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Project No. 23339

Fiscal Year 2002 Groundwater Monitoring Annual Report, Test Area North, Operable Unit 1-07B

August 2003

Idaho National Engineering and Environmental Laboratory
Bechtel BWXT Idaho, LLC

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Idaho National Engineering and Environmental Laboratory
Idaho Completion Project
Idaho Falls, Idaho 83415

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Fiscal Year 2002
Groundwater Monitoring Annual Report, Test Area North, Operable Unit 1-07B

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ABSTRACT

This report presents organic, radiological, and water level data collected in support of groundwater monitoring requirements at Test Area North, Operable Unit 1-07B. During Fiscal Year 2002 (FY-02), groundwater monitoring followed the routine sampling plan where a larger number of wells were sampled in comparison to the FY-00's statistical sampling. This is the last annual report in which the "routine" and "statistical" sampling program labels will be used. Beginning in FY-03, annual groundwater monitoring sampling will follow a performance/compliance monitoring strategy as introduced herein and described in the Monitored Natural Attenuation Remedial Action Work Plan for Test Area North Final Groundwater Remediation, Operable Unit 1-07B. This year's sampling approach was conducted for the purpose of monitoring and evaluating overall plume dynamics and the effectiveness of remedial actions. This document describes groundwater sampling, well maintenance, groundwater level measurement activities, evaluates activity results, and presents a summary.

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ACRONYMS

amsl	above mean sea level
ANP	aircraft nuclear propulsion
bgs	below ground surface
bls	below land surface
COC	contaminant of concern
DAR	Document Action Request
DCE	dichloroethene
DOE-ID	U.S. Department of Energy Idaho Operations Office
EPA	U.S. Environmental Protection Agency
FLUTe™	Flexible Liner Underground Technology
FY	fiscal year
IDEQ	Idaho Department of Environmental Quality
INEEL	Idaho National Engineering and Environmental Laboratory
ISB	in situ bioremediation
MCL	maximum contaminant level
MDA	minimum detectable activity
MNA	monitored natural attenuation
NLCI	no-longer-contained-in
NPTF	New Pump and Treat Facility
OU	operable unit
PCE	perchloroethene (tetrachloroethene)
PE	performance evaluation
QA	quality assurance
QC	quality control
RAWP	Remedial Action Work Plan

ROD	Record of Decision
RPD	relative percent difference
RSD	relative standard deviation
SAM	Sample & Analysis Management
SDG	sample delivery group
TAN	Test Area North
TCE	trichloroethene
TSF	Technical Support Facility
VOC	volatile organic compound
WAG	waste area group

Fiscal Year 2002 Groundwater Monitoring Annual Report, Test Area North, Operable Unit 1-07B

1. INTRODUCTION

This annual groundwater monitoring report is being written to present the sampling results and water level measurements conducted under the Phase C Groundwater Monitoring Plan (INEEL 2002a) for performance monitoring strategy of the trichloroethene (TCE) plume at Test Area North (TAN), Operable Unit (OU) 1-07B. Operable Unit 1-07B includes the Technical Support Facility (TSF) -05 Injection Well (which is the source of the TCE contamination) and the surrounding groundwater contamination (TSF-23). The data collected and presented in this report has assisted in the development of the Monitored Natural Attenuation (MNA) Remedial Action Work Plan (RAWP) (DOE/ID 2003a) for implementation of MNA remediation activities. The RAWP is intended to facilitate the collection of analytical and water level data for evaluation of trends resulting from restoration activities and natural processes. The data that was collected during MNA groundwater monitoring activities is conducted in accordance with the *Remedial Design/Remedial Action Scope of Work Test Area North Final Groundwater Remediation Operable Unit 1-07B* (DOE-ID 2002a).

The Phase C Groundwater Monitoring Plan (INEEL 2002a) specified the wells to be sampled and the parameters for analysis based on the data requirements identified in the Record of Decision (ROD) Amendment (DOE-ID 2001). This document is the last annual report to be written under this plan. Future annual groundwater monitoring reports will be written under the MNA Operations, Monitoring, and Maintenance (OM&M) Plan for Test Area North, Operable Unit 1-07B (DOE-ID 2003b). The OM&M Plan was prepared as part of the MNA RAWP (DOE-ID 2003a).

Also included within this document is a record of TAN area well maintenance activities. Historically presented in a separate document, the well maintenance information has been included in Section 3 to:

- Provide information on the monitoring well network's integrity
- Assist in the interpretation of data
- Document fiscal year well maintenance activities.

1.1 Regulatory Background

The Idaho National Engineering and Environmental Laboratory (INEEL) is divided into 10 Waste Area Groups (WAGs) to manage environmental operations mandated under the *Federal Facility Agreement and Consent Order* (FFA/CO) (DOE-ID 1991). The TAN Facility is designated as WAG 1 and is divided into two operable units (OU). Operable Unit 1-10 is assigned to TAN Facility soil remediation and Operable Unit 1-07B encompasses the TSF-05 Injection Well and the surrounding groundwater contamination (TSF-23).

In August 1995, the ROD (DOE-ID 1995) was issued for OU 1-07B and amended in 2001 by the ROD Amendment (DOE-ID 2001). The remedial actions chosen in the ROD, and modified in the ROD Amendment are in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 (42 USC § 9601) as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986 (42 USC § 9601). In addition, remedies comply, to the extent possible, with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (55 FR 8665) and are intended to satisfy the requirements of the *Federal Facility Agreement and Consent Order* (FFA/CO).

1.2 Site Background

The TAN complex is located approximately 80 km (50 mi) northwest of Idaho Falls in the northern portion of the INEEL and extends over an area of approximately 30 km^2 (12 mi^2). The Technical Support Facility (TSF) is centrally located within TAN and consists of several experimental and support facilities that are, and were, for conducting research and development activities on reactor performance. The TSF covers an area of approximately 460 × 670 m (1,500 × 2,200 ft) and is surrounded by a security fence. The TSF-05 Injection Well is located in the southwest corner of TSF. Three other major test facilities are located near TSF and are considered part of TAN. These facilities are the Specific Manufacturing Capability (SMC)/Containment Test Facility (CTF) (formerly the Loss-of-Fluid Test [LOFT] Facility), the Initial Engine Test (IET) Facility, and the Water Reactor Research Test Facility (WRRTF).

Operations at TAN began in 1953 to support the U.S. Air Force aircraft nuclear propulsion (ANP) project and later supported testing activities that simulated accidents involving the loss of coolant from nuclear reactors. Liquid wastes generated from these activities were disposed of into the fractured basalt of the Snake River Plain Aquifer using the TSF-05 Injection Well from 1953 to 1972. These wastes included organic, inorganic, and low-level radioactive wastewaters added to industrial and sanitary wastewater.

Contaminant releases to TAN groundwater were first identified in 1987 when low levels of the organic compounds TCE and tetrachloroethene (PCE) were detected in the production wells that supply drinking water to TSF. Subsequent sampling of TAN aquifer monitoring wells confirmed the presence of organic compounds TCE, PCE, and cis and trans-1,2-dichlorothene (DCE), and the radionuclides tritium (^{3}H), strontium-90 (^{90}Sr), cesium-137 (Cs-137), and uranium-234 (U-234) as contaminants above risk-based concentrations (DOE-ID 1995).

1.3 Environmental Subsurface Setting

The environmental subsurface setting is summarized here; a complete description is given in DOE-ID 1995, DOE-ID 1998, and EGG 1994 plus a discussion of site conceptual models is given in Martian 1999 and Martian 2002. The subsurface geology of TAN is characterized by basalt flows with sedimentary interbeds, overlain by fine-grained sediments. The basalt has been described as highly variable, from dense to highly vesicular, and from massive to highly fractured. Individual flow units have a median thickness of approximately 4.5 m (15 ft). The sedimentary interbeds at TAN have a median thickness of approximately 1.2 m (4 ft) and are thinner than interbeds found elsewhere on the INEEL.

Numerous interbeds have been identified beneath TAN, two of which (referred to as the PQ and QR interbeds), can be consistently correlated throughout the area. Both the PQ and QR interbeds consist of clay or silt. The PQ interbed, ranging from 1 to 4 m (1 to 13 ft) thick, has been encountered in only approximately 50% of the wells drilled deep enough to show the interbed and appears to be laterally discontinuous. The QR interbed has been found to be laterally continuous throughout the TAN region with a range of thickness from 3 to 17 m (10 to 56 ft) and is located from about 130 to 145 m (427 to 478 ft) below ground surface. The QR interbed impedes the vertical movement of water and contaminants in the aquifer and acts as the lower confining layer for the TCE plume. (It appears to isolate the upper 200 ft of the aquifer in the vicinity of the TSF-05 Injection Well from the lower portion of the aquifer.)

The undulating, subhorizontal topography of the basalt flows tends to prevent vertical flow of groundwater as made evident by the estimated horizontal to vertical hydraulic conductivity ratios as high as 500:1 based on aquifer tests at the INEEL (DOE-ID 1998). The characteristics of the basalt aquifer have led to the existence of preferential flow paths. Flow in the aquifer is dominated by the most permeable zones, which exist primarily along the boundaries of the basalt flows.

1.4 Purpose

As per Section 7.3, "Project Reporting," of the Phase C Groundwater Monitoring Plan, this document has been organized to present groundwater monitoring data collected during FY-02, as well as historical data for wells included in the groundwater monitoring plan. The purpose of the FY-02 report is to present, summarize, evaluate, and interpret critical data regarding contaminant concentrations. In addition, TAN well maintenance activities (usually reported independently) have been included in this document to report on the integrity of the monitoring wells network and to provide additional information that may be necessary for analytical data interpretation.

2. ANNUAL GROUNDWATER MONITORING

2.1 Objectives and Completion Status

Annual groundwater sampling for FY-02 followed the routine sampling approach as described in the Phase C Groundwater Monitoring Plan (INEEL 2002a). The plan called for the sampling of 54 wells for organic, radiological, and other parameters. Of these 54 wells, 39 were to be sampled as listed in the Sample and Analysis Plan (SAP) number INEEL/EXT-99-21, plan table revision 13, dated October 14, 2002. Analytical data from the remaining 15 wells was obtained through data sharing from other 1-07B sampling programs at TAN, as diagrammed in Table 2-1. Data from sampled wells has been used to evaluate plume dynamics and effectiveness of the selected remedy (see Section 7). The sampled wells are located within or near the TCE plume, as illustrated in Figure 2-1.

Table 2-1. 1-07B groundwater sampling programs and associated wells.

