, though not entirely.

OBSERVER SIGNATURE: [signature]

DATE: 8-13-96

96-001MS(H)/082296

Y-12 PLANT GWPP DEVELOPMENT WATER FIELD SCREENING/DISPOSAL SHEET

WELL NO. GW-835 SITE: S3 Ponds

APPROX. VOLUME OF DEVELOPMENT WATER: 48 gallons

CALIBRATION OF INSTRUMENTS (check those instruments calibrated to manufacturer's specifications):

pH meter	X	(model)	Horiba Model U-7
Sp. Cond. meter	X	(model)	YSI S-C-T Meter Model 33
Organic vapor meter	X	(model)	Century/Foxboro OVA Model 128
Beta/gamma meter	X	(model)	Ludlum Model 3 Survey Meter with G-M Pancake Probe
Alpha meter	X	(model)	Ludlum Model 12 Count Ratemeter with Scintillation Tube Probe

FIELD SCREENING RESULTS:

Date	Time	pH	Sp. Cond.	Organic Vapors*	Beta/ Gamma	Alpha
8-13-96	0908	6.5	1350 µmhos/cm	NA	40 cpm	0 cpm
8-13-96	0920	6.5	1200 µmhos/cm	NA	40 cpm	0 cpm
8-13-96	0930	6.5	1100 µmhos/cm	NA	40 cpm	0 cpm
8-13-96	0938	6.5	1010 µmhos/cm	NA	50 cpm	0 cpm
8-13-96	0948	6.6	910 µmhos/cm	NA	30 cpm	0 cpm
8-13-96	0959	6.5	980 µmhos/cm	NA	40 cpm	0 cpm
8-13-96	1011	6.6	890 µmhos/cm	NA	40 cpm	0 cpm
		(4.0-10.5)	(<1000 µmhos/cm)	(<5 ppm)	(<100 cpm)	(<500 cpm)

*No headspace analysis, all development water contained.

Weather: Cloudy, breezy

Temp.: Low- to upper-70s°F

DISPOSITION: Drill-site Disposal

Containerization X

(Labeled?) (y)/n

Describe: Development water placed in 330-gal. P-T Tank.

On-site Geologist (print): Timothy Coffey - SAIC

Signature: [signature]

Date: 8-13-96

Y-12 PLANT GWPP DEVELOPMENT WATER FIELD SCREENING/DISPOSAL SHEET

WELL NO. GW-835 SITE: S3 Ponds

APPROX. VOLUME OF DEVELOPMENT WATER: 48 gallons

CALIBRATION OF INSTRUMENTS (check those instruments calibrated to manufacturer's specifications):

pH meter	X	(model)	Horiba Model U-7
Sp. Cond. meter	X	(model)	YSI S-C-T Meter Model 33
Organic vapor meter	X	(model)	Century/Foxboro OVA Model 128
Beta/gamma meter	X	(model)	Ludlum Model 3 Survey Meter with G-M Pancake Probe
Alpha meter	X	(model)	Ludlum Model 12 Count Ratemeter with Scintillation Tube Probe

FIELD SCREENING RESULTS:

Date	Time	pH	Sp. Cond.	Organic Vapors*	Beta/ Gamma	Alpha
8-13-96	1023	6.6	890 μmhos/cm	NA	30 cpm	0 cpm
		(4.0-10.5)	(<1000 μmhos/cm)	(<5 ppm)	(<100 cpm)	(<500 cpm)

*No headspace analysis, all development water contained.

Weather: Cloudy, breezy Temp.: Low- to upper-70s°F

DISPOSITION: Drill-site Disposal ____ Containerization X

(Labeled?) (y)/n

Describe: Development water placed in 330-gal. P-T Tank.

On-site Geologist (print): Timothy Coffey - SAIC

Signature: Timothy Coffey Date: 8-13-96

96-001MS(H)/082296

Y-12 GWPP-DWG 93N-00001

Y-12 PLANT GROUNDWATER PROTECTION PROGRAM	WELL NO. GW-835
EQUIPMENT DECONTAMINATION INSPECTION SUMMARY	INSTALLATION ☐ P&A ☐ DEVELOPMENT ☒

LOCATION: S3 Ponds

DATE: START: 8-13-96

DECONTAMINATION CREW: G. Shillings

FINISH: 8-13-96

EQUIPMENT	DECON DATE	INSPECTION DATE	INSPECTION (PASS/FAIL)	INSPECTOR'S INITIALS
DRILL RIG ______ (Mast, Chassis, Cables, Carousel, Hoses, Etc.)	NA	—	—	—
DRILLING TOOLS (Pipe Wrenches, Hand Tools, Lifting Bells, Clevis, Chains, Etc.)	NA	—	—	—
DOWN HOLE TOOLS (Drilling Rods, Stabilizers, Washover Pipe, Bits, Etc.)	NA	—	—	—
WELL CONSTRUCTION MATERIALS (Casing, Screen, Centralizers, Etc.)	NA	—	—	—
WORKOVER RIG ______ (Mast, Chassis, Cables, Hoses, Etc.)	NA	—	—	—
DEVELOPMENT TOOLS (Tubing, Bailers, Pumps, Etc.)	8-9-96	8-13-96	Pass	TJC
OTHER EQUIPMENT OR RE-INSPECTIONS (SPECIFY)				

COMMENTS:

ORNL-DWG 90M-13756

Y-12 PLANT GROUNDWATER PROTECTION PROGRAM	WELL NO. GW-836
WELL DEVELOPMENT ACTIVITY/PROGRESS REPORT	PAGE 1 of 2

LOCATION: S3 Ponds	DATE: START: 8-14-96
BAILER: G. Shillings - Highland Drilling Co.	FINISH: 8-15-96
HELPERS: NA	
DRILL: NA	LOGGED BY: Timothy Coffey - SAIC

DATE	TIME		ACTIVITY/COMMENTS
	START	FINISH	
8-14-96	0702	0725	Arrive at GW-836 site. Don personal protective equipment (PPE).
	0725	0733	Enter exclusion zone. Uncap well, organic vapors in casing headspace = 0.0 ppm. Measure water level at 10.0 ft. below ground surface (BGS). Calculate a well volume of 9.3 gallons.
	0733	0738	Commence bailing the well. Bail 4 gallons of water out of the well; water sample is turbid (silty). Breathing zone analysis (BZA) while bailing = 0.0 ppm.
	0738	0743	Screen water sample. Readings: pH = 7.1, conductance = 940 µmhos/cm, temperature = 14.7°C.
	0743	0747	Continue bailing the well. Bail another 5.3 gallons of water out of the well; water sample is turbid (beginning to clear slightly) and has an odor of acetone. Well is dry.
	0747	0753	Screen water sample. Readings: pH = 7.3, conductance = 760 µmhos/cm, temperature = 14.9°C.
	0753	0823	Wait for well to recharge.
	0823	0830	Continue bailing the well. Well is still dry. Plan to let well recharge overnight and continue tomorrow. Leave bailer and water handling equipment within the exclusion zone.

96-001MS(H)/082296

ORNL-DWG 90M-13757

Y-12 PLANT GROUNDWATER PROTECTION PROGRAM	WELL NO. GW-836
WELL DEVELOPMENT ACTIVITY/PROGRESS REPORT continued	PAGE 2 of 2

DATE	TIME		ACTIVITY/COMMENTS
	START	FINISH	
8-14-96	0830	0844	Y-12 Plant RADCON representative, D.M. Smith, scans
(cont.)			instruments and personnel out of the exclusion zone. Depart site.
8-15-96	0837	0849	Arrive at GW-836 site. Don PPE, and enter exclusion zone.
	0849	0853	Commence bailing the well. Bail approximately 1.5 gallons of
			water out of the well; water sample is slightly turbid. Well is dry.
	0853	0858	Screen water sample. Readings: pH = 6.9, conductance =
			1530 µmhos/cm, temperature = 14.7°C.
	0858	0913	S. Walker (Environmental Restoration Organization) terminates
			development of GW-836 due to poor recharge. Decontaminate
			bailer and water handling equipment. D.M. Smith scans equipment
			and personnel out of the exclusion zone.
	0913	0926	Pack up equipment. Depart site.
			Development of GW-836 is complete.

ORNL-DWG 90M-13612

Y-12 PLANT GROUNDWATER PROTECTION PROGRAM

MONITORING WELL DEVELOPMENT PROGRESS

WELL NO. GW-836

LOCATION: S3 Ponds

ONE WELL VOLUME: 9.3 GALLONS

WELL INSTALLATION COMPLETION DATE: 7-16-96

DATE	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	pH	DISSOLVED SOLIDS (μS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
8-14-96	4	Turbid (silty)	7.1	940	4	0.4	
8-14-96	5.3	Turbid	7.3	760	9.3	1.0	1.
8-15-96	1.5	Slightly Turbid	6.9	1530	10.8	1.2	1.
RESULTS AT END OF DEVELOPMENT		Slightly Turbid	6.9	1530	10.8	1.2	

COMMENTS:

1. Well bailed to dryness.

ORNL-DWG 90M-13755

Y-12 PLANT GROUNDWATER PROTECTION PROGRAM

MONITORING WELL DEVELOPMENT SUMMARY

WELL NO. GW-836

METHOD OF DEVELOPMENT: 4-liter bailer

DEVELOPMENT OBSERVED BY: Timothy Coffey - SAIC

DEVELOPMENT DATE:
START: 8-14-96
FINISH: 8-15-96

ONE WELL VOLUME: 9.3 GALLONS

TOTAL GALLONS PUMPED: 10.8 TOTAL WELL VOLUMES PUMPED: 1.2

INITIAL pH: 7.1 FINAL pH: 6.9

INITIAL SPECIFIC CONDUCTANCE: 940 µmhos/cm FINAL: 1530 µmhos/cm

DESCRIPTION OF INITIAL TURBIDITY: Turbid (silty)

DESCRIPTION OF FINAL TURBIDITY: Slightly Turbid

FINAL MEASURED TURBIDITY: Not Analyzed

WELL APPROVED BY: W.K. Jago - HSEA

ODOR OF WATER: Acetone odor

WATER DISCHARGED TO:
- ☐ GROUND SURFACE
- ☐ STORM SEWERS
- ☐ DRUMS
- ☐ TANK TRUCK
- ☒ STORAGE TANKS
- ☐ OTHER ______

INITIAL PRE-DEVELOPMENT WATER DEPTH: 10.0 ft BGS on 8-14-96

DEVELOPMENT OBSERVATIONS: Well is apparently a poor-producer. Well dried up rapidly during development, and appears to recharge extremely slowly.

OBSERVER SIGNATURE: Timothy Coffey

DATE: 8-15-96

96-001MS(H)/082296

Y-12 PLANT GWPP DEVELOPMENT WATER FIELD SCREENING/DISPOSAL SHEET

WELL NO. GW-836 SITE: S3 Ponds

APPROX. VOLUME OF DEVELOPMENT WATER: 10.8 gallons

CALIBRATION OF INSTRUMENTS (check those instruments calibrated to manufacturer's specifications):

pH meter	X	(model)	Horiba Model U-7
Sp. Cond. meter	X	(model)	YSI S-C-T Meter Model 33
Organic vapor meter	X	(model)	Century/Foxboro OVA Model 128
Beta/gamma meter	X	(model)	Ludlum Model 3 Survey Meter with G-M Pancake Probe
Alpha meter	X	(model)	Ludlum Model 12 Count Ratemeter with Scintillation Tube Probe

FIELD SCREENING RESULTS:

Date	Time	pH	Sp. Cond.	Organic Vapors*	Beta/ Gamma	Alpha
8-14-96	0738	7.1	940 µmhos/cm	NA	40 cpm	0 cpm
8-14-96	0747	7.3	760 µmhos/cm	NA	40 cpm	0 cpm
8-15-96	0853	6.9	1530 µmhos/cm	NA	40 cpm	0 cpm
		(4.0-10.5)	(<1000 µmhos/cm)	(<5 ppm)	(<100 cpm)	(<500 cpm)

*No headspace analysis, all development water contained.

Weather: 8-14-96: Early a.m. fog, then clear.
8-15-96: Early a.m. fog, then clear.

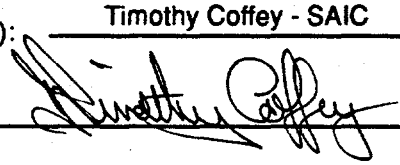
Temp.: 8-14-96: Low- to upper-60s°F
8-15-96: Low- to upper-60s°F

DISPOSITION: Drill-site Disposal ______ Containerization X

(Labeled?) (y)/n

Describe: Development water placed in 330-gal. P-T Tank.

On-site Geologist (print): Timothy Coffey - SAIC

Signature: 

Date: 8-13-96

96-001MS(H)/082296

Y-12 PLANT GROUNDWATER PROTECTION PROGRAM

EQUIPMENT DECONTAMINATION INSPECTION SUMMARY

WELL NO. GW-836

INSTALLATION ☐
P&A ☐
DEVELOPMENT ☒

LOCATION: S3 Ponds

DATE: START: 8-14-96

DECONTAMINATION CREW: G. Shillings

FINISH: 8-15-96

EQUIPMENT	DECON DATE	INSPECTION DATE	INSPECTION (PASS/FAIL)	INSPECTOR'S INITIALS
DRILL RIG ____ (Mast, Chassis, Cables, Carousel, Hoses, Etc.)	NA	—	—	—
DRILLING TOOLS (Pipe Wrenches, Hand Tools, Lifting Bells, Clevis, Chains, Etc.)	NA	—	—	—
DOWN HOLE TOOLS (Drilling Rods, Stabilizers, Washover Pipe, Bits, Etc.)	NA	—	—	—
WELL CONSTRUCTION MATERIALS (Casing, Screen, Centralizers, Etc.)	NA	—	—	—
WORKOVER RIG ____ (Mast, Chassis, Cables, Hoses, Etc.)	NA	—	—	—
DEVELOPMENT TOOLS (Tubing, Bailers, Pumps, Etc.)	8-13-96	8-13-96	Pass	TJC
OTHER EQUIPMENT OR RE-INSPECTIONS (SPECIFY)				