Phase C SAP Program Wells				
		In Situ Bioremediation SAP Program		
			New Pump and Treat Facility SAP Program Wells	
ANP-8	TAN-21	TAN-10A	TAN-29	TAN-33
GIN-2	TAN-22A	TAN-25		TAN-36
GIN-4	TAN-23A	TAN-26		TAN-43
Mw-2	TAN-24A	TAN-27		TAN-44
TAN-01	TAN-32	TAN-28	5 Total NPTF Wells	
TAN-02	TAN-34	TAN-30A		
TAN-03	TAN-47	TAN-31		
TAN-04	TAN-48	TAN-37		
TAN-05	TAN-50	TAN-D2		
TAN-06	TAN-51	TSF-05		
TAN-07	TAN-52	11 Total ISB Wells		
TAN-08	TAN-54			
TAN-11	TAN-55			
TAN-13A	TAN-56			
TAN-14	TAN-57			
TAN-15	TAN-58			
TAN-16	TAN-D1			
TAN-17	TAN-D3			
TAN-18	USGS-24			
TAN-19				
54 Total MNA Wells				

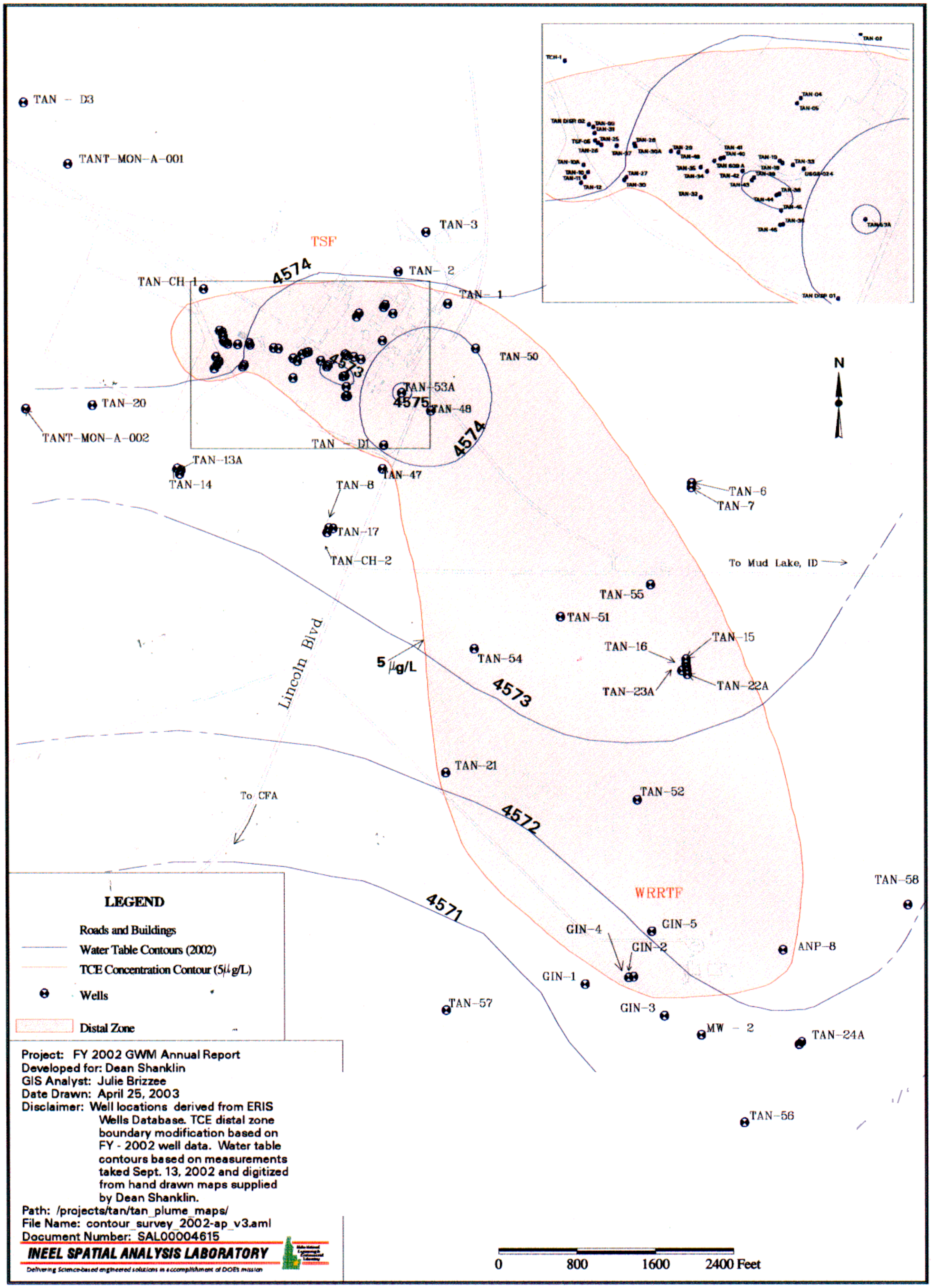

Figure 2-1. Well location and water level contour map for Test Area North.

The planned versus the performed sampling activities are detailed in Appendix F. Of the 54 wells selected for sampling, 52 were actually sampled with the results listed in Section 5. The remaining two wells (TAN-01 and ANP-8) were not accessible for sample collection due to the TAN Facility changes since the last annual sampling round (FY-00). In FY-01, well TAN-01 was isolated from the TAN water distribution system when it was determined that the air sparger unit was not functioning and would, therefore, not adequately remove the volatile organic compounds (VOCs) from the extracted groundwater. With the well's production pump isolated from the storage/distribution system, no containment was available for purge water during the planned sampling event (estimated purge water volume of 15,000 gal from the 150 hp submersible turbine).

The INEEL sought and obtained a No Longer Contained In (NLCI) Determination from the Idaho Department of Environmental Quality (IDEQ) for the ANP-8 production well. After several meetings, the IDEQ stated that they would grant a NLCI determination if the INEEL installed an active treatment to remove the VOCs in the water. Rather than install a treatment system, and because of the desire to reduce the footprint at TAN, the INEEL decided to shut down the production well. Once this was done, a NLCI determination was obtained from the IDEQ for water that was drained from the distribution system. With no containment available for purge water during the planned sampling event, the ANP-8 well (like production well TAN-01) could not be sampled.

2.2 Phase C Description

Through Fiscal Year 2001, annual sampling was performed according to the *Fiscal Year 1999 and 2000 Groundwater Monitoring Plan Test Area North, Operable Unit 1-07B* (INEEL 1999a). Phase C monitoring began in FY 2002 with the intent to follow a three-year repeating strategy that would alternate annually between routine, none, and statistical sampling. This strategy was to provide a full round of monitoring data once every 4 years, and a limited round of statistical sampling every 4 years that is offset by 2 years from the routine sampling rounds. This approach was to provide the opportunity to evaluate axial trend data with a 2-year frequency and plume dynamics with a 4-year frequency. The routine and statistical sampling approaches are described in Section 2.3 of this report.

In addition to developing the two sampling approaches with a long-term monitoring strategy, the Phase C Groundwater Monitoring Plan was intended to:

- Develop and justify sampling and analysis objectives
- Discuss types of sampling to be conducted, including groundwater monitoring, groundwater level measurements, and the types of analyses to be performed
- Determine sample location and frequency
- Describe sampling equipment and sample collection procedures to be used
- Specify a consistent logical process for sample designation throughout the duration of monitoring
- Identify health and safety requirements, waste management, and quality assurance (QA) requirements
- Develop a general schedule for the reporting of monitoring results.

2.3 Historical Background

The first groundwater monitoring report produced for the 1-07B project was the *Fiscal Year 1996 Groundwater Monitoring Annual Report Test Area North Operable Unit 1-07B* (INEEL 1997a). The plan's purpose was to organize and present groundwater monitoring data collected during FY-96, and provide a summary of the historical sampling data for each of the wells covered under the then existing groundwater monitoring plan. All wells were to be sampled on an annual basis for years 1 through 4 of the monitoring program. In addition, quarterly sampling was to be conducted from wells that had only been sampled two or fewer times. This was needed to provide representative concentrations for the contaminants of concern (COCs), namely volatile organic compounds, tritium, and metals. The same approach was followed in 1997. However, by 1998, changes to the original monitoring plan prompted the implementation of a new sampling approach that was followed in the third round of sampling, which eliminated the planned fourth quarter sampling round. The new sampling strategy was referred to as the statistical sampling approach and was defined as "a monitoring program designed to fulfill the requirements for annual plume monitoring that would provide data for the statistical analysis of spatial and temporal trends." This was accomplished through the collection and analysis of triplicate and duplicate sampling rounds as described in *Fiscal Year 1998 Groundwater Monitoring Annual Report Test Area North Operable Unit 1-07B* (INEEL 1999b).

In May 1999, the *Fiscal Year 1999 and 2000 Groundwater Monitoring Plan Test Area North, Operable Unit 1-07B* (INEEL 1999a) was produced that further modified the sampling approach. In addition to maintaining the statistical sampling approach, a routine sampling approach was implemented for FY-99. The routine sampling strategy was defined as "a sampling approach conducted for the purpose of monitoring and evaluating overall plume dynamics. This was accomplished by expanding the parameter list and number of wells to be sampled. Further details can be found in *Fiscal Year 1999 and 2000 Groundwater Monitoring Plan Test Area North Operable Unit 1-07B* (INEEL 1999a).

By FY-00, the 1-07B project developed a sampling strategy that would alternate annually between the routine sampling approach, no annual sampling (referred to as "none"), and the statistical sampling approach. This strategy was to provide a full round of monitoring data once every 4 years and a limited round of statistical sampling every 4 years that was to be offset by 2 years from the routine sampling rounds. This was intended to provide the opportunity to evaluate axial trend data with a 2-year frequency and plume dynamics with a 4-year frequency. The statistical sampling approach (conducted in FY-00) and the routine sampling approach (conducted in FY-02) (FY-01 was changed to a none year due to funding) are described in the Phase C Groundwater Monitoring Plan.

As the routine sampling round for FY-02 was in process, a long-term monitoring strategy was being developed that would eliminate the terms "statistical," "none," and "routine," and would, in the future, refer to MNA sampling as "annual" to be conducted in phases as described in *Monitored Natural Attenuation Remedial Action Work Plan for Test Area North Final Groundwater Remediation, Operable Unit 1-07B* (DOE-ID, 2003a).

3. MONITORING WELL NETWORK

3.1 Monitoring Well Network Description

There are currently 93 wells at and near the TAN Facility that were installed from 1949 through 2000. They have an average depth of 398 ft with the deepest well (piezometer) at 1200 ft (TAN-CH1) and the shallowest at 244 ft (TAN-13A). Wells having open boreholes at and/or below the water table number 31, with 59 wells having either casing and screen or perforated casing. The remaining three wells have a combination of screened and open borehole (TAN-53A, USGS-7, and TAN-48).

The wells at TAN were installed for a variety of original functions with the following breakdown:

- 2 piezometers (TAN-CH1, TAN-CH2)
- 3 surface water drainage wells (TAN-D1, TAN-D2, TAN-D3)
- 3 disposal wells (Initial Engine Test (IET) -Disposal, FET-Disposal, TSF-05)
- 3 CERCLA injection wells (TAN-31, TAN-49, TAN-53A)
- 3 extraction wells (TAN-38, TAN-39, TAN-40)
- 5 production wells (ANP-8, FET-1, FET-2, TAN-1, TAN-2)
- 74 monitoring and observation wells

3.2 FLUTe™ Liners

Vertical flow (both up and down) exists within some wells at TAN. Samples collected from open boreholes or from wells with long screens would more likely represent a mixture of water above and below the sampler inlet and not be representative of the actual location where the sampling device is located. Efforts by the project to ensure that samples collected are representative have evolved through several efforts (INEEL 2002b) with current refined efforts focusing on the installation of Flexible Liner Underground Technology (FLUTe™) Liners in select wells at TAN.

A FLUTe™ Liner is classified as a multilevel sock sampler. It is a rugged, flexible tubular membrane that supports and seals the borehole wall allowing groundwater samples to be collected at many locations from the same borehole. Each liner is custom-built for a specific borehole and is installed by simply extending the inverted liner into the borehole and allowing it to turn inside out as it lines the borehole walls. Air (or water) pressure drives the liner into the hole as it is installed.

The liners are held in place using water. The liner fully plugs the borehole and places individual sample ports at preselected locations. Individual sampling lines, coming from the sample ports, are grouped in sleeves on the inner surface of the liner. Each sampling line draws from a discrete location within the borehole, ideally from a location where horizontal flow through a water-bearing fracture zone has been identified. At each sampling port, a permeable layer is located on the outside of the liner, between the liner and the borehole wall. The fluid sample is drawn from the borehole wall via the permeable layer. The flow geometry of the fluid is very similar to sampling from an interval isolated by a straddle packer. However, unlike a straddle packer, the liner cannot be bypassed to an open hole above or below the sampling interval (Shanklin 2001).

The first FLUTe™ Liner was installed in well TAN-51 in November 2001 and the remaining four liners were installed in wells TAN-48, -52, -54, and -55 in June 2002.

3.3 Well Maintenance (Fiscal Year 2002 Activities)

Test Area North FY-02 well maintenance activities are summarized here, and a complete description is given in *Long-Term Stewardship Fiscal Year 2002 Well Maintenance Report* (INEEL 2003). Several well maintenance activities were conducted on TAN monitoring wells during FY-02 in response to identified well deficiencies and as part of the ongoing effort to maintain the integrity of the 1-07B monitoring well network. Table 3-1 lists the wells and activities conducted during FY-02.

Surface wellhead protection was installed around 48 TAN wells (Table 3-2). Guard posts, constructed of 4-in. diameter schedule 40 steel pipe, were installed around a total of 46 wells. The posts were painted yellow for high visibility. Each well received three guard posts with two permanently placed in concrete and the third removable for well access (see Figure A-1 in Appendix A). Two additional wells (TAN-49 and TAN-53A) had concrete jersey barriers installed around the wellhead as an alternative to guard posts. All wells currently not contained in an enclosure have guard posts or concrete barriers.

Table 3-1. Well maintenance performed during Fiscal Year 2002.

Well Name	Maintenance Performed	Completion Date
GIN-2	Replaced dedicated submersible sampling pump and wiring.	10/01/02
GIN-4	Replaced dedicated submersible sampling pump and wiring.	10/01/02
TAN-03	Redeveloped to remove sediment and debris.	9/23/02
TAN-04	Replaced dedicated submersible sampling pump. Lowered pump placement by 5 ft.	9/10/02
TAN-08	Redeveloped to remove sediment and debris.	9/20/02
TAN-11	Redeveloped to remove sediment and debris.	9/25/02
TAN-13A	Redeveloped to remove sediment and debris.	9/16/02
TAN-18	Replaced dedicated submersible sampling pump. Installed stainless steel riser pipes.	9/10/02
TAN-33	Installed variable speed electric submersible pump set on Teflon-lined polyethylene discharge tubing. Pump inlet set at 290 ft bls.	2/25/02
TAN-36	Installed variable speed electric submersible pump set on Teflon-lined polyethylene discharge tubing. Pump inlet set at 297 ft bls.	2/25/02
TAN-38	Replaced carbon steel riser pipe, below the water table, with stainless steel. Installed a &electric flange between the remaining carbon steel and new stainless steel.	9/27/02
TAN-39	Replaced carbon steel riser pipe, below the water table, with stainless steel. Installed a &electric flange between the remaining carbon steel and new stainless steel.	10/03/02
TAN-40	Replaced carbon steel riser pipe, below the water table, with stainless steel. Installed a &electric flange between the remaining carbon steel and new stainless steel.	9/26/02
TAN-43	Installed variable speed electric submersible pump set on Teflon-lined polyethylene discharge tubing. Pump inlet set at 300 ft bls.	2/25/02
TAN-44	Installed variable speed electric submersible pump set on Teflon-lined polyethylene discharge tubing. Pump inlet set at 300 ft bls.	2/25/02
TAN-52	Extended the outer protective casing to accommodate FLUTe™ liner installation.	6/01/02
TAN-56	Removed rock obstruction at 380 ft below land surface (bls). Redeveloped the well.	8/09/02
TAN-58	Removed the bridge at 300 ft bls. Redeveloped the well.	8/09/02

Table 3-2. Test Area North wells receiving surface wellhead protection during Fiscal Year 2002.

ANP-5”	OWSLEY-2”	TAN-36	TAN-52
ANP-6”	P&W-1[a]	TAN-37	TAN-53A[b]
ANP-7”	P&W-2[a]	TAN-42	TAN-54
ANP-9”	P&W-3[a]	TAN-43	TAN-55
ANP-10”	PSTF”	TAN-44	TAN-56
FET Disposal	TANT-MON-A-001	TAN-45	TAN-57
GIN-1	TANT-MON-A-002	TAN-46	TAN-58
GIN-2	TAN-14	TAN-47	TAN-D2
GIN-3	TAN-15	TAN-48	USGS-07”
GIN-4	TAN-32	TAN-49[b]	USGS-24”
GIN-5	TAN-33	TAN-50	USGS-25”
NO NAME”	TAN-34	TAN-51	USGS-26”

a. Administratively controlled by the U.S. Geological Survey. Guard posts Installed with USGS permission.
b. Well with removable concrete barrier as an alternative to guard posts.

4. ANNUAL WATER LEVEL MEASUREMENTS

4.1 Background and History

The annual water level measurements were collected on September 13, 2002, from monitoring wells in and surrounding TAN to track historical trends and monitor the hydraulic gradient. All data were corrected for barometric effects and referenced to a common datum. As per the recommendation of the United States Geological Survey, corrections for borehole deviations were not conducted since calculated threshold correction factors were significantly less then 0.3 ft (INEEL 2002c). A table listing the water level elevations for the various wells, and the procedure used to correct for barometric pressure effects, are provided in Appendix B.

Water level measurement frequency has been reduced from quarterly to annually beginning in FY 1999. This frequency change was based on the rate of groundwater travel (estimated to be 0.5 ft/day at TAN), the mobility and persistence of the constituents of concern, and the interests and goals of the monitoring program, all of which were considered to justify the frequency change.

Seasonal fluctuations in groundwater elevations do occur in the TAN area and average 1.2 m (4 ft) (INEEL 2001) with elevation highs typically occurring during May and lows in October. Excluding anthropologic influences, major changes in groundwater elevations (observed over months) are attributed to aquifer recharge fluctuations while minor changes (observed over hours or days) are due to barometric pressure fluctuations. Groundwater flow direction is not known to change, regionally, at TAN during the year. A snapshot of TAN area water levels, taken at any time of the year, can satisfy project needs provided the measurement event be conducted during a short time frame (within 4 hours) to minimize barometric pressure fluctuations.

On the day that water level measurements were taken (September 9, 2002), production well TAN-01 was locked-out-tagged-out and production well TAN-02 was in operation. The New Pump and Treat Facility (NPTF) was operating, extracting groundwater from TAN-38 at 454 L/m (120 gpm) and TAN-39 at 432 L/m (114 gpm), and injecting the combined 886 L/m (234 gpm) into TAN-53A. A reported 18,927 L (5,000 gal) of Groundwater Treatment Facility (GWTF) rinse water containing 1% by volume sodium lactate was injected into TAN-31 on September 11, 2002, at a rate of 40 gpm, which would have caused no effect on water level measurement in the surrounding area on September 13 (confirmed by transducer data showing that water levels at and near TAN-31 returned to ambient levels within hours of the end of the injection). The most significant recharge feature, with respect to the groundwater contamination at TAN, is the TSF-07 Disposal Pond located west of Well TSF-05. This pond receives about 107,279 L (28,340 gal) per day of wastewater (INEEL 2002d). It is believed to be a source of aquifer recharge that locally shifts the hydraulic gradient to the east, as observed in Figure 2-1 (DOE/ID 1998).

4.2 Fiscal Year 2002 Water Level Data

Figure 4-1 illustrates the regional water table map based on the FY-02 adjusted data (listed in Appendix B). Consistent with past years' water table maps, Figure 4-1 was created from an American Standard Code for Information Interchange (ASCII) text file containing well coordinates and calculated water level elevations through Surfer@for Windows, Version 6 computer software. Two notable changes observed since the last published annual report in FY-00 are (1) the area to the north and west of the TAN facility exhibits a more shallow gradient above well TAN-D3, and (2) the influence of the New Pump and Treat Facility (NPTF) on the water table southeast of well TAN-D3. Neither change alters the direction of regional groundwater flow as discussed in Section 7.4.