COMMENTS:

Y-12 PLANT GROUNDWATER PROTECTION PROGRAM	WELL NO. GW-837
WELL DEVELOPMENT ACTIVITY/PROGRESS REPORT	PAGE 1 of 4

LOCATION: S3 Ponds	DATE: START: 8-16-96
BAILER: J. Gallaher - Highland Drilling Co.	FINISH: 8-19-96
HELPERS: NA	
DRILL: NA	LOGGED BY: Timothy Coffey - SAIC

DATE	TIME		ACTIVITY/COMMENTS
	START	FINISH	
8-16-96	0803	0838	Arrive at GW-837 site. Waiting for water containment tank to be brought to site.
	0838	0850	Don personal protective equipment (PPE).
	0850	0853	Enter exclusion zone. Uncap well, organic vapors: in casing headspace = 12 ppm (max), in breathing zone = 0.0 ppm. Measure water level at 8.2 ft below ground surface (BGS). Calculate a well volume of 12.9 gallons.
	0853	0900	Commence bailing the well. Bail 4 gallons of water out of the well; water sample is turbid. Water sample also has an indistinguishable chemical odor.
	0900	0904	Screen water sample. Readings: pH = 5.7, conductance = 8900 μmhos/cm, temperature = 18.1°C.
	0904	0911	Continue bailing the well. Bail another 7 gallons of water out of the well; water sample is turbid, but appears to be clearing slightly. Water still has a chemical odor.
	0911	0915	Screen water sample. Readings: pH = 5.6, conductance = 8900 μmhos/cm, temperature = 18.9°C.

ORNL-DWG 90M-13757

Y-12 PLANT GROUNDWATER PROTECTION PROGRAM	WELL NO. GW-837
WELL DEVELOPMENT ACTIVITY/PROGRESS REPORT continued	PAGE 2 of 4

DATE	TIME		ACTIVITY/COMMENTS
	START	FINISH	
8-16-96	0915	0919	Continue bailing the well. Bail another 3 gallons of water out of the
(cont.)			well; water sample is turbid with a sweet, chemical odor. Well is
			beginning to dry up.
	0919	0924	Screen water sample. Readings: pH = 5.5, conductance
			= 9100 μmhos/cm, temperature = 14.9°C (temperature instrument,
			YSI meter, acting strangely; reading is jumpy).
	0924	0930	Continue bailing the well. Bail another 6 gallons of water out of the
			well; water sample is turbid with a sweet, chemical odor.
	0930	0936	Screen water sample. Readings: pH = 5.5, conductance
			= 9300 μmhos/cm, temperature = 14.8°C.
	0936	0939	Continue bailing the well. Bail another 3 gallons of water out of the
			well; water sample is turbid with a sweet, chemical odor. Well is
			nearly dry.
	0939	0943	Screen water sample. Readings: pH = 5.5, conductance
			= 9800 μmhos/cm, temperature = 14.8°C.
	0943	0955	Wait on well to recharge.
	0955	0957	Continue bailing the well. Bail another 3 gallons of water out of the
			well; water sample is slightly turbid. Well is nearly dry again.
	0957	1002	Screen water sample. Readings: pH = 5.5, conductance
			= 9800 μmhos/cm, temperature = 18.1°C (jumpy). Plan to let well
			recharge over the weekend. Leave bailer and water handling
			equipment within the exclusion zone.

ORNL-DWG 90M-13757

Y-12 PLANT GROUNDWATER PROTECTION PROGRAM	WELL NO. GW-837
WELL DEVELOPMENT ACTIVITY/PROGRESS REPORT continued	PAGE 3 of 4

DATE	TIME		ACTIVITY/COMMENTS
	START	FINISH	
8-16-96	1002	1009	Y-12 Plant RADCON representative, D.M. Smith, scans instruments
(cont.)			and personnel out of the exclusion zone. Depart site.
8-19-96	0701	0720	Arrive at GW-837 site. Don PPE.
	0720	0726	Enter exclusion zone. Uncap well, organic vapors: in casing
			headspace = 6 ppm (max), in breathing zone = 0.0 ppm.
	0726	0734	Bail the well. Bail 6 gallons of water out of the well; water sample
			is slightly turbid and still has the unidentifiable chemical odor.
	0734	0738	Screen water sample. readings: pH = 5.6, conductance
			= 9500 µmhos/cm, temperature = 17.0°C.
	0738	0744	Continue bailing the well. Bail another 6 gallons of water out of the
			well; water sample is slightly turbid and still has a chemical odor.
	0744	0748	Screen water sample. Readings: pH = 5.6, conductance
			= 9700 µmhos/cm, temperature = 14.7°C (temperature instrument
			jumping around again).
	0748	0753	Continue bailing the well. Bail another 5 gallons of water out of the
			well; water sample is moderately turbid (well is nearly dry).
	0753	0758	Screen water sample. Readings: pH = 5.6, conductance
			= 9800 µmhos/cm, temperature = 14.7°C.
	0758	0830	Wait on well to recharge.
	0830	0838	Continue bailing the well. Bail another 6 gallons of water out of the
			well; water sample is slightly turbid.

ORNL-DWG 90M-13757

Y-12 PLANT GROUNDWATER PROTECTION PROGRAM				WELL NO. GW-837
WELL DEVELOPMENT ACTIVITY/PROGRESS REPORT continued				PAGE 4 of 4

DATE	TIME		ACTIVITY/COMMENTS
	START	FINISH	
8-19-96	0838	0843	Screen water sample. Readings: pH = 5.6, conductance = 9700
(cont.)			µmhos/cm, temperature = 14.7°C.
	0843	0855	Wait on well to recharge.
	0855	0902	Continue bailing the well. Bail another 6 gallons of water out of the
			well; water sample is moderately turbid (well is dry).
	0902	0905	Screen water sample. Readings: pH = 5.7, conductance
			= 9700 µmhos/cm, temperature = 14.9°C. Terminate development.
	0905	0916	Decontaminate bailer and water handling equipment. Y-12 Plant
			representative, D.M. Smith, scans equipment and personnel out of
			the exclusion zone.
	0916	0931	Pack up equipment. Depart site.
			Development of GW-837 is complete.

96-001MS(H)/082896

ORNL-DWG 90M-13612

Y-12 PLANT GROUNDWATER PROTECTION PROGRAM

MONITORING WELL DEVELOPMENT PROGRESS

WELL NO. GW-837

LOCATION: S3 Ponds

ONE WELL VOLUME: 12.9 GALLONS

WELL INSTALLATION COMPLETION DATE: 7-17-96

DATE	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	pH	DISSOLVED SOLIDS (μS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
8-16-96	4	Turbid	5.7	8900	4	0.3	
8-16-96	7	Turbid	5.6	8900	11	0.9	
8-16-96	3	Turbid	5.5	9100	14	1.1	
8-16-96	6	Turbid	5.5	9300	20	1.6	
8-16-96	3	Turbid	5.5	9800	23	1.8	1.
8-16-96	3	Slightly Turbid	5.5	9800	26	2.0	1.
8-19-96	6	Slightly Turbid	5.6	9500	32	2.5	
8-19-96	6	Slightly Turbid	5.6	9700	38	2.9	
8-19-96	5	Moderately Turbid	5.6	9800	43	3.3	1.
8-19-96	6	Slightly Turbid	5.6	9700	49	3.8	
8-19-96	6	Moderately Turbid	5.7	9700	55	4.3	1.
RESULTS AT END OF DEVELOPMENT		Moderately Turbid	5.7	9700	55	4.3	

COMMENTS:

1. Well bailed to dryness.

96-001MS(H)/082396

ORNL-DWG 90M-13755

Y-12 PLANT GROUNDWATER PROTECTION PROGRAM

MONITORING WELL DEVELOPMENT SUMMARY

WELL NO. GW-837

METHOD OF DEVELOPMENT: 4-liter bailer

DEVELOPMENT DATE:
START: 8-16-96
FINISH: 8-19-96

DEVELOPMENT OBSERVED BY: Timothy Coffey - SAIC

ONE WELL VOLUME: 12.9 GALLONS

TOTAL GALLONS PUMPED: 55 TOTAL WELL VOLUMES PUMPED: 4.3

INITIAL pH: 5.7 FINAL pH: 5.7

INITIAL SPECIFIC CONDUCTANCE: 8900 μmhos/cm FINAL: 9700 μmhos/cm

DESCRIPTION OF INITIAL TURBIDITY: Turbid

DESCRIPTION OF FINAL TURBIDITY: Moderately Turbid

FINAL MEASURED TURBIDITY: Not Analyzed

WELL APPROVED BY: W.K. Jago - HSEA

ODOR OF WATER: Unidentifiable, sweet/pungent chemical odor

WATER DISCHARGED TO:
- ☐ GROUND SURFACE
- ☐ STORM SEWERS
- ☐ DRUMS
- ☐ TANK TRUCK
- ☒ STORAGE TANKS
- ☐ OTHER ______

INITIAL PRE-DEVELOPMENT WATER DEPTH: 8.2 ft BGS on 8-16-96

DEVELOPMENT OBSERVATIONS: Well is a moderate to good producer. Well easily gave up more than 1 well volume during development sessions, and appears to recharge fairly quickly. Overall, the water cleared fairly significantly, but samples obtained prior to drying up were slightly more turbid (from sediment accumulation still at bottom of well).

OBSERVER SIGNATURE: Timothy Coffey

DATE: 8-19-96

96-001MS(H)/082896

Y-12 PLANT GWPP DEVELOPMENT WATER FIELD SCREENING/DISPOSAL SHEET

WELL NO. GW-837 SITE: S3 Ponds

APPROX. VOLUME OF DEVELOPMENT WATER: 55 gallons

CALIBRATION OF INSTRUMENTS (check those instruments calibrated to manufacturer's specifications):

pH meter	X	(model)	Horiba Model U-7
Sp. Cond. meter	X	(model)	YSI S-C-T Meter Model 33
Organic vapor meter	X	(model)	Century/Foxboro OVA Model 128
Beta/gamma meter	X	(model)	Ludlum Model 3 Survey Meter with G-M Pancake Probe
Alpha meter	X	(model)	Ludlum Model 12 Count Ratemeter with Scintillation Tube Probe

FIELD SCREENING RESULTS:

Date	Time	pH	Sp. Cond.	Organic Vapors*	Beta/ Gamma	Alpha
8-16-96	0900	5.7	8900 µmhos/cm	NA	40 cpm	0 cpm
8-16-96	0911	5.6	8900 µmhos/cm	NA	30 cpm	0 cpm
8-16-96	0919	5.5	9100 µmhos/cm	NA	40 cpm	0 cpm
8-16-96	0930	5.5	9300 µmhos/cm	NA	30 cpm	0 cpm
8-16-96	0939	5.5	9800 µmhos/cm	NA	50 cpm	0 cpm
8-16-96	0957	5.5	9800 µmhos/cm	NA	30 cpm	0 cpm
8-19-96	0734	5.6	9500 µmhos/cm	NA	40 cpm	0 cpm
		(4.0-10.5)	(<1000 µmhos/cm)	(<5 ppm)	(<100 cpm)	(<500 cpm)

*No headspace analysis, all development water contained.

Weather: 8-16-96: Fog early, then clearing.
8-19-96: Fog early, then clearing.

Temp.: 8-16-96: Mid-60s to mid-70s0s°F
8-19-96: Mid-60s to upper-70s°F

DISPOSITION: Drill-site Disposal ______ Containerization X

(Labeled?) (y)/n

Describe: Development water placed in 330-gal. P-T Tank.

On-site Geologist (print): Timothy Coffey - SAIC

Signature: [signature] Date: 8-19-96

96-001MS(H)/082396

Y-12 PLANT GWPP DEVELOPMENT WATER FIELD SCREENING/DISPOSAL SHEET

WELL NO. GW-837 SITE: S3 Ponds

APPROX. VOLUME OF DEVELOPMENT WATER: 55 gallons

CALIBRATION OF INSTRUMENTS (check those instruments calibrated to manufacturer's specifications):

pH meter	X	(model)	Horiba Model U-7
Sp. Cond. meter	X	(model)	YSI S-C-T Meter Model 33
Organic vapor meter	X	(model)	Century/Foxboro OVA Model 128
Beta/gamma meter	X	(model)	Ludlum Model 3 Survey Meter with G-M Pancake Probe
Alpha meter	X	(model)	Ludlum Model 12 Count Ratemeter with Scintillation Tube Probe

FIELD SCREENING RESULTS:

Date	Time	pH	Sp. Cond.	Organic Vapors*	Beta/ Gamma	Alpha
8-19-96	0744	5.6	9700 µmhos/cm	NA	50 cpm	0 cpm
8-19-96	0753	5.6	9800 µmhos/cm	NA	40 cpm	0 cpm
8-19-96	0838	5.6	9700 µmhos/cm	NA	40 cpm	0 cpm
8-19-96	0902	5.7	9700 µmhos/cm	NA	40 cpm	0 cpm
		(4.0-10.5)	(<1000 µmhos/cm)	(<5 ppm)	(<100 cpm)	(<500 cpm)

*No headspace analysis, all development water contained.

Weather: 8-16-96: Fog early, then clearing.
8-19-96: Fog early, then clearing.

Temp.: 8-16-96: Mid-60s to mid-70s0s°F
8-19-96: Mid-60s to upper-70s°F

DISPOSITION: Drill-site Disposal ______ Containerization X

(Labeled?) (y)/n

Describe: Development water placed in 330-gal. P-T Tank.