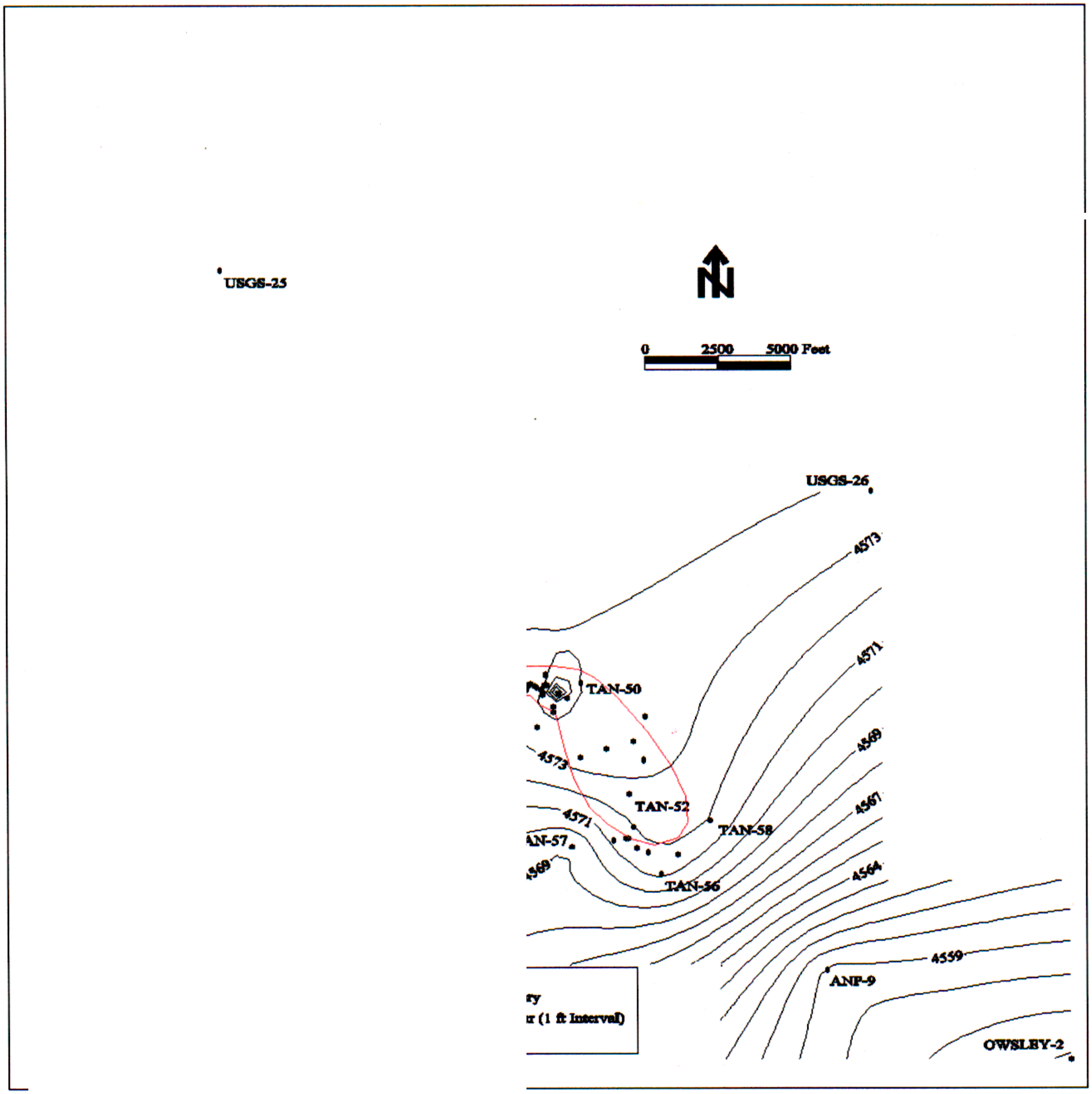

Figure 4-1. Regional scale water table map using corrected annual water level survey data dated September 13,2002 (contours expressed in feet above mean sea level).

Figure 4-2 is an orthographic projection of the water table surface at the TAN plume area. The surface plot is constructed of constant northing and easting lines with 1-ft contour interval water levels. The projection is rotated 25 degrees counterclockwise, creating a view from southwest to northeast and having a tilt of 30 degrees from planar view. This figure illustrates the mounding at well TAN-534 the distal zone outline, and the subregional down-gradient location of well TAN-57 from the southeast comer of the distal zone. This observation at well TAN-57 is compatible with regional groundwater flow and supports the position of local heterogeneity consistent with the vertical profile discussion in Section 7.

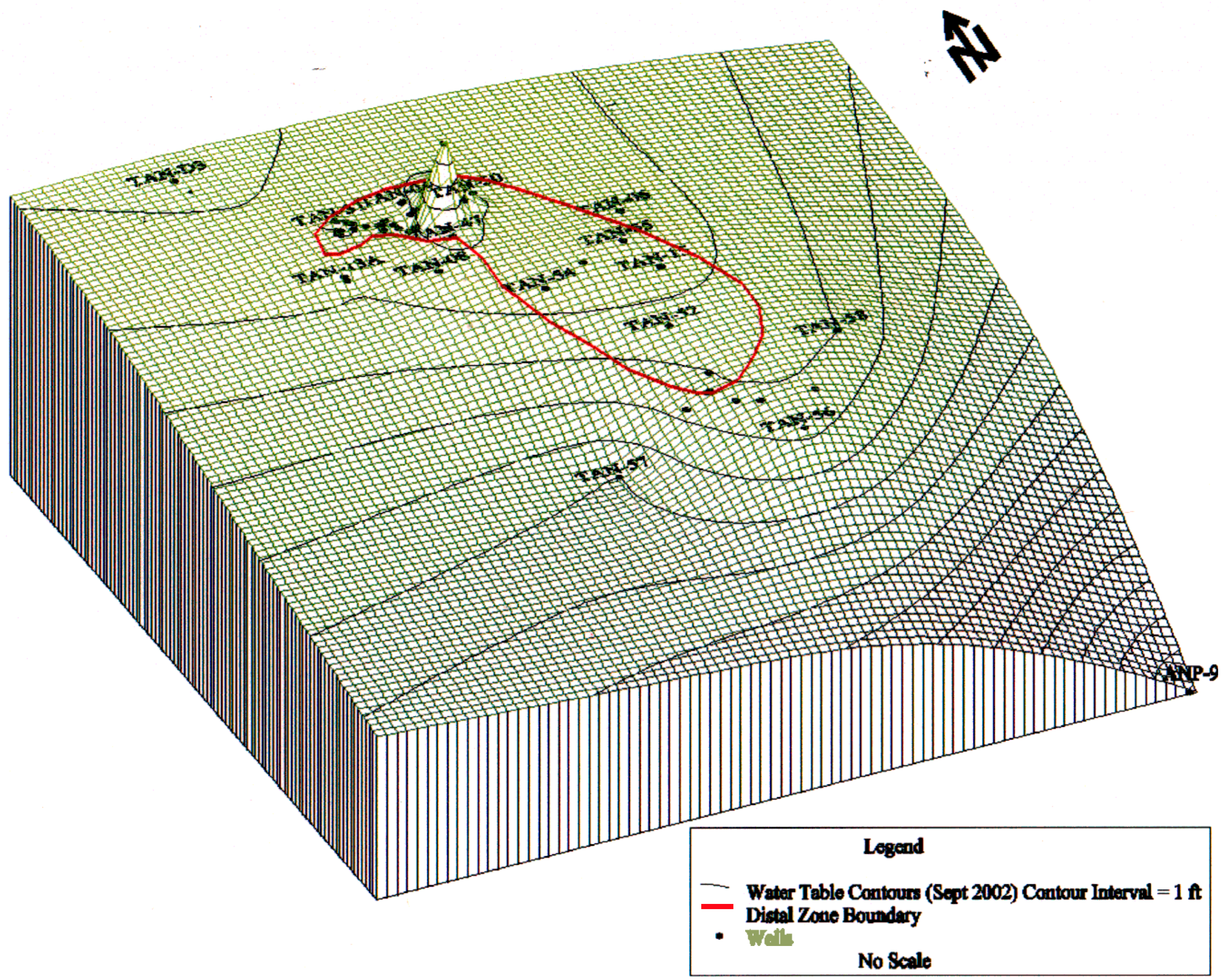

Figure 4-2. Orthographic project of the Test Area Noah area water table surface showing the mounding at well TAN-53A, the distal zone boundary, and downgradient slope from the distal zone to well TAN-57.

Water level measurements were taken from an area measuring approximately 12.9 km (8 mi) north-to-south × 10.5 km (6.5 mi) east-to-west. An elevation of water levels ranged from 1,397 m (4,583.1 ft) in Well USGS-25 (located northeast of the TAN Facility) to 1,388.6 m (4,555.9 ft) in Well WSLEY-2 (located in the area's extreme southeast corner). Using these elevation extremes, the area-wide gradient is 6.2E-4 from northwest to southeast. To the southeast, the gradient between Wells ANP-9 and OWSLEY-2 is calculated to be 4.2E-4 (consistent with the value reported in the FY-01 GWM Report [INEEL 2001]). The area along the axis of the distal zone between Wells TAN-48 and TAN-24A has a calculated hydraulic gradient of 3.5E-4 (in contrast to a reported hydraulic gradient of 2.9E-4 as reported in the FY-01 GWM Report [INEEL 20011).

Using the corrected water level data, regional and subregional groundwater flow directions were graphically determined using triangulation with the results illustrated in Figure 4-3. Within the distal zone, groundwater flow is due south with a localized potential south-southwest flow direction near well TAN-57. This localized potential flow direction was consistent with past triangulation exercises using collected FY-00 and FY-01 annual water level data.

4.3 Determination of Head Difference

An evaluation of vertical head differences was conducted using closely spaced piezometers set at different depths. This condition exists at TAN-CH2 where port 1 (shallow) and port 2 (deep) are installed in a single borehole. Water level measurements taken from the two ports show a decreasing head per increasing depth exists beneath the Q R confining interbed. The water level from port 1, with the inlet screen at 148.8to 151.6 m (487.33 to 497.33 ft) bgs, was calculated to be 1,395.3 m (4,577.68 ft) above mean sea level (amsl), while the water level from port 2 with the inlet screen at 329.2 to 332.2 m (1,080 to 1,090 ft) bgs, was calculated to be 1,393.5 m (4,571.81 ft) amsl for a difference of 1.8 m (5.87 ft). The QR interbed is located from 1,322.2 to 1,324.4 m (4,338 to 4,345 ft) amsl at TAN-CH2.

Closely spaced well pairs, having different completion depths (above the QR interbed) were used to identify relative head differences in the aquifer (Table 4-1). Of the five well pairs evaluated, three pairs showed a potential vertical flow upward while the remaining two showed a potential downward vertical flow.

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a. The QR interval consists primarily of silt and clay having a depth that ranges from about 137 to 143 m (450 to 470 ft) bls, with a thickness of about 2.6 m (12 ft). The QR interval appears to be laterally continuous in the area surrounding TAN and effectively confines contaminants within the aquifer (EGG, 1994).