On-site Geologist (print): Timothy Coffey - SAIC

Signature: [signature] Date: 8-19-96

6-001MS(H)/082396

Y-12 GWPP-DWG 93N-00001

Y-12 PLANT GROUNDWATER PROTECTION PROGRAM

EQUIPMENT DECONTAMINATION INSPECTION SUMMARY

WELL NO. GW-837

INSTALLATION ☐
P&A ☐
DEVELOPMENT ☒

LOCATION: S3 Ponds

DATE: START: 8-16-96

DECONTAMINATION CREW: J. Gallaher

FINISH: 8-19-96

EQUIPMENT	DECON DATE	INSPECTION DATE	INSPECTION (PASS/FAIL)	INSPECTOR'S INITIALS
DRILL RIG ______ (Mast, Chassis, Cables, Carousel, Hoses, Etc.)	NA	—	—	—
DRILLING TOOLS (Pipe Wrenches, Hand Tools, Lifting Bells, Clevis, Chains, Etc.)	NA	—	—	—
DOWN HOLE TOOLS (Drilling Rods, Stabilizers, Washover Pipe, Bits, Etc.)	NA	—	—	—
WELL CONSTRUCTION MATERIALS (Casing, Screen, Centralizers, Etc.)	NA	—	—	—
WORKOVER RIG ______ (Mast, Chassis, Cables, Hoses, Etc.)	NA	—	—	—
DEVELOPMENT TOOLS (Tubing, Bailers, Pumps, Etc.)	8-16-96	8-16-96	Pass	TJC
OTHER EQUIPMENT OR RE-INSPECTIONS (SPECIFY)				

COMMENTS:

96-001MS(H)/082396

APPENDIX B
AQUIFER PUMPING TEST RESULTS

This appendix presents the results of the aquifer pumping test performed on November 12, 1996, in pumped piezometer (GW-835) and nine nearby observation piezometers (GW-836 and TPB-06, -07, -15, -16, -18, -26, -29, and -30) (Fig. B.1). A constant flow pumping test was attempted to characterize the unconsolidated aquifer and estimate the pumping flow rates the piezometer could sustain with time.

A pumping pre-test was performed in GW-835 on November 4, 1996, to determine the recharge rate of the aquifer and confirm the potential for the piezometer to serve as the pumped piezometer for the upcoming aquifer test. A bladder pump was installed and used to pump groundwater from the piezometer to determine the recharge rate of the aquifer. A recharge rate of 2.5 L/min was measured while a constant water level elevation was observed in the piezometer. Attempts to increase the discharge rate above 2.5 L/min were unsuccessful due to limitations of the bladder (pneumatic) pump and the water column above the intake of the pump (~ 6.5 ft).

These results confirmed that GW-835 could yield a sufficient volume of groundwater to allow the performance of the aquifer pumping test. It also determined that a rate of 2.5 L/min would be the minimum rate that the piezometer would be pumped for the duration of the test.

Pumping pre-tests were also performed in GW-834 and GW-837. Recharge rates were 60 mL/min and 50 mL/min, respectively. Based on the results, aquifer pump tests were not proposed at these locations. GW-836 was not pre-tested due to extremely slow recharge rates observed during the attempted development of the piezometer (Appendix A).

Implementation. A pneumatic purge pump with a discharge capacity of up to 15 L/min was installed in GW-835 to be used during the aquifer pumping test. Table B.1 presents the schedule developed for recording of the water levels in the pumped and observations piezometers.

Table B.1. Measurement frequency in piezometers

	Time period (min)	Measurement frequency		Time period (min)	Measurement frequency
			Observation		
GW-835:	0-5	15 sec	**piezometers:**	0-60	2 min
(pumped	5-10	30 sec	(GW-836,	60-120	5 min
piezometer)	10-20	1 min	TPB-06, -07,	120-240	10 min
	20-60	5 min	-15, -16, -18,	240-360	30 min
	60-300	30 min	-26, -29, and -30)	360-termin.	60 min
	300-termin.	60 min			

The test was initiated at 0850 on November 12, 1996. Prior to beginning the test, water levels were measured in the pumped and observation piezometers to determine pre-test water table level. The elevation

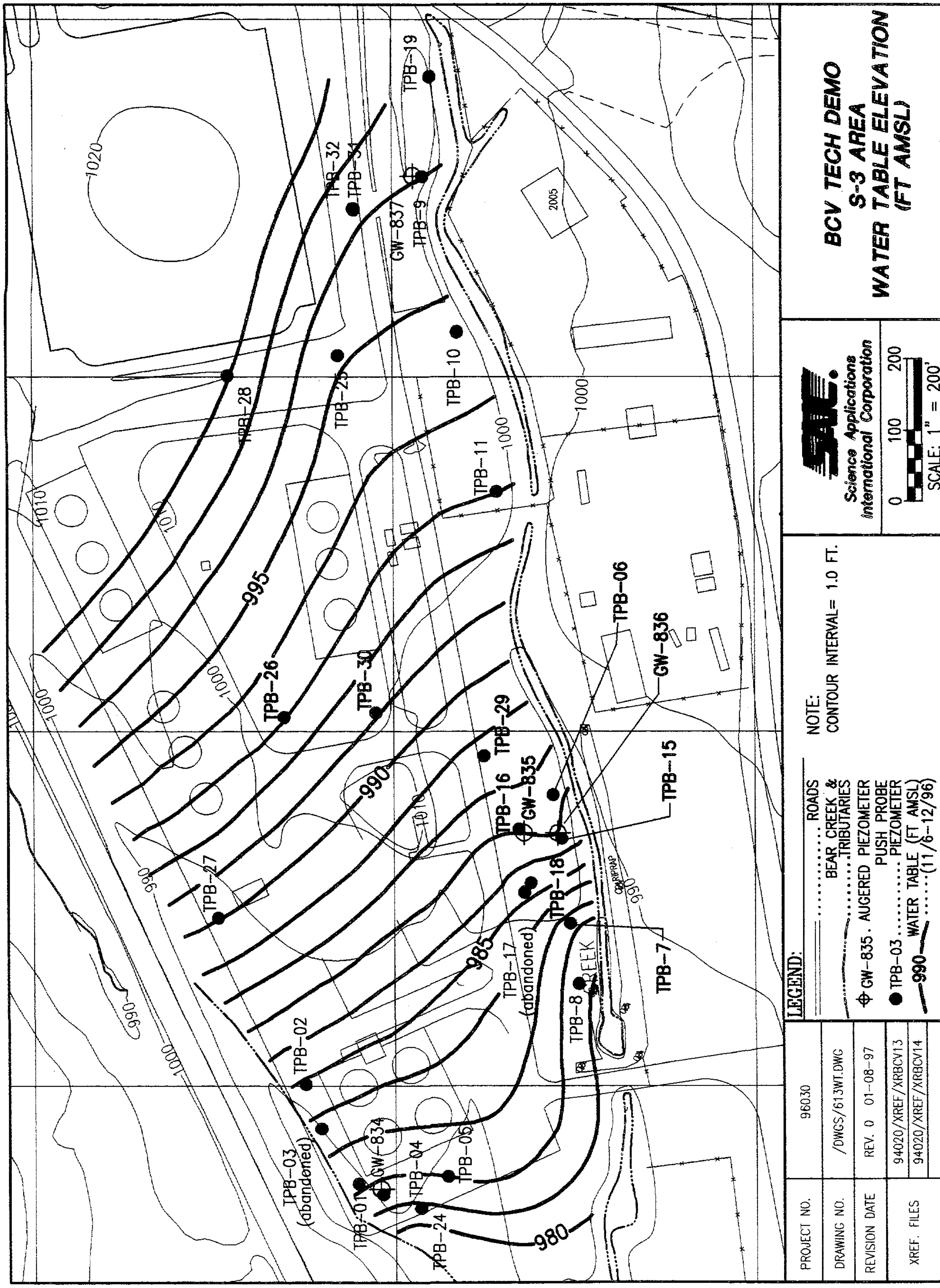


Fig. B.1. Water table elevation in S-3 Area - November 6 through 12, 1996.

of the water table prior to the test is shown in Fig. B.1. Depths to water in the piezometers are a composite of water levels measured from November 6 through 12, 1996.

Results. The water level responses during the aquifer pumping test are shown in Fig. B.2. Little response to the pumping of GW-835 was noted in the observation piezometers. Much of the fluctuation in water levels could most likely be attributed to normal daily variation in the water table. Slight drawdown, though, was observed in TPB-18, but as the test progressed the piezometer appeared to recharge. Water levels in piezometers GW-836 and TPB-07, -26, -29, and -30 rose in elevation as the test progressed.

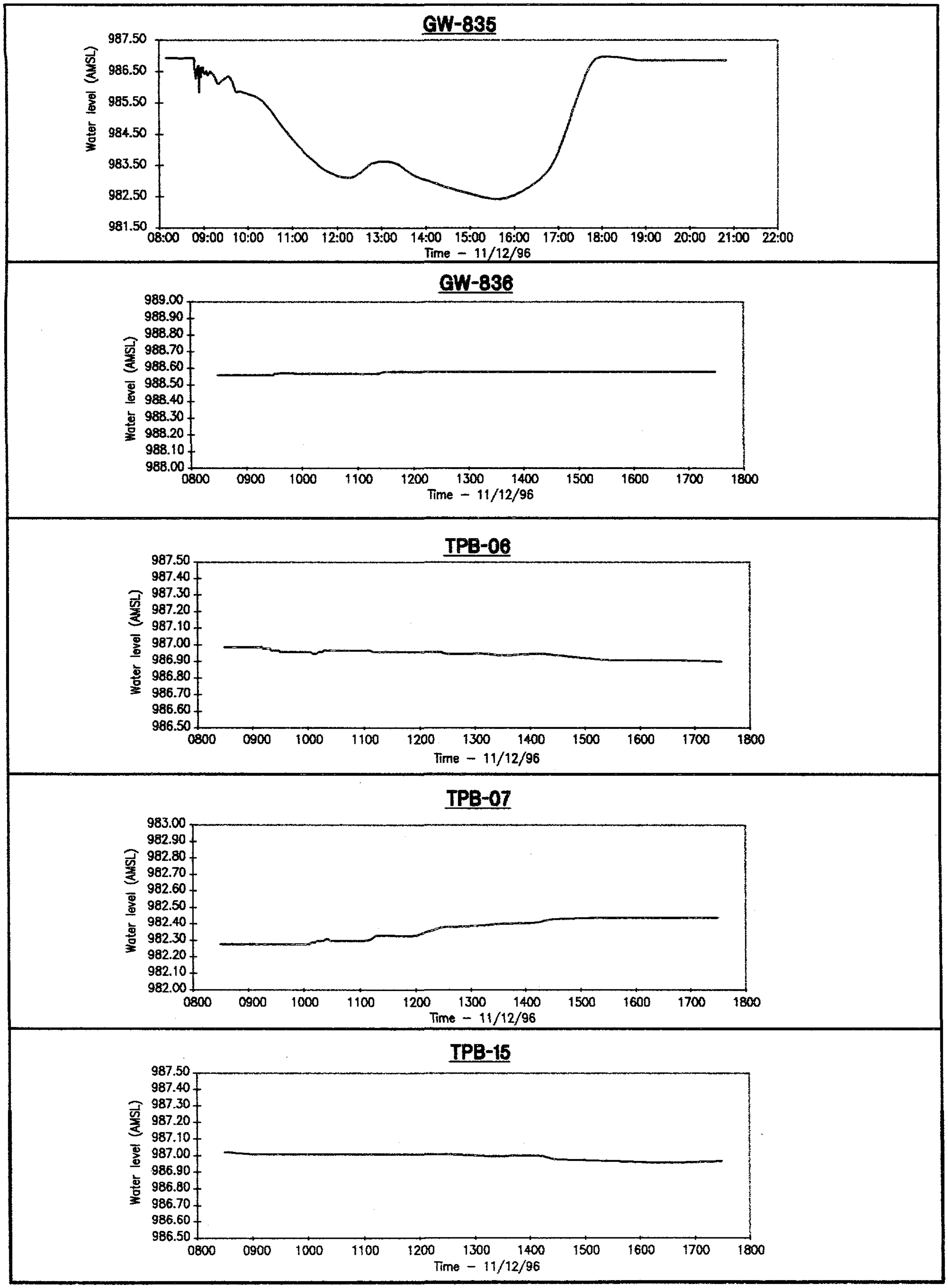
Based on the lack of response in the observation piezometers (especially in TPB-16, ~ 8 ft from GW-835), pumping rate was increased in an attempt to observe a constant rate of drawdown in the pumped piezometer. A rate ~6 L/min was established and maintained over the greater part of the test period. This rate appeared to be the maximum possible using the installed purge pump. The water level in the pumped well (GW-835) stabilized and remained relatively constant at this flow rate.

At 1725, the pump began to cycle erratically. The test was terminated at this time based on continued lack of response in the observation piezometers. Within 5 min of turning the pump off in GW-835, water level returned to within 0.07 ft of the pre-test level. Total drawdown in GW-835 during the test was ~4 ft from pre-test water level.

Groundwater grab samples were collected at the beginning, middle, and near end of the test period. These samples were analyzed for radiochemistry (gross alpha/beta and fluorimetric uranium), nitrate (as nitrogen), and TDS by the Y-12 ASO. Analytical results are presented in Table B.2.