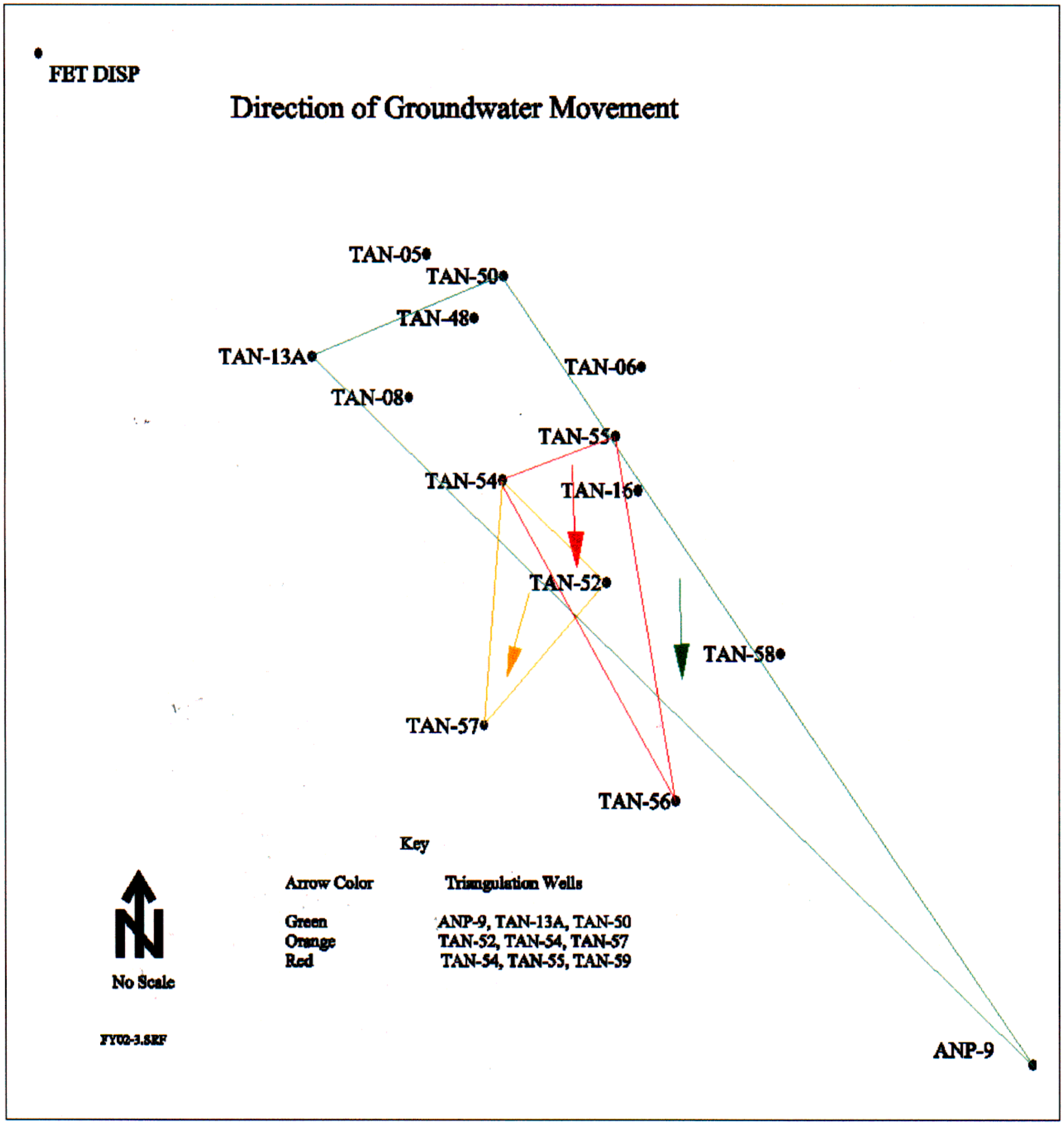

Figure 4-3. Direction of groundwater movement south of the Test Area North.

Table 4-1. Potential vertical flow directions in paired Test Area North wells

Well Name[a]	Screen Top (ft bgs)	Screen Bottom (ft bgs)	Total Depth (ft bgs)	Water Elevation (ft amsl)	Elevation Difference (ft)	PQ Interbed (ft bgs)	Direction of Groundwater Flow
TAN-28	220	260	262	4573.80	0.45	Absent	↑
TAN-30A	300	320	321	4574.25			
TAN-18	496	516	519	4573.27	0.48	224 to 239	1
TAN-19	396	416	448	4573.75			
TAN-13A	216	236	244	4573.74	0.66	182 to 190	1
TAN-14	376	396	404	4573.08			
TAN-15	232	252	255	4573.28	0.04	282 to 288	↑
TAN-16	302	322	323	4573.32		(TAN-16 only)	
TAN-22A	511	531	538	4573.21	0.03	282 to 288	t
TAN-23A	435	455	467	4573.18			

a. See Figure 2-1 for well locations.

5. ANALYTICAL REQUIREMENTS AND RESULTS

During Fiscal Year 2002, samples were collected and analyzed for the analytical parameters listed in Table 5-1 (organic and radionuclide analysis). The analyses were performed in accordance with established EPA methods, with the exception of radionuclide analyses. The radionuclide analyses were performed in accordance with the *Idaho National Engineering Laboratory Sample Management Office Statement of Work for Radionuclide Analysis* (INEL 1995). This document establishes the required detection limits and quality assurance requirements for the analytical methods to be employed. All analytical results underwent a cursory review by a Sample and Analysis Management (SAM) chemist under the guidance of technical procedure TPR-79 or the current guidance document form. The cursory review process checked to make sure that: (1) the analyses requested in the TOS/SOW were performed and reported, (2) authorized analytical methods were used, (3) analysis holding times were met, and (4) the contractually agreed-upon turnaround times were met. In conjunction with the cursory review, SAM data management personnel performed checks to verify the data entered into an INEEL database containing environmental sampling results called Integrated Environmental Data Management System (IEDMS) is the actual value reported on the laboratory data report (transcription error checks). Appendix C includes the historical Operable Unit (OU) 1-07B database updated with FY 2002 analytical data. The data tables are organized so that contaminant and geochemical changes through time, for any well location, can be readily observed.

Table 5-1. Specific analytical requirements and methods for organic and radionuclide analyses.

Analytical Parameter	Analytical Method	Laboratory Performing Analyses
Organic Analyses		
VOCs (PCE, TCE, cis-DCE, trans-DCE, vinyl chloride)	SW-846 Method 8260A (EPA 1986)	Severn Trent, St. Louis
Radionuclide Analyses		
Strontium-90	Guidance from ER Statement of Work (SOW) –163	General Engineering Laboratories, Charleston, SC
Tritium	Radiochemistry-Tritium in water (Revision A)	

5.1 Water Quality Parameters

During each groundwater-sampling event, water quality parameters are measured and recorded to obtain additional information about aquifer conditions. The parameters measured and recorded were pH, temperature, specific conductance, oxidation-reduction potential (ORP), and dissolved oxygen. A Hydrolab MiniSonde **(SN** 38149) was used to collect field parameter readings during the sampling events at wells GIN-2 and GIN-4. A Hydrolab Quanta **(SN** 324809) was used to collect field parameter readings during all other sampling events (including wells equipped with FLUTe™ Liners). Measurements were taken at the wellhead using a flow-through cell. The data were collected as per the requirements stated in the Groundwater Monitoring (GWM) Plan and were used in the field to monitor aquifer conditions and parameter stability during well purging and sampling. The data are listed in Appendix C.

These data have limited use due to several factors such as sensor maintenance and equipment calibration history, aboveground versus in situ measurements, operator use, and surface weather conditions. It was noted that the two highest groundwater temperature readings were taken on days with surface temperature readings of 42" and 36" C (107" and 97" F). Temperature changes will affect dissolved oxygen, and pH readings taken from the field parameter probe using a flow-through cell.

However, in a general sense, the collected data can be used to assess chemical and biological reactions that are taking place within the TCE plume. Field parameter data collected from the FLUTe™ Liners have provided the opportunity to evaluate water quality readings per depth in a single borehole and compare that to TCE concentrations.

5.2 Organic Analyses

The primary VOCs include PCE, TCE, cis- and trans-dichloroethene (DCE), and vinyl chloride. Table 5-2 contains VOC data for each of the wells sampled during FY 2002 monitoring. Contaminant concentrations and locations have been influenced by the GWTF (Ground Water Treatment Facility), which operated from February 1994 until October 1998. They continue to be influenced by the continuing in situ bioremediation **(ISB)** activities, which began in January 1999, and by the operation of the ASTU, which began in November 1998 and was suspended in December 2000.

Table 5-2. Summary of volatile organic compound analytical results for Test Area North groundwater monitoring wells.

Well Name	Depth (ft)	Sample Collection Date	PCE (ug/L)	TCE (ug/L)	cis-DCE (ug/L)	trans-DCE (ug/L)	Vinyl Chloride (ug/L)
GIN-2	368	10/15/02	1.2J	3.2 J	<5	<5	<5
GIN-2 dup	368	10/15/02	1.1J	2.9 J	<5	<5	<5
GIN-4	290	10/15/02	2.2 J	7	<5	<5	<5
Mw-2	236	6/10/02	<5	<5	<5	<5	<5
TAN-02	335	6/25/02	<5	<5	<5	<5	<5
TAN-03	252	6/12/02	<5	<5	<5	<5	<5
TAN-04	235	10/15/02	9	29	0.38 J	<5	<5
TAN-05	297	6/19/02	5.3	19	<5	<5	<5
TAN-06	240	6/10/02	<5	<5	<5	<5	<5
TAN-07	300	6/17/02	<5	<5	<5	<5	<5
TAN-08	231	6/17/02	<5	<5	<5	<5	<5
TAN-10A	233	8/5/02	2 J	7.1	<5	<5	<5
TAN-11	301	7/11/02	16	52	0.56 J	<5	<5
TAN-13A	221	6/17/02	<5	<5	<5	<5	<5
TAN-13A dup	221	6/17/02	<5	<5	<5	<5	<5
TAN-14	378	6/12/02	<5	<5	<5	<5	<5
TAN-15	238	7/11/02	6.5	40	1.1J	<5	<5
TAN-16	306	7/22/02	5.6	43	1.3J	<5	<5
TAN-17	337	6/17/02	<5	<5	<5	<5	<5
TAN-18	500	10/2/02	<5	<5	<5	<5	<5
TAN-19	404	6/19/02	14	81	<5	<5	<5
TAN-21	440	7/25/02	3.6 J	7	<5	<5	<5
TAN-21 dup	440	7/25/02	3.0 J	6.5	<5	<5	<5
TAN-22A	520	7/15/02	<5	<5	<5	<5	<5
TAN-23A	440	7/22/02	13	120	3.9 J	<5	<5
TAN-24A	231	6/10/02	<5	0.72 J	<5	<5	<5
TAN-25	218	8/5/02	<10	8 J	4.7 J	210	4.3 J
TAN-26	389	8/5/02	<10	0.9 J	0.53 J	56	1 J
TAN-26 dup	389	8/5/02	<10	.083 J	0.54 J	55	1.2J
TAN-27	235	8/5/02	4.8 J	35	2.1 J	<10	<5

Table 5-2. (continued).