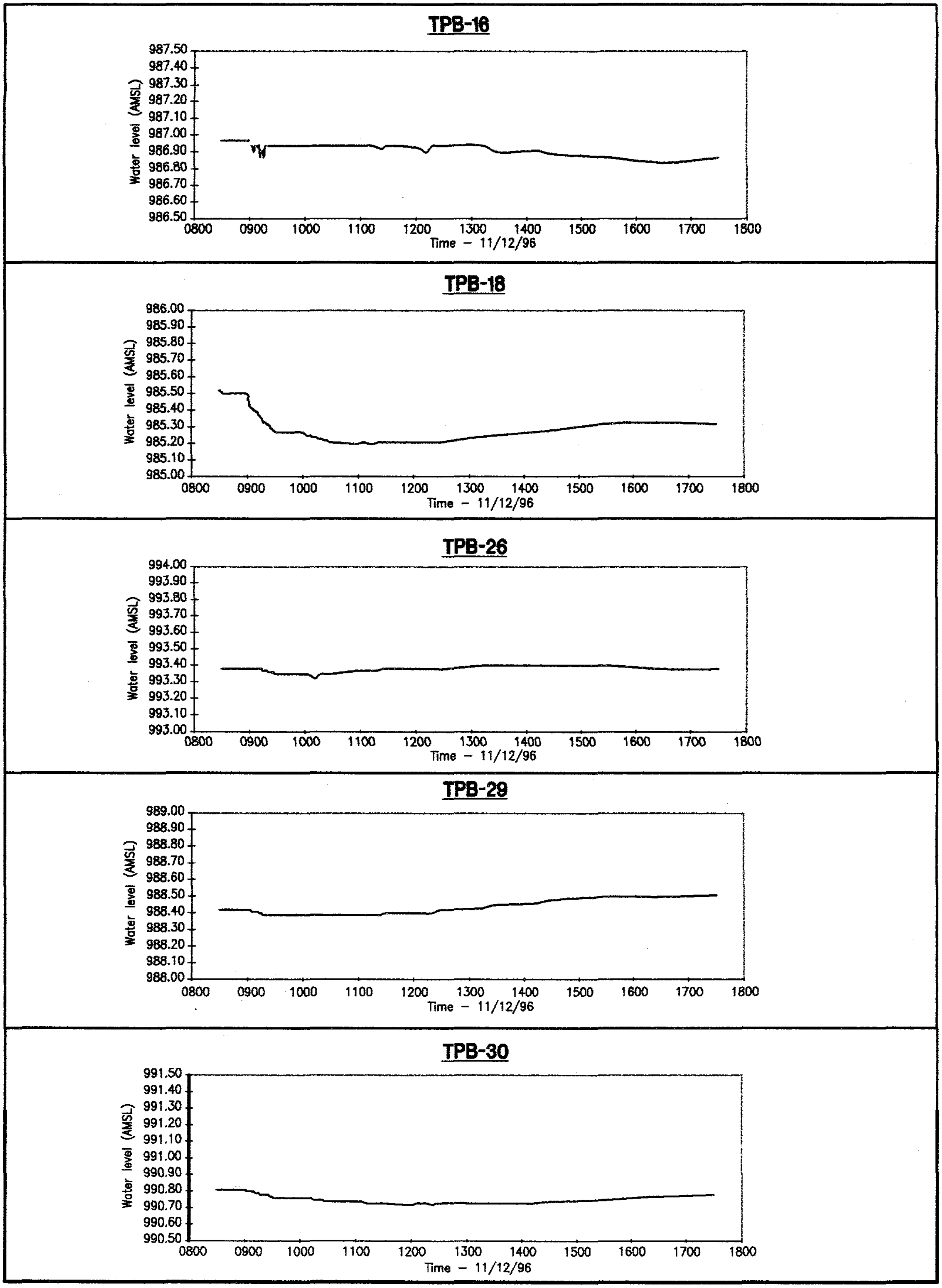
Table B.2. Aquifer test period groundwater analytical results from GW-835

Sample no. Collection date Collection time	BPA2D1 11/12/96 0932	BPA2D2 11/12/96 1247	BPA2D3 11/12/96 1430
	Analysis		
Alpha activity, pC/L	550	490	500
Beta activity, pC/L	260	260	230
Uranium (fluorimetric), ppm	1.3	1.2	1.2
Nitrite as Nitrogen, mg/L	25	24	24
Total dissolved solids, mg/L	690	670	680



SAIC CAD FILE: 96030\DWGS\610PUMP.DWG

Fig. B.2. Aquifer pumping test water levels in pumped piezometer (GW-835) and observation piezometers (ft-AMSL).



SAIC CAD FILE: 96030\DWGS\610PUMP2.DWG

Fig. B.2 (continued)

APPENDIX C
SURVEY COORDINATES

Table C.1. Survey coordinates of sample locations Y-12 Plant grid

Location ID	East coordinate	North coordinate	Surface elevation (ft-AMSL)	TOC elevation (ft-AMSL)
GW-834	50855.00	30020.30	991.93	995.04
GW-835	51358.36	29822.02	997.94	1000.91
GW-836	51356.24	29774.56	997.97	1001.00
GW-837	52281.57	29969.06	1005.22	1007.96
TPB-01	50862.26	30050.68	990.33	994.12
TPB-02	51002.32	30123.76	991.72	995.00
TPB-04	50846.69	30017.36	990.30	992.35
TPB-05	50872.25	29928.39	991.20	994.33
TPB-06	51410.93	29781.15	998.17	1000.28
TPB-7	51229.86	29757.29	996.63	999.48
TPB-8	51144.29	29745.83	988.87	991.64
TPB-9	52281.32	29958.44	1004.51	1006.78
TPB-10	52062.66	29911.55	1005.04	1007.16
TPB-11	51838.90	29858.65	1003.08	1005.53
TPB-12	49773.83	30063.55	975.63	978.82
TPB-13	49551.56	29970.97	969.94	972.73
TPB-14	49478.25	29912.20	971.70	973.73
TPB-15	51349.84	29768.96	997.91	1000.27
TPB-16	51363.03	29828.61	998.21	999.44
TPB-18	51286.82	29812.18	997.30	999.97
TPB-19	52420.49	29948.10	1001.36	1004.01
TPB-20	49702.40	30009.87	975.75	978.33
TPB-21	49752.14	29940.63	980.97	983.44
TPB-22	49791.72	29873.18	980.13	982.51
TPB-23	49471.15	29914.63	972.76	975.00
TPB-24	50827.71	29965.39	991.53	994.34
TPB-25	52029.77	30074.96	1007.68	1009.03
TPB-26	51520.13	30151.23	1000.36	1003.21
TPB-27	51237.66	30244.31	998.72	1001.49
TPB-24	50827.71	29965.39	991.53	994.34

Table C.1 (continued)