Well Name	Depth (ft)	Sample Collection Date	PCE (ug/L)	TCE (ug/L)	cis-DCE (ug/L)	trans-DCE (ug/L)	Vinyl Chloride (ug/L)
TAN-28	240	8/5/02	14 J	1300	180	200	<10
TAN-29	255	6/3/02	20 J	780 B	130	37	<5
TAN-30A	310	8/5/02	3.7 J	70	9.7	40	1.4 J
TAN-31	258	8/5/02	<5	2.3 J	1.9J	270	<10
TAN-32	250	7/16/02	11	130	15	14	<5
TAN-33	289	6/5/02	15	140	8	3.1 J	<5
TAN-33 dup	289	6/5/02	14	140	<5	<5	<5
TAN-34	310	6/26/02	10	190	30	51	<5
TAN-36	296	6/5/02	4.0 J	61	4.1 J	1.6J	<5
TAN-36 dup	296	6/5/02	4.0 J	61	4.2 J	1.7J	<5
TAN-37	240	8/5/02	4.2 J	390	55	190	4.9 J
TAN-43	299	6/5/02	10	130	8.9	3.2 J	<5
TAN-44	295	6/5/02	6.6	92	6	2.4 J	<5
TAN-44 dup	295	6/5/02	6	89	<5	<5	<5
TAN-47	270	7/18/02	1.1J	3.3 J	<5	<5	<5
TAN-48	225	8/26/02	14	200	9.4	<5	<5
TAN-48	273	8/26/02	8.5	120	6	<5	<5
TAN-48	317	8/26/02	2.7 J	210 E	11	<5	<5
TAN-48	345	8/26/02	14	160	7.8	<5	<5
TAN-48 dup	345	8/26/02	13	160	7.9	<5	<5
TAN-48	381	8/26/02	5.2	64	3.3 J	<5	<5
TAN-48	412	8/26/02	2.5 J	53	4.1 J	<5	<5
TAN-48	431	8/27/02	3.0 J	55	4.2 J	<5	<5
TAN-48	225	8/27/02	14	200	9.3	<5	<5
TAN-48	273	8/27/02	9.2	130	6.3	<5	<5
TAN-48	381	8/27/02	3.0 J	61	4.5 J	<5	<5
TAN-50	438	7/11/02	4.9 J	26	0.64 J	<5	<5
TAN-51	240	8/19/02	24	180	4.4J	<5	<5
TAN-51	263	8/19/02	17	96	1.9J	<5	<5
TAN-51	283.5	8/20/02	8.9	67	1.4J	<5	<5
TAN-51	322	8/20/02	9.9	52	0.95 J	<5	<5
TAN-51	342	8/20/02	5.3	45	0.98 J	<5	<5
TAN-51 dup	342	8/20/02	5.4	45	0.95 J	<5	<5
TAN-51	367	8/20/02	6.6	57	1.4J	<5	<5
TAN-51	413	8/20/02	24	240	9.1 J	<5	<5
TAN-51	460	8/20/02	20	190	6.8 J	<5	<5
TAN-51	342B	8/20/02	5	43	0.95 J	<5	<5
TAN-52	220	9/3/02	7.2	36	0.72 J	<5	<5
TAN-52	242	9/3/02	9.8	49	0.99 J	<5	<5
TAN-52	266	9/3/02	8.6	50	1.2J	<5	<5
TAN-52	303	9/3/02	8.9	45	0.87 J	<5	<5
TAN-52	361	9/3/02	5.4	38	1 J	<5	<5
TAN-52	373	9/3/02	9	51	1.2J	<5	<5
TAN-52 dup	373	9/3/02	7.4	43	1 J	<5	<5
TAN-52	395	9/4/03	8.6	49	1.2J	<5	<5
TAN-52	438	9/4/02	8.7	41	0.85 J	<5	<5

Table 5-2. (continued).

Well Name	Depth (ft)	Sample Collection Date	PCE (ug/L)	TCE (ug/L)	cis-DCE (ug/L)	trans-DCE (ug/L)	Vinyl Chloride (ug/L)
TAN-52	456	9/4/02	8.3	40	0.78 J	<5	<5
TAN-52	266	9/4/02	9.7	47	0.91 J	<5	<5
TAN-52	373	9/4/02	8.3	50	1.3J	<5	<5
TAN-52	438	9/4/02	8.4	42	0.86 J	<5	<5
TAN-54	234	8/21/02	13	120	3.6 J	<5	<5
TAN-54	318	8/21/02	9.3	92	2.9 J	<5	<5
TAN-54	330.5	8/21/02	15	120	3.4 J	<5	<5
TAN-54	347	8/21/02	17	130	3.4 J	<5	<5
TAN-54	373	8/21/02	12	110	3.2 J	<5	<5
TAN-54 dup	373	8/21/02	13	110	3.1 J	<5	<5
TAN-54	394	8/21/02	17	140	4.0 J	<5	<5
TAN-54	420	8/21/02	17	130	3.7 J	<5	<5
TAN-54	460	8/21/02	20	170	4.7 J	<5	<5
TAN-55	221	8/27/02	9.3	70	2.0 J	0.61 J	<5
TAN-55	251	8/27/02	8.1	58	1.6J	<5	<5
TAN-55	265	8/28/02	8.7	83	3.1 J	<5	<5
TAN-55 dup	265	8/28/02	8.6	81	3.1 J	0.99 J	<5
TAN-55	317	8/28/02	17	150	5.6	1.9J	<5
TAN-55	332	8/28/02	17	150	5.5	1.8J	<5
TAN-55	373.5	8/28/02	16	140	4.7 J	1.6J	<5
TAN-55	404	8/28/02	14	120	4.2 J	1.4J	<5
TAN-55	439	8/28/02	11	88	2.9 J	<5	<5
TAN-55	449	9/4/02	12	77	2.4 J	<5	<5
TAN-55	461	9/4/02	12	76	2.4 J	<5	<5
TAN-56	343	7/9/02	<5	<5	<5	<5	<5
TAN-57	353	7/8/02	0.88 J	1.8J	<5	<5	<5
TAN-58	295	6/20/02	<5	<5	<5	<5	<5
TAN-D1	300	7/23/02	13	120	4.0 J	<5	<5
TAN-D2	241	8/5/02	<10	38	3.2 J	110	1.6J
TAN-D3	257	6/26/02	<5	<5	<5	<5	<5
TSF-05	289	8/6/02	<5	29	67	390	37
USGS-24	260	6/25/02	13	150	7.5	2.8 J	<5

B = Method blank contamination.
dup = Duplicate sample.
E = Estimated result. Result concentration exceeds the calibration range.
J = Estimated value (organics only).

The TCE data are graphically illustrated in Figure 2-1 showing the 5 ug/L isopleth. The shape of the plume has remained relatively unchanged and appears similar to the plume illustration published in the *Explanation of Significant Differences from the Record of Decision for the Technical Support Facility Injection Well (TSF-05) and Surrounding Groundwater Contamination (TSF-23) and Miscellaneous No Action Sites, Final Remedial Action, Operable Unit 1-07B, Waste Area Group 1, Idaho National Engineering and Environmental Laboratory* (INEEL 1997b). However, significant change has occurred with respect to TCE concentrations in the medial zone. As illustrated in Figure 5-1, the 500 ug/L isopleth has been significantly altered from year 1998 through 2000 (INEEL 2001). Figure 5-2 illustrates the current 500 ug/L isopleth for TCE based upon the FY-02 data.

5.3 Radionuclide Analyses

Radionuclide analyses included strontium-90 and tritium (Table 5-3 and Table 5-4). Data tables outlining the historical analytical results through FY 2002 annual monitoring are presented in Appendix C. As expected, the radionuclide concentrations are highest in the hot spot, decreasing with distance from TSF-05. The monitoring data and the implications of radionuclide mobilization are discussed in Section 7 of this report.

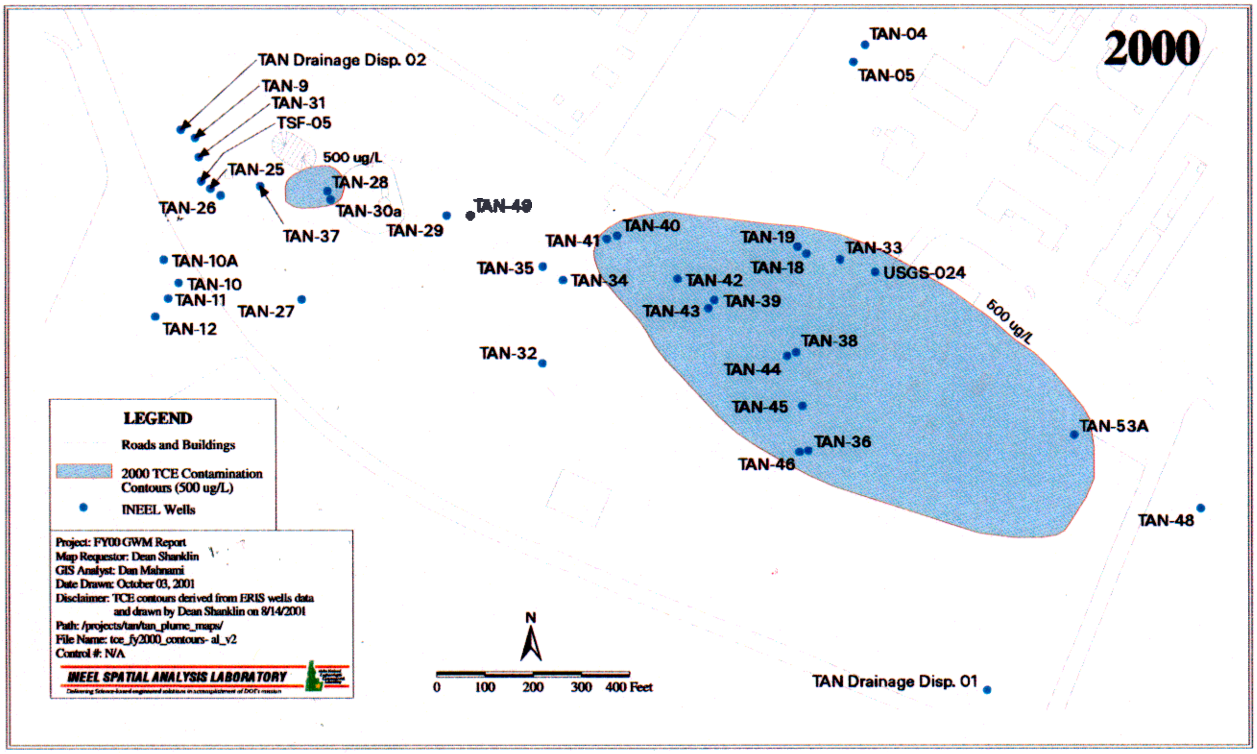

Figure 5-1. Geographical location of the medial zone (as defined in INEEL 1997b) showing trichloroethene concentration contours for 2000 (from INEEL 2001).

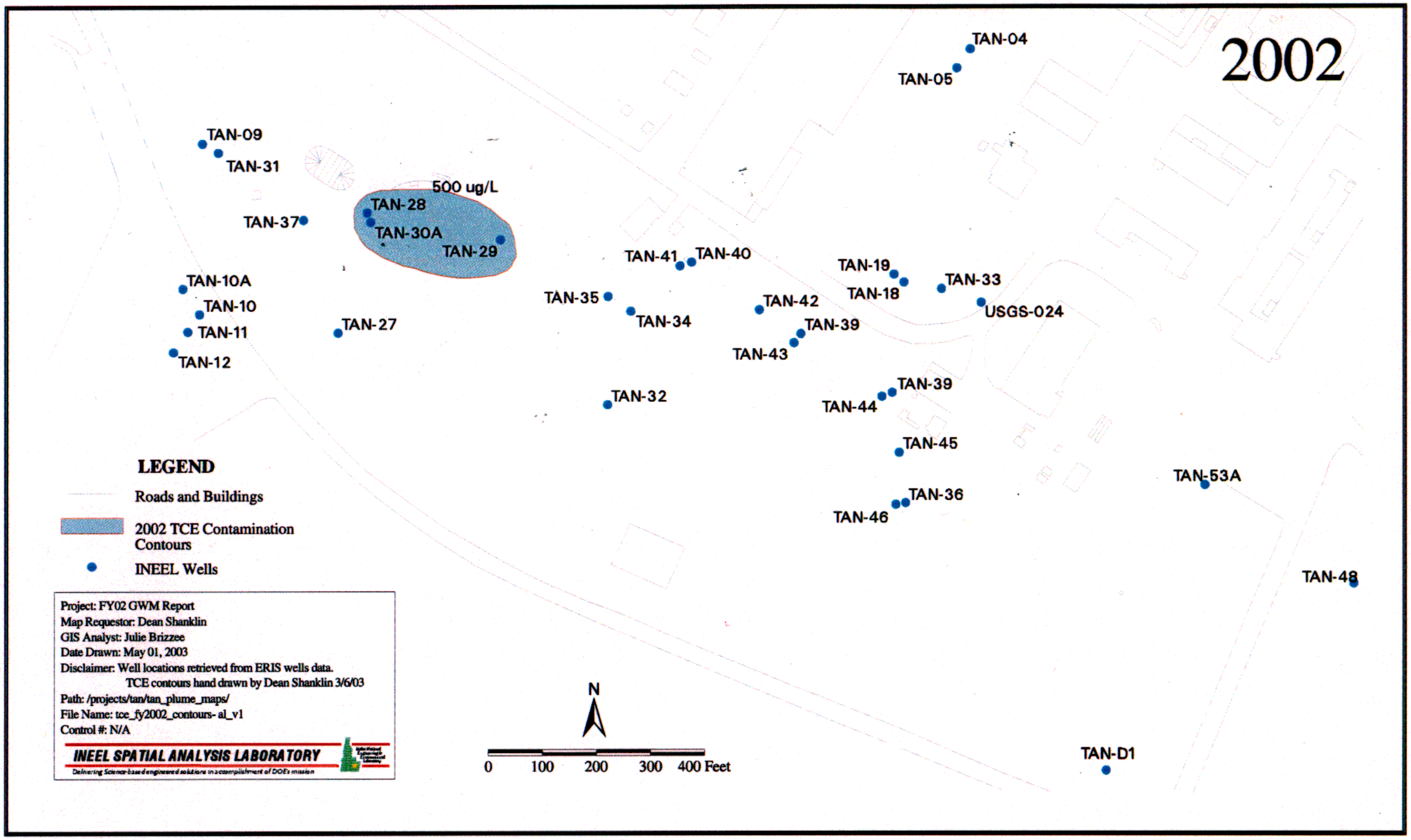

Figure. 5-2. Geographical location of the medial zone (as defined in INEEL 199%) showing trichloroethene concentration contour for year 2002.

Table 5-3. Summarv of strontium-90 analvtical results.

Well Name	Sample Depth (ft)	Sample Collection Date	Result (pCi/L)	+/-	MDA
TAN-02	335	6/25/02	0.0514	0.159	0.715
TAN-03	252	6/12/02	0.407	0.222	0.87
TAN-04	235	10/15/02	0.237	0.106	0.401
TAN-05	297	6/19/02	0.0677	0.167	0.74
TAN-11	301	7/11/02	0.131	0.109	0.469
TAN-13A	221	6/17/02	0.0179	0.135	0.612
TAN-13A dup	221	6/17/02	0.156	0.183	0.791
TAN-14	378	6/12/02	0.056	0.2	0.903
TAN-18	500	10/2/02	-0.0659	0.0868	0.489
TAN-19	404	6/19/02	0.0624	0.167	0.749
TAN-25	218	8/5/02	1320	283	0.774
TAN-26	289	8/5/02	188	27	0.84
TAN-26 dup	389	8/5/02	190	30.2	0.527
TAN-28	240	8/5/02	265	45.1	0.55
TAN-29	255	6/3/02	12.8	1.66	0.405
TAN-31	258	8/5/02	1360	235	0.627
TAN-32	250	7/16/02	1.00	0.21	0.437
TAN-33	289	6/5/02	-0.242	0.0686	0.448
TAN-33 dup	289	6/5/02	-0.0525	0.0837	0.444
TAN-34	310	6/26/02	3.02	0.472	0.734
TAN-36	296	6/5/02	-0.0231	0.0839	0.43
TAN-36 dup	296	6/5/02	-0.029	0.144	0.874
TAN-43	299	6/5/02	-0.0039	0.0877	0.441
TAN-44	295	6/5/02	0.0676	0.104	0.48
TAN-44 dup	295	6/5/02	0.121	0.0935	0.4
TAN-47	270	7/18/02	-0.0235	0.0799	0.424
TAN-48	273	8/26/02	-0.0116	0.0844	0.365
TAN-50	438	7/11/02	0.0498	0.0818	0.382
TAN-D1	300	7/23/02	-0.0113	0.0844	0.428
TAN-D3	257	6/23/02	0.338	0.208	0.842
USGS-24	260	6/25/02	0.336	0.202	0.828

Table 5-4. Summarv of tritium analvtical results.

Location	Depth (ft)	Sample Collection Date	Result (pCi/L)	+/-	MDA
GIN-2	368	10/15/02	47.4	113	382
GIN-2 dup	368	10/15/02	46.5	111	375
GIN-4	290	10/15/02	25.2	115	391
MW-2	236	6/10/02	0.0	78.4	283
TAN-02	335	6/25/02	58.4	86	298
TAN-03	252	6/12/02	27.1	78.2	276
TAN-04	235	10/15/02	426	130	408
TAN-05	297	6/19/02	190	87.3	277
TAN-06	240	6/10/02	27.5	79.4	281
TAN-07	300	6/17/02	110	84.3	282
TAN-08	231	6/17/02	55.2	81.3	282
TAN-10A	233	8/5/02	168	108	356
TAN-11	301	7/11/02	1670	107	273
TAN-13A	221	6/17/02	27.3	78.8	279
TAN-13A dup	221	6/17/02	27.4	79.1	280
TAN-14	378	6/12/02	56.1	85.2	286
TAN-15	238	7/11/02	353	84.7	266
TAN-16	306	7/22/02	206	83.8	272
TAN-17	337	6/17/02	137	84.9	279
TAN-18	500	10/2/02	-52.1	69.1	238
TAN-19	404	6/19/02	930	121	279
TAN-21	440	7/25/02	20.3	80.8	272
TAN-22A	520	7/15/02	11.7	79.6	269
TAN-23A	440	7/22/02	768	93.4	273
TAN-24A	231	6/10/02	163	85.9	277
TAN-25	218	8/5/02	2270	174	344
TAN-26	389	8/5/02	2490	183	353
TAN-26 dup	389	8/5/02	2520	186	357
TAN-27	235	8/5/02	472	119	350
TAN-28	240	8/5/02	5180	245	353
TAN-29	255	6/3/02	2520	169	280
TAN-30A	310	8/5/02	3000	195	350
TAN-31	258	8/5/02	1550	155	348
TAN-32	250	7/16/02	2010	111	270
TAN-33	289	6/5/02	2720	177	285

Table 5-4. (continued).

Location	Depth (ft)	Sample Collection Date	Result (pCi/L)	+/-	MDA
TAN-33 dup	289	6/5/02	2270	160	273
TAN-34	310	6/26/02	2960	183	279
TAN-36	296	6/5/02	2770	182	296
TAN-36 dup	296	6/5/02	2720	176	282
TAN-37	240	8/5/2002	4520	231	352
TAN-43	299	6/5/02	2990	181	280
TAN-44	295	6/5/02	3530	198	288
TAN-44 dup	295	6/5/02	3180	191	290
TAN-47	270	7/18/02	-28.8	79.9	272
TAN-48	225	8/26/02	3310	143	309
TAN-48	273	8/26/02	3310	141	303
TAN-48	317	8/26/02	2730	138	318
TAN-48	345	8/26/02	2780	136	309
TAN-48 dup	345	8/26/02	2470	129	300
TAN-48	381	8/26/02	1330	117	317
TAN-48	412	8/26/02	593	104	316
TAN-48	431	8/27/02	650	103	308
TAN-48	225	8/27/02	3190	143	314
TAN-48	273	8/27/02	3020	141	316
TAN-48	381	8/27/02	1010	107	303
TAN-50	438	7/11/02	317	85.8	272
TAN-51	240	8/19/02	1250	135	294
TAN-51	263	8/19/02	679	116	300
TAN-51	283.5	8/20/02	365	101	297
TAN-51	322	8/20/02	504	107	296
TAN-51	342	8/20/02	251	95.2	295
TAN-51 dup	342	8/20/02	225	94.5	297
TAN-51	367	8/20/02	249	94.7	293
TAN-51	413	8/20/02	1520	146	298
TAN-51	460	8/20/02	1350	140	297
TAN-51	342B	8/20/02	252	95.7	296
TAN-52	220	9/3/02	224	80.7	260
TAN-52	242	9/3/02	285	78.5	249
TAN-52	266	9/3/02	320	76.8	241
TAN-52	303	9/3/02	413	86	267
TAN-52	361	9/3/02	307	85.9	273

Table 5-4. (continued).