Location ID	East coordinate	North coordinate	Surface elevation (ft-AMSL)	TOC elevation (ft-AMSL)
TPB-29	51465.49	29876.85	999.88	1003.11
TPB-30	51526.39	30024.42	1000.06	1003.72
TPB-31	52234.25	30052.04	1007.42	1011.00
TPB-32	52236.31	30053.34	1007.29	1010.35
BC-135	52261.33	29923.70	996.53	NA
BC-200	52240.08	29933.36	996.45	NA
BC-300	52162.31	29907.52	995.34	NA
BC-400	52071.93	29875.86	996.47	NA
BC-500	51968.83	29838.67	995.75	NA
BC-600	51867.33	29824.86	996.18	NA
BC-700	51730.22	29835.68	993.34	NA
BC-800	51664.16	29851.77	991.97	NA
BC-900	51568.14	29805.42	989.50	NA
BC-1000	51486.31	29769.34	988.55	NA
BC-1030	51413.51	29756.01	986.95	NA
BC-1100	51395.34	29753.24	986.50	NA
BC-1200	51278.20	29717.51	982.42	NA
BC-1300	51175.68	29704.18	981.37	NA
BC-1400	51080.55	29706.77	978.81	NA
NT1-000	50684.39	29892.57	977.70	NA
NT1-075	50735.25	29964.66	977.44	NA
NT1-100	50768.49	29962.8	978.63	NA
NT1-200	50813.92	30054.54	978.90	NA
NT1-300	50912.64	30105.66	980.37	NA
NT1-390	50993.64	30143.47	982.71	NA
NT1-400	51002.03	30159.45	982.65	NA
NT1-500	51086.34	30222.79	985.40	NA
NT1-575	51145.17	30275.04	989.48	NA
NT2-000	49204.42	29474.25	958.46	NA
NT2-100	49310.73	29519.52	959.06	NA
NT2-200	49385.56	29551.56	959.63	NA

Table C.1 (continued)

Location ID	East coordinate	North coordinate	Surface elevation (ft-AMSL)	TOC elevation (ft-AMSL)
NT2-300	49425.94	29632.27	961.61	NA
NT2-400	49412.26	29715.58	962.51	NA
NT2-500	49441.54	29794.90	962.85	NA
NT2-600	49484.70	29859.36	963.31	
NT2-645	49510.40	29896.11	963.98	
NT2-700	49572.13	29881.54	964.97	NA
NT2-800	49607.18	29971.78	965.29	NA
NT2-900	49656.14	30045.32	967.94	NA
NT2-970	49717.68	30092.01	967.88	NA
NT2-1000	49746.42	30094.82	968.01	NA
NT2-1120	49878.94	30154.55	969.96	NA

DISTRIBUTION

1. L. V. Asplund
2. W. D. Bostick
3. B. Gu
4. C. S. Haase
5. K. T. Klasson
6. L. Liang
7. H. C. Newsom
8. P. T. Owen
9. L. B. Raulston
10. C. M. Smith
11. A. J. Stewart

12–14. J. H. Vanderlan

15. D. B. Watson
16. File—EMEF DMC—RC
17. R. Adkisson, Entech, 560 Oak Ridge Turnpike, Suite 2, Oak Ridge, Tennessee 37830
18. W. Goldberg, MSE Technology Applications, Inc., P.O. Box 4078, Butte, Montana 59702
19. M. Leavitt, Science Applications International Corporation, 800 Oak Ridge Turnpike, P.O. Box 2502, Oak Ridge, Tennessee 37831
20. D. Moss, Science Applications International Corporation, 800 Oak Ridge Turnpike, P.O. Box 2502, Oak Ridge, Tennessee 37831
21. B. Sams, Jacobs Engineering Group Inc., 125 Broadway Ave., Oak Ridge, Tennessee 37830

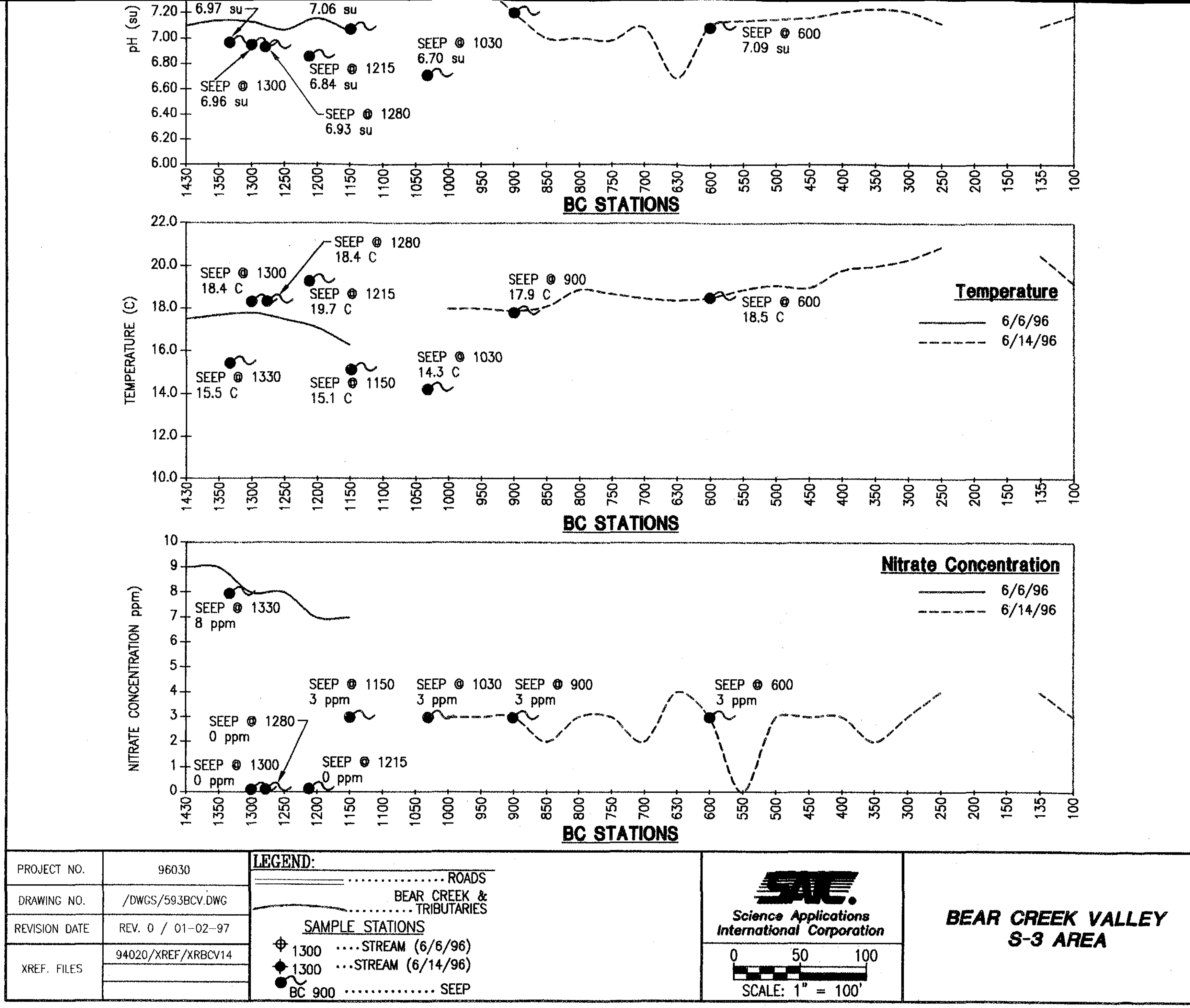


Fig. 2. Bear Creek surface water sample locations and field screening results.