Location	Depth (ft)	Sample Collection Date	Result (pCi/L)	+/-	MDA
TAN-52	373	9/3/02	328	88.5	281
TAN-52 dup	373	9/3/02	392	86.4	270
TAN-52	395	9/4/03	355	84.9	267
TAN-52	438	9/4/02	231	86.2	278
TAN-52	456	9/4/02	308	86.1	274
TAN-52	266	9/4/02	473	86.4	265
TAN-52	373	9/4/02	325	88.5	281
TAN-52	438	9/4/02	198	76.6	248
TAN-54	234	8/21/02	631	104	267
TAN-54	318	8/21/02	901	124	298
TAN-54	330.5	8/21/02	710	114	289
TAN-54	347	8/21/02	729	117	297
TAN-54	373	8/21/02	787	119	298
TAN-54 dup	373	8/21/02	840	121	296
TAN-54	394	8/21/02	867	122	296
TAN-54	420	8/21/02	858	121	293
TAN-54	460	8/21/02	758	118	297
TAN-55	221	8/27/02	204	96.1	313
TAN-55	251	8/27/02	353	97.5	309
TAN-55	265	8/28/02	875	87.2	246
TAN-55 dup	265	8/28/02	766	105	309
TAN-55	317	8/28/02	1060	109	308
TAN-55	332	8/28/02	987	111	317
TAN-55	373.5	8/28/02	832	103	299
TAN-55	404	8/28/02	986	103	291
TAN-55	439	8/28/02	816	106	310
TAN-55	449	9/4/02	656	93.3	278
TAN-55	461	9/4/02	695	93.3	276
TAN-56	343	7/9/02	3.4	81.1	274
TAN-57	353	7/8/02	74.7	83.7	279
TAN-58	295	6/20/02	27.4	79.2	280
TAN-D1	300	7/23/02	2360	116	271
TAN-D2	241	8/5/02	337	115	354
TAN-D3	257	6/26/02	27.7	80	283
TSF-05	289	8/6/02	2710	187	348
USGS-24	260	6/25/02	2970	183	278

6. QUALITY ASSURANCE/QUALITY CONTROL SAMPLING

The purpose of collecting and analyzing quality assurance (QA) and quality control (QC) samples is to confirm the achievement of project objectives and data quality objectives (DQOs). The overall objectives associated with the TAN groundwater monitoring are discussed in the Phase C Groundwater Monitoring Plan (INEEL 2002a). The planned data uses, sampling design, types of analyses, required detection limits, precision, accuracy, completeness, and comparability needs are identified in the following sections. The evaluation of DQOs and the extent to which objectives were achieved are also discussed. The quality assurance/quality control discussion in this section is based on the sampling activities conducted under the Phase C Groundwater Monitoring Plan and does not include shared data from other sampling programs as described in Section 2.1 of this report.

6.1 Introduction (Precision and Accuracy)

6.1.1 Overall Precision

Precision is a measure of the reproducibility of measurements under a given set of conditions. In the field, precision is affected by sample collection procedures and by the natural heterogeneity of the matrix. Field precision is the difference between overall precision and laboratory precision. Overall precision (field and laboratory) can be evaluated by the use of duplicate samples collected in the field. Greater precision typically is required for chemicals with very low action levels that are close to background concentrations. Allowable laboratory precision for water samples is defined as having a relative percent difference (WD) less than, or equal to, approximately 20%. Relative percent difference is defined as:

Sample result difference/average * 100%

Table 6-1 summarizes the overall precision for the groundwater monitoring conducted during FY 2002. The W D was calculated only for those samples that were true positive values for both the initial sample and the field duplicate (nondetects and estimated values were not evaluated). As can be seen from the table, no RPDs for any analytes exceeded 20%.

Table 6-1. Overall precision for the groundwater monitoring conducted during FY-02.

Analyte	Well	Depth (ft)	Sample	Duplicate	Units	RPD %
Tetrachloroethene	TAN-48	345	14	13	µg/L	7.4
Trichloroethene	TAN-48	345	160	160	µg/L	0.0
cis-1,2-Dichloroethene	TAN-48	345	7.8	7.8	µg/L	0.0
Tritium	TAN-48	345	2780	2470	pCi/L	11.8
Tetrachloroethene	TAN-51	342	5.3	5.4	µg/L	1.9
Trichloroethene	TAN-51	342	45	45	µg/L	0.0
Tetrachloroethene	TAN-52	373	9	7.4	µg/L	19.5
Trichloroethene	TAN-52	373	51	43	µg/L	19.1
Tritium	TAN-52	373	328	392	pCi/L	17.8
Tetrachloroethene	TAN-54	373	12	13	µg/L	8.0
Trichloroethene	TAN-54	373	110	110	µg/L	0.0
Tritium	TAN-54	373	787	840	pCi/L	6.5
Tetrachloroethene	TAN-55	265	8.7	8.6	µg/L	1.2
Trichloroethene	TAN-55	265	83	81	µg/L	2.4
Tritium	TAN-55	265	875	766	pCi/L	13.3

6.1.2 Overall Accuracy

Accuracy is a measure of bias in a measurement system. Accuracy is affected by methods used for sample preservation, sample handling, and the sample matrix. The effects of the first three can be assessed by the evaluation of the results of field blanks, trip blanks, and equipment rinsates. The presence of a contaminant in the field blank, trip blank, or rinsate reveals that cross-contaminationhas occurred.

Laboratory accuracy is assured through the use of standard methods and by employing the use of calibration standards traceable to the National Institute of Standards and Technology. All instrumentation is calibrated prior to use per the procedures outlined in the analytical methods and as required by the SAM statements of work. Laboratory accuracy is assessed through the use of matrix spikes and laboratory control samples. The number of laboratory quality control (QC) samples is specified in the analytical methods employed and in the SAM statements of work (or task order statements of work). Evaluation criteria for the QC samples are specified in data validation technical procedures (TPRs) for the SAM. For samples analyzed in accordance with Contract Laboratory Program (CLP) protocol, validation is performed in accordance with that protocol.

The analytical accuracy of all the VOC and radiological samples was excellent. All VOC and radiological analyses done on blanks and rinsates were below detectable limits (see data results in Appendix D).

The INEEL Sample and Analysis Management Program assessed the organic and radiological results obtained for performance evaluation (PE) for the samples listed in Table 6-2 and Table 6-3, which also contain sample evaluations. The PE samples for organic analysis were prepared by Environmental Resource Associates (ERA) and submitted to Severn Trent Laboratories, Inc., St. Louis, Missouri, as double blinds along with the project samples. The PE samples for radiological analysis were submitted to General Engineering Laboratories, Inc., (GEL) as double blinds and were included with the regular project samples. The Analytical Laboratories Department (ALD) QC Lab, located at the Idaho Nuclear Technology and Engineering Center (INTEC), prepared the PE samples.

Table 6-2. Performance evaluation samples for organic analysis.

PE Sample ID	Compound	Certified Value (µg/L)	Performance Acceptance Limits (µg/L)	Reported Result” (µg/L)
1WR08401VA	1,2-Dichloroethene (total)	50.2	33.6-62.2	47
	Tetrachloroethene	15.9	10.2-18.9	12
	Trichloroethene	24.2	17.1-29.5	19
	Vinyl chloride	34.6	17.7-52.2	43
1WR08501VA	1,2-Dichloroethene (total)	0.00	Nondetect	<10
	Tetrachloroethene	0.00	Nondetect	<5
	Trichloroethene	0.00	Nondetect	<5
	Vinyl chloride	0.00	Nondetect	<5

a. The reported results for all required target compounds met the acceptance criteria

Table 6-3. Performance evaluation samples for radiological analysis.

PE Sample ID	Radionuclide	Reference Activity (pCi/L)	Lab Result (pCi/L)	Lab Uncertainty (1a) (Std Dev)	Lab Uncertainty (1a) (RSD)	LAB/REF Ratio	Evaluation Flag"
1WRO8401R8	^{3}H	6217	6040	+/-0 161	3%	0.97	A
1WR08401RB	^{90}Sr	4.101	4.00	+/-0.92	23%	0.98	A
1WR08501R8	^{3}H	1522	1940	+/- 137	7%	1.26	W
1WR08501RB	^{90}Sr	16.13	19.5	+/-2.7	14%	1.21	A
1WR08601R8	^{3}H	3192	3070	+/- 130	4%	0.96	A
1WR08601RB	^{90}Sr	8.856	8.09	+/- 1.15	14%	0.91	A

a. Performance Status (Evaluation Flag).
A = Acceptable (acceptance criteria were satisfied).
W = Warning (Lab/Ref Ratio outside acceptance range or mean difference is greater than 3).

6.2 Completeness

Completeness is a measure of the quantity of usable data collected during an investigation. The Phase C Groundwater Monitoring Plan (INEEL 2002a) required an overall completeness goal of 90% for this project.

For FY 2002, a total of 39 wells were to be sampled during the summer sampling activities (June–October 2002) according to the methodology outlined in the Phase C Groundwater Monitoring Plan (INEEL 2002a). Of the 39 wells, only two (ANP-8 and TAN-01) were not sampled. Both of these wells (production wells) were under lock-out-tag-out restrictions and unavailable for sampling. The only other deviation from the plan was the collection of a replacement sample with a duplicate from well TAN-21 in response to the laboratory compromising the original VOC sample. A total of 199 analytical samples were planned; 194 were collected. This yields a completeness of 97.5%.

The Phase C Groundwater Monitoring Plan called for duplicate samples to be taken at a rate of one per 20 and was collected at a rate of one for every 12 samples. Field blanks were scheduled to be collected at a rate of one per 20 and were collected at a rate of one for every nine samples. Rinsates were scheduled to be collected at a rate of one per 20 samples and were collected at a rate of one for every 16 samples.

6.3 Comparability and Representativeness

Comparability is a qualitative characteristic that refers to the confidence with which one data set can be compared to another. As a minimum, comparable data must be obtained using unbiased sample designs. If sampling designs are not unbiased, the reasons for selecting another design should be well documented. Representativeness is a qualitative parameter that expresses the degree to which the sampling and analysis data reflect the characteristics being measured. The representativeness criterion is best satisfied by confirming that sampling locations are selected properly, and that a sufficient number of samples are collected to meet the confidence level required by the intended use of the data.

Data comparability was ensured through the use of standard sample collection techniques with adherence to QA/QC in accordance with the Quality Assurance Project Plan for Waste Area Groups 1, 2, 3, 4, 5, 6, 7, 10, and Inactive Sites (DOE-ID 2002b), the use of field QC samples, and the use of standard analytical methods by the laboratories. The data collected for each well are intended to supplement existing monitoring data in support of the remedial action goals of the project. Therefore, the combined knowledge obtained from all of those sources can be used to assess internal consistency of the data set.

6.4 Sample Delivery Groups

A sample delivery group (SDG) includes samples collected at about the same time (see Appendix E). The samples could be collected from any well, and the SDG can contain trip and field blanks. The actual number of samples in a group ranged from one to 22 and was limited by the number of samples that will physically fit in a sample cooler (used for shipping). For VOC analytes, the number did exceed the typical maximum of 20 samples per SDG. The chain of custody number of the one sample taken from the SDG was used to identify the SDG. Quality assurance was provided for each SDG by including trip and field blanks, which are comprised of deionized water containing preservatives per sample analysis requirements